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Executive Summary

The 64th issue of Sosyoekonomi Journal presents a rich and diverse collection of 25 research articles covering a wide range of contemporary socioeconomic, technological, environmental, and financial topics. This issue offers readers valuable theoretical and empirical insights into today's most pressing academic and practical challenges.

The first article by Özalp, Şimşir, and Doğan explores the challenges faced by international students in Türkiye, revealing issues such as discrimination and cultural adaptation difficulties. Yardımcı Bozdoğan, in the second article, examines the influence of economic policy uncertainty (EPU) from major trade partners on Türkiye's real effective exchange rate, demonstrating how global dynamics affect national currencies. The third article by Pourabdollah et al. compares financial complexity across Türkiye, Iran, Saudi Arabia, and the UAE, finding that Türkiye holds the highest systemic risk. Aktar, in the fourth article, investigates the relationship between maternal education, economic development, and infant mortality in Türkiye from 1960 to 2010. In the fifth article, Eren analyses mergers and acquisitions' impact on acquirers' stock returns in Türkiye, finding positive abnormal returns before announcement dates but not afterwards.

Akın and Seyfettinoğlu, in the sixth article, focus on the location choices of R&D firms, highlighting the importance of knowledge spillovers. In the seventh article, Kahramani Koç and Öztürk evaluate the financial performance of transportation and storage companies using multi-criteria decision-making techniques. In the eighth article, Keskin et al. assess consumers' perspectives on corporate social responsibility in Türkiye. Gürer and Değirmencioğlu, in the ninth article, study SEKA Postası newspaper's role in industrial and urban cultural development. The tenth article by Kaya et al. examines the Environmental Kuznets Curve in BRICS countries, focusing on the impact of military expenditures and nuclear energy use.

The eleventh article by Büyükipekçi and Duman measures the digital maturity of automotive firms in Konya, noting areas for improvement in smart factories. Öztop, in the twelfth article, investigates the effects of inflation and policy rates on stock indices in the Fragile Five economies. Aydın Ünal, in the thirteenth article, ranks Turkish insurance companies based on sustainability using novel fuzzy methods. Özkan Alakaş, Şahin, and Güler, in the fourteenth article, analyse the mediating roles of online trust and perceived risk between website design and purchase intention. Aygün Alıcı and Kızıltan, in the fifteenth article, explore the relationship between non-precarious employment and unemployment.

The sixteenth article by Fikirli and Şahin shows that social interactions positively influence photovoltaic system adoption in Türkiye. In the seventeenth article, Ayla highlights spatial influences on domestic savings rates in the EU-15 and Türkiye. The eighteenth article by Demirel and Boduroğlu investigates the social work needs of university students from single-parent families. In the nineteenth article, Savcı and Acaray reveal that job crafting moderates the adverse effects of work overload on task performance. Tazegül et al., in the twentieth article, confirm that economic policy uncertainty adversely affects tax revenues in Türkiye.

In the twenty-first article, Aslan validates the Environmental Kuznets and Load Capacity Curve hypotheses for Türkiye, showing positive effects from renewable energy and energy efficiency. Ekinler et al., in the twenty-second article, apply artificial neural networks to predict corporate profitability, incorporating ESG scores and financial indicators. Karşıyakalı and Çetin, in the twenty-third article, argue that Türkiye's current population exceeds the optimal level for ecological sustainability. In the twenty-fourth article, Aydoğdu and Uyar analyse volatility spillovers between energy commodities and precious metals using advanced econometric methods. Finally, Olğaç Akar

et al., in the twenty-fifth article, reveal how big data is strategically used in the banking sector for customer-focused marketing insights.

Sosyoekonomi Journal sincerely thanks all authors, reviewers, and editorial board members whose dedicated contributions have been instrumental in shaping the quality and success of this issue. We firmly believe the studies published here will make valuable contributions to the scientific community. We also extend our heartfelt thanks to our readers and followers for their continued support and interest. We hope this issue will enlighten and inspire academics and practitioners alike.

Dr. Emre ATSAN
Co-Editor-in-Chief

Editörün Notu

Sosyoekonomi Dergisi'nin 64. sayısı; sosyoekonomik, teknolojik, çevresel ve finansal alanlardaki güncel konuları ele alan 25 araştırma makalesiyle dikkat çekmektedir. Bu sayıda yer alan çalışmalar, ilgili alanlardaki kuramsal yaklaşımları ve ampirik bulguları bir araya getirerek, farklı disiplinlerden araştırmacılar ve uygulayıcılar için kapsamlı bir değerlendirme zemini sunmaktadır.

Özalp, Şimşir ve Doğan'ın yazdığı ilk makalede, Türkiye'deki uluslararası öğrencilerin karşılaştığı ayrımcılık ve kültürel uyum gibi sorunlar ele alınmaktadır. İkinci makalede Yardımcı Bozdoğan, Türkiye'nin reel efektif döviz kuru üzerindeki başlıca ticaret ortaklarının ekonomik politika belirsizliğinin (EPU) etkisini analiz ederek küresel dinamiklerin ulusal para birimlerine etkisini göstermektedir. Pourabdollah ve diğer yazarlar üçüncü makalede Türkiye, İran, Suudi Arabistan ve BAE'deki finansal karmaşıklığı karşılaştırmakta ve Türkiye'nin en yüksek sistemik risk seviyesine sahip olduğunu ortaya koymaktadır. Aktar'ın dördüncü makalesi, 1960-2010 döneminde Türkiye'de anne eğitimi, ekonomik kalkınma ve bebek ölümleri arasındaki ilişkiyi incelemektedir. Beşinci makalede Eren, Türkiye'de birleşme ve satın alma duyurularının alıcı şirketlerin hisse senedi getirilerine etkisini analiz etmiş; duyuru öncesinde pozitif anormal getiriler tespit edilmiştir.

Altıncı makalede Akın ve Seyfettinoğlu, Ar-Ge firmalarının konum seçimini bilgi yayılımı açısından değerlendirmektedir. Yedinci makalede Kahramani Koç ve Öztürk, ulaşım ve depolama sektöründeki şirketlerin finansal performansını çok kriterli karar verme teknikleriyle incelemiştir. Sekizinci makalede Keskin ve diğer yazarlar, Türkiye'deki tüketicilerin kurumsal sosyal sorumluluk algısını değerlendirmiştir. Dokuzuncu makalede Gürer ve Değirmencioğlu, SEKA Postası gazetesinin endüstriyel gelişim ve kent kültüründeki rolünü incelemiştir. Onuncu makalede Kaya ve diğer yazarlar, BRICS ülkelerinde askeri harcamalar ve nükleer enerji kullanımının Çevresel Kuznets Eğrisi üzerindeki etkilerini değerlendirmiştir.

On birinci makalede Büyükipekçi ve Duman, Konya'daki otomotiv firmalarının dijital olgunluk düzeylerini analiz etmiş ve özellikle akıllı fabrika alanında iyileştirme gerekliliğini vurgulamıştır. On ikinci makalede Öztop, Kırılgan Beşli ekonomilerinde enflasyon ve politika faiz oranlarının borsa endeksleri üzerindeki etkisini araştırmıştır. Aydın Ünal'ın on üçüncü makalesinde, bulanık mantık temelli yöntemlerle Türk sigorta şirketlerinin sürdürülebilirlik performansı sıralanmıştır. On dördüncü makalede Özkan Alakaş, Şahin ve Güler, web sitesi tasarımı ile satın alma niyeti arasındaki ilişkide çevrimiçi güvenin ve algılanan riskin aracılık rolünü incelemiştir. On beşinci makalede Aygün Alıcı ve Kızıltan, güvenceli istihdam ile geniş tanımlı işsizlik arasındaki ilişkiyi analiz etmiştir.

Fikirli ve Şahin'in on altıncı makalesi, Türkiye'de fotovoltaik sistemlerin benimsenmesinde sosyal etkileşimin olumlu etkisini ortaya koymaktadır. On yedinci makalede Ayla, AB-15 ve Türkiye'de yurtiçi tasarruf oranlarının mekânsal etkilerini analiz etmiştir. On sekizinci makalede Demirel ve Boduroğlu, tek ebeveynli aile yapısına sahip üniversite öğrencilerinin sosyal hizmet ihtiyaçlarını değerlendirmiştir. On dokuzuncu makalede Savcı ve Acaray, iş yükünün görev performansı üzerindeki olumsuz etkisinin iş zanaatkârlığıyla nasıl dengelendiğini ortaya koymuştur. Yirminci makalede Tazegül ve diğer yazarlar, Türkiye'de ekonomik politika belirsizliğinin vergi gelirleri üzerindeki olumsuz etkisini doğrulamıştır.

Yirmi birinci makalede Aslan, Türkiye için Çevresel Kuznets ve Taşıma Kapasitesi Eğrisi hipotezlerini doğrulamış ve yenilenebilir enerji ile enerji verimliliğinin olumlu etkilerini ortaya koymuştur. Yirmi ikinci makalede Ekinler ve diğer yazarlar, yapay sinir ağlarıyla net kâr tahmini yaparken ESG skorları ve finansal göstergelerin etkisini analiz etmiştir. Karşıyakalı ve Çetin, yirmi üçüncü makalede Türkiye'nin mevcut nüfus düzeyinin ekolojik sürdürülebilirlik açısından optimalin

üzerinde olduğunu savunmaktadır. Yirmi dördüncü makalede Aydoğdu ve Uyar, enerji emtia piyasaları ile değerli metaller piyasaları arasındaki volatilite geçişlerini ileri ekonometrik yöntemlerle incelemiştir. Son olarak, yirmi beşinci makalede Olğaç, Akar ve diğer yazarlar, bankacılık sektöründe büyük verinin müşteri odaklı pazarlama içgörüleri elde etmekteki stratejik kullanımını ortaya koymaktadır.

Sosyoekonomi Dergisi olarak, bu sayıya katkı sunan tüm yazarlarımıza, hakemlerimize ve editör kurulu üyelerimize içten teşekkürlerimizi sunarız. Özverili katkılarınız, bu sayının akademik niteliğini şekillendirmede büyük rol oynamıştır. Bu sayıda yer alan çalışmaların bilim dünyasına değerli katkılar sağlayacağına yürekten inanıyoruz. Ayrıca, okuyucularımıza ve takipçilerimize uzun yıllardır süregelen destek ve ilgileri için gönülden teşekkür ederiz. Bu sayının hem akademik çevrelere hem de uygulayıcılara ilham verici ve aydınlatıcı olmasını diliyoruz.

Dr. Emre ATSAN
Yayın Kurulu Başkan Yardımcısı

International Student Mobility: Socioeconomic Factors and Encountered Problems in the Eskişehir Sample[1]

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Uluslararası Öğrenci Hareketliliği: Eskişehir Örnekleminde Sosyoekonomik Faktörler ve Karşılaşılan Problemler[2]

Abstract

International student mobility is gaining importance due to globalisation and the expansion of cultural and academic interactions between countries. Türkiye has drawn considerable attention from international students in recent years, ranking among the top 10 countries globally in terms of the number of international students it hosts. This study examines the challenges faced by international students studying in Türkiye and the socioeconomic push-pull factors that influence their educational choices. The research employed a qualitative approach using semi-structured interviews. International students studying at universities in Eskişehir were selected through snowball sampling, and interviews were conducted using a semi-structured interview form. The results revealed that international students encounter challenges such as discrimination, language learning difficulties, and cultural adaptation issues in Türkiye.

Keywords	:	International Student, Mobility, Education, Socioeconomic Factors, Adaptation.
JEL Classification Codes	:	A14, F22, Z13.

Öz

Uluslararası öğrenci hareketleri, küreselleşmenin etkiyle giderek önem kazanmakta ve ülkeler arasındaki kültürel ve akademik etkileşimi arttırmaktadır. Son dönemlerde uluslararası öğrencilerin dikkatini çeken Türkiye, barındırdığı uluslararası öğrenci sayısıyla dünyada ilk 10'a girmeyi başarmıştır. Bu çalışmanın amacı, Türkiye'de eğitim gören uluslararası öğrencilerin karşılaştıkları sorunları ve eğitim tercihlerini şekillendiren sosyo-ekonomik itici-çekici faktörleri incelemektir. Çalışma, nitel araştırma yöntemlerinden yarı yapılandırılmış mülakat tekniğiyle yapılmıştır. Eskişehir'deki üniversitelerde öğrenim gören uluslararası öğrenciler, kartopu örnekleme yöntemi ile seçilmiş ve görüşmeler yarı yapılandırılmış görüşme formu kullanılarak yapılmıştır. Elde edilen sonuçlara göre, uluslararası öğrencilerin Türkiye'de ayrımcılık, dil öğrenme zorlukları ve kültürel adaptasyon gibi sorunlarla karşılaştıkları belirlenmiştir.

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1. Introduction

Migration has historically shaped the economic, cultural, and social dynamics of many societies. From the conceptual aspect, migration refers to people leaving the regions where they were born to become residents of other areas, with millions seeking better opportunities in different countries. For example, as stated in a report by Gallup Research Company, approximately 750 million people worldwide are estimated to be willing to migrate to regions with better conditions (Gallup, 2018). A significant portion of these individuals (23%) prefer the United States of America, with others preferring the United Kingdom, United Arab Emirates, Germany, Spain, Italy, and other European Union countries (Ratha et al., 2022: 35; Nghia, 2019: 759). Although not all aspiring migrants can fulfil their desires, many begin their journeys to achieve their dreams. The World Bank's 2023 report indicates that approximately 184 million people worldwide, including approximately 37 million refugees, migrate for better economic opportunities or are displaced due to socio-political reasons (World Bank, 2023). The primary reasons for migration include economic issues, natural disasters, sociopolitical factors, demographic growth, educational opportunities, and conflicts. Although migration generally manifests in various forms, educational migration has gained significant importance in the modern era. In particular, international student mobility (ISM) is a key phenomenon, emphasising the academic aspect of migration while fostering knowledge, cultural exchange, and economic contributions across borders. Furthermore, large-scale migration is not limited solely to economic and sociopolitical reasons; educational migration has become a significant driver of global movement. In addition, the opportunities presented by globalisation have made international student mobility (ISM) one of the most prominent indicators of educational and cultural exchanges between countries. Millions of students crossing national borders to pursue education not only improve their academic knowledge and skills but also expand the sociocultural diversity of the host countries (Lipura & Collins, 2020: 343). This is not a one-sided endeavour; institutions and states that aim to benefit financially from the widespread mobility of international students show interest in them.

It is essential to distinguish between the concepts of mobility and migration to gain a better understanding of this subject. The concepts of mobility and migration, which lay the foundation of this study, are often used interchangeably in the literature (Anderson & Blinder, 2024: 2; Kajsa, 2019: 27). The concept of mobility, as used in the literature, refers to short-term spatial relocations, whereas migration means longer-term or permanent relocations (Castles, 2010: 1566-1567). However, as can be seen in King's (2002: 90) statement, "*never-straightforward boundary between migration and mobility*," it is complicated to make distinct separations between these two concepts. Nonetheless, the term "mobility" is predominantly preferred in studies on student movements (Carbajal & Calvo, 2021: 418; Castles, 2010: 1567). The primary reason for this preference is the constantly

changing factors (job opportunities, lifestyle, welfare, etc.) that influence whether a student will remain in the host country after completing their education (Alberts, 2017: 36; Cheung & Xu, 2014: 212; Murphy-Lejeune, 2002: 2; Nghia, 2019: 760). Moreover, similar to the conceptual discussions on migration and mobility, a distinction should also be made between international students and those from other countries. For instance, as emphasised by OECD (2011: 65), international and international students are examined in two categories. UNESCO and OECD define international students as those who leave their countries to enrol in higher education, whereas international students are not citizens of the country in which they reside, either having long-term residence or being born there. Therefore, international students and those who have migrated alone or with their families for reasons such as work, asylum, war, and other similar reasons, as well as those born in the host country (UNESCO, 2018: 97; Kyei, 2021: 299). For all these reasons, this study prefers the term "mobility" over "migration" to emphasise the change of countries by international students for educational purposes.

There are numerous studies on ISM in the international literature, making the topic rich in resources (Alberts, 2017; Brooks & Waters, 2011; De Haas et al., 2020; Kajsa, 2019; King, 2002; Lomer, 2018; Nghia, 2019; Tarc, 2019). Many studies on ISM are shaped within the framework of micro approaches. From a macro perspective, it can be stated that host countries strive to develop policies and create socioeconomic environments that enhance the internationalisation of their education systems and attract high-quality ISM (Böhm et al., 2004: 12; Knight, 2004: 8; Kondakci, 2011: 576; Qiang, 2003: 248-249; Tarc, 2019: 716). Examining these studies, the factors that attract or deter students from studying abroad are generally discussed, along with the willingness of countries to develop their student policies and implement innovations within their education systems to attract high-quality international students (IS). Therefore, host countries develop policies to increase the number of successful international students by establishing research funds and fostering cooperation among educational institutions (Fakunle, 2021: 674). Furthermore, international students contribute to the sociocultural structure of the host region by developing significant ties with local people. Thus, the international mobility of educated human capital tends to move from less developed or developing regions to developed ones (Beine et al., 2001: 276; Docquier & Rapoport, 2011: 682-683; Rasamoelison et al., 2021: 3913). Developed countries aiming to enhance their educated human capital are enacting numerous social and economic regulations related to international students to attract high-quality students. In this regard, significant educational and life opportunities in developed countries become pretty appealing to students who compare their domestic opportunities with those of other nations. Developed countries receiving migrants significantly enhance their global competitiveness by facilitating the acceptance of international students (Yıldırım et al., 2021: 109). Besides macro factors, the micro approach views international students as consumers who migrate to create new job opportunities and develop their academic skills (Lomer, 2018: 11). Micro-level studies on ISM often focus on "attractive" (Findlay et al., 2011: 124; Mazzarol & Soutar, 2002: 83-84), "motivational" (Brooks & Everett, 2009: 334; Zhou, 2015: 7), and "determinant" factors to understand why and where international students are willing to

study (Gonzalez et al., 2011: 123; King & Raghuram, 2013: 127). The factors are divided into three parts in the micro model to better capture the complexity of international student experiences. The micro model is also categorised in this way to reveal the interactions between students' desires, motivations, and the contextual realities of their chosen destinations. Ultimately, such a distinction helps to understand how different elements shape students' decisions about international education (Gonzalez et al., 2011: 123; King & Raghuram, 2013: 127). In addition to students' desires and aspirations, the living standards of the destination country can also be considered a micro factor. These factors generally reflect students' psychological and socioeconomic desires (Lipura & Collins, 2020: 345). In this respect, the micro approach examines students' migration motivations at more socio-psychological levels. This approach evaluates the push and pull factors that encourage students to pursue education abroad, taking into account each student's individual preferences and needs. For instance, a student's motivation to study abroad might be driven by the desire to attend a high-quality university, whereas another student might prioritise the aspiration to live in a country with better living standards. Research on the micro approach often highlights students' deprivation of educational opportunities in their home countries and their desire to attend a high-quality university (Fakunle, 2021: 674; Böhm et al., 2004: 12).

Recent studies showed that international student mobility toward developed countries has been rapidly increasing due to factors such as job opportunities, high quality of life, continuing education, wars, and religious and political conflicts (Carbajal & Calvo, 2021: 419; Khalid & Urbański, 2021: 244; Zanabazar et al., 2021: 8). Even though the number of international students studying in different countries was approximately two million in 2000, this number reached six million as of the year 2019 (Fidler et al., 2023: 353). From a proportional perspective, the number of international students enrolled in higher education increased by 152% between 1998 and 2019 (Weber & Van Mol, 2023: 1). Additionally, as indicated in OECD data, the number of international students in higher education reached a record high in 2021. In 2021, more than 4.3 million international students were studying in OECD countries, with the majority coming from China and India. According to the OECD, "Most international students in OECD countries come from Asia. In 2021, nearly 60% of international students in the OECD came from Asia, mostly from China and India. Compared to 2014, the share of international students from Asia has increased, while the share from Europe has decreased. This increase was particularly strong in the European OECD countries, where the share of Asian students increased from 30% to 36%." (OECD, 2023: 34). This increase in international student mobility is closely related to the frequently discussed topic of internationalising higher education. This phenomenon is primarily attributed to the rise of the middle class and increased mobility opportunities in developing countries, including high-population countries like China and India (Geiger & Pécoud, 2013: 3; Weber & Van Mol, 2023: 2). Developed countries, on the other hand, place great importance on increasing the number of international students to meet labour force needs and sustain economic development in the face of ageing populations (Bryla, 2018: 2-3; Tremblay, 2005: 3). From this perspective, international students are considered ideal

immigrants for developed countries thanks to their young age, entrepreneurship, skills, and language abilities (Scott et al., 2015: 2). The relationship between migration and education draws the attention of universities, governments, and researchers, who see creating attractive educational opportunities as crucial (Böhm et al., 2004: 11; Brooks & Waters, 2011: 18; King & Sondhi, 2017: 95; Lomer, 2018: 13).

The United States of America, Germany, and the United Kingdom are among the most prosperous countries in establishing funds and encouraging students to increase their ISM. For example, in 2020, 80% of international students coming to the United Kingdom from less developed and developing countries were from non-EU countries (Fidler et al., 2023: 354). The number of international students choosing the United States of America increased from 842,384 in 2014 to approximately 1,057,188 in the 2022/23 academic year (Statista, 2024). Similarly, the number of international students in the United Kingdom also increased from 428,724 in 2014 to 679,970 in the 2021/22 academic year (Cuibus & Walsh, 2022). Between 2019/20 and 2022/23, the number of international students studying abroad in Germany increased by 11.3%, from 411,601 to 458,210 students (Erudera, 2024). Despite being primarily a student-sending country, according to UNESCO data, approximately 51,146 Turkish students were studying abroad as of 2023. This number has been consistent in recent years, reflecting Türkiye's growing trend of sending students overseas for higher education. In addition to this information, Türkiye has recently risen to 10th place among countries receiving international students (UNESCO, 2023). The number of international students choosing Türkiye increased from 48,183 in 2014 to 336,366 in 2023 (YÖK, 2023).

2. Problems Encountered: Socioeconomic Push and Pull Factors

The significant increase in ISM worldwide has led to students facing specific challenges. Studies in this area identified numerous issues such as language learning difficulties, cultural adaptation, academic achievement, feelings of loneliness, discrimination, and relationships with the local population (Bohon et al., 2005: 45; Yeh & Inose, 2002: 70; Yılmazel & Atay, 2022: 2). Even though various assumptions were proposed to analyse these problems, the push and pull models are the most used in the literature. The push and pull model aims to explain the primary reason for the formation of ISM using the labour market example (Todaro & Maruszko, 1987: 113). Push factors affecting students' mobility decisions argue that ISM cannot be reduced to students' psychological preferences. Instead, it is necessary to focus on students' socioeconomic status and the political conditions of their country. For instance, Findlay (2011: 183) notes that universities in the United Kingdom offer significant opportunities through their active recruitment policies, which generate financial returns from international students through accommodation and tuition fees (Van Mol & Timmerman, 2014: 466). When considering the pull factors, job opportunities, housing conditions, and high welfare levels in the destination country play important roles in driving student mobility. In addition, sociopolitical factors such as quality healthcare services and ease of cultural adaptation influence students' preferences (Carbajal & Calvo, 2021: 422; Khalid & Urbański, 2021: 250).

Several theories have been developed to explain the push and pull factors that contribute to ISM. Human capital theory provides a significant framework for understanding the relationship between education and economic development. Human capital theory (HCT) assumes that education improves individuals' productivity skills and capacities (Bahat & Karakütük, 2024: 132). HCT states that education, as an investment in individuals, contributes to the cognitive stock level of productive human capacity, thereby increasing work efficiency (Almendarez, 2013: 21-22). For instance, Psacharopoulos & Woodhall (1997) consider quality education as an investment in human capital, highlighting that providing quality education to individuals yields stronger outcomes than physical investments. Similarly, Becker (2009) asserts that improving human capital is crucial in safeguarding a nation's economic interests. From these perspectives, the core argument underpinning HCT is that individuals' learning capacities are more valuable than other resources involved in producing goods and services. When human resources are utilised effectively, the resulting outcomes are highly productive for individuals, institutions, and society (Schultz, 1961: 1-2). For example, Becker (1992: 85), a key advocate of the theory, emphasises the multifaceted educational dimension of human capital, stressing the societal benefits of education in his statement, "*Schooling, a computer training course, expenditures on medical care, lectures on the virtues of punctuality and honesty are capital too, in the sense that they improve health, raise earnings, or add to a person's appreciation of literature over much of his or her lifetime*." Therefore, higher education is a deliberate investment that prepares individuals for the workforce, enhances productivity, and supports international growth and development. Psacharopoulos (2008: 446) emphasises the significance of human capital in yielding important macroeconomic, political, and cultural outcomes and highlights its positive implications at the micro level by demonstrating how individuals' educational levels affect their income. Furthermore, Psacharopoulos (2008: 446) suggests that educational investments produce higher returns, particularly in low- and middle-income countries. In this context, improving the quality of education and fostering multicultural education systems contribute to accelerated economic growth and enhanced social welfare (Aksoy et al., 2011: 69-70; Özsoy, 2016: 165). With the internationalisation of education, the mobility of students between countries is increasing, thereby accelerating the acquisition of international economic, cultural, political, and communicative capital. International students learn foreign languages, acquire cultural knowledge, and develop the ability to adapt to the norms of their host countries, thereby sustaining intercultural communication. Moreover, they seek knowledge about foreign labour markets, institutions, and legal systems to strengthen their capital (Gerhards & Hans, 2013: 100). International student mobility can also be considered a means of investing in human capital. Consequently, perceiving education and living abroad as investment tools, they are motivated to pursue education in regions with high levels of human capital. In this context, international students aim to move to places where they can achieve higher returns through the capital they gain via education (Van Weber & Von Mol, 2023: 3).

Besides human capital theory, the migration transition theory is the most frequently cited in ISM. This theory, similar to the human capital theory, posits a direct relationship

between economic development and migration, claiming that countries attract migration based on their level of development (de Haas, 2021: 2; Skeldon, 2012: 155; Zelinsky, 1971: 221). As stated by de Haas (2021: 24) and Carling & Schewel (2018: 945), individuals aspiring to migrate to developed countries must enhance their social, economic, and cultural capital to overcome migration barriers. This theory emphasises micro-level reasons beyond macro frameworks, arguing that students' desires for an ideal lifestyle and plans increase their aspirations to study in developed countries (De Haas et al., 2020: 62). Additionally, as the welfare levels in underdeveloped and developing countries rise, so does the awareness of opportunities and conditions in developed countries, thus positively influencing individuals' desires to migrate. Considering the assumptions of push and pull factors, international students perceive studying in developed countries as a window of opportunity (De Haas et al., 2020: 62). Furthermore, Weber and Van Mol (2023: 3) highlight that developed countries also seek to attract international students who are pursuing career advancement and quality education. This approach suggests that the increase in welfare levels in underdeveloped and developing countries concurrently raises the educational aspirations of individuals of higher education age, thereby accelerating student mobility to developed countries. The recent rapid increase in ISM also impacts developed countries. Countries aiming to attract quality international students strive to become centres of attraction by creating new educational policies to compete in the knowledge economy (Khadria, 2009: 107; Raghuram, 2013: 138; Ziguras & Law, 2005: 60).

The push model frequently addresses why students do not pursue education in their home country. This model assumes that factors such as religious intolerance, terrorism, war, inadequate legal systems, unequal opportunities, and poor job prospects in their home countries compel students to seek education abroad (Parkins, 2010: 7). In this context, several studies emphasised unemployment as the most significant push factor. As Ibrahim et al. (2019: 1909-1910) stated, the excessive population growth in underdeveloped and developing countries triggers unemployment, pushing students to seek education abroad. Similarly, Llull (2014: 26) found that students, driven by poor living conditions and limited job opportunities in their home countries, pursue education in developed countries to improve their living standards and those of their families. Urbanski (2022: 13) noted that health, housing, and nutrition problems, as well as natural disasters, also drive students to migrate to other countries. Furthermore, studies argue that educational inequalities, deficiencies in the legal system, and religious reasons drive student mobility (Doerschler, 2006: 1113-1114. These studies suggest that international students seek education in developed countries to enhance their earnings and improve economic conditions.

In conclusion, the notion that the problems students face in both their home countries and host countries are related to push and pull factors is also debated in the literature. In the push-pull model, it is assumed that students make decisions regarding educational mobility in three stages, influenced by these factors (Mazzarol & Soutar, 2002: 82-85). First, students consider the educational opportunities, special conditions, and problems they encounter in their home country. Considering their evaluations, they move to countries where they perceive the pull factors more favourably (Ahmad & Buchanan, 2016: 175). In the second

stage, students evaluate the sociopolitical image of the host country. From this perspective, the country with the most attractive pull factors is considered the best place to study (Ahmad & Buchanan, 2016: 175; Eder et al., 2010: 233). Here, criteria such as the host country's living standards, costs, safety, political stability, technological facilities, and cultural characteristics are significant. The third and final stage involves deciding which university to attend. Students evaluate factors such as the quality of the university, post-graduation job opportunities, variety of courses, educational programs, and information technologies. This stage is often referred to as "academic pull factors" (Balaz & Williams, 2004: 217; Lipura & Collins, 2020: 345; Mazzarol & Soutar, 2002: 83). Although high living standards and good job opportunities in the desired study countries are seen as important pull factors, visa ease, travel, and accommodation costs are significant barriers students face. For example, universities demanding high tuition fees are considered non-economical by students. Moreover, Wilkins et al. (2013: 136) and Naidoo (2007: 287) found that education costs play a significant role in students' choice of study destination.

There is a considerable body of research on ISM in Türkiye. These studies predominantly focus on topics such as the internationalisation of higher education, students' academic experiences, economic and social dimensions, employment, competitiveness, public and education policy, adaptation, and migration (Yalçınkaya & Beşirli, 2022; Metin, 2022; Kethüda, 2015; Topal & Tauscher, 2020; Levent & Karaevli, 2013; Baş & Eti, 2020; Akgül, 2019; Metin & Sevinç, 2024; Gönültaş et al., 2023). In the study conducted by Yalçınkaya and Beşirli (2022), it was found that countries adopting an outward-facing education model experience a faster internationalisation process in higher education, resulting in increased student flows to these countries. Furthermore, one of the significant results of this study is that Türkiye, due to its geographical location, attracts a substantial number of international students from neighbouring regions. Similarly, Metin (2022) emphasises the existence of intense student mobility towards countries that rapidly internationalise their higher education systems, noting that well-educated students in Türkiye increasingly prefer to stay in the countries they move to due to better employment opportunities and favourable immigration policies. Kethüda (2015) argues, on the other hand, that international students choose Türkiye to receive higher-quality education, but they face significant dissatisfaction. Additionally, this study found that due to the high-risk perception of the service sectors in Türkiye, students negatively influence others' decisions to consider studying in the country. Topak & Tauscher (2020) claim that, in addition to historical, linguistic, and cultural factors, Türkiye's geographical location plays a significant role in students' decisions to choose the country for their education. Levent and Karaevli (2013) revealed in their study that economically strong countries are the most preferred destinations for education as students seek better living standards. They recommend increasing employment opportunities and implementing international structural changes in education in Türkiye. Similarly, Baş and Eti (2020) emphasise the need to enhance employment opportunities and enforce anti-discrimination policies. A significant result achieved in this study is that the discrimination experienced by students from Africa creates pressure on their decision to study in Türkiye, highlighting the need for policies that enhance

cultural integration. Akgül (2019) primarily focuses on employment, emphasising that international students are often employed informally in Türkiye. Furthermore, it is noted that when these students return to their home countries, they are more inclined to engage in trade with Türkiye. Metin & Sevinç (2024) reached similar conclusions as the studies above, asserting that internationalisation policies have increased student mobility. Another key result of this study is that students contribute to the national income of the countries where they study while also playing a significant role in human capital development. Finally, in a study conducted by Gönültaş et al. (2023), the challenges faced by students in Türkiye were evaluated, with the first being communication issues with locals due to limited proficiency in the Turkish language. Additionally, it was found that students struggle with adaptation due to cultural differences and lifestyle variations in Türkiye. Similarly, studies show that European students face similar problems to those in Türkiye (Arnot & Pinson, 2015; Dryden-Peterson, 2016; Jeffery & Murison, 2011). The results obtained from these studies indicate that international students face numerous challenges, including language barriers, cultural adaptation difficulties, housing issues, visa complications, inadequate guidance, discrimination, ineffective teaching methods, loneliness, and strained relationships with others. For instance, in a study carried out by Hari et al. (2023), it was determined that international students receiving education in Canada faced discrimination because of their ethnic origins. These issues prompt students to reassess the critical socioeconomic factors that influence their mobility to desired study destinations. Although pull factors, such as job opportunities and good living conditions, have been widely discussed in studies, micro-level reasons have also been found to influence students' location preferences significantly. In this context, this study aims to examine the problems faced by international students studying in Türkiye and the socioeconomic push-pull factors influencing their educational choices.

3. Methodology

3.1. Research Model

The qualitative research method was employed in this study to understand and explain the perceptions underlying students' daily life experiences, the problems they encounter during their education in Türkiye, the push-pull factors that influence their decision to choose Türkiye, and their mobility decisions. The interview technique, a qualitative research method, was employed in this study because it focuses on developing an in-depth understanding and allows participants to share their experiences interactively. The qualitative research method was employed in this study to understand and explain the perceptions underlying students' daily life experiences, the problems they encounter during their education in Türkiye, the push-pull factors that influence their decision to choose Türkiye, and their mobility decisions. The interview technique, a qualitative research method, was employed in this study due to its focus on developing an in-depth understanding and allowing participants to share their experiences interactively (Creswell, 2013: 77; Neuman, 2022: 319). This study is based on the push-pull factors influencing international students' decisions to study in Türkiye and the problems they encounter, drawing on

previous studies on the ISM. Moreover, the sub-themes of language learning, the quality of the Turkish education system, experiences of discrimination, cultural adaptation, plans, desires to work or study in developed countries, free education, and Türkiye's geographical proximity to the European Union are examined to determine their influence on students' preference for Türkiye. The distinctive features of this study are its use of a phenomenological design and the in-depth focus this design offers on the experiences of international students in the city of Eskişehir, Türkiye. Furthermore, while other studies predominantly adopt quantitative methods to analyse the current situation, this study employs interview techniques to explore socioeconomic factors that push or pull students toward pursuing education in Türkiye based on the student's perceptions. In this study, following a literature review and analysis of official statistical data, the semi-structured interview technique, a qualitative research method, was selected to understand the problems faced by international students enrolled in universities in Eskişehir, Türkiye and their reasons for choosing Türkiye as a study destination. This study aims to analyse the discussions in the literature on ISM, reveal the connections between frequently used perspectives, and provide a resource for future research. In the international literature, the mobility of international students to Western countries, characterised by high human capital, living standards, and job opportunities, is often discussed.

The primary research question of the present study is: What problems do international students encounter during their education process in Türkiye, and what push-pull factors motivate them to study in the country? Therefore, this study's phenomenological design was chosen for data interpretation, which aims to reveal students' views on the situations expressed in the research problem. This choice is made because it allows delving into the essence of students' views and experiences, facilitating a better understanding of the subject. As stated by Merriam (2009: 23), phenomenological design is effective in studies that employ in-depth interview techniques and is suitable for examining intense human perceptions and emotions. Furthermore, the phenomenological design enables an in-depth examination and interpretation of international students' experiences, as well as the revelation of their understanding and beliefs about various events or subjects (Creswell, 2013: 77-81).

In 2024, the number of international students studying in Eskişehir was 14,223 at Anadolu University, 1,642 at Eskişehir Osmangazi University, and 416 at Eskişehir Technical University (YÖK, 2023). The primary reason for selecting Eskişehir in this research is that it hosts three universities. Additionally, these universities have many international students. Lastly, Eskişehir embodies both the traditional and modern characteristics of Türkiye, providing a suitable environment for examining adaptation processes to cultural differences. Participants were primarily selected from students studying at the Faculty of Theology at Eskişehir Osmangazi University through their social groups. The student selection process began with international students studying at the Faculty of Theology, as they are very active in student social media groups within their own countries, allowing the researcher to reach other students more efficiently. An effort was made to balance the distribution of students' genders and countries of origin as much as possible.

Some students declined to participate in the interviews due to unspecified sensitivities. However, interview forms outlining the researcher's intent were distributed to gain sufficient participants and trust. Snowball sampling was employed to select participants for this study, with strategies developed to ensure an adequate number of participants. Snowball sampling, also known as chain-referral sampling, is a sampling method that facilitates the identification of study participants. It is often preferred when a sufficient number cannot be obtained through purposive or random sampling (Biernacki & Waldorf, 1981: 141; Kennedy-Shaffer et al., 2021: 1919).

3.2. Validity and Reliability

There are many methods to ensure validity and reliability in qualitative research. The researcher must detail the data collection process, procedures, and how the conclusions were reached to support the study's reliability. In addition to obtaining at least verbal consent from participants, having the interview questions reviewed and commented on by two experts in the field also increases the study's reliability (Kuckartz, 2014: 160). In this study, to ensure reliability, face-to-face pilot interviews were conducted with five international students studying in Eskişehir before selecting the research samples to formulate the sub-questions. Due to language barriers, two of these interviews were conducted in English. These interviews lasted approximately 12 hours, and the data were transcribed due to the students' sensitivities. Using multiple languages allowed students to elaborate on their thoughts. Pilot interviews are crucial for clarifying issues and addressing future considerations (Kim, 2010: 191). After the pilot interviews, transcripts were provided to participants for verification, further supporting reliability. This step is recommended by Lincoln and Guba (1985: 438-439) and Cresswell and Miller (2000: 125-126) to increase a study's reliability and validity. This approach encourages participants' voices to be heard in qualitative research and promotes a participant-centred perspective. Participant feedback provides an opportunity to correct misunderstandings and fill in missing information, thereby enhancing the realism and reliability of the research results (Merriam & Tisdell, 2016: 246).

3.3. Developing Data Collection Tool and Collecting Data

A semi-structured interview form was used for data collection in the research process. The primary reason for using this form is that semi-structured interview questions provide in-depth data on the topics being analysed (Mason, 2002: 73; DiCicco-Bloom & Crabtree, 2006: 40). However, aspects such as preparing research questions, reaching participants, ensuring participants understand the questions correctly, and transcribing interviews are crucial factors to consider in semi-structured interviews (Neuman, 2022: 441-453). The data collection was conducted with international students studying at three universities in Eskişehir: Eskişehir Osmangazi University (n = 25), Anadolu University (n = 20), and Eskişehir Technical University (n = 12). Each interview lasted approximately one hour, with the participants' permission obtained. However, the study's limitations include students' sensitivities about being recorded, deficiencies in Turkish language skills, cultural

differences, and difficulties with self-expression. The information recorded during the interviews was analysed using thematic analysis, with the data being transcribed and the resulting codes categorised. After categorisation, themes were created using a thematic approach that facilitates the revelation of interpretative and descriptive meanings (Xu & Zammit, 2020: 2). Determining the number of participants in qualitative research is challenging (Braun & Clarke, 2006: 81-82). The themes derived from the research questions were adapted according to the information provided by participants. Data from all interviews (n = 57) were coded until saturation, adapting to the information provided by the participants. Maxqda 2024 was used for transcribing, coding, and creating themes from the interviews.

Table 1 below categorises the push and pull factors influencing international students' decisions to study in Türkiye, their challenges, and the data collected from their daily life experiences into themes and subthemes.

Table: 1
Subthemes and Themes

Themes	Problems and Everyday Life Experiences in Türkiye	Driving Socioeconomic Factors on the Education Path	Attractive Socioeconomic Factors on the Education Path
Sub Themes			
1.	Ethnic Discrimination	War	The Quality of Turkish Universities and its Impact on the Transition to Europe
2.	Language Issues	The Sub-theme of Quality of Education	Scholarship Opportunities Cultural and Religious Affinity
3.	Adaptation to Local Culture	Inequality of Opportunity and Costs	Geographical Proximity to Europe
4.	Education System	Job Opportunities	Job Opportunities

Table 2 presents the demographic characteristics of the participating students, with their names coded using nicknames.

Table: 2
Information about International Students

Variable	Demographics	n	%
Gender	Male	27	47.37
	Female	30	52.63
Age	18-22	28	49.12
	23-25	22	38.60
	26+	7	12.28
Country	Sudan/Iraq/Palestine	12	21.05
	Greece/Yemen/Egypt/Kazakhstan	12	21.05
	Iran/Georgia/France/Ethiopia/Indonesia/Afghanistan	12	21.05
	Jordan/Uzbekistan/Chad/Zambia/Tanzania/Serbia/Saudi Arabia/Syria/Somalia/Russia/Papua New Guinea/Nigeria/ Nepal/Mauritania/Macedonia/Kyrgyzstan/Gambia/Morocco/Burkina Faso/Bosnia-Herzegovina/Azerbaijan	21	31.58
Education Level	Bachelor's	42	73.68
	Postgraduate	13	22.81
	Associate	2	3.51
Programs	Medicine/Divinity	10	17.54
	International Relations/Business Administration/Electrical and Electronics Engineering	9	15.79
	Biology/English Teaching/Pharmacy/Architecture/Medical Laboratory Techniques/Tourism Management/Political Science/Economics	16	28.07
	Computer Engineering/Chemistry/Primary School Teaching/Industrial Engineering/Dentistry/Midwifery/Finance/ Chemical Engineering/Civil Engineering/Gastronomy/Psychological Counselling and Guidance/Mechanical Engineering/English Language and Literature/Turkish Language and Literature/Finance/ Law/Control and Automation Engineering/Pre-school Teaching/Public Relations/Mechanical Engineering/Journalism/Environmental Engineering	23	40.35

In conclusion, a total of 57 international students participated in this study. To enhance the students' confidentiality and the reliability of the research, nicknames were assigned to the participants. Initially, demographic information about the students was collected through a form provided before the interviews (see Table 2). The present study involved 27 female and 30 male participants. Moreover, 28 participants were between the ages of 18 and 22, 22 were between the ages of 23 and 25, and 7 were 26 and older. Their countries evenly distribute the number of students, as shown in Table 2. For example, the total number of students from Sudan, Yemen, and Palestine is 12, with each country represented by four students in the table. A similar arrangement has been made for other countries to enhance the table's overall appearance. Additionally, the students' educational levels are provided sequentially in the table. Finally, in Table 2, students are categorised by the programs they are enrolled in and distributed equally among each country. For instance, the students enrolled in the faculties of Medicine and Theology consist of 10 individuals, with five students from each faculty. This arrangement was preferred to maintain the visual coherence of the table. Each student took approximately three minutes to answer the demographic questions, which required simple responses.

4. Results

Three main themes were identified in this study. The first theme addresses the problems encountered and daily life experiences in Türkiye. The second theme, push factors in the education path, examines the reasons that compel students to study in Türkiye due to socio-economic, political, and educational issues in their home countries. Lastly, the third theme, pull factors in the education path, explores the factors that attract students to study in Türkiye. Additionally, the students' responses were not altered, and their answers were presented as they were, without correction for any language errors. When interpreting the interviews, nicknames, gender ("M" for male and "F" for female), age, education level ("B" for Bachelor's, "M" for Master's, and "A" for Associate's), the students' countries, and the departments they study in were indicated in parentheses at the end of each sentence.

4.1. Problems and Everyday Life Experiences in Türkiye

First, examining the sub-theme of ethnic discrimination, it can be seen that some international students who come from countries with distinct cultures and religious backgrounds experience significant challenges in culturally adapting to life in Türkiye. Among these challenges, the primary issue is being marginalised due to racial differences. Upon arriving in Eskişehir, students faced discrimination and tried to overcome these difficulties by gradually adapting to Turkish culture. Some students attribute this discrimination to the information Turkish citizens acquire from social media.

"Unfortunately, we occasionally encounter such unpleasant incidents, especially among Arabic students. There are many prejudiced people among the Turks who see fake news on social media and act accordingly. However, many students, including

foreigners, help them, so I don't take this issue too seriously (Mohammed Farac, M, 22, B, Palestine, Medicine)."

"We generally face it. Due to the news on social media, a great prejudice has formed against all of us. Recently, while travelling by tram, a woman looked badly at a child without a coat and said, 'Look at him, wandering around like Syrians.' The child wasn't Syrian, but it was very clear that she despised and disliked Syrians, as evidenced by her comparison (Sundar, F, 23, B, Syria, Pharmacy)."

Most of the students in the sample are from Africa, the Middle East, and Asia. Therefore, Arabic is the official language in most of these countries. The study's results on ethnic discrimination align with the issues students face, as reported by Baş and Eti (2020). In their research, Baş & Eti (2020) found that African-origin students experienced exclusion due to their language and skin colour. However, this study did not find any evidence regarding skin colour; instead, it was observed that students faced discrimination due to the language they used.

Examining the sub-theme of language issues, students encounter many problems because they use their local language in public transportation. For example, students coming from African countries and those whose native language is Arabic are particularly reactive and face the most discrimination. Arabic-speaking students frequently reported being mistaken for Syrians and consequently facing backlash. In addition to social media, international students believe that Turkish families instil negative perceptions and feelings toward Arab ethnicity in their children during their upbringing. Additionally, African students claim that they are marginalised due to speaking Arabic. Therefore, students believe that Arabic-speaking students in Türkiye are perceived as Syrians.

"Yes, I have often seen them look at me strangely because I am a foreigner. Especially once, they thought I was Syrian because I spoke Arabic, and they started to insult me (Hamadi, M, 25, B, Egypt, Pharmacy)."

"For example, when I first arrived in 2019, even if you sat in a seat where two people were sitting on the bus, no one would sit in the seat next to us (Abdulrezzak, M, 24, B, Tanzania, Electrical and Electronics Engineering)."

"Yes, I encountered it very often. I lived in Türkiye for six years and faced racism because of my colour or language. In some places, I was expelled for speaking Arabic, and many times, I experienced being called 'black woman' instead of being addressed as 'miss' or 'please' when they forgot my name. There were many instances where I was asked to leave my seat on public transportation (Fatima, F, 23, B, Mauritania, Chemistry)."

"Turks are brought up with the education from their families that Arabs are like this or like that, which is a wrong way of thinking (Kadriye, F, 23, B, Iraq, Theology)."

As shown, another cause of discrimination is related to language use. The results obtained in this study share some similarities with those of Hari et al. (2023). Hari et al. (2023) concluded that Asian-origin students studying in Canada during the COVID-19

period were subjected to various forms of discrimination because of the language they used. In addition to ethnic discrimination, Baş and Eti (2020) also found that students faced discrimination due to their language use, which aligns with the results of this study regarding this sub-theme.

In the sub-theme Adaptation to Local Culture, besides discrimination, another frequent problem for students is the cultural adaptation process. However, some students noted that identifying as "Muslim" helped them avoid issues related to cultural adaptation. Despite claiming that they did not face religious problems in Türkiye due to the majority-Muslim population, most students experienced issues with food, language, and communication with their surroundings. As stated by the students, these problems are easily overcome after the first year, facilitating cultural adaptation. The emphasis on the first year originates from enrolling in preparatory classes and becoming fluent in Turkish by the end of the year. Students who struggle to communicate with locals often cannot form a social circle outside their group of friends from their home country. Adaptation to local food and eating habits continues throughout the preparatory class.

> *"Initially, I encountered difficulties, but they were all due to the language barrier. So far, I have learned how to communicate effectively with people and address specific individuals, such as Ajna, a 25-year-old male from Bosnia and Herzegovina who is pursuing a career in preschool teaching."*
> *"There are probably some differences between Georgian and Turkish nations, but it wasn't challenging or hard to adapt to Turkish social culture and foods (Nia, K, 25, LÜ, Georgia, Tourism Management)."*
> *"Yeah, but not too much. Perhaps the way Turkish people live is a bit different from that in my country. Additionally, I can say that the dorm food is very hard to adapt to (Mohamed Murtada, E, 25, L, Sudan, Mechanical Engineering)."*

Cultural adaptation is one of the challenges frequently faced by individuals who migrate to regions with significantly different cultures from their own. The results achieved in this study align with those reported by Bohon et al. (2005) and Yeh & Inose (2002), indicating similar outcomes. Students often experience adaptation challenges until they become accustomed to the culture of the locations where they pursue their education. Similarly, a study by Gönültaş et al. (2023) highlighted that students who initially struggle with speaking Turkish also face adaptation issues, reaching conclusions consistent with this study.

When the education system sub-theme is analysed, it is very difficult for students studying in different countries to adapt to the education system of the host country they are in. One of the most common problems students face is the difference between the education systems in their home countries and Türkiye. Some students believe the Turkish education system is based on repetitive and demanding exams. Others pointed out deficiencies in instructors' English language skills. Additionally, students frequently emphasised the intensity of course schedules, the strictness of instructors, and adherence to rules.

"This place is more disciplined. In Azerbaijan, the discipline is less than here. However, in terms of rules, for example, there are disciplinary penalties (Asile, F, 22, B, Azerbaijan, Business Administration)."

"My worst experience was with the professors. As a foreigner, they don't understand you and expect a lot from us. Considering that Türkiye is an international city and country, it is a significant disadvantage for professors who do not know English (Ajna, F, 25, M, Bosnia-Herzegovina, Pre-school Teaching)."

"My education in Türkiye is more disciplined and stricter than in my home country."

"However, in my home country, the education system is more flexible and offers a wider range of elective courses, allowing me to develop my interests more freely (Rashid, M., 20, B, Afghanistan, Economics)."

Internationalising the educational system appears to be of significant importance in this context. Enhancing academic competencies and advancing the internationalisation of the Turkish higher education system could provide substantial benefits in addressing these challenges. For instance, similar to the results achieved in this study, Metin & Sevinç (2024) argued for the development of educational policies targeted at international students and emphasised that international students encounter problems with the use of English and the suitability of the educational system during their academic journey. Fakunle (2021) also emphasised in his study that the lack of adherence to international standards in the educational system contributes to specific student issues, suggesting that students seek higher education institutions to advance their development more efficiently.

Similarly, some students criticised the duration of education at Turkish universities in the education system sub-theme. Students from Africa and the Middle East claimed that undergraduate education in their home countries typically lasts three years. The extended duration of schooling is troubling for students, who believe it causes financial and emotional strain when planning for the future. Some students emphasised that the extended duration of education results in wasted time rather than providing quality education.

"(…) The number of years required to complete a course may differ. Here in Türkiye, 4-year-olds are considered children, while in my country, they are considered 3 years old. We spend more time. (Jahia, K., 20, L, Gambia, Chemical Engineering)."

In my country, I believe a university degree typically takes three years. It varies from department to department, but it usually is three years. It seems like a waste of time (Hanan, F, 20, B, Ethiopia, Business Administration)."

"In Burkina Faso, instead of a university entrance exam, there is a Baccalaureate diploma. A bachelor's degree typically takes 3 years, a master's degree takes 2 years, and a doctorate typically takes 3 years. Extending the duration is costly (Gahiji, M, 30, M, Burkina Faso, Biology)."

The results indicate that while some students highlighted the abundance of exams, others claimed that instructors generally have a disciplined character. Additionally, disciplinary penalties, instructors' language skills, the length of education, and problems

stemming from the rote-learning system are common issues faced by students. Furthermore, students expressed that instructor teaching in Turkish made it difficult for them to participate in classes and that they had to warn the instructors about this.

4.2. Driving Socioeconomic Factors on the Education Path

Sociopolitical and economic issues, as well as the inadequacy of the education system in their home countries, force international students to seek education abroad. The sub-theme of war constitutes an integral part of the research. Most students participating in the study face numerous problems due to the war in their countries. For example, students from the Middle East generally emphasised the impact of war and mentioned that they had to pursue education in other countries due to war-related problems. Students also believe that a peaceful and stable environment enhances educational productivity.

"Other than the war in our country, an important factor in my education in another country (Sundar, F, 23, B, Syria, Pharmacy)."
"I never considered going abroad to a foreign country, and due to the current war, I also cannot return to my country (Meryem, F, 29, M, Palestine, Political Science and International Relations)."
"Yes. For example, there was a major sectarian war in Iraq where everyone killed each other. Still, in Türkiye, there aren't as many sectarian problems as possible (Kadriye, F, 23, B, Iraq, Theology)."

As observed, war is a significant phenomenon that compels students to pursue education abroad. Like the present study, Kyei (2021) emphasises how war influences students' desire to seek educational opportunities abroad. For instance, due to the ongoing war between Ukraine and Russia, the Council of Higher Education has provided specific accommodations, such as the option for lateral transfers, for international students in Türkiye (YÖK, 2022).

Another factor emphasised frequently is the sub-theme of quality of education. For instance, students who highlighted the absence of desired programs in their home countries mainly study in engineering faculties.

"My country has no architecture education; it only offers civil engineering programs. Türkiye is a developed country in architecture, and the relations between my country and Türkiye are improving (Hasan, M, 22, B, Nigeria, Architecture)."
"For example, the quality of education in Saudi Arabia is quite inadequate. It is not as high as here (Hanan, F, 20, B, Saudi Arabia, Business Administration)."
"Because I wanted to continue my education, but there is no master's program in Jordan for Turkish Language and Literature, I came to Türkiye (Runiriha, F, 29, M, Jordan, Turkish Language and Literature)."

The cost of living has a substantial impact on students' decisions regarding their education. Additionally, the quality of education in the destination countries plays a crucial

role in shaping their preferences (Van Mol & Timmerman, 2014). For example, Weber & Van Mol (2023) assert that the quality of education in the chosen country is a key factor in students' choices. Similar results were observed in this study, where students who selected Türkiye expressed that the quality of education here was superior to that in their home countries. In line with the studies above, Kethüda (2015) also concluded that international students travel to other countries to pursue higher-quality education. This study corroborates the results reported in the studies above. However, it also diverges by identifying that students chose Türkiye due to the absence of their desired field of study in their home countries.

In the same sub-theme, inequality of opportunity and costs in students' home countries is also significant. Some students complained about not being accepted into the programs they desired in their home countries and criticised their countries for this. However, a holistic view of the interviews indicates that economic conditions largely determine the students' experiences of inequality. In this sense, inadequate scholarships and high living costs in their home countries are general issues that trouble students.

> *"The cost of education in Türkiye is something I couldn't afford compared to my own country (Romario, M, 19, B, Egypt, Architecture)."*
> *"Before coming here, I did some research about Türkiye. I found it somewhat affordable financially, whereas the economic cost in my country is high (Kafele, F, 26, B, Yemen, English Teaching)."*

Khalid Urbański (2021) state that disparities in opportunities are a significant factor compelling students to pursue education in other countries. The same study also found that students are motivated to study abroad due to the high cost of education in their home countries. The results of this study align with those obtained in other studies. Furthermore, Parkins (2010) emphasises that disparities in opportunities and education costs are a push factor, driving students to seek scholarship opportunities in other countries for their studies.

The sub-theme of job opportunities shows that one of the most motivating factors for students is different job opportunities. The inadequacy of job opportunities in underdeveloped or developing countries drives students to pursue education in other countries instead of their own. Some students believe they cannot find a job in their home country after obtaining their bachelor's degree. A significant portion of the students who participated in this study emphasised that job opportunities in Türkiye are better than in their own country.

> *"There is a job problem in my own country. Now I see this place as my second home and plan to become a Turkish citizen to find a job (Ajna, F, 25, M, Bosnia-Herzegovina, Pre-school Teaching)."*
> *"I want to venture into Eastern Europe. It is difficult to find a job in my country and Türkiye (Abdurrahim, M, 23, B, Iran, Control and Automation Engineering)."*

"As I said, I will work wherever I find a job. It is entirely job-related; I will work wherever I find a job, here or in Europe. For example, in Germany or elsewhere (Secat, M, 20, B, Yemen, Industrial Engineering)."

The literature examining employment opportunities contains numerous studies. In this regard, job opportunities constitute a prominent factor influencing student choices. For instance, studies by Carbajal & Calvo (2021) and Khalid & Urbański (2021) revealed that students migrate to other countries due to job opportunities. After completing their education, they often remain in the host countries because of the abundance of employment prospects. Other studies have reached similar conclusions (see Llull, 2014; Levent & Karaevli, 2013). The results achieved in this study also parallel the sub-theme results of the studies above.

4.3. Attractive Socioeconomic Factors on the Education Path

Considering the quality of Turkish universities and their impact on the transition to Europe, it is understood that the quality of Turkish universities and their role in facilitating the transition to Europe are two of the most emphasised factors driving students to pursue education in Türkiye. The perception that Turkish universities' educational system and structure are similar to those in Europe is a significant motivator for students to study in Türkiye. For instance, some students frequently highlight the recognition of Turkish universities in Europe, the ease of acceptance at European universities with the diplomas they receive, and the opportunities provided by the Erasmus mobility program.

"Turkish universities are increasingly recognised in education quality, and some institutions are globally ranked (Aman, M, 19, B, Nepal, Dentistry)."
"Türkiye hosts leading universities with the highest academic quality and a wide range of offerings. Several Turkish universities are internationally recognised as prestigious educational institutions offering top-notch education at reasonable tuition fees compared to similar international institutions' costs (Hajer, M, 30, M, Sudan, Electrical and Electronics Engineering)."
"I believe that after obtaining a diploma, it is effective in terms of its recognition by European countries. Because many universities here are reputable and their diplomas are recognised (Helen, F, 23, B, Greece, Theology)."
"Yes, the university ECTS system is very close to Europe, and there are a lot of Turkish universities recognised by Europe (Mohamed Murtada, M, 25, B, Sudan, Mechanical Engineering)."

The cost of living in various countries significantly affects students' preferences. The quality of education and the provision of financial resources to support student's education emerge as attractive factors influencing their choices. Students who perceive the cost of living in Türkiye as more affordable often seek ways to migrate to European countries after completing their education. In this context, Türkiye serves as a transit country. For instance, studies by Ahmad & Buchanan (2016) and Eder et al. (2010) also conclude that living costs

impact students' preferences. The present research shares similarities with these studies. Moreover, regarding students who aim to use Türkiye as a transit route, İçen et al. (2022) suggest that international students studying in Türkiye view the country as a bridge for transitioning to European countries. The present study also reaches similar conclusions.

Moreover, in the scholarship sub-theme, it is found that students who want to study in other countries research the conditions of the country they will go to when making their choice. The first sub-theme used to identify the attractive reasons for students to study in Türkiye is the scholarship opportunities provided by Türkiye for international students. Students frequently mentioned scholarships during the interviews. For example, medical students' attitudes on this issue are pretty strong due to the high cost of medical education in Türkiye and their own countries. However, the scholarship category ranks second after the sub-theme of quality university education in students' preference for Türkiye.

> *"A good relationship also facilitates finding scholarships, sponsors, and funding while being here. Many different scholarships are offered to students from my country in Türkiye, making it as easy as studying in other countries (Abdulrezzak, M, 24, B, Tanzania, Electrical and Electronics Engineering)."*
> *"The quality of education at universities comes first for me in my decision to study here, but scholarship opportunities are also significant, along with cultural experience and personal interests (Eleri, F, 20, B, Ethiopia, Medical Laboratory Techniques)."*
> *"A scholarship was necessary for my education. I earned admission here with a 100% scholarship, so it was a good opportunity for me (Zerina, F, 23, B, North Macedonia, Psychological Counseling and Guidance)."*

In a study by Atabaş and Köse (2023), results similar to those reported in the present study were reached, indicating that scholarships are a significant factor for international students seeking education abroad. Additionally, Balaz and Williams (2004) and Lipura and Collins (2020) highlighted the importance of scholarships in covering living expenses, emphasising that financial support is central to international students' preferences.

Considering the sub-theme of cultural and religious affinity, it is understood that besides scholarships being an essential factor, students' cultural and religious expectations of students also motivate them to pursue education in Türkiye. During the interviews, students emphasised that their families sent them to Türkiye for religious reasons and that the decision was not solely theirs. Some students also stated that they chose Türkiye because they believed they could practice their religious duties comfortably. For students of Turkish descent, the situation differs as they claim to have come to Türkiye by emphasising ethnic similarities.

> *"I came to Türkiye because it is a Muslim country (Abdulaziz, M, 24, B, Chad, Theology)."*

"Among the reasons for choosing Türkiye is the high quality of education. Another reason is that we are Muslims, and Türkiye is a Muslim country, so we feel comfortable here. We are advantaged compared to other countries; we can find a mosque every 200 meters, and nobody interferes with our religious beliefs (Paulias Atopare, M, 21, B, Papua New Guinea, Biology)."

"Kazakh and Turks are similar languages and peoples, so this is important (Gül, F, 18, B, Kazakhstan, Gastronomy)."

"It was a bit easier for me because my native languages are Kazakh and Uyghur. For example, Turkish, Uyghur, and Kazakh are like each other. That's important in my choice (Sandina, F, 20, B, Kazakhstan, Finance)."

Although religion is essential, cultural closeness also significantly influences students' preferences. Cultural closeness and religious similarity are among the most frequently emphasised situations in students' decisions to choose Türkiye. One significant result of this study is that the students claim that their cultural and religious characteristics are similar to those in Türkiye. In particular, students of Turkish origin stated that they preferred to study in Türkiye because their language was close to Turkish. In addition, students frequently emphasised that they wanted to study in Türkiye because they believed that religious life in Türkiye was similar to their own country. Moreover, students who feel culturally and religiously close to Türkiye have expressed their desire to pursue education in the country for several reasons. For instance, Türkiye's rich cultural heritage resonates with many students. Blending Eastern and Western cultures creates a unique environment that attracts those interested in diverse cultural experiences. Many students share similar cultural and religious values with Türkiye, fostering a sense of belonging and community. This shared understanding enhances their motivation to study in an environment that aligns with their beliefs. Since the historical ties between Türkiye and various countries create a sense of familiarity, students often feel connected through shared history. Lastly, the perception of Türkiye as a hospitable country enhances students' willingness to study. They believed that Turkish society's warm and welcoming nature could ease their adaptation. The results of this study share similarities with those reported by Yalçınkaya and Beşirli (2022) and Topak and Tauscher (2020), both of which found that international students prefer Türkiye for educational purposes due to geographic, religious, and cultural reasons. The study carried out by Topak and Tauscher (2020) addressed the impacts of cultural, historical, and religious factors on students' educational choices, concluding that these reasons influence students to pursue education in Türkiye. Similarly, Doerschler (2006) and Dustmann and Frattini (2014) argued that cultural and religious reasons affect student choices and noted that students are more inclined to study in countries with higher religious tolerance. The results achieved in this study also align with other studies, showing that students are tempted to study in countries where they can be more comfortable regarding religion and culture.

Even if cultural and religious similarities are often highlighted as pull factors, the geographical proximity to the European sub-theme also takes into account the resemblance of the Turkish education system to that of European countries and Türkiye's geographical

location, which are influential in shaping students' preferences. Arab ethnic students, who could choose from many countries (such as Qatar, the United Arab Emirates, and Saudi Arabia), have prioritised Türkiye due to its geographical proximity to Europe. Moreover, regardless of their country of origin, some students aim to complete their undergraduate education in Türkiye and then pursue graduate studies in Europe.

> *"Türkiye, located at the intersection of Europe and Asia, provides easy access to both continents, making it an attractive location for students seeking to explore various cultures and travel opportunities to Europe (Aman, M, 19, B, Nepal, Dentistry)."*
> *"... I also want to conduct my business in Europe; the transition is easy (Kostas Dimitriadis, M, 24, B, Greece, International Relations)."*
> *"Türkiye's geographical and educational proximity to Western countries adds to its appeal for education, offering a blend of Eastern and Western influences (Otabek, M, 20, B, Kazakhstan, International Relations)."*
> *"I wanted to choose a country close to Iran. I also wanted my family to be able to come to me easily (Farzad, M, 21, B, Iran, Medicine)."*
> *"I chose this place because it is close to Iraq. I never considered living in the West (Ashna, F, 23, B, Iraq, Theology)."*

The results achieved in this study are similar to those reported by Zijlstra (2020) and İçen et al. (2022), which highlighted the importance of Türkiye's geographic proximity to Europe in students' preferences. Both studies emphasised that students consider Türkiye's location a significant factor in their decision-making process.

The job opportunity's sub-theme is among the most frequently discussed topics in interviews, serving as both push and pull factors. This is primarily due to the lack of job opportunities in their home countries and the belief that they will earn higher incomes in developed countries. Poor economic conditions in their home countries and inadequate job opportunities motivate international students to seek education in countries with better employment opportunities and higher living standards. This expectation motivates students to pursue education in developed or developing countries. Besides the lack of job opportunities, students also emphasise the working conditions, income, and living standards in the countries they wish to visit during interviews. Although finding a job seems to be a general reason, students who emphasise job opportunities expressed that they are in Türkiye to have a more comfortable life.

> *"There are many factories in Eskişehir. They produce a lot of things. That's why I looked it up on Google. There is a sugar factory in Eskişehir. There is trade, and there are factories related to chemical engineering. I wanted to come here (Abidemi, M, 28, B, Zambia, Finance)."*
> *"If I find a job here, I will work (Secat, M, 20, B, Yemen, Industrial Engineering)."*
> *"One of the reasons is that my country has numerous problems; education is frequently interrupted. There are no jobs; life is difficult (Abubakar, M, 19, B, Sudan, Civil Engineering)."*

The studies conducted by Carbajal and Calvo (2021), Khalid and Urbański (2021), and Zanabazar et al. (2021) also share similarities with the results obtained in this sub-theme, which indicate that students are drawn to countries with higher job opportunities. Metin (2022) and Levent and Karaevli (2013) reached similar conclusions, asserting that job prospects are a significant factor that attracts students to pursue education abroad.

In conclusion, the most frequently expressed push and pull factors for international students (n = 40) are the desire to continue their education. The second reason is Türkiye's cultural and religious similarity to their home countries (n=38). The third factor attracting students to study in Türkiye (n = 28) is its comparatively affordable economic conditions. Other frequently mentioned topics include scholarships (n = 28) and friends' recommendations (n = 12). Lastly, Türkiye's proximity to Europe has also influenced students' decisions to study there (n = 35). However, this result does not imply that all students will migrate to Europe for further education or employment. For instance, 18 students expressed their intention to stay in Türkiye after completing their education. Additionally, 13 students, including most medical students, plan to return to their home countries after completing their education. Finally, considering the problems encountered, international students studying in Türkiye have reported negative experiences due to discrimination (n = 15), difficulties in learning the language (n = 32), cultural adaptation (n = 27), and the complexity and length of the education system (n = 30).

5. Conclusion and Suggestions

This study emphasises that international student mobility to Türkiye is quite intense and demonstrates that the interaction of various factors shapes this mobility. Therefore, the challenges students face and the reasons for choosing Türkiye are crucial topics that need to be analysed at individual and societal levels. These results offer valuable insights for developing policies to enhance the educational experiences of international students in Türkiye. Examining the results achieved, the present study first focuses on the profiles of international students studying in Eskişehir and the problems they encounter. Interviews revealed that students in Eskişehir experience discrimination, difficulties in learning the language, cultural adaptation issues, and concerns related to the education system. Some students were found to face discrimination based on their ethnic backgrounds. Moreover, challenges in learning Turkish and adapting to a different culture are significant difficulties students encounter. Furthermore, the reasons why students choose Türkiye were examined in detail. Factors such as the quality of education at Turkish universities, the country's religious and cultural similarity, geographical location, economic opportunities, and scholarship options are considered influential in students' decisions to choose Türkiye. A significant result in the present study is the systemic similarity between universities in Türkiye and those in Europe. In this respect, Türkiye's perception as a bridge to Europe plays a vital role in students' decisions to choose Türkiye. Moreover, in addition to the scholarship opportunities provided by Türkiye, the relatively lower costs of education and living compared to other countries also influence students' decisions.

According to the results achieved in this study, students face significant challenges in the social integration process in Türkiye due to language barriers and ethnic discrimination. Arabic-speaking and African-origin students, in particular, frequently reported being excluded because of their skin colour and the language they speak. Students are often subjected to various forms of discrimination, primarily due to social media and misconceptions held by the local population. Such discriminations hinder students' long-term cultural adaptation. Another significant result of this study is that students experience difficulties adapting to local food and lifestyles, especially during their first year in Türkiye. It was found that preparatory classes and Turkish language courses helped students successfully navigate the process of societal adaptation. From this perspective, the first year is a critical period for students in terms of cultural integration and socialisation. Another significant result is that students are primarily motivated to choose Türkiye because its education system is similar to that of Europe, making Türkiye a gateway for transitioning to Europe. Mainly from the perspective of international students, programs like Erasmus are essential for facilitating future transitions to Europe. Additionally, transitioning to Europe has a significant impact on the students' long-term educational and career plans. A final notable result is the significant increase in students' motivation to find employment in Türkiye. Many students said they would consider staying in Türkiye if provided with quality job opportunities. It is also understood that many students choose to study in Türkiye due to difficulties in finding employment in their home countries.

This study offers suggestions for better analysing ISM's multidimensional nature and developing policies in this area. First, policy recommendations are prioritised and listed in three sub-recommendations: scholarships and financial support, improving the quality of education, and integrating into the labour market. In the context of scholarships and financial support, Türkiye should allocate more financial resources to increase the quality of international student mobility. Existing scholarship programs should be expanded to allow more students to benefit from these opportunities. Special emphasis should be placed on scholarship programs for disadvantaged groups to increase their access to educational opportunities. The second recommendation is to enhance the quality of education in Türkiye and its compliance with international standards. This way, the aim should be to attract more quality international students to the country. Additionally, Turkish universities should be encouraged to participate in international accreditation processes, aligning the education system with global standards. Incentives should also be provided for academic staff to gain international experience and improve their foreign language proficiency. The third recommendation involves developing policies to facilitate the integration of international students into the labour market after their education. In this context, post-graduation residence and work permits should be simplified, and programs should be established to assist international students in finding employment. Finally, support policies should be developed to encourage employers in the country to hire international students.

In conclusion, this study also offers other research suggestions. More detailed and comprehensive studies on the problems faced by international students in Türkiye should be carried out. These studies should examine students' motivations for choosing Türkiye

through various factors such as educational quality, economic opportunities, and cultural interaction. Additionally, it is recommended to investigate the bureaucratic, language, and cultural barriers that students encounter during the adaptation process. Furthermore, researchers interested in exploring this topic could delve deeper into the sociocultural adaptation processes of students and conduct long-term observations to gain detailed insights into the challenges they face. Specific issues such as language barriers, discrimination, the commodification of higher education, religious challenges, and family pressures can be investigated using mixed methods. Lastly, it is recommended that those interested in this topic also focus on the labour market and discuss the challenges faced by international students in this area. Moreover, as this study primarily focused on students from low-income countries, researchers are encouraged to enrich their work by examining students' experiences from developed countries and the push-and-pull factors that lead them to pursue education in Türkiye. Addressing language barriers and cultural adaptation, universities in Türkiye could offer more comprehensive orientation and cultural integration programs specifically designed for international students. These programs could provide practical insights to help students adjust to life in Türkiye more easily. Additionally, guidance and support programs could be developed to help international students adjust to the Turkish educational system. These would focus on specific topics such as the exam structure and academic expectations, helping students to enhance their academic performance. Given the frequent reports of discrimination, universities might consider implementing cross-institutional policies to combat discriminatory practices. Awareness campaigns could also be developed to counteract biases stemming from social media and foster greater community engagement.

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The Effect of Economic Policy Uncertainty (EPU) of the Trade Partner Countries on the Real Effective Exchange Rate of Türkiye

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Ticaret Ortağı Ülkelerin Ekonomik Politika Belirsizliğinin (EPU) Türkiye Reel Efektif Döviz Kuru Üzerindeki Etkisi

Abstract

This study investigates whether external uncertainties, which significantly impact the exchange rate through various economic channels, are a determining factor in the Turkish economy. The research analyses the impact of the effective exchange rates (EPUs) of five countries, among Türkiye's most important trading partners, on Türkiye's real effective exchange rate using monthly quantile regression for the period 2000-2021. According to the key findings, the EPUs in the UK and France increase the value of the Turkish lira against foreign currencies, resulting in an appreciation of the TL, while the EPUs of the USA and Germany decrease the value of the Turkish lira, resulting in a depreciation of the TL. In addition, Russia's EPU has a negative impact on Türkiye's real effective exchange rate at only the highest quantile level. The results reveal that the Turkish economy is affected by any economic event in foreign powers, highlighting how globalisation has blurred the distinction between national borders and how countries are interconnected through invisible ties.

Keywords	:	EPU Index, Economic Policy Uncertainty, Real Effective Exchange Rate.
JEL Classification Codes	:	E60, D80, F40.

Öz

Bu çalışmanın amacı, çeşitli ekonomik kanallara sahip olan döviz kurunun kontrol edilmesinde kilit rol oynayan dış belirsizliklerin Türkiye ekonomisi üzerinde belirleyici bir güce sahip olup olmadığını araştırmaktır. Araştırmada, Türkiye'nin en önemli ticaret partnerlerinden olan beş ülke EPU'sunun Türkiye'nin reel efektif döviz kuru üzerindeki etkisi, 2000-2021 dönemi için aylık frekansta kantil regresyon kullanılarak analiz edilmektedir. Temel bulgulara göre, İngiltere ve Fransa için EPU, Türk lirasının yabancı para birimleri karşısındaki değerini artırırken (TL için değer kazancı), ABD ve Almanya için EPU ise Türk lirasının değerini düşürmektedir (TL için değer kaybı). Ayrıca, Rusya'nın EPU'su Türkiye'nin reel efektif döviz kurunu yalnızca en yüksek yüzdelik kantil diliminde negatif olarak etkilemektedir. Sonuçlar, küreselleşme ile birlikte dünya sınırlarının ortadan kalktığını ve ülkelerin birbirini bağlayan görünmez bağlarla birbirine bağlandığını göstermenin yanı sıra, Türkiye ekonomisinin dış güçlerde yaşanan herhangi bir ekonomik olaydan nasıl etkilendiğini ortaya koymaktadır.

Anahtar Sözcükler	:	EPU Endeksi, Ekonomik Politika Belirsizliği, Reel Efektif Döviz Kuru.

1. Introduction

The world has faced numerous events that have caused global political and economic uncertainty to date. Borders have disappeared as the world has opened its doors to globalisation, and the situation has reached the point where an economic, political, or social event in any country can affect other countries. Over the last few years, economic and political events began with the Arab Spring and continued with the trade wars and the COVID-19 coronavirus pandemic. While the pandemic persisted, the events related to the Russian Federation's occupation of Ukraine also affected the countries' relations. As these events unfold around the world and the world continues to develop and change rapidly, changes such as these produce a perception of political and economic instability, increasing worldwide uncertainty.

Economic uncertainty could be defined as unexpected alterations that affect the economic atmosphere and how these changes in monetary, fiscal, or other government policies affect firms (Abel, 1983: 228-233), while the World Bank (1997) defines political uncertainty as "Political uncertainty is the incapacity to endure shocks from the outside and inside that upend the socioeconomic system". A country's economy and political atmosphere are inextricably linked, much like the two halves of an apple. This is because uncertainties, whether in political or economic life, increase the risk of delaying businesses' and individuals' expenditures and investments, as they cause market uncertainty.

Economic policy uncertainty (EPU) refers to the situation in which there are uncertainties and fluctuations regarding the direction of a country's economic policies (Jmaii & Gargour, 2023). These uncertainties can make it challenging to predict policy trends and changes in monetary, fiscal, and trade policies, as well as other economic decisions (Liming et al., 2020: 1; Gupta et al., 2018). Policy uncertainties play a critical role in shaping the economic results of each country. Uncertainty is very significantly impacted by the spending and investment of governments, policies, businesses, and households (Kostka and Van Roye, 2017). In particular, increasing unemployment and income inequality, which are common problems in many countries, as well as immigration and sudden fluctuations in oil prices, have made interlinked global economies even more disruptive (Dong et al., 2019). In this respect, Baker et al. (2016: 1594-1602) say that the global financial crises, partisan policies spreading in the USA, and uncertain economic policies raise concerns.

The effects of the EPU on the real effective exchange rate can vary depending on various factors. Political and economic instabilities can impact the financial and economic sectors, particularly the exchange rate, through multiple channels (Ozcelebi & Izgi, 2023). Trade barriers, preferences, import-export policies, external debt situations, capital movements, portfolios, and relative productivity can be considered as these channels (Kostka & Van Roye, 2017). When the EPU increases, uncertainty and risk become apparent in investors and international capital markets. In this case, confidence in the country's economy may decrease, and foreign investors may lose interest in the country's assets. This may impact the country's demand for foreign exchange, resulting in a downward pressure

on the real effective exchange rate. If a country's exchange rate is subject to a free-floating system, an increase in the EPU can directly affect the country's exchange rate. Investors' demand for the local currency may decrease due to uncertainty, which may pressure the exchange rate. An increase in EPU may cause uncertainties in trade policies, making it difficult for export and import firms to forecast future trade conditions. This, in turn, may affect the deterioration in the foreign trade balance and, thus, the exchange rate. On the other hand, the increase in the EPU could also impact the central bank's monetary policy determination process (Liming et al., 2020). The central bank may be more cautious in an uncertain economic environment. This, in turn, can affect interest rates or the money supply, leading to changes in the exchange rate. All of these can cause fluctuations in the currency markets. These fluctuations can lead to short-term volatility in the exchange rate. In this case, the exchange rate can change rapidly, which in turn affects the real effective exchange rate. All these factors cause fluctuations in exchange rates due to their uncertain nature. The link between economic uncertainty and the exchange rate has a decisive impact on the economy through various channels (Kostka & Van Roye, 2017).

Figure: 1
Exports by Country (2022, billions $)
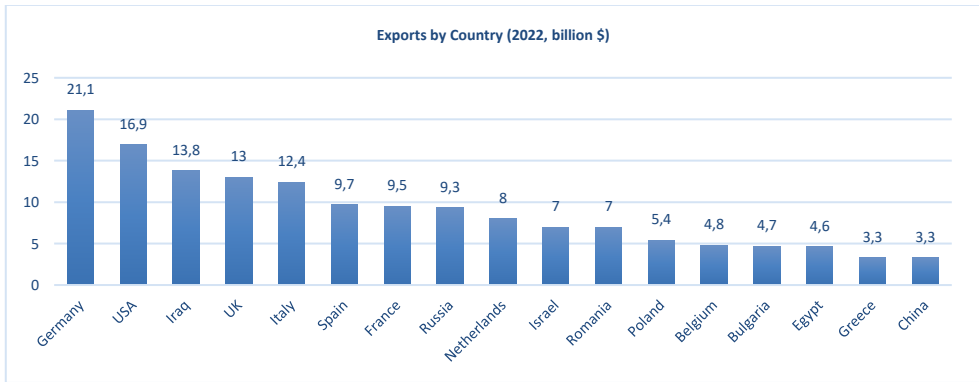
Sources: TİM- 2022 Export Assessment by Turkish Exporters Assembly.

When we look at the TİM-2022[1] Export Assessment (see Figure 1), it is clear that Germany is the country to which Türkiye exports the most in 2022, with a value of $21.1 billion. Following Germany, the United States ranks second with $16.9 billion, Iraq ranks third with $13.8 billion, the United Kingdom ranks fourth with $13.0 billion, and Italy ranks fifth with $12.4 billion. While five out of the top ten countries are members of the EU, the fact that the USA, from North America, Iraq, and Israel, from the Middle East, are on the list indicates that Türkiye's capabilities in market diversity have improved. Therefore, the sample-generated economies are the five selected trading partners of Türkiye, including the United States, France, Germany, the United Kingdom, and Russia. The motivation behind

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[1]   TİM- Turkish Exporters Assembly (Türkiye İhracatçılar Meclisi).

the study is the lack of an extensive theoretical and empirical examination of the impact of economic uncertainty in countries with which Türkiye trades on Türkiye's exchange rate.

The study shows the effects of EPU on the exchange rate, as measured by these countries' news-based Economic Policy Uncertainty Index. The EPU index catches uncertainty from policy, news, economic indicators, and the market (Baker et al., 2016: 1598-1600). This index is measured as follows, combining all of these variables into a new measure (the EPU index) by averaging three components: the amount of economic uncertainty connected to policy covered by newspapers, the number of federal tax law provisions that are about to expire, and the degree of disagreement among economic predictors. The study employs the Quantile Regression methodology to investigate the association between countries' EPU and Türkiye's exchange rate across different quantiles, as examining samples in these quantiles reveals the relationship more clearly. Comprehending relationships between factors outside the data's mean is made possible by the quantile regression methodology, which clarifies non-normally distributed outcomes and has nonlinear associations with predictor variables. In this respect, the research correlated economic policy uncertainties with exchange rate fluctuations over 22 years (2000-2021) at a monthly frequency using Quantile Regression. Therefore, due to the nature of the research and the data gathered, the study contributes to finance and economics by illuminating the consequences of EPU on the exchange rate. This study is particularly beneficial for academics, financial analysts, researchers, and economists, as it provides valuable insights into the impact of policy uncertainty on currency fluctuations.

The study findings indicate that economic uncertainties in the UK and France increase the value of the Turkish lira against foreign currencies, resulting in appreciation for Türkiye, which in turn enhances Türkiye's trade competitiveness. On the other hand, the economic policy uncertainties of the US and Germany diminish the value of the Turkish lira. Moreover, Russia's EPU has the most significant impact on the domestic real effective exchange rate in the highest quantile. The results can originate from Türkiye's strong or weak trade relations with these countries. When Türkiye's relations with the US and Germany are taken into consideration, it becomes apparent that they have more sensitive relationships. Therefore, Türkiye can easily be influenced by economic or political events in the US and Germany. As a result, the effect of the EPU on the real effective exchange rate is a complex issue. It may vary depending on the country's economic structure, policy framework, and international conditions. The likelihood of volatility and changes in the exchange rate increases with uncertainty.

The rest of the paper is structured as follows: Section 2 addresses the literature about EPU. Section 3 mentions the data and methodology. Section 4 presents the study's results and findings. The last part includes the conclusion.

2. Background Literature

The literature reveals a historical relationship between the appreciation of the national currency and the political atmosphere of countries. Political issues significantly influence the exchange rate, where positive political indicators raise the currency's value, whereas political tensions weaken or depreciate its value (Blomberg & Hess, 1997: 189-205). Political uncertainty and instability have a direct impact on the currency exchange rate (Youness, 2022: 414-424). For example, the political context significantly increases exchange rate volatility. Lobo and Tufte (1998: 351-365) note that political factors, including elections, political systems, and policy decisions, have a significant impact on the exchange rates of numerous currencies.

The World Bank (1997) defines political uncertainty as "the inability to endure shocks from outside and inside that upend the socioeconomic system." On the other hand, economic uncertainty is defined as unexpected changes that affect the economic ecosystem and how fiscal, monetary, or other government policies affect firms (Abel, 1983: 228-233). According to Osterloh (2010: 5), a nation's political climate can affect its economic performance. Due to the decline in investment resulting from political instability, employment rates and productivity suffer, incomes fall, and eventually, inflation results (Easterly & Rebelo, 1993: 429-430; Benhabib & Spiegel, 1992: 144-145). Therefore, political and economic risks are represented by political events and decisions that affect the business environment, causing investors to remember their investments with a reduced margin of profit (Howell & Chaddick, 1994: 76).

Besides the micro context, each nation's financial and economic policies are intimately linked to its economic strategy (Gupta, 2018). Fundamental concerns regarding the function of macroeconomic stabilisation measures underlie interest in policy uncertainty and its impact on economic activity (Mumtaz & Ruch, 2023: 6). Hence, uncertainty or instability significantly affects the financial and economic sectors, particularly the exchange rate. The unstable political environment of countries is a significant factor that weakens national economies and deters investors; therefore, economic prosperity is generally linked to political stability and security. For example, Aisen and Veiga (2011: 3) characterise political instability as a serious condition that harms economic performance. Political instability reduces policymakers' expectations of the inadequacy of short-term macroeconomic policies (Kostka & Van Roye, 2017). Moreover, political uncertainty leads to frequent policy changes, negatively impacting local economies through economic and political fluctuations.

Regarding economic control mechanisms, economic policy announcements determine the business cycle expectations. Therefore, expectations have a deterministic effect on decision-makers in an economic environment. Announcements impact expectations, but so does the uncertainty surrounding the direction that economic policy will take in the future (Beckmann & Czudaj, 2017: 2). Therefore, uncertainties affect the economy through various channels. One of the most important factors is the exchange rate,

which is influenced by multiple factors, including trade barriers, preferences, import-export policies, external debt situation, capital movements, portfolios, and relative productivity (Kostka & Van Roye, 2017). All these factors cause fluctuations in exchange rates due to their uncertain nature. The link between the exchange rate and economic uncertainty has a decisive impact on the economy through these channels (Kostka & Van Roye, 2017).

Economic policy uncertainties (EPU) contribute to exchange rate volatility (Bartsch, 2019: 21; Nilavongse, 2020: 4). There is a negative mean and excessive dependency between EPU and FERs (real exchange rates) because provide compelling proof of causality-invariance from both local and U.S. financial and EPU to FER (Al-Yahyee et al., 2019: 66). Economic policy uncertainties are reflected in countries as economic fluctuation and changes in the exchange rate. Political polarisation and division, as well as the growing role of government spending in the economy overall, are the leading causes of the rise in the EPU index in the USA during the 1960s (Baker et al., 2016: 4). According to another study involving US-related work, if the US EPU remains low, high-yielding currencies are appreciated, while the Japanese yen depreciates, and otherwise conversely (Kido, 2016: 52). Both the home country (ten countries[2]) and during difficult economic times, concern about US economic policy increases currency volatility (Krol, 2014: 251-252). The article highlights that policy uncertainties, particularly during economic downturns, can hinder economic growth by amplifying volatility in foreign exchange markets. International investors need to be aware of the risks associated with EPU in the foreign exchange market. For example, while China's EPU has been very high since 2016, the exchange rate has experienced significant fluctuations during this period (Dai et al., 2017: 37). Moreover, although the local currency depreciates in most quantiles during a floating exchange rate period, it increases under specific quantiles in response to increased uncertainty around Russian economic policy (Sohag et al., 2021: 542-544). Moreover, the EPU index has a positive link with the exchange rates of the Indian rupee and the new Mexican peso (Aimer, 2021: 126). Policy uncertainty has negative impacts on economic growth, consumption, and investment in Türkiye, where high uncertainty leads to more investment declines than production and consumption (Şahinöz & Coşar, 2018: 1-4). The COVID-19 pandemic ultimately impacted our lives until a few years ago, shifting the focus from uncertainty in monetary and fiscal policy to uncertainty in trade policy (Song et al. 2022: 14).

EPU hinders imports of non-durable consumer goods, capital goods, and those used in export production. It has been demonstrated that a 1% increase in policy uncertainty results in a 0.02% decrease in the growth of goods and services trade volume, indicating that uncertainty hinders trade growth (Constantinescu et al., 2020: 287). On the other hand, as EPUs contain indefinite structures, their effects vary from country to country; each country's EPU can have a heterogeneous impact on other countries (Chen et al., 2020: 3-4). For

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[2] *Canada, the Euro Area, Japan, Sweden, the United Kingdom, Brazil, India, Mexico, South Africa and South Korea.*

example, China's exchange rate volatility is affected differently by EPU in different countries (Chen et al., 2020: 3).

In summary, the EPU is commonly used as an indicator to enhance the predictive ability of macroeconomic models for future exchange rate events (Abid, 2020: 7-10). However, although the literature has decisively examined how the exchange rate is affected by uncertainty in economic policy, these studies are limited to certain countries due to difficulties in accessing data.

In Figure 2, the EPU of the US indicates that some political and economic issues emerged between 1985 and 2019. The Black Monday event occurred on October 19, 1987, when the world's stock markets experienced significant losses in a short period, directly affecting the US exchange rate. As evident in various political and economic issues, the exchange rate has always been sensitive to political factors, including elections, political systems, and policy decisions, which significantly influence the exchange rates of many currencies (Lobo & Tufte, 1998: 351-365). Apart from this, restrictive policy activities applied by countries to each other's trade are also a significant determinant of exchange rates. In 2018, President Trump formally declared trade conflicts with numerous countries. Starting with steel and aluminium tariffs, uncertainties emerged worldwide, and the US exchange rate negatively affected this situation. Issues such as epidemics that affect the entire world and occur unexpectedly impact human health production chains and exchange rates due to their uncertain nature. For example, the emergence of the COVID-19 coronavirus had a significant impact on the dollar rate. Thus, all these events affected the other economies of countries such as Türkiye.

Figure: 2
EPU Index for the US

Source: S.R. Baker et al., "Measuring Economic Policy Uncertainty."
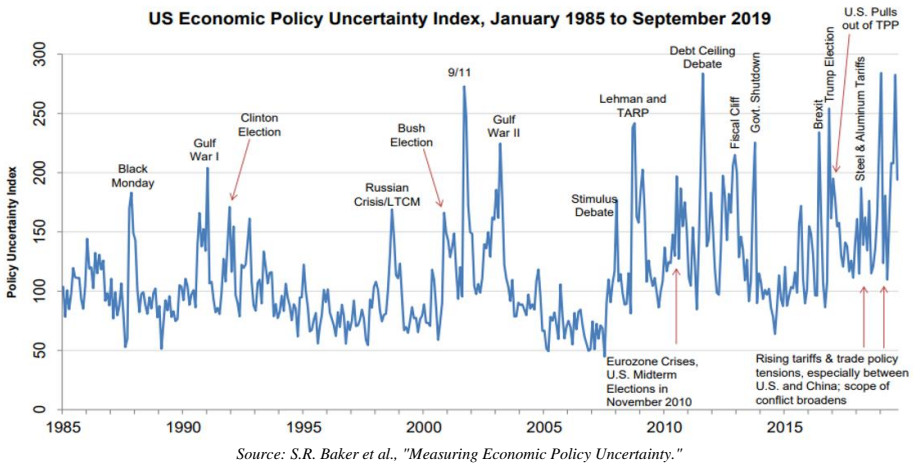
Figure: 3
EPU Index for Türkiye
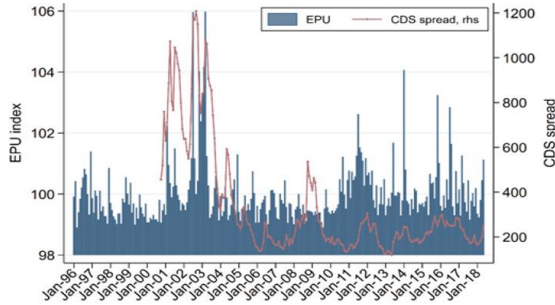
Source: La-Bhus Fah Jirasavetakul & A. Spilimbergo, Economic Policy Uncertainty in Turkey

Figure 3 illustrates Turkish EPU data, highlighting fluctuations arising from political and economic uncertainty over time (Jirasavetakul & Spilimbergo, 2018: 9). Notable uncertainties are evident, including the 2001 financial crisis, the 2008 financial crisis, and the European debt crisis in 2010. For 2001, both EPU and CDS (Credit Default Swaps) spreads are very high. This indicates that political and economic uncertainties increased, as did market risk perception, during the 2001 Turkish economic crisis. A similar effect can be observed in the 2008-2009 global financial crisis. Economic policy uncertainty may have increased the country's risk premium by negatively affecting investor perception. Considering the connection between economic activity and the uncertainty of economic policy in Türkiye policy uncertainty, the negative effect of EPU on the economy, consumption, and investment in Türkiye is proven (Şahinöz & Coşar, 2018: 3). Economic policy uncertainty can increase the risk premium, making it harder for foreign capital to flow in and raise financing costs. Therefore, governments must adopt transparent and consistent policies. In times of uncertainty, volatility in financial markets can be controlled by developing risk management tools. For example, using the Central Bank's reserve management and liquidity tools more effectively can help in this process. Economic policy uncertainty has a direct impact on financial stability at both local and global levels. Therefore, countries should adopt more predictable policies to ensure economic stability.

Figure: 4
The US, UK, Germany, France, and Russia's Economic Policy Uncertainties (EPUs)

US EPU

UK EPU

Germany EPU

France EPU

Russia EPU
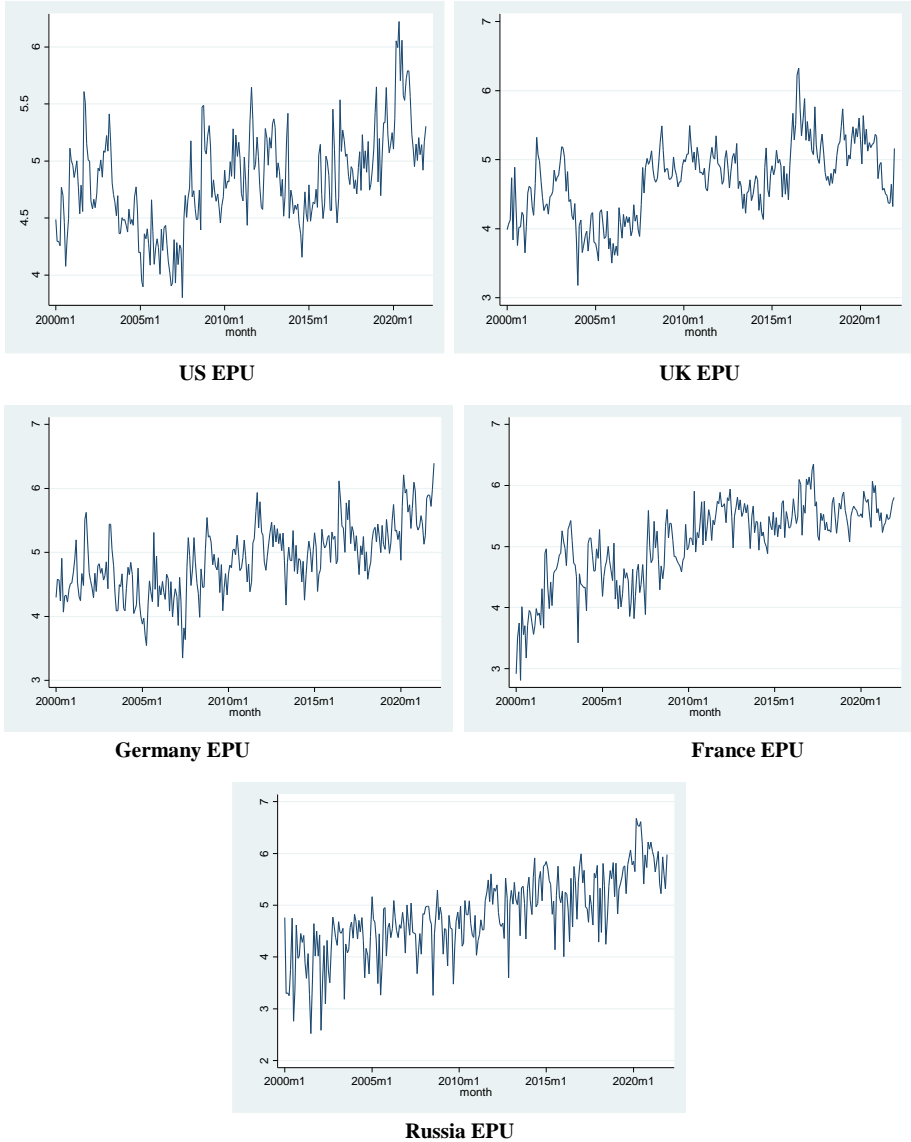
Source: Data is obtained from <policyuncertainty.com>; charts are created using STATA.

Figure 4 displays the EPU index charts for the United States, United Kingdom, Germany, France, and Russia. A notable standard feature of the charts is that, strikingly,

EPU increased in 2020 in these five countries due to the COVID-19 crisis. Significant EPU increases are observed periodically in all countries. These increases can be associated with significant economic and political events. The US EPU reached exceptionally high levels during and after the 2008 crisis. In addition, an increase was observed around 2016. This may have been due to the US presidential elections and policy changes. Examining the UK EPU graph reveals that EPU levels have increased significantly since 2016, mainly due to the impact of the Brexit process. In Europe, EPU fluctuations have generally become more pronounced during and after the Eurozone crisis. Germany and France may have been affected by global crises and political uncertainties in Europe. Russia's EPU has shown a significant upward trend since 2014, likely due to the Crimean crisis and subsequent sanctions. The long-term upward trend in all countries may indicate increasing uncertainty in the global economic system. Therefore, countries must take initiatives to increase their policies and international economic cooperation.

3. Data and Methodology

The datasets cover the period from 2000 to 2021, with data available for every month. The Real Broad Effective Exchange Rate for Türkiye is a dependent variable, expressed as a monthly index (2010=100), obtained from the FRED Economic Database. Weighted averages of bilateral exchange rates, adjusted for relative consumer prices, are used to calculate real effective exchange rates.

The EPU index is calculated using a variety of indicators, including the frequency with which policy uncertainty is mentioned in the news. However, this study used the EPU index, which is widely used to examine recent economic uncertainty. The EPU index is based on policy uncertainty collected from the news (Baker et al., 2013: 14-15). The index adopted three different measures of uncertainty based on newspapers from the US, UK, Germany, France, and Russia. The EPU index for countries is sourced from "policyuncertainty.com." For example, for the US, to measure economic policy uncertainty, the first component of this index is composed of three types of key elements, which come from 10 significant newspapers (San Francisco Chronicle, Houston Chronicle, USA Today, Miami Herald, Chicago Tribune, Dallas Morning News, Washington Post, Los Angeles Times, Boston Globe, and the Wall Street Journal) which is an index of search results. To create the index, researchers ran monthly searches for publications that included the phrases "uncertain" or "uncertainty," "economic" or "economics," and one or more of the following terms: "congress," "legislature," "white house," "regulatory," or "federal reserve". The total number of articles within a given article is divided by the raw number of policy uncertainty elements and months to observe how the volume of articles has changed over time for that specific article. From January 1985 to December 2009, the data for each item is standardised to a one-unit standard deviation. Then, for each month, the normalised values are added to create a multi-paper index. Between January 1985 and December 2009, the data was renormalised to an average of 101.8. The statistics from the preceding two months may be slightly revised with each subsequent monthly update. Some online publications do not instantly update their online archives with all stories, so the totals for the past 1-2 months

will vary significantly. The same procedure is also used to obtain the EPU index of the UK, Germany, France, and Russia. For example, 11 newspapers are used to measure the UK EPU index. For Germany and France EPU (for the European indices), two newspapers are used per country: Corriere Della Sera and La Stampa in Italy; El Mundo and El Pais in Spain; Le Monde and Le Figaro in France; Handelblatt and Frankfurter Allgemeine Zeitung in Germany; The Times of London and Financial Times in the United Kingdom. Kommersant was used as the newspaper to obtain Russian EPU data. The definitions and sources of Türkiye's real effective exchange rate, the EPU variables, and control variables are indicated for five foreign countries in Table 1.

Table: 1
Variables, Definitions, and Data Sources

Variables	Definitions	Sources
Real Effective Exchange Rate	Real Broad Effective Exchange Rate for Türkiye; CPI-based; period averages; Index 2010 = 100; Monthly; Not Seasonally Adjusted (Logarithmic Form) (An increase indicates an appreciation of the economy's currency against a broad basket of currencies).	Bank for International Settlements (FRED Economic Data)
Economic Policy Uncertainty (EPU)	Economic Policy Uncertainty (for USA, UK, Germany, France, and Russia) (As logarithmic Form)	www.policyuncertainty.com
Consumer Price Index (CPI) for Türkiye, Monthly Data	Index 2015=100, Not Seasonally Adjusted	Federal Reserve Economic Data (FRED)
Interest Rate for Türkiye, Monthly Data	Per cent per Annum, Not Seasonally Adjusted	Federal Reserve Economic Data (FRED)
Commodity Terms of Trade (TOT) of Türkiye, Monthly Data	The ratio of a country's relative export price to its relative import price (net export price index)	IMF Data

The quantile regression of the study can be written with the following equation:

$$Q_r(REXR_i / EPU_i) = a_0^r + B^r EPU_i + \gamma^r X + \varepsilon^r$$

According to equation, $Q_r(REXR_i/EPU_i)$ represents a quantile function of reel effective exchange rate evaluated at τ^{th} quantile, where $\tau \in (0, 1)$. The model is examined in the 5%, 25%, 50%, 75%, and 95% quantiles.

Table: 2
Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
EPU of US	4.825391	0.4271762	3.801823	6.222504
EPU of UK	4.703297	0.5311821	3.17955	6.324759
EPU of Germany	4.893346	0.5291106	3.347585	6.393484
EPU of France	5.060402	0.6571988	2.808971	6.353732
EPU of Russia	4.817591	0.7492331	2.517596	6.676623
Real Effective Exchange Rate for Türkiye	4.367308	0.1952738	3.67402	4.643621
Consumer Price Index (CPI) for Türkiye	4.225786	0.6673135	2.503633	5.574502
Interest Rate for Türkiye	2.993706	0.6408347	2.169054	4.094345
Terms of Trades (TOT) of Türkiye	4.620461	0.0150843	4.595872	4.653657

REXR is the monthly real effective exchange rate. EPU_i represents EPU for each country (US, UK, Germany, France, and Russia). The vector of coefficient $\beta\tau$ quantifies the level of exchange rate volatility dependency at the τth quantile with respect to EPU_i, which is the primary focus of the study. A group of control variables is represented by X. γ^{τ} will vary based on which quantile is being assessed. The control variables are successive: the

consumer price index (inflation) for Türkiye, the interest rate for Türkiye, and the terms of trade of Türkiye. Descriptive statistics and 264 observations for the 2000-2021 monthly data are presented in Table 2.

4. Results

In the analysis, the variables' data utilised in the study were employed by taking their logarithm to overcome the variable variance problem and to create efficient and systematic results (Ashwin Kumar et al., 2016: 298-7; Wang & Dong, 2021; Bhat et al., 2022). Table 3 presents the regression results for both the Quantile and OLS models for comparison. According to the regression results, the model explains 71% of the variance (R-square: 0.7057). According to Table 3, the quantile regression results indicate that the EPU for the US has a negative sign for every quantile, and this relationship is also statistically significant (except for the 75% and 95% quantiles). The EPU for the UK has a positive sign, and almost all quantiles are statistically substantial (except the 5% quantile). Additionally, the OLS result for the UK EPU is statistically significant and positive. The EPU for Germany has a negative sign and is statistically significant, except for the 75th and 95th percentiles. It is also statistically significant for OLS. The EPU for France has a positive sign for the 5%, 25%, and 50% quantiles, where the quantile and OLS regression are statistically significant. However, for the 75% and 95% quantiles, they are not statistically significant and have a negative sign. The EPU for Russia has a generally negative sign (except for the 50th and 75th percentiles, which have a positive sign); however, this difference is not statistically significant, except for the highest quantile, at 95%.

The interpretation of the results reveals heterogeneity among countries in the magnitude and persistence of their EPU shocks' responses to the real exchange rate. When the economic policies of the USA, Germany, and Russia (only the 95th quantile) are uncertain, the Turkish currency tends to depreciate. On the other hand, when the economic policies of the UK and France are unsure, the Turkish currency tends to appreciate. The results show that policy uncertainty in the trading partner countries has led to the depreciation or appreciation of the national currency.

According to the results, the variables of Türkiye's inflation rate, consumer price index, interest rate, and terms of trade are statistically significant and have negative signs. As shown in Table 3, a 1% increase in trade volume during the relevant period results in a decrease in the REXR. The effect of the terms of trade is relatively consistent across all quantiles (5% to 95%). This shows that the terms of trade have a similar effect on the exchange rate at all levels (lowest, middle and highest). The coefficient value in the OLS estimate is -6.213733, indicating that a one-unit decrease in the terms of trade results in a reduction of approximately 6.2 units in the exchange rate. According to the definition of the Bank for International Settlements (BIS), the REXR is structured in a way that any rise (or loss) in value is considered appreciation (or depreciation) (Bank for International Settlements [BIS], n.d.). Terms of trade can benefit real exchange rates; when they improve, the real exchange rate of the exporting country should be appreciated. An improvement in

trade terms would lead to an appreciation of the real exchange rate. However, the results indicate that the terms of trade lead to a depreciation of the domestic real effective exchange rate.

Table: 3
Quantile vs. OLS Regression Results

Dependent Variable: Real Effective Exchange Rate (REXR) for Türkiye						
	Quantile Regression					OLS Regression
	5%	25%	50%	75%	95%	OLS
EPU of US	-.144268***	-.1355942***	-.0997039***	-.0244317	-.0139153	-.079831***
	(.040219)	(.0497065)	(.0414082)	(.0308096)	(.0271663)	(.0276806)
EPU of UK	. 0136549	. 0722991***	. 0710719***	.0532059***	. 0574683***	.0405704***
	(.0288075)	(.0356031)	(.0296593)	(.0220678)	(.0194583)	(.0198267)
EPU of Germany	-.1265309***	-.1307144***	-.0731009**	-. 0341404	-. 0319815	-.1054195***
	(.0330828)	(.0408869)	(.034061)	(.0253429)	(.0223461)	(.0227692)
EPU of France	.1895249***	.1187725***	.0647388**	-.0078001	-.0298897	.0985177***
	(.0302729)	(.0374141)	(.031168)	(.0231904)	(.0204481)	(.0208352)
EPU of Russia	-.0251014	-.0069954	. 0062136	. 0027714	-.0251951*	-.0020883
	(.0203715)	(.025177)	(.0209738)	(.0156055)	(.0137601)	(.0140206)
Consumer Price Index for Türkiye	-.4424548***	-.3337675***	-.383416***	-.4002457***	-.4391689***	-.357938***
	(.034431)	(.042553)	(.035449)	(.0263756)	(.0232567)	(.023697)
Interest Rate for Türkiye	-.1972004***	-.151156***	-.1611427***	-.1880293***	-.1820674***	-.1689864***
	(.0314275)	(.038841)	(.0323567)	(.0240748)	(.0212279)	(.0216299)
Terms of Trades of Türkiye	-.7.081781***	-7.155007***	-6.006497***	-6.115098***	-4.763477***	-6.213733***
	(.9235832)	(1.141452)	(.9508917)	(.7075054)	(.6238416)	(.6356534)
_cons	39.5576***	39.5966***	34.38064***	35.02018***	-28.84075***	35.31786***
	(4.244548)	(5.245815)	(4.37005)	(3.25151)	(2.867014)	(2.921297)
Prob>F = 0.0000 R-square= 0.7057						
The square brackets and parenthesis numbers represent p-values and standard errors, respectively. Significance levels: *10%, **5%, ***1%.						

5. Conclusion

EPU is a deterministic power that affects the real effective exchange rate. Türkiye can be positively or negatively affected by events in foreign countries. The study employs quantile regression analysis to investigate the relationship between Türkiye's real effective exchange rate and the EPU of various markets from 2000 to 2021, with a monthly frequency. Our main findings are as follows. The EPUs of five countries have an asymmetric and heterogeneous effect on Türkiye's real effective exchange rate. If the US and Germany's EPU increases, the domestic real effective exchange rate increases, so it depreciates. However, if the UK and France's EPU rise, the domestic REXR will decrease, so it is appreciated. Moreover, only in the highest quantile does Russia's EPU increase, resulting in a depreciation of the real effective exchange rate. The inference is that the economic uncertainties in these five countries have asymmetric effects on Türkiye's real exchange rate. Thus, Türkiye is affected heterogeneously by the uncertainties of different countries. Intuitively, it can be said that the more a country has trade relations with another country, the more likely it is to be affected by that country's domestic issues.

The topic of EPU is an important indicator for understanding the dynamic of exchange rate changes. In a changing world, uncertainties are crucial in controlling the exchange rate, especially concerning policymakers. Therefore, this issue should be handled carefully to illustrate the connection between exchange rates and economic policy uncertainty. These findings offer policymakers valuable insights to inform their decisions on managing the exchange rate and maintaining economic stability. Since the EPU can

negatively affect the real effective exchange rate, countries have specific political implications and duties in this regard. Governments should establish a stable and coherent policy framework to minimise EPU. Setting long-term economic goals and policy guidelines can increase investor confidence and limit the effects of the EPU. Governments should communicate transparently and openly about economic policies and changes. Uncertainty can be reduced when investors and businesses have access to accurate and timely information about future policy decisions. Structural reforms are crucial for strengthening the economic framework and enhancing competitiveness. A stable and predictable economic environment supports investment decisions and can reduce the negative effects of the EPU. Governments can develop risk management tools against EPU. For example, financial derivatives or insurance mechanisms can be used to manage currency risk. Coordination and consensus among different policy actors, such as the central bank, Ministry of Finance, and government, are necessary. The compatibility and mutual support of other policy areas can reduce the effects of the EPU. Stability and cooperation in global economic relations may limit the effects of the EPU. Trade agreements, investment agreements, and international cooperation mechanisms can help reduce uncertainty. Economic policymakers need to be aware of economic issues and develop their analytical skills. Investments in education and research can inform accurate, data-driven decisions, enabling a deeper understanding of and more effective management of economic uncertainty.

The study supports that the effects of economic policy uncertainty (EPU) on a country's exchange rate are asymmetric and heterogeneous. This confirms that the impact of EPU on macroeconomic indicators is not static when evaluated in the international economy and may vary according to the country's context. In addition, the inference that a country's foreign trade and financial linkages increase its sensitivity to economic uncertainties in other countries provides an important contribution to the international trade theory.

States need to adopt a stable, transparent, and coordinated approach to limit the impact of uncertainty in economic policy on the real effective exchange rate. In this context, policymakers prioritise maintaining financial stability, enhancing investor confidence, and fostering economic growth. Finally, obtaining Türkiye's EPU data and examining its effect on our exchange rate is left to future studies. Furthermore, the potential divergence between the short-term and long-term impacts of economic uncertainty on exchange rates warrants further investigation and is, therefore, deferred to future research.

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Financial Complexity: A Comparison Study of Türkiye, Iran, Saudi Arabia and the UAE

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Finansal Karmaşıklık: Türkiye, İran, Suudi Arabistan ve BAE Üzerine Karşılaştırmalı Bir Çalışma

Abstract

Over the last few decades, the global financial network has become increasingly complex due to the rapid growth in science and technology, as well as the expanding number of financial instruments worldwide. In this setting, several issues and problems arose, including the rising systemic risk in the financial sector, which in turn increased the sector's vulnerability. In emerging markets, such as Türkiye, Iran, Saudi Arabia, and the UAE, the potential risk may arise due to the financial complexity of these markets. Therefore, the probability of crises will increase. This study investigated the complexity of financial systems in these countries using McCabe's network approach from 2005 to 2020. Measuring complexity indicates that Türkiye, with a score of 95, Iran (77), Saudi Arabia (49), and the UAE (36) have been graded in terms of financial complexity. As a result, Türkiye has the highest, and the UAE has the lowest systemic risk among these countries. Additionally, the results suggest that capital markets do not play a significant role in these economies.

Keywords	:	Financial Complexity, McCabe's Complexity, Türkiye, Iran, Saudi Arabia, United Arab Emirates.
JEL Classification Codes	:	C58, C63, C45.

Öz

Son yıllarda, bilim ve teknolojideki hızlı büyüme ve artan sayıdaki finansal araçlar nedeniyle küresel finansal ağ daha karmaşık bir hale gelmiştir. Bu durum finans sektöründe sistemik riskin artması ve dolayısıyla bu sektörün daha fazla kırılgan hale gelmesi gibi bazı sorunları beraberinde getirmiştir. Türkiye, İran, Suudi Arabistan ve BAE gibi gelişmekte olan piyasalarda, bu tür piyasaların finansal karmaşıklığı nedeniyle olası riskler ortaya çıkabilir. Bu bağlamda kriz olasılığı artabilir. Bu çalışmada, 2005-2020 yılları arasında McCabe'nin karmaşıklık ölçütü kullanılarak bu 4 ülkedeki finansal sistemlerin karmaşıklığı araştırılmıştır. Araştırma sonucuna göre, 95 ile Türkiye, 77 ile İran, 49 ile Suudi Arabistan ve 36 ile BAE finansal karmaşıklık açısından derecelendirilmiştir. Türkiye en yüksek, BAE ise en düşük sistemsel riske sahiptir; sermaye piyasasının incelenen ekonomilerde etkili bir rolü olmadığı görülmüştür.

Anahtar Sözcükler	:	Finansal Karmaşıklık, McCabe Karmaşıklık Ölçütü, Türkiye, İran, Suudi Arabistan, Birleşik Arap Emirlikleri.

1. Introduction

The economic efficiency and stability of the country's financial sector are essential for achieving a healthy economy. The financial market has a significant capacity to drive a country's growth and development. This market is the core of the economic system, and if this fails, the performance of the economic system as a whole will suffer. In other words, the ability of markets and financial institutions to reduce market friction can lead to a more efficient allocation of resources, thereby accelerating long-term economic growth (Diamond, 1984; Boyd & Prescott, 1986; King & Levine, 2010).

Nearly all opinions suggest that financial markets may sometimes be too interconnected, thereby creating systemic risk. The risk in these markets could cause significant damage and losses to the global economy. Previously, it was discussed that some companies or institutions are so large that their failure may have worse consequences for the economic system (ECB, 2010).

Systemic risk in financial markets refers to the potential for a sudden collapse of a financial system, resulting in instability within the financial markets. Since this risk has a pervasive effect on the entire system and is quickly transmitted to the entire capital market or the country's economy, it is referred to as systemic risk. The simultaneous movement between different market segments causes this risk. In other words, systemic risk occurs when there is a high correlation between the risks and crises of various market segments (Acharya et al., 2009). The systemic risk in a country's economy may depend on the degree of complexity and interconnection between the country's economy and its financial sector. One way to assess a country's systemic risk is to examine its financial system using network theory.

In network science, the structure of networks plays an essential role in directing micro-events to macro-phenomena. This issue will worsen when there is a high correlation between different market parts. In other words, the behaviour of networks is influenced by their structure. It is necessary to model these systems to investigate the structure of complex and real networks such as economic systems. In the financial sector, the strong potential of network analysis has recently been highlighted as a tool to understand better financial markets and models, as well as assess systemic risk. In other words, the global financial system can be shown as a large, complex network (Caccioli et al., 2018). Financial networks, like stock markets, are complex systems that can be modelled and analysed using network science techniques.

Market structure studies conducted from a network perspective can significantly enrich the traditional perspective adopted in economics. Network analysis, which considers the overall structure of the network, contributes to existing theoretical results on systemic risk in the interbank market and provides a stronger basis for assessing contagion risk through simulations. In general, there are three stages to control systemic risk as a scientific research field; the first step is to understand and model the mechanisms and phenomena of

the real world, the second is to predict the future state of the system, and the third and last step is to regulate the system to prevent the occurrence of undesirable happenings. For this purpose, this paper aims to calculate systemic risk by measuring the complexity of a financial system.

2. Background Literature

Raddant & Kennett (2016) examined the network of financial markets in an article. For this purpose, they analysed 4000 stocks from 15 countries and estimated the statistical relationships between pairs of stocks from different markets using the regression and GARCH methods. The results showed that countries such as the United States and Germany are at the core of the global stock market. Additionally, the energy, materials, and financial sectors play a crucial role in connecting markets, a role that has intensified over time for the energy and materials sectors. They also calculated interconnectedness using network theory to depict the relationship between sectors and capital markets.

Gofman (2017) estimated a network-based model of the over-the-counter interbank loan market in the United States to investigate the effectiveness and stability of the bank size restriction policy proposed to reduce financial network entanglement and improve financial stability. Results showed that transaction efficiency decreases with limitations in interaction and the shrinking of the banking network as intermediary chains become more extended and limit the linking of banks to each other, leading to increased financial stability.

Using network analysis, Tang et al. (2018) studied two major markets, China and the United States of America. The research found that the characteristics of the networks and hierarchical structures differ between the two stock markets.

Chowdhury et al. (2018), in a study titled The Changing Network of Financial Linkage: the Asian Experience, which the Asian Development Bank publishes, investigated the changing network of financial markets for six periods from 1995 to 2016, constructing a network that captures the concepts of the direction of links between markets, the significance of these links, and their strength. Emphasis is placed on the transition of the networks before and after the Asian financial crisis of 1997-1998 and the global financial crisis of 2008-2009. The analysis encompasses 19 European countries, including Türkiye, 15 countries from Asia and the Pacific, two from Africa, two from North America, and four from Latin America. The analysis reveals an increase in interconnectedness during periods of stress and a decline in links following crisis periods. Results indicate a general deepening of connections between the Asian market and the rest of the world over the past two decades. They suggest that many of these markets have transitioned from being primarily linked to developed non-Asian markets through key bridge markets, such as Hong Kong and China, to creating stronger direct links with these external markets, highlighting the importance of key geographical nodes in market development.

Espinosa-Vega and Russel (2020) developed a theoretical model to investigate the relationship between the entanglement of financial institutions, systemic financial crises, and long-term recessions. The financial institutions examined in this research are banks, and the relationship between banks is defined only through the transfer of assets.

Using the Lorenz model, Liao et al. (2020) introduced a system of differential equations to simulate a financial system. Results indicated that the behaviour of this system was unpredictable and sensitive to initial conditions. Examining the dynamics of this system showed pseudo-random behaviour. In other words, the financial model exhibits chaotic behaviour, according to the assumptions made in the research. Therefore, the financial system is complex.

Botta et al. (2022) presented an agent-based model that integrates an increasingly complex financial sector with a real aspect of the economy. This study examined the impact of the increasing complexity of the financial system and its associated financial products on economic growth, macroeconomic stability, and income inequality. The simulation results of this research indicate that although higher financial complexity may lead to faster economic growth, it also contributes to financial fragility in an economic system prone to crisis and exacerbates income inequality.

Li et al. (2022) investigated the effect of financial network complexity on financial stability. Due to the difficulty of modelling the real financial network, random matrices were used as a substitute for the financial network matrix.

Salim et al. (2023) employed a network model to examine the interrelationship between financial data in the capital market. For this purpose, they utilised the United States stock market statistics for the period 2002-2019, the principal component analysis (PCA) method, and the Granger causality test. According to their research, the correlation coefficient for the studied stock returns is statistically significant, indicating a strong initial relationship and daily movement in the market under study.

Most studies have examined only a part of the financial market and have been done in one or two countries. The present study aims to investigate and compare four countries (Türkiye, Iran, Saudi Arabia, and the United Arab Emirates) from the perspective of financial institutions and their relationship and influence on the entire economy because in emerging economies in recent years, the flow of capital entering the country has increased, which has brought high returns and exposed the financial system to potential risks, including systemic risk. The ability to manage these flows largely depends on the level of complexity of the domestic financial network; therefore, it is necessary to examine the financial networks of these countries and their corresponding levels of complexity. In the upcoming research, the financial systems of Türkiye, Iran, Saudi Arabia, and the UAE will be examined from the perspective of financial development variables. For this purpose, using the financial development variables provided by the World Bank, all aspects of the financial sector in

these countries have been considered, and the financial network for each country has been calculated and analysed.

3. The Importance of Research

The necessity of achieving a healthy economy in any country lies in the efficiency and capability of the country's financial sector. In general, the task of the financial sector in the economy is to transfer credit funds and capital from savers, financial institutions, and capital owners to investors, producers of goods and services, and the government. One of the other tasks of this sector is to move with the real sector of the economy, which provides the flow of goods and services from producers to consumers and human power from households to producers. These processes require financial exchanges, which, alongside technological advancements, lead to an increase in complexity and entanglement within countries' financial systems. On the one hand, increasing complexity in the financial system leads to higher efficiency, faster economic growth, and ease and speed of financial transactions. On the other hand, it has created challenges and increased costs, making the financial system more vulnerable and ultimately rendering the financial markets more fragile. For this reason, examining the financial systems of countries from the perspective of network analysis, measuring their complexity, and exploring ways to reduce it in economic and financial systems, as well as the decision-making processes, is critical.

4. Financial System Network Methodology

The financial market comprises various components, including commercial banks, insurance companies, hedge funds, individual investors, and central banks. These components interact through the buying and selling of financial assets, creating complex networks of financial liabilities, mutual assets, and correlations in asset returns (Caccioli et al., 2018). The advantage of modelling the financial system as a complex network is that it is possible to directly analyse the complex feedback between micro and macro phenomena without simplifying the structure of financial links. The network approach to financial systems is essential for assessing systemic risk and financial stability. It can help reduce or increase the external effects that the risk associated with a single institution may cause to the entire system.

Modelling a financial network with numerous connections is crucial because each connection can potentially amplify the spread of contagion within the financial network. Additionally, any connection between system components in the financial system increases systemic risk in a non-linear manner (Tabak et al., 2018). Kumar (2018) states that systemic risk refers to the risk of the entire financial system collapsing, which is caused by the weakness of the structure or correlation within the financial system as a whole. Systemic risk occurs when there is a high correlation between different market segments. In other words, the basis of systemic risk is the correlation between losses (Ostad et al., 2021). The systemic risk depends on the collective behaviour of financial network components and their degree of interconnection.

The complex structure of links between financial institutions and infrastructures, as well as among sectors of the economy or entire financial systems, can be represented using a network representation or graph. By understanding the financial system as a complex and dynamic network, empirically analysing its characteristics, and developing contagion and behavioural models, one can gain a deeper understanding of systemic risk and identify better variables, institutions, and financial markets that have systemic importance.

Therefore, to model the financial system, it is necessary to specify its components separately and then calculate the relationship between these components using the correlation coefficient. Since any country's financial system aims to achieve financial development, the World Bank's Global Financial Development Database has developed a comprehensive and relatively simple conceptual framework for measuring financial development worldwide. This framework identifies four key variables that indicate the good performance of a financial system: financial depth, accessibility, efficiency, and stability. These four dimensions are then measured for two primary components in the financial sector: financial institutions and financial markets.

The selected variables for examining the financial system in the selected countries of the region (Türkiye, Iran, Saudi Arabia, and the UAE), according to the statistics available in the World Bank reports, are described in Table 1. There are 22 variables; 12 variables fall into the financial depth category, two variables are categorised as efficiency, one variable is related to instability, and the rest are classified as 'others'. These variables are primarily located in the financial institutions group, with three specifically related to financial markets. Financial institutions, including banks, other depository financial institutions, and insurance institutions. Financial markets encompass the stock market and the OTC (over-the-counter) market.

Table: 1
Details of Variables

Row	Variable	Index Name	Description	Symbol
1	Financial Depth	Private credit by deposit money banks to GDP(%)	Domestic money banks provide the private sector with financial resources as a share of GDP. They comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits.	DI.01
2	Financial Depth	Deposit money banks' assets to GDP(%)	Total assets held by deposit money banks as a share of GDP. Assets include claims on the domestic real nonfinancial sector, which comprises central, state, and local governments, nonfinancial public enterprises, and the private sector. Deposit money banks comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits.	DI.02
3	Financial Depth	Deposit money bank assets to deposit money bank assets and central bank assets(%)	Total assets held by deposit money banks as a share of the sum of deposit money bank and Central Bank claims on the domestic nonfinancial real sector. Assets include claims on the domestic real nonfinancial sector, which comprises central, state, and local governments, nonfinancial public enterprises, and the private sector. Deposit money banks comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits.	DI.04
4	Financial Depth	Liquid liabilities to GDP (%)	The ratio of liquid liabilities to GDP. Liquid liabilities are also known as broad money or M3. They are the sum of currency and deposits in the central bank (M0), plus five transferable deposits and electronic currency (M1), plus time and savings deposits, foreign currency transferable deposits, certificates of deposit, and securities repurchase agreements (M2), plus travellers' checks, foreign currency, time deposits, commercial paper, and shares of mutual funds held by residents.	DI.05
5	Financial Depth	Central bank assets to GDP(%)	The ratio of central bank assets to GDP. Central bank assets are claims on the domestic real non-financial sector by the central bank.	DI.06

6	Financial Depth	Financial system deposits to GDP(%)	Demand, time and saving deposits in deposit banks and other financial institutions as a share of GDP.	DI.08
7	Financial Depth	Life insurance premium volume to GDP(%)	The ratio of life insurance premium volume to GDP. Premium volume refers to the insurer's direct premiums earned or received during the preceding calendar year.	DI.09
8	Financial Depth	Nonlife insurance premium volume to GDP (%)	The ratio of non-life insurance premium volume to GDP. Premium volume refers to the insurer's direct premiums earned (for Property/Casualty) or received (for Life/Health) during the preceding calendar year.	DI.10
9	Financial Depth	Private credit by deposit banks and financial institutions to GDP(%)	Private credit by deposit money banks and other financial institutions as a percentage of GDP.	DI.12
10	Financial Depth	Domestic credit to private sector (% of GDP)	Domestic credit to the private sector refers to financial resources provided to the private sector, such as loans, purchases of non-equity securities, trade credits, and other accounts receivable that establish a claim for repayment. For some countries, these claims include credit to public enterprises.	DI.14
11	Financial Depth	Stock market capitalisation to GDP(%)	The total value of all listed shares in a stock market is a percentage of the country's GDP.	DM.01
12	Financial Depth	Stock market total value traded to GDP(%)	The total value of all traded shares in a stock market exchange is a percentage of the country's GDP.	DM.02
13	Efficiency	Stock market (%)turnover ratio	The total value of shares traded during the period is divided by the average market capitalisation.	EM.01
14	Efficiency	Credit to government and enterprises to GDP(%)	The ratio of credit extended by domestic banks to the government and state-owned enterprises to GDP.	EI.08
15	Stability	Bank credit to bank (%)deposits	Domestic money banks provide financial resources to the private sector as a share of total deposits. Domestic money banks comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits. Total deposits include demand, time, and savings deposits in banks.	SI.04
16	Other	Bank deposits to (%) GDP	The total value of demand, time and saving deposits at domestic deposit money banks as a share of GDP. Deposit money banks comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits.	OI.02
17	Other	External loans and deposits of reporting banks vis-à-vis the banking sector (% of domestic bank deposits)	Percentage of loans and deposits of reporting banks to the domestic bank deposits in the banking sector.	OI.10
18	Other	External loans and deposits of reporting banks vis-à-vis the nonbanking sectors (% of bank deposits)	Percentage of loans and deposits of reporting banks compared to those of the non-banking sector in domestic bank deposits.	OI.11
19	Other	External loans and deposits of reporting banks vis-à-vis all sectors (% of bank deposits)	Percentage of loans and deposits of reporting banks compared to all sectors in domestic bank deposits.	OI.12
20	Other	Remittance inflows (%)to GDP	Workers' remittances and compensation of employees comprise current transfers by migrant workers, as well as wages and salaries earned by non-resident workers. Data comprise three items defined in the fifth edition of the IMF's Balance of Payments: workers' remittances, compensation of employees, and migrants' transfers.	OI.13
21	Other	Consolidated foreign claims of BIS reporting banks to (%) GDP	The ratio of consolidated foreign claims to GDP among banks reporting to the BIS. In the consolidated banking statistics, claims granted to nonresidents are referred to as cross-border claims. Local claims refer to the foreign affiliates (branches or subsidiaries) of domestic banks in the host country, which are resident in the country of the host country's residents.	OI.14
22	Other	The ratio of global leasing volume to (%) GNP	Ratios calculated by White Clarke Global Leasing Report.	OI.17

Reference: World Bank Report.

The first step is to identify the variables. If the correlation between pairs of variables is calculated, their relationship with each other is determined. Considering that the financial sector is a dynamic system, the investigated variables are examined during the investigated period to capture the dynamics within this system. For this purpose, the required data for the countries of Türkiye, Iran, Saudi Arabia, and the United Arab Emirates were examined from 2005 to 2020, the last year of available data.

After defining the variables, the next step is to calculate the correlation matrix between pairs of variables. The interaction network, based on the correlation matrix, is used

to analyse the type and level of connection between components in the financial network of these countries. To do this, the Pearson correlation (equation no. 1) is used to obtain the correlation matrix of the indicators of the financial system for the examined variables for each country:

$$\rho_{i,j}(\Delta t) = \frac{(r_i r_j) - (r_i)(r_j)}{\sqrt{(r_i^2 - (r_i)^2)(r_j^2 - (r_j)^2)}} \tag{1}$$

The correlation matrix between the inspected variables, calculated at a 1% significance level, is generated using SPSS software to input the adjacency matrix. The third step is to estimate the adjacency matrix, which is defined by Equation 2. If the correlation between two variables is significant, a value of 1 is placed in the matrix; otherwise, a value of 0 is placed in the matrix.

$$A_{N \times N}[i, j] = \begin{cases} 1 & if (V_i, V_j) \in E \\ 0 & otherwise \end{cases} \tag{2}$$

For analysing the financial system, using network analysis, the graph of the financial system should be drawn, which is step four, known as drawing a network for a financial system. The use of graphs in social network research has clarified many complex phenomena (Morzy et al., 2017). These simple extensions or refinements of binary simple graphs offer powerful tools for understanding complex interrelations across multiple settings. In a multilayered network, when networks are observed over time, pairs of nodes can become connected (Koskinen et al., 2023).

A given network can be represented in several ways, for example, using an adjacency matrix defined as Equation 2. Each of the network's components is related to each other (Pearson's correlation coefficient is significant at the 1% level), as indicated by the number 1. Conversely, variables and components that are unrelated to each other are assigned a value of 0. The calculation of the adjacency matrix is used as input for the graph, and the resulting graph is examined in terms of its structure and performance. Additionally, for complexity calculations, the adjacency matrix will serve as the input for the financial network. We used Python software to create a network or graph of the financial systems of the countries under investigation, where the inputs were the adjacency matrices calculated for each country.

Finding useful visual representations of the graphs of a complex process is equivalent to finding a good dimensional reduction of an N-dimensional system, where N is the number of nodes. A graph or network is one of the most comprehensive methods for calculation and forecasting in a system. Networks are becoming increasingly important in contemporary information science because they provide a holistic model for representing many real-world phenomena (Morzy et al., 2017). A graph is the best way to convey complex networks because it allows for a comprehensive model representing many real-world phenomena. A system with a more significant number of components and a higher degree of interconnection is more complex.

In general, a network (or graph) is a visual representation of a set of interconnected components. Each of these components is referred to as a "vertex" or "node". Vertices are also connected through "edges". A graph is defined as (V, E), where V is the set of vertices and E is the set of edges. A network is an ordered pair $G = \langle 0 \rangle$, where $V = \{V1, \ldots, VN\}$ is the set of vertices (nodes) of this network and $E = \{(Vi, Vj) \in V \times V\}$ is the set of edges.

5. Internal Financial Network Analysis

5.1 Central Criteria

A key concept in network analysis that also applies to the financial system is centrality. In a broad sense, centrality refers to the importance of a node in the network. Traditional centrality measures the number of links ending at a node (degree) or leaving a given node or the distance from other vertices via the shortest paths. In other words, the variable with the most significant number of links to other variables is at the core or centre of the network, and changes in this variable affect most of the variables in the network, also transferring the behaviour of other variables to the entire network. Therefore, it is very important to identify the core variable in the network.

5.2 Network Structure

In a network, a variable may not be related to any of the variables in the network; however, when it is related to other variables, the properties and behaviour of a node (component) cannot be analysed based solely on the properties and behaviours of that node. This node may be influenced by nodes linked to it and nodes with no direct link but are connected and affected. Therefore, to understand the behaviour of a node, the behaviour of many nodes must be analysed, including nodes that may be several nodes away from each other in the network. Additionally, the number of loops formed in a network impacts the overall performance of the entire network.

5.3 Network Complexity Measuring

One method of analysing a network is to examine it from the perspective of complexity or interconnectedness. Complexity refers to the quality or state of being complicated to understand, perform, or create. Complexity is often associated with uncertainty, a lack of control, or a lack of transparency (Cambridge Dictionary). One of the most widely accepted indicators of network complexity is McCabe's cyclomatic number, calculated according to Equation 3, which involves five steps or a final step.

$$V(G) = E - N + 2 \tag{3}$$

In this equation, E is the number of edges, and N is the number of nodes in the network or graph. V(G) represents the maximum number of independent paths that can be represented through the network. Table 2 provides an overview of the complexity number and the corresponding meaning of V(G).

Table: 2
Concept of Graph Complexity Number

Complexity	Concept	Systemic Risk
10-1	Structured graph, high testability	Low
20-10	Complex graph, medium testability	Medium
40-20	Complex graph, low testability	High
40>	Graph too complex, untestable	Too high

Sources: <http://www.mccabe.com/>.

6. Experimental Results of the Research

The limitation of this study was accessing data for all investigated countries. Since this research aims to examine the financial network of Türkiye, Iran, Saudi Arabia, and the UAE, for the results to be comparable, the selected variables must have sufficient overlap for comparison. For this, 22 financial development variables provided by the World Bank have been selected. In Türkiye and Iran, data were available for 22 financial development variables covering the entire study period from 2005 to 2020, the last year of data availability. For Saudi Arabia and the United Arab Emirates, data were available for 18 and 19 variables, respectively.

To examine the financial network, it is necessary to re-examine the steps of the network analysis. In brief, the correlation matrix was calculated for pairs of variables across these countries. Then, the Adjacency matrix is obtained using the correlation matrix. For the pair of variables with a significant correlation at the 1% level, the value is 1; otherwise, it is 0. The adjacency matrix was calculated for all four countries; the results are in the appendix. Using the Adjacency matrix, the financial network of each country is drawn separately using Python software. The results are shown in the set of figures below.
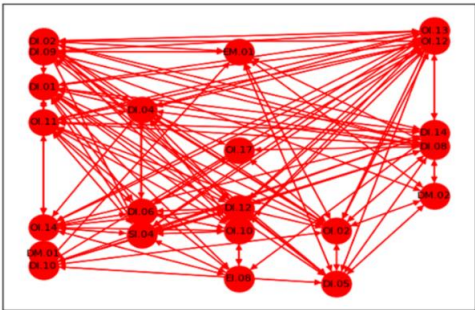
Türkiye's Financial Network   **Iran's Financial Network**
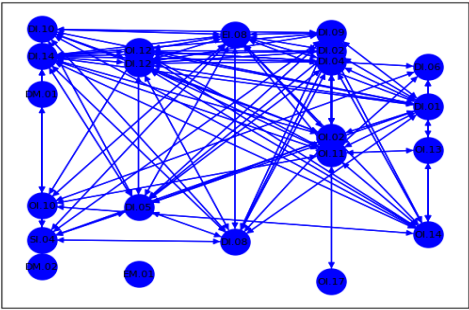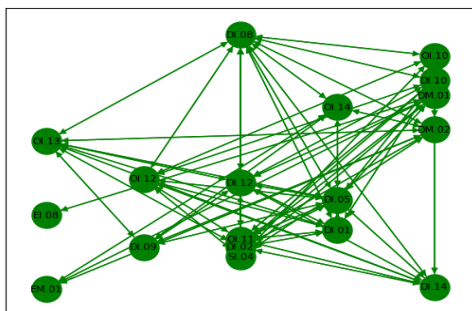
Saudi Arabia's Financial Network   **UAE's Financial Network**
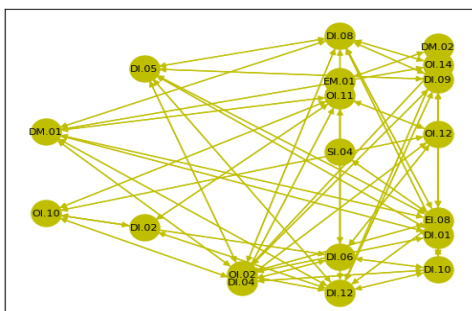
In Türkiye's financial graph, private credit by deposit money banks and other financial institutions to GDP (DI.12) and private credit by deposit money banks to GDP (DI.01) have 16 connections with different variables in the network, representing the highest number of edges in Türkiye's financial network. In general, it can be concluded that in Türkiye, credits paid to the private sector are the most important part of the financial network. In other words, it forms the core of this network. Stock market capitalisation to GDP (DM.01) in the financial graph of Türkiye is not related to any variable and is considered a neutral variable. The amount of complexity calculated using the McCabe number for Türkiye's financial network, using equation 3, has been obtained at 95, which is the highest in all the countries in this study and indicates a very high complexity in this country, which creates a too high systemic risk as a result of this high complexity.

In the graph drawn for Iran's financial system, Credit to the government and state-owned enterprises as a percentage of GDP (EI.08) and domestic credit to the private sector (DI.14) have 15 edges, with the highest number of edges in the financial graph. After these two variables, credit by deposit money banks to GDP (DI.01) and private credit by deposit money banks and other financial institutions to GDP (DI.12) have the highest number of edges, i.e. 12. In other words, the variables related to government, domestic, and private credits are at the core of Iran's financial network, so banks and credits in the financial graph play a central role in Iran's financial system. Moreover, the stock market turnover ratio (EM.01) is unrelated to any other variable in the existing financial system. Additionally, stock market capitalisation to GDP (DM.01) and Stock market total value traded to GDP (DM.02), the only capital market variables examined in this study, are related and not associated with other variables. The calculated complexity number for Iran's financial graph is 77, indicating that the system's complexity and systemic risk in this network is too high. In other words, considering that the model's components exhibit a high degree of correlation, there is a possibility of system collapse, particularly in the banking and credit sectors, which could lead to a crisis.

In the case of Saudi Arabia, the ratio of financial system deposits to GDP (DI.08) has a significant relationship with 13 variables in the network. Therefore, this variable is the

core of Saudi Arabia's financial network. Liquid liabilities to GDP (DI.05) are related to 12 variables in the network and are placed after the core variable. In the Saudi financial network, the neutral variable with little or no significant relationship with another part of the financial system is a credit to the government. State-owned enterprises to GDP (EI.08): According to the calculations, the complexity number obtained for Saudi Arabia is 49, which is lower than that of Türkiye and Iran. Still, according to the interpretation presented in Table 2, this graph is also classified as having a high complexity and too systemic risk.

In the UAE's financial network, similar to Türkiye, private credit by deposit money banks and other financial institutions as a percentage of GDP (DI.12) is the network's core. In the financial network of this country, the variables DM.02 and EM.01, i.e., the stock market's total value as a percentage of GDP and the stock market turnover ratio, are closely related and do not exhibit a significant correlation with other variables. This issue can lead to the conclusion that in the financial network of the UAE, bank and private sector credits are among the most critical components of this network, while financial markets have a partial effect on this network and operate independently of it. The calculated complexity number for the UAE is 36, indicating high complexity. However, this amount is lower compared to Türkiye, Iran, and Saudi Arabia, suggesting the lowest systemic risk among the four countries under review.

Table 3 summarises the results of the analysis of the drawn financial networks in terms of the number of financial complexities using equation 3.

Table: 3
Results of Network Graphs: 2005-2020

Country	Number of variables	Number of edges	Central Variable(s) in the graph	McCabe's Complexity Number	Systemic Risk
Türkiye	22	115	DI.01-DI.12	(115-22)+2=95	Too high
Iran	22	97	DI.14 - EI.08	(97-22)+2=77	Too high
Saudi Arabia	18	65	DI.08	(65-18)+2=49	Too high
UAE	19	53	DI.12	(53-19)+2=36	High

According to the surveys, the core of the financial network in each of the four countries is comprised of variables related to financial depth, i.e., banks and other financial institutions. In Türkiye, Iran, and the UAE, credits play an effective role, while in Saudi Arabia, deposits are more important than credits. Additionally, in all four countries, the capital market is relatively unimportant in the financial network and functions as a distinct part of the economy. Moreover, in Iran, the government plays a significant role in the financial sector, whereas in other countries, the role of the private sector in the financial economy is more prominent.

7. Conclusion and Policy Recommendation

In this article, the level of financial complexity in Türkiye, Iran, Saudi Arabia, and the UAE is calculated and analysed using McCabe's complexity method and the financial development variables provided by the World Bank from 2005 to 2020. The results of the investigations show that the calculated complexity numbers for Türkiye, Iran, and Saudi

Arabia are 95, 77 and 49, respectively. According to the results, i.e. the financial complexity numbers, Türkiye, Iran and Saudi Arabia have very high complexity and consequently high systemic risk. Compared to these three countries, the UAE has the lowest complexity score of 36 and exhibits the lowest systemic risk among the three mentioned countries.

Additionally, the financial graph (network) investigation reveals that, during the period under investigation, the primary and core sectors in the financial systems of the four countries are banks and credit institutions, specifically the money market. This means the capital market does not play a decisive role in their economy. Moreover, in Iran, the government plays a more significant role than the private sector, whereas the private sector is more influential in Türkiye, Saudi Arabia, and the UAE. In Türkiye, Iran and the United Arab Emirates, credits are significant, but deposits are more critical in Saudi Arabia.

McCabe's high complexity number, and thus, high systemic risk in all of these countries, indicates that the financial systems in these countries are fragile in the event of a sudden change in their financial sector, which can significantly impact the entire system. So policymakers can improve and track the results of the policies they adopt in the financial system. Therefore, they should be more cautious in their financial system strategies. Additionally, the core of financial systems prioritises policymakers for appropriate reform in the financial system. According to the results, based on the importance of the banking sector in all investigated countries, the money market is more effective than the capital market. This suggests that debt-based financing is more prevalent in the money markets of these countries than asset-based funding in their capital markets.

To reduce the financial complexity and systemic risk in these countries, it is necessary to decentralise the financial system. According to the results obtained for the countries investigated governments must focus on developing the capital market in the financial market rather than the money market. For this purpose, governments can facilitate the process of companies entering the capital market, thereby reducing the influence of the money market while also developing capital markets. Therefore, the financial system will be diversified similarly.

To reduce financial complexity, we suggest that company financing should be through the capital market rather than banks and the money market, especially in Iran, Türkiye, and Saudi Arabia, which have high McCabe complexity numbers, identifying high systemic risk.

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Appendix: Research Findings

Adjacency Matrix of Pairs Variable (Türkiye)

	DI.06	DI.04	DI.02	DI.14	DI.08	DI.09	DI.05	DI.10	DI.12	DI.01	DM.01	DM.02	EM.01	EI.08	SI.04	OI.02	OI.14	OI.12	OI.10	OI.11	OI.17	OI.13
DI.06	0	1	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	1	1	1	1	0
DI.04	1	0	1	0	1	0	0	0	1	1	0	0	0	0	1	1	1	1	1	1	1	1
DI.02	0	1	0	1	1	0	1	1	1	1	0	0	1	0	1	1	1	1	1	1	0	1
DI.14	0	0	1	0	0	0	0	1	1	1	0	0	0	1	1	0	1	1	0	1	0	1
DI.08	0	1	1	0	0	1	1	1	1	1	0	1	1	0	0	1	0	0	0	1	1	1
DI.09	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	1
DI.05	0	0	1	0	1	1	0	1	1	1	0	1	1	0	0	1	0	0	0	0	0	1
DI.10	0	0	1	1	1	0	1	0	1	1	0	1	0	0	0	1	0	0	0	0	0	1
DI.12	1	1	1	1	1	0	1	1	0	1	0	0	0	1	1	1	1	1	1	1	0	1
DI.01	1	1	1	1	0	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	0	1
DM.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DM.02	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
EM.01	0	0	1	0	1	1	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0
EI.08	0	0	0	1	0	0	0	0	1	1	0	0	0	0	1	0	1	0	1	1	0	0
SI.04	1	1	1	1	0	0	0	0	1	1	0	0	0	1	0	0	1	1	1	1	0	1
OI.02	0	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	0	1	0	1	1	1
OI.14	1	1	1	1	0	0	0	0	1	1	0	0	0	1	1	0	0	1	1	1	0	1
OI.12	1	1	1	1	0	0	0	0	1	1	0	0	0	0	1	1	1	0	1	1	0	1
OI.10	1	1	1	0	0	0	0	0	1	1	0	0	0	1	1	0	1	1	0	1	0	1
OI.11	1	1	1	1	1	0	0	0	1	1	0	0	0	1	1	1	1	1	1	0	0	1
OI.17	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
OI.13	0	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	0	0

Adjacency Matrix of Pairs Variable (Iran)

	DI.06	DI.04	DI.14	DI.02	DI.08	DI.09	DI.05	DI.10	DI.12	DI.01	DM.01	DM.02	EM.01	EI.08	SI.04	OI.02	OI.14	OI.12	OI.10	OI.11	OI.17	OI.13
DI.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1
DI.04	0	0	1	1	1	1	1	1	0	1	1	0	0	0	1	0	1	1	0	1	0	0
DI.14	0	1	0	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	0	0
DI.02	0	1	1	0	1	1	1	0	1	1	0	0	0	0	1	0	1	1	1	0	1	0
DI.08	0	1	1	1	0	1	1	1	1	1	0	0	0	0	1	1	1	0	0	0	0	0
DI.09	0	1	1	1	1	0	1	1	1	1	0	0	0	0	1	1	1	0	0	0	0	0
DI.05	0	1	1	1	1	1	0	1	1	1	0	0	0	0	1	1	1	0	0	0	0	0
DI.10	0	0	1	0	1	1	1	0	1	1	0	0	0	0	1	1	1	1	0	1	0	0
DI.12	0	1	1	1	1	1	1	1	0	1	0	0	0	0	1	0	1	1	0	1	0	0
DI.01	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	1	1	0	1	0	0
DM.01	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
DM.02	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
EM.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EI.08	0	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	0	0
SI.04	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
OI.02	0	1	1	1	1	1	1	1	1	1	0	0	0	1	1	0	0	0	0	0	0	0
OI.14	1	1	1	1	0	0	0	1	1	1	0	0	0	1	0	0	0	1	1	1	0	1
OI.12	1	1	1	1	0	0	0	1	0	0	0	0	0	1	0	0	1	0	1	0	0	0
OI.10	1	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	0	1	0	0
OI.11	1	1	1	1	0	0	0	0	1	1	0	0	0	1	0	0	1	1	1	0	1	1
OI.17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
OI.13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0

Adjacency Matrix of Pairs Variable (Saudi Arabia)

	DI.02	DI.14	DI.08	DI.09	DI.05	DI.10	DI.12	DI.01	DM.01	DM.02	EM.01	EI.08	SI.04	OI.14	OI.12	OI.10	OI.11	OI.13
DI.02	0	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	1
DI.14	1	0	1	0	1	1	1	1	0	0	0	0	0	0	1	0	1	1
DI.08	1	1	0	0	1	1	1	1	0	1	0	0	1	1	1	1	1	1
DI.09	0	0	0	0	1	0	1	0	0	1	0	0	0	1	0	0	0	1
DI.05	1	1	1	1	0	1	1	1	1	0	0	0	0	1	1	0	1	1
DI.10	1	1	1	0	1	0	1	1	0	0	0	0	0	0	1	0	1	0
DI.12	1	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	1
DI.01	1	1	1	0	1	1	1	0	0	0	0	0	0	0	1	0	1	1
DM.01	1	0	0	0	1	0	1	0	0	0	1	1	1	0	0	0	0	0
DM.02	0	0	1	1	0	0	0	0	0	0	1	0	1	1	0	1	1	1
EM.01	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
EI.08	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SI.04	0	0	1	0	0	0	0	0	1	1	0	0	0	0	1	1	1	0
OI.14	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0
OI.12	0	1	1	0	1	1	0	1	0	0	0	0	1	0	0	1	1	0
OI.10	0	0	1	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0
OI.11	0	1	1	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0
OI.13	1	1	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0

Adjacency Matrix of Pairs Variable (UAE)

	DI.06	DI.04	DI.02	DI.08	DI.09	DI.05	DI.10	DI.12	DI.01	DM.01	DM.02	EM.01	EI.08	SI.04	OI.02	OI.14	OI.12	OI.10	OI.11
DI.06	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1
DI.04	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1
DI.02	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1
DI.08	0	0	0	0	1	1	0	1	1	1	0	0	1	0	1	1	0	0	0
DI.09	0	0	0	1	0	1	0	1	1	0	0	0	1	0	1	0	0	0	0
DI.05	0	0	0	1	1	0	0	1	1	0	0	0	1	0	1	0	0	0	0
DI.10	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0
DI.12	0	0	1	1	1	1	1	0	1	1	0	0	1	0	1	1	0	0	0
DI.01	0	0	0	1	1	1	1	1	0	1	0	0	1	0	1	1	0	0	0
DM.01	0	0	0	1	0	0	0	1	1	0	0	0	1	0	1	1	0	0	1
DM.02	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
EM.01	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
EI.08	0	0	0	1	1	1	0	1	1	0	0	0	0	0	1	1	0	0	0
SI.04	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
OI.02	0	0	0	1	1	1	0	1	1	1	0	0	1	0	0	1	0	0	0
OI.14	0	0	0	1	0	0	1	1	1	0	0	0	1	0	1	0	0	0	0
OI.12	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
OI.10	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
OI.11	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0

Economic Development, Maternal Education and Infant Mortality in Türkiye 1960-2010

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Türkiye'de Ekonomik Kalkınma, Anne Eğitimi ve Bebek Ölüm Hızları 1960-2010

Abstract

This study revisits the unusual relationship between infant mortality and economic growth in Türkiye between 1960 and 2010, considering the effects of female education. The independent influences of economic development and women's education on infant mortality are assessed using fractional polynomial regressions applied to World Bank data on 108 middle-income countries, as well as indirect mortality estimations and logistic regressions with Turkish census data from 1985 to 2000 and Demographic and Health Surveys from 1993 to 2008. Results show that Türkiye consistently displayed higher levels of infant mortality in comparison to other countries at similar levels of economic development, but eliminating significant within-country disparities in women's primary and secondary school education could have removed both subpopulation-level heterogeneity in death rates and population-level excess deaths.

Keywords   :   Infant Mortality Rates, Economic Development, Maternal Education, Socioeconomic Factors.

JEL Classification Codes :   I15, I14, N30.

Öz

Bu çalışma bebek ölümleri ile ekonomik büyüme arasındaki Türkiye'ye özgü ilişkiyi yeniden değerlendirerek, ülkenin kadın nüfus eğitim düzeyinin bu ilişkiyi nasıl etkilemiş olabileceğini sorgulamaktadır. 1960 ve 2010 yılları arasında ekonomik büyüme ve anne eğitiminin birbirlerinden bağımsız olarak ölüm hızları üzerindeki etkileri Dünya Bankası'nın 108 orta-gelirli ülkeye ilişkin verileri ile kullanılan kesirli polinom regresyonları, 1985-2000 nüfus sayımı ve 1993-2008 Demografik ve Sağlık Araştırması verilerine uygulanan Brass dolaylı ölüm tahmin metodu, ve lojistik regresyonlar ile incelenmektedir. Sonuçlar, diğer orta-gelirli ülkelerle karşılaştırıldığında Türkiye'nin sürekli olarak beklenenden yüksek seviyelerde bebek ölüm hızı sergilediğini, ancak annelerin eğitimindeki eşitsizliklere yatırım yapılmış olması halinde hem ülke genelindeki fazladan ölümlerin hem de alt nüfus düzeyinde ölüm hızlarındaki heterojenliğin ortadan kaldırabileceğini göstermektedir.

Anahtar Sözcükler   :   Bebek Ölüm Hızları, Ekonomik Kalkınma, Anne Eğitimi, Sosyoekonomik Faktörler.

1. Introduction

Infant mortality rates (IMRs) in developing countries are considered to be the most responsive to economic progress among various measures of mortality, as repeatedly indicated by higher-order correlation coefficients recorded between countries' IMRs and GDP per capita levels (Preston, 1975; Hanmer et al., 2003; Preston, 2007; Schady & Friedman, 2007; Baird et al., 2011). Comprising the value of all goods and services produced within a specified period, GDP is considered the most reliable indicator of a country's living standards. Its growth as an aggregate income level implies a more significant real consumption of items by families, such as food, housing, and access to medical services, which positively affect health. While the association of GDP levels with mortality is significant due to the multiplicity of factors represented by GDP as an indicator, its relation with infant mortality is even stronger because mortality from infectious diseases to which infants and children are most vulnerable is primarily reactive to rising income and nutritional status levels (Preston, 1980; Cutler et al., 2006; Preston, 2007).

Türkiye's infant mortality trends in the second half of the twentieth century have been described as a 'demographic puzzle' by social scientists and demographers due to persistently higher than expected or "excess" death rates given the levels of economic progress (Gursoy, 1992; Gursoy, 1994; Aksit & Aksit, 1989; Behar et al., 1999; Koc & Eryurt, 2017). For instance, Aksit and Aksit, who examined the determinants of infant and child mortality in the 1980s, noted, "It is known that the historical relationship between income and mortality can be highly variable during economic development, yet it is puzzling that Sri Lanka with one-third of the Turkish GNP has half the Turkish infant mortality" (1989: 571). Gursoy-Tezcan stated, "In Türkiye, as in most Middle Eastern countries, neither the GNP per capita nor other development criteria seem to explain the high incidence of infant deaths" (1992: 131). In addition, population studies from earlier years revealed that national infant mortality rates were influenced by significant regional and provincial disparities (Fisek, 1969; Shorter & Macura, 1982), with notable differences among metropolitan, urban, and rural residential types (Shorter, 1969; Goldberg & Adlakha, 1969). Although these studies acknowledged the role of uneven levels of modernisation and industrialisation across Türkiye in contributing to such variations, most rather stressed the role of sociocultural factors in delaying the infant mortality transition, particularly problematising low levels of maternal education even in large urban centres (Fisek, 1989; Goldberg & Adlakha, 1969; Aksit & Aksit, 1989).

Although it is known that Türkiye's experience with IMRs was 'exceptional' in the sense of being markedly at variance with what would have been expected based on economic growth alone, the relationship between GDP and IMRs needs to be revalidated after considering Türkiye's closing decades of transition. The same holds for the relationship between female education and IMRs. More recent studies either use individual-level data with a broad set of socio-economic variables without comparing the effects of mothers' education and economic resources on mortality as separate determinants (Yanikkaya & Selim, 2010; Yetim et al., 2021) or use aggregate- and individual-level data to specifically

target its regional and/or ethnic variations (Eryurt & Koc, 2015; Koc et al., 2008). This article presents the results of the most extensive study of its kind on Türkiye, encompassing various levels of analysis, a comprehensive period, diverse data sources, and effective empirical strategies, as well as the number of reports from reproductive-age women. It has four main goals. First, it attempts to empirically update the analysis on the association between IMR and national income levels until the very end of Türkiye's infant mortality transition, using a large cross-national dataset on lower- and upper-middle-income countries between 1960 and 2010. This way, we can get a comprehensive picture of the extent of population-level deviation (in excess deaths) from the shared experience in other developing countries. Second, the paper tries to account for the influence of female schooling levels on infant mortality in the same pool of countries using gender ratios in primary and secondary education. Third, the study aims to produce mortality estimates to measure the extent of within-country heterogeneities since the 1970s, obtained by applying the Brass method to reports from over two million women regarding the survivorship of their children. In addition, the role of maternal education in mitigating the main inequalities between the East and the rest of the country, as well as between the Kurdish and Turkish populations, is examined using counterfactual analysis with indirectly estimated IMRs and population distributions. Fourth and last, the study tries to assess the independent effects of material resources and maternal education on the risk of infant mortality in families, using survival histories of children born between 1988 and 2008.

The following section introduces the economic and cultural theories of infectious disease mortality decline, previously proposed by demographers who reported strong associations and causal relationships of IMR with national income levels and maternal education in developing countries. The method section describes the demographic procedures and data used in Türkiye's aggregate and individual-level analyses. After presenting the main findings in the results section, the paper addresses possible implications of the conclusions of the discussion section and concludes.

2. Economic and Cultural Theories of Mortality Decline from Infectious Diseases

Much of the significant and sustained reductions in mortality in the history of both developed and developing countries have been due to decreased mortality from infectious and parasitic diseases to which infants and children are the most vulnerable. These diseases are commonly known as pneumonia, diarrhoea, whooping cough, measles, smallpox and malaria. Previous theories that have been advanced to explain mortality declines from these causes are divided between a) "Economic" explanations with an emphasis on improvements in a population's standards of living and b) "cultural" explanations that invoke ideational shifts with which individuals conceive the medical causes of diseases, and methods of prevention and treatment.

The economic argument with an emphasis on improving standards of living favoured *nutritional improvements* as the leading cause of mortality decline in high-mortality

populations due to two main reasons (McKeown, 1976; Fogel, 1986; Fogel, 2004): First, economic improvements increase the per capita supply of food that alleviates the prevalence of chronic or severe malnutrition. Second, economic development improves food quality and dietary composition. It reduces nutritional deficiencies, such as iron and protein-energy malnutrition, which are closely related to negative growth and health outcomes in infants and young children. In addition, a reciprocal and synergistic relationship exists between nutritional status and infection (Scrimshaw, 1968; Scrimshaw, 1997; Lunn, 1991). Malnutrition is associated with a decrease in immunocompetence and increased susceptibility to infectious diseases, whereas infection results in a more malnourished subject, completing the vicious circle. Given that malnutrition is a significant factor in the occurrence of infections and infections are a common precipitating factor of malnutrition, the economic argument suggests that deaths from infectious diseases in a high-mortality population cannot be eliminated in the absence of population-level improvements in standards of living and nutritional status.

Cultural explanations of mortality decline have emphasised the role of socio-cultural and behavioural factors as determinants of health and mortality improvements in developing countries (Caldwell & McDonald, 1982; Caldwell, 1986, 1990, 1994). This emphasis was based on a perception of mortality decline as a 'social' transition in addition to an 'economic' one, which required changes in attitudes toward life and death, as well as in the cultural and normative contexts and systems of values, beliefs, ideologies, and normative pressures. Maternal education, the most significant driver of social change, was associated with the emergence of a new, calculating rationality that transformed the grounds of the processes of decision-making about health, consequently moving these decisions from the realm of custom and tradition (i.e. fatalism) to a legitimate object of rational choice (i.e. a sense of control of destiny). Another key element produced by maternal education was the ability to rattle the cage of cultural and traditional constraints: It was the most significant driver of mortality decline, not primarily because of enhancing women's involvement as mothers to use and efficiently allocate the material resources available, but because of the greater autonomy it brings with important health benefits for children, mainly through educated mothers' rejection of traditional age and sex differentiations in power, decision-making and benefits in families.

Thus, earlier economic and cultural studies of mortality decline in developing countries empirically investigated mortality reductions as a product of one of the two fundamental sources of change at the population level: primarily as a function of profound economic changes or somewhat independent of economic changes and dependent on ideational shifts. Both groups of arguments were supported by evidence. The pioneering work by Preston (1975, 1980, 1985), who decomposed mortality reductions into economic and other structural factors, showed that mortality trends cannot be dissociated from countries' national income levels at any point in time, even though the cross-sectional relationship might change due to other factors related to the availability and accessibility of the new medical technologies. Other studies that followed Caldwell's seminal work on cultural effects demonstrated that maternal education had a strong, independent and positive

impact on infant survival in developing countries, even after statistically controlling for other important variables such as family income or urban/rural type of residence (Hobcraft et al., 1984; Mensch et al., 1985; Cleland & van Ginneken, 1988; Cleland, 1990). These studies identified numerous mechanisms between education and mortality and stated that educated mothers attached a higher value to the welfare and health of their children, had greater decision-making power on health-related matters, were less fatalistic about diseases and death, more knowledgeable about disease and cure, more innovative in the use of remedies, and more likely to adopt new codes of behaviour that have indirect but positive consequences for the health of infants.

In more recent years, some studies presented updated empirical analyses on the effects of economic growth and female education on infant and child mortality in developing countries (Kuhn, 2010; Fuchs et al., 2010; Pamuk et al., 2011; Baker et al., 2011, Lutz and Kebede, 2018). All of these studies were in agreement that children of better-educated mothers are at a lower risk of mortality on all continents and across all levels of socio-economic development. In addition, they empirically found that per capita GDP is such a powerful determinant of mortality that any other powerful determinant (such as female education) is better understood by first stripping out income effects. The findings on the *relative* strength of economic growth and female education were consistent in that the impact of education dominated that of income and wealth in both aggregate- and individual-level analyses. For instance, Fuchs et al. (2010) used data from the Demographic and Health Surveys (DHS) from Africa, Asia and Latin America to test the existence of independent effects of education and wealth and to establish which effect is more important, found that the educated poor was doing better than the uneducated with more incredible wealth in these countries. Pamuk et al. (2011), who similarly used DHS from 43 low- and lower-income nations, showed that the decline in the average odds of infant death with increasing education level was more significant than the decline associated with household wealth at the national level, but the impact of education was even more important in families and communities.

3. Methodology

Given the availability of information on past economic growth and mortality trends for many countries today, it is possible to investigate this relationship for Türkiye and determine to what extent its experience diverged from that of other developing countries. The effect of national income on mortality levels in a group of countries can be estimated by fractional polynomial modelling, as proposed by Royston and Altman (1994) and Royston and Sauerbrei (2008). Fractional polynomials generalise the polynomial function, allowing for a nonlinear relationship between a dependent variable (national income levels) and an independent variable (IMRs), but require that all power terms are positive integers. Fractional polynomial models are more flexible and permit fractional and negative exponents, which is more appropriate if IMR drops rapidly with increasing GDP values until it hits a floor. For a single predictor x, polynomial fractions are of the form:

$$Y = \beta_0 + \beta_1 x + \beta_2 x^2 + \cdots + \beta_h x^h + \varepsilon \tag{1}$$

where h (the degree of the polynomial) is selected from the set [-2, -1, -0.5, 0, 0.5, 1, 2, 3] alone and in pairs, the Stata software attempts 44 different models involving these polynomials. It selects a model with the best-fitting combination of powers. In models involving repeated powers, the second term is multiplied by ln (x). For instance, the model FP (2,2) is of the form:

$$Y = \beta_0 + \beta_1 x^2 + \beta_2 x^2 \ln(x) \qquad (2)$$

The most straightforward means of determining whether certain countries differ significantly from others in their response to economic growth is to recompute the relationship between national income per capita and infant mortality in a group of countries and, on each occasion, employ a dummy variable representing a different country from the group. This is equivalent to adding the country from which an observation derives as an independent, explanatory variable to the equation. Since the dummy variable takes the value of 1 if an observation is in a country and 0 otherwise, the coefficient of the dummy would thus indicate by how much, on average, death rates in a particular country lie above or below the regression line. The average excess infant mortality Türkiye (D=1) experienced between 1960 and 2010, compared to other middle-income countries, was obtained by applying this procedure to cross-sectional data from 108 countries classified as either lower- or upper-middle-income countries (World Bank, 2023). Repeating the same procedure for each country enabled comparisons based on the sign and size of d_i. The magnitude of excess deaths was also viewed from a different angle, namely, by comparing observed mortality levels in Türkiye with those expected if Türkiye had experienced the same relation between GDP and IMR as in other middle-income countries. To achieve this, the relationship between detrended GDP and IMR in the pooled sample of countries (excluding Türkiye) was first estimated and subsequently used, along with Türkiye's GDP levels, to compute counterfactual values. Ratios of observed to expected values were used to determine whether Türkiye would have experienced lower IMRs if the Turkish GDP time trend had remained unchanged, but the relation between GDP and IMR in the pooled sample of developing countries had prevailed. If this is the case, these ratios become measures of the extent of Turkish "underachievement," which can be explained by unmeasured factors unrelated to GDP that have kept Türkiye's IMR at levels exceeding those expected given its national income levels. Finally, maternal education, the most significant indicator of unmeasured (cultural) factors not related to GDP, was integrated into estimations in two steps by adding the Gender Parity Index (GPI) in primary school education (i.e. ratio of female to male students enrolled at the primary level of education) and GPI in secondary school education (i.e. the ratio of female to male students enrolled at the secondary level of education) to the relationship between GDP and IMRs in middle-income countries.

The next group of analyses were conducted at the subpopulation level. The study of heterogeneity and subgroup analysis of infant mortality within Türkiye by geographical location, ethnicity, and maternal education relied on a robust indirect estimation method in demography that specifically targets infant mortality. The Brass method, which revolutionised the estimation of infant and child mortality in developing countries, uses the

actual proportions of children born who have died to indicate infant mortality (Manual X UN, 1983; Preston et al., 2001: 224-233). Because the sample size of mothers who report about the survivorship of their children is the largest in a census, the Brass method was primarily applied to the Turkish census data from 1985, 1990 and 2000, using proportions of children ever born and proportions of children surviving by mother's five-year age group. However, four cross-sections of the DHS from 1993, 1998, 2003, and 2008 were also analysed to verify the accuracy of the results by ethnicity. The UN software package for mortality measurement, MORTPAK, and its CEBCS procedure were used to estimate IMRs. Turkish censuses could generate estimates for twenty-five years between 1971 and 1996, and DHS data produced estimations between 1979 and 2004.

By default, the Brass method generates four sets of IMRs, each corresponding to one of the four model life tables produced by the Coale-Demeny system (Coale & Demeny, 1966; Coale et al., 1983). Each model life table has a different pattern of age-specific mortality and a characteristic pattern in early life mortality: The 'north' model is distinguished by relatively low mortality in infancy and after age 50, 'east' model is characterised by relatively high mortality in infancy and after age 50, 'south' model is characterised by high mortality under age 5, low mortality at ages 40-60 and high mortality over age 65, and 'west' model is identified as an 'average' mortality pattern. The reported IMRs in this study were generated for the 'south' model (with Trussell's set of adjustment factors), as it historically aligns most closely with the Turkish experience (Shorter & Macura, 1982). Appendix Figure 1 shows that country-level IMR estimates produced using these specifications, based on reports from over 2 million women in the Turkish Censuses, were highly similar to the IMRs reported by the World Bank (2023).

Figure: 1
Ratios of Observed to Expected IMR in Türkiye using the Relation between GDP and IMR that Prevails in Middle-Income Countries
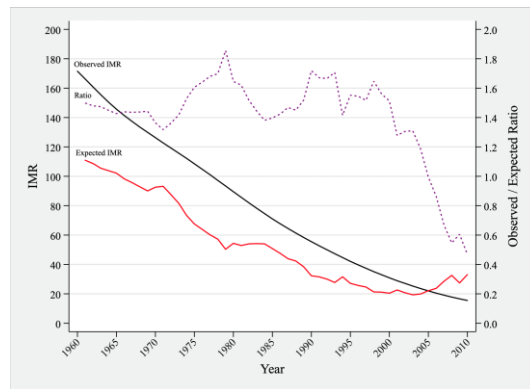
Data Source: The World Bank, World Development Indicators, 2023

Regional and ethnic variations in infant mortality were investigated by using regions, regional and urban-rural combinations of locations, and the Kurdish ethnicity. Regional analysis was limited to the Marmara, East Anatolia, and Southeast Anatolia regions to avoid clutter. Geographical combinations were constructed as replicates of some of the categories used by Shorter and Macura (1982) earlier, spanning the period from 1945 to 1970. They included a) Istanbul and Izmir, b) Urban West, c) Rural Central and d) Rural East. As no direct question of ethnicity was available through census data, the estimation of Kurdish infant mortality levels using census data was performed by selecting ten provinces in eastern Türkiye where the percentage of Kurds in the total population was at least 60% in 1990 (Mutlu, 1996). This group of estimations was supported by DHS data that included answers to a question about respondents' native language and, therefore, provided a more accurate measure of Kurdish ethnicity. Variations in maternal education with the Brass method were estimated across mothers with less than primary education, primary education, secondary education, and a university degree. Estimated IMRs were later used to calculate the expected reduction in infant mortality based on counterfactual scenarios, which assumed hypothetical educational distributions of women at the country and subpopulation levels. These counterfactual scenarios are helpful as they demonstrate the contribution of women's educational distribution to high death rates. They answer how much reduction in IMR would be expected if every mother in the country or a given subpopulation had at least a primary school education. Appendix Table 1 presents the sample size of women in each Brass estimation with further explanations.

Lastly, an individual-level analysis of the main determinants of infant mortality was conducted using the DHS data from 1993 to 2008. Although DHS data can capture only the final years of Türkiye's mortality transition, it is still rich in detailed survival histories for children born in the last 5 years preceding the survey, as well as sociodemographic indicators. Here, the main goal was to assess the independent effects of economic resources and mothers' education on utilising maternal and child health services and the risk of infant mortality, controlling for other potentially confounding socio-demographic and socio-economic characteristics of families, mothers and children. To achieve this, the pooled individual recode file of ever-married women aged 15-49 was reshaped into a long format, with children born to these women serving as the unit of observation. The outcome variables, prenatal care and infant mortality were constructed as binary variables, taking a positive value if the mother received prenatal care or the child died before their first birthday. The formula of the logistic regressions that modelled prenatal care utilisation and risk of infant mortality is:

$$\ln \frac{P\ (outcome)}{1-P\ (outcome)} = \alpha_+ \beta_1 x_{1+} \beta_2 x_{2+} \ldots + \beta_k x_k \tag{3}$$

where P = Probability of prenatal care utilization or infant death

X = vector of independent variables (1-k)

Household wealth, one of the two most important independent variables, was categorised into five levels of economic status, ranging from the poorest to the wealthiest households. The other crucial independent variable, the mother's education, was constructed as a categorical variable that differentiated between women with no education, women with primary education, and women with secondary or higher education. Other socio-economic variables included ethnicity, type of residence (urban or rural), five DHS regions, and the father's education. The mother's age, sex, birth order of the child, and the survey year were used as controls.

Table: 1

Significant Coefficients of Country Dummy Variables (di) in Fractional Polynomial Regressions Relating National Income to Infant Mortality Rates in Middle-Income Countries 1960-2010

Countries	Coef.	Std. Err.	Countries	Coef.	Std. Err.
Angola	67,86	4,40	Vanuatu	-13,76	4,46
Nigeria	57,17	3,58	Russian Federation	-14,16	5,28
Cote d'Ivoire	55,32	3,43	Georgia	-14,22	5,50
Equatorial Guinea	52,19	4,62	Kenya	-14,63	3,56
Benin	32,15	3,53	Jordan	-14,88	3,73
Cameroon	31,33	3,51	Montenegro	-14,99	7,60
Djibouti	30,40	5,03	Serbia	-15,72	6,30
Haiti	30,27	3,54	Mauritius	-15,90	4,28
Gabon	30,18	3,95	Colombia	-16,13	3,54
Pakistan	30,10	3,53	Paraguay	-16,97	3,72
Comoros	27,59	4,52	Grenada	-17,11	4,35
Bolivia	26,44	3,52	Dominica	-19,97	4,34
Algeria	24,24	3,53	Albania	-20,26	4,84
Turkiye	23,42	3,58	Kyrgyz Republic	-20,86	5,52
South Africa	22,09	4,17	Bulgaria	-21,12	4,53
Bangladesh	22,05	3,57	Armenia	-21,87	5,50
Nepal	20,02	3,63	Guyana	-22,13	3,52
Egypt, Arab Rep.	19,55	3,71	Thailand	-22,54	3,52
Senegal	18,01	3,53	Samoa	-23,02	4,67
Lao PDR	16,80	4,88	Jamaica	-23,27	3,55
Eswatini	16,64	3,53	Belarus	-23,50	5,49
Bhutan	15,85	4,53	Vincent and the Grenadines	-23,73	3,52
Namibia	15,48	4,54	Fiji	-25,07	3,53
Morocco	15,44	3,53	Ukraine	-26,23	5,13
India	15,34	3,56	Moldova	-26,39	6,30
Guatemala	14,75	3,54	Costa Rica	-26,40	3,53
Iran, Islamic Rep.	14,31	4,11	Philippines	-27,42	3,52
Brazil	11,27	3,56	Bosnia and Herzegovina	-27,44	6,10
Mauritania	11,07	3,57	Solomon Islands	-27,46	3,83
Mongolia	10,91	4,60	Cuba	-28,03	3,94
Peru	10,36	3,55	Malaysia	-30,61	3,53
Argentina	-7,80	3,98	Tonga	-31,13	4,18
Belize	-8,87	3,82	China	-32,83	3,88
Zimbabwe	-9,78	3,54	Vietnam	-41,00	4,94
Lebanon	-10,82	5,27	Sri Lanka	-48,28	3,47
North Macedonia	-11,95	5,50	Myanmar	-51,80	3,89
St. Lucia	-12,75	4,60			

Notes: i. Only those middle-income countries with significant coefficients at the .95 confidence interval are shown here. ii. All models control for t (Year 1959) using linear, quadratic and cubic terms. Data Source: The World Bank, World Development Indicators, 2023.

4. Results

Table 1 presents the ranked regression coefficients for country dummy variables, which display significant effects on infant mortality levels, either positive or negative, independent of the impact of economic growth jointly estimated for all countries between

1960 and 2010. Those countries with coefficients (di) at either end of the list are 'exceptions' in the sense that their observed mortality levels significantly deviate from what would be expected by the relationship between economic progress and infant mortality gains in the pool of developing countries. Those countries that appear at the top are the underachievers, displaying higher-than-expected rates of infant mortality, while those at the bottom are the ones that outperform and reduce mortality beyond what would be expected given their economic performance. The coefficient for Türkiye is both significant and positive, and it appears to be the first coefficient from an upper-middle-income country in this list. It is also more critical than the coefficients of countries such as Argentina, Brazil, Colombia, Bulgaria and Ukraine, which have had similar economic performances to Türkiye. The value of the coefficient indicates an average excess of 23.4 infant deaths per 1,000 births between 1960 and 2010, which cannot be explained solely by national income levels.

Another way to assess the magnitude of excess deaths is by comparing the observed mortality levels with those expected if Türkiye had experienced the relationship between GDP and IMR observed in other middle-income countries. To do this, the relation between detrended GDP and IMR in the pooled sample of countries (excluding Türkiye) is first estimated (see Appendix Table 2). Next, Türkiye's GDP levels and the model's parameter estimates are used to compute counterfactual values. Figure 1 displays ratios of observed to expected values of IMR. Here, the ratios above unity indicate that if the Turkish GDP time trend had remained unchanged, but the relation between GDP and IMR in the pooled sample had prevailed (if Türkiye had the same average relationship as other middle-income countries), Türkiye would have experienced a significantly lower IMR. Until 2005, the ratios hovered in the range of 1.19-1.86, suggesting that IMRs should have been up to 54% lower than the observed, conditional on economic performance.

These ratios reflect the extent of unmeasured factors unrelated to GDP that contributed to Türkiye's IMR remaining at levels exceeding those expected, given its economic achievements.

A plausible argument is that lagging improvements in female education, the most significant driver of social change, delayed Türkiye's decline in infant mortality despite improvements in national income. The results of two additional regressions, which include GPI in primary school education and GPI in secondary education, are presented in Table 2. Türkiye's country variable is still significant but notably reduced after controlling for female-to-male ratios in primary education and only loses its significance after controlling for female-to-male ratios in secondary education: The initial country coefficient corresponding to 23.4 excess deaths (per 1,000 births on average) in the first model, is reduced almost by half to 12.3 in the second model, and later to 3.4 excess deaths (per 1,000 births on average) in the third model. Therefore, the gap in infant mortality between Türkiye and other middle-income countries shrinks notably when we control for primary education and disappears entirely when we control for secondary education, demonstrating the powerful role of female education, independent of the effect of economic growth, on mortality. Between Models 1 and 3, the coefficients associated with GDP are altered,

indicating a weakened effect on IMR after including gender ratios in primary and secondary education. For example, a $1,000 increase in GDP from $1,000 to $2,000 decreases the IMR by 14.4%, 12.3%, and 10.2% in the first, second, and third models, respectively. Between Model 2 and Model 3, the coefficient associated with gender ratios in primary education is significantly reduced but remains statistically significant, and its magnitude is more extensive than that associated with gender ratios in secondary education. While a one percentage point increase in the male ratio in primary education decreases the IMR by 0.96 in the second model, a one percentage point increase in the to-male ratio in primary and secondary education decreases the IMR by 0.40 and 0.38, respectively, in the third model.

Table: 2
Fractional Polynomial Regressions Relating National Income Levels and Female-To-Male Ratios in Education to Infant and Child Mortality Rates Between 1960 and 2010 in Middle-Income Countries

	Model I				Model II				Model III			
Number of obs	4.001				2.766				2.024			
F	(6, 3994)	=	1074,85		(7, 2758)	=	789,18		(8, 2015)	=	621,26	
Prob > F	0,0000				0,0000				0,0000			
R-squared	0,62				0,67				0,7115			
	Coef.		Std. Err.	t	Coef.		Std. Err.	t	Coef.		Std. Err.	t
Constant	183,64	★★★	2,90	63,39	208,41	★★★	8,31	25,09	214,91	★★★	8,92	24,11
gdp_1	-9,13	★★★	0,35	-26,01	-1,94	★★★	0,08	-24,12	-5,38	★★★	0,38	-14,21
gdp_2	0,87	★★★	0,04	23,59	0,01	★★★	0,00	16,12	0,50	★★★	0,04	12,56
GPI in primary school education					-0,97	★★★	0,03	-31,70	-0,41	★★★	0,05	-8,10
GPI in secondary school education									-0,38	★★★	0,03	-13,02
Country dummy variable for Türkiye	23,42	★★★	3,58	6,55	12,32	★★★	3,33	3,70	3,14		3,28	0,96
t	-0,25		0,34	-0,73	0,80		0,88	0,91	-0,53		0,92	-0,57
t^2	-0,05	★★★	0,01	-3,58	-0,07	★★	0,03	-2,50	-0,03		0,03	-1,07
t^3	0,00	★★★	0,00	-20,31	0,00	★★★	0,00	3,15	0,00	★	0,00	1,85

Notes: i. *** = $p<0.01$, ** = $p<0.05$, * = $p<0.10$. ii. After trying 44 different models involving polynomials, the selected model for Models 1, 2, and 3 uses the powers (0.5-0.5), (0.5-1), and (0.5-0.5) as the best-fitting combination of polynomials. iii. In Model 1 and Model 3, gdp_1 and gdp_2 reflect the terms associated with (GDP per capita ^ 0.5) and (GDP per capita ^ 0.5) * ln (GDP per capita), respectively. In Model 2, they reflect (GDP per capita ^ 0.5) and (GDP per capita). Data Source: The World Bank, World Development Indicators, 2023.

Having established at the population level that higher levels of female education would have exerted significant negative effects on infant mortality, independent of the impact of economic growth, one can assess to what extent different distributions of maternal education at the subpopulation level contributed to disparities in IMR across Türkiye. Infant mortality trends across three regions and four regional and urban-rural combinations of locations are displayed in Figure 2, demonstrating the principal axes of inequality in death rates. The upper panel compares the most economically advanced Marmara region with the least economically advanced regions of East and Southeast Anatolia. In the early 1970s, when Türkiye's country-level IMR was 116 and regional IMRs ranged between 106 and 132, Southeast Anatolia was one of the regions with relatively lower mortality levels (IMR = 112). Marmara and East Anatolia are high mortality regions with IMRs of 120 and 122, respectively. Marmara experienced significant mortality gains from the 1970s onward, but the decline curve in both the East Anatolia and Southeast Anatolia regions is less steep. Although IMRs in the mid-1990s converged around 33 in most other regions, East Anatolia and Southeast Anatolia had IMRs of 39 and 41, respectively. This corresponds to 18% and 24% more infant deaths in these regions at this time.

Figure: 2
Estimated IMRs by Selected Regions and Geographical Divisions in Türkiye

Panel A   Panel B
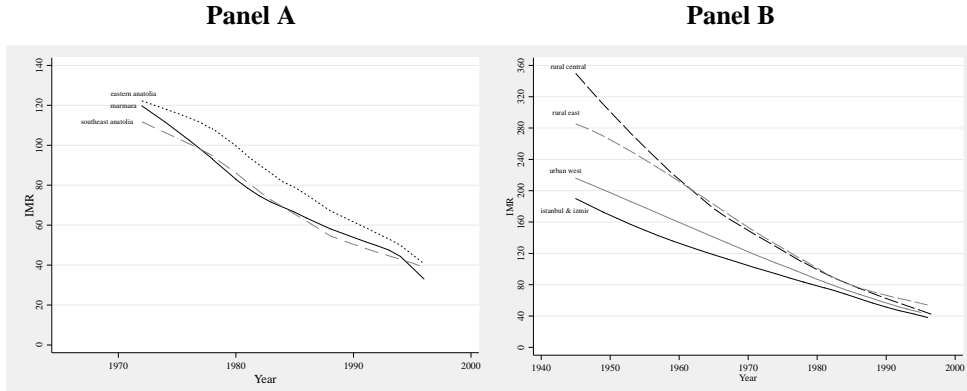
Notes: i. Except for Istanbul and Izmir, all geographical divisions are measured by representative locations. The cities of Aydın and Usak represent the urban West. Rural Kırşehir and Sivas represent rural Central Anatolia. Rural Mardin, Hakkari, Siirt, Sırnak, Kars, Igdir and Ardahan represent rural East. These arbitrary choices may differ from those in urban and rural units in Shorter and Macura's (1982) estimations.

The lower panel examines geographical variations in infant mortality in two ways: first, by presenting earlier IMR estimates from Shorter and Macura (1982) for the period 1945-1970, and second, by distinguishing between metropolitan, urban, and rural areas. This graph compares the country's most advanced regions: two metropolitan centres in the west, less-industrialized urban centres in the West, and the least developed rural areas in central and eastern Türkiye. At first glance, the results indicate a significant fluctuation in initial mortality rates across the country, with an IMR of 260 at the national level reflecting very different mortality experiences. In the mid-1940s, for instance, a significant gap existed in the initial mortality levels experienced in Istanbul and Izmir, on the one hand, and the rural central and eastern regions, on the other, which had IMRs of 182, 350, and 285, respectively. Therefore, the starting infant mortality rates in rural central and rural eastern areas are 92% and 57% higher than in metropolitan cities. Another feature is the relatively slow mortality decline rate in the rural east throughout the analysis period despite higher starting mortality levels in the 1940s. By contrast, the mortality decline in rural central areas is faster. It reduced the IMR by 87% between 1945 and 1995, eliminating most of the initial disadvantages compared to Western metropolitan and urban areas. The gap in IMR between Istanbul and Izmir, as well as the rural east, remains significant by the end of the 1990s: the infant mortality level in the rural east is 42% higher than in the most advanced regions in the west.

Locations that experienced a stalling of mortality, specifically the East and Southeast Anatolia regions in the upper panel and eastern rural areas in the lower panel, are considered traditional areas of the Kurdish population, despite massive movements that geographically redistributed the Kurds to the western and southern parts of the country during the 1990s. Thus, Figure 3 shifts focus to infant mortality levels in the Kurdish population between the

early 1970s and mid-2000s, based on census and DHS data estimations. The figure reveals several important features. The first is that the IMR in predominantly Kurdish provinces (estimated from census data) decreased by 48% between the early 1970s and the late 1990s, dropping from 108 to 56. This is a minor reduction compared to the rates estimated for other high-mortality locations during the same period. Second, IMR estimates from the DHS data, representing the Kurdish population not only in predominantly Kurdish provinces in the east but across all regions in Türkiye, are very close to the rates in Kurdish provinces, at least until the mid-1980s. There is a divergence after this period, and the IMRs estimated for traditional Kurdish provinces are lower than those calculated for the entire Kurdish population using DHS data. This finding is compatible with the higher participation of the younger Kurdish population in internal migration at that time, as a result of which we may be underestimating Kurdish infant mortality or introducing more bias using Kurdish provinces rather than more accurate measures of ethnicity. In other words, if Kurdish infant deaths are occurring outside these provinces, we are not counting them. Third and most importantly, a comparison of levels between Kurdish and Turkish infant mortality reveals that IMR was lower among the Kurdish population until the end of the 1980s, but there was a 'cross-over' in rates at the beginning of the 1990s when the Kurdish mortality decline slows down and eventually comes to a halt. Ten years before the cross-over, the Turkish IMR was in the range of 114 and 66, and the Kurdish IMR was in the range of 92 and 66. After the cross-over, the rates increasingly diverge, leading to a large disadvantage gap for the Kurdish population by the mid-2000s. The Turkish IMR is 35, and the Kurdish IMR is 43, or 23% higher. Kurdish provinces also experienced a crossover in IMRs, even though census data show a gap only for a short time, until the mid-1990s.

Figure: 3
Estimated IMRs by Ethnicity in Türkiye
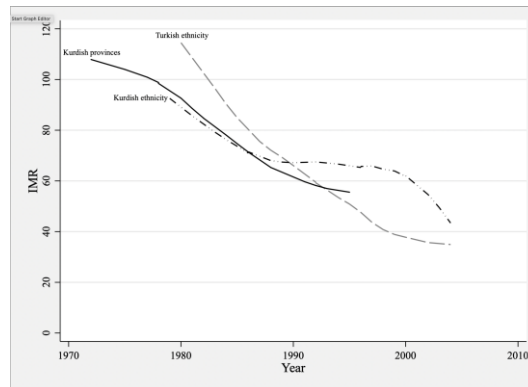
Notes: i. Agri, Bitlis, Bingol, Diyarbakir, Hakkari, Mardin, Siirt, Batman,
Sirnak and Kars are the names of the ten Kurdish-majority provinces.

Suppose maternal education is strongly associated with infant mortality. In that case, it is plausible that lack of satisfactory levels of education, particularly in some

subpopulations of women of reproductive age (for instance, among Kurdish women residing in eastern Türkiye), is a contributing factor to high levels of death rates observed in these groups. Consequently, it is also a contributing factor to the excess IMR observed at the country level, especially in comparison to other countries at similar levels of economic achievement but with less unequal distributions of education or lower rate schedules at the lower end of the *educational distribution*. To determine the extent to which the distribution of maternal education by geographical location or ethnicity explains the disparities described in Figures 2 and 3, the IMRs by mothers' educational attainment need to be estimated first. The results of this estimation are presented in Figure 4, which demonstrates the most striking variation in death rates in Türkiye, based on the initial levels in the early 1970s, the rates achieved by the mid-1990s, and the pace of decline in between.

Figure: 4
Estimated IMRs by Maternal Education in Türkiye
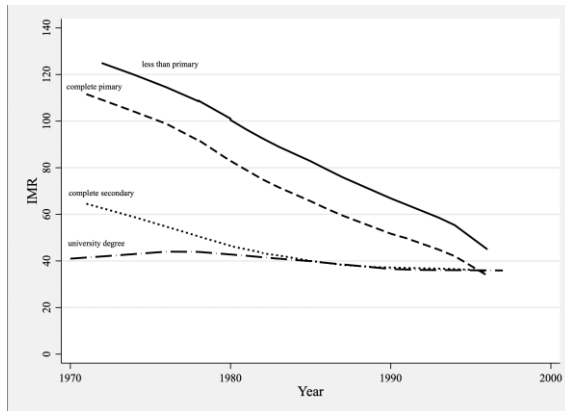
The starting IMRs of mothers with less than primary education, primary education, secondary education, and university degrees are 125, 112, 65 and 41, respectively. To put it another way, the infant mortality level experienced by mothers without any educational attainment is more than two times higher than that of mothers with a university degree and almost twice as high as that of mothers with secondary education. The gap is large enough to suggest two mortality regimes until the end of the 1980s, one shared by those with complete primary school education or less and another shared by secondary education graduates and university degree holders. During the period from the early 1970s to the late 1990s, the intensity of change was most significant for mothers with primary education, followed by those without a complete primary education. The IMR of mothers with less than primary education decreased by 64%, whereas the IMR of mothers with primary education declined by 70%. The IMR of mothers with a university degree declined by only 12%. The pace of decline in infant deaths to mothers with complete secondary education is slower than declines in lower educational categories, with nearly two-thirds of their intensity. The gap in mortality rates between mothers with no education and those with some level of education

shrinks but does not disappear by the mid-1990s. Currently, the IMR of mothers with less than primary education is 45, whereas the IMRs of mothers with primary education, secondary education and university degrees are 34-36.

Table: 3
Counterfactual Infant Mortality Rates by Maternal Education

	Türkiye		
	C(x) in 1985	Observed IMR in 1985	Counter
Less than Primary Education	36,25	83	66
Primary Education	55,39	66	
Secondary Education	6,45	40	
University Degree	1,91	40	
Total	100,00	69,70	63,62
	Kurdish Provinces		
	C(x) in 1985	Observed IMR in 1985	Counter
Less than Primary Education	79,82	83	66
Primary Education	17,66	66	
Secondary Education	1,89	40	
University Degree	0,63	40	
Total	100,00	78,68	65,28
	Istanbul and Izmir		
	C(x) in 1985	Observed IMR in 1985	Counter
Less than Primary Education	23,55	83	66
Primary Education	61,43	66	
Secondary Education	11,47	40	
University Degree	3,55	40	
Total	100,00	65,81	61,86
	East Anatolia		
	C(x) in 1985	Observed IMR in 1985	Counter
Less than Primary Education	64,51	83	66
Primary Education	32,06	66	
Secondary Education	2,73	40	
University Degree	0,71	40	
Total	100,00	75,82	64,99
	Southeast Anatolia		
	C(x) in 1985	Observed IMR in 1985	Counter
Less than Primary Education	77,21	83	66
Primary Education	19,40	66	
Secondary Education	2,56	40	
University Degree	0,83	40	
Total	100,00	78,28	65,04
	Rural East		
	C(x) in 1985	Observed IMR in 1985	Counter
Less than Primary Education	74,53	83	66
Primary Education	23,4	66	
Secondary Education	1,61	40	
University Degree	0,47	40	
Total	100,00	77,89	65,38

Notes: i. Only those women of reproductive age with a non-missing value on the number of everborn children are included in the analysis. ii. C(x) refers to the proportion of women in each education category in the 1985 census year. iii. The author's estimations of the IMRs were observed in 1985 by educational category (Figure 4). Data Source: Turkish census data for 1985, 1990, and 2000.

Values of IMR that would have been observed if every mother completed at least primary school education are displayed in Table 3. If every mother had at least a primary school education in 1985, Türkiye's population-level IMR would decline by 9%, dropping from 70 to 64. This change may seem trivial, but it is expected, given that the main dissimilarity was identified above to be between mothers with less than a secondary school education and those with at least a secondary school education. If every mother graduated from secondary school, Türkiye's IMR would drop to 40 in 1985, a substantial reduction of 43%. However, even though the condition requiring mothers to have at least a primary

school education may seem inconsequential compared to the impact of secondary education, its significance increases when we focus on high-mortality subpopulations. For instance, in East and Southeast Anatolia, where the percentage of women without any education was 65% and 77% in 1985, the counterfactual scenario in which every woman who has ever given birth has at least primary school education decreases the IMR by 14% and 17%, respectively. This also eliminates the gap between metropolitan cities, Istanbul and Izmir, and these locations. In the same counterfactual scenario, the IMR in Kurdish-populated provinces would decline by 17%, and rural eastern regions would experience a 16% reduction.

Table: 4
The Proportion of DHS Children Who Died During Infancy by DHS Year and Selected SES Indicators

		1993	1998	2003	2008
By Household Wealth Index	Poorest households	0,081	0,060	0,049	0,025
	Poorer households	0,047	0,050	0,036	0,020
	Middle-wealth households	0,058	0,036	0,027	0,014
	Richer households	0,030	0,033	0,025	0,015
	Richest households	0,023	0,018	0,009	0,014
By Mother's Education	No education	0,062	0,065	0,057	0,026
	Primary education	0,055	0,039	0,026	0,019
	Secondary education and Higher	0,015	0,024	0,016	0,013
Geographical Region	West	0,044	0,030	0,023	0,009
	South	0,052	0,033	0,025	0,022
	Central	0,057	0,043	0,025	0,018
	North	0,039	0,035	0,027	0,011
	East	0,058	0,059	0,041	0,024
Urban or Rural Place of Residence	Rural	0,060	0,054	0,039	0,020
	Urban	0,044	0,036	0,028	0,018
Ethnicity	Turkish	0,046	0,039	0,022	0,015
	Kurdish	0,068	0,047	0,050	0,024
Total		0,050	0,042	0,032	0,019

Data Source: Türkiye DHS 1993, 1998, 2003 and 2008.

Given the powerful role of education in reducing infant mortality at the population and subpopulation levels, we next assess whether two indicators of socioeconomic status (SES) at the individual level -education and material resources -act independently on the risk of infant mortality in families. The proportion of DHS children born between 1988 and 2008 who died during infancy is presented in Table 4 by survey year and the most critical SES indicators. At first glance, the proportions of children who died during infancy by region, ethnicity and maternal education are consistent with prior Brass estimates: Children born to families in the eastern region with Kurdish ethnicity and low maternal education have higher infant mortality rates throughout all DHS years. The results of logistic estimations on the use of prenatal care and the risk of mortality applied to the same DHS data, along with these and other critical socio-economic variables, are presented in Table 5. It is important to note that, according to the model results predicting the risk of infant mortality, region and ethnicity are statistically insignificant determinants once household wealth and maternal education are controlled for.

Table: 5
Results of Logistic Regressions Predicting Prenatal Care During Pregnancy and Infant Mortality in Türkiye (1993-2008)

Dependent Variable	Prenatal Care During Pregnancy				Infant Mortality			
Number of Observations	14.719				15.620			
LR chi2	4951,68				196,33			
Prob>chi2	0,0000				0,0000			
	Odds Ratio	Standard Error	z	P>z	Odds Ratio	Standard Error	z	P>z
Household Wealth								
Poorest Households (Omitted)	-	-	-	-	-	-	-	-
Poorer Households	1,74	0,10	9,44	0,000	0,83	0,10	-1,51	0,132
Middle-Wealth Households	2,72	0,19	14,38	0,000	0,81	0,11	-1,51	0,132
Richer Households	3,91	0,34	15,78	0,000	0,70	0,12	-2,13	0,034
Richest Households	6,48	0,87	13,84	0,000	0,51	0,12	-2,86	0,004
Mother's Education								
No Education (Omitted)	-	-	-		-	-	-	-
Primary Education	1,62	0,09	8,43	0,000	0,88	0,10	-1,11	0,267
Secondary Education And Higher	3,39	0,36	11,45	0,000	0,68	0,13	-2,00	0,046
Father's Education								
No Education (Omitted)	-	-	-	-	-	-	-	-
Primary Education	1,08	0,09	0,97	0,332	1,24	0,20	1,35	0,177
Secondary Education And Higher	1,77	0,17	6,08	0,000	0,94	0,18	-0,35	0,727
Geographical Region								
West (Omitted)	-	-	-	-	-	-	-	-
South	0,74	0,06	-3,44	0,001	0,99	0,16	-0,06	0,956
Central	0,46	0,04	-9,21	0,000	1,17	0,18	1,04	0,298
North	0,60	0,06	-5,40	0,000	0,89	0,16	-0,65	0,518
East	0,32	0,03	-13,69	0,000	1,10	0,17	0,63	0,528
Urban or Rural Place of Residence								
Urban	1,35	0,07	5,95	0,000	1,03	0,10	0,25	0,805
Ethnicity								
Turkish (Omitted)	-	-	-	-	-	-	-	-
Kurdish	0,76	0,05	-4,08	0,000	1,00	0,14	-0,03	0,976
Other	1,07	0,12	0,58	0,563	1,04	0,22	0,21	0,836
Mother's Age								
15-19	0,94	0,12	-0,52	0,604	1,96	0,45	2,95	0,003
20-24	0,78	0,06	-3,44	0,001	1,42	0,21	2,44	0,015
25-29	0,83	0,06	-2,73	0,006	1,15	0,15	1,03	0,303
30-34 (Omitted)	-	-	-	-	-	-	-	-
35-39	1,18	0,10	1,89	0,059	1,11	0,18	0,64	0,524
40-44	1,18	0,15	1,31	0,189	1,12	0,25	0,51	0,609
45-49	1,25	0,32	0,85	0,394	1,33	0,52	0,72	0,470
Child Sex								
Female	0,96	0,04	-0,85	0,395	0,89	0,08	-1,33	0,183
Birth Order	0,87	0,01	-9,47	0,000	1,10	0,03	3,63	0,000
DHS Year								
1993 (Omitted)	-	-	-	-	-	-	-	-
1998	1,17	0,07	2,65	0,008	0,85	0,10	-1,47	0,143
2003	2,21	0,14	12,89	0,000	0,62	0,07	-3,99	0,000
2008	8,21	0,70	24,79	0,000	0,36	0,05	-6,76	0,000
Constant	1,24	0,19	1,39	0,165	0,05	0,01	-10,38	0,000

Data Source: Türkiye DHS 1993, 1998, 2003 and 2008.

According to the results of logistic estimation predicting prenatal care utilisation, mothers in higher wealth categories are significantly more likely to receive prenatal care during pregnancy than mothers in the lowest wealth category. Compared with the poorest households, the odds of prenatal care utilisation increase gradually in the range of 1.74-6.48 in wealthier households. Additionally, in comparison to children born to women with no education, children born to women with primary education are 62% more likely to receive prenatal care, and children born to women with secondary education are 2.4 times more likely to receive prenatal care. Thus, the difference in the probability of utilising prenatal care between the most and least educated mothers is almost equivalent to the difference

between the richest and poorest households. The effect of mothers' secondary education on prenatal care use is also more significant than the effect of fathers' secondary education. The results of logistic estimation on the risk of infant mortality reveal that children born to families in the poorest households have 30% and 49% more likelihood of death in comparison to children born to families in richer and the richest households, respectively. However, children born to women with secondary or higher education are 34% less likely to die during infancy than children born to women with no education, indicating that the difference in the risk of infant mortality between children born to mothers with secondary or higher education, and no education, is more significant than the difference in the risk of mortality between children in richer and the poorest households. Mother's primary school education is not statistically related to infant mortality, a finding that is consistent with the increasing weight of secondary education on infant mortality decline in the later phases of mortality transition. In contrast to a mother's education, a father's education is not significantly associated with the risk of infant mortality. Together, both groups of findings demonstrate that families' economic resources and mothers' education have exerted independent and strong influences on infant mortality.

5. Discussion

For decades, Türkiye was considered a singular case among countries undergoing mortality decline due to its exceptionally high infant mortality rates. Reductions were achieved. However, a significant gap in death rates persisted compared to other countries in Europe and elsewhere with similar levels of economic development. This study has examined two fundamental forces of change that could have been experienced commonly across Türkiye's population and impacted its mortality trends on a large scale: economic growth and improvements in female education. The powerful association between economic improvements and infant mortality reductions is due to the critical importance of nutrition for survival gains, but the positive effect of the cultural and attitudinal change brought by education on infant survivorship is caused by multiple mechanisms that include better health-specific knowledge, rejection of fatalism and other traditional beliefs, greater female empowerment and autonomy.

This study presents an updated assessment of the relationship between infant mortality, on the one hand, and national income and female education levels, on the other, using a large dataset on middle-income countries. The cross-national analysis of the relationship between national income and infant mortality confirmed an anomaly: Türkiye consistently displayed excess levels of infant mortality between 1960 and 2010. If Türkiye had experienced the same GDP-IMR relationship estimated for middle-income countries, substantial reductions (up to 54%) in death rates could have been observed until 2005. While this was interpreted as evidence for unmeasured factors unrelated to GDP that kept Türkiye's IMRs at levels exceeding those expected, given its economic performance, the results of regression models incorporating female-to-male ratios in education, as well as cross-national analysis, highlighted Türkiye's historically significant gender gap in education. Two findings based on the interpretation of Türkiye's country variable (which measures the

extent of its excess rates) stood out: The coefficient remained significant but was significantly reduced once the model controlled for female primary education, and it lost its statistical significance entirely once the model controlled for female secondary education. Both findings supported the argument that low maternal education levels might have delayed Türkiye's mortality transition at the expense of economic growth. Second, the subpopulation-level analysis presented in this study aimed at geographic and ethnic variations in infant mortality that characterised Türkiye's mortality transition. Indirectly estimated mortality rates with census and DHS data described the extent of inequalities in deaths, while the hypothetical educational distributions of reproductive-age women, with education-specific mortality rate schedules, showed that a large portion of these inequalities could have been eliminated with primary school education. Third, an individual-level analysis of the main determinants of infant mortality risk revealed that families' material resources and mothers' education were the only significant socioeconomic status (SES) factors associated with the risk of infant mortality. Having a mother with secondary or higher education (rather than no education) had a more substantial effect on the risk of infant mortality than living in a rich household (rather than a poor household). Because this part of the analysis corresponded to the very end of Türkiye's mortality transition, mothers' primary school education was not found to be significantly related to the risk of infant mortality.

Some points are worth mentioning. A third explanation of infectious disease mortality transition intentionally left out from the theoretical boundaries of this paper emphasises the social interventions in public health (theoretically not an automatic outcome of economic development) as one of the main drivers of infant mortality decline in high mortality settings (Szreter, 1988; Morel, 1991; Easterlin, 2004). First, correcting environmental conditions that expose populations to disease is possible only through public health initiatives, as most risk factors are beyond individual control. Services that promote health, such as providing pure water supply, proper sewage disposal and spraying insecticides, are beyond individual means. Second, individuals often lack access to modern health facilities and adequate health infrastructure. These methods of public health to control the spread of infectious diseases require, by principle, the development of new institutions centring on the public health system, with functions including sanitation, health education, regulation, and the financing and direct provision of health services (such as immunisation campaigns or oral rehydration therapies). Third, social interventions in public health are crucial not only for the implementation of new techniques of disease control but also for providing the public with knowledge of the mechanisms of infectious disease causation, transmission, and treatment. In this sense, they have the potential to reduce health inequalities through maternal education, as well as other SES indicators.

One limitation of the current study is its inability to isolate the role of public health interventions in reducing infant mortality. While health expenditure per capita is an effective indicator of public health investments in a given country, this data is only available from the 2000s onwards in the group of middle-income countries. Similarly, measures such as 'percentage of mothers who received antenatal care during pregnancy', 'percentage of births attended by skilled health staff', or 'percentage of children who have received medical

treatment after fever and/or cough' are inconsistently available after the 1990s. The only measures that can be used for middle-income countries and are suitable to the period of analysis in this paper are 'hospital beds per 1,000 people' and 'physicians per 1,000 people', which can be seen as somewhat unpolished indicators for measuring the capacity of health care systems and its relation to infant mortality rates in countries. When these variables are added to the last regression model predicting infant mortality, the estimation sample size shrinks considerably, but both appear to be significant predictors, and their inclusion increases the R-squared value (see Appendix Table 4).

Despite the limited ability to test the role of public health factors, the analytic approach adopted in this study was based on the primary opposition between the economic and cultural theories of infectious disease mortality decline in developing countries. There is a nuance in the main findings: The empirical inconsistency between IMR-GDP in Türkiye's case does not necessarily attest to the weakness of economic explanation and its emphasis on nutritional improvements as the key driver of mortality decline but to the impediment factors; the cultural and ideational constraints, existing in the absence of satisfactory levels of education in the female population. These constraints limited the response of infant death rates to improving economic conditions at the population level, while stark inequalities in primary and secondary education at the subpopulation level were the maintainers of high mortality. Since infant deaths remain common in the developing world today, the implication of these findings for future research in high-mortality settings is that maternal education is critically important as a driver of social change and should accompany economic change to avoid mortality lags and achieve equal reductions. Türkiye's experience over five decades between 1960 and 2010 suggests that there is some degree of independence between the effects of economic and social development and that whereas the former can contribute to infant mortality decline in the absence of the latter, its effects are ultimately conditioned by mothers' education having a powerful role in children's survival outcomes.

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Appendix Figure: 1
Estimated IMRs for Türkiye with the Brass Method 1971-1996
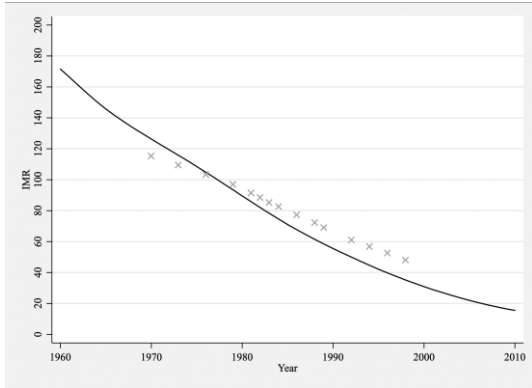
*Notes: i. The solid line represents IMRs reported by the World Bank, as per the World Development Indicators 2023.
Indirectly estimated IMRs using the Brass technique, as estimated by the author, are marked with an X.*

Appendix Table: 1
Mothers' Samples Used in Brass Estimations

Total Sample - Census		1985	1990	2000
		500.059	705.564	912.889
By Geographical Regions - Census		**1985**	**1990**	**2000**
Black Sea		32.935	73.069	78.718
Marmara		93.979	127.343	176.911
Aeagan		59.908	72.397	90.032
Mediterranean		57.004	68.674	93.212
Central Anatolia		68.847	89.594	110.161
East Anatolia		38.422	50.872	59.610
Southeast Anatolia		10.148	19.298	25.115
By Geographical Divisions - Census		**1985**	**1990**	**2000**
Istanbul and Izmir		62.015	81.626	113.187
Urban West		1.941	3.062	4.077
Rural Central		1.318	5.358	4.934
Rural East		10.491	11.660	7.951
Kurdish-Majority Provinces - Census		**1985**	**1990**	**2000**
		22.641	34.676	42.282
By Ethnicity - DHS	**1993**	**1998**	**2003**	**2008**
Turkish	5.671	6.879	6.249	5.700
Kurdish	665	1.390	1.529	1.465
By Education - Census		**1985**	**1990**	**2000**
Less than Primary Education		130.921	151.152	127.796
Primary Education		200.056	298.938	399.628
Secondary Education		23.303	36.759	73.150
University Degree		6.886	14.200	32.962

*Notes: i. Mothers' samples consist of all women of reproductive age (15-49) with a non-missing value on the number of ever-born children. ii. Except
for Istanbul and Izmir, all geographical divisions are measured by representative locations. The cities of Aydın and Uşak represent the urban West.
Rural Kırşehir and Sivas represent rural Central Anatolia. Rural Mardin, Hakkari, Siirt, Sırnak, Kars, Igdir and Ardahan represent rural East.*

Appendix Table: 2
Results of Fractional Polynomial Regression Relating National Income Levels to Infant Mortality Rates between 1960 and 2010 in Middle-Income Countries

Number of Observations	3951			
F(5,3945)	1249,92			
Prob>F	0,00			
R-squared	0,61			
	Coefficient	Standard Error	t	P<t
Constant	184,26	2,93	62,94	0,000
gdp_1	-9,36	0,36	-26,25	0,000
gdp_2	0,89	0,04	23,87	0,000
t	-0,20	0,34	-0,57	0,565
t^2	-0,05	0,01	-3,58	0,000
t^3	0,00	0,00	4,54	0,000

Notes: i. Türkiye is excluded from this analysis. ii. After trying 44 different models involving polynomials, the selected model uses the powers 0.5 and 0.5 as the best-fitting combination of polynomials. iii. gdp_1 and gdp_2 reflect the terms associated with (GDP per capita ^ 0.5) and (GDP per capita ^ 0.5) * ln (GDP per capita), respectively. iv. The model controls for t (Year 1959) using linear, quadratic and cubic terms.

Appendix Table: 3
Descriptive Statistics for the Analysis of Infant Mortality with DHS Data (1993-2008)

	1993		1998		2003		2008	
	%	n	%	n	%	n	%	n
Infant Death	5,05	188	4,24	151	3,20	145	1,89	73
Total Number of Children		3.724		3.565		4.533		3.857
Prenatal Care During Pregnancy	64,04	2.383	66,38	2.357	73,00	3.301	89,42	2.662
Total Number of Children		3.721		3.551		4.522		2.977
Household Wealth Index								
Poorest Households	22,48	837	24,12	860	27,73	1.257	32,30	1.246
Poorer Households	22,15	825	23,34	832	21,38	969	23,80	918
Middle-Wealth Households	22,15	825	22,75	811	17,43	790	18,87	728
Richer Households	19,01	708	17,07	609	19,17	869	14,26	550
Richest Households	14,21	529	12,71	453	14,30	648	10,76	415
Total Number of Children		3.724		3.565		4.533		3.857
Mother's Education								
No Education	29,00	1.080	24,49	873	26,94	1.221	21,70	837
Primary Education	55,08	2.051	55,54	1.908	50,23	2.277	50,92	1.964
Secondary Education and Higher	15,92	593	19,97	712	22,83	1.035	27,38	1.056
Total Number of Children		3.724		3.565		4.533		3.857
Father's Education								
No Education	7,92	295	7,35	261	7,73	349	4,33	166
Primary Education	56,67	2.110	51,82	1.839	48,60	2.194	48,17	1.847
Secondary Education and Higher	35,40	1.318	40,83	1.449	43,66	1.971	47,50	1.821
Total Number of Children		3.723		3.549		4.514		3.834
Geographical Region								
West	21,56	803	19,47	694	21,22	962	16,88	651
South	20,60	767	18,65	665	13,10	594	12,89	497
Central	21,70	808	19,47	694	13,94	632	17,27	666
North	15,82	589	12,90	460	8,12	368	9,13	352
East	20,33	757	29,51	1.052	43,61	1.977	43,84	1.691
Total Number of Children		3.724		3.565		4.533		3.857
Urban or Rural Place of Residence								
Rural	40,17	1.496	35,65	1.271	32,45	1.471	32,88	1.268
Urban	59,83	2.228	64,35	2.294	67,55	3.061	67,12	2.589
Total Number of Children		3.724		3.565		4.533		3.857
Ethnicity								
Turkish	79,19	2.949	69,82	2.489	61,57	2.791	62,90	2.426
Kurdish	17,83	664	25,02	892	33,80	1.532	32,36	1.248
Other	2,98	111	5,16	184	4,63	210	4,74	183
Total Number of Children		3.724		3.565		4.533		3.857

Mother's Age									
	15-19	4,73	176	4,54	162	3,18	144	2,70	104
	20-24	29,59	1.102	27,69	987	25,04	1.135	22,97	886
	25-29	31,74	1.182	33,02	1.177	33,40	1.514	34,25	1.321
	30-34	20,81	775	20,39	727	22,44	1.017	23,31	899
	35-39	9,13	340	10,49	374	11,01	499	11,67	450
	40-44	3,41	127	3,23	115	4,24	192	4,23	163
	45-49	0,59	22	0,65	23	0,71	32	0,88	34
Total Number of Children			3.724		3.565		4.533		3.857
Child Sex									
	Male	51,45	1.916	52,45	1.870	51,25	2.323	50,51	1.948
	Female	48,55	1.808	47,55	1.695	48,75	2.210	49,49	1.909
Total Number of Children			3.724		3.565		4.533		3.857
Birth Order	Mean		2,84		2,75		2,93		2,69
	SD		2,23		2,13		2,34		2,01
	Min		1		1		1		1
	Max		15		16		17		15
Total Number of Children			3.724		3.565		4.533		3.857

Data Source: Türkiye DHS 1993, 1998, 2003 and 2008.

Appendix Table: 4
Results of Fractional Polynomial Regressions Relating National Income, Female-To-Male Ratios in Education, and Two Public-Health Measures to Infant Mortality Rates Between 1960 and 2010 in Middle-Income Countries and Türkiye

	Model IV				**Model V**				**Model VI**			
Number of Observations	814				766				515			
F	(9, 804)	=	233,06		(9, 756)	=	248,49		(10, 504)	=	182,35	
Prob>F	0,0000				0,0000				0,0000			
R-squared	0,72				0,75				0,78			
	Coef.		Std. Err.	t	Coef.		Std. Err.	t	Coef.		Std. Err.	t
Constant	216,43	★★★	14,10	15,35	230,52	★★★	13,33	17,29	237,94	★★★	15,23	15,62
gdp_1	-1,34	★★★	0,12	-11,22	-1,54	★★★	0,11	-13,69	-5,09	★★★	0,55	-9,19
gdp_2	0,01	★★★	0,00	7,36	0,01	★★★	0,00	9,85	0,48	★★★	0,06	8,36
GPI in primary school education	-0,42	★★★	0,09	-4,90	-0,59	★★★	0,09	-6,94	-0,39	★★★	0,11	-3,61
GPI in secondary school education	-0,37	★★★	0,05	-7,48	-0,22	★★★	0,05	-4,40	-0,37	★★★	0,07	-5,25
Physicians per 1,000 people	-4,07	★★★	0,44	-9,17					-2,39	★★★	0,758	-3,16
Hospital beds per 1,000 people					-1,38	★★★	0,21	-6,69	-0,29		0,35	-0,83
Country dummy variable for Türkiye	-2,51		3,94	-0,64	3,48		3,34	1,04	-0,15		3,89	-0,04
t	-3,26	★★	1,32	-2,47	-4,13	★★★	1,26	-3,29	-4,00	★★★	1,47	-2,72
t^2	0,05		0,04	1,20	0,08	★	0,04	1,86	0,08		0,05	1,57
t^3	0,00		0,00	-0,48	0,00		0,00	-1,09	0,00		0,00	-0,97

*Note: *** = p<0.01, ** = p<0.05, * = p<0.10. Data Source: The World Bank, World Development Indicators, 2023.*

The Impact of Mergers and Acquisitions on Acquirers' Stock Returns: Evidence from Türkiye

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Birleşme ve Satın Almaların Satın Alan Şirketlerin Hisse Senedi Getirilerine Etkisi: Türkiye'den Kanıtlar

Abstract

This study investigates investors' reactions to domestic merger and acquisition (M&A) announcements in Türkiye between 2016 and 2023. The study analyses investor reactions using the event study method. The analysis encompasses 91 domestic acquisition announcements. The acquirers' abnormal returns are calculated using the market model and evaluated using a comprehensive set of test statistics. The analysis results indicate that abnormal returns are generally positive and significant before the M&A announcement date. Nevertheless, this effect does not persist after the first announcement date. These findings provide evidence for the hypothesis that the markets are not semi-efficient.

Keywords   : Mergers and Acquisitions (M&A), Event Study, Investor Reaction.

JEL Classification Codes : G14, G34.

Öz

Bu çalışmanın amacı, 2016-2023 yılları arasında Türkiye'de yurt içi birleşme ve satın alma (M&A) duyurularına yatırımcıların verdiği tepkileri olay çalışması yöntemini kullanarak incelemektir. Bu amaçla analize 91 yurtiçi satın alma duyurusu dâhil edilmiştir. Anormal getiriler piyasa modeli kullanılarak çeşitli pencerelerde hesaplanmış ve kapsamlı bir test istatistik seti kullanılarak değerlendirilmiştir. Analiz sonuçları, birleşme ve devralmaların duyurulduğu tarihten önce anormal getirilerin genellikle pozitif ve anlamlı olduğunu göstermektedir. Ancak, bu etki duyuru tarihinden sonra devam etmemektedir. Bu bulgular, piyasaların yarı etkin formda etkin olmadığı hipotezini desteklemektedir.

Anahtar Sözcükler : Birleşme ve Satın Alma, Olay Çalışması, Yatırımcı Tepkisi.

1. Introduction

Companies must identify and utilise new resources to maintain operational sustainability in the current economic environment, which is marked by increasing rivalry. With the rise of globalisation, companies must expand to stay competitive in a rapidly changing business environment. Mergers and acquisitions (hereinafter referred to as M&A) provide organisations with a crucial opportunity to acquire new resources. Several factors motivate firms to engage in M&A activities. These factors encompass the drive to gain a competitive edge, achieve cost savings using economies of scale, capitalise on synergies, increase market share, and diversify the portfolio (Dilshad, 2013). The primary objective of a firm engaged in M&A activities is to generate higher future profits and enhance its returns. Prior research has investigated the impact of M&A announcements on investor value and the presence of abnormal returns (hereinafter referred to as AR) in the stocks of associated companies during the period surrounding the M&A announcement. Hence, when a listed firm participates in an M&A, it creates a sense of expectation among investors regarding the corporation's future profitability. Empirical evidence suggests that this expectation has a positive impact on stock values (Rani et al., 2015).

This study examines investors' reactions to domestic M&A announcements in Türkiye between 2016 and 2023, considering both short-term and long-term effects. This study employs an event study approach to calculate abnormal returns. The current research calculates various metrics, such as average abnormal returns (hereinafter AAR), cumulative average abnormal returns (hereinafter CAAR), precision-weighted cumulative average abnormal returns (hereinafter PWCAAR), and average buy and hold returns (hereinafter ABHAR), to determine the investors' reactions during the days around the announcement date. The analysis examines three specific dates of announcements: the first M&A announcement, the announcement by the Capital Markets Board (CMB), and the announcement of M&A registration. The sample comprises 91 companies engaged in domestic acquisitions, all of which are listed on Borsa Istanbul. The current study focuses on investors' reactions to the acquirers' stocks rather than the target companies, as the latter are not publicly traded.

The findings of the current study indicate that there are positive and significant ARs in the first M&A pre-announcement event windows. Conversely, in the post-announcement event windows, although there are positive ARs, no considerable relationships are observed. Furthermore, the significant and positive abnormal returns observed around the first M&A announcement do not persist around the second (CMB announcement) and third (M&A completion) announcement dates. These findings provide strong evidence of insider trading around M&A announcements.

This study makes a significant contribution to the existing literature in several ways. Firstly, the study analyses investor reactions to M&A announcements, considering three various event dates. Most studies in the literature focus on the date of the announcement of M&A completion. This study, however, differs from the literature in that it analyses investor

reactions around three different announcement dates. This allows for determining whether there are any differences in the returns of the acquiring companies. Secondly, this study calculates CAAR, AAR, PWCAAR, and BHAR. Consequently, standard AR, AAR, and CAAR are controlled by the precision-weighted CAR and ABHAR methodologies. Thirdly, using a comprehensive set of test statistics, including both parametric and non-parametric tests, ensures that the reliability and robustness of the findings extend beyond the conventional statistical tests typically applied in previous M&A event studies.

The subsequent sections of the paper are structured as follows: The second section provides an overview of the literature concerning M&A. The third section elucidates the data collection process and methodology employed. The fourth section assesses the outcomes derived from the event study analyses. Finally, the fifth section encapsulates the findings in the conclusion.

2. Literature Review

Most studies on M&A activities aim to determine whether companies' stock values increase before and after the M&A process and whether shareholders benefit accordingly. In these studies, the hypothesis is tested to determine whether abnormal returns are generated through M&A transactions. While some studies in this framework investigate the impact on stock prices in the short term, which encompasses the period immediately preceding and following M&A announcements, other studies examine the long-term performance of companies. Some studies have demonstrated significant changes in the stocks of companies before and after M&A announcements (Andrade et al., 2001; Antoniadis et al., 2014; Rani et al., 2015; Dilshad, 2013; Liargovas & Repousis, 2011). Furthermore, some studies have indicated that M&A announcements result in positive AR, CARs, and CAAR (Seth et al., 2000; Wilcox et al., 2001; Lepetit et al., 2004; Scholtens & Wit, 2004; Vergos & Christopoulos, 2008; Anand & Singh, 2008; Rheaume & Bhabra, 2008; Zhu & Malhotra, 2008; Kumar & Panneerselvam, 2009; Laabs & Schiereck, 2010; Hekimoğlu & Tanyeri, 2011; Liargovas & Repousis, 2011; Kashiramka & Rao, 2013; Dilshad, 2013; Genç & Coşkun, 2013; Rani et al., 2013; Mallikarjunappa & Nayak, 2013; Rani et al., 2015; Akben-Selcuk, 2015; Şahin & Doğukanlı, 2015; Adnan & Hossain, 2016; Upadhyay & Kurmi, 2020; Ahmed et al., 2023), whereas others have reported negative AR, CAR, and CAAR (Capron & Pistre, 2002; DeLong, 2003; Sachdeva et al., 2017; Pandey & Kumari, 2020). A small number of studies have not identified any impact (Rosen, 2006; Hassan et al., 2007; Barai & Mohanty, 2010; Mall & Gupta, 2019; Yang & Chen, 2021). The findings of the studies in the literature are inconsistent. The majority of these studies use the event study method.

In the context of M&A announcements in the literature, some studies have investigated whether there are abnormal returns in the stock prices of target companies. In their 2011 study, Hekimoğlu and Tanyeri analysed the impact of M&A announcements by 125 Turkish companies on the stock returns of target companies between 1991 and 2009. The calculation of abnormal returns relies on the date of the first official public

announcement. The results indicate that the CAARs are 8.93%, 10.96%, and 10.87% for event windows of 3, 7, and 11 days, respectively. The AARs are positive and statistically significant from one day before the M&A announcement until two days following the announcement date. Akben-Selcuk (2015) examines the effect of M&A announcements by 67 Turkish companies on the performance of the target companies' stocks. The results indicate that M&A announcements have positive and significant CAAR values for the stocks of target companies within short-term windows.

Furthermore, some studies have investigated the effect of M&A announcements on the stock performance of the acquiring company. Vergos and Christopoulos (2008) examined the impact on the stocks of 11 Greek banks after M&A announcements between 1998 and 2007. The study focuses on acquiring banks. The M&A announcement date is considered the completion date of the acquisition. The acquisition of domestic Greek banks generates 6% ARs in the event window (0...+20). On the other hand, foreign acquisitions (0...+20) generate abnormal returns of -1.4 % in the event window. Zhu and Malhotra (2008) examined the impact of 114 M&A announcements on stock prices between 1999 and 2005. The study analysed 114 foreign acquisitions of Indian companies, with the first announcement date considered the M&A announcement date. The results indicate that the acquisition of Indian firms generates positive CARs of 2.4% and 3.2% in the (-1...+1) and (-2...+2) event windows, respectively, and negative CARs of 6.8% in the post-event window (+3...+20). In their 2010 study, Laabs and Schiereck examined the long-term effects of 230 M&A announcements in the automotive industry on the stock prices of acquiring companies. The announcement date is considered to be the M&A deal date. Although positive and significant CAAR values are observed in short-term event windows, BHAR values exhibit a negative trend in the long term. Kashiramka and Rao (2013) examine the impact of 101 M&A announcements on shareholders' wealth in the Indian information technology and information technology-based services (IT&ITeS) sectors. The study considers the first media announcement to be the date of the M&A announcement. The findings reveal positive returns on the stocks of the acquiring companies. Rani et al. (2013) examine the stock performance of M&A announcements in 623 Indian companies. The event date is defined as the date of the first public announcement in a newspaper. The findings indicate that acquiring Indian companies' stocks generates positive and significant CARs before the announcement date, whereas CARs exhibit a negative trend after the announcement date. A recent study by Ahmed et al. (2023) examines the impact of M&A announcements on the stock performance of 568 companies in China and Hong Kong. The (-26...+26) window findings indicate a positive and significant CAAR of 3.39%. Furthermore, although there is a positive CAAR in the windows before the announcement date, it later turns into a negative CAAR.

Some researchers have investigated the effect of M&A announcements on the stock performance of acquirers and target firms. In their study, Seth et al. (2000) examine the impact of M&A announcements in the United States on the stock prices of 100 firms, both those acquiring and those being acquired. Their findings indicate that the stocks of target companies generate abnormal returns around M&A announcements, whereas there is no

effect on the stocks of acquiring companies. Scholtens and Wit (2004) compare bank mergers between the United States and Europe, examining the differences in shareholder returns for large bank mergers during the announcement period. The study revealed differences in the CARs of European and American target and acquiring companies. At the time of the M&A announcement, target banks in Europe and the US exhibited positive ARs. Furthermore, the returns of US target banks were higher than those of European targets. Anand and Singh (2008) analyse five major bank mergers in India using the event study method. In the study, the ARs are calculated regarding a single event date. This date refers to the announcement of the M&A in the media. The study indicates that acquiring and target banks exhibit positive and significant CARs. Furthermore, the entire sample exhibits positive and statistically substantial CAR values of 4.29% and 11.13% in the (-1...+1) and (-10...+10) event windows, respectively. In their 2011 study, Liargovas and Repousis examine the impact of M&A announcements on stock prices in the Greek banking sector. The study's dataset consists of 9 acquirers and target banks. The M&A completion date is considered the event date. The study's findings indicate a positive and significant impact on stock prices in the windows before M&A announcements but a negative impact after the announcement. In their 2013 research, Dilshad examined the effect of M&A announcements on the stocks of 18 acquiring and target banks in the European region. The announcement date represents the first trading day on which M&A news reaches the market. The findings revealed that, in the short term, acquiring banks exhibited positive CAR values. However, the long-term showed no effects.

Furthermore, most studies estimate abnormal returns based on only one M&A announcement. In contrast, few studies have calculated abnormal returns around the date of the first M&A announcement or the date of the M&A completion announcement. In their 2013 study, Genç and Çoşkun analysed the stock performance of M&A announcements by 214 Turkish companies. The study calculates ARs based on the M&A announcement date and the M&A completion date. The findings indicate that acquiring and target companies generate positive and significant cumulative abnormal returns (CARs) in the event windows preceding the first M&A announcement date. The results indicate no significant impact on the stocks of the acquiring companies before the M&A completion announcement. Conversely, there is evidence of positive and significant CARs in the stocks of target companies. In their 2015 study, Şahin and Doğukanlı analysed the impact of M&A announcements on the stock performance of 13 Turkish banks. The M&A announcement date, the first negotiation date, and the contract date are all considered. The study analyses only target banks. The findings indicate that positive CAR values emerged before the M&A announcement date. However, CAR values show a negative trend after the announcement date.

In financial markets, it is paramount to ascertain which M&A announcements are perceived as more significant by market participants. Consequently, this study examines investor responses to different M&A announcement dates.

Table: 1
A Brief Overview of the Results of Studies on the Return to Shareholders in the Context of M&A

Study	CAARs (%)	Event window (days)	Sample size	Sample Period	Findings
Seth, Song and Pettit (2000)	7.57***	(-10…+10)	100	1981-1990 USA	In the United States, ARs have been identified in the share price of the acquirers.
Wilcox, Chang and Grover (2001)	33.5****	(-2…0)	88	1996-98 USA	The M&A announcements have been noted to exert a positive impact on the ARs of telecommunications firms in the United States.
Lepetit, Patry and Rous (2004)	2.412*** 2.624***	(-7…+7) (-15…+15)	180	1991-2001 13 European markets	The announcement of the M&A agreement results in a statistically significant and positive increase in the share prices of the target corporations.
Scholtens and Wit (2004)	12.65**** 9.28***	(-3…+31)	81 20	1990-2000 USA, Europe	Target banks produce notably higher returns than acquiring banks.
Vergos and Christopoulos (2008)	6*** -1.4**	(0…+20) (0…+50)	11	1998-2007 Greek banks	The study's results suggest that acquisitions by Greek banks have a positive and statistically significant influence, whereas those conducted by foreign banks have a negative and statistically significant impact.
Anand and Singh (2008)	4.29*** 5.39** 9.71*** 11.13**	(-1…+1) (-2…+2) (-5…+5) (-10…+10)	5	1999-2005 Indian private-sector banks	The study's findings indicate a positive and statistically significant reaction to M&A announcements in the short term. However, this situation cannot be sustained in the long term.
Rheaume and Bhabra, (2008)	-0.44, 1.08, 1.15**, 0.34, 1.76, 0.56, 0.54, -0.18	(-1…+1)	2421	1993-2005 USA, A diversity of knowledge-based industries	There have been mixed reactions to M&A announcements in the short term, and the study's results are inconsistent.
Zhu and Malhotra (2008)	2.4**** 3.2**** -6.8****	(-1…+1) (-2…+2) (+3…+20)	74	1999-2005 Indian firms acquiring U.S firms	Although there is a positive and significant investor reaction to M&A announcements in short event windows, this reaction reverses in longer event windows.
Kumar and Panneerselvam (2009)	3.24*** 1.59	(-60…+60) (-40…+40)	493	1998-2006 Indian firms	The effect on the acquirer firms is significantly negative, whereas the impact on the target firms is positive.
Laabs and Schiereck, (2010)	2.23*** 2.03*** 1.84*** 2.05**** 1.46***	(-20…+20) (-20…+10) (-10…+10) (0…+5) (0…20)	230	1981-2007 Automotive supply industry	The results indicate a positive and statistically significant investor reaction in both the long and short event windows.
Hekimoğlu and Tanyeri (2011)	8.93*** 10.96**** 10.87****	(-1…+1) (-3…+3) (-5…+5)	172	1991-2009 Türkiye	The results of the study indicate that there are significant and positive ARs in short-term event windows.
Liargovas and Repousis (2011)	11*** 4*** 6*** 4***	(-30…+1) (0…+1) (-10…0) (-1…+1)	9	1996-2009 Greek Banking Sector	The findings demonstrate that during the periods preceding M&A announcements, observable positive cumulative abnormal returns (CAARs) were evident in stock prices.
Kashiramka and Rao (2013)	28.12*** 15.15*** 4.94***	(-60…+60) (-35…+35) (-1…+1)	101	1999-2009 Indian IT sector	For acquiring firms, the announcement of an acquisition has positive and significant returns.
Dilshad (2013)	>0 =0	(-5…+5) (-30…+30)	18	2001-2010 European Bank M&A	The acquiring companies achieved positive ARs.
Genç and Coşkun (2013)	5.37*** 2.45*** 1.54**** 0.03	(-40…+40) (-10…+10) (-1…+1) (+2…+10)	214	2001-2011 Türkiye	A statistically significant positive return was observed before M&A announcements. However, this effect was not observed in post-announcement windows.
Rani, Yadav, and Jain (2013)	1.20*** 2**** -2.62****	(-20…-2) (-5…+5) (+2…+20)	623	2003-2008 Indian	Despite the positive, statistically significant returns observed before the M&A announcement, this reaction reverses in long-term post-announcement windows.
Mallikarjunappa and Nayak (2013)	36.68****	(-30…+30)	227	1998-2007 Indian	The findings of the study indicate that there are positive and significant ARs in the event windows preceding M&A announcements, whereas there are negative ARs in the long-term event windows following the announcement.
Rani, Yadav, and Jain (2015)	1.79**** -3.09**** 2.60**** 0.55**	(-20…-2) (+2…+20) (-5…0) (0…+5)	522	2003-2008 Indian	The results of the study indicate that there are positive and significant ARs in the windows preceding M&A announcements. However, following the announcement, this trend reverses.
Akben-Selcuk (2015)	5.25**** 5.93**** 6.02*** 8.53**	(-1…+1) (-2…+2) (-5…+5) (-10…+10)	67	2000-2014 Türkiye	The results indicate a positive and statistically significant investor reaction to M&A announcements.
Şahin and Doğukanlı (2015)	7.69**** 4.56**** 5.99**** -4.93*** -2.21***	(-1…+1) (-2…0) (-5…0) (0…+5) (0…+10)	13	2002-2021 Turkish Banking Sector	The analysis's results indicate that stock prices exhibited an upward trend before the announcement date, while returns subsequently became negative after that date.
Upadhyay and Kurmi (2020)	-21.98***	(-20…+20)	10	2020 Banking Sector in India	The findings show statistically significant and negative CAARs for all event windows.
Ahmed et al. (2023)	2.35 3.39**	(-26…+26)	568	2012-16 Hong Kong and China	The study's findings indicate that there are positive and significant ARs in event windows around M&A announcements.
Capron and Pistre (2002)	-34.00	(-20…+1)	101	1988-92 US and Europe	Zero or negative returns for acquirers
DeLong (2003)	-2.51**** 14.70****	(-7…+7) (-15…+15)	54	1991-95 US Banking Industry	The findings indicate that investors tend to react negatively to the stocks of acquiring companies. Conversely, positive ARs are observed in the stocks of the acquired companies.

Adnan and Hossain (2016)	1.01 0.72	(-5…+5)	100	2015 USA markets	The findings demonstrate a positive ARs before M&A announcements. This suggests that there is information leakage regarding positive news.
Sachdeva, Sinha, and Kaushik (2017)	-0.98 -0.89	(+1…+5) (+1…+10)	85	1991-2010 Indian	The results indicate negative ARs that are not strong in short-term event windows following M&A announcements.
Pandey and Kumari (2020)	-3.87**** -9.43	(-30…0) (0…+30)	14	2010-2020 India and the United States Banking Sector	Investors tend to exhibit an adverse reaction before the announcement of an M&A transaction.
Rosen (2006)	1.86	(-2…+2)	500	1982-2001 US	The periods after the M&A announcement do not exhibit any significant effect.
Hassan et al. (2007)	1.81	(-1…+1)	405	1981-2004 US pharmaceutical industry	The results demonstrate that ARs are not observed in event windows around M&A announcements.
Barai and Mohanty (2010)	1.166 1.096 -0.023	(-1…+1) (-5…+5) (-10…+10)	1177	1996- 2008 India	Acquirers do not generate significant ARs in India
Mall and Gupta (2019)	3.96	(-8…+8)	428	2008-2015 India	The findings demonstrate that abnormal changes in stock returns are not observed around M&A announcements.
Yang and Chen (2021)	-2.473	(-20…+20)	118	2004-2014 China	The results indicate that there are no ARs on target firms' stocks in the event windows around M&A rumours.

*, **, ***, and **** indicate the statistical significance at the 0.10, 0.05, 0.01, and 0.001 levels, respectively.

Table 1 provides a concise overview of the research results using the event study approach to evaluate how firms' stock prices behave before and after M&A announcements. Many studies indicate that investors react positively and significantly to M&A announcements in the stocks of both acquiring and target companies. A review of the existing literature on mergers and acquisitions (M&A) in finance reveals that numerous studies have employed event studies to examine the performance of stocks before and after acquisitions. However, the findings have been inconclusive.

The results of the current study are consistent with those of Seth, Song, and Pettit (2000), Wilcox, Chang, and Grover (2001), Lepetit, Patry, and Rous (2004), Scholtens and Wit (2004), Kumar and Panneerselvam (2009), Hekimoğlu and Tanyeri (2011), Liargovas and Repousis (2011), Kashiramka and Rao (2013), Genç and Coşkun (2013), and Ahmed et al. (2017), but not consistent with the results of Capron and Pistre (2002), DeLong (2003), Sachdeva, Sinha, and Kaushik (2017), Upadhyay and Kurmi (2020), and Pandey and Kumari (2020).

3. Data and Methodology

The dataset consists of companies listed on Borsa Istanbul (BIST) that submitted M&A applications to the Capital Markets Board (CMB) between 2016 and 2023. Specifically, 98 companies that filed merger applications via the Public Disclosure Platform (PDP) with the CMB during this period were manually identified. Of these 98 companies, 91 had their merger applications approved by the CMB, while 7 were rejected. Table 2 illustrates the distribution of companies that filed M&A applications by year and sector.

This study employs an event study method to analyse the M&A announcements of 91 companies. The stock closing prices for these companies were sourced from the Finnet database. The M&A announcement dates of the companies were manually obtained from the Public Disclosure Platform (PDP) website. Subsequently, abnormal returns were computed based on three announcement dates. These are as follows:

- The initial announcement date for M&A (first announcement)
- The date of the announcement of the CMB approval (second announcement)

- The date of the announcement of the registration of the M&A (third announcement)

Table: 2
A Distribution of M&A Announcements by Years and Sectors (2016-2023)

Year	Total Announcements of M&A	M&A Completed	Percentage	Sectors	N	Percentage
2016	7	7	7.69	Financial	36	40%
2017	11	9	9.89	Manufacturing	29	32%
2018	13	12	13.19	Wholesale and Retail Trade	7	8%
2019	15	13	14.29	Technology	6	7%
2020	9	9	9.89	Energy	5	5%
2021	11	11	12.09	Construction and Public Works	3	3%
2022	15	13	14.29	Transportation and Storage	2	2%
2023	17	17	18.68	Real Estate Activities	1	1%
Total	**98**	**91**	**100.00**	Administrative and Support Service Activities	1	1%
				Education, Health, Sports and Other Social Services	1	1%

Source: KAP (Public Disclosure Platform).

An event study is a methodology employed in finance to assess the impact of an unexpected economic, political, or social event on a company's stock returns (MacKinlay, 1997; Campbell et al., 2010; Benninga, 2014). It is crucial to establish that three fundamental assumptions are satisfied to confirm the validity of an event study's findings. The first assumption is related to the efficient markets hypothesis, which is one of the most important foundations of the event study. The efficient markets hypothesis is based on the assumption that securities reflect all information in the market (Fama, 1991: 1575). Fama (1970: 383) divided market efficiency into three categories: weakly efficient, semi-strongly efficient, and strongly efficient. The Event study method assumes that markets are efficient in a semi-strong form (McWilliams & Siegel, 1997). The second assumption concerns that the relevant event is unexpected by market participants and represents new information for investors. In the event study, ARs are assumed to be a response to new information in the market (McWilliams & Siegel, 1997). The third assumption is based on the claim that a researcher can isolate the effect of one event from the impact of other events. To eliminate the confounding effects of different events, researchers typically conduct their analyses by considering short event windows (Konchitchki & O'Leary, 2011).

An event study typically comprises seven stages (Campbell et al., 1997). The first stage is to define the event. The second stage involves selecting the enterprises to be included in the analysis. The third stage consists of calculating both normal and abnormal returns. The fourth stage is to choose an estimation method. The fifth stage involves testing the technique. The sixth stage consists of interpreting the experimental results and findings. The seventh and final stage is to conclude.

Figure 1 illustrates the timeline of the event study. The length of the estimation window is represented by the period from T_0 to T_1. When the event occurs (the M&A announcement) at time 0, the event window is represented by the period from T_1 to T_2. The length of the post-event window covers the period from T_2 to T_3.

Figure: 1
Event Study Timeline
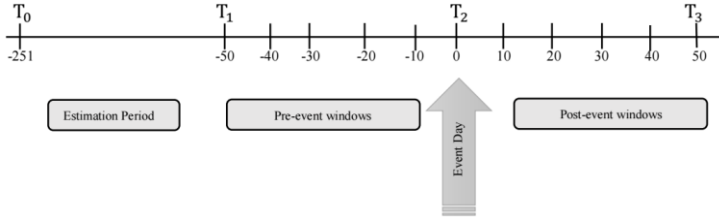
The estimation window is utilised to establish the typical behaviour of a stock relative to a market or sector index. As a result, to estimate a stock's return within the estimation window, a model representing normal behaviour is required. Typically, a regression model is utilised for this objective. A typical estimation window of 250 trading days is crucial for achieving reliable results. A 250-day estimation window is commonly considered reasonable for producing reliable results. Nevertheless, the selected samples may not represent a sufficiently large number of days, or the study design may not be optimal. In this case, a minimum of 126 observation days is required to ensure the reliability of the observations. Suppose fewer than 126 observations are present within the estimation window. In that case, it is possible that the market model's parameters may not accurately reflect the actual stock price movements, thereby affecting the relationship between stock returns and market returns (Benninga, 2014). By the methodology employed in this study, the estimation window is defined as 200 days. In this study, AARs are calculated in 61 different windows spanning 30 days before and 30 days after the announcement date. Furthermore, CAAR, PWCAAR, and ABHAR are computed for 62 windows over 50 days before and 50 days after the merger announcement date. Moreover, the CAAR and PWCAAR for the entire sample are calculated for seven various windows: (-30...+30), (-20...+20), (-15...+15), (-10...+10), (-5...+5), (-3...+3), and (-1...+1). Additionally, CAAR and PWCAAR are estimated in six distinct event windows across 10 sub-sectors to identify investor reactions to M&A announcements specific to each industry. Consequently, investors' reaction to M&A announcements in short- and long-term event windows is analysed.

There are numerous ways to apply the event study method. The literature contains a variety of methodologies for calculating ARs. Dyckman et al. (1984) conducted studies utilising several models, concluding that the least squares (LS) market model yielded superior results. Consequently, this study has chosen the least squares (LSM) market model as the estimation method. The expected returns in the LSM market model are calculated using the following formula:

$$ER_{it} = \alpha + \beta RM_{mt} + \varepsilon_{i,t} \tag{1}$$

where α and β are the constant and slope coefficients of the LSM regression model. RM_{mt} represents the rate of return of the benchmark index (BIST 100) on day t. The coefficients α

and β are calculated using 200 days estimation data at t_{-251} and t_{-50}. Accordingly, ARs are calculated according to the following formula:

$$AR_{it} = R_{it} - ER_{it} \tag{2}$$

where AR_{it}it represents the AR of index i on day t. R_{it} represents the actual return of index i on day t, while ER_{it}, represents the expected return of index i on day t.

The logarithmic method is used to calculate the actual daily return of the benchmark index and all company stocks. Consequently, the R_{it} it is calculated as follows:

$$R_{it} = ln\left(\frac{P_{it}}{P_{it_{-1}}}\right) \times 100 \tag{3}$$

where P_{it} represents the price of index i on day t and P_{it-1} represents the price of index i before day t. The AAR for each day during the event window period is calculated as follows:

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{it} \tag{4}$$

where AAR_t represents the AAR on day t and N is the total number of companies. The CAAR for the event window period is calculated as follows:

$$CAAR_{(\tau_1,\tau_2)} = \frac{1}{n}\sum_{i=1}^{n} AAR_{(\tau_1,\tau_2)} \tag{5}$$

where CAAR is the cumulative average abnormal returns, τ_1 is the start of the event window and τ_2 is the end of the event window. This implies that the CAAR is the sum of all abnormal returns that occur during the event window.

The study also calculates the standard CAAR, as well as the PWCAAR. The PWCAAR is obtained using the relative weights of each stock. The PWCAAR is weighted inversely proportional to the standard deviation of each stock. The PWCAAR (as a weighted average of the original CAR) preserves the sample interpretation of the standardised CAAR (Cowan, 2007). The PWCAAR is superior to the CAAR and the average standardised CAR. The PWCAAR is calculated according to the following equation:

$$\text{PWCAAR}_{T_1 T_2} = \sum_{J=1}^{N} \sum_{t=T_2}^{T_2} \omega_j\, AR_{jT} \tag{6}$$

$$\omega_j = \frac{\left(\sum_{t=T_1}^{T_2} \delta_{AR_{jt}}^2\right)^{-\frac{1}{2}}}{\sum_{i=1}^{N}\left(\sum_{t=T_1}^{T_2} \delta_{AR_{jt}}^2\right)^{-\frac{1}{2}}} \tag{7}$$

$$\delta_{AR_{jt}}^2 = \frac{\sum_{k=T_{D_b}}^{T_{De}} (AR_{jk})^2}{D_j - 2}\left[1 + \frac{1}{D_j} + \frac{(R_{mt} - \bar{R}_m)^2}{\sum_{k=T_{D_b}}^{T_{De}} (R_{mk} - \bar{R}_m)^2}\right] \tag{8}$$

where D_j, denotes the number of non-missing estimation window returns for company j. R_{mt} represents the returns of the benchmark indices on day t in the event window, while R_{mk} represents the return of the benchmark index on day k in the estimation window. $\overline{R_m}$ represents the average benchmark (BIST 100) returns over the estimation period, while k denotes the trading day within that period.

To ensure the robustness and reliability of the findings, the BHAR method is employed as an alternative to the standard CAR. In their 1997 and 1999 publications, Barber and Lyon, as well as Lyon et al., argue that tests based on standard CAR are not suitable for event studies in long-term windows. Instead, they demonstrate that the BHAR approach is more robust for evaluating AR in longer event windows. In the current study, ABHAR for returns in longer event windows are calculated by the following equation:

$$BHAR_{i[\tau_1\tau_2]} = \prod_{\tau_2}^{\tau_1}(1 + R_{i,t}) - \prod_{\tau_2}^{\tau_1}(1 + R_{m,t}) \tag{9}$$

where $R_{i,t}$ represents the returns of company i on day t and $R_{m,t}$ represents the return of the benchmark index (BIST 100) on day t.

4. Statistical Significance of Abnormal Returns

All parametric test statistics assume that stock returns follow a normal distribution, except for the Skewness-Corrected T-test. Unlike parametric tests, non-parametric tests do not rely on normality assumptions regarding stock returns and can be used with smaller sample sizes. Consequently, four parametric test statistics and three non-parametric test statistics are employed to assess the robustness and reliability of the results.

The first parametric test is the Patell Z test, developed by Patell (1976). The Patell Z-test is a robust test for CAR distribution across the event window and variance in event window AR. Standardising the AR before portfolio construction assigns a lower weight to the AR of securities with significant variances than the simple time series t-test. However, it is sensitive to cross-sectional dependence and event-induced volatility. The test statistic for the null hypothesis, with CAAR ($H_0: CAAR = 0$) equal to zero, is as follows:

$$Patell_z = \frac{1}{\sqrt{N}}\sum_{i=1}^{N}\frac{CSAR_i(\tau_1,\tau_2)}{S(CSAR_i)} \tag{10}$$

where $CSAR_i$ represents the cumulative standard abnormal return of company i.

The second parametric test is the cross-sectional t-test. Brown and Warner (1980) demonstrated that it is robust against high event-induced variance. Similarly, Boehmer, Musumeci, and Poulson (1991) showed that standard cross-sectional tests are comparable in size but more robust. The test statistic for the null hypothesis is the cross-sectional t-test (Cross-Sectional Test, abbr.: Csect T) with CAAR ($H_0: CAAR = 0$) equal to zero, formulated as follows:

$$T_{cross} = \frac{CAAR_{(t_1, t_2)}}{\hat{\sigma}_{CAAR_{(t_1, t_2)}}} \tag{11}$$

Under the null hypothesis, CAAR ($H_0: CAAR = 0$) are equal to zero. The variance estimator of this test statistic is based on the cross-section of ARs.

$$\hat{\sigma}_{CAAR_{(t_1, t_2)}} = \frac{1}{N(N-d)} \sum_{i=1}^{N} [CAR_i(t_1, t_2) - CAAR_{(t_1, t_2)}]^2 \tag{12}$$

The third parametric test is the standardised cross-sectional t-test, also known as the BMP test (abbr.: StdCSect T). The standardised t-test developed by Boehmer et al. (1991) is a robust test against the distribution of ARs over the CAAR. The standardised cross-sectional t-test is also robust against event-induced volatility and serial correlation. However, it is sensitive to cross-sectional correlation. The test statistic for the null hypothesis, with CAAR ($H_0: CAAR = 0$) equal to zero, is as follows:

$$t = \sqrt{N} \frac{\overline{SCAR}}{S_{(\overline{SCAR})}} \tag{13}$$

where, $\overline{SCAR}_i(\tau_1, \tau_2) = \frac{1}{N} \sum_{i=1}^{N} SCAR_i(\tau_1, \tau_2)$ and

$$S^2_{\overline{SCAR}} = \frac{1}{(N-1)} \sum_{i=1}^{N} [SCAR_i(\tau_1, \tau_2) - \overline{SCAR}(\tau_1, \tau_2)]^2 \tag{14}$$

The fourth parametric test, the skewness-corrected test (abbreviated T), was developed by Hall (1992) and corrects the test statistics for potential skewness in the distribution of returns. The test statistic for the null hypothesis, with CAAR ($H_0: CAAR = 0$) equal to zero, is as follows:

$$t = \sqrt{N} \left(S + \frac{1}{3} \gamma S^2 + \frac{1}{27} \gamma^2 S^3 + \frac{1}{6N} \gamma \right) \tag{15}$$

As far as the ingredients are concerned, first recall the cross-sectional sample variance,

$$S^2_{\overline{SCAR}} = \frac{1}{(N-1)} \sum_{i=1}^{N} [CAR_i(\tau_1, \tau_2) - CAAR(\tau_1, \tau_2)]^2 \tag{16}$$

Next, the corresponding sample skewness is given by,

$$\gamma = \frac{N}{(N-2)(N-1)} \sum_{i=1}^{N} \frac{[CAR_i(\tau_1, \tau_2) - CAAR(\tau_1, \tau_2)]^3}{S^3_{\overline{CAAR}}}, \tag{17}$$

$$S = \frac{CAAR}{S_{CAAR}} \tag{18}$$

The first non-parametric test, the Generalized Sign Test (abbr.: Generalized Sign Z), proposed by Cowan (1992), is based on the ratio of positive CAR over the event window p_0^+. Under the null hypothesis, this ratio should not systematically deviate from the ratio of

positive CARs over the estimation window p_{est}^+. Given that the proportion of positive CARs is a binomial random variable, the following test statistic is employed:

$$z = \frac{\omega - N.\hat{p}}{\sqrt{N.\hat{p}(1 - N.\hat{p}}} \tag{19}$$

where ω denotes the number of the CAR_i during the event window that are positive. $\hat{p}$ denotes the fraction of the $(AR_{i,t})$ during the estimation window (across both i and t) that are positive.

The second non-parametric test, the Generalized Rank Z Test (Abbr.: G-Rank Z) developed by Kolari and Pynnonen (2011), works with standardised ARs instead of simple ARs and, in practice, is a robust test against high event-induced variance. Additionally, Monte Carlo studies have demonstrated that this test is robust to serial return correlations that may arise in specific stocks. The test statistic for the null hypothesis, with CAAR ($H_0: CAAR = 0$) equal to zero, is as follows:

$$z = \frac{\bar{U}_{L_1+1}}{S_{\bar{U}_{L_1+1}}}, \tag{20}$$

$$S_{\bar{U}_{L_1+1}}^2 = \frac{L_1}{12N (L_1+2)} \tag{21}$$

The third non-parametric test, the Generalized Rank T Test (abbreviated as Generalized Rank T), developed by Kolari and Pynnonen (2011), is robust against cross-sectional and serial correlation of returns, as well as the event-induced volatility problem. The test statistic for the null hypothesis, with CAAR ($H_0: CAAR = 0$) equal to zero, is as follows:

$$t = Z.\left(\frac{L_1-1}{L_1-Z^2}\right) \text{ with } Z = \frac{\bar{U}_{L_1+1}}{S_{\bar{U}}} \tag{22}$$

i company's standardized CAR ($SCAR_i$),

$$SCAR_i^* = \frac{SCAR_i}{S_{SCAR}}, \tag{23}$$

$$S_{SCAR}^2 = \frac{1}{(N-1)}\sum_{i=1}^{N}[SCAR_i(\tau_1, \tau_2) - \overline{SCAR}(\tau_1, \tau_2)]^2 \text{ ve } \overline{SCAR} = \frac{1}{N}\sum_{i=1}^{N} SCAR_i \tag{24}$$

This, for any i company, gives a time series of length $L_1 + 1$:

$$\{GSAR_{i,1}, ..., GSAR_{i,L_1}, GSAR_{i,L_{1+1}}\} = \{SAR_{i,T_0}, ..., SAR_{i,T_1}, SCAR_i^*\} \tag{25}$$

Subsequently, for any i company's,

$$U_{i,t} = \frac{rank(GSAR_{i,t})}{L_1+2} - 0.5 \tag{26}$$

5. Empirical Findings

This study section presents the AAR, CAAR, PWCAAR, and ABHAR calculated around the M&A initial announcement date, CMB approval announcement date, and M&A registration announcement date. However, the tables do not include CAAR, PWCAAR, and ABHAR values that are not statistically significant around the announcement dates.

Table: 3
AAR and Test Statistics on and Around First M&A Announcements (N = 91)

Day	AARs AAR (%)	Pos:Neg	Parametric Tests Patell Z	Csect T	StdCSect T	Skewness-Corrected T	Non-Parametric Tests GenSign Z	Gen Rank Z	Gen Rank T
-30	0.30	43:48	1.583	0.878	1.434	0.922	0.303	0.488	0.499
-29	-0.30	37:54	-1.204	-1.11	-1.263	-1.034	-0.968	-1.3	-1.33
-28	-0.30	35:56	-1.354	-0.928	-1.388	-0.882	-1.392	-1.411	-1.444
-27	0.30	46:45	0.902	1.298	1.054	1.38	0.939	0.835	0.855
-26	0.10	43:48	0.706	0.308	0.74	0.33	0.303	0.129	0.132
-25	-0.30	32:59	-0.587	-1.551	-0.766	-1.481	-2.027**	-1.635	-1.673*
-24	-0.20	37:54	-0.091	-0.768	-0.106	-0.728	-0.968	-1.012	-1.035
-23	-0.40	32:59	-1.517	-1.4	-1.603	-1.334	-2.027**	-1.964**	-2.008**
-22	0.20	42:49	0.997	0.76	0.894	0.821	0.091	0.277	0.283
-21	-0.30	35:56	-1.169	-0.848	-1.257	-0.823	-1.392	-1.289	-1.321
-20	0.60	43:48	1.744*	1.899*	1.561	2.196**	0.303	0.694	0.71
-19	0.10	42:49	0.383	0.312	0.398	0.341	0.091	0.1	0.102
-18	0.60	49:42	2.110**	1.993**	1.916*	2.261**	1.574	1.624	1.662*
-17	0.50	49:42	2.264**	1.829*	2.435**	1.733*	1.574	2.470**	2.527**
-16	0.10	41:50	-0.041	0.418	-0.04	0.443	-0.12	-0.853	-0.873
-15	0.00	40:51	0.348	0.069	0.35	0.059	-0.332	0.052	0.053
-14	0.00	35:56	-0.155	-0.105	-0.109	-0.11	-1.392	0.17	0.174
-13	-0.40	39:52	-1.516	-1.355	-1.47	-1.55	-0.544	-0.794	-0.812
-12	0.40	47:44	1.158	0.943	0.747	0.928	1.151	1.286	1.315
-11	0.30	45:46	0.514	0.704	0.361	0.738	0.727	0.413	0.422
-10	-0.10	37:54	-0.571	-0.344	-0.58	-0.328	-0.968	-0.959	-0.982
-9	0.10	46:45	0.76	0.312	0.573	0.352	0.939	0.733	0.75
-8	-0.20	38:53	0.041	-0.426	0.034	-0.43	-0.756	-0.154	-0.158
-7	0.30	47:44	1.162	0.816	1.005	0.811	1.151	1.15	1.177
-6	-0.10	35:56	-0.875	-0.198	-0.69	-0.161	-1.392	-1.2	-1.228
-5	0.30	51:40	0.516	0.969	0.53	0.979	1.998**	0.959	0.983
-4	**0.70**	**52:39**	**2.516****	**2.241****	**2.287****	**2.357****	**2.210****	**2.096****	**2.144****
-3	0.30	46:45	1.392	1.17	1.317	1.232	0.939	0.819	0.838
-2	0.00	39:52	0.72	0	0.649	0.007	-0.544	0.041	0.042
-1	**0.80**	**51:40**	**3.128****	**2.305****	**2.413****	**2.591****	**1.998****	**2.114****	**2.161****
0	0.30	45:46	1.850*	0.662	1.379	0.682	0.727	1.134	1.159
1	-0.20	39:52	-0.126	-0.663	-0.094	-0.667	-0.544	-0.24	-0.246
2	0.10	47:44	-0.171	0.441	-0.165	0.457	1.151	-0.615	-0.629
3	0.00	42:49	-0.237	-0.115	-0.223	-0.097	0.091	-0.812	-0.831
4	**-0.40**	**37:54**	**-1.019**	**-1.686***	**-1.236**	**-1.737***	**-0.968**	**-1.923***	**-1.968***
5	0.00	39:52	0.415	0.07	0.433	0.084	-0.544	-0.263	-0.269
6	0.30	46:45	2.094**	1.004	1.722*	1.017	0.939	1.254	1.283
7	-0.40	40:51	-1.379	-1.218	-1.257	-1.26	-0.332	-1.327	-1.358
8	-0.30	36:55	-1.034	-0.948	-1.144	-0.95	-1.18	-1.266	-1.296
9	**0.60**	**53:38**	**1.497**	**1.956***	**1.493**	**1.911***	**2.422****	**2.357****	**2.409****
10	0.10	38:53	-0.21	0.388	-0.186	0.431	-0.756	-0.123	-0.125
11	0.50	48:43	1.311	1.241	0.851	1.347	1.363	0.882	0.902
12	0.40	50:41	1.026	1.248	0.909	1.287	1.786*	1.05	1.074
13	0.00	37:54	-0.019	0.036	-0.019	0.067	-0.968	-0.336	-0.343
14	0.00	43:48	0.023	0.142	0.022	0.133	0.303	-0.311	-0.318
15	**-0.60**	**36:55**	**-2.128****	**-2.116****	**-2.221****	**-2.147****	**-1.18**	**-1.941***	**-1.986****
16	0.50	44:47	1.543	1.526	1.298	1.673*	0.515	0.583	0.596
17	-0.20	39:52	-1.117	-0.651	-1.166	-0.639	-0.544	-1.517	-1.553
18	0.10	41:50	0.339	0.555	0.336	0.591	-0.12	-0.136	-0.139
19	0.40	38:53	0.908	1.113	0.764	1.218	-0.756	-0.039	-0.039
20	0.20	40:51	-0.005	0.592	-0.005	0.617	-0.332	-0.302	-0.309
21	0.50	52:39	1.852*	1.757*	1.729$	1.814*	2.210**	1.880$	1.924$
22	**-0.70**	**28:62**	**-2.729****	**-2.670****	**-3.306****	**-2.593****	**-2.663****	**-3.534*****	**-3.618*****
23	-0.10	43:48	0.275	-0.274	0.352	-0.272	0.303	-0.17	-0.174
24	0.50	40:51	1.127	1.760*	1.168	1.948*	-0.332	0.535	0.547
25	0.90	43:48	2.597***	2.350**	2.001**	2.922***	0.303	1.381	1.414
26	-0.30	35:56	-1.31	-1.191	-1.453	-1.182	-1.392	-1.817*	-1.859*
27	**0.70**	**54:37**	**2.343****	**2.050****	**2.216****	**2.146****	**2.634****	**2.243****	**2.296****
28	0.60	41:50	1.304	1.717*	1.145	1.950*	-0.12	0.925	0.946
29	-0.20	38:53	-0.353	-0.53	-0.378	-0.499	-0.756	-0.288	-0.295
30	0.50	46:45	1.905*	1.168	1.378	1.281	0.939	1.35	1.381

Note: *, **, ***, and **** indicate the statistical significance at the 0.10, 0.05, 0.01, and 0.001 levels, respectively.

Table 3 reports the results of the AAR 30 days before and 30 days after the date of the first M&A announcement. Additionally, the AAR values corresponding to each day of the event window are graphically depicted in Figure 2.

As illustrated in Table 3, the AAR values remain stable and positive in the pre-announcement windows, starting 5 days before and continuing until the announcement date (0). The positive AAR value reached its maximum (0.80%) on the day before the announcement day. Among these values, AAR values 4 and 1 days before the announcement date are significant according to parametric and non-parametric test statistics. Additionally, in 61-day AAR windows, 41-day AAR values are positive, while 20-day AAR values are negative. The positive and significant AAR values on days 4 and 1 before the announcements indicate that investors perceived the M&A announcement as beneficial for them. Furthermore, 52 and 51 AARs of 91 companies were positive on the 4th and 1st days before the announcement. However, it is observed that the positive AAR values, which had started 5 days before the announcement, turned into an adverse reaction in the days following the announcement. This adverse reaction becomes significant on the 4th, 15th, and 22nd days after administration. Positive and significant AAR values are observed on the 9th and 27th days after the announcement.

Figure: 2
-30…+30 AAR (%) (First M&A Announcements)
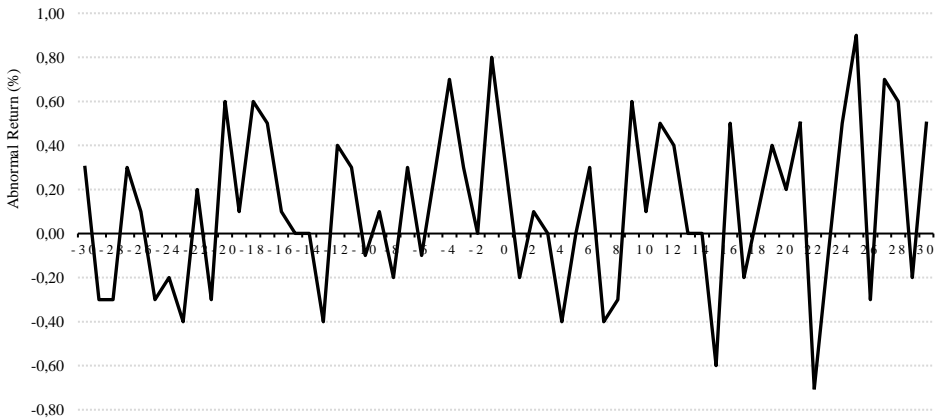
Table 4 reports the CAAR and the PWCAAR for 64 windows before the M&A announcement dates. Figure 3 graphically depicts the CAAR and PWCAAR corresponding to 64 event windows. Notably, all CAAR and PWCAAR values within the 27-event window ranging from (-27…0) to (-1…0) exhibit positive and statistical significance based on both parametric and non-parametric tests. It can be observed that the values of CAAR and PWCAAR exhibit a gradual decline from the 50th day before the event to the day of the

announcement. The CAAR values start at 3.60% on day -50, peak at 4.70% in windows (-22...0) and (-20...0), and remain positive in all windows until the day before the event (-1...0), reaching 1.10%. The highest CAAR values, at 4.70%, are observed in the (-22…0) and (-20…0) event windows. The highest PWCAAR value, at 3.90%, is observed at (-20…0). Both parametric and non-parametric test statistics indicate the presence of statistically significant CAAR and PWCAAR values at the 0.01 and 0.001 levels in the (-5…0) and (-4…0) windows. In the post-announcement event windows, the highest CAAR and PWCAAR values (5.40% and 2.50%) are significant in the (0...+50) window according to parametric and nonparametric tests.

Table: 4
CAAR, PWCAAR, and Test Statistics on and around First M&A Announcements
(N = 91)

Cumulative Average Abnormal Return (%)				Parametric Tests				Non-Parametric Tests		
Event Window	CAARs (%)	PWCAARs (%)	Pos:Neg	Patell Z	Csect T	StdCSect T	Skewness-Corrected T	GenSign Z	Gen Rank Z	Gen Rank T
(-50…0)	3.60	2.70	53:38	1.890*	1.317	1.440	1.453	-0.134	0.882	0.884
(-40…0)	3.60	3.80	51:40	2.481**	1.518	1.809*	1.668*	1.132	1.601	1.628
(-30…0)	3.90	3.60	47:44	2.823***	1.779*	2.094**	1.877*	1.151	2.059**	2.106**
(-29…0)	3.60	3.10	47:44	2.581***	1.725*	1.957*	1.807*	1.151	1.996**	2.041**
(-28…0)	3.90	3.40	46:45	2.848***	1.898*	2.137**	1.972*	0.939	2.291**	2.343**
(-27…0)	4.20	3.80	50:41	3.154***	1.983*	2.296**	2.053**	1.786*	2.352**	2.406**
(-26…0)	3.90	3.70	47:44	3.039***	1.869*	2.233**	1.928*	1.151	2.236**	2.287**
(-25…0)	3.80	3.40	52:39	2.958***	1.833*	2.136**	1.906*	2.210**	2.347**	2.402**
(-24…0)	4.10	3.40	50:41	3.134***	2.014**	2.244**	2.096**	1.786*	2.497**	2.555**
(-23…0)	4.30	3.30	51:40	3.217***	2.222**	2.364**	2.280**	1.998**	2.681***	2.742***
(-22…0)	4.70	3.70	53:38	3.603****	2.546**	2.667***	2.548**	2.422**	3.014***	3.083***
(-21…0)	4.50	3.50	55:36	3.471****	2.532**	2.657***	2.447**	2.845***	3.039***	3.109***
(-20…0)	4.70	3.90	57:34	3.808****	2.783***	2.954***	2.558**	3.269***	3.488****	3.569****
(-19…0)	4.10	3.70	61:30	3.512****	2.516**	2.741***	2.30**	4.117****	3.413****	3.491****
(-18…0)	4.00	3.60	61:30	3.515****	2.478**	2.693***	2.155**	4.117****	3.416****	3.493****
(-17…0)	3.40	3.10	56:35	3.114***	2.119**	2.359**	1.863*	3.057***	3.060***	3.130***
(-16…0)	2.90	2.60	53:38	2.655***	1.779*	1.964*	1.569	2.422**	2.567**	2.627***
(-15…0)	2.70	2.70	54:37	2.747***	1.716*	2.0**	1.488	2.634***	2.660***	2.722***
(-14…0)	2.70	2.60	53:38	2.747***	1.799*	2.024**	1.551	2.422**	2.663***	2.725***
(-13…0)	2.70	2.60	52:39	2.885***	2.010**	2.205**	1.840*	2.210**	2.658***	2.720***
(-12…0)	3.20	2.90	52:39	3.414****	2.558**	2.637***	2.50**	2.210**	2.883***	2.949***
(-11…0)	2.80	2.60	51:40	3.219****	2.529**	2.741***	2.572**	1.998**	2.597***	2.656***
(-10…0)	2.50	2.60	53:38	3.207***	2.596***	2.947***	2.674***	2.422**	2.930***	2.998***
(-9…0)	2.60	2.80	54:37	3.545****	2.622**	3.203***	2.724***	2.634***	3.166***	3.238***
(-8…0)	2.40	2.60	55:36	3.483****	2.556**	3.134***	2.662***	2.845***	3.123***	3.195***
(-7…0)	2.60	2.50	56:35	3.680****	3.172**	3.327***	3.477****	3.057***	3.166***	3.239***
(-6…0)	2.40	2.10	55:36	3.495****	3.201***	3.382***	3.621****	2.845***	3.137***	3.210***
(-5…0)	2.40	2.50	56:35	4.133****	3.627****	4.117****	4.174****	3.057***	4.003****	4.096****
(-4…0)	2.20	2.40	54:37	4.297****	3.234***	4.021****	3.876****	2.634***	3.919****	4.010****
(-3…0)	1.40	1.80	54:37	3.546****	2.144**	3.065***	2.533**	2.634***	2.971***	3.040***
(-2…0)	1.10	1.50	54:37	3.291****	1.999**	2.980***	2.237**	2.634***	2.917***	2.983***
(-1…0)	1.10	1.30	55:36	3.521****	2.164**	2.801***	2.525**	2.845***	2.769***	2.831***
(0…+1)	0.20	0.90	47:45	1.692*	0.458	1.490	0.457	0.928	0.992	0.977
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
(0…+28)	3.50	1.40	47:44	1.675*	1.455	1.145	1.517	1.151	1.504	1.538
(0…+29)	3.40	1.40	47:44	1.582	1.388	1.092	1.422	1.151	1.551	1.587
(0…+30)	3.80	1.80	49:42	1.899*	1.601	1.333	1.641	1.574	1.917*	1.960*
(0…+40)	4.40	1.90	55:36	1.882*	1.718*	1.403	1.816*	1.998**	1.809*	1.850*
(0…+50)	5.40	2.50	62:29	2.141**	2.101**	1.717*	2.143**	2.421**	2.408**	2.464***

*Note: *, **, ***, and **** indicate the statistical significance at the 0.10, 0.05, 0.01, and 0.001 levels, respectively.*

The findings indicate that investors perceive M&A announcements as beneficial and exhibit a positive reaction one month before the announcement dates. In contrast, although there is evidence of positive CAAR and PWCAAR in the event windows after the announcement date, these observations are not statistically significant. Investors' positive and significant reactions before M&A announcements, but their insignificant reactions afterwards, suggest the possibility of leaked information about M&A deals. In the post-event

period, positive and significant CAAR, PWCAAR, and ABHAR values are observed within
the long-term event windows (0...+40) and (0...+50).

Figure: 3
-50…+50 CAAR and PWCAAR First M&A Announcements

Table: 5
ABHARs and Test Statistics on and around First M&A Announcements (N = 91)

Average Buy-and-Hold Abnormal Returns			Parametric Tests	
Event Window	(ABHARs) (%)	Pos:Neg	Csect T	Skewness-Corrected T
(-50…0)	5.96	53:38	1.3607	1.7078*
(-40…0)	6.78	51:40	1.8671*	2.4318**
(-30…0)	5.39	47:44	1.8047*	2.2594**
(-29…0)	4.95	47:44	1.7499*	2.1697**
(-28…0)	5.15	46:45	1.9153*	2.3491**
(-27…0)	5.66	50:41	2.03**	2.500**
(-26…0)	5.12	47:44	1.9396**	2.3282**
(-25…0)	5.05	52:39	1.892*	2.3078**
(-24…0)	5.36	50:41	2.0298**	2.5243***
(-23…0)	5.36	51:40	2.2311***	2.7061***
(-22…0)	5.56	53:38	2.5492***	3.0077***
(-21…0)	5.07	55:36	2.5535***	2.8411***
(-20…0)	5.27	57:34	2.8216***	3.0909****
(-19…0)	4.56	61:30	2.544***	2.8115***
(-18…0)	4.39	61:30	2.5769***	2.6925***
(-17…0)	3.72	56:35	2.2366***	2.3039***
(-16…0)	3.17	53:38	1.9287**	1.9715**
(-15…0)	3.01	54:37	1.8894*	1.8652*
(-14…0)	2.91	53:38	1.9492*	1.8818*
(-13…0)	2.82	52:39	2.0113**	1.9619**
(-12…0)	3.18	52:39	2.4294**	2.4457**
(-11…0)	2.73	51:40	2.3524**	2.4103**
(-10…0)	2.34	53:38	2.3261**	2.4241**
(-9…0)	2.46	54:37	2.3852**	2.5078***
(-8…0)	2.41	55:36	2.3956**	2.5389***
(-7…0)	2.54	56:35	2.9474***	3.28***
(-6…0)	2.25	55:36	2.9436***	3.3946****
(-5…0)	2.33	56:35	3.381****	3.9574****
(-4…0)	2.10	54:37	3.0006****	3.6715****
(-3…0)	1.40	54:37	1.9873**	2.415**
(-2…0)	1.05	54:37	1.8588*	2.1101**
(-1…0)	1.07	55:36	2.086**	2.4615**
⋮	⋮	⋮	⋮	⋮
(0…+25)	4.05	48:43	1.5643	1.8878$
(0…+26)	3.87	44:47	1.3755	1.6976
(0…+27)	4.85	46:45	1.5539	2.0097**

(0…+28)	5.69	47:44	1.661	2.2541***
(0…+29)	5.42	47:44	1.6456	2.169**
(0…+30)	5.71	49:42	1.8085	2.3583***
(0…+40)	6.78	55:36	1.8671*	2.4318***
(0…+50)	7.24	62:29	2.1685***	2.5347***

Note: *, **, ***, and **** indicate the statistical significance at the 0.10, 0.05, 0.01, and 0.001 levels, respectively.

Table 5 presents the ABHARs and the corresponding test statistics across 64 windows, with 32 before and 32 after M&A announcements. Additionally, the ABHARs in various windows between -50 and +50 are illustrated in Figure 4. The results of the ABHARs analysis are consistent with those of the CAARs and PWCAARs in Table 4. The results of ABHARs analyses are evaluated using two parametric test statistics. Table 5 illustrates that the highest ABHARs are observed in the 50 days preceding the announcement date (7.24 %), a statistically significant value. ABHARs values 4 and 5 days before the announcement are significant at the 1%. Similar to the findings observed with CAARs and PWCAARs, ABHARs results are significant in both the pre-announcement and 40th and 50th-day post-announcement windows. The results indicate that the longer investors wait to sell their holdings in the period surrounding M&A announcements, the greater the profit they will make.

Figure: 4
-50…+50 ABHARs (%) First M&A Announcements
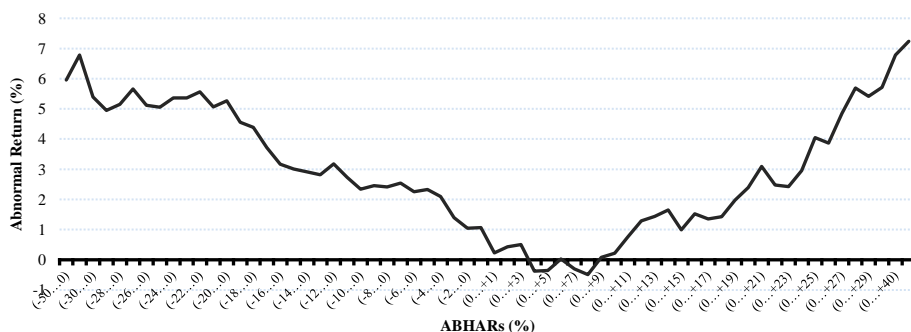
Table 6 reports the CAAR and PWCAAR values in 64 windows, calculated around the second announcement date. However, Table 6 excludes the CAAR and PWCAAR values due to their lack of statistical significance. Table 6 and Figure 5 show an upward trend in CAARs and PWCAARs, starting 50 days before the announcement and reaching a minimum point 15 days before the announcement. A positive trend starts 8 days before the announcement date. However, investors' reaction to the second M&A announcement was not stronger than the first M&A announcement. At the same time, there is a noticeable decrease in the statistical significance of CAARs and PWCAARs. Parametric and nonparametric test statistics show that the most significant CAAR and PWCAAR are observed in the (-5...0) and (-4...0) time windows. On the third day after the second M&A announcement, the values of CAAR and PWCAAR were not statistically significant.

Table: 6

CAAR, PWCAAR, and Test Statistics on and around Second M&A Announcements
(N = 91)

	Cumulative Average Abnormal Return (%)			Parametric Tests				Non-parametric Tests		
Event Window	CAARs (%)	PWCAARs (%)	Pos:Neg	Patell Z	Csect T	StdCSect T	Skewness-Corrected T	GenSign Z	Gen Rank Z	Gen Rank T
(-50…0)	4.40	2.30	50:41	1.831*	1.804*	1.730*	1.977*	1.818*	1.678*	1.503
(-40…0)	4.50	2.30	52:39	2.041**	2.034**	1.950*	2.262**	1.607	1.883*	1.688*
(-30…0)	4.00	1.50	53:38	1.894*	1.943*	1.725*	2.186**	2.519**	1.949*	1.724*
(-29…0)	4.00	1.70	54:37	2.006**	1.985*	1.816*	2.217**	2.729***	2.127**	1.882*
(-28…0)	3.90	1.60	51:40	1.957*	1.933*	1.749*	2.154**	2.097**	1.996**	1.765*
(-27…0)	3.50	1.50	50:41	1.788*	1.739*	1.575	1.90*	1.887*	1.859*	1.644
(-26…0)	3.10	1.00	49:42	1.477	1.586	1.312	1.70*	1.676*	1.597	1.412
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
(-8…0)	1.20	1.70	51:40	1.973**	1.378	1.896*	1.549	2.374**	2.102**	1.864*
(-7…0)	0.90	1.30	47:44	1.598	1.145	1.618	1.276	1.529	1.592	1.413
(-6…0)	0.70	1.10	54:37	1.483	0.914	1.522	0.969	3.008***	2.138**	1.897*
(-5…0)	1.00	1.40	52:39	1.911*	1.220	1.858*	1.289	2.586***	2.348**	2.083**
(-4…0)	1.40	1.30	55:36	2.449**	1.877*	2.292**	2.080**	3.220***	2.774***	2.461**
(-3…0)	1.20	0.90	53:38	2.046**	1.757*	1.904*	1.926*	2.797***	2.059**	1.827*
(-2…0)	0.60	0.60	49:42	1.261	1.063	1.217	1.084	1.952*	1.717*	1.524
(-1…0)	0.80	0.70	54:37	1.929*	1.699*	1.824*	1.778*	3.008***	2.517**	2.235**
(0…+1)	0.80	0.40	48:43	1.693*	1.440	1.261	1.531	1.740*	2.192**	1.945*
(0…+2)	0.30	0.60	49:42	0.821	0.599	0.692	0.609	1.952*	1.480	1.312
(0…+3)	0.20	0.20	48:43	0.378	0.236	0.324	0.240	1.740*	1.335	1.184
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
(0…+50)	2.20	1.40	41:46	1.047	0.784	0.817	0.775	0.313	1.457	1.306

*Note: *, **, ***, and **** indicate the statistical significance at the 0.10, 0.05, 0.01, and 0.001 levels, respectively.*

Figure: 5
-50…+50 CAAR and PWCAAR (%) Second M&A Announcements
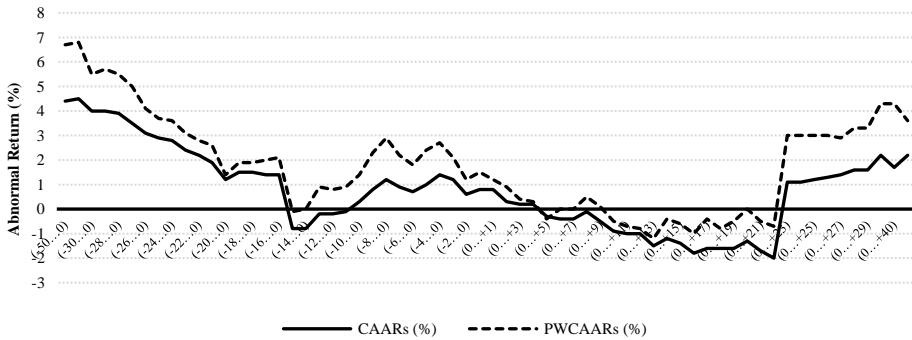
Table 7 and Figure 6 illustrate the ABHAR values within the (-50...+50) event window. Before the second M&A announcement, the (-50...0) and (-40...0) event windows exhibited maximum ABHAR values of 6.15% and 6.03%, respectively. These values are statistically significant at the 0.05 and 0.01 levels, respectively. However, the period from the 23rd to the fourth day before the announcement date shows no significant ABHAR. In addition, significant ABHAR is observed in the short-term windows before the announcement. In the event windows after the second M&A announcement, no statistically significant ABHAR are observed. The ABHAR results calculated around the second announcement date are similar to those of the CAAR and PWCAAR. Figure 6 illustrates a positive, decreasing trend in the value of ABHAR from the 50th day before the second M&A

announcement until the 15th day. It follows a horizontal trend in the following event windows.

Table: 7
ABHAR and Test Statistics on and around Second M&A Announcements (N = 91)

Average Buy-and-Hold Abnormal Return			Parametric Tests	
Event Window	(ABHAR) (%)	Pos:Neg	Csect T	Skewness-Corrected T
(-50…0)	6.15	50:41	1.8247*	2.2549**
(-40…0)	6.03	52:39	2.0167***	2.6307***
(-30…0)	5.31	53:38	1.9489*	2.6035***
(-29…0)	5.27	54:37	1.9948*	2.643***
(-28…0)	5.03	51:40	1.9384*	2.558***
(-27…0)	4.60	50:41	1.8015*	2.3147**
(-26…0)	4.01	49:42	1.6995*	2.0996**
(-25…0)	3.75	51:40	1.7305*	2.0602**
(-24…0)	3.49	52:39	1.6738*	1.9671**
(-23…0)	3.04	50:41	1.5568	1.7585*
⋮	⋮	⋮	⋮	⋮
(-4…0)	1.41	55:36	1.8486*	2.1414**
(-3…0)	1.20	53:38	1.7806*	1.9935**
(-2…0)	0.61	49:42	1.1026	1.1365
(-1…0)	0.83	54:37	1.7176*	1.8191*
⋮	⋮	⋮	⋮	⋮
(0…+50)	2.67	41:46	0.8254	0.8795

*Note: *, **, ***, and **** indicate the statistical significance at the 0.10, 0.05, 0.01, and 0.001 levels, respectively.*

Figure: 6
-50…+50 ABHAR (%) Second M&A Announcements

ABHAR %
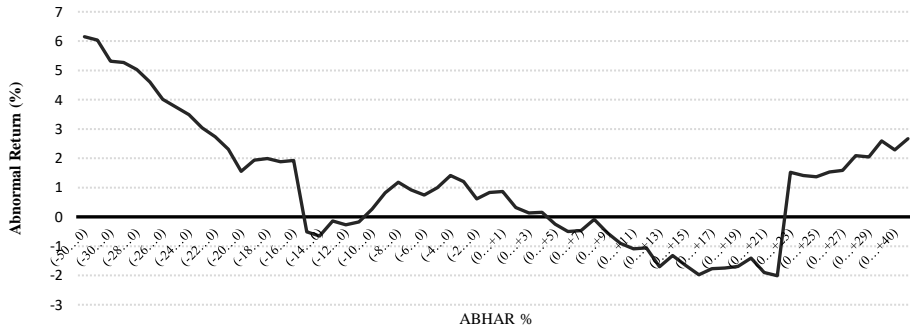
Table 8 and Figure 7 illustrate the CAAR and PWCAAR surrounding the third announcement date. In Table 8, statistically insignificant values have been excluded. Except for the (-50...0) window, there are no positive and significant CAAR and PWCAAR in the period surrounding the M&A completion announcement. Figure 5 illustrates that the values of CAAR and PWCAAR around the announcement exhibit a horizontal trend. The event windows around the M&A completion announcement show no significant CAAR or PWCAAR. This suggests that equity market participants may have already factored M&A announcements into their pricing.

Table: 8
CAAR, PWCAAR, and Test Statistics on and around Third M&A Announcements
(N = 91)

Cumulative Average Abnormal Return (%)				Parametric Tests				Non-Parametric Tests		
Event Window	CAAR (%)	PWCAAR (%)	Pos:Neg	Patell Z	Csect T	StdCSect T	Skewness-Corrected T	GenSign Z	Gen Rank Z	Gen Rank T
(-50…0)	4.90	3.30	55:36	2.112**	2.107**	1.976*	2.254**	2.701***	2.280**	2.101**
(-40…0)	3.40	2.20	54:37	1.679*	1.744*	1.518	1.815*	1.438	1.642	1.516
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
(-2…0)	-0.70	-0.80	36:55	-1.599	-1.358	-1.60	-1.276	-1.064	-1.940*	-1.857*
(-1…0)	-0.70	-0.80	37:54	-2.010**	-1.362	-1.702*	-1.318	-0.854	-1.624	-1.556
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
(0…+50)	2.10	2.40	52:39	1.489	0.718	0.851	0.965	0.118	1.565	1.443

Figure: 7
-50…+50 CAAR and PWCAAR (%) Third M&A Announcements
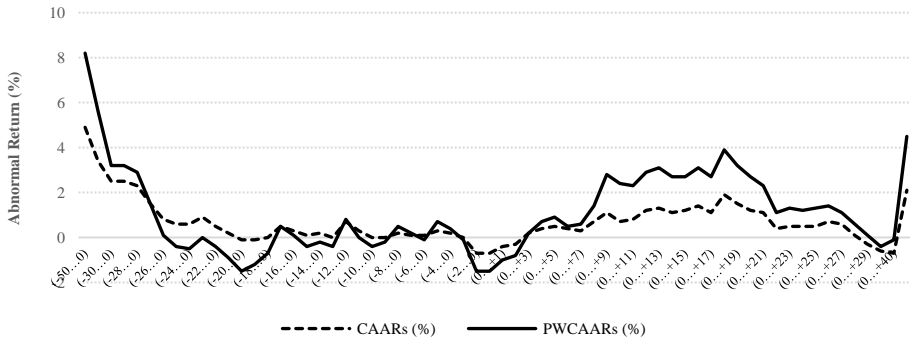
Table 9 and Figure 8 illustrate the ABHAR surrounding the third M&A announcement date. There are no statistically significant ABHAR values around the third M&A announcement date, except the (-50...0) event window. These findings suggest that equity market participants may have already factored M&A announcements into their pricing. Figure 8 illustrates a downward trend in ABHAR values from day 50 to day 21, followed by a horizontal trend in post-event windows. These findings are consistent with the CAAR and PWCAAR values.
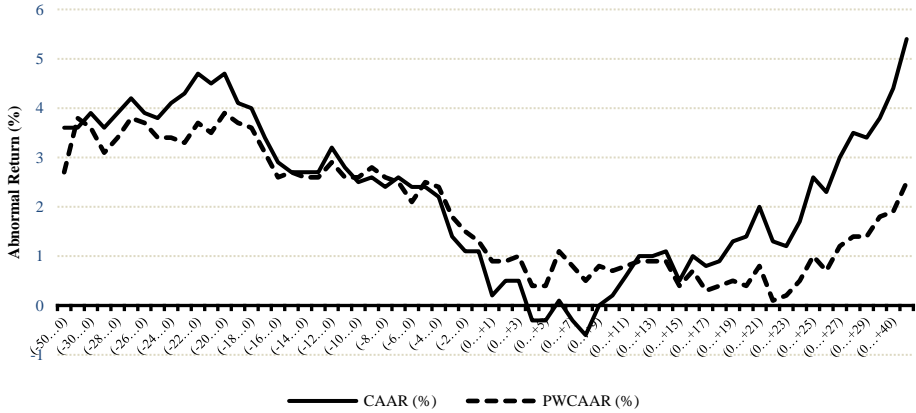
Table: 9
ABHAR and Test Statistics on and around Third M&A Announcements (N = 91)

	Average Buy-and-Hold Abnormal Return		Parametric Tests	
Event Window	(ABHAR) (%)	Pos:Neg	Csect T	Skewness-Corrected T
(-50…0)	0.0604	55:36	2.1649**	2.4951**
⋮	⋮	⋮	⋮	⋮
(0…+50)	0.0373	52:39	1.09	1.1972

Figure: 8
-50…+50 ABHAR (%) Third M&A Announcements
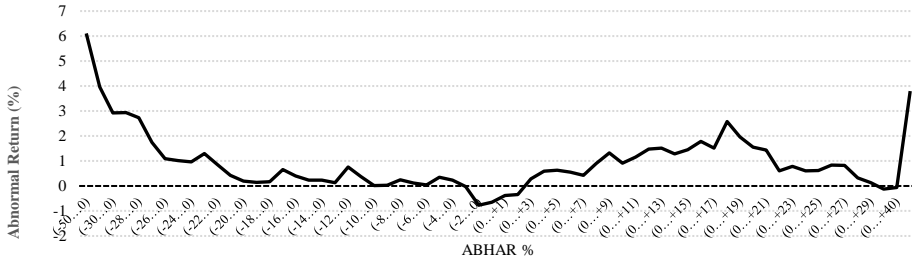
Table: 10
Various Windows CAAR, PWCAAR, and Test Statistics
(First M&A Announcements)

Event Window	CAARs (%)	PWCAARs (%)	N	Parametric Tests				Non-parametric Tests		
				Patell Z	Csect T	StdCSect T	Skewness-Corrected T	GenSign Z	Gen Rank Z	Gen Rank T
(-30…+30)	7.50	4.80	91	3.129***	2.671***	2.548**	3.083***	3.269***	2.511**	2.570**
(-20…+20)	5.90	3.40	91	2.920***	2.355**	2.048**	2.475**	3.114***	2.239**	2.308**
(-15…+15)	2.90	2.30	91	1.917*	1.385	1.430	1.321	2.021**	1.873*	1.928*
(-10…+10)	2.40	2.60	91	2.240**	1.704*	2.065**	1.725*	2.021**	1.658*	1.706*
(-5…+5)	1.90	2.30	91	2.668***	2.298**	2.778***	2.337**	2.021**	2.361**	2.427**
(-3…+3)	1.30	1.70	91	2.444**	2.001**	2.634***	2.091**	2.021**	2.069**	2.131**
(-1…+1)	0.90	1.40	91	2.798***	1.637	2.657***	1.677*	1.809*	2.642***	2.718***

*Note: *, **, ***, and **** indicate the statistical significance at the 0.10, 0.05, 0.01, and 0.001 levels, respectively.*

Table 10 presents the CAAR and PWCAAR calculation results in various event windows. Both the short-term and long-term windows exhibit positive and significant CAAR and PWCAAR. The findings reveal a stronger positive investor reaction to M&A announcements in the long term than short-term events. This indicates that the later the investors sell their stocks around M&A announcements, the more gains they will realise.

Table 11 reports CAAR and PWCAAR values in 10 sectors and six event windows. CAAR and PWCAAR values are evaluated using two parametric and two non-parametric test statistics. In the (-20...0) event window, it is observed that positive and significant CAAR and PWCAAR are present in the financial institutions (4.9% and 4%) and technology (9.8% and 10.5%) sectors, respectively. Similarly, positive and significant CAAR and PWCAAR are observed in the financial institutions (2.8% and 1.9%) and technology (6.9% and 7.3%) sectors, respectively, within the (-10...0) event window. In the (-5...0) event window, positive and significant CAAR and PWCAAR are observed in financial institutions (3% and 2.4%), manufacturing (2.4% and 3.1%), technology (4.4% and 4.3%), and transportation and storage (5.5% and 5.5%) sectors. It can be observed that positive and significant CAAR and PWCAAR occur in the technology, transportation and storage, construction, and public works sectors following announcements at (0...5), (0...10), and (0...20). In general, sectoral results indicate that investors tend to react positively and significantly five days before M&A announcements. This means that the (-5...0) event window is the most profitable period for investors.

Table: 11
Sectoral CAAR, PWCAAR, and Test Statistics (First M&A Announcements)

Sectors	Event Window	CAAR (%)	PWCAAR (%)	N	Csect T	Skewness-Corrected T	Gen Sign Z	Gen Rank T
		Cumulative Average Abnormal Return			**Parametric Tests**		**Non-Parametric Tests**	
Financial	(-20…0)	4.90	4.00	36	1.369	1.243	1.634	2.280**
Manufacturing		1.40	2.00	29	0.795	0.786	1.945*	1.422
Wholesale and Retail Trade		-0.10	0.60	7	-0.022	-0.005	-0.277	-0.375
Technology		9.80	10.50	6	3.405**	2.769**	2.023**	2.465**
Energy		18.60	10.60	5	2.697**	1.831	1.438	1.474
Construction and Public Works		-1.30	-1.40	2	-0.137	1.0	0.095	-0.168
Transportation and Storage		4.80	6.70	2	0.384	1.0	0.062	0.447
Real Estate Activities		19.18	-	1	-	-	-	1.1014
Administrative and Support Service Activities		23.96	-	1	-	-	-	0.7815
Education, Health, Sports and Other Social Services		7.67	-	1	-	-	-	0.6364
Financial	(-10…0)	2.80	1.90	36	1.510	1.584	0.628	1.850$
Manufacturing		1.40	2.30	29	0.960	0.967	1.197	1.226
Wholesale and Retail Trade		0.40	2.80	7	0.154	0.144	0.479	-0.026
Technology		6.90	7.30	6	4.409***	4.662***	2.849***	3.008***
Energy		3.80	5.10	5	0.807	0.587	1.438	1.493
Construction and Public Works		2.90	3.00	2	0.548	1.0	0.095	-0.182
Transportation and Storage		1.40	2.30	2	0.243	1.0	0.062	0.239
Real Estate Activities		9.60	-	1	-	-	-	0.7617
Administrative and Support Service Activities		-6.18	-	1	-	-	-	-0.2785
Education, Health, Sports and Other Social Services		6.08	-	1	-	-	-	0.697
Financial	(-5…0)	3.00	2.40	36	2.251**	2.628**	2.304**	2.892***
Manufacturing		2.40	3.10	29	2.40**	2.728**	1.945*	2.558**
Wholesale and Retail Trade		0.90	1.30	7	0.511	0.524	0.479	0.239
Technology		4.40	4.30	6	3.048**	2.224*	2.023**	2.354**
Energy		-1.60	-1.50	5	-0.572	-0.428	-1.248	-1.331
Construction and Public Works		-0.70	-0.70	2	-2.152**	1.0	-1.323	-2.219**
Transportation and Storage		5.50	5.50	2	14.169**	1.0	1.478	2.40**
Real Estate Activities		8.32	-	1	-	-	-	0.8938
Administrative and Support Service Activities		2.47	-	1	-	-	-	0.1507
Education, Health, Sports and Other Social Services		-2.88	-	1	-	-	-	-0.4471
Financial	(0…+5)	0.00	0.60	36	-0.044	-0.019	-0.712	0.058
Manufacturing		-1.50	-0.40	29	-1.753*	-1.640	-0.673	-1.762*
Wholesale and Retail Trade		2.30	0.70	7	0.804	0.774	0.479	0.401
Technology		2.00	1.50	6	1.173	1.303	1.198	1.046
Energy		-4.90	-3.50	5	-1.080	-1.270	0.543	-0.622
Construction and Public Works		0.10	0.10	2	0.041	1.0	0.095	-0.015
Transportation and Storage		6.90	7.10	2	6.282****	0.0	1.478	2.339***
Real Estate Activities		-3.17	-	1	-	-	-	-0.3406
Administrative and Support Service Activities		2.99	-	1	-	-	-	0.1825
Education, Health, Sports and Other Social Services		5.11	-	1	-	-	-	0.7932
Financial	(0…+10)	-1.10	-0.20	36	-0.605	-0.662	-0.377	0.026
Manufacturing		-0.50	0.00	29	-0.317	-0.282	0.075	-0.886
Wholesale and Retail Trade		6.30	3.60	7	1.429	1.881	1.236	1.536
Technology		5.40	5.20	6	2.901**	1.307	2.023**	2.330**
Energy		-8.50	-7.30	5	-1.413	-1.985	-1.248	-1.176
Construction and Public Works		7.20	7.20	2	19.917**	1.0	1.512	1.710*
Transportation and Storage		10.30	11.40	2	1.508	1.0	1.478	1.433
Real Estate Activities		-8.67	-	1	-	-	-	-0.6879
Administrative and Support Service Activities		7.09	-	1	-	-	-	0.3195
Education, Health, Sports and Other Social Services		-1.27	-	1	-	-	-	-0.1456
Financial	(0…+20)	-1.20	-1.60	36	-0.322	-0.40	0.293	0.459
Manufacturing		-0.70	-0.10	29	-0.294	-0.249	-0.299	-0.696
Wholesale and Retail Trade		15.00	-2.20	7	1.590	1.991$	0.479	0.418
Technology		9.80	12.40	6	3.011**	1.925	2.023**	2.311**
Energy		-1.10	2.50	5	-0.094	-0.079	-0.353	0.068
Construction and Public Works		10.50	10.60	2	2.728	1.0	1.512	1.432
Transportation and Storage		10.40	12.60	2	0.741	1.0	0.062	0.790
Real Estate Activities		-10.50	-	1	-	-	-	-0.603
Administrative and Support Service Activities		12.56	-	1	-	-	-	0.4097
Education, Health, Sports and Other Social Services		-11.76	-	1	-	-	-	-0.9758

Note: *, **, ***, and **** indicate the statistical significance at the 0.10, 0.05, 0.01, and 0.001 levels, respectively.

6. Conclusions and Implications

Using an event study methodology, this study examines the stock price performance of 91 Turkish companies involved in domestic mergers and acquisitions (M&A) between 2016 and 2023. Explicitly analysing the stock performance of acquiring companies, the study calculates abnormal returns around three key M&A announcement dates: the initial M&A announcement, the Capital Markets Board (CMB), and the M&A registration announcement.

In addition to estimating standard AR, PWCAAR and ABHAR are assessed in this study. Furthermore, abnormal returns are evaluated according to parametric and non-parametric test statistics. Consequently, the reliability and robustness of the findings are analysed. Firstly, AAR is calculated in 61 windows, 30 days before and 30 days after the first announcement. Subsequently, around the three announcement dates, CAAR, PWCAAR, and ABHAR are reported in 64 different windows, 50 days before and 50 days after the announcement. Finally, around the first announcement, CAAR and PWCAAR are reported in eight windows.

The results of the AAR, calculated in 61 different windows, indicate that investors' reactions were positive, spanning from 5 days before the first announcement date to the announcement day. However, only the -4th and -1st day AARs are significant. After the first announcement date, the values of AARs were observed to fluctuate. Around the first M&A announcement date, CAARs and PWCAARs values are consistently positive from day -27th to day -1st, and all of these values are statistically significant, according to both parametric and non-parametric statistical tests. During the event window (-22 to 0), the CAAR value reaches its maximum, with a value of 4.70%. The PWCAAR value reaches its maximum during the event window (-20 to 0), with a value of 3.90%. According to parametric and non-parametric test statistics, both values are statistically significant. Nevertheless, while the CAAR and PWCAAR values are positive in the post-announcement event windows, they are not statistically significant, except for the (0…+40) and (0…+50) event windows. Furthermore, the results of the ABHAR are consistent with those of the CAAR and PWCAAR. Table 10 demonstrates that the CAAR and PWCAAR values for the eight different event windows are positive and statistically significant. It also appears that the CAAR and PWCAAR values in the long-term event windows are higher than in the short-term event windows. The analysis results indicate that investors reacted positively to the first M&A announcements in the event windows before the announcement. These findings suggest that when merger and acquisition (M&A) information is disclosed, investors attempt to assess it within a relatively brief period. This evidence supports the hypothesis that the market is inefficient in its semi-strong form, thereby confirming the notion that information about mergers and acquisitions (M&A) is leaked to investors. The AR observed before the announcement can be explained by insider trading. Furthermore, investors may realise a significant return if they purchase shares in the acquiring company twenty-two days before the announcement date and sell them on the announcement date. In addition, the longer investors hold shares of acquiring companies within the (-50...+50) event window, the

greater the profit potential. It can be observed that investors tend to react positively to M&A announcements in a sectoral context in the pre-event windows. However, this reaction appears to decrease in the post-announcement windows. Investors demonstrated a positive and significant response in the financial institutions, manufacturing, technology, transportation, and storage sectors, particularly within the event window of (-5...0). Additionally, investors reacted positively and significantly to M&A announcements in the technology sector, especially in the pre-and post-announcement windows.

The findings generally indicate that investors tend to react strongly and positively to M&A announcements in event windows preceding the first announcement date. However, investors' reactions gradually weakened in the event windows surrounding the second and third M&A announcements. This suggests that information about M&A may have leaked to the financial markets before the announcement. In this case, market participants have already factored the news about M&A announcements into their pricing, indicating that markets are not semi-strong-form efficient.

The results of the current study are consistent with those of Seth, Song, and Pettit (2000), Wilcox, Chang, and Grover (2001), Lepetit, Patry, and Rous (2004), Scholtens and Wit (2004), Kumar and Panneerselvam (2009), Hekimoğlu and Tanyeri (2011), Liargovas and Repousis (2011), Kashiramka and Rao (2013), Genç and Coşkun (2013), and Ahmed et al. (2017), but not consistent with the results of Capron and Pistre (2002), DeLong (2003), Sachdeva, Sinha, and Kaushik (2017), Upadhyay and Kurmi (2020), and Pandey and Kumari (2020).

The findings of this study are specific to Türkiye and cannot be generalised to other countries or regions. It would be beneficial to employ a range of analytical techniques to enhance the study. In particular, the impact of M&A announcements on stocks in different sectors could be analysed.

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The Role of Absorptive Capacity in R&D Firms' Location Choice[1]

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Ar-Ge Firmalarının Yerleşim Seçiminde Özümseme Kapasitesinin Rolü[2]

Abstract

This study investigates the location choice behaviour of firms engaged in R&D activities in Türkiye. The primary objective is to analyse the effect of firm absorptive capacity on location choice. The empirical analysis is based on a firm-oriented approach, considering location as a source of knowledge-based competitive advantage. The TurkStat Research and Development Activities Survey (2019) Micro Data Set is the primary data source. The cross-sectional data set, created for 2019, includes data on 5,871 firms in the Micro Data Set. The geographical scope of the sample is NUTS Level 1 regions, where the headquarters of the R&D firm is located. The estimation method is the Nested Logit model. Results indicate that R&D firms in Türkiye tend to be located in regions with intense knowledge spillovers and favourable demand conditions. This results in an uneven distribution of R&D firms across regions. It is clear from the study's evidence that policymakers should consider the unique competencies and objectives of firms and regions in designing regional development and industrial policies.

Keywords   :   Location Choice, Firm Location, Absorptive Capacity, R&D, Regional Development.

JEL Classification Codes :   R30, O30, O32, R11.

Öz

Bu çalışma, Türkiye'de Ar-Ge faaliyeti yürüten firmaların yerleşim seçim davranışını araştırmaktadır. Birincil amaç, firma özümseme kapasitesinin yerleşim seçimi üzerindeki etkisini analiz etmektir. Çalışmanın ampirik analizi, firma-odaklı bir yaklaşıma dayanmakta ve yerleşimin bilgiye dayalı rekabetçi güç kaynağı olmasını göz önüne almaktadır. Temel veri kaynağı, TÜİK Mali ve Mali Olmayan Şirketler Araştırma-Geliştirme Faaliyetleri Araştırması (2019) Mikro Veri Setidir. 2019 yılı için oluşturulan yatay kesit veri seti İBBS Düzey 1 bölgelerinde Ar-Ge faaliyetinde bulunan

5 bin 871 firmayı içermektedir. Tahmin yöntemi, Nested Logit modeldir. Sonuçlara göre Türkiye'deki Ar-Ge firmaları, bilgi ortamı ve talep koşulları bakımından elverişli yerleri seçme eğilimindedir. Bu eğilim, Ar-Ge firmalarının bölgeler arasında eşitsiz dağılmasıyla sonuçlanmaktadır. Dolayısıyla, politika yapıcıların bölgesel kalkınma ve sanayi politikaları tasarlarken firmaların ve bölgelerin yetenekleri ve hedeflerini dikkate alması elzemdir.

Anahtar Sözcükler : Yerleşim Seçimi, Firma Yerleşimi, Özümseme Kapasitesi, Ar-Ge, Bölgesel Kalkınma.

1. Introduction

The location or relocation of a firm is a crucial decision that determines the spatial distribution of its factors of production and technology. Therefore, the location decision may result in several advantages and disadvantages that affect not only the firm but also other elements of the economic order. This is why researchers from different disciplines have sought to answer the question, "Where does production take place, and what forces determine the location choice?"

According to the relevant literature, several external and internal factors influence a firm's location choice (Alacer & Delgado, 2012; Arauzo-Carod et al., 2010; Townroe, 1969). External factors primarily relate to characteristics specific to the industry in which the firm operates or the region in which it is located. The most commonly highlighted external factors are agglomeration economies, labour market conditions, market demand conditions and competitive structure, economic outlook and conditions of the location, geographical accessibility and infrastructure, public policy and privileges, and sectoral and/or regional technology and knowledge (Arauzo-Carod et al., 2010; Feldman, 1999; Hoover, 1937, 1948; Malecki, 1985; Ferreira et al., 2016; Rossi, 2019; Townroe, 1969). On the other hand, internal factors frequently pointed out are the personality and behavioural characteristics of decision-making economic actors (entrepreneurs, firms, enterprises, companies, etc.) and firm characteristics (such as size, ownership structure, management structure, efficiency) (Alguacil et al., 2023; Arauzo-Carod et al., 2010; Chen & Yu, 2008; Jo & Lee, 2014; Townroe, 1969).

Modern views on the issue of location are dominated by a state of "ubiquity", where factors of production can be efficiently sourced in global markets due to globalisation. This new situation, in which all economic activities can be carried out anywhere, has given rise to the view that the importance of proximity or location has diminished. However, opposing views have also emerged. For these views, location is still important as a source of competitive advantage (Gertler, 1995; Feldman, 1999; Maskell & Malmberg, 1999b; Porter, 2000). This is because firms need input to differentiate themselves from others and thus gain competitive advantage in a system where many things are ubiquitous simultaneously. This refers to "the implicit and more sticky knowledge, as opposed to codified (tradable) knowledge" (Maskell & Malmberg, 1999a: 180), which spreads rapidly among actors. Innovation occurs based on implicit knowledge, and the accompanying strategic

differentiation has dynamised the competition between firms. The need to "be there" (Gertler, 1995) has increased due to the requirement to access implicit knowledge; thus, the proximity between actors in the value chain has become more critical than in the past (MacKinnon et al., 2002).

In light of the theoretical considerations, it would not be incorrect to say that accessibility to knowledge lends importance to a location. Such a location will facilitate the utilisation of complex and dynamic technological expertise in the production process. This reduces the uncertainty surrounding the innovation activity. This, in turn, enhances competitiveness by positively affecting firms' efficiency and improving innovation performance and productivity (Porter, 2000; Sridhar & Wan, 2010). Within the framework of knowledge-based competition, firms' ability to exploit the advantages offered by a location and to differentiate themselves depends on their ability to create and utilise knowledge or to improve their ability to do so (Maskell & Malmberg, 1999b; Seçkin, 2015). Through these skills, firms can absorb implicit and localised knowledge and capabilities. Thus, they can be competitive by developing unique technological competencies and capacities (Maskell & Malmberg, 1999a).

The fact that gaining knowledge-based competitive advantage is realised around the location, sector and network specificity of knowledge makes the role of firms' absorptive capacity in this process indispensable. The absorptive capacity is a capability based on knowledge and learning. Cohen & Levinthal (1990: 128-129) define it as "the ability to recognise the value of new information, assimilate it, and apply it to commercial ends." It is widely accepted that a firm's ability to develop unique experiences, expertise, and routines and to create innovative and commercially viable products, processes, models, and designs is crucial. This makes absorptive capacity a driver of knowledge-based competitiveness (Fosfuri & Tribó, 2008; Zahra & George, 2002), and thus a key factor in location decisions. Therefore, absorptive capacity can influence and alter both the firm and its external environment. It contributes to forming a regional knowledge base and pattern of learning, innovation and capability. As a result, based on their absorptive capacity, firms are likely to locate in regions (national or sub-national, such as clusters or peripheries) where they can generate or share knowledge in interaction with other actors, including firms, universities, and research institutions.

In this context, the scope of our study is to examine the location choices of firms engaged in research and development (R&D) activities and, thus, the reasons behind the regional distribution of these firms. Our primary objective is to analyse the location choice of firms by considering location as a source of competitive advantage based on knowledge and its implicit nature. To this end, an empirical analysis was conducted on a location model based on random utility maximisation, focusing on the effect of absorptive capacity. The estimation method is the Nested Logit model, which stands out among unordered discrete choice models by exhibiting a hierarchical choice structure. The primary data source is the Turkish Statistical Institute (TurkStat) Financial and Non-Financial Corporations Research and Development Activities Survey (2019) Micro Data Set. The cross-sectional data set

created for 2019 and used in the estimation includes data on 5,871 firms in the Micro Data Set, variables specific to the sector and location (region) in which they operate, and variables representing the absorptive capacity of these firms.

The contribution of this study is to analyse the location problem by considering the ability of location as a source of knowledge-based competitive advantage and the impact of implicit knowledge on firm location. Adopting a firm-oriented approach, we examined the effects of firm-, industry-, and region-specific factors, as well as the firm's absorptive capacity. Furthermore, we dealt with both potential and dynamic absorptive capacity. Thus, we examined the effects of the abilities that build absorptive capacity, namely the ability to identify, assimilate, and use knowledge. Lastly, to our knowledge, this study is the first to analyse the location choice of R&D firms in Türkiye. Therefore, we anticipate that our findings and inferences will help shape the studies on "location" and guide the formulation of policies towards Türkiye's industrial and technological targets.

The rest of the paper is organised as follows. Section 2 discusses the previous studies on location. Section 3 provides information about the methodology and data set used in the empirical analysis. Section 4 presents the main empirical results. The final section presents the findings and offers policy recommendations.

2. Literature Review

Researchers from various economic approaches, starting with David Ricardo and Adam Smith, have sought to answer the question of "where production takes place and what forces determine the location choice." They primarily addressed the location choice of production costs, particularly transportation costs and factors of production, following the early models of Location Theory (Von Thünen, 1826; Launhardt, 1882; Weber, 1909). Hence, the common aim of these studies is to identify the factors that cause the agglomeration or dispersion of economic actors or activities. They differ from each other in their primary focus on the location choice. Accordingly, they address the location problem from either a region-oriented (e.g., regions, cities) or a decision-maker-oriented (e.g., firms, entrepreneurship) perspective. As a result, the empirical models differentiate between econometric specification and method, the sample characteristics, and the location factors the researchers used. Below, we mention studies from both groups.

When a region-oriented solution is sought for a location problem, the research question considers how region- and/or sector-specific factors influence location choice. This approach offers flexibility to researchers due to the easily accessible regional-level data. Therefore, it is possible to examine the effects of different factors on location choice. Generally, agglomeration economies place special emphasis on explaining the attractiveness of specific regions. In addition, this approach's main disadvantage is that the effect of factors internal to the firm and entrepreneur on the choice process couldn't be analysed.

Campi et al. (2004) is one of these group of studies. It examines the location choices of new manufacturing firms by considering the life cycle of the industries. It categorises the industries as natural resource-intensive, labour-intensive, economies of scale, differentiated products, and R&D-intensive. The study reveals that the technological density and the life cycle of industries influence the location choice of new firms in Spain for the periods 1985-90 and 1991-1994. Interestingly, it reveals that smaller cities with higher levels of specialisation attract the attention of new firms. The larger cities have become less attractive despite their dense population and diversification. Berkoz and Turk (2009) also demonstrate that economies of scale, labour market, and infrastructure are crucial to foreign direct investment (FDI) firms' location choices in Türkiye. It indicates that FDI firms emphasise the availability of high-quality and low-cost inputs, a skilled labour force, accessibility, transportation, climate, and infrastructure. At the macro level, on the other hand, they appear to be concerned about Türkiye's economic and political stability.

Li and Zhu (2017) and Gómez Antonio and Sweeney (2021) are two other studies that focus on the attractiveness of a region. Li and Zhu (2017) investigate the impact of spatial dependence and heterogeneity on the location choice process of high-tech firms. It was discovered that new high-tech firms are generally located in townships with more established businesses and a smaller population. The proximity to urban centres, rather than highways, universities, or parks, appears more significant for firms. Planning policies encourage high-tech firms to establish operations in economic and technological development zones, as well as innovation incubators. On the other hand, Gómez Antonio and Sweeney (2021) specifically investigate the role of knowledge spillovers in high- and medium-high-technology manufacturing firms in Madrid between 2000 and 2016. It finds that the primary driver of the firms' location choice is knowledge spillovers from firms in the same industry but not from universities. Similarly, Jofre-Monseny et al. (2011) demonstrate that cooperation and networking, which emerge from agglomeration economies, are vital for new manufacturing firms. In particular, labour market pooling dominates the process of location choice, and input sharing follows it. Knowledge spillover effects are low and relevant only at a local level.

Besides agglomeration economies, government policies aimed at enhancing regions' business climate are a crucial location factor. Chin (2013) analyses the location of new establishments in the USA using quantitative and qualitative approaches. Discussing the conditions of regions and neighbourhoods, the empirical analysis shows that existing employment, population density and dominant firms determine the location of new establishments. In-depth interviews reveal that founders' thoughts are crucial in determining the locations of new establishments, including natural amenities, historical atmosphere, and physical settings. Li et al. (2016) and Yavan (2006) demonstrate that this is also true for high-growth firms in the USA and FDI firms in Türkiye, respectively. For Li et al. (2016), the factors favouring high-growth firms may differ from general location factors. The effects of this specific factor vary significantly depending on the type of area (urban or rural) and industrial sector.

According to Yavan (2006), the geographical distribution of FDI firms in Türkiye from 1990 to 2003 was influenced by the social, cultural, and geographical characteristics of NUTS-3 level regions, as well as economic conditions. These include socio-cultural amenities, crime, terrorism, violence, closeness to coasts or coastal regions, and metropolitan effect. Infrastructure, government policy and incentives, labour and agglomeration economies are other factors that affect the location of FDI firms. Berkoz and Turk (2005) also show the importance of these factors in the case of Türkiye in the same period. FDI firms pay attention to agglomeration economies, population growth, previous investment, infrastructure, market growth, and inhabitants' access to bank credit. Deichmann et al. (2003), another study that examined FDI firms' location choice in Türkiye for the year 1995, adds the depth of local financial markets, human capital and coastal access to these factors. Furthermore, Tatoglu and Glaister (1998) highlight that the importance of the location factors for FDI firms in Türkiye in the same year varies depending on the country of origin of these firms, the mode of entry (acquisition or greenfield), the industry and the size of the venture.

Lall and Chakravorty (2004) demonstrate a sharp distinction between the factors affecting the location decisions of state-owned and private sectors in India. Private-sector firms prioritise efficiency-related economic geographies or institutional factors, such as closeness to industrial clusters and coastal districts or liberalisation and structural reforms. In contrast, state-owned (central government) firms appear not to be driven by economic geography factors. Manjón-Antolín and Arauzo-Carod (2011) address the issue by examining location and relocation decisions in Catalonia. It demonstrates that the new firms' location choice and the existing firms' relocation choice differ from the factors that make a municipality more attractive. These factors include population density, urbanisation economies, industrial diversity, labour market characteristics, and infrastructure. Karahasan (2015) and Sanchez-Reaza (2018) also control the effects of these factors on firms' locations. Karahasan (2015) demonstrates that the regional distribution of new firms in Türkiye is primarily driven by demand, business cycles, human capital, and financial capital at the provincial (NUTS-3) level. Additionally, tests on the roles of geography and spatial dependence reveal that regional networks are important to new firms. Sanchez-Reaza (2018) identifies that job diversification, formed by urbanisation economies, is a key factor affecting firms' location in Tanzania. Localisation economies, competitive markets, and market access are other factors that make a particular location attractive.

The research question examines the impact of firm-, sector-, and region-specific factors on location choice, informed by a firm-oriented approach. Such a model construction helps examine firm- and entrepreneur-specific characteristics. However, the accessibility of microdata is a significant drawback. On the other hand, the empirical method is generally one of the discrete choice models (DCMs), such as logit, generalised extreme value (GEV), probit or mixed logit models. Additionally, high-technology and/or knowledge-intensive industries, particularly the manufacturing sector, draw the attention of researchers. The geographical scope encompasses sub-regions, regions, states, and nations. Agglomeration

economies and human capital receive considerable attention in the studies. The availability of microdata enables the researchers to focus on the behavioural aspect of the choice process.

Chen and Yu (2008) is a case in point. It examines how managers of high-tech firms decide on a location strategy within a science park in Hsinchu, Taiwan. Employing the decision-making trial and evaluation laboratory (DEMATEL) and analytic network process (ANP) methods, this analysis explains the location choice process by highlighting the value and benefits of clustering. Results show that entrepreneurial spirit, talent pool and support infrastructure are important for managers. Network effects create a competitive and collaborative workplace, diffusing new knowledge and business intelligence. Meanwhile, an entrepreneurial spirit, lead users, and a talent pool bring low transaction costs. Lafuente et al. (2010) is another study that discusses the effect of personal motivation, in addition to other location factors, on location choice. It examines the choice of rural and urban locations made by knowledge-intensive service activity (KISA) firms in Catalonia between 2003 and 2006. The findings reveal that the entrepreneurs' motives and quality of life drive firms to relocate to rural areas. In contrast, the local attitude towards entrepreneurship is a serious obstacle to choosing rural localities.

Ferreira et al. (2016) is another study that discusses the effect of personal motivation, in addition to other location factors, on location choice. It shows that firms operating in knowledge-intensive business services tend to be located in urban areas, whereas firms in the construction, agriculture, services manufacturing and mining sectors are more likely to be located in rural areas. The characteristics and expectations of entrepreneurs, as well as the climate and local attitude towards business, also affect the firms' location choice. Yavan (2010) also demonstrates the importance of climate and quality of life in the decision to locate Foreign Direct Investment (FDI) in Türkiye. The results highlight the crucial role of agglomeration economies, labour pool, public investment and road network.

What is surprising about Yavan's (2010) results is that wage, productivity, unionisation, sea and air transportation, free zones, and instability are not significant determinants of FDI firms' location choices in Türkiye. However, Kayam et al. (2011) show that Turkish FDI firms are treated differently. Due to low labour costs, they prefer MENA and transition economies to EU countries. Other factors that determine the location choice of Turkish firms include accessibility to consumers and suppliers, market penetration, the presence of Turkish firms and population, cultural similarity, trade opportunities and trade agreements, skilled labour, and transportation costs. Demirbag et al. (2010) demonstrate that other factors are crucial for Turkish multinational enterprises (MNEs) location strategy. Accordingly, when deciding to locate one of the two specific country groups (EU and Former Soviet Union) and two broad regions (developed countries and emerging countries), Turkish MNEs pay more attention to the level of political constraints, the level of knowledge infrastructure, subsidiary density and size, and industry R&D intensity.

Similarly, Barrios et al. (2006), Devereux et al. (2007), and Kohlhase and Ju (2007) demonstrate that public policy or incentives affect firms' location choices. Barrios et al.

(2006) and Devereux et al. (2007) find firms' responsiveness to government subsidies and public incentives is low, whereas Kohlhase and Ju (2007) reveal that local property taxes have a deterrent influence on the location choice of firms, primarily operated in oil and gas, manufacturing, services and finance, insurance and real estate (FIRE) industrial groups. For Devereux et al. (2007), the low responsiveness to government subsidies in Great Britain is the interaction between agglomeration externalities and these policy instruments. Both domestic and multinational firms are less responsive to subsidies in locations with fewer incumbents in their industry. According to Kohlhase and Ju (2007), the effect of agglomeration economies is lower than the deterrent effect of property taxes present in the FIRE and services industries. The benefits of localisation and urbanisation economies affect firms in both these industries, while oil and gas and the manufacturing industries seem not to benefit from proximity to other firms. In contrast, Barrios et al. (2006) argue that agglomeration economies have a considerable influence on multinational high-tech firms in the Republic of Ireland.

Other studies emphasise the importance of agglomeration economies on the geographical distribution of firms. One of them is Deichmann et al. (2005). The results indicate that agglomeration economies have a significant influence on the location patterns of manufacturing firms with 20 or more employees in Indonesia. Alcacer and Delgado (2012) differ from others in that they decompose the impact of agglomeration economies into internal (intra-firm) and external (inter-firm) components. The case of biopharmaceutical firms in the US from 1993 to 2005 reveals that both agglomeration economies have a positive impact on location choice; however, their effects vary among firms' plants and activities, including R&D, manufacturing, and sales. Jo and Lee (2014) also examine the impact of different types of agglomeration. It demonstrates that firms' technological capabilities and agglomeration economies interact to influence location choice in South Korea. For firms with low technological capability, competitive specialisation is crucial. On the other hand, firms with high technological capability tend to be located in regions characterised by complementary specialisation.

Akın and Seyfettinoğlu (2022) present findings on how the impact of certain factors on firms' locations in Türkiye varies according to the technological intensity of the industry in which firms operate. High-tech firms (high, medium-high, or medium-low) tend to choose regions with a diversified and deepened labour pool, sectoral diversity, and knowledge spillovers. On the other hand, low-tech firms place more importance on specialisation arising from localisation economies. Similarly, Bottazzi and Gragnolati (2015) previously demonstrated the collaborative role of technological dynamics and agglomeration economies in the Italian context. Results indicate that the firms' location affects urbanisation and sector-specific localisation economies. For Bottazzi and Gragnolati (2015), technological dynamics that produce sector-specific positive externalities are the primary motive in location choice.

Lastly, Sridhar and Wan (2010) analyse the location choice of firms in cities of different sizes (large, medium, and small) in three countries: India, China, and Brazil. It

reveals that capital cities are not attractive when they are significant. Labour-intensive firms, in particular, do not choose large cities in India and China. The availability of inputs attracts firms to India and China while deterring firms in Brazil. In contrast to China, the post-reform period has a positive influence on the location choice of firms in India.

Compared to previous studies, our contribution is threefold. First, we adopt a firm-oriented approach to the location problem, overcoming the microdata constraint commonly found in the literature. This allowed us to analyse the effect of firm-specific characteristics in addition to industry and region. Second, we examine the firm's absorptive capacity as a firm-specific location factor regarding its potential and dynamic aspects. This also enables us to focus on the location as a source of competitive advantage, leveraging its knowledge and implicit nature. Lastly, to our knowledge, this study is the first to analyse the location choice of R&D firms in the case of Türkiye. On the other hand, a significant limitation of our study is that we cannot examine the effect of entrepreneur-specific factors on location choice due to a lack of data at the entrepreneur level. Nevertheless, we anticipate that our findings and inferences will be helpful for future studies and guide policies towards Türkiye's industrial and technological targets.

3. Empirical Methodology and Data

3.1. Location Choice Model

The location choice model analysed in the present study assumes that the R&D firms regard location as a source of knowledge-based competitive advantage. It is based on the Nested Logit (NL) model, which features an unordered choice structure with a multinomial dependent variable. The NL model is theoretically grounded in random utility maximisation, which enables the modelling of choice behaviour with a deterministic rule while accounting for some uncertainties in the choice process (e.g., unobservable attributes of alternatives and individual characteristics of the decision-maker, as well as statistical measurement errors). This enables researchers to investigate how decision-makers and alternative-specific characteristics affect the choice behaviour of a decision-maker who chooses the alternative with the maximum utility (Ben-Akiva & Lerman, 1985; Ben-Akiva & Lerman, 1999).

Accordingly, the location choice model for the R&D headquarters of firms is defined in closed form in Equation (1):

$$\pi_{ij} = f[S_i, KI_i, SS_i, AC_i, C_j] + \varepsilon_{ij} \tag{1}$$

where i is firm; j is the location of the statistical unit where the R&D activity is performed, and ε_{ij} is the error term. Equation (1) implies that a firm's expected profit at a location π_{ij} is a function of the firm size (S), sectoral knowledge intensity (KI), sectoral specialisation (SS), absorptive capacity (AC) and characteristics (C) specific to the choice alternatives (regions).

Due to uncertainty regarding firm behaviour and a variety of factors influencing expected profit, observing π_{ij} is practically impossible. To address this limitation, the assumption that "if the firm's expected profit for location A is greater than that for other location(s), the firm will choose to locate in A" is introduced into the model (as in Artz et al., 2016; Barrios et al., 2006; Bottazzi & Gragnolati, 2015; Hansen, 1987; Jofre-Monseny et al., 2011). Thus, a firm's location choice is expressed by a dummy variable with the value 1 if the firm chooses the relevant region and 0 otherwise, as given below in Equation (2):

$$y_{ij} = \begin{cases} 1 \; ; \; \pi_{ij} > \pi_{ik} \; , \forall j \neq k \\ \quad 0 \; ; \; otherwise \end{cases} \tag{2}$$

where, y_{ij}, indicates that the firm *i* chooses to be located in region *j* by assuming that firms are risk neutral (Devereux et al., 2007). It represents the statistical unit where R&D activities are conducted. As a result, the variables "BOLGE_KOD" and "ILKAYITNO" in the TurkStat (2020) are matched. They refer to the location of the intramural R&D activity and the Nomenclature of Territorial Units for Statistics (NUTS) Level 2 region code of the statistical unit (i.e. headquarters unit) where the questionnaire is applied, respectively.

Equation (3) provides the basic empirical specification within this framework. Table 1 presents information on the indicators of the variables, along with some descriptive statistics.

$$y_{ij} = \beta_0 + \beta_1 size_i + \beta_2 kia_i + \beta_3 spec_i + \beta_4 basic\_res_i + \beta_5 app\_res_i + \beta_6 exp\_nprod_i + \beta_7 exp\_npros_i + \beta_8 res\_rate_i + \beta_9 exp\_rate_i + \alpha_1 pop\_g_j + \varepsilon_{ij} \tag{3}$$

In Equation (3), firm size (*size*) is calculated as the share of the firm's employees in the total number of employees within its size group in the region where it operates. Firm size has generally been analysed in terms of the number of employees (Alguacil et al., 2023; Arauzo-Carod & Antolín, 2004; Kohlhase & Ju, 2007; Liviano & Arauzo-Carod, 2014; Weterings & Knoben, 2013) or, where data are available, capital, investment or turnover (Akbaşoğulları & Duran, 2020; Akın & Seyfettinoğlu, 2022; Alguacil et al., 2023; Arauzo-Carod & Antolín, 2004; Fotopoulos & Louri, 2000). We were unable to include the logarithm of the number of employees in the model as a variable because it resulted in a multicollinearity problem. Since the Micro Data Set does not contain data on financial indicators, such as firm capital, we could not use these indicators either. There is a general expectation that firm size positively affects location choice; however, several research studies have shown that its effect may vary depending on the region or country (Sridhar & Wan, 2010) or sector (Kohlhase & Ju, 2007; Sanchez-Reaza, 2018). In line with the common expectation, the firm's relative size is expected to affect the likelihood of regions being chosen favourably.

kia reflects sectoral knowledge intensity. It is a dummy variable that takes the value 1 if the sector in which the firm operates is among the Eurostat Knowledge Intensive Activities (KIA) by NACE Rev. *2 - total KIA* (Eurostat, 2022) and 0 otherwise. Many

location studies examined the impact of knowledge as a part or end product of localisation economies, labour quality, accessibility and knowledge and technology policies. Among these, the presence of or proximity to universities, innovation centres, science parks, research laboratories, etc., where actors produce and share knowledge and technology in interaction (Chen & Yu, 2008; Ferreira et al., 2016; Gómez-Antonio & Sweeney, 2021; Lafuente et al., 2010; Li & Zhu, 2017) are the most commonly used ones. In addition, the impact of funds and incentives provided to the region (Chin, 2013), the number of innovative firms in the region (Deakins & Bensemann 2019), the number of registered patents (Chin, 2013; Maggioni, 1999; Siedschlag et al., 2013), regional or sectoral R&D intensity and knowledge/technology intensity (Campi et al., 2004; Demirbag et al., 2010; Maggioni, 1999; Malecki, 1984; Weterings & Knoben, 2013) have also been investigated.

Previous studies have shown that a location's knowledge and technology environment will increase the probability of firms choosing that location. As noted by Malecki (1985), it is vital for R&D firms as it reflects the availability of skilled labour. This suggests that firms make location choices based on the importance of localised knowledge, skills and competencies. Eurostat's (2022) total-KIA classification by NACE Rev.2 comprises various subsectors from industry to services sectors. All these subsectors' knowledge needs and environments are different. Thus, it is expected that regions providing firms operating in KIA sectors with sufficient sectoral knowledge and knowledge environment have a higher possibility of being chosen.

Table: 1
Descriptive Statistics

Variable	Indicator	Definition	Mean	Std. Dev.	Min.	Max.
S	size	The share of the firm's number of employees in its size group (micro, small, medium, large) in the region where it operates (%).	0.85	3.55	0.28	100
KI	kia	This is a dummy variable that takes 1 if the sector (by NACE Rev.2) in which the firm operates is defined by Eurostat as knowledge-intensive activity (total KIA); otherwise, it takes 0.	-	-	0	1
SS	spec	The share of firms that operate in the same region (by NUTS) and sector (by NACE Rev.2) with the firm in total firms (%).	3.47	4.49	0.02	12.83
AC	basic_res	Basic research activity expenditure in total intramural R&D expenditure (%)	23.30	34.97	0	100
	app_res	Applied research activity expenditure in total intramural R&D expenditure (%)	28.30	35.41	0	100
	exp_nprod	Experimental new product activity expenditure in total intramural R&D expenditure (%)	28.29	35.22	0	100
	exp_npros	Experimental new process activity expenditure in total intramural R&D expenditure (%)	5.79	14.46	0	100
	res_rate	The share of researchers in the firm's total R&D personnel (%)	77.52	29.60	0.65	100
	exp_rate	The share of expenditure on researchers in the firm's total R&D expenditure (%)	63.20	29.13	0	100
C	pop_g	Annual growth rate of population by region (2019, ‰)	20.48	8.76	-10.70	29.53

spec represents localisation economies within the scope of static externalities. Similar to other empirical studies (Alamá-Sabater et al., 2011; Deichmann et al., 2005; Jo & Lee, 2014; Kohlhase & Ju, 2007; Li & Zhu, 2017), its unit of measurement is the number of firms. It is calculated as the ratio of the number of firms operating in the same NACE Level 2 sector in a region to the total number of firms in that region. Previous studies show that firms tend to locate in regions with other firms operating in the same sector, using similar labour, and with high forward and backward linkages. Numerous studies (Alcacer & Delgado, 2012; Artz et al., 2016; Barrios et al., 2006; Deichmann et al., 2005; Jo & Lee, 2014; Jofre-Monseny et al., 2011; Karahasan, 2010; Kohlhase & Ju, 2007; Lall & Chakravorty, 2004) have also shown that the impact of localisation economies on location may vary depending

on the technological structure of the main sector, related sector(s) and firms' competence. Accordingly, for firms in sectors where sector-specific returns to specialisation are important, the spec is expected to increase the tendency to locate in a region. From the point of R&D firms, the effect of the spec is expected to be positive in favour of Marmara, considering it includes TR10 (Istanbul) and TR42 (Kocaeli, Sakarya, Düzce, Bolu, Yalova), which had the highest (28.5%) and third highest (7.3%) shares of the number of R&D personnel in 2019, respectively. TR10 and TR42 also had higher shares of Gross Domestic R&D Expenditures (GERD) (26.4% and 9.5%, respectively) than other regions that year. Besides, Ankara stands out among the different regions. It had the highest share of R&D expenditure (31.6%) and the second-highest share of R&D personnel (18.7%) in 2019. Hence, it can be expected that the spec will positively affect the probability of Western Anatolia being chosen (TurkStat, 2024a).

In the literature, the effect of a firm's absorptive capacity on location choice is typically analysed through R&D activities, particularly R&D intensity (Alañón-Pardo & Arauzo-Carod, 2013; Audretsch & Belitski, 2020; Cohen & Levinthal, 1990; Mowery et al., 1996; Park et al., 2023; Xiao et al., 2023). R&D intensity could not be included in our model due to the lack of data on firms' sales values in the TurkStat (2020) Micro Data Set. As an alternative, the model could not use the logarithmic transformation of R&D expenditures due to the multicollinearity problem. Nevertheless, this constraint paves the way for this study to employ distinct variables representing a firm's absorptive capacity. Thus, two groups of variables representing different absorptive capacities are included in Equation (3).

The first group includes *basic_res*, *app_res*, *exp_nprod* and *exp_npros,* which describe a firm's learning process and experience. These are the shares of total intramural R&D expenditure allocated to basic research, applied research, experimental new product development, and experimental new process development[3], respectively. Each activity dynamically feeds the capabilities that are central to the development of a firm's absorptive capacity (Cohen & Levinthal, 1990; Fosfuri & Tribó, 2008; Van Den Bosch et al., 1999; Zahra & George, 2002). Accordingly, *basic_res* is the activity of acquiring knowledge; *app_res* is the activity of acquiring, synthesising and assimilating knowledge; and *exp_nprod* and *exp_npros* are the activities that develop the capability to integrate, transform, use and apply knowledge. The second group, on the other hand, consists of two variables (*res_rate* and *exp_rate*) representing the potential of a firm's absorptive capacity. *res_rate* is the share of researchers in the firm's total R&D personnel. *exp_rate* is the share of expenditures on researchers in the firm's intramural R&D expenditures. Both variables capture individual absorptive capacities within a firm, the organisational strategy (structure) for skill acquisition, and R&D efforts for pre-knowledge acquisition.

Firms are expected to gravitate towards regions that develop their absorptive capacity's dynamic and potential sides. This is because, as emphasised in the literature (Audretsch & Feldman, 1996; Audretsch et al., 2004; Fujita et al., 1999), these regions are

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[3] *For the definition of types of R&D activities, see OECD, 2015.*

likely to have a knowledge environment that enables them to benefit from knowledge spillovers and learning resources. Accordingly, the variables *basic_res*, *app_res*, *exp_nprod*, *exp_npros*, *res_rate* and *exp_rate* are expected to be positive for regions that can contribute to developing firms' absorptive capacity and negative for other regions. In this regard, it is evident that Marmara and Western Anatolia, which have many technical and/or research universities (Council of Higher Education of Türkiye, 2024), R&D and design centres, technology development centres (Ministry of Industry and Technology, 2024), researchers and other R&D staffs, as well as more significant contribution to Türkiye's GERD (TurkStat, 2024a), have a higher advantage compared to other regions.

pop_g is a region's annual population growth rate (per thousand). It is included in the model to reflect local demand conditions that have been accepted as an important location factor since the first location models. Previous studies have examined the impact of local demand conditions through the population (Akın & Seyfettinoğlu, 2022; Alamá-Sabater et al., 2011; Berkoz & Turk, 2009; Devereux et al., 2007; Maggioni, 1999; Yavan, 2006) and income indicators (Basile et al., 2008; Brülhart et al., 2007; Chin, 2013; Devereux et al., 2007; Guimarães et al., 2004; Maggioni, 1999; Ramaul & Ramaul, 2018; Siedschlag et al., 2013; Yavan, 2006) or per capita tax revenue (Karahasan, 2010, 2015) and per capita consumption level (Bottazzi & Gragnolati, 2015). We could not include the population density and the logarithm of population level, as the first prevents the maximisation of the log-likelihood function and causes multicollinearity. In addition, due to data limitations, we could not analyse the effect of income and consumption. The generally accepted expectation about the impact of the demand conditions is that it positively affects the probability of a chosen region. Therefore, the *pop_g* is expected to have a favourable effect on the probability of choosing.

3.2. Estimation Method

We estimate Equation (3) employing the Nested Logit (NL) model estimation method. The NL model is a Discrete Choice Model (DCM) that takes researchers beyond the standard multinomial logit (MNL; McFadden, 1974) model. It simply groups the similar alternatives into subgroups (nests). This creates a hierarchical structure of the other options, so the error terms of the choice alternatives do not necessarily need to be uncorrelated. Hence, it relaxes the *Independence from Irrelevant Alternatives (IIA)* assumption of the MNL model, requiring the error terms of the choice alternatives to be independent of each other (Hensher & Greene, 1999; Wooldridge, 2001; Train, 2003; Baltas, 2007).

In the NL model, the choice set $C_j = \{1, 2, \ldots, J\}$ is assumed to be divided into non-overlapping subsets (nests) $B_k = \{1, \ldots, K\}$. The choice process involves choosing one of the sub-sets $B_1, B_2, \ldots, B_K$ and a specific alternative from the chosen subset $(c_1, \ldots, c_J)$. This hierarchical choice process is formulated as in Equation (4) (Greene, 2008):

$$C_j = [c_1, \ldots, c_J] = [(c_{1|B_1}, \ldots, c_{J_1|B_1}), \ldots, (c_{1|B_K}, \ldots, c_{J_K|B_K})] \tag{4}$$

Nesting choice alternatives in multiple levels, as in Equation (4), creates a substitution pattern between alternatives that visually resembles an inverted tree. Figure 1 illustrates the two-level NL tree, which shows the choice structure we analysed. In Figure 1, the choice set of 13 alternatives (C_j) based on NUTS Level 1 regions is divided into five nests (B_k). The set of choice alternatives C_j =(*Eastern Marmara, Istanbul, Western Marmara, Izmir, Aegean[4], Mediterranean, Western Anatolia, Central Anatolia, Southeastern Anatolia, Central Eastern Anatolia, Northeastern Anatolia, Eastern Black Sea, Western Black Sea*) is divided into the subsets B_k =(*Marmara, Aegean-Mediterranean, Anatolia, Eastern Anatolia, Black Sea*). The choice process refers to the non-sequential choice among the choice subsets and the choice of a specific location alternative (e.g. Istanbul $(c_{j|k} = c_{Istanbul|Marmara})$) from a chosen subset (e.g. $(B_k = B_{Marmara})$) from Marmara nests). See Appendix Table A for NUTS regions of Türkiye.

Figure: 1
Tree Structure for Location Choice of R&D Firms (Two-Level Nested Logit)
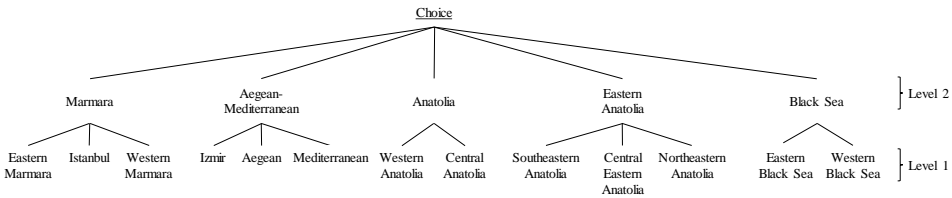
The two-level hierarchical choice structure exemplified in Figure 1 can be extended to three or more levels. However, we assigned attributes to only the model's first level, as Hensher et al. (2005) suggested, since there is no common set of attributes to distinguish between higher choices. We also considered the risk of high-level NL models containing high levels of variance. Detailed information on the NL model can be found in Greene (2008), Hensher and Greene (1999), Hensher et al. (2005) and Train (2003).

3.3. Data Set

The primary data source is the 2019 Financial and Non-Financial Corporations Research and Development Activities Survey Micro Data Set, which TurkStat (2020) produces annually and makes publicly available. The population growth rate data was obtained from the TurkStat Regional Statistics Database as an exception.

The TurkStat (2020) Micro Data Set is compiled within the scope of the R&D Activities Survey. The geographical scope of the R&D Activities Survey is NUTS Level 2 regions. The 2019 universe consists of 14,532 firms. Among these, the number of respondent firms is 14,169. The Micro Data Set comprises statistics on R&D expenditures and R&D

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[4]   *The "Aegean" alternative in the choice set includes other Aegean provinces except İzmir.*

personnel of 7,514 financial and non-financial companies (FNFCs) that conduct intramural R&D. The surveyed FNFCs in the 2019 R&D Activities Survey represent 64.2% of the total intramural R&D expenditures in 2019.

We created a cross-sectional data set for 2019, including firm-, industry-, and region-specific variables (see Table 1). The sample's geographical scope encompasses NUTS Level 1 regions that host the firm's headquarters, where intramural R&D activity is carried out. Thus, the sample includes 5,871 out of 7,514 firms in the Micro Dataset.

Figure: 2
Regional Distribution of R&D Expenditures (2019, 2021)
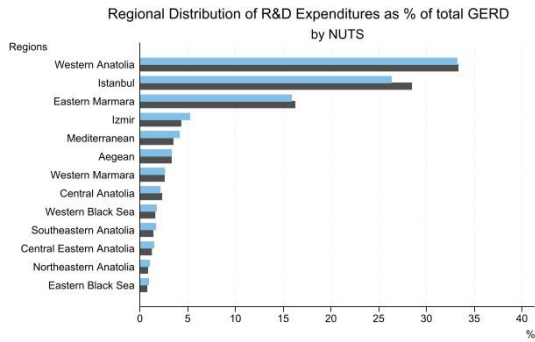
Source: Turkstat (2024a), Research and Development Activities Survey Statistics.

Figure: 3
Regional Distribution of R&D Personnel (2019, 2021)
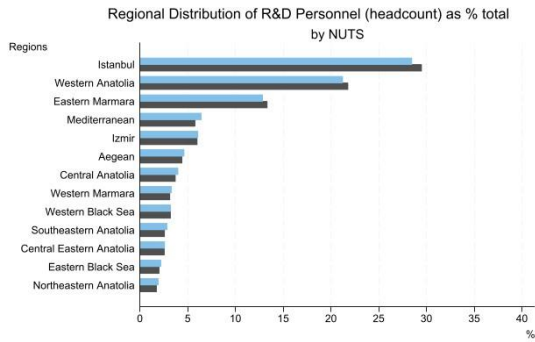
Source: Turkstat (2024a), Research and Development Activities Survey Statistics.

According to Micro Data Set, in 2019, Istanbul (2,118), Western Anatolia (1,512), and Eastern Marmara (714) hosted the majority of FNFCs performing R&D in the centre unit. NUTS Level 1 regions with the fewest FNFCs were Northeastern Anatolia (28) and Eastern Black Sea (33). It can be seen that there was an uneven distribution of R&D firms

throughout the regions in 2019. However, this has also been the case in previous and future years. R&D Activities Survey Statistics (TurkStat 2024a) show that R&D expenditures and human resources were unevenly distributed across Türkiye's regions in 2019 and 2021. This is illustrated in Figures 2 and 3.

Some subregions within Northeastern Anatolia, Eastern Black Sea, Central Eastern and Southeastern Anatolia have a lower level or share of many socio-economic indicators than the Türkiye average. For instance, Income and Living Conditions Survey Statistics (TurkStat, 2024b) show that TRB2 (Van, Muş, Bitlis, Hakkari) in Central Eastern Anatolia has had the lowest mean annual equivalized household disposable income for years. Furthermore, according to GDP statistics by provinces (TurkStat, 2024c), Ağrı (TRA2; Northeastern Anatolia), Şanlıurfa (TRC2; Southeastern Anatolia), and Van (TRB2; Central Eastern Anatolia) are consistently the provinces with the lowest estimated GDP per capita. The same statistics also show that the final three provinces with the lowest contribution to Türkiye's GDP are typically Tunceli (TRB1; Central Eastern Anatolia), Ardahan and Bayburt (TRA2 and TRA1; Northeastern Anatolia).

Figure 4 illustrates the contribution of NUTS Level 2 Regions to Türkiye's GDP in 2022. It is evident that western regions, particularly the subregions of Marmara, dominated Türkiye's domestic production that year. Subregions in Central Eastern, Southeastern, and Northeastern Anatolia, as well as the Western Black Sea, had the lowest share of total GDP in 2022. This unequal income distribution among regions results in additional inequalities. The Central Eastern, Northeastern, and Southeastern Anatolia subregions also suffer from high unemployment rates and low labour force participation rates, as well as the lowest school life expectancy, average years of schooling, literacy rates, and literacy rates among women (TurkStat, 2024c), among other issues. As a result, resources associated with industry, services, education, and research-based activities tend to concentrate in the western regions of Türkiye. NUTS definitions of statistical regions of Türkiye are given in Appendix Table A.

Figure: 4
The Share of GDP by Regions, at Current Prices, 2022
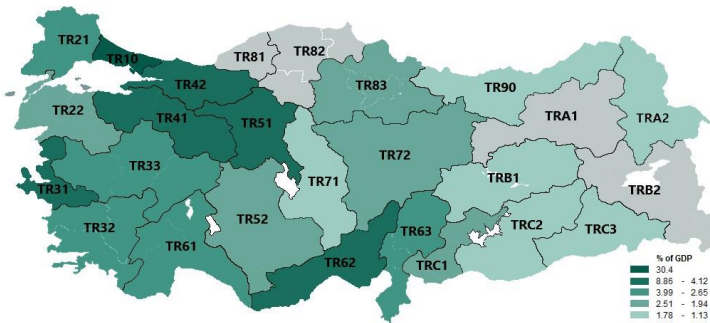
4. Empirical Results

The estimation results of the NL model (Equation (3)) are given in Table 2. In the upper part of Table 2, the number of observations at each level ($N = 13 \times k$) equals the sum of the number of times the alternative is chosen (k). The LR test statistics test the appropriateness of the NL model against the MNL model with the null hypothesis that "all-inclusive values are equal to 1 (IV=1)". According to the $\chi^2_{(5)}$ value of the test, the null hypothesis is rejected at significance levels of 1%. Therefore, the NL model structure is appropriate.

Table: 2
Nested Logit Model Results

LR ($IV = 1$): $\chi^2_{(5)} = 269.55$				$Log - likelihood = $ -9822.2194 $N = 76323$ $k = 5871$		
Lower Nest						
Population Growth Rate	pop_g	0.0486*** [0.0449] (0.0188)				
Upper Nest						
Levels						
		Marmara	**Aegean-Mediterranean**	**Anatolia**	**Eastern Anatolia**	**Black Sea**
Dissimilarity Parameters (λ)		0.3514	1.4366	0.3973	0.8424	0.3462
Firm Size	size	0 (base group)	0.2117*** (0.0324)	0.0981*** (0.0375)	0.3278*** (0.0348)	0.3360*** (0.0357)
Knowledge Intensity	kia		0.9487*** (0.0883)	0.5712*** (0.0783)	1.8382*** (0.1801)	2.0539*** (0.2340)
Specialisation	spec		-0.6533*** (0.0420)	-0.0362*** (0.0080)	-4.1579*** 0.4387	-5.2310*** (0.7168)
Absorptive Capacity	basic_res		-0.5779*** (0.1632)	-0.0688 (0.1509)	-0.6244** (0.3125)	0.6035 (0.5500)
	app_res		-0.5690*** (0.1595)	-0.0378 (0.1506)	-0.4514 (0.3075)	0.7853 (0.5578)
	exp_nprod		-0.8205*** (0.1627)	-0.0842 (0.1610)	-1.0696*** (0.3147)	0.2015 (0.5770)
	exp_npros		-1.3164*** (0.3120)	-0.2279 (0.2695)	-0.9886* (0.5523)	0.1708 (0.8533)
	res_rate		-0.0005 (0.0013)	0.0038*** (0.0012)	0.0022 (0.0025)	0.0020 (0.0039)
	exp_rate		-0.0092*** (0.0013)	-0.0077*** (0.0012)	-0.0173*** (0.0026)	-0.0250*** (0.0036)

Notes:
1. Marmara is the base group.
2. *p < 0.10, **p < 0.05, ***p < 0.01. The standard errors in parenthesis.
3. $\chi^2_{5,0.05} = 11.070$ and $\chi^2_{5,0.01} = 15.086$.

In Table 2, the "Lower Nest" refers to the results obtained by choosing an alternative within a nest. According to the lower nest estimation results, a sub-region's population growth rate (pop_g) positively affects the average choice probability of that sub-region relative to others in the same nest. This finding is consistent with both the expectation and the previous studies (Akın & Seyfettinoğlu, 2022; Alamá-Sabater et al., 2011; Bottazzi & Gragnolati, 2015; Brülhart et al., 2007; Karahasan, 2010, 2015; Yavan, 2006). Market demand conditions influence the location choices of R&D firms in Türkiye in the region. The greater the potential for goods or services in a region, the greater the tendency for R&D firms to locate there.

"Upper Nest" in Table 2 gives the findings about the impact of firm- and industry-specific factors on the choice of a nest. Two issues need to be addressed regarding the upper nest results. Firstly, as a requirement of the estimation method, Marmara, which has the highest frequency of choice, is determined as the base group. Therefore, the results for the upper nest are interpreted in comparison to the Marmara. Secondly, the dissimilarity parameters (λ) for each nest measure the degree of correlation of random shocks and consistency with utility maximisation. As can be seen from Table 2, except for $\lambda_{Aegean-Mediterranean}$, all other λ's are in the range of (0,1). This indicates that the Marmara, Anatolia, Eastern Anatolia, and Black Sea regional groups are consistent with utility maximisation for all model explanatory variables' values. However, there is consistency with utility maximisation for some values of the explanatory variables in the Aegean-Mediterranean region (Train, 2003).

According to the upper nest estimation results, the relative firm size increases the probability of a region being chosen compared to Marmara at a significance level of 1%. The parameter estimates indicate that the relative size of a firm provides more advantages to the Black Sea and Eastern Anatolia in particular. This finding is consistent with previous studies (Kohlhase & Ju, 2007; Sanchez-Reaza, 2018; Sridhar & Wan, 2010), which suggest that the effect of firm size can differ across decision-makers, regions/countries, or sectors. More precisely, firm size can be related to the entrepreneur's characteristics, such as geographical or ethnic origin, motivation, and experience, or sectoral characteristics. Additionally, based on our study, it can be concluded that relatively large R&D firms tend to be located near other R&D firms of similar size. This implies that R&D firms' strategies of utilising network relationships that facilitate the flow of knowledge and communication are important in their location choice.

Sectoral knowledge intensity (kia) positively affects the average probability of choosing a regional group compared to Marmara at a 1% significance level. Sectoral knowledge intensity enables a region to be selected by R&D firms. This result supports the previous findings (Campi et al., 2004; Demirbag et al., 2010; Ferreira et al., 2016; Maggioni, 1999; Malecki, 1984, 1985; Hart et al., 1989; Weterings & Knoben, 2013). Notably, the importance of sectoral knowledge intensity is inversely proportional to the number of knowledge-intensive R&D firm headquarters located in the region. For example, the Aegean-Mediterranean region, including Anatolia and Eastern Anatolia, has a higher concentration of knowledge-intensive firms than the Black Sea region. However, these regions are less likely to be chosen than the Black Sea region. Similarly, the Aegean-Mediterranean is more likely to be selected than Anatolia, which has more knowledge-intensive firms, but less likely than Eastern Anatolia, which has fewer knowledge-intensive firms. This suggests that the location choice of firms in knowledge-intensive sectors may be influenced by both objective factors, such as sectoral competition, regional advantages, and incentive opportunities, as well as subjective (personal) factors specific to the firm and its entrepreneur.

Sectoral specialisation ($spec$) has a negative effect on the probability of a region being chosen compared to the Marmara at a significance level of 1%. Increasing specialisation in the sector where an R&D firm operates is advantageous for Marmara (and Istanbul in the case of Marmara) and disadvantageous for other regions. Furthermore, sectoral specialisation has a greater adverse effect on Eastern Anatolia and the Black Sea than on Anatolia and the Aegean-Mediterranean. It is believed that the industrial and demographic diversity in Anatolia and the Aegean-Mediterranean region is more notable compared to Eastern Anatolia and the Black Sea. These two western regions appeal to R&D firms due to the large number of production- and sales-oriented firms, as well as the highly educated and skilled workers they employ. The finding on the effect of sectoral specialisation justifies the previous findings (Alcacer & Delgado, 2012; Artz et al., 2016; Deichmann et al., 2005; Henderson, 1991; Jo & Lee, 2014; Jofre-Monseny et al., 2011; Kohlhase & Ju, 2007; Lall & Chakravorty, 2004; Li & Zhu, 2017).

The budget share that an R&D firm allocates to basic research ($basic\_res$), applied research (app_res), experimental new product development (exp_nprod) and experimental new process development (exp_npros) is inversely related to the probability of location choice. $basic\_res$, exp_nprod and exp_npros are statistically significant for the Aegean-Mediterranean and Eastern Anatolia, while app_res is statistically significant only for the Aegean-Mediterranean. Accordingly, the choice probability of the Aegean-Mediterranean and Eastern Anatolia by R&D firms decreases compared to Marmara as the budget share allocated to basic research ($basic\_res$) increases. As the budget share of firms' R&D expenditures for experimental new product development (exp_nprod) and new process development (exp_npros) activities increases, the probability of choice for Aegean-Mediterranean and Eastern Anatolia decreases in favour of Marmara. On the other hand, an increase in the share of applied research activity expenditures in total intramural R&D expenditures (app_res) decreases the probability of R&D firms located in the Aegean-Mediterranean region compared to Marmara. This suggests that R&D firms in Türkiye tend to locate in regions where they can improve the dynamic aspect of their absorptive capacity. This tendency of firms gives Marmara an advantage over other regions.

The indicators reflecting the potential aspect of firm absorptive capacity and individual absorptive capacities within the firm, the share of employed researcher personnel (res_rate) and the share of expenditures on researcher R&D personnel in intramural R&D expenditures (exp_rate), affect the probability of location choice in different directions. res_rate is statistically significant only for Anatolia. Accordingly, an increase in the number of researcher personnel among total personnel in an R&D firm increases the probability of choosing Anatolia over Marmara. In contrast, the share of expenditures on employed researcher personnel in intramural R&D expenditures (exp_rate) has a negative effect on the choice probability of regions. As spending on research and development personnel increases, R&D firms find the Marmara region more attractive for their headquarters. It can be concluded that R&D firms attach importance to the richness of a location in terms of researchers but also consider the level of compensation paid to

researchers in that location. They are more likely to gravitate toward the Marmara rather than allocating a larger budget for researchers in the alternative locations of Anatolia, the Aegean-Mediterranean, Eastern Anatolia, and the Black Sea. In particular, when the share of researcher personnel expenditures is in question, it is noteworthy that the researcher resources in Marmara are preferred over those in Anatolia. Personnel costs can turn a location's advantageous outlook into a disadvantage for R&D firms.

Table 3 presents pre-estimation information and post-estimation probabilities about the R&D firms' location choice. The pre-estimation information includes the frequency and percentage of selection data for each alternative (sub-region) and nest. It provides information on the regional distribution (in number and percentage, respectively) of firms in the estimation sample. The post-estimation probabilities, on the other hand, cover the average choice and transition (marginal and conditional) probabilities. They reflect the unobserved component of the expected utility of a location choice. Moreover, the last column provides information on the consistency between the actual observed and predicted location choices.

Table: 3
Information on R&D Firms' Location Choice

Region (Nest)	Sub-region (Alternative)	Preliminary Information		Post-estimation Probabilities			Consistency
		Frequency selected	Per cent selected	Marginal probability	Conditional probability	Choice probability	
	Eastern Marmara	717	12.213		0.191	0.093	0.029
	Istanbul	2119	36.093		0.764	0.371	-0.010
	Western Marmara	45	0.766		0.045	0.022	-0.014
Marmara		2881	49.072	0.486			
	Izmir	544	9.266		0.319	0.056	0.037
	Aegean	228	3.883		0.302	0.053	-0.014
	Mediterranean	235	4.003		0.378	0.066	-0.026
Aegean-Mediterranean		1007	17.152	0.174			
	Eastern Anatolia	1512	25.754		0.896	0.258	0.000
	Central Anatolia	175	2.981		0.104	0.030	0.000
Anatolia		1687	28.734	0.288			
	Southeast Anatolia	94	1.601		0.565	0.019	-0.003
	Central Eastern Anatolia	67	1.141		0.25	0.008	0.003
	Northeast Anatolia	28	0.477		0.185	0.006	-0.001
Eastern Anatolia		189	3.219	0.034			
	Western Black Sea	33	1.261		0.696	0.013	0.000
	Eastern Black Sea	74	0.562		0.304	0.006	0.000
Black Sea		107	1.823	0.019			

Note: The estimated and conditional probabilities are average.

According to the pre-estimation information in Table 3, the majority (36.09%) of R&D firms chose Istanbul in 2019. It is followed by Western Anatolia (25.75%), Eastern Marmara (12.21%) and Izmir (9.27%). According to the distribution of R&D firms across Marmara, Anatolia, the Aegean-Mediterranean region, Eastern Anatolia, and the Black Sea region, approximately half (49.1%) of the R&D firms are located in Marmara. Anatolia (28.7%) and Aegean-Mediterranean (17.2%) followed it. The least chosen sub-regions were Eastern Black Sea (0.56%) and Northeastern Anatolia (0.48%).

The marginal probabilities (P_{iB_k}) in the post-estimation probabilities column group reflect the situation where R&D firms choose a location by considering the characteristics

specific to them and the sector in which they operate. P_{iB_k} are the same for all choice alternatives in a nest. The estimated P_{iB_k} values illustrate that when R&D firms take into account attributes specific to themselves and the sector in which they operate, they are more likely to choose Marmara rather than other regions. In contrast, the Black Sea is the least attractive alternative for R&D firms.

The conditional probabilities $(P_{ij|B_k})$ give the information on the probability of choosing a particular alternative within a nest given that this nest is chosen. It reflects the situation in which R&D firms consider the specific characteristics of the sub-regions in the choice set when choosing a location. According to the $P_{ij|B_k}$ values, while it is known that a firm chooses Marmara, this firm is probably (with probability 0.76) to choose Istanbul among the sub-regions in Marmara. When a firm is known to choose the Aegean-Mediterranean region, the sub-region most likely chosen is Izmir. For an R&D firm that chooses to locate in Anatolia, the conditional probability of selecting Western Anatolia is higher than that of Central Anatolia. On the other hand, among Eastern Anatolia sub-regions, Southeastern Anatolia is the most chosen by R&D firms. Lastly, the Western Black Sea appears more attractive to R&D firms that choose the Black Sea region as their location.

In Table 3, the total choice probability relates to the choice among the 13 sub-regions in the choice set, considering firm-, industry-, and region-specific characteristics jointly. The total choice probability for any choice alternative is equal to the product of the transition probabilities $(P_{ij} = P_{ij|B_k}P_{iB_k})$. Overall, Istanbul and Western Anatolia are more likely to be chosen by R&D firms. Compared to others, Eastern Anatolia and the Black Sea subregions are less likely to be selected.

Finally, the "Consistency" column shows the consistency between the observed and estimated location choices of R&D firms. The consistency values differ between each sub-region's pre-estimation choice percentage and the post-estimation choice probability. According to these values, particularly for Western Anatolia, Central Anatolia, Southeastern Anatolia, Central Eastern Anatolia, Middle Eastern Anatolia, Northeastern Anatolia, Western Black Sea and Eastern Black Sea, the estimated location behaviour is in close consistency with the observed one. The consistency of the estimated model with the actual location behaviour is relatively lower for the other sub-regions (Eastern Marmara, Istanbul, Western Marmara, İzmir, Aegean and Mediterranean).

5. Discussion

This study examines the location choice of firms engaged in R&D activities in Türkiye. Considering location as a source of knowledge-based competitive advantage, we estimate a location choice model focusing on the effect of firm absorptive capacity. The cross-sectional data set for 2019 covers firms in the TurkStat Financial and Non-Financial Corporations Research and Development Activities Survey (2019) Microdata Set. The estimation method is the Nested Logit model. This methodology enables us to assess the

impact of the potential and dynamic aspects of firms' absorptive capacity, as well as other internal and external location factors, on location choice. Therefore, we anticipate that this study will fill an important gap in the literature and be beneficial for researchers and policymakers.

Our results clearly show that R&D firms in Türkiye tend to be located in regions with intense knowledge spillovers, individual absorptive capacity, and favourable demand conditions, which align with their capacity to develop and renew their knowledge base. These regions (Marmara, Central Anatolia, Aegean and Mediterranean) are mostly in western Türkiye. In particular, the three major metropolises, Istanbul, Ankara, and Izmir, attract R&D firms through their research, knowledge, and network infrastructure. This aligns with the conventional view that R&D firms are sensitive to local agglomeration factors such as educated and qualified human capital and sectoral and individual knowledge flows. Results also reveal that knowledge is localised and sticky in particular regions of Türkiye. Both dynamic and potential aspects of firm absorptive capacity make Marmara, especially Istanbul, more attractive than Aegean-Mediterranean, Central Anatolia, Eastern Anatolia and Black Sea. Marmara provides firms with plenty of opportunities to develop the components of their absorptive capacities (recognising, assimilating, and applying the information) and access knowledge sources.

The tendency of R&D firms towards particular western regions of Türkiye, which are already developed and industrial centres, indicates that a more balanced distribution of R&D firms and activities is crucial. This is because the uneven distribution of R&D firms creates disadvantages for the growth and competitiveness of other regions, particularly those heavily dependent on sectors where local knowledge and specialisation are crucial. This poses some potential risks for these regions regarding their competitiveness, absorptive capacity, and level of development and growth. Hence, it is crucial to design regional, industrial, and technological policies that align with the region's growth potential, unique competencies, attributes, and objectives. Furthermore, the differences between regions that prioritise increasing regional competitiveness and developing local knowledge and those that prioritise improving global competitiveness through industrial and technological policies, as well as other horizontal policies, should not be neglected. Implementing such policies will help regions increase their competitiveness, capacity, and level of development in the long run.

The importance of proximity to knowledge for R&D firms is a factor that increases the stickiness of knowledge in certain regions of Türkiye. To constrain this, regions need to overcome their deficiencies in physical accessibility, institutional capacity, absorptive capacity, intra- and extra-regional knowledge spillovers and networking opportunities. Taking steps to this end, considering the interactions between regions and sectors, global sectoral trends, and the type of knowledge and human capital required by firms will also help develop R&D, innovation, and entrepreneurship ecosystems.

Another downside of the strong tendency of R&D firms to locate in Istanbul and the Marmara region is that the area is a high-risk earthquake zone. On February 6, 2023, an earthquake struck southeastern Türkiye, killing many people and causing irreparable material and moral damage to the public, region and Türkiye. Regarding economic concerns, the negative impact of earthquakes on the accumulation of social and human capital, including implicit knowledge and local knowledge, capabilities, and competencies, is quite significant. Based on this experience, predicting the adverse effects of a possible future Marmara earthquake on the Turkish economy is not difficult. Although the region affected by the February 6 earthquakes and the Marmara differ in production structure and diversity of factors, the potential threat to industrial production and knowledge resources should not be underestimated. Accordingly, knowledge resources and industry in Marmara should be shifted to other suitable regions.

Future studies must elucidate the impact of different firm-specific and particularly entrepreneur-specific location factors. Moreover, a sub-national scale analysis would effectively highlight the critical role of local knowledge and specialisation. The relocation strategies of R&D firms and the multi-location strategies of firms that may conduct R&D activities outside their headquarters or in multiple locations are also worth investigating. Through this, it will be possible and interesting to examine the impact of localised knowledge from different regions on a firm's location choice.

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Appendix Table: A
NUTS Definitions of Statistical Regions of Türkiye

Level 1		Level 2	
Code	Name	Code	Name
TR1	Istanbul	TR10	Istanbul
TR2	Western Marmara	TR21	Tekirdağ, Edirne, Kırklareli
		TR22	Balıkesir, Çanakkale
TR3	Aegean	TR31	Izmir
		TR32	Aydın, Denizli, Muğla
		TR33	Manisa, Afyon, Kütahya, Uşak
TR4	Eastern Marmara	TR41	Bursa, Eskişehir, Bilecik
		TR42	Kocaeli, Sakarya, Düzce, Bolu, Yalova
TR5	Western Anatolia	TR51	Ankara
		TR52	Konya, Karaman
TR6	Mediterranean	TR61	Antalya, Isparta, Burdur
		TR62	Adana, Mersin
		TR63	Hatay, Kahramanmaraş, Osmaniye
TR7	Central Anatolia	TR71	Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir
		TR72	Kayseri, Sivas, Yozgat
TR8	Western Black Sea	TR81	Zonguldak, Karabük, Bartın
		TR82	Kastamonu, Çankırı, Sinop
		TR83	Samsun, Tokat, Çorum, Amasya
TR9	Eastern Black Sea	TR90	Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane
TRA	Northeastern Anatolia	TRA1	Erzurum, Erzincan, Bayburt
		TRA2	Ağrı, Kars, Iğdır, Ardahan
TRB	Middle Eastern Anatolia	TRB1	Malatya, Elazığ, Bingöl, Tunceli
		TRB2	Van, Muş, Bitlis, Hakkari
TRC	Southeastern Anatolia	TRC1	Gaziantep, Adıyaman, Kilis
		TRC2	Şanlıurfa, Diyarbakır
		TRC3	Mardin, Batman, Şırnak, Siirt

Analysis of Financial Performance of Companies in the BIST Transportation and Storage Sector with Multi-Criteria Decision-Making Techniques[1]

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BIST Ulaştırma ve Depolama Sektöründeki Şirketlerin Finansal Performanslarının Çok Kriterli Karar Verme Teknikleri ile Analizi[2]

Abstract

This study calculates the profitability, growth rates, and financial performance of BIST Transport and Storage Sector enterprises between 2013 and 2022, using financial statement values obtained from the Public Disclosure Platform (KAP). In this context, the importance of the criteria was determined by the Entropy method, using eight evaluation criteria, and then both individual and sectoral financial performance scores of the companies were determined using MAIRCA (Multi Attributive Ideal-Real Comparative Analysis) and MABAC (Multi-Attributive Border Approximation Area Comparison) methods. The findings showed that the companies' profit-loss status was affected by the increase or decrease in their assets, equity, sales and other items in both individual and sectoral financial success rankings, and the particular situation notifications of the companies were also effective.

Keywords : Financial Performance, Profitability and Growth Rates, Entropy, MAIRCA, MABAC, Transport and Storage Sector.

JEL Classification Codes : L25, L91.

Öz

Bu çalışmada, 2013-2022 yılları arasında BIST Ulaştırma ve Depolama Sektöründe faaliyet gösteren işletmelerin kârlılık ve büyüme oranları ile finansal performanslarının Kamuyu Aydınlatma Platformu'ndan (KAP) elde edilen finansal tablolardaki değerler kullanılarak hesaplanması amaçlanmıştır. Bu kapsamda, 8 değerlendirme kriteri kullanılarak Entropi yöntemi ile kriterlerin önem derecesi belirlenmiş, ardından şirketlerin hem bireysel hem de sektörel finansal performans puanları MAIRCA (Multi Attributive Ideal-Real Comparative Analysis) ve MABAC (Multi-Attributive Border Approximation Area Comparison) yöntemleri kullanılarak belirlenmiştir. Elde edilen bulgulara göre, şirketlerin kâr-zarar durumlarının şirketlerin hem bireysel hem de sektörel finansal başarı

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sıralamalarında aktiflerinde, öz kaynaklarında, satışlarında ve diğer kalemlerinde meydana gelen artış veya azalışlardan etkilendiği, şirketlerin özel durum bildirimlerinin de etkili olduğu görülmüştür.

Anahtar Sözcükler : Finansal Performans, Kârlılık ve Büyüme Oranları, Entropi, MAIRCA, MABAC, Ulaştırma ve Depolama Sektörü.

1. Introduction

Along with globalisation, changing and developing technology has eliminated the notion that countries' trade is limited to local markets, allowing countries to open up to international markets. Logistics activities are the backbone of countries' opening up to international markets and competing. The level of development and logistics performance in a country's logistics activities has a significant impact on the country's position in the global market.

Economic indicators are one of the key components of a country's development and economic growth. Another factor that enables these economic indicators to develop and change is logistics. (Türkoğlu & Duran, 2019: 89). The effective and efficient continuation of logistics activities, representing a significant part of the global economy, significantly contributes to national economies and businesses. With logistics activities, the goods and services produced by the enterprises can be offered to the international market without time and space restrictions. The country's crucial geopolitical position makes significant contributions to Türkiye's economy through global trade, positively impacting the development of the logistics sector. Logistic activities are involved in producing the product from its raw state until it reaches the final consumer and in the reverse process of this progression. A healthy supply chain process is essential for delivering goods and services of the highest quality to customers at the desired location and time, at the lowest cost, both in local and international markets, effectively and efficiently.

Due to the uncertainty problems arising from changes in global markets and financial crises, the importance of efficiency in complex financial decision-making is gradually increasing (Tunahan & Çınaroğlu, 2018: 317). These situations have led to the need to calculate financial results for businesses. The evaluation of financial results reveals the continuity of companies, their current success, investment levels, what they do and do not do correctly in terms of their activities, their risks, and how effectively and efficiently they use their resources. Additionally, financial results enable businesses to identify their strengths and weaknesses both individually and sectorally. In this direction, it can produce solutions to eliminate its weaknesses and develop strategies to protect its strengths. In addition, financial success is crucial for businesses to gain a competitive advantage through effective cost management in their sector and international markets, ensuring continuous growth. Companies can determine their financial results status and make predictions about their future goals to create accurate plans and take necessary measures in advance to mitigate any potential negativity.

It is a well-established fact that the primary objectives of businesses are to achieve sustainable long-term growth while also minimising costs and maximising profits. To achieve all these goals, the financial success of the enterprises must be high. It is known that many factors play an essential role in determining their economic success. It is generally considered that the most critical measure of financial success among these factors is making a profit. Said and Ali (2016) *defined profitability as the ability of a company to generate a profit from its sales, total assets, and capital*. Therefore, they emphasised that profitability analysis is crucial for long-term investors. Additionally, countries must have a sustainable and profitable economy to compete in global markets and provide sufficient financial resources. Accordingly (Nguyen & Nguyen, 2020: 47), identifying the different factors that directly or indirectly affect profitability has been an important research topic in economics, strategic management, accounting, and finance. In addition, growth rates indicate the company's position in the sector (Farrokh et al., 2016: 365; Rezaie et al., 2014: 5035). Growth rates show the increase or decrease of an amount compared to the previous year (Rezaie et al., 2014: 5035). Businesses need an analysis of their growth rates to determine their position in the sector and to take measures against the contractions they experience.

In this study, the financial results of 7 companies operating in the Transportation and Storage sector on the BIST were analysed using Entropy, MAIRCA, and MABAC methods, which examined profitability and growth rates based on financial statements obtained from KAP between 2013 and 2022. A total of eight evaluation criteria were used: asset profitability, main operating profit, net profit, and equity profitability ratio, as well as four profitability measures and four growth rates: asset growth, primary operating profit growth, net profit growth, and equity growth. First, the individual financial results of the companies for the specified years were calculated, and then their financial results within the sector were analysed. Thus, it aims to provide the necessary information to the company managers, investors, lenders, company stakeholders, and the government about the financial results of 7 companies operating in the Transportation and Storage sector. When an investor is considering investing in a company, they often struggle to make a decision solely based on the company's financial results. Therefore, the investor chooses which company to invest in by examining the company's financial results individually as well as within the broader sector. In this respect, this article's study provides information to the reader in various aspects, including the investor's investment decision, the lending institution's decision on whether to grant a loan and the state's opinion about the company.

2. Literature Review

More than one financial ratio is used to calculate a business's financial results, which are analysed and examined through various econometric models and methods. This study encompasses literature reviews on calculating the financial results of logistics sectors, regardless of the ratio discussed and the multi-criteria decision-making techniques employed.

In the article studies of Feng and Wang (2000), it was aimed to calculate the financial results of five airlines operating in Taiwan using a total of 22 variables and the TOPSIS method. The findings have shown that financial ratios can be more effective when used in conjunction with other factors to evaluate airline performance.

In the study conducted by Wang and Lee (2009), the financial results of three large container shipping companies operating in Taiwan were evaluated using the GIA method. The strength and weakness indices of these enterprises were determined by assessing their financial results, and the performance ranking was established based on total values.

In their study, Korkmaz and Uygurtürk (2010) evaluated the financial results of 20 enterprises operating in the maritime transportation sector, which were registered on US stock exchanges, using their financial statements from 2008 to 2010. "Ratio analysis" and "TOPSIS method" were used. In general, it has been determined that the 'C' values of the enterprises have been close to each other over the years. In addition, according to the performance values listed based on 'C' values, it was determined that there was an increase for some enterprises (CKH, EGLE, and SFL-coded enterprises) and a decrease for others (SSW and DAC-coded enterprises).

In their study, Başdeğirmen and Tunca (2017) examined the financial success of nine companies in the logistics sector, which were among the "Top 500 Big Businesses" published by Capital magazine in 2016, using the GIA method. The study used the following evaluation criteria: export, number of employees, turnover, total assets, profit before tax, and equity. The results revealed that the equity and total active evaluation criteria were the most critical factors affecting financial results for the logistics sector, with the criterion of lower importance being the pre-tax profit criterion.

In Özbek's (2018) article, a model was developed to evaluate the performance of 8 companies in the logistics sector, as listed in the 2017 Fortune 500, which incorporates national and international activities using SWARA, COPRAS, GIA, and TOPSIS methods.

In their study, Perçin and Aldalou (2018) aimed to develop a financial analysis model using an integrated "Fuzzy AHP" and "Fuzzy TOPSIS" method. With this model, the financial results of Pegasus and Turkish Airlines Inc., which were registered on the BIST in 2015 and 2016, were calculated. The results showed that Pegasus had better financial success.

Tunahan and Çınaroğlu (2018) aimed to evaluate and rank the financial success of the top 5 airlines in Europe between 2012 and 2016 using AHP and TOPSIS methods. Eight financial evaluation criteria were used for the analysis. As of the years mentioned above, Ryanair and EasyJet have achieved the best financial success, while Lufthansa has experienced the lowest financial success.

Meydan et al. (2018) examined the relationship between financial openness and the financial results of the Transportation and Storage sector between 1996 and 2016. Financial

results were evaluated using the ratio analysis method, and financial transparency was assessed through the VAR Model. The results showed that while the financial openness rate initially reacted negatively to changes in the borrowing and current ratio, this reaction became positive in subsequent periods.

In the study by Oral and Kipkip (2019), the financial successes of eight transportation sector enterprises listed on BIST between 2014 and 2018 were examined using the "TOPSIS" and "PROMETHEE" methods. According to the TOPSIS method, the results showed that the TLMAN transportation enterprise ranked first in terms of performance in 2014, 2016, 2017, and 2018. According to the "PROMETHEE" method, TLMAN transportation enterprise ranked first in 2014, fifth in 2015, fourth in 2016, third in 2017 and second in 2018.

In their study, Tufan and Kılıç (2019) evaluated the financial results of six logistics sector enterprises registered on the BIST for the period 2014-2018, using data from their financial statements through the "TOPSIS" and "VIKOR" methods. According to the analysis methods, companies with high financial results exhibit distinct differences, while those with low financial results display similar characteristics.

In the article by Macit and Göçer (2020), the financial results of Pegasus Air Transportation Inc. and Turkish Airlines Inc. registered in the BIST transportation and storage sector in 2008, were analysed using the GIA method. The results showed that Pegasus Air Transportation Inc. had higher financial results. On the other hand, Turkish Airlines Inc. had better profitability rates.

In the article by Sakarya and Aksu (2020), the financial results of enterprises operating in the transportation sector, as recorded in the BIST between 2013 and 2017, were evaluated using the TOPSIS method. As a result of the findings, they were listed as the enterprises with the most successful financial results in the form of RYSAS, CLEBI, CLEBI, BEYAZ and CLEBI in 2013-2017. On the other hand, THYAO, BEYAZ, RYSAS, PGSUS and THYAO have been ranked as the enterprises with the most unsuccessful financial results over the years.

In a study by Özbek and Ghouchi (2021), the financial results of the five most successful airlines in Europe between 2009 and 2018 were analysed using the WASPAS and EDAS methods. Twelve evaluation criteria were used in the study. The findings showed that Ryanair's business had the highest financial results in these years, while Lufthansa's company had the lowest.

In the article by Elmas and Özkan (2021), the financial results of companies registered in the "BIST Transportation and Storage Sector" between 2015 and 2019 were calculated using integrated SWARA-OCRA methods. The results showed that BEYAZ was the company with the best financial results over these years. Although the ranking changed over five periods, it was determined that Doco was among the top three companies.

Additionally, it was noted that RYSAS and THYAO were among the companies with the lowest financial results, although their rankings fluctuated over the five periods.

Huang et al. (2021) aimed to investigate the financial results of nine US-based airlines between 2015 and 2019 using data envelopment analysis and truncated regression. The research results revealed that the operating efficiency of the airlines increased continuously; however, the efficiency at the profitability stage remained stationary, indicating that resource allocations were necessary for the airlines to make further progress in overall efficiency.

In their study, Sakarya and Saçkes (2022) aimed to calculate the profitability-oriented financial results ranking of businesses using the Analytical Hierarchy Process (AHS) integrated Gray Relations Analysis (GIA) methods of 8 companies registered in the "BIST Transportation and Storage Sector" between 2018-2020 and to analyse the changes experienced during the Covid-19 pandemic. Fifteen cash-based financial ratios were used as criteria for evaluating financial results. In 2018, it was determined that the TLMAN enterprise's highest performance was in the THYAO enterprise's last place. While the enterprise with the highest performance in 2020 was BEYAZ, it was determined that the THYAO enterprise was in last place, as it had been in 2018.

Upon examining the literature, it was found that most studies measured companies' financial results and success within their respective sectors. In this study, unlike in the literature, both individual and sectoral financial results and success rankings of companies were determined. In addition, the small number of studies that consider profitability and growth rates together as evaluation criteria has increased the study's originality.

3. Research Methodology

Both subjective and objective methods are used to determine criterion weights in MCDM techniques. In this study, the importance of the criteria was determined using numerical values in the decision matrix, thereby eliminating the influence of the decision maker's opinion. This was achieved by applying the Entropy method, a well-established objective method, to calculate the importance weights of the criteria. In addition, when studies conducted using MCDM techniques in the literature were examined, the TOPSIS method was most frequently preferred. In this study, financial results success score values were determined separately using both methods, selecting the most up-to-date MAIRCA (2014) and MABAC (2015) methods, which were chosen based on the years of their emergence in MCDM techniques. The necessary information about the methods is given below.

3.1. Entropy Method

Rudolph Clausius first defined entropy as a measure of disorder and uncertainty in 1865. Later, in 1948, Shannon expressed the discrete probability distribution as a measure of uncertainty (Ayçin, 2020: 132). Entropy weight is defined as a parameter that expresses

how close different alternatives with a particular attribute approach each other (Wang & Lee, 2009: 8962).

The variables in the formulas used to calculate the entropy value are defined as follows (Ayçin, 2020: 132-133);

A_i: i decision alternative (i= 1,2,···,m)

C_j: j evaluation criterion (j = 1,2,···,n)

x_{ij}: j the value received by alternative i according to the evaluation criterion

p_{ij}: j normalised value received by alternative i according to the evaluation criterion

k: Entropy coefficient

e_j: Entropy value

d_j: f degree of agglomeration

w_j: j weight of evaluation criterion (j = 1,2, ...,n)

The Entropy Method consists of five steps. These are (Lotfi & Fallahnejad, 2010: 55);

1. Step: "Creating the decision matrix"

$$D = \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} \begin{bmatrix} x_{11} & x_{12} \, ... & x_{1n} \\ x_{21} & x_{22} \, ... & x_{2n} \\ \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & x_{mn} \end{bmatrix} \tag{1}$$

2. Step: "Normalization of the decision matrix"

$$P_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}}} \; ; \; \forall_{i,j} \tag{2}$$

3. Step: Calculation of Entropy values related to the criteria:

$$e_{ij} = -k \sum_{j=1}^{n} P_{ij} \cdot \ln(P_{ij)} \; ; \; i = 1,2, ..., m \text{ ve } j = 1,2, ..., n \tag{3}$$

4. Step: Calculation of degrees of differentiation:

$$d_j = 1 - e_j \qquad (j = 1,2, ...,n) \tag{4}$$

5. Step: Calculation of entropy criteria weights;

In the fifth step, which is the last step, the degree of differentiation of each criterion is proportioned to the total degree of differentiation, and such Entropy criterion weights are calculated.

$$W_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \tag{5}$$

As shown in Formula 3, the natural logarithm function is used when calculating entropy values. Since the negative values in the decision matrix can cause problems in calculations, they should be converted into positive values using various correction methods found in the literature. These values are transformed using the Z-Score standardisation transformation developed by Zhang et al. (2014). In the entropy method, firstly, the negative values in the decision matrix are converted into positive ones using Formula 6 with the Z-score standardisation transformation (Ayçin, 2020: 134).

$$Z_{ij} = \frac{X_{ij} - \bar{X}_j}{\sigma_j} \tag{6}$$

$\bar{X}_j$ and σ_j, j in Formula 6 represents the mean and standard deviation of the criterion. After obtaining the mean and standard deviation values, the negative values in the decision matrix are converted to positive values using Formula 7.

$$z'_{ij} = z_{ij} + A \; ; A > |min z_{ij}| \tag{7}$$

In Formula 7, after determining the lowest z_{ij} value calculated for the criterion, a constant A number higher than the absolute value of this value was added to all values in the criterion and its z_{ij} values z'_{ij} were converted into positive values (Ayçin, 2020: 134).

3.2. MAIRCA Method:

The MAIRCA method, as defined by Pamucar et al. in 2014 (Ayçin, 2020: 190; Yıldızbaşı and Çalık, 2021: 443), assumes that determining the gap between ideal and empirical weights constitutes the basic assumption of the MAIRCA method. The stages of the MAIRCA method are given below (Pamucar et al., 2018: 1646; Gigovic et al., 2016: 11).

1. Step: Creating the decision matrix;

$$X = \begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{bmatrix} x_{11} & x_{12} \dots & x_{1n} \\ x_{21} & x_{22} \dots & x_{2n} \\ \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} \dots & x_{mn} \end{bmatrix} \tag{8}$$

2. Step: Identifying the priorities of alternatives;

The decision maker is neutral regarding all other options and does not have a priority among them. All alternatives are equal for the decision maker. Here, m represents the total number of other options, and i represents the alternative priority.

$$P_{Ai} = \frac{1}{m} \tag{9}$$

$$\sum_{i=1}^{m} P_{Ai} = 1 \qquad i = 1,2,\dots,m \tag{10}$$

$$P_{A1} = P_{A2} = \dots = P_{Am} \tag{11}$$

3. Step: Creating a theoretical rating matrix;

$$T_p = \begin{bmatrix} P_{A1}w_1 & P_{A1}w_2 \dots & P_{A1}w_n \\ P_{A2}w_1 & P_{A2}w_2 \dots & P_{A2}w_n \\ \vdots & \vdots & \vdots \\ P_{Am}w_1 & P_{Am}w_2 & P_{Am}w_n \end{bmatrix} \tag{12}$$

4. Step: Creation of the actual rating matrix;

- For benefit type criterion (preferred higher criterion value):

$$t_{rij} = t_{pij} \cdot \left(\frac{x_{ij} - x_{ij}^{-}}{x_{ij}^{+} - x_{ij}^{-}} \right) \tag{13}$$

- For cost type criterion (preferred sub-criterion value):

$$t_{rij} = t_{pij} \cdot \left(\frac{x_{ij} - x_{ij}^{+}}{x_{ij}^{-} - x_{ij}^{+}} \right) \tag{14}$$

$$T_r \qquad \begin{bmatrix} t_{r11} & t_{r12} \dots & t_{r1n} \\ t_{r21} & t_{r22} \dots & t_{r2n} \\ \vdots & \vdots & \vdots \\ t_{rm1} & t_{rm2} & t_{rmn} \end{bmatrix} \tag{15}$$

5. Step: Creating the total gap matrix;

$$g_{ij} = t_{pij} - t_{rij} \; g_{ij} \; \nabla \; [0, \infty) \tag{16}$$

$$G = T_p - T_r = \begin{bmatrix} g_{11} & g_{12} \dots & g_{1n} \\ g_{21} & g_{22} \dots & g_{2n} \\ \vdots & \vdots & \vdots \\ g_{m1} & g_{m2} & g_{mn} \end{bmatrix} \tag{17}$$

6. Step: Identification of the total gap with alternatives;

As a result of the calculations, if the (A_i) theoretical degree and the actual degree of (t_{pij}) an alternative (C_j) for a criterion (t_{rij}) are equal to each other and have a non-zero value, the gap will be zero$(g_{ij} = 0)$. When such a situation arises, it is emphasized $(A_i^+$ that the relevant alternative will be the (A_i)ideal alternative (C_j) for the relevant criterion. However, if the (A_i) theoretical degree (t_{pij}) and the actual degree of an alternative $(C_j)$for

a criterion are equal $\left(t_{rij}\right)$ to zero, the gap value will also be zero($t_{pij} = t_{rij} = g_{ij} = 0$). In such a case, the relevant alternative (A_i^-) will be (A_i) the worst alternative (C_j) for the relevant criterion (Ayçin, 2020: 192).

7. Step: Calculating the Value of the Final Criteria Functions of Alternatives

$$Q_i = \sum_{j=1}^{n} g_{ij} \quad , \quad i = 1,2, \dots, m \tag{18}$$

3.3. MABAC Method

Pamučar and Ćirović introduced the MABAC method in 2015. This method evaluates the distances of the criterion functions of the decision alternatives to the boundary approach area. The symbols of the variables in the application phase of the method are expressed as follows (Pamučar & Ćirović, 2015: 3019; Ayçin, 2020: 160):

A_i: i decision alternative (i = 1, 2, …., m)

C_j: j evaluation criteria (j = 1, 2, …. , n)

x_{ij}: j the value received by alternative i according to the evaluation criterion

x_i^+: maximum values in the columns

x_i^-: minimum values in the columns

v_{ij}: weighted values

m : number of decision alternatives

Number of Criteria

q_i: distance value from border proximity area

G: boundary proximity area matrix

V: weighted decision matrix elements

Q: Distance of decision alternatives to the border proximity area

G^+: upper proximity area

G^-: lower proximity area

S_i: criterion function of each decision alternative

The MABAC method consists of seven steps. The following steps are outlined below (Pamučar & Ćirović, 2015: 3019; Ayçin, 2020: 160).

Step 1: Creating the decision matrix:

$$X = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} ; i = 1, \dots \dots m \text{ and } j = 1, \dots n \tag{19}$$

Step 2: Normalization of the decision matrix

- For benefit type criterion (preferred higher criterion value):

$$r_{ij} = \frac{x_{ij} - x_j^{min}}{max_j^{min} x_j} \tag{20}$$

- For cost type criterion (preferred sub-criterion value):

$$r_{ij} = \frac{x_{ij} - x_j^{max}}{min_j^{max} x_j} \tag{21}$$

Step 3: Weighting the decision matrix

$$v_{ij} = w_j * (1 + r_{ij}) \tag{22}$$

Step 4: Determine the boundary proximity field matrix

$$g_i = \left(\prod_{i=1}^{m} v_{ij} \right)^{1/m} \tag{23}$$

After calculating the g_i values for each criterion, a boundary proximity area matrix (G) in n*1 format is created.

$$G = [g_i]_{1*n} 0 \tag{24}$$

Step 5: Determine the distances (Q) of each decision alternative to the boundary proximity area

The Q matrix is calculated for all criteria by determining the distances from the boundary proximity area using the following equation.

$$Q = (v_i - G) = \begin{bmatrix} v_{11} - g_1 & v_{12} - g_2 & \dots & v_{1n} - g_n \\ v_{21} - g_1 & v_{22} - g_2 & \dots & v_{2n} - g_n \\ \dots & \dots & \dots & \dots \\ v_{m1} - g_1 & v_{m2} - g_2 & \dots & v_{mn} - g_n \end{bmatrix} = \begin{bmatrix} q_{11} & q_{12} & \dots & q_{1m} \\ q_{21} & q_{22} & \dots & q_{2m} \\ \dots & \dots & \dots & \dots \\ q_{n1} & q_{n2} & \dots & q_{nm} \end{bmatrix} \tag{25}$$

Step 6: Creating the locations of decision alternatives according to the border proximity area

$$A_i \in \begin{cases} G^+ & if \ q_{ij} > 0 \\ G & if \ q_{ij} = 0 \\ G^- & if \ q_{ij} < 0 \end{cases} \tag{26}$$

Step 7: Sequence of decision alternatives

$$S_i = \sum_{j=1}^{n} q_{ij} \tag{27}$$

Sample of the Research and Data Collection Process:

The main population of the research was determined to be 10 enterprises operating in the Transportation and Storage Sector registered with BIST. The study covers 2013-2022, and the sample was formed by considering the quoted years of the enterprises operating in the Transportation and Storage Sector. Since GRSEL 2022, TLMAN 2018 and TUREX were listed on the stock exchange in 2021, they were excluded from the analysis. Research data was obtained from KAP. The names and stock exchange codes of the enterprises used within the scope of the analysis operating in the Transportation and Storage Sector traded in BIST are obtained from KAP and shown in Table 1.

Table: 1
Enterprises Analyzed in the Transportation and Warehousing Sector and Their Codes

Item	Code	Company Name
1	BEYAZ	Beyaz Filo Oto Kiralama A.Ş.
2	CLEBI	Çelebi Hava Servisi A.Ş.
3	DOCO	Do & Co Aktiengesellschaft
4	GSDDE	Gsd Denizcilik Gayrimenkul İnşaat Sanayi veTicaret A.Ş.
5	PGSUS	Pegasus Hava Taşımacılık A.Ş.
6	RYSAS	Reysaş Taşımacılık ve Lojistik Ticaret A.Ş.
7	THYAO	Türk Hava Yolları A.O.

The financial ratio data of the Transport and Storage enterprises in the study were calculated using formulas based on information obtained from their financial statements. The evaluation criteria and codes used in the research are given in Table 2.

Table: 2
Evaluation Criteria and Codes

Item	Code	Evaluation Criteria	Purpose
1	AK	Active Profitability	Maximum
2	EFK	Operating profit	Maximum
4	NK	Net profit	Maximum
5	ÖK	Return on Equity	Maximum
6	AB	Active Growth	Maximum
7	EFKB	Main Operating Profit Growth	Maximum
8	NKB	Net Profit Growth	Maximum
10	ÖB	Equity Growth	Maximum

4. Analysis and Findings of the Research

The research accessed data from KAP surveys conducted with seven companies operating in the BIST Transport and Storage Sector between 2013 and 2022. The values obtained from the financial statements, including four profitability and four growth rates used in the research, were examined for each company and each year. Then, the annual financial ratios of each company were arranged in the Excel program, and the importance of

the evaluation criteria was determined using the Entropy method. This method was used because it is objective and the decision maker's subjective intervention in the analysis results. Then, the businesses' individual and sectoral financial results rankings were calculated using MAIRCA and MABAC methods.

4.1. Analysis of Criteria Weights of Companies by Entropy Method

The entropy method is an objective method used to determine the severity () w_j of the criteria consisting of 5 steps. In addition, since including negative values in the research data can cause problems in calculating the method, it consists of 6 steps, which involve converting negative values into positive values using the Z-Score conversion process developed by Zhang (2014) (Ayçin, 2020: 132). These steps were calculated separately for each company and year using the Excel program, and a decision matrix was generated. Then, the importance weight ratings (w_j) of the criteria were determined. Because each step is excessive, the w_j values obtained by calculating only with formula 5 in the study are given in Table 3 and Table 5. Table 3 presents horizontal evaluation criteria and vertical w alt j values of companies.

Table: 3
My Criteria Determined by Entropy Method Importance Weight Ratings

Companies/Criterias	AK	EFK	NK	ÖK	AB	EFKB	NKB	ÖB
BEYAZ	0,1045	0,1184	0,0867	**0,0609**	0,1702	0,1618	**0,2083**	0,0892
CLEBI	0,0945	**0,0240**	0,0942	0,0832	0,2198	0,1653	0,0634	**0,2557**
DOCO	0,0847	0,0569	**0,0550**	0,0648	**0,2467**	0,2131	0,1433	0,1356
GSDDE	0,1630	0,1137	0,1049	0,0869	0,1320	0,0677	**0,0489**	0,2828
PGSUS	0,0990	0,0710	0,0698	0,1099	0,1001	**0,0601**	0,1411	0,3491
RYSAS	0,1130	**0,0231**	0,1262	0,0517	0,1329	0,1205	0,0669	**0,3658**
THYAO	0,1255	0,1796	0,0947	0,1071	0,1049	0,0894	**0,0852**	**0,2136**

When Table 3 is examined, for BEYAZ, the most crucial criterion for the company is Net Profit Growth, while the least important criterion is Return on Equity. For CLEBI, GSDDE, PGSUS, RYSAS, and THYAO companies, the most crucial criterion is Equity Growth. For CLEBI and RYSAS, the least important criterion is Operating Profit; for GSDDE and THYAO, it is Net Profit Growth; and for PGSUS, it is Operating Profit Growth. The most crucial criterion for DOCO is Asset Growth, while the least important criterion is Net Profit. Table 3 shows that the Equity Growth criterion is generally the most important, followed by Net Profit Growth.

4.2. Analysis of Annual Financial Performance of Companies by MAIRCA and MABAC Methods

The MAIRCA method is a 7-step method used to determine the gap between ideal and empirical weights (Ayçin, 2020: 190). The MABAC method, on the other hand, calculates score values by taking into account their distance to the border approach area and consists of 7 steps (Pamučar & Ćirović, 2015: 3019; Ayçin, 2020: 160). The decision matrices and w_j values determined for each company and each year through the Entropy

Method were used in MAIRCA and MABAC methods. Score values were calculated by determining the steps required for both methods separately for each year and company. As in the entropy method, the score values obtained only for each company and each year in this study are shown in Table 4 and Table 6 due to the high number of evaluation steps in both methods.

Table 4 presents the financial performance score values of the companies obtained using the MAIRCA and MABAC methods used in the research. The MAIRCA method (X) and MABAC method (Y) symbols are shown in Table 4 to facilitate the interpretation and comparison of the results by financial information users.

Table: 4
Results Obtained by MAIRCA and MABAC Methods

Companies/Years	BEYAZ		CLEBI		DOCO		GSDDE		PGSUS		RYSAS		THYAO	
	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
2013	6	6	8	8	2	2	4	4	1	1	3	3	7	7
2014	9	9	7	7	6	6	6	6	7	7	4	4	5	5
2015	1	1	6	6	4	4	8	8	6	6	8	8	3	3
2016	5	5	9	9	8	8	10	10	9	9	9	9	8	8
2017	7	7	4	4	9	9	9	9	5	5	6	6	9	9
2018	10	10	3	3	3	3	3	3	4	4	10	10	4	4
2019	2	2	5	5	7	7	5	5	3	3	7	7	6	6
2020	4	4	10	10	10	10	7	7	10	10	1	1	10	10
2021	8	8	1	1	5	5	1	1	8	8	5	5	2	2
2022	3	3	2	2	1	1	2	2	2	2	2	2	1	1

When Table 4 is examined, it is observed that according to the MAIRCA and MABAC methods, the years in which companies were successful and unsuccessful in terms of individual financial performance are equal. It is assumed that this situation demonstrates the applicability of CKKV techniques in calculating financial performance and confirms the method's superiority. For BEYAZ, the year with the most successful financial performance was 2015, while the year with the least successful performance was 2018. For CLEBI, the most successful year was 2021, while the least successful year was 2020. For DOCO, the most successful year was 2022, while the least successful year was 2020. For GSDDE, the most successful year was 2021, while the least successful year was 2016. For PGSUS, the most successful year was 2013, while the least successful year was 2020. For RYSAS, the most successful year was 2020, while the least successful year was 2018. THYAO's most successful year was 2022, while its least successful year was 2020. It is believed that both the COVID-19 pandemic in 2020 and factors such as companies' profitability, sales levels, loss conditions, and the unique situation announcements made by companies in their public disclosures support the years in which companies were successful or unsuccessful.

4.3. Analysis of Annual Criteria Weights by Entropy Method

The findings are presented in Table 5, with the evaluation criteria listed horizontally and the years listed vertically.

Table: 5
Significance Weight Ratings of the Criteria Determined by Entropy Method

Years/Criteria	AK	EFK	NK	ÖK	AB	EFKB	NKB	ÖB
2013	0,1258	**0,0583**	0,0837	0,1263	0,1935	0,0845	0,1157	**0,2122**
2014	0,1321	0,1124	0,0689	0,0932	0,1041	0,0694	**0,0683**	**0,3516**
2015	0,1208	**0,0477**	0,0493	0,1057	0,0578	**0,4367**	0,0535	0,1285
2016	0,1535	0,0822	**0,0745**	**0,1821**	0,1180	0,1635	0,0934	0,1330
2017	0,1358	0,0816	0,0811	0,1897	0,1124	0,1485	**0,0779**	**0,1728**
2018	0,1138	0,1322	0,1358	**0,0866**	0,1234	**0,1698**	0,1325	0,1058
2019	0,0985	0,0967	**0,0550**	0,0995	0,0766	0,1282	**0,3572**	0,0884
2020	0,1423	0,0602	0,0763	0,0953	0,0428	0,2309	**0,0424**	**0,3099**
2021	0,1429	0,1844	0,1573	0,0771	0,0863	0,0638	**0,0709**	**0,2174**
2022	0,1258	**0,0583**	0,0837	0,1263	0,1935	0,0845	0,1157	**0,2122**

Table 5 shows that the Equity Growth criterion is generally the most important, followed by the Main Operating Profit Growth criterion.

4.4. Analysis of Annual Financial Performance of Companies by MAIRCA and MABAC Methods

The MAIRCA and MABAC methods used in the research rank financial performance from best to worst. Table 6 presents the rankings using the MAIRCA method (X) and the MABAC method (Y) symbols.

Table: 6
Results Obtained by MAIRCA and MABAC Methods

Companies / Years	2013		2014		2015		2016		2017		2018		2019		2020		2021		2022	
	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
BEYAZ	5	5	7	7	2	2	1	1	3	3	7	7	1	1	2	2	5	5	4	4
CLEBI	7	7	1	1	3	3	4	4	1	1	1	1	3	3	5	5	2	2	2	2
DOCO	3	3	4	4	5	5	2	2	4	4	5	5	6	6	3	3	6	6	6	6
GSDDE	6	6	6	6	1	1	7	7	7	7	2	2	7	7	6	6	1	1	1	1
PGSUS	1	1	5	5	6	6	6	6	2	2	4	4	2	2	7	7	7	7	7	7
RYSAS	2	2	3	3	7	7	5	5	5	5	6	6	5	5	1	1	4	4	5	5
THYAO	4	4	2	2	4	4	3	3	6	6	3	3	4	4	4	4	3	3	3	3

When Table 6 is examined, the sectoral financial performance success rankings of companies between 2013 and 2022 can be observed. The companies' success or failure in terms of financial performance has been explained by examining both financial statement items and special circumstance disclosures.

It is assumed that PGSUS's launch of a new route in 2013 led to an expansion of flight operations and increased sales revenue, contributing to a rise in profitability and sectoral success. On the other hand, it is assumed that CLEBI's increasing financial expenses in 2013, along with a decline in profit and resulting losses, led to the company having the lowest financial performance in the sector.

In 2014, it is believed that CLEBI's significant increase in sales revenue and net profit compared to the previous year, along with the capital increase it carried out, contributed to its success in the sector. Additionally, when examining the financial figures of companies for 2014, it is observed that while other companies in the sector made a profit, BEYAZ

company incurred a loss in 2014. This is considered to have led to the company's financial underperformance within the sector.

In 2015, GSDDE acquired financial fixed assets. Additionally, the company saw an increase in its total assets, equity, and sales revenue compared to previous years. These factors are believed to have positively impacted the company's financial success. On the other hand, RYSAS experienced a decline in its total assets, equity, and sales revenue in 2015. It is assumed that these declines had a negative impact on the company's financial performance.

In 2016, it is assumed that BEYAZ's increases in equity, sales revenue, gross profit, and operating profit led to it becoming the company with the best financial performance in the sector. In 2016, GSDDE experienced a significant decline in gross and operating profit, resulting in a net loss. This decline is believed to have negatively impacted the company's financial performance, making it the least successful in the sector in terms of financial performance.

In 2017, the increase in sales revenue, along with the rise in gross profit and operating profit at CLEBI company, is assumed to have been reflected in the net profit margin, resulting in a significant increase compared to the previous year. This positive development is believed to have supported the company's financial success within the sector. In 2017, GSDDE company, like in 2016, incurred losses, which is thought to have negatively impacted its financial performance within the sector.

The increases in total assets, sales revenue, gross profit, and operating profit of CLEBI significantly boosted its net profit for the period. These increases are assumed to have supported the company's position as the most financially successful in 2018. In 2018, the downturn in the automotive sector significantly reduced BEYAZ's sales revenue. This led to a substantial decline in its net profit compared to the previous year, which is believed to have lowered its financial performance and success within the sector.

In 2019, BEYAZ company's total assets, equity, sales revenue, gross profit, and operating profit increased compared to the previous year, which significantly boosted the company's net profit for the period. It is believed that these positive developments contributed to the company's financial success, making it the most successful company in the sector in terms of financial performance in 2018. On the other hand, GSDDE experienced a decline in sales revenue, gross profit, and operating profit, which negatively impacted its net profit for the period, resulting in a loss. It is assumed that these factors negatively affected the company's sectoral performance.

In 2020, RYSAS made a significant contribution to the logistics sector and the national economy by carrying out Türkiye's first export block train operation. Additionally, the company purchased containers due to increased international railway transportation. Furthermore, RYSAS experienced increased sales revenue, gross profit, and operating profit

compared to previous years, while the growth rate of the company's assets also rose. It is believed that these positive developments led to the company becoming the most successful in its sector. The COVID-19 pandemic, a global outbreak, led to restrictions that negatively impacted many industries, including aviation. In 2020, the limits resulted in a decline in PGSUS's flight and passenger numbers, which decreased the company's sales revenue. At the same time, the company experienced significant decreases in gross and operating profit, and in 2020, it incurred its most crucial loss in recent years. This harmful situation is also assumed to have negatively impacted the company's sectoral performance.

In 2021, GSDDE's capital increase, significant growth in sales revenue, and substantial increases in gross profit and operating profit compared to the previous year are believed to have positively impacted its net profit, thereby enhancing its sectoral performance. At the same time, due to the COVID-19 pandemic, increased waiting times at ports led to higher freight rates. This situation is considered to have had a positive impact on the maritime sector. For PGSUS, the effect of the pandemic's restrictions continued into 2021, and the company's net profit declined further, resulting in losses. This situation is thought to have negatively affected the company's performance within its sector.

In 2022, the increase in sales revenue, equity, total assets, gross profit, and operating profit at GSDDE is believed to have contributed to the company's sectoral financial performance. On the other hand, the significant declines in net profit growth and core operating profit of PGSUS in 2022 are thought to have negatively impacted the company's sectoral financial performance.

5. Concluding Remarks

In an increasingly global and competitive environment, companies require financial results analysis to achieve a maximum profit and minimum cost policy, which is one of their primary objectives, and to foster sustainable growth. Additionally, financial results analysis can determine the extent to which companies utilise their resources efficiently. At the same time, it is closely related to both internal and external stakeholders. In this case, internal and external stakeholders are informed about the company's current success status, its profitability, and the extent to which it fulfils financial procedures. At the same time, an investment policy is determined, and investors are provided with direction in decision-making. The financial results of enterprises are calculated based on the values in the financial statement items.

Today, the logistics sector is the lifeblood of countries, supporting the development of international trade, providing a global competitive advantage, ensuring the continuity of production without disruption, facilitating the adequate provision of import and export activities, and facilitating the complete transmission of information flow between companies. The growth and development of the logistics sector contribute significantly to the country's economy. Logistics activities are involved in each process, from the raw state of the product to its production and delivery to the customer. Their ability to carry out

warehousing activities, one of the logistics activities, effectively and efficiently also enables the production process to be carried out entirely without errors. Additionally, businesses can gain a cost advantage by utilising transportation activities effectively, thereby increasing efficiency. Considering all these reasons, companies can gain a competitive advantage in the global market by using their procurement processes and logistics activities effectively and efficiently.

It has been determined that MCDM techniques have been frequently preferred in the literature in recent years in financial result studies. In most of the studies, the company's sectoral financial results were analysed year by year. In this study, unlike in the literature, companies' individual and sectoral financial results were calculated by analysing them year by year. Furthermore, the scarcity of studies in the literature that combine profitability and growth rates makes this research unique among other studies.

The study employed eight evaluation criteria, comprising four profitability and four growth rate metrics, considering profit maximisation and the mission of achieving sustainable growth, which are among the enterprises' primary objectives. The financial results of seven companies in the Transportation and Storage Sector traded on the BIST between 2013 and 2022 were analysed.

According to the results of the Entropy Analysis, the criterion importance weight ratings were obtained on a company basis. While net profit growth was the most crucial criterion for the BEYAZ company, equity profitability was identified as the criterion with the lowest importance. While the criterion with the highest significance level for the CLEBI company is the equity growth criterion, the criterion with the lowest significance level is determined to be the primary operating profit. While the highest criterion of importance for DOCO is active growth, the lowest criterion is net profit. It was concluded that the highest importance criterion of the GSDDE company was the equity growth criterion, and the lowest criterion was the net profit growth. It has been determined that the most crucial criterion for the PGSUS company is equity growth, and the least critical criterion is primary operating profit growth. While the criterion with the highest level of importance belonging to the RYSAS company was the equity growth criterion, the lowest criterion was the main operating profit. Finally, it has been concluded that the highest criterion of the importance level of THYAO company is the equity growth criterion, and the lowest criterion is the net profit growth criterion.

According to the MAIRCA and MABAC Analysis results, the findings were obtained based on the ranking of companies' financial results in terms of individual years, categorised as most successful and most unsuccessful. While BEYAZ's most successful year was 2015, its least successful year was 2018. While 2021 was the best year for CLEBI, 2020 was the worst. While the year in which DOCO showed the highest financial results was determined as 2022, the lowest year was defined as 2020. It was concluded that 2021 was the most successful year for the GSDDE company, while 2016 was the least successful. It has been reached that the year with the highest financial results for PGSUS company is 2013, and the

year with the lowest performance is 2020. While RYSAS had the best performance in 2020, it had the worst in 2018. Finally, THYAO company's best year was 2022, while its worst was 2020.

According to the findings of the Entropy Analysis, the yearly criterion was the most crucial criterion for 2013; the highest criterion was the equity growth criterion, while the lowest criterion was the main operating profit. In 2014, the criterion with the highest severity was the equity growth criterion, while the criterion with the lowest severity was net profit growth. In 2015, it was found that the criterion with the highest importance level was the main operating profit growth criterion, and the lowest criterion was the main operating profit criterion. While the criterion with the highest severity for 2016 was the equity profitability criterion, the lowest criterion was the net profit criterion. For 2017, it was found that the criterion with the highest degree of importance was equity growth, and the lowest criterion was net profit growth. In 2018, the criterion with the highest importance weighting was the main operating profit growth criterion, while the criterion with the lowest importance weighting was equity profit. For 2019, the highest degree of importance criterion was net profit growth, while the lowest criterion was net profit. It has been concluded that the criterion with the highest degree of importance for 2020 is equity growth, and the criterion with the lowest degree of importance is net profit growth. In 2021, the criterion of highest importance was determined as the equity growth criterion, while the criterion of lowest importance was defined as the net profit growth criterion. In 2022, the criterion of highest importance was determined as the net profit criterion, while the criterion of lowest importance was defined as the equity profitability criterion.

According to the results of MAIRCA and MABAC Analyses, the findings were obtained based on the ranking of companies with the most successful and least successful annual financial results within the sector. In 2013, the best company was PGSUS, while the worst was CLEBI. In 2014, while BEYAZ showed the worst financial results, CLEBI ranked first in financial success. While GSDDE showed the best financial success in 2015, RYSAS was determined as the company with the worst financial success. In 2016, while GSDDE ranked last, CLEBI ranked first. While CLEBI company had the best financial results in 2017 and 2018, GSDDE in 2017 and BEYAZ company in 2018 were determined to be the worst companies in terms of financial results. While the financial results of the GSDDE company fell to last place in 2019, the BEYAZ company achieved the best financial results. In 2020 and 2021, PGSUS ranked last among the most affected companies in the sector due to pandemic restrictions. RYSAS in 2020 and GSDDE in 2021 were the companies that achieved the best financial results. Finally, in 2022, GSDDE ranked first in the sector, while DOCO was the most unsuccessful company.

According to the MAIRCA method, the values in the financial results ranking were obtained by ranking from the most minor to the largest, whereas according to the MABAC method, the values in the financial results ranking were obtained by ranking from the largest to the most minor. Whether the values are ranked from small to large or from large to small, it has been observed that the individual and sectoral financial results rankings of companies

between 2013 and 2022 show similar results. This situation reveals that MCDM techniques are effective methods for calculating financial results.

When the Entropy Analysis results are evaluated, the following suggestions can be made to companies operating in the Transportation and Storage Sector registered with BIST to increase their financial results individually;

- It has been determined that the equity growth criterion is of the highest importance and weight in the CLEBI, GSDDE, PGSUS, RYSAS, and THYAO companies. These enterprises must pay attention to increases in equity growth rates to further enhance their financial results.
- It was observed that the net profit growth criterion of BEYAZ company was determined to be the criterion with the highest importance. BEYAZ can move its financial results to the top by focusing on net profit growth. BEYAZ company can increase its net profit growth rate by keeping its expenses and costs to a minimum.
- Finally, it has been determined that DOCO company's asset growth criterion is the most crucial. DOCO can enhance its financial performance by increasing its profit, liquidity, real estate holdings, stock, and other assets.

When the Entropy Analysis results are evaluated, the following suggestions can be made to companies operating in the Transport and Storage Sector registered with BIST to improve their financial results in terms of the sector;

- It was determined that equity growth was the most critical criterion in 2013, 2014, 2017, 2020 and 2021. In line with this result, it can be said that the companies analysed in the Transportation and Storage Sector should emphasise the increase in equity capital to increase their financial results in the years in question.
- In 2015, the main operating profit growth criterion was the highest degree of importance criterion. Therefore, to increase their sectoral financial results in 2015, these companies should emphasise the primary operating profit growth rate increase. Companies can increase their profitability by maintaining their core business efficiently and effectively.
- In 2016, the criterion with the highest management weight was equity profitability. For these companies to improve their sectoral financial results in 2016, they need to focus on increasing the return on equity ratio.
- In 2019, the criterion with the highest severity was the net profit growth criterion. To increase their sectoral financial results in 2019, these companies must consider increasing their net profit growth rate. Net profit is the profit of the enterprise after tax. These companies can increase their net profit growth rates by maximising their profits and reducing expenses and costs.
- Finally, it was concluded that the net profit criterion was the most critical in 2022. As in 2019, companies can enhance their financial performance by increasing their net profits while reducing costs.

The research results provide businesses within the sector with the opportunity to compare themselves to their competitors, and investors who will invest in the sector have the chance to compare firms within it. In addition, determining the companies' financial results individually and every year allows them to assess their current situation, protect their strengths, and take measures against the negative aspects they may encounter by identifying their weaknesses. Additionally, it has been demonstrated that the profitability and growth rates used as evaluation criteria can be considered financial result indicators by financial information users. Upon examining the research results, it was found that studies on Transportation and Storage companies in the literature did not yield similar findings. We can explain that the reason for this situation is that the MCDM methods used, the evaluation criteria discussed (profitability and growth rates), the periods covered by the research (2013-2022) and the economic and social factors experienced in these periods differ and the limited number of companies listed on the stock exchange affects this situation.

The findings obtained in this study are considered to be the limitations of the study, including the sample (BIST Transport and Storage Sector), the financial results evaluation criteria used (profitability and growth rates), the method chosen (MAIRCA & MABAC), the ranking of importance levels (Entropy), and the scope for the 2013-2022 period. The limitations of the research limit the research findings obtained in this context.

This study selected the BIST Transportation and Storage sector. In future studies, different sectors enrolled in BIST or other countries can be chosen as samples, and a different perspective can be revealed by expanding the study based on the methods used, different evaluation criteria and different periods. Additionally, the entropy method determined the importance of the requirements in this study. Other MCDM techniques can be used to determine the severity of the criteria for future studies. Additionally, by increasing the number of companies operating in the logistics sector that can be reached, a comparison can be made between countries in the logistics sector, and a contribution can be made to the existing literature.

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Examining the Criteria Affecting Corporate Social Responsibility in Businesses from the Consumer Perspective Using the Pythagorean Fuzzy Entropy Technique

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İşletmelerde Kurumsal Sosyal Sorumluluğu Etkileyen Kriterlerin Pisagor Bulanık Entropi Tekniğiyle Tüketici Perspektifinden İncelenmesi

Abstract

Corporate social responsibility (CSR) serves as a self-regulation mechanism for businesses and a framework for consumers to evaluate companies. Carroll's (1991) CSR pyramid categorises these responsibilities, which can differ depending on cultural and economic contexts. This study examines Corporate Social Responsibility (CSR) in the context of Carroll's pyramid from the perspective of Turkish consumers, based on expert interviews analysed using the "Pythagorean Fuzzy Entropy" method. The results reveal that Turkish consumers prioritise businesses' "economic" responsibilities the most, followed by "philanthropic" responsibilities. "Ethical" responsibilities are ranked slightly lower, with "legal" responsibilities considered the least important in this context.

Keywords : Corporate Social Responsibility, Carroll's Pyramid of Corporate Social Responsibility, Pythagorean Fuzzy Entropy, Consumer.

JEL Classification Codes : M14, B55, C44.

Öz

Kurumsal sosyal sorumluluk (KSS), işletmeler için bir özdenetim mekanizması ve tüketiciler için şirketleri değerlendirme çerçevesi işlevi görmektedir. Carroll'un (1991) KSS piramidi, bu sorumlulukları kategorize eder ve bunlar, kültürel ve ekonomik bağlamlara bağlı olarak farklılık gösterebilir. Bu çalışma, Carroll'un piramidi bağlamında Türk tüketicilerinin perspektifinden KSS'yi incelemektedir ve bu amaçla uzman görüşmeleri "Pisagor Bulanık Entropi" yöntemiyle analiz edilmiştir. Sonuçlar, Türk tüketicilerin işletmelerin "ekonomik" sorumluluklarını en fazla önceliklendirdiğini, bunu "hayırseverlik" sorumluluklarının izlediğini ortaya koymaktadır. "Etik" sorumluluklar biraz daha düşük bir sırada yer alırken, "yasal" sorumluluklar bu bağlamda en az önemli olarak değerlendirilmiştir.

Anahtar Sözcükler : Kurumsal Sosyal Sorumluluk, Carroll'un Kurumsal Sosyal Sorumluluk Piramidi, Pisagor Bulanık Entropi, Tüketici.

1. Introduction

The concept of corporate social responsibility (CSR), which initially emerged from a philanthropic perspective but has evolved into a more comprehensive framework over time, offers an opportunity to evaluate the activities of businesses through a holistic paradigm that encompasses all stakeholder interests. Corporate social responsibility, which embodies conflicting interests, assumes a decisive role in the corporate decision-making process and behaviour of businesses. The fact that the test of whether an activity is beneficial or detrimental to society is essentially a moral question adds an ethical dimension to the concept of Corporate Social Responsibility (CSR) for both businesses and stakeholders (Branco & Rodrigues, 2007). In line with the expectations of the public, employees, customers, and, in short, all stakeholders, today's businesses have become even more eager to increase their CSR activities, both because they are seen as social citizens in society and because of the assumption that social responsibility efforts will be rewarded by society. Changes such as the blurring of borders, legal and political regulations, mass media, the widespread use of social media, and increased awareness of sustainability and human rights have led consumers to better understand their responsibilities towards nature, society, and the future, and accordingly paved the way for CSR practices to become more critical.

One reason for considering nature and the environment as stakeholders is the interests of future generations (Jacobs, 1997, cited in Branco and Rodrigues, 2007). Where it is impossible to consult the natural environment or future generations, if there is a concern for the natural environment or the future among the interests of legitimate stakeholders, this must be considered. Moreover, as part of the status of stakeholders and the obligations owed to them, the adoption of beneficial plans depends solely on people. The onus, therefore, is on decision-makers and all those who influence them to create the necessary mechanisms, both socially and individually (Branco & Rodrigues, 2007).

2. Corporate Social Responsibility

Today's businesses are transforming into new models in the global world order. Porter and Kramer (2006) argued that incorporating CSR activities into core operational processes, which they consider the new competitive strategy of the twenty-first century, plays a crucial role in sustainable development (Guo et al., 2015). CSR activities have many consequences, such as increasing firm value (Serveas & Tamayo, 2012), strengthening financial performance (Sharma & Aggarwal, 2021; Alay et al., 2024), improving corporate image (Pomering & Johnson, 2009; Virvilaitė & Daubaraitė, 2011; Ali et al., 2019; Al Mubarak et al., 2019). CSR contributes to better financial performance by directly reducing costs, increasing productivity, and indirectly increasing consumer satisfaction (Loureiro et al., 2012). The European Commission has defined corporate social responsibility as a concept that companies voluntarily contribute to a better society and a cleaner environment (Commission of The European Communities, 2001). In this context, businesses can play a role in developing and expanding corporate social responsibility by integrating social,

environmental, ethical, consumer, and human rights issues into their operations in line with applicable laws. Public institutions can play a role in developing and expanding corporate social responsibility by providing support through voluntary policies and complementary regulations.

Corporate social responsibility is predominantly associated with the concept of stakeholders. Clarkson (1995) defines stakeholders as individuals or groups with a past, present or future interest in a company or its activities or who may make demands. Thus, the concept of a stakeholder refers to all individuals and groups that are affected by a business's activities. Clarkson, who categorises stakeholder groups as primary and secondary stakeholders, defines primary stakeholders as a group that jeopardises the continuity of the business and without which it cannot survive, while secondary stakeholders are those who affect or are affected by the company but who are not essential for the survival of the company by not transacting with the company (Clarkson, 1995). Stakeholder theory, on the other hand, deals with businesses with this paradigm and argues that the relationships that companies establish with stakeholder groups outside the business play a decisive role in their success (Aktan & Börü, 2007), based on the question "for whose benefit and at whose expense should the firm be managed?" (Freeman, 1998). Therefore, this study aims to examine consumers, who constitute the largest stakeholder group for a business.

To understand the journey of corporate social responsibility from being a philanthropic activity and a strategic social tool to becoming a purpose, it is essential to examine its development from a historical perspective. Carroll, who made significant contributions to the CSR literature, accepted the starting point of the subject as the 1930s and 1940s and stated that the first noteworthy references of these years can be considered as Chester Barnard's (1938) "The Functions of the Executive", JM Clark's (1939) "Social Control of Business" and Theodore Kreps' (1940) "Measurement of the Social Performance of Business" (Carroll, 1999). Although some researchers (Sen, 2011; as cited in Govindan et al., 2015) argue that the first references to the subject were emphasised in the 1930s with Berle and Means' book "The Modern Corporation and Private Property" (1930), most researchers consider Bowen (1953) as the namesake of the concept since the first official terminological use was made by Bowen (Carroll, 1979; Carroll, 1999; Wartick & Cochran, 1985). In his work, Bowen (1953) emphasised the obligations of businesses in this area by pointing to the pursuit of the desired course of action about society's goals and values. In this context, Bowen's work is regarded as the foundational point in the literature on corporate social responsibility (Carroll, 1999; Maignan, 2001). In the 1950s, shaped by Bowen's (1953) paradigm and based on the belief that businesses are vital centres of power and decision-making, the awareness that corporate activities and decisions touch the lives of citizens in many areas of life began to prevail. The question "What kind of responsibilities can businessmen reasonably be expected to assume towards society?" which came to the agenda with Bowen in these years, is the dominant theme of the period's literature (Carroll, 1999). Based on the need to clarify the conceptual framework of CSR in the 1960s, it is seen that the concept expanded with different paradigms in terms of management philosophy.

Finally, in the 1970s, more formal and specific definitions of CSR emerged, along with an explanatory emphasis on corporate social performance. In the 1980s, efforts were made to further measure and research CSR, with a greater focus on alternative thematic frameworks. In this context, corporate social performance in the 1980s and 1990s provided a basis for emphasising alternative themes such as corporate citizenship, stakeholder theory, and business ethics theory (Carroll, 1999). CSR, which has been the subject of numerous empirical studies since the 2000s, is now a symbol of being a social citizen, enhancing corporate image (Pomering & Johnson, 2009; Virvilaitė & Daubaraitė, 2011; Ali et al., 2019; Al Mubarak et al., 2019) and being seen as a strategic tool (Branco & Rodrigues, 2006).

CSR studies, particularly since the 1990s, have become one of the most popular topics in the marketing literature, with their consumer-oriented research, which focuses on an important stakeholder group. CSR is widely accepted as an effective communication tool for increasing customer loyalty and building reputation (Bronn & Vrioni, 2001). In this context, it has been the subject of numerous studies as an important strategic tool for today's marketers (Brown & Dacin, 1997; Marin & Ruiz, 2007; Mohr & Webb, 2005; Sen & Bhattacharya, 2001). CSR activities are recognised as a valuable strategic tool in many marketing areas, such as brand image and customer satisfaction (Mohammed et al., 2018), customer loyalty (Mandhachitara & Pooltholg, 2011; Servera-Francés & Piqueras-Tomás, 2019; Islam et al., 2021), word-of-mouth marketing (Hanaysha, 2021), consumer preference (Boccia & Sarnacchiaro, 2018), purchase intention (Sen & Bhattacharya, 2001).

Consumers, who represent one of the largest stakeholder groups in studies on corporate social responsibility, are considered to be a highly influential factor. Today, consumer profiles are changing rapidly. For example, since it is known that consumers belonging to Generation Z are more sensitive to environmental and social issues compared to previous generations, businesses that allocate resources to CSR activities are likely to be more successful than their competitors (Aysuna-Türkyılmaz & Leblebicioğlu, 2022). With the aforementioned global-scale changes and developments, it is evident that the consumption preferences of today's consumers have become more responsible, and their perceptions of businesses have become increasingly socially informed. However, it would be helpful to clarify the difference between responsible consumption and CSR perception to clarify the issue. While responsible consumption encompasses the social responsibility dimension of consumers' consumption preferences and actions, CSR perception refers to how consumers perceive the social responsibility activities of businesses (Ramasamy & Yeung, 2009). In this context, the research subject is how consumers perceive CSR.

Researchers argue that customer-oriented CSR activities increase global brand value, while combined CSR plans targeting multiple stakeholders produce better results (Karaman & Akman, 2017). According to a market survey conducted by Ipsos MORI research company in 2000 with 12,000 consumers in 12 European countries, 70% of consumers stated that the organisation's commitment to social responsibility is important when purchasing products or services, and one in five people are willing to pay more for products with social

value and environmental responsibility (<www.csreurope.org>; cited in Ramasamy & Yeung, 2009). Similarly, Mohr and Webb (2005) found that corporate social responsibility in the environmental sense affects purchase intention more strongly than price; Alrubaiee et al. (2017) found that CSR has a direct positive impact on customer value, corporate image, and marketing performance; Chen et al. (2015) found that CSR image has an effect on brand prestige, consumer-business identification, and purchase intention; Sen and Bhattacharya (2001) stated that CSR-related activities have an impact on consumer identification, emotional motives, and product perceptions and thus have the ability to create perceptions and behaviours in favour of the company; Lee et al. (2012) stated that CSR activities are a strong predictor of consumer-enterprise identification and customer loyalty by affecting consumer perceptions. Research indicates that CSR awareness is highly likely to translate into purchase intentions in consumers (Tian et al., 2011). Another piece of data that may be important for building long-term and sustainable trust is the finding that consumers' perceptions of CSR activities affect their perceived product quality and satisfaction, both of which are direct and indirect predictors of trust (Swaen & Chumpitaz, 2008).

CSR activities can influence marketing activities and also serve as antecedents of CSR. Consumer perceptions of a business's CSR activities are influenced by factors such as brand, reputation, and communication. Research indicates that perceived financial performance and ethical statements made by the business influence consumer perceptions of corporate social responsibility and that corporate reputation is a significant predictor of consumer trust and loyalty (Stanaland et al., 2011; Poolthong & Mandhachitara, 2009).

2.1. Carroll's Pyramid of Corporate Social Responsibility

Carroll (1991) argues that for corporate social responsibility to be accepted by businesses, it should be conceptualised to encompass all their duties within a framework to understand the components related to the nature of the concept. In this context, he explained the responsibilities of businesses in four interdependent and mutually supportive dimensions. These responsibilities encompass economic, legal, ethical, and philanthropic aspects. These are said by Carroll (1991) as follows:

- **Economic responsibility:** It expresses the responsibility of businesses to produce and make a profit within a reason-for-being paradigm. First, enterprises are profit-motivated units that produce goods and services consumers need in line with their primary role. As this situation has evolved into a focus on maximising profit over time, other responsibilities of enterprises are based on economic considerations.
- **Legal responsibility:** Legal responsibility refers to the need to act within the framework of legal requirements when performing economic tasks. Society strongly expects businesses to take responsibility for their profits and act by the law. Businesses are expected to fulfil their economic mission by the law. At this point, legal responsibilities reflect a codified ethical view.

- **Ethical responsibility:** Ethical responsibility refers to the need for businesses to act in accordance with established norms that define appropriate behaviour when conducting their activities. Although businesses fulfil some ethical norms by acting in line with their economic and legal responsibilities, ethical responsibilities include unwritten societal expectations to protect and respect the rights of stakeholders. In this respect, it may imply a higher performance requirement for businesses than that required by law. The ethical responsibilities of businesses are constantly the subject of public debate, as they are seen by society as obligations to meet expectations. Different paradigms of public opinion complicate the situation for firms. Ethical norms are the driving force of law, and therefore, ethical responsibility forces legal responsibility to expand due to its constant interaction with the legal layer of responsibility.
- **Philanthropic responsibility:** Philanthropic responsibilities refer to active participation and a common desire to improve social life. Contributions to the arts, education, and other areas are examples. In a sense, philanthropic responsibility is closely tied to businesses being good corporate citizens. Philanthropic responsibilities differ from ethical responsibilities in that the public has no moral and ethical expectations. Although the public wants to see businesses in beneficial activities for society, they do not consider this situation unethical when the desired level is not achieved. The pyramid of corporate social responsibility is illustrated in Figure 1.

Figure: 1
Corporate Social Responsibility Pyramid
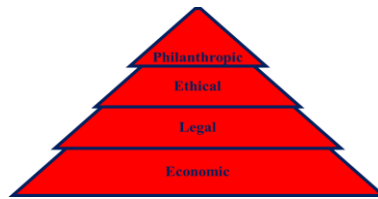
Source: Carroll, 1991.

Carroll (1991: 42) states that economic performance is the basic building block of all other activities. This is followed by legal responsibility, as the law determines whether an activity is acceptable. Ethical responsibility is the obligation to avoid and/or minimise harm to stakeholders by acting with integrity and fairness. Finally, philanthropic responsibility refers to the expectation that businesses are good corporate citizens. This is related to the expectation that businesses benefit society through financial and human resources, thereby improving the quality of life.

Research on corporate social responsibility from a consumer perspective suggests that consumer perception of CSR may differ culturally and at the level of economic development (Ramasamy & Yeung, 2009; Katz et al., 2001; Latteman et al., 2009). The

results of consumer research based on this classification, as presented by Carroll, indicate that it varies depending on culture, geography, the country's economic status, and level of development. For example, Nurunnabi et al. (2019) and Alfakhri et al. (2020), in their research conducted in the Arabian region, concluded that philanthropic responsibility ranked first and attributed this result to the influence of the zakat culture prevalent in Islamic geography. In a study conducted by Rahim et al. (2011) in Malaysia, the importance of the dimensions was ranked as follows: economic, philanthropic, ethical, and legal. Similarly, a survey conducted by Atan and Halim (2012) on Muslim consumers noted that compliance with the law was the most critical dimension for consumers. In a study conducted by Ramasamy and Yeung (2009) in China, findings parallel to Carroll's pyramid were found. Maignan (2001) argued that while US consumers perceive economic performance as the primary responsibility of businesses, French and German consumers perceive economic achievements as secondary and stated that French and German consumers are primarily interested in businesses that comply with social norms, not businesses that achieve high levels of economic performance.

The evaluation of these economic and social interests by consumers and their perspectives, which may not overlap or even conflict, is a topic worthy of research. Although Carroll's pyramid has been the subject of countless studies, the consumer side of the issue is a relatively neglected area of research. In Türkiye, there is no widespread understanding of the priority of types of responsibilities (within Carroll's framework) that consumers expect from firms, as evaluated from the consumer's perspective, based on the CSR pyramid. With the primary motivation of the studies above that differ contextually, this study aims to reveal the consumer's approach to CSR dimensions through the eyes of experts. In addition, the fact that there is no study evaluating experts' opinions on the subject and integrating different research methods into the subject can be stated as a novelty.

3. Methodology

This research was conducted by gathering experts' opinions, drawing on their knowledge and experience to evaluate corporate social responsibility (CSR) from a consumer perspective. The primary reason for utilising expert opinions is their high capacity to represent the views of a broad consumer base, ensuring that the findings reflect diverse and informed perspectives.

To achieve this, experts were selected based on their field of study, title, and professional experience, aiming to capture insights into the tendencies of many consumers. The experts include management and marketing academics specialising in corporate governance and providing consultancy services to the private sector. Their academic expertise adds theoretical depth to the analysis. Additionally, marketing managers from well-established Turkish companies with strong corporate governance compliance were included, offering practical insights into market dynamics and consumer behaviour. Senior

banking executives with Capital Markets Board (CMB) licenses were also involved, providing strategic perspectives and extensive experience in regulated industries.

Each expert brings at least 10 years of professional experience, ensuring their ability to provide nuanced and reliable evaluations of CSR. This carefully curated group of professionals represents a diverse range of expertise, combining academic, corporate, and industry-specific knowledge. The experts' detailed qualifications, experience, and roles are presented in the table below, demonstrating their ability to comprehensively represent consumer perspectives. This diverse group of experts ensures a holistic and well-rounded evaluation of CSR priorities from the consumer perspective, making the study comprehensive and highly relevant.

Table: 1
Information on Experts Contributing to the Study

Expert	Field of Study	Profession	Professional Experience	Education Level
E1	Banking	Branch Manager	12	Master's Degree
E2	Airlines	Project Manager	10	Ph.D.
E3	Banking	Customer Representative	11	Bachelor's Degree
E4	Banking	HR Director	15	Master's Degree
E5	FMCG	Marketing Manager	13	Master's Degree
E6	Management	Academician	10	Ph.D.
E7	Marketing	Academician	22	Ph.D.
E8	Marketing	Academician	26	Ph.D.

Ethics committee approval was obtained from Istanbul Medeniyet University Social and Human Sciences Scientific Research and Publication Ethics Committee with the number E-38510686-050.04-2400017273.

Maximum variation sampling was used as a sampling method in this study. The maximum variation sampling method increases the diversity of individuals in the sample to provide maximum diversity to the research subject (Coyne, 1997: 628; Kuzucu-Yapar & Keskin, 2023). In this study, the sample group was selected from individuals and researchers with at least 10 years of professional experience in the field of CSR. The research method employed was the "Pythagorean Fuzzy Entropy" method, which is considered a highly suitable tool for measuring precision and fuzziness. The primary purpose of this approach is to enable the weighing of different factors according to their importance (Zeng et al., 2020) and their sensitivity to measurement uncertainty in information. However, one of the method's main advantages is that the weighting is done objectively, as it is an information-based method (Kumar et al., 2020). The Pythagorean Fuzzy Entropy method employed in this study offers superiority in effectively managing uncertainties and objectively determining criterion weights, particularly in multi-criteria decision-making problems. One of the method's main advantages is that it provides a broader uncertainty management capacity than classical and intuitionistic fuzzy methods since the sum of the squares of the membership and non-membership degrees is less than one. Moreover, with an entropy-based approach, the data obtained from expert opinions are objectively weighted, and information

loss is minimised. These features make the method more flexible and reliable than alternative fuzzy decision-making techniques (Zeng et al., 2020).

3.1. Pythagoras Fuzzy Numbers

Intuitionistic fuzzy sets, introduced by Atanassov in 1986 as an extension of classical fuzzy sets, have been widely utilised by researchers across various fields to address uncertainties. However, these sets may not always meet specific criteria, significantly when the degrees of membership and non-membership exceed 1. To overcome this limitation, Yager proposed Pythagorean fuzzy sets in 2013, as they offer a more comprehensive representation of uncertainty. Pythagorean fuzzy sets are considered generalisations of intuitionistic fuzzy sets in specific scenarios, providing greater power and flexibility in handling uncertainty-related problems (Mohd & Abdullah, 2017; İlbahar et al., 2018).

Unlike intuitionistic fuzzy sets, where the sum of membership and non-membership degrees can exceed 1, Pythagorean fuzzy sets maintain a constraint where the sum of their squares cannot exceed 1 (İlbahar et al., 2018; Zeng et al., 2016; Zhang & Xu, 2014). This characteristic makes Pythagorean fuzzy sets more robust and suitable for effectively managing uncertainties in diverse applications.

The Pythagorean fuzzy set is defined in Equation 1:

$$p = \left\{ x, p(m_p x), v_p(x) \,|\, x \,Î\, X \right\} \tag{1}$$

Here μ_p: x $\mapsto$ [0,1] denotes the degree of membership, while v_p: x $\mapsto$ [0,1] denotes the degree of non-membership. Thus, for $x \in X$

$$(m_p(x))^2 + (v_p(x))^2 £ 1 \tag{2}$$

As can be seen, the sum of the squares of the degrees of their membership or non-membership cannot exceed 1. The degree of uncertainty of Pythagorean fuzzy sets $\pi_p(x)$ is determined by the equation (3) below.

$$\pi_p(x) = \sqrt{1 - (m_p(x))^2 - (v_p(x))^2} \tag{3}$$

For two Pythagorean fuzzy sets;

$$p_1 = \left\{ x, p_1(m_{p1} x), v_{p1}(x) \,|\, x \,Î\, X \right\} \text{ ve } p_2 = \left\{ x, p_2(m_{p2} x), v_{p2}(x) \,|\, x \,Î\, X \right\}$$

Arithmetic operations for Pythagorean fuzzy sets are shown in 4-7;

$$p_1 \ddot{A} p_2 = p\left(\sqrt{m_{p_1}^2 + m_{p_1}^2 - m_{p_1}^2 m_{p_1}^2}, v_{p1} v_{p2} \right) \tag{4}$$

$$p_1 \ddot{A} \, p_2 = p\left(m_{p1}m_{p2}\sqrt{v_{p_1}^2 + v_{p_2}^2 - v_{p_1}^2 v_{p_2}^2}\right) \tag{5}$$

$$\lambda p = p\left(\sqrt{1 - (1 - m_p^2)^\lambda}, (v_p)^\lambda\right), \lambda^3 \; 0 \, ve \, \hat{I} \; R \tag{6}$$

$$p^\lambda = p\left((m_p)^\lambda, \sqrt{1 - (1 - v_p^2)^\lambda}\right), \lambda^3 \; 0 \tag{7}$$

3.2. Pythagorean Fuzzy Entropy

Entropy was initially introduced as a measure of uncertainty in physics. Later, Shannon mathematically formalised this concept, which began to be widely utilised in various fields, emphasising computer science (Sahin & Yip, 2017). In this study, consumers' evaluations of the concept of CSR will be analysed by applying the Pythagorean Fuzzy Entropy method to determine the weights of economic, legal, ethical and philanthropic responsibilities in Carroll's CSR pyramid. Pythagorean fuzzy numbers are employed in the analysis, and the corresponding linguistic terms are presented in the table below (Peng & Yang, 2015).

Table: 2
Pythagorean Fuzzy Numbers Linguistic Terms

Criteria Importance	Value
Extremely Important	(0.85:0.15)
Very Important	(0.75:0.25)
Important	(0.65:0.35)
Medium	(0.55:0.45)
Unimportant	(0.35:0.65)
Very Unimportant	(0.25:0.75)
Extremely Unimportant	(0.15:0.85)

The entropy method is a weighting technique based on uncertainty. Initially, criteria are defined, and then the weighting process is carried out using the Pythagorean Fuzzy Entropy method. The steps of the fuzzy entropy method are as follows (Aksakal, 2021).

Step 1: *Creation of the decision matrix*

Data are collected and evaluated for each alternative by converting them into linguistic expressions. These linguistic terms are transformed into Pythagorean fuzzy numbers to form the decision matrix (D).

In the decision matrix shown below, m is the number of alternatives, n is the number of criteria, and x_{ij} is the value of criterion j for alternative i.

$$D = \begin{bmatrix} x_{11} & x_{12} & x_{13} & \cdots & \cdots & x_{1n} \\ x_{21} & x_{22} & x_{23} & & \cdots & x_{2n} \\ x_{31} & x_{32} & x_{33} & & \cdots & x_{3n} \\ \vdots & \vdots & \vdots & \ddots & & \\ x_{m1} & x_{m2} & x_{m3} & & & x_{mn} \end{bmatrix}$$

Step 2: *Determining the degree of hesitation*

The membership and non-membership degrees specified in Equation 2, as well as the degrees of indecision defined in Equation 3, are expressed with any Pythagorean fuzzy set P (μ, v), where μ, v, $\pi \in [0,1]$ satisfies the condition in Equation 8.

$$m^2 + v^2 + \pi^2 = 1 \tag{8}$$

The degree of uncertainty measures the degree of certainty of the information obtained. Including the degree of uncertainty in the definition of entropy provides a better measure of the total uncertainty contained in the Pythagorean fuzzy set.

Step 3: *Determination of Pythagorean fuzzy entropy and comprehensive entropy*

E^{*}: Pythagorean Fuzzy Set(X) $\mapsto$ [0,1], being a real function and representing the fuzzy entropy of Pythagorean Fuzzy Set (X), is expressed as E*(P) for Pythagorean Fuzzy Set P contained in X in equation 9 below.

$$E^{*}(P) = \frac{1}{m} \sum_{i=1}^{m} (1 - |m_p(x_{ij}) - v_p(x_{ij})|) \tag{9}$$

Xu, Zhang, and Li proposed a comprehensive entropy approach for fuzzy Pythagorean sets, which combines the aforementioned fuzzy entropy and degree of instability (Xu et al., 2020).

$$E(P) = \frac{1}{m} \sum_{i=1}^{m} [E^{*}(p_i)\pi_p(x_{ij}) - \pi_p E^{*}(p_i)] \tag{10}$$

$$E(P) = \frac{1}{m} \sum_{i=1}^{n} [1 - \pi_p(x_{ij}))| m_p(x_{ij}) - v_p(x_{ij})|] \tag{11}$$

Here, (P_i P) is shown as a separate element from the Pythagorean fuzzy set.

Step 4: *Determination of criterion weights with comprehensive entropy of intuitionistic fuzzy sets*

Among the criteria weighting methods, the entropy weighting method is widely used (Zeleny, 1982). A fuzzy Pythagorean mean comprehensive entropy-weighted analysis was used to determine the criteria weighting (Xu et al., 2020). It is shown in Equation 12.

$$w_j = \frac{1 - E_j}{n - \Sigma_{j=1}^{n} E_j} \tag{12}$$

4. Results

The importance levels of economic, legal, ethical and philanthropic responsibilities in Carroll's CSR pyramid will be determined by applying the Pythagorean Fuzzy Entropy method to consumers' evaluations of the concept of CSR. In line with the literature review and expert opinions, it was decided to subject the four dimensions mentioned in Carroll's CSR pyramid to the research and to use the scale consisting of 16 questions developed by Maignan (2001) in his cross-cultural study on the subject, shown in Table 3. Eight different experts were consulted to calculate the weights of these dimensions. The experts consisted of senior managers with at least 10 years of experience and professors with numerous academic publications on CSR who lecture in this field.

Table: 3
Statements on Consumers' Evaluation of CSR Dimensions from the Experts' Perspective

	Economic Responsibility
ECO1	According to consumers, businesses should maximise their profits.
ECO2	According to consumers, businesses should strictly control production costs.
ECO3	According to consumers, businesses should plan for their long-term success.
ECO4	According to consumers, businesses should continually strive to improve their economic performance.
	Legal Responsibility
LEG1	According to consumers, businesses should ensure that their employees act according to the standards set by law.
LEG2	According to consumers, businesses should avoid setting aside contractual obligations.
LEG3	According to consumers, businesses should avoid breaking the law, even if it helps to improve performance.
LEG4	According to consumers, businesses should always adhere to the principles of the regulatory system.
	Ethical Responsibility
ETH1	According to consumers, businesses should not allow ethical concerns to impact their economic performance negatively.
ETH2	According to consumers, businesses should prioritise respect for ethical principles over economic performance.
ETH3	According to consumers, businesses should adhere to well-defined ethical principles.
ETH4	According to consumers, businesses should refrain from compromising their ethical standards to achieve corporate goals.
	Philanthropic Responsibility
PHI1	According to consumers, businesses should play a role in addressing social problems.
PHI2	Consumers believe that businesses should participate in the management of public affairs.
PHI3	According to consumers, businesses should allocate their resources to philanthropic activities.
PHI4	According to consumers, businesses should play a societal role that extends beyond generating profits.

Source: Maignan, 2001.

The 16-question scale developed by Maignan (2001) was administered to eight experts to elicit the weights assigned to consumers on Carroll's CSR dimensions. For this purpose, the degree of importance of each statement, as shown in Table 1, was asked.

Experts were asked to respond on a seven-point scale ranging from extremely important to extremely unimportant to evaluate the relevant statements for consumers.

Step 1: *Creating the Decision Matrix*

Calculations were made by considering the degree of importance that the experts assigned to each statement during their evaluation. For example, in the decision matrix for the economic responsibilities dimension, shown in Table 4, the statement ECO1 was deemed necessary by the first expert, whereas it was evaluated as moderately crucial by the second expert. The other statements were similarly calculated using Table 1 and are presented in Tables 4-6 in the first step.

Table: 4
Economic Responsibilities Dimension Decision Matrix

Experts	ECO1	ECO2	ECO3	ECO4
E1	P (0.65:0.35)	P (0.75:0.25)	P (0.35:0.65)	P (0.35:0.65)
E2	P (0.55:0.45)	P (0.65:0.35)	P (0.85:0.15)	P (0.55:0.45)
E3	P (0.65:0.35)	P (0.75:0.25)	P (0.75:0.25)	P (0.85:0.15)
E4	P (0.75:0.25)	P (0.85:0.15)	P (0.85:0.15)	P (0.75:0.25)
E5	P (0.55:0.45)	P (0.55:0.45)	P (0.55:0.45)	P (0.35:0.65)
E6	P (0.35:0.65)	P (0.65:0.35)	P (0.75:0.25)	P (0.55:0.45)
E7	P (0.55:0.45)	P (0.85:0.15)	P (0.75:0.25)	P (0.85:0.15)
E8	P (0.55:0.45)	P (0.35:0.65)	P (0.55:0.45)	P (0.35:0.65)

Table: 5
Legal Responsibilities Dimension Decision Matrix

Experts	LEG1	LEG2	LEG3	LEG4
E1	P (0.75:0.25)	P (0.85:0.15)	P (0.75:0.25)	P (0.75:0.25)
E2	P (0.85:0.15)	P (0.85:0.15)	P (0.85:0.15)	P (0.85:0.15)
E3	P (0.85:0.15)	P (0.65:0.35)	P (0.55:0.45)	P (0.65:0.35)
E4	P (0.85:0.15)	P (0.85:0.15)	P (0.75:0.25)	P (0.75:0.25)
E5	P (0.75:0.25)	P (0.35:0.65)	P (0.85:0.15)	P (0.85:0.15)
E6	P (0.85:0.15)	P (0.75:0.25)	P (0.75:0.25)	P (0.85:0.15)
E7	P (0.75:0.25)	P (0.75:0.25)	P (0.85:0.15)	P (0.85:0.15)
E8	P (0.65:0.35)	P (0.35:0.65)	P (0.75:0.25)	P (0.85:0.15)

Table: 6
Ethical Responsibilities Dimension Decision Matrix

Experts	ETH1	ETH2	ETH3	ETH4
E1	P (0.65:0.35)	P (0.75:0.25)	P (0.65:0.35)	P (0.75:0.25)
E2	P (0.85:0.15)	P (0.85:0.15)	P (0.85:0.15)	P (0.85:0.15)
E3	P (0.55:0.45)	P (0.55:0.45)	P (0.35:0.65)	P (0.55:0.45)
E4	P (0.65:0.35)	P (0.65:0.35)	P (0.75:0.25)	P (0.85:0.15)
E5	P (0.75:0.25)	P (0.85:0.15)	P (0.85:0.15)	P (0.85:0.15)
E6	P (0.75:0.25)	P (0.65:0.35)	P (0.75:0.25)	P (0.55:0.45)
E7	P (0.65:0.35)	P (0.55:0.45)	P (0.65:0.35)	P (0.65:0.35)
E8	P (0.75:0.25)	P (0.85:0.15)	P (0.75:0.25)	P (0.85:0.15)

Table: 7
Philanthropic Responsibilities Dimension Decision Matrix

Experts	PHI1	PHI2	PHI3	PHI4
E1	P (0.55:0.45)	P (0.25:0.75)	P (0.35:0.65)	P (0.65:0.35)
E2	P (0.85:0.15)	P (0.55:0.45)	P (0.85:0.15)	P (0.85:0.15)
E3	P (0.65:0.35)	P (0.25:0.75)	P (0.85:0.15)	P (0.75:0.25)
E4	P (0.75:0.25)	P (0.65:0.35)	P (0.75:0.25)	P (0.75:0.25)
E5	P (0.65:0.35)	P (0.15:0.85)	P (0.25:0.75)	P (0.55:0.45)
E6	P (0.35:0.65)	P (0.25:0.75)	P (0.75:0.25)	P (0.65:0.35)
E7	P (0.75:0.25)	P (0.65:0.35)	P (0.75:0.25)	P (0.85:0.15)
E8	P (0.55:0.45)	P (0.15:0.85)	P (0.25:0.75)	P (0.35:0.65)

After creating the decision matrices, the degrees of indecision and the comprehensive entropy values of the Pythagorean fuzzy sets will be calculated.

Steps 2 and 3: *Determining the degree of uncertainty and the comprehensive entropy of Pythagorean fuzzy sets*

In the second and third steps, firstly, the degree of hesitation (π) was determined using the values of membership (μ) and non-membership (v) defined in the decision matrix in the first step, and then the comprehensive entropy values (E) were determined for each statement using the degrees of membership, non-membership and hesitation. These details are provided for each dimension separately in Tables 8 through 11.

Table: 8
Determining the Comprehensive Entropy of the Economic Responsibilities Dimension

	ECO1				ECO2				ECO3				ECO4			
Experts	μ	v	π	E	μ	v	π	E	μ	v	π	E	μ	v	π	E
E1	0.65	0.35	0.67	0.90	0.75	0.25	0.61	0.81	0.35	0.65	0.67	0.90	0.35	0.65	0.67	0.90
E2	0.55	0.45	0.70	0.97	0.65	0.35	0.67	0.90	0.85	0.15	0.50	0.65	0.55	0.45	0.70	0.97
E3	0.65	0.35	0.67	0.90	0.75	0.25	0.61	0.81	0.75	0.25	0.61	0.81	0.85	0.15	0.50	0.65
E4	0.75	0.25	0.61	0.81	0.85	0.15	0.50	0.65	0.85	0.15	0.50	0.65	0.75	0.25	0.61	0.81
E5	0.55	0.45	0.70	0.97	0.55	0.45	0.70	0.97	0.55	0.45	0.70	0.97	0.35	0.65	0.67	0.90
E6	0.35	0.65	0.67	0.90	0.65	0.35	0.67	0.90	0.75	0.25	0.61	0.81	0.55	0.45	0.70	0.97
E7	0.55	0.45	0.70	0.97	0.85	0.15	0.50	0.65	0.75	0.25	0.61	0.81	0.85	0.15	0.50	0.65
E8	0.55	0.45	0.70	0.97	0.35	0.65	0.67	0.90	0.55	0.45	0.70	0.97	0.35	0.65	0.67	0.90
	Comprehensive Entropy **1.85**				Comprehensive Entropy **1.65**				Comprehensive Entropy **1.64**				Comprehensive Entropy **1.69**			

Table: 9
Determining the Comprehensive Entropy of the Legal Responsibilities Dimension

	LEG1				LEG2				LEG3				LEG4			
Experts	μ	v	π	E	μ	v	π	E	μ	v	π	E	μ	v	π	E
E1	0.75	0.25	0.61	0.81	0.85	0.15	0.50	0.65	0.75	0.25	0.61	0.81	0.75	0.25	0.61	0.81
E2	0.85	0.15	0.50	0.65	0.85	0.15	0.50	0.65	0.85	0.15	0.50	0.65	0.85	0.15	0.50	0.65
E3	0.85	0.15	0.50	0.65	0.65	0.35	0.67	0.90	0.55	0.45	0.70	0.97	0.65	0.35	0.67	0.90
E4	0.85	0.15	0.50	0.65	0.85	0.15	0.50	0.65	0.75	0.25	0.61	0.81	0.75	0.25	0.61	0.81
E5	0.75	0.25	0.61	0.81	0.35	0.65	0.67	0.90	0.85	0.15	0.50	0.65	0.85	0.15	0.50	0.65
E6	0.85	0.15	0.50	0.65	0.75	0.25	0.61	0.81	0.75	0.25	0.61	0.81	0.85	0.15	0.50	0.65
E7	0.75	0.25	0.61	0.81	0.75	0.25	0.61	0.81	0.85	0.15	0.50	0.65	0.85	0.15	0.50	0.65
E8	0.65	0.35	0.67	0.90	0.35	0.65	0.67	0.90	0.75	0.25	0.61	0.81	0.85	0.15	0.50	0.65
	Comprehensive Entropy **1.49**				Comprehensive Entropy **1.57**				Comprehensive Entropy **1.54**				Comprehensive Entropy **1.45**			

Table: 10

Determination of the Comprehensive Entropy of the Ethical Responsibilities Dimension

Experts	ETH1				ETH2				ETH3				ETH4			
	μ	v	π	E	μ	v	π	E	μ	v	π	E	μ	v	π	E
E1	0.65	0.35	0.67	0.90	0.75	0.25	0.61	0.81	0.65	0.35	0.67	0.90	0.75	0.25	0.61	0.81
E2	0.85	0.15	0.50	0.65	0.85	0.15	0.50	0.65	0.85	0.15	0.50	0.65	0.85	0.15	0.50	0.65
E3	0.55	0.45	0.70	0.97	0.55	0.45	0.70	0.97	0.35	0.65	0.67	0.90	0.55	0.45	0.70	0.97
E4	0.65	0.35	0.67	0.90	0.65	0.35	0.67	0.90	0.75	0.25	0.61	0.81	0.85	0.15	0.50	0.65
E5	0.75	0.25	0.61	0.81	0.85	0.15	0.50	0.65	0.85	0.15	0.50	0.65	0.85	0.15	0.50	0.65
E6	0.75	0.25	0.61	0.81	0.65	0.35	0.67	0.90	0.75	0.25	0.61	0.81	0.55	0.45	0.70	0.97
E7	0.65	0.35	0.67	0.90	0.55	0.45	0.70	0.97	0.65	0.35	0.67	0.90	0.65	0.35	0.67	0.90
E8	0.75	0.25	0.61	0.81	0.85	0.15	0.50	0.65	0.75	0.25	0.61	0.81	0.85	0.15	0.50	0.65
	Comprehensive Entropy **1.69**				Comprehensive Entropy **1.63**				Comprehensive Entropy **1.61**				Comprehensive Entropy **1,57**			

Table: 11

Determining the Comprehensive Entropy of the Philanthropic Responsibilities Dimension

Experts	PHI1				PHI2				PHI3				PHI4			
	μ	v	π	E	μ	v	π	E	μ	v	π	E	μ	v	π	E
E1	0.55	0.45	0.70	0.97	0.25	0.75	0.61	0.81	0.35	0.65	0.67	0.90	0.65	0.35	0.67	0.90
E2	0.85	0.15	0.50	0.65	0.55	0.45	0.70	0.97	0.85	0.15	0.50	0.65	0.85	0.15	0.50	0.65
E3	0.65	0.35	0.67	0.90	0.25	0.75	0.61	0.81	0.85	0.15	0.50	0.65	0.75	0.25	0.61	0.81
E4	0.75	0.25	0.61	0.81	0.65	0.35	0.67	0.90	0.75	0.25	0.61	0.81	0.75	0.25	0.61	0.81
E5	0.65	0.35	0.67	0.90	0.15	0.85	0.50	0.65	0.25	0.75	0.61	0.81	0.55	0.45	0.70	0.97
E6	0.35	0.65	0.67	0.90	0.25	0.75	0.61	0.81	0.75	0.25	0.61	0.81	0.65	0.35	0.67	0.90
E7	0.75	0.25	0.61	0.81	0.65	0.35	0.67	0.90	0.75	0.25	0.61	0.81	0.85	0.15	0.50	0.65
E8	0.55	0.45	0.70	0.97	0.15	0.85	0.50	0.65	0.25	0.75	0.61	0.81	0.35	0.65	0.67	0.90
	Comprehensive Entropy **1.73**				Comprehensive Entropy **1.63**				Comprehensive Entropy **1.56**				Comprehensive Entropy **1.65**			

After calculating the comprehensive entropies for each statement, the next step is to calculate the total weights of the dimensions.

Step 4: *Determination of criteria weights with Pythagorean Fuzzy Sets comprehensive entropy*

In the fourth step, the total weights of each statement and dimension were calculated using the comprehensive entropy values obtained in steps two and three, as shown in Tables 11-14. The weights of the dimensions were calculated as 0.2853 for economic responsibilities, 0.2584 for philanthropic responsibilities, 0.2509 for ethical responsibilities, and 0.2054 for legal obligations, respectively. The sum of the values obtained from Tables 12-15 gives a value of 1.

Table: 12

Calculation of the Economic Responsibilities Dimension Weight

Comprehensive entropy	ECO1	ECO2	ECO3	ECO4	SUM
W_j	0.0855	0.0654	0.0647	0.0696	**0.2853**

Table: 13

Calculation of the Weight of the Legal Responsibilities Dimension

Comprehensive entropy	LEG1	LEG2	LEG3	LEG4	SUM
w_j	0.0488	0.0575	0.0543	0.0449	**0.2054**

Table: 14
Calculation of Ethical Responsibilities Dimension Weight

Comprehensive entropy	ETH1	ETH2	ETH3	ETH4	SUM
wⱼ	0.0693	0.0633	0.0613	0.0570	**0.2509**

Table: 15
Calculating the Weight of the Philanthropic Responsibilities Dimension

Comprehensive entropy	PHI1	PHI2	PHI3	PHI4	SUM
wⱼ	0.0734	0.0630	0.0565	0.0654	**0.2584**

5. Concluding Remarks

This research evaluates the corporate social responsibility dimensions that Turkish consumers expect from businesses in the context of Carroll's CSR pyramid from the perspective of experts in the field. The research reveals which aspects of the steps in Turkish consumers' CSR pyramid differ from those in similar studies from other cultures. In addition, it differs from its counterparts in its understanding of the importance of corporate social responsibility dimensions expected from businesses in Turkish culture, as well as the method it employs.

Corporate Social Responsibility (CSR) refers to a business's dedication to promoting sustainable economic development and collaborating with employees, the local community, and society as a whole to enhance their overall quality of life (World Business Council on Sustainable Development, 2000; as cited in Manasakis, 2018). Although businesses will fulfil this commitment, what stakeholders expect from businesses is the determinant of the issue. In this research, with this paradigm, the CSR evaluations of consumers, one of the largest stakeholder groups, are discussed in line with experts' opinions. The results of the research can be summarised as follows.

The results of this study indicate that, according to experts in Türkiye, consumers primarily expect businesses to demonstrate economic responsibility (0.2853). Economic responsibility is closely followed by philanthropic responsibility (0.2584) and ethical responsibility (0.2509). The relatively least weighted dimension is legal responsibility (0.2054). When the difference of 0.0075 is considered insignificant (the difference between philanthropic and ethical responsibility), it will be possible to say that the research findings point to a three-step flattened pyramid.

The first finding of the research reveals that customers perceive businesses primarily as economic and profit-oriented entities, considering their primary responsibility to be economic. This aligns with the American consumer profile identified in Maignan's (2001) study, which compared consumer perceptions across different countries. However, it is essential to note that our results indicate that economic responsibilities can be reconciled with social and ethical interests, as reflected in the correlation values (0.2853, 0.2584, 0.2509). These results also suggest that an organisation needs to develop policies that

demonstrate to consumers its commitment to philanthropic and ethical responsibilities, particularly when utilising corporate social responsibility activities as a marketing strategy.

One of the key reasons why philanthropic and ethical responsibilities follow economic responsibilities stems from Türkiye's cultural structure. When evaluating the pyramid of research results, it appears that charitable responsibility precedes ethical responsibility by a minimal margin, while legal responsibility emerges with a more significant distinction, in line with Hofstede's cultural dimensions of femininity and collectivism (Hofstede Insights). It is not surprising that our country, which exhibits feminine and collectivist cultural characteristics, displays philanthropic and collectivist tendencies and creates parallel beliefs that align with these cultural dimensions. In addition, the results obtained are consistent with the research conducted by Rahim et al. (2011) in Malaysia, which is not far from our country, regarding the femininity dimension, and yielded similar findings. Studies are evaluated.

The most unexpected finding of this study was that legal responsibility ranked last. When the results are compared with similar studies, the low prioritisation of legal obligation (4th place) aligns with findings by Rahim et al. (2011) in Malaysia. This outcome may be associated with the applicability of legal regulations or the level of consumer compliance with laws in developing countries. Similarly, the relatively low importance of legal responsibility may indicate that consumers perceive this dimension as secondary in the Middle East and Islamic regions, as reflected in the findings of Nurunnabi et al. (2019), where legal responsibility ranked 3rd.

Our research further reveals that while economic responsibilities are ranked highest, the structure of priorities differs from Carroll's pyramid in the context of our sample. The ethical and philanthropic responsibility dimensions exhibit similar importance, suggesting a more compressed pyramid concept where these two responsibilities are nearly equal in importance. Considering Türkiye's cultural characteristics- marked by strong femininity and collectivist values- the close association between benevolence, benefiting others, and the ethical codes expected from businesses may be attributed to these cultural traits. Moreover, compared to similar studies, it is reasonable to assert that, according to expert insights, Turkish consumers perceive Carroll's pyramid dimensions as an integrated whole rather than as distinct and separate tiers.

The results of the research show that Carroll's pyramid, which expresses the priorities regarding the responsibilities of businesses, differs from Carroll's pyramid, and at the same time, when the statistical values of the CSR dimensions examined under these four headings are evaluated, it is not very insignificant from the consumer's point of view according to the experts, the consumer perceives CSR as a whole with close weights and surprisingly, ethical and philanthropic activities should be considered almost as important as economic interests.

Like any research study, ours has certain limitations. First, a significant limitation is that the experts selected to represent consumers may primarily evaluate consumer expectations within the scope of the industries in which they are involved. Expanding future research to include experts from diverse sectors could provide a more comprehensive understanding of consumer expectations regarding corporate social responsibility (CSR) across different industries and help identify whether our findings are applicable in other industrial contexts.

Another limitation is that, although including experts from corporate companies serving all of Türkiye is a strength, our findings overlook local differences and subcultural variations. This limitation restricts our ability to explore how regional differences might influence consumer expectations. It is plausible that CSR expectations vary significantly across regions in Türkiye, reflecting diverse cultural and economic contexts.

In light of these limitations, future studies would benefit from examining CSR expectations within varied industrial and subcultural contexts. Additionally, while this study relies on expert opinions due to their strong capacity to represent consumer perspectives, expanding the research tradition to include studies directly engaging with consumers would provide richer insights and further contribute to the field.

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Representation of Daily Life in SEKA Postası as a Business Newspaper in the Industrial Development Process

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Endüstriyel Kalkınma Sürecinde Bir İşletme Gazetesi Olan SEKA Postası'nda Gündelik Hayatın Temsili

Abstract

This study aims to investigate the role of SEKA Postası newspaper in promoting the sustainability of industrial development and shaping urban culture. The news published in SEKA Postası newspaper was examined quantitatively using the content analysis method. The results obtained in the study demonstrate that the newspaper effectively represents the social aspect of the industry, featuring a diverse range of news content, including sports, cinema, exhibitions, concerts, health, travel, marriage, and education. The results reveal that SEKA Postası, a business newspaper, undertook a compelling mission to develop the city's daily life.

Keywords : Industrialization, City Culture, Daily Life, Newspaper, SEKA Postası.

JEL Classification Codes : O1, D83, L82.

Öz

Bu çalışmada SEKA Postası gazetesinin, endüstriyel gelişim sürecinin sürdürülebilirliğinin sağlanmasında ve kent kültürünün oluşumundaki rolünün ortaya konulması amaçlanmaktadır. SEKA Postası gazetesinde yayımlanan haberler, içerik analizi yöntemi kullanılarak niceliksel olarak incelenmiştir. Çalışmada elde edilen sonuçlar, gazetenin spordan, sinemaya; sergiden, konsere; sağlıktan, geziye; evlilikten, eğitime farklı haber içerikleri ile sanayinin sosyal yönünü temsil ettiğini göstermektedir. Sonuçlar, işletme gazetesi olan SEKA Postası'nın kentin gündelik hayatının gelişmesinde etkin bir misyon üstlendiğini ortaya koymaktadır.

Anahtar Sözcükler : Endüstrileşme, Kent Kültürü, Gündelik Hayat, Gazete, SEKA Postası.

1. Introduction

Economic development and industrialisation are critical factors determining a city's cultural life. Industrialised cities play a pioneering role in laying the foundations of a city's cultural dynamics and establishing the economic infrastructure that will have a dominant impact on urban life. Thanks to its geographical location and hinterland, Kocaeli, one of the important industrial cities of Türkiye, is the centre of large industrial enterprises. The fact that the Türkiye Selüloz ve Kağıt Fabrikaları A.Ş. (SEKA), one of the first industrial organisations in the history of the Republic, and SEKA, as it was commonly known in later years, was established in this city confirms this strategic geographical position. In this sense, SEKA not only contributed to the economic development process of the town through paper production but also significantly contributed to the social and cultural development of Kocaeli and Izmit. SEKA pioneered significant changes in the socio-cultural structure of the city across various fields, including education through the Friends of Children Association, established by the institution's employees; sports with the Kağıtspor Club; and culture and arts, with the cinema-theatre hall and SEKA Cinema. In this context, mass media such as SEKA Postası newspaper, SEKA Magazine and SEKA Radio, which were published and printed within SEKA, ensured the representation and, in other words, the carrier of the city's cultural values.

SEKA Postası, which continued its publication life as a business newspaper for 27 years, was published as four pages every 15 days until the last years of its publication life. Political and economic developments in the country caused changes in the publication interval of SEKA Postası. Despite these developments, the newspaper managed to maintain its continuity of publication, with a total of 2,488 pages across 517 issues. SEKA Postası's publication planning, diversity of content and the fact that it was printed within an enterprise are important in ensuring the integration of industry and urban culture.

In the first part of the study, the adventure of Türkiye's industrial development process is discussed, followed by a historical examination of the importance of the city of Kocaeli, which has been home to various civilisations, and the role played by SEKA in the industrialisation process. In the last section, the role of the mass media operating within SEKA in the dissemination of the cultural values of the city is explained, and the news on sports, education, health, culture and arts and daily life in the printed copies of the newspaper SEKA Postası are examined quantitatively by content analysis method. It attempted to identify which news items published in the newspaper reflected the representation of urban culture and whether the social and political developments of the period, as well as the changes in the administrative structure of SEKA, influenced the content that revealed this representation process.

2. Türkiye's Industrial Development Process

The Industrial Revolution brought about the transition to mechanised production in many fields of the world's economic production process. Following this process, with the

acceleration of technological developments, initial investments, then production, and subsequently incomes began to increase worldwide. As a result, economic growth has become the primary process that determines the wealth and poverty of nations, especially after World War II (Bahar, 2005: 66-68; Pamuk, 2018: 1). With this revolution, steam engines and other new technologies were first introduced in Western Europe and North America, and then in different parts of the world (Pamuk, 2018: 5).

The Ottoman Empire, with an economic structure based on agriculture, handicrafts, and guild-style organisation, lagged behind Western countries because it was unable to carry out the transformations brought about by the Industrial Revolution (Bahar, 2005: 66-68). Türkiye's industrialisation progressed slowly in the 19th century, while productivity in industry and transport was on an upward trend (Pamuk, 2018: 5).

This century ushered in a distinct period for Ottoman society and its economic structure, one that differed from the previous one. During the 17th and 18th centuries, the traditional structures of Ottoman culture and the economy remained essentially unchanged. Between the 1820s and the outbreak of the First World War, the Ottoman Empire encountered the Western world's military, political, and economic power. In this context, the economy began to shift towards a new economic order characterised by capitalism (Pamuk, 2007: 191). In the Ottoman Empire, large-scale industrial enterprises were initiated by the state in the 1830s and 1840s to meet the needs of the army and the state, but these enterprises had to suspend their production after a short period. The second wave of capitalist industrial enterprises utilising imported technology started to develop in the 1880s (Pamuk, 2007: 225).

It is observed that the liberal policies pursued in the Ottoman Empire after the 1908 Revolution, which aimed to unite different ethnic elements within the concept of the Ottoman nation, began to be abandoned after the defeats in the Balkan Wars and that the Union and Progress government, which came to power, tried to create a Turkish bourgeoisie during the war years. In Pamuk's words, the aim was to create a self-sufficient economy through agriculture and industry. Ideas such as establishing national companies and national banks, as well as organising Muslim tradespeople and merchants, began to spread alongside the ideas of Turkish nationalism (1999: 185). From the Ottoman period to the 20th century, Türkiye inherited structures based on agriculture, open to foreign trade and, in this context, to foreign capital, as well as a strong centralised state and agricultural structures with a high concentration of small producers. Pamuk (1999: 198) states that these features constitute the distinctive character of Ottoman society and economy, as well as the specific dimensions of Ottoman heritage.

During the Republican period, the Turkish industry found the opportunity to reactivate with the contributions of Atatürk. Following the First Economic Congress in Izmir, which convened on 17 February 1923, institutions were established to support private entrepreneurs and outside capital and production. In this context, the Free Economy Policy started to be followed (Doğan, 2013: 212-213). Although the political regime in this period

preserved the capitalist property structure, it also maintained the understanding of the necessity of state intervention in economic life from the beginning. During this period, the issue of basing economic development on the power of the Turkish entrepreneurial class, which was formed with the state's contribution, became more clearly evident, especially at the Izmir Economic Congress (Tezel, 1982: 130-135).

During this period, several measures were implemented to develop the industry and encourage private-sector investment. 1925, the Bank of Industry and Maadin was established, and the Law on Incentive Industry was enacted in 1927. In addition to these, it was envisaged to ensure industrialisation through the private sector by making new arrangements regarding the tax exemption of the export expenses of the industries that would be oriented towards exports and the organisation of tradesmen and craftsmen (Bahar, 2005: 69; Kepenek, 1984: 44). Sümerbank and Etibank, which emerged in Türkiye in the 1930s, played an important role in implementing statist industrialisation programmes and developing public entrepreneurship. One of the important functions of Sümerbank was to implement the state's manufacturing industry investment programmes and operate the state factories that were established (Tokgöz, 2011: 302).

Regulations ensuring the implementation of the principle of statism in the economy began to be institutionalised. With the implementation of state-led planned industrialisation, the aim was to produce the country's basic industrial goods through public enterprises. Within the framework of the First Five-Year Industrial Plan, implemented between 1934 and 1938, the goal was to establish factories in six different industrial branches: chemistry, paper and cellulose, mining, textiles, ceramics, and iron and steel. The task of executing and coordinating the plan was assigned to Sümerbank. The establishment of textile and weaving factories in many Anatolian cities marked the beginning of a planned industrialisation period. Within the plan's scope, Kayseri Cloth Factory in 1935 and İzmit Paper Factory in 1936 were enthusiastically welcomed (Tokgöz, 2011: 78-81). In 1936, following the establishment of the İzmit First Paper Mill, the city also saw the opening of chlorine alkali, cellulose, newsprint, and cigarette paper mills. Türkiye's first paper mill, whose foundation was laid in İzmit in 1934, began production two years later and started operating under the name Sümerbank Selüloz Sanayii Müessesesi in 1939. It was renamed Türkiye Selüloz ve Kağıt Fabrikaları A.Ş. (SEKA) in 1955 (Doğan, 2013: 214-215).

Boratav (1993: 45) states that from 1930 to 1939, protectionism and statism were two determining features of economic policies. Describing these years as the first industrialisation period in terms of the results of the economic policies pursued, Boratav states that while the world economy was being dragged into a great depression, the Turkish economy closed to the outside world and entered into an attempt at national industrialisation by the state (Boratav, 1993: 90).

Following the Second World War, it was observed that the adoption of new technologies in agriculture led to significant productivity increases. With the migration of a portion of the agricultural workforce to cities, the number of people employed in the

industrial and service sectors has increased. The increase in productivity and production led to a rise in incomes, which in turn led to an increase in physical investments and equipping the population with more tools and equipment (Pamuk, 2018: 5). After the war, the Turkish economy differed from the classical capitalist development process in the sense that it became increasingly dependent on external sources. After this period, Türkiye was unable to integrate its resources into the global economy; it was able to carry out its accumulation process to a significant extent, relying heavily on external resources (Boratav, 1993: 147).

From the 1950s to the early 1960s, Türkiye once again adopted a liberal economic policy by making decisions to support private investors. In the first five years of these 10 years, it was observed that industrialisation was based on domestic consumption through the private sector and was dependent on agricultural activities. Within the scope of the First Five-Year Development Plan, it is evident that industry was allocated an important place alongside the farm sector, and industrial investments commenced (Bahar, 2005: 79; Doğan, 2013: 217). An industrial structure based on the import substitution of basic consumer goods, with its foundations laid in the 1930s, is one of Türkiye's leading industrial characteristics. This industrial structure, which is oriented towards processing domestic agricultural and mineral raw materials, did not change significantly by the 1960s (Şahin, 1998: 103).

With the increase in the need for foreign exchange to increase production and to provide external financing for the necessary investments and with the rise in oil prices, there was a problem in the balance of payments in Türkiye towards the end of the 1970s and the government of the period took the 24 January Decisions on 24 January 1980 to support and encourage the industry. With these decisions, it is evident that the import substitution policy, one of the industrialisation strategies implemented for many years, was abandoned. Instead, an industrialisation policy in which exports are at the forefront has started to be implemented. In the 57 years from 1923, when the Republic of Türkiye was proclaimed, to 1980, when the 24 January Decisions were taken, it was aimed to follow an economic policy aiming to reduce external dependence by implementing an import substitution industrialisation policy; however, although this strategy initiated an industrialisation movement, the desired level could not be reached (Bahar, 2005: 86-87; Doğan, 2013: 218).

Pamuk (2018: 7-8), in his book on Türkiye's 200-year economic history, states that the economic policies implemented have shown significant changes from period to period. Emphasising that in the 19th century, the open economy model was abandoned and replaced by a protectionist industrialisation strategy in the first half of the 20th century and after World War II, Pamuk states that after 1980, this model was replaced by neoliberal policies and the process of opening the economy to the outside world.

From the Ottoman Empire to the Republican period and beyond, Türkiye's industrial and economic development process has been shaped by the steps taken under the conjuncture. The Ottoman state, which lagged behind the Industrial Revolution's production model, experienced a period of economic decline. In the period when the 2nd Constitutional Monarchy was proclaimed, although some steps were taken to encourage domestic industry,

they were insufficient. In the Republican period, an economic model consisting of private entrepreneurs with state support was tried to be established. In particular, the adoption of legal regulation to encourage industry in 1927 and the opening of many factories, especially in the paper and pulp industry, within the scope of planned industrialisation policies, helped leave behind the troubled period of the world economic depression in 1929. In this context, not only the economic decisions taken but also the mass media are of great importance in the economic development process, industrialisation and the development of urban culture. The newspaper SEKA Postası and the radio station SEKA Radio of the enterprise, which was the first paper mill of the Republican era and was later renamed Türkiye Selüloz ve Kağıt Fabrikaları A.Ş. (SEKA) in 1955, have long represented and promoted İzmit urban culture. In this study, after presenting the importance of mass media in shaping urban culture within a general framework, the role of SEKA in industrial development and the emergence of urban culture is examined by analysing the content presented in these two communication tools.

3. Development of Kocaeli Urban Culture and SEKA Postası Newspaper

Helle defines urbanisation and industrial society as follows: "Whereas before industrialisation, the individual was integrated into a system of order imposed on him from the outside, in today's industrial society, the efficiency of integration is gradually being transferred from outside the system to the inside of the individual, provided, of course, that the social maturity of the individual is sufficient for this to happen." (1996: 74).

The history of Kocaeli dates back to Astakoz, the oldest known settlement in the region, which the Phrygians established in the 12th century BC. Today, Izmit takes its place from the city known as Nikomedia in the Kingdom of Bithynia (262 BC). The town, under Byzantine control during the Roman Empire, lost its importance due to natural disasters. In the 11th century, while Nikomedia was under the control of the Seljuks, it was again included in the Byzantine sovereignty with the Crusades. This demonstrates that the Izmit region has been a geographical area that has attracted various societies throughout history. The city came under Ottoman rule during the reign of Orhan Gazi and later faced British and Greek occupation during World War I. The town was liberated from enemy occupation on June 28, 1921, and gained the status of a province in 1924 (Çalık, 2007: 885; Kocaeli İl Kültür ve Turizm Müdürlüğü, 2023; Oral, 2007; Öztüre, 1981; Ulugün, 2020).

When examining the history of the local press in Kocaeli, it is evident that the first printing house in the city was established in 1860 to print books required by the monastery in Akmeşe. Following this printing house, the first lithographic printing house in Izmit was established during the First World War. Until 1915-1916, there was no Turkish printing house in Izmit, and three people printed the first newspaper in Kocaeli on a stone printing machine (Kocaeli Yıllık, 1973: 139). After the War of Independence, the newspaper suspended publication during the Greek occupation and resumed publication weekly as the official newspaper of Kocaeli until 1933.

In the following years, respectively; "Türkyolu newspaper in 1921, Hürfikir in 1923, Körfez newspaper in 1938, which was the first newspaper printed with a typesetting machine in İzmit, Genç Düşünceler newspaper, Marmara newspaper in 1939, Yeşil İzmit in 1943, Hürsöz newspaper in 1948, Yavuz İzmit and Yaman İzmit newspapers published by İhsan Yazman in 1950 and 1951, Bizimşehir newspaper in 1951, 27 Mayıs newspaper and Zafer newspaper in 1960, Demokrat Kocaeli in 1950, Büyük Dava newspaper in the 1950s, Azim in 1950, İstiklâl in 1961, Kocaeli Adalet in 1970, Hedef newspaper in 1962, Seka Post in 1954, Doğuş in 1960, Körfez Newspaper in the 1960s, although the exact publication date is unknown, Sesim magazine, Işık newspaper, Yeni Yarımca, Karamürsel Post and Chamber of Commerce and Industry Newspaper were published in 1967." (Kocaeli Yıllık, 1973: 139).

Along with the development of the local press in Kocaeli, the SEKA factory, founded on 14 August 1934 in İzmit, produced 3,959 tonnes of paper and cardboard when it began production in 1936, contributing to the publication of local newspapers printed on local paper, as part of the discourse of the First Turkish Paper. SEKA is one of the important symbols of modern paper production in Türkiye during industrialisation. From its establishment until 27 January 2005, when the decision was made to close the plant, SEKA was one of the enterprises that played a significant role in Türkiye's industrial production (Aydın et al., 2002; Balkı, 2012: 65; Oral, 2007).

In addition to being an industrial enterprise, SEKA has also made social contributions to urbanisation. The Friends of Children Association, founded by SEKA employees, contributed to the education of young children, while the aid campaigns organised contributed to developing social awareness. The Company established the Kağıtspor Club to promote sports culture, which operates in various branches, including football, wrestling, sailing, and basketball. In addition, investments were made in fields, courts, swimming pools, and social gathering areas to support sports infrastructure (Balkı, 2010, 2012; Dölen, 2015; Kocabaşoğlu et al., 1996; Sarıoğlu, 2013).

The cinema-theatre hall, which SEKA operated for its employees, constituted one of the places that contributed to the city's cultural life. The SEKA Cinema, which served the city's people over the years, featured important period films. The well-known theatre troupes of the period that visited Kocaeli performed their shows in the multifunctional SEKA Cinema Hall, located within SEKA. Exhibitions, meetings of political figures with the public, and conferences held in these halls instilled a love of art in Kocaeli and contributed to the city's political life (Balkı, 2001; Bayar, 2002). Since its foundation, SEKA has offered services that prioritise cultural activities.

Industrial establishments constitute a socioeconomic means of transmission between the past and the present. Beyond producing an identity for the urban phenomenon, social memory and consciousness emerge as unique through industrial establishments (Çalık, 2007: 886). With the establishment of SEKA, the flow of daily life in the social structure changed, innovations began to emerge in the working practices of the workers, and communities came together in different places and socialised. From kindergartens to

cinemas, sports events to family gatherings, SEKA ensured the integration of the city and industry, as well as the integration of the town and its workers. This way, SEKA built an educated, culturally socialised, and active working-class culture in Kocaeli.

SEKA Postası was printed at the SEKA Printing House, which was established in 1944. The newspaper began its printing journey with old printing machines acquired from the Sublime Porte. During this process, a 1907 model machine was utilised, which frequently malfunctioned and did not print cleanly (Balkı, 2010: 133). Social activities at SEKA increased after 1955. According to Kocabaşoğlu et al. (1996: 211), one important step taken in this regard was the launch of a four-page, tabloid-sized periodical called SEKA Postası, published every 15 days on the first anniversary of SEKA's founding. The success of the newspaper, which is the eyes and ears of the people of İzmit and its window to the outside world, has been reported by local newspapers such as Işık, Hürsöz, Türkyolu-Bizimşehir, Kocaeli, Yeni Yarımca, Doğuş and publications such as Sesim Magazine and Kocaeli National Education Bulletin (Sarıoğlu, 2013: 17). The newspaper, which started its publishing life with the slogan It does not talk about politics, it is a professional and business newspaper, was published on four pages (six pages in some copies) in five columns, measuring 41x57.5 cm. SEKA Postası, whose price was 1 cent and 6-7 thousand copies were printed. It included business and papermaking news, as well as culture, art, and social events on its pages (Şimşek, 2007: 149).

Launched on 21 June 1956 with the encouragement of Enver Atafırat, the General Manager of SEKA at the time, SEKA Postası, which was a business newspaper, was taken care of by Cevdet Yakup Baykal for a while, with Nihat Önür as its managing editor, and in the following years the newspaper became identified with the name of Naci Girginsoy. Under Girginsoy's management, SEKA Postası went beyond being a business newspaper providing news from the paper mills and included technical information, production reports, circulars and regulations, as well as all kinds of artistic, cultural and sporting events in the city (Sarıoğlu, 2013: 8). Girginsoy was one of Kocaeli's important writers, whose columns were published in the local press. Girginsoy also wrote novels, stories, and essays, as well as articles for theatre and cinema, which appeared in various magazines (Balkı, 2010: 124).

Balkı (2010) describes Naci Girginsoy, the chief writer and editor-in-chief of the newspaper, as writing all the articles, conducting interviews, editing the pages, working as a photojournalist and running after clichés. Balkı states that Girginsoy was identified with the newspaper and that his adventure continued for 26 years. Naci Girginsoy wrote the news on art, cinema, theatre, literature, and sports for SEKA Postası. The newspaper, which had been published for approximately 28 years, was closed down in 1984 and replaced by SEKA Magazine, a colourful and higher-quality publication in terms of printing (Balkı, 2010: 123). In addition to industrial investments, the enterprise has implemented various activities and projects that touch the socio-cultural lives of its employees and stakeholders in the city. In 1998, the SEKA plant was privatised and transferred to the Kocaeli Metropolitan Municipality in 2005, after which it began operating as a social recreational area (Balkı, 2010, 2012; Kocabaşoğlu et al., 1996; Sarıoğlu, 2013).

4. Methodology

Firstly, Türkiye's industrial development process is discussed, and the role of mass media in industrialisation and the formation of Kocaeli's urban culture is historically constructed through a literature review. In the previous section, the significance of SEKA Postası newspaper as a mass medium in reflecting urban culture is revealed, and information is provided about other communication tools, such as SEKA Magazine and SEKA Radio, which the institution also publishes. Within the scope of the study, the news content in the SEKA Postası newspaper, which has been published for 27 years, was examined using the quantitative content analysis method. The news content in the printed copies of the newspaper was physically counted and identified, and the data obtained were compiled into tables. In this context, the numerical data received from the news contents were examined to answer the research questions developed in the study.

The content analysis method is a research technique that enables the systematic realisation of communication content within the framework of predetermined categories. These contents, such as newspaper articles, television news, movies, radio programs, and cinema films, can vary. In other words, it is possible to examine all kinds of textual, visual and audio content and documents using this method. Among social science research methods, content analysis has emerged as a method for examining the content of mass media (Geray, 2014: 135). The method was initially characterised as an empirical method aimed at objectively and systematically describing the content of texts subject to communication. However, with the development of this methodology over time, it has also begun to be used to examine the content of social scientific data (Alver, 2003: 241).

According to Berger (1996: 104), content analysis is one of the research techniques that involve measuring, in other words, counting, the number of certain things in specific forms of communication, such as cartoons, situation comedies, and news. The basic assumption of content analysis is based on the research of messages and the illumination of communication to the people who receive these messages. As a sociological analysis method, Berger (1996: 106) argues that this analysis technique reflects the social perspectives the mass media reveals. According to Riffe, content analysis remains an important tool for researchers who more directly investigate how cognitive processes and effects at the individual level are related to message characteristics (2005: 9).

According to Geray (2014: 135), who defines content analysis as one of the research techniques that enable the systematic realisation of communication content within the framework of predetermined categories, the content in question can consist of newspaper news or articles, as well as television news, films, radio programs and movies. This analysis technique can analyse all kinds of textual, visual and auditory content and documents. Content analysis has emerged as a method used in social science research for analysing "mass media" content. In his book Content Analysis, Klaus Krippendorff describes content analysis as follows: first, content analysis is an empirically established method, exploratory in terms of procedure, and predictive or indirect (2004: 17). There are several field studies

in which content analysis method is used on newspaper news; Nejdet Atabek's "Gazete Haberlerinde Etik Standartların Yükseltilmesinde Okur Temsilcisinin Rolü" (2013), Ali Murat Vural, Hatun Boztepe Taşkıran et al. "Risk İletişiminde Geleneksel Medya: Gazete Haberlerinin Deprem Felaketleri Örnekleminde Analizi" (2022) and "Türkiye'de İklim Haberciliği: Kuraklık Haberleri Üzerine Bir İçerik Analizi" (2023) by Özge Cengiz can be cited as examples. Since the main research topic of the study involves testing research questions developed using the content analysis method, considering similar studies in this context reveals empirical research methods that contribute to the original value.

The quantitative content analysis technique is widely used to analyse written texts. In this context, in the categorisation stage, the repetition frequency of words and concepts in the text content is determined. Open coding is more commonly used since the content on the visible surface of the text is coded. For example, the frequency of a word or concept in the text is evaluated and noted. In open coding, the searched word either exists or does not exist. Therefore, it is stated that the reliability of this method is relatively high (Neuman, 2017). In the coding process, the researcher plans how to divide the data to be analysed into meaningful wholes (Yıldırım & Şimşek, 2000). According to Silverman (2018), labelling the words, sentences and paragraphs determined while coding in content analysis is seen as one of the practical ways.

4.1. Aim and Importance of the Study

With its geographical location and production capacity, Kocaeli is one of the important industrial cities in Türkiye. SEKA, one of the first industrial enterprises established in Izmit during the industrialisation process of the Republic's history, has assumed a role that has further strengthened the city's potential. SEKA contributed to the paper production process and played an important role in reflecting various social, economic, cultural, and daily life developments within the institution and in the city to its people. Mass media plays a crucial role in preserving and disseminating urban culture to the public. The study hypothesises that the newspaper Seka Post contributed to the formation of urban culture in the industrial development process. In this context, the study aims to investigate the institution's contribution to the formation of urban culture in the industrial development process through the newspaper SEKA Postası, which was published by the institution and printed in its printing facilities. The following research questions were developed in the study in which the news contents related to urban culture in SEKA Postası newspaper were examined:

- Which news items in SEKA Postası newspaper were prominent in reflecting the urban culture?
- Did the social and political developments of the period and the changes in the administrative structure of the enterprise lead to differentiation in the news content represented in SEKA Postası newspaper?
- As a business newspaper, does SEKA Postası incorporate the thematic subject distinctions typical of mass newspapers into its news content?

4.2. Scope and Limitations of the Study

Within the scope of the study, 2,488 pages of news content from 484 printed copies of Seka Postası newspaper were examined over 27 years, from June 21, 1956, to January 1, 1983. In all printed copies of Seka Postası newspaper, which are bound in the Kocaeli Metropolitan Municipality SEKA Paper Museum Documentation Center archive, news on sports, education, health, culture, and arts, as well as daily life topics related to urban culture, were quantitatively examined. İzmit Paper and Cardboard Factory is recognised as one of the pioneers of the city's social and cultural life. The factory, where activities such as cinema, various sports branches, theatre, artistic courses, and conferences were held, also served as a school and cultural centre (Balkı, 2010: 142; Şenyurt, 2010). Sarıoğlu (2013) stated that the newspaper was a versatile and satisfying publication organ and added that it covered the following topics: state dignitaries visiting SEKA, commemorative meetings, holidays, news on trade unionism, fire drills, collective bargaining agreements, decisions taken, developments in the country and the world, poems, essays, articles, travel articles, interviews, sports events, films, theatre performances, exhibitions, concerts, ceremonies, SEKA camp, SEKA Children' Friends Association activities, kindergarten, bazaars, circumcision weddings, marriage news, health column, helpful information, some technical inventions, news about İzmit, fair news, new books, cartoons, humour, jokes and developments in daily life are among the topics covered in the pages of the newspaper. In addition to the codes identified through the literature review, the study incorporated themes that were also identified during the review process. Based on the deductive research approach, the topics were identified through a review of written sources in Seka Postası newspaper and testimonies from the period. In the literature review conducted within the scope of this study, a total of 60 variables were identified under five main headings that represent urban culture. In this context, 19 variables under the title of sports, five variables under the title of education, three variables under the title of health, 16 variables under the title of culture and arts and 17 variables under the title of daily life were collected and included in the study. The fact that in-house news, columns, and visual materials were not included in the study constitutes a limitation.

5. Findings and Discussion

In the study, the data obtained according to the variables under five main headings were tabulated by the year of publication of the SEKA Postası newspaper. This framework tries to reveal the extent to which SEKA Postası, as a business newspaper, covers events in socio-cultural life.

Table: 1
"Sports" Themed News Content Published in Seka Postası Newspaper (1956-1982)

Year of Publication	Number of Publications	Football	Basketball	Wrestling	Boxing	Sail	General	Volleyball	Cycling	Pitcher / Shooting	Swimming	Shovel	Gymnastics	Tennis	Athletics	Horse Racing	Table Tennis	Chess	Fencinh	Rally
1956	12	12		1	6	4						3								
1957	24	13	3	5	11	3		3					2		1					
1958	24	38	2	11	2	5	5			1							1			
1959	23	35	7	22		2	1													
1960	19	43		12		1	4	2		1										
1961	14	15	13	5	8	5	2	2				1								
1962	22	25	11	17	5	8	10	1	1	1	2			2						
1963	23	34	12	1	2		6	1	2	1	1			2						
1964	23	45	6	4	2		4	1		1	2		1							
1965	19	47	2	4	3	1	2		3	3			1			1				
1966	23	59	5	5	2	3	1	1	3	1										
1967	22	42	4		3				1						1					
1968	23	39	4		3	3	1	5	1											
1969	24	26	7		8	3	2													
1970	24	25	7	6	11	3	1	3							1					
1971	22	7	7		6			3						1	1	1				
1972	23	14	6		2			1	1											1
1973	14	13	3		1	1		1												
1974	22	8	8		1	1			3		2						1			
1975	18	15	5					1			1									
1976	19	10	10															1		
1977	14	10			1			4												
1978	10	7	4		1															
1979	9	5	1		1		1													
1980	8	7	2		1			1											1	
1981	5	5	2		4			2					1		1					
1982	1	3	1																	
Total	**484**	**602**	**132**	**93**	**84**	**43**	**40**	**31**	**15**	**10**	**8**	**5**	**5**	**5**	**4**	**2**	**2**	**1**	**1**	**1**

When the 19 variables determined through the sports theme within the scope of the study are examined, it is evident that football constitutes the most frequently covered news content, with 602 news items. On the other hand, chess, fencing and rally were covered only once each. In addition to team sports such as football, basketball, and volleyball, the newspaper also featured news items on individual sports, including wrestling, boxing, cycling, swimming, and rowing. It is noteworthy that SEKA Postası, which was published from 1956 to 1982, featured sports such as fencing, rally, shooting, cycling, tennis, and athletics, which may have been considered relatively unknown to the public, given the socio-economic context in Türkiye. Upon reviewing the period during which the examined news items were published, it becomes apparent that the newspaper featured news from various sports branches between 1956 and 1966. During the period of SEKA Postası's publication from 1975 to 1982, it is noteworthy that the number of news items related to the subject decreased, and the focus shifted to football news. It can be stated that the reason for this transformation lies in the decrease in the number of newspaper publications and the reduction in the activities in sports branches in particular. In addition, in parallel with Kocaeli's geographical location, unique content from the sailing, rowing and swimming branches of Kağıtspor, which operates within the SEKA enterprise, also found a place on the pages.

Table: 2
"Education" Themed News Content Published in Seka Postası Newspaper
(1956-1982)

Year of Publication	Number of Publications	Course	Seminar	Nursery	General	Apprentice
1956	12			5		
1957	24		1	4		
1958	24	3		2		
1959	23	3		3		
1960	19	2		2		
1961	14	1		1		
1962	22	3				
1963	23	12	4	2		
1964	23	6	2	1		
1965	19	6	4	1		
1966	23	2	2	1		
1967	22	2	8	1		
1968	23	4	11			
1969	24	8	9			
1970	24	5	5		2	
1971	22	2	3			
1972	23	8	10	1		
1973	14	2	7	1		
1974	22	8	6			2
1975	18	4	1			
1976	19	3	2	3		
1977	14	3	4			
1978	10		1			
1979	9	2	1			
1980	8			1		
1981	5	1	2			
1982	1					
Total	**484**	**90**	**83**	**29**	**2**	**2**

Within the scope of the study, when the five variables determined through the education theme in Table 2 are examined, the course comprises shared news content consisting of 90 news items. On the other hand, only two news items are under the apprentice title. Since SEKA Postası is a business newspaper, its importance to in-service training and personnel development is evident from the news items on courses and seminars. In this framework, the importance the enterprise attributes to education policy over the 27 years examined is apparent from the periodic coverage of news items on the subject. In addition to being an industrial enterprise, the examination process also revealed information about the nursery established under the SEKA Children's Friends Association, one of its contributions to urban life, and the activities of this nursery for both employees and the city. When the years in which news on education was published are examined, it is observed that there was an increase in the number of news articles on the subject between 1963 and 1973, indicating the intensity of in-house training processes in SEKA. However, from 1978 to the end of the newspaper's publishing life, the number of news items related to education decreased. At the same time, the existing news items were limited to only one or two. This transformation process is an indicator of the policies followed by the enterprise regarding its activities, but it can also be evaluated as a sign of a noticeable decrease in the space allocated to education in the newspaper's content.

Table: 3
"Health" Themed News Content Published in Seka Postası Newspaper (1956-1982)

Year of Publication	Number of Publications	Vaccine	Health	Disease
1956	12			
1957	24			
1958	24			1
1959	23			
1960	19			3
1961	14			
1962	22			
1963	23	4	3	1
1964	23	3	3	3
1965	19	1	3	
1966	23			
1967	22			
1968	23			
1969	24			
1970	24	1		
1971	22	1	1	
1972	23	1		
1973	14	1		
1974	22			
1975	18			
1976	19			
1977	14			
1978	10			
1979	9			
1980	8			
1981	5			
1982	1			
Total	**484**	**12**	**10**	**8**

Within the scope of the study, when the three variables determined through the health theme in Table 3 are examined, vaccination is the shared news content, comprising 12 news items. On the other hand, it is observed that only eight news items were covered under the title of disease in the newspaper. During the period when SEKA Postası was published, it was noted that the newspaper featured news items aimed at raising awareness and reminding readers about vaccines used in the treatment of various diseases, particularly tuberculosis, within the context of global and Turkish social public health. Health-themed news items were less common in the newspaper than the headings of sports and daily life. Upon examining the data in the table, it is evident that the newspaper featured health-themed news only between 1963 and 1965 and again between 1970 and 1973, during its 27-year publishing life. Notably, the organisation did not give sufficient importance to news items on the theme of health compared to news items on sports, arts or daily life, and very little space was allocated to news items on the subject.

Table: 4
"Culture and Arts" Themed News Content Published in Seka Postası Newspaper (1956-1982)

Year of Publication	Number of Publications	Theatre	Cinema	Fair / Pavilion / Stand	Exhibition	Concert	Folklore	Film	Radio	Conference	Fashion Show	Book	Music	Interview	Ballet
1956	12		3	2											
1957	24		10	2		1	4								
1958	24				1	4									
1959	23	3	6		1	3				2					
1960	19	14	4			1								1	
1961	14	8	1		4	4					1				
1962	22	19	10	3	3	6				1	1				
1963	23	34	13	2	2	6									
1964	23	31	11	3		2	2		1	1				1	
1965	19	16	4	3	2	1		2	8					1	
1966	23	12	11	6	4	2		2		1					1
1967	22	9	8	1	2			1							
1968	23	9	2	1	1			2	2	1					
1969	24	4	5	2	4	2	1	2		2		2			
1970	24	12	8	1	6		1								
1971	22	13	6	8	1	2	1	1			2				
1972	23	10	7	6	6	2	1								
1973	14	3	2	2	4	3									
1974	22	7	4	5	3		2								
1975	18	4	1	2	1	1					1				
1976	19	2	3	4	2										
1977	14	1	2	6			2								
1978	10	2	1	1											
1979	9	7		1		2	1	1			1				
1980	8	2	2	1	2	2	1								
1981	5	3	2	1	1	2									
1982	1	1	1												
Total	**484**	**226**	**127**	**63**	**52**	**44**	**19**	**10**	**9**	**8**	**6**	**2**	**2**	**1**	**1**

When the 16 variables determined through the culture and arts theme included in the scope of the study are examined, theatre constitutes the shared news content with 226 news items. On the other hand, it is noted that only one news item was covered under the titles interview and 'ballet'. Activities such as theatre, cinema, fairs, exhibitions, and concerts are the most prominent cultural events in the city. Due to Kocaeli's proximity to Istanbul, many private theatre companies performed their plays on the SEKA stage. It is noteworthy that SEKA Cinema, which brought popular films of the period to the city's people, mainly since the early 1960s, emerged as one of the city's socialising venues. When examining the news content on "culture and arts," it is evident that the intellectual follow-up of the news is conducted before and after the events. In addition, the newspaper also features news on fashion shows held at the SEKA plant, reflecting the fashion culture, as well as news on SEKA Radio, which has an educational mission. There were also news reports on SEKA's regular participation in the country's fair events and its representation of the city in this context. When the contents of the news items between the years of publication of the examined news items are discussed, it is observed that the news items related to theatre and cinema activities took the lead between 1962 and 1972. In this context, the number of news items covering all branches of art is noteworthy. However, from 1979 until the publication's end, the number of news items decreased, and the number of available news items was

limited to 10 or 12 per issue. The reason for this decrease in the number of news items is that SEKA did not give sufficient importance to content related to art activities towards the end of its publishing life due to the social and political developments of the period.

Table: 5
"Daily Life" Themed News Content Published in Seka Postası Newspaper
(1956-1982)

Year of Publication	Number of Publications	Death	Birth	Wedding / Marriage	Engagement	Event	Family Meeting	Circumcision	Prom	Meeting	Iftar	Congress	Mevlut	Kermes	Band
1956	12	8	9	9	2				1			1			
1957	24	10	26	2	1	1		3	1						
1958	24	10	35	8	5	1	4	2							
1959	23	10	41	7	2		2	2							
1960	19	6	28	6	2	1	2	3	1						
1961	14	8	21	11	4	1	2	2	2						
1962	22	13	36	17	3	6	6	4	1						
1963	23	14	41	9	4	4	4	2	1	1		4			
1964	23	10	47	14	4	1	1	1	1						
1965	19	8	36	12	3	3	3	2		1					
1966	23	22	27	23	6	6	4	1							
1967	22	17	15	6	5		3	2					2		1
1968	23	17	18	8	6		2	2	3				3		
1969	24	27	13	18	8		2	1	2		2		3		
1970	24	49	18	21	7	14	6	1	5		1	2	1	2	
1971	22	44	12	14	15	12	3	2	2			5	1		
1972	23	37	10	20	12	26	3	3	2		1				
1973	14	28	9	10	6	10	4		1		2			1	
1974	22	25	19	25	22	8	1		1		1			1	
1975	18	30	16	10	11	8	2		3		2				
1976	19	47	15	20	8	13	4		1		2				
1977	14	44		17	7	14	2		1	6	1			3	
1978	10	49	24	17	7	8			2	6					
1979	9	51	33	20	6	7	2	1	2	2					
1980	8	24	13	9	5	6	1		1	1					
1981	5	26	14	19	4	2	3			2				1	
1982	1	5	2	3	1	3								1	
Total	**484**	**639**	**578**	**355**	**166**	**155**	**66**	**34**	**33**	**19**	**12**	**12**	**10**	**9**	**1**

When the 17 variables related to the theme of daily life within the scope of the study are examined, death and decease constitute the most common news item, with 639 news items. On the other hand, only one news item was covered under the band title. It has been determined that death-death news about employees, first-degree relatives of employees and critical public figures are reported and shared in the newspaper with the logic of internal information. In addition, to share the employees' happiness within the organisation, news about their newborn children was covered as much as death-death news. As a business newspaper, SEKA Postası, in its role as an indicator of corporate awareness, has been found to include news on weddings, engagements, and circumcisions, which aim to strengthen social ties. Additionally, it is observed that events such as family meetings, bazaars, iftar, and mevlit, which are organised as social activities within the organisation and bring together the families of employees, are also covered in the newspaper. When the news items on daily life in the table are examined, it is evident that the content on the themes of sports, education, health, and arts was concentrated between 1966 and 1979. In the news items, in-

house personnel were covered as the subject. At the same time, upon examining the data, it was found that the preferred news topic in terms of diversity was 'daily life'. Except for 1956, the first year the newspaper was founded, and 1982, when the last issue was published, it is noteworthy that news items based on daily life have appeared in the newspaper every year.

6. Conclusion

As an institution that has grown over the years within the framework of Türkiye's industrialisation process, the SEKA paper enterprise has not only been an industrial enterprise but also assumed an active role in the urbanisation process of the period, taking various socio-cultural steps since the 1950s. Within this framework, the newspaper SEKA Postası, which serves as the starting point of the research, has established itself as an important stakeholder in Kocaeli city culture, comparable to the contribution of a product to the development of an industry. The presence of the enterprise in socio-cultural life was not limited to the SEKA Postası newspaper but became more widespread through SEKA Radio, the SEKA Children's Friends Association, Kağıtspor, and SEKA Magazine.

The research questions developed within the study's scope were tested by examining the data on news content in the SEKA Postası newspaper, which was compiled into tables for analysis. In this context, the study primarily aimed to answer the first research question, which was developed to determine which news items in the SEKA Postası newspaper are emphasised in reflecting urban culture. When the data obtained from sports, daily life, culture, and arts-themed topics in the newspaper were evaluated, it was observed that activities related to urban culture were carried out, and the sustainability of socialisation was ensured through these activities. In particular, 602 news items focused on football, 555 on weddings, marriages, engagements, and circumcisions, and 449 on theatre, cinema, exhibitions, and concerts were presented to readers as indicators of social cohesion. In the newspaper, 29 news items on nursery services were identified, indicating the social benefit of the enterprise. It was determined that these items aimed to announce innovative steps towards developing social life, alongside a total of 193 news items on balls, fashion shows, and events.

When the distribution of topics related to the themes of Sports, Education, Health, Culture-Arts, and Daily Life in the SEKA Postası newspaper is evaluated by year, it is observed that they are similar to the news content. It is noteworthy that from the beginning of the 1960s until 1973, news about education, health, culture, and the arts was featured prominently in the newspaper, while sports news content, primarily related to various branches, occupied a larger portion of the newspaper from its inception until the mid-1960s. From the second half of the 1960s to the 1980s, it can be observed that developments related to daily life occupied a larger portion of the newspaper's pages. On the other hand, from the late 1970s until 1982, when SEKA Postası ceased publication, there was a significant decrease in news content representing all these themes due to the limited number of newspapers published and the social and political developments of the period.

When the research question developed within the scope of the study, whether the social and political developments of the period and the changes in the administrative structure of the enterprise caused a differentiation in the news content represented in SEKA Postası newspaper is evaluated, it is determined that the publication planning and news content of the newspaper changed within the framework of both economic and political events during the 27 years of periodic publication. During the May 27, 1960 military intervention, SEKA Postası was not published from October 1960 until March 1961. Additionally, it has been observed that during periods when the enterprise managers changed, there were corresponding changes in the news content, the page design of the newspaper, and the content and size of the logo and visual materials. It has been observed that various news about the production reports and activities of Çaycuma, Aksu, and Dalaman enterprises, which started operations after SEKA, were widely covered in the pages of SEKA Postası, aiming to increase awareness of industrialisation within the enterprise.

When the last research question of the study about whether SEKA Postası, as a business newspaper, includes thematic subject distinctions in the news content of mass newspapers is evaluated, it is seen that SEKA Postası includes examples such as photo-news, column and travel column, as well as trying to implement the innovative editorial content approach emerging in the mass media. In addition, innovations in newspaper publishing were identified in the scanning study conducted on the printed copies, including the Technical, Art, and Magazine sections, the Five-Minute Puzzle, Humor, and Your Fortune columns, the Spor Toto 12-Column Prediction column, and the Customer Corner.

Within the scope of the study, 60 variables were identified under five headings assumed to represent urban culture in SEKA Postası newspaper. A total of 3,979 news items were identified within the scope of five different themes, as determined in 484 published newspaper issues. Among the total number of news, 2089 news about daily life ranked first with a rate of 52.50%, followed by sports with 1084 news and a rate of 27.24%, culture and arts with 570 news and a rate of 14.33%, education with 206 news and a rate of 5.18%, and health news with 30 news and a rate of 0.75%. When the data sets that emerged in the distribution of the topics related to the themes of Sports, Education, Health, Culture and Daily Life in the newspaper according to years are evaluated, it is determined that the hypothesis developed that the newspaper contributes to the formation of urban culture in the industrial development process is confirmed.

Within the framework of the examination of news content in the newspaper SEKA Postası, which operates within the SEKA enterprise, it was determined that the research questions developed in the study were confirmed. In this framework, it was concluded that SEKA Postası, a business newspaper, played a crucial role in the industrialisation process by assuming a mission that represented the social aspect of the industry, contributing to the awareness of urbanisation. In this sense, it contributed to the development of the city's cultural life. In the context of the relationship between industrialisation and daily life, the content presented by mass media, excluding newspapers, can be examined within the scope of various academic studies. In future academic studies similar to this study, in which the

relationship between urban culture and industrialisation will be addressed together, oral history studies that will reflect the testimonies of people representing the memory of the city, structured interview techniques or "ethnographic" research method, which involves in-depth participant observation for qualitative research design, can be used. Additionally, the news content and visual materials in the SEKA Magazine, published by the SEKA enterprise, can also be examined in future studies. The data obtained within the scope of the survey can also be used in research on the effects of other institutions operating in the industrialisation process on urban culture.

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The Effect of Nuclear Energy Use and Military Expenditures on The Formation of The Environmental Kuznets Curve: A Study for BRICS Countries

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Nükleer Enerji Kullanımı ve Askeri Harcamaların Çevresel Kuznets Eğrisinin Şekline Etkisi: BRICS Ülkeleri Üzerine Bir Araştırma

Abstract

The Environmental Kuznets Model examines the relationship between per capita income level and environmental quality. This study aims to estimate the current Environmental Kuznets Curve (EKC) model, which considers military expenditures and foreign direct investments in Brazil, China, India, Russia, and South Africa, with a focus on countries that produce nuclear energy. In this regard, the data for these countries from 1992 to 2020 were subjected to econometric analysis. Three control variables -carbon emissions per capita, GDP per capita, and the share of nuclear energy in total energy consumption -were used in the econometric model. According to the findings, the EKC in these countries is U-shaped. The study also aims to fill the gap in the literature by estimating the EKC model that considers the military expenditures and foreign direct investments of countries producing nuclear energy.

Keywords : The Environmental Kuznets Curve (EKC), BRICS, Military Expenditures, Nuclear Energy, Foreign Direct Investment.

JEL Classification Codes : C33, Q53, Q56.

Öz

Çevresel Kuznets Modeli, kişi başına düşen gelir düzeyi ile çevre kalitesi arasındaki ilişkiyi incelemektedir. Bu çalışma, nükleer enerji üretebilen Brezilya, Çin, Hindistan, Rusya ve Güney Afrika'nın askeri harcamalarını ve doğrudan yabancı yatırımlarını dikkate alan güncel Çevresel Kuznets Eğrisi modelini tahmin etmeyi amaçlamaktadır. Bu doğrultuda söz konusu ülkelerin 1992-2020 dönemine ait verileri ekonometrik analize tabi tutulmuştur. Ekonometrik modellemede kişi başına karbon emisyonu, kişi başına GSYİH ve nükleer enerjinin toplam enerji tüketimindeki payı olmak üzere üç kontrol değişkeni kullanılmıştır. Bulgulara göre, bu ülkelerdeki Çevresel Kuznets Eğrisi "U" şeklindedir. Çalışma ayrıca nükleer enerji üreten ülkelerin askeri harcamalarını ve doğrudan yabancı yatırımlarını dikkate alan Çevresel Kuznets Eğrisi modelini tahmin ederek literatürdeki boşluğu doldurmayı da amaçlamaktadır.

Anahtar Sözcükler : Çevresel Kuznets Eğrisi, BRICS, Askeri Harcamalar, Nükleer Enerji, Doğrudan Yabancı Yatırımlar.

1. Introduction

Achieving a stable level of economic growth is a fundamental objective shared by all nations. The Second World War severely damaged the economies of many countries. Countries started to develop aggressive growth policies to overcome the destruction caused by war. Since then, the amount of carbon emissions into the atmosphere has increased globally. This choice of countries brought the sustainability of natural resources, one of the basic inputs of economic activity, to the agenda.

The BRICS countries (Brazil, Russia, India, China, and South Africa), which are the focus of this study, are among the countries that produce significant carbon emissions worldwide. The carbon emission levels of these countries and their reasons can be analysed under several headings:

- **Industrialisation**: The BRICS countries undergo a faster industrialisation process than industrialised countries. As a major industrial production centre, China, in particular, uses large quantities of fossil fuels.
- **Energy Production**: Energy production in these countries is generally based on fossil fuels, including coal, oil, and natural gas. China and India have large shares of coal in electricity generation.
- **Population**: The BRICS countries comprise a significant portion of the world's population. The large and rapidly growing population increases energy demand, leading to higher carbon emissions.
- **Agriculture and Forestry**: Agricultural activities and deforestation are significant sources of carbon emissions, particularly in Brazil, where the destruction of Amazonian forests has had a considerable impact. Agricultural employment and natural resource utilisation often ignore environmental sustainability.
- **Economic Growth**: These countries are increasing industrial and energy production to sustain economic growth. This process is usually carried out without considering environmental impacts.
- **Political and Social Factors**: Factors such as government policies shaped within the framework of the geopolitical position, military expenditures, environmental regulations, renewable energy investments and increased environmental awareness may affect carbon emissions in BRICS countries.

Economic activities, such as significant increases in military expenditures and investments, can cause environmental problems. These ecological problems also disadvantage the economic structure. The economy and the environment have a mutually impacting relationship. Therefore, ecological resources are an important factor in sustainable economic development. Most countries also have a dynamic relationship between environmental sustainability, investments, and economic activities. Clean energy options are crucial for economic recovery and development in this context.

As is well known, energy is crucial for the continuity of economic activities (Bozkaya et al., 2022: 82600). Studies show that countries that produce nuclear energy tend to exhibit good economic performance and high levels of environmental sustainability (Apergis, 2016: 268). Continuous efforts are being made to promote a clean and sustainable environment worldwide. In many studies, the use of nuclear energy is becoming increasingly widespread due to its low carbon emissions (Duran et al., 2022: 70570). Governments also provide support for clean energy and the environment. It should not be forgotten that nuclear energy offers a way to achieve a resilient and low-carbon system. While countries make military expenditures and investments, they take various measures to reduce nuclear energy and carbon emissions. These measures have also become prerequisites for sustainable development, making it essential for the global economy to address the negative impacts of global warming. It is necessary to remember that renewable energy largely relies on natural cycles, and investments must be made to develop infrastructure that harnesses these cycles effectively. It is observed that most developing countries that prefer nuclear energy are unable to make these investments.

There is a lack of research in the literature on the relationship between military expenditures and the EKC. However, capitalism drives countries to engage in wars and acquire better and superior weapons (Elveren, 2021: 9), thereby increasing the importance of military expenditures for national economies daily. The political and economic systems implemented in recent years have led to increased tensions between countries. Events such as the Russia- Ukraine War and the tensions in the Middle East, such as the Israeli-Palestinian War, which have become almost commonplace, result in increased military expenditures. In today's world, systems are being destroyed by war on one hand and rebuilt on the other, revealing that the primary goal of countries in defence and security is to maintain stability. Thus, countries must choose to direct more of their capital to military expenditures. This study was conducted to address this gap and highlight the importance of the issue. The hypothesis obtained by Kuznets in his time series study, which utilised data sets from Germany, England, and the USA, has guided our study. The impact of economic activities and economic growth on the environment remains a subject of ongoing scientific study. The EKC expresses the relationship between national income per capita and environmental pollution. According to Kuznets (1955), a relationship exists between environmental pollution and economic development. This relationship is shaped like an "inverted U." The EKC explains the relationship between the deterioration of environmental conditions and the per capita income level. In his study, Kuznets revealed that environmental pollution initially increases and then decreases during the phase of economic growth and development (Akyıldız, 2008: 142-143). In other words, when economic growth increases, environmental pollution initially increases, the trend reverses after a particular threshold value, and as the level of economic development increases, environmental awareness increases and environmental pollution decreases (Erataş & Uysal, 2014: 6). The reason for the inverted U-shaped relationship between per capita income level and environmental pollution is due to structural and technological effects. In economies heavily reliant on agriculture, the environment is significantly impacted. However, with the development of

industry and the use of clean and advanced tools, the rate of environmental pollution has decreased. In short, while increased industrialisation sometimes leads to environmental degradation, it also yields positive results in some countries. In other words, another essential point in the EKC is that as income levels continue to increase, the inverted U-shape situation reverses, and thus, environmental degradation decreases. Kuznets also emphasised the need to increase environmental awareness and stated that environmental pollution should be reduced.

The BRICS countries (Brazil, Russia, India, China, and South Africa) play a crucial role in analysing the EKC because these nations exhibit distinct dynamics in their economic growth processes and environmental issue management. Here are some points that highlight the significance of BRICS countries in the analysis of the EKC:

- **Stages of Development**: The BRICS countries represent various stages of development within the EKC. While some countries are undergoing rapid industrialisation, others are making progress in addressing environmental degradation.
- **Economic Growth:** With their high growth rates and large populations, the BRICS countries account for significant environmental changes and resource consumption. Understanding whether economic growth leads to environmental impacts is critical for analysing developments in these nations.
- **Policies and Governance:** The BRICS countries adopt different approaches to developing environmental policies and laws. This diversity can provide valuable insights for determining adequate ecological protection and sustainable strategies.
- **Global Impact:** The BRICS countries account for a significant portion of global carbon emissions. Therefore, understanding the relationship between environmental quality and economic growth in these nations and developing applicable policies is crucial for global environmental policies.
- **Interpretive Differences:** The BRICS countries may experience the EKC differently due to the influence of diverse cultural, political, and economic structures. This situation allows for universal lessons to be drawn for environmental management and sustainable development policies.

In summary, the BRICS countries provide the necessary depth and variety to understand the relationship between economic growth and environmental quality within the context of the EKC. Their experiences can also yield significant insights for other developing nations.

The study's primary purpose is to investigate how the relationship between environmental quality and economic growth, known as the Environmental Kuznets Curve (EKC), changes in the context of nuclear energy use and military expenditures for developing economies. The policy problem this study focuses on is whether the defence expenditures of developing countries, due to the geopolitical risks they face and the cheaper nuclear energy they use to fuel their growing economies, support environmental degradation.

This is because if countries that have achieved a certain level of economic growth through defence expenditures and nuclear energy consumption cause an ecological disaster over time, it will destroy the importance of the economic success previously achieved for future generations. This study focuses on BRICS countries to investigate the relationship between environmental quality, military expenditures, and nuclear energy use. These countries, which have been the subject of many economic studies, attracted attention in 2001 when Jim O'Neill, an economist working at Goldman Sachs, coined the term 'BRIC', which consists of the initials of Brazil, Russia, India and China (O'Neill, 2001:1). At that time, these countries had large surface areas and middle-income but rapidly growing economies. For these reasons, they were projected to be among the world's largest economies by 2050. In 2006, these four countries officially came together to form BRIC. With South Africa's participation in 2010, this group was renamed BRICS. BRICS countries, which have achieved stable growth, are the most suitable country group for this study's empirical analysis, as they can produce nuclear energy and continually expand their military assets due to various geopolitical conflicts.

The study is organised into three sections. The first section will draw the conceptual framework of the EKC. The second section presents a literature review of studies on the EKC. In the third and final section, the relevant data of some countries that can produce nuclear energy will be subjected to econometric analysis, and the shape of the EKC in these countries will be determined. The study concludes with a section that evaluates the findings of the econometric analysis.

2. Conceptual Framework

The EKC explains the relationship between per capita income and environmental pollution. Its theory is based on the work of Simon Kuznets. In his study, Kuznets (1955) revealed the relationship between economic growth and income distribution. Accordingly, it is argued that income inequality will increase in the early stages of economic growth and decrease later.

This idea, put forward by Kuznets, became an important issue to be emphasised. Many transnational organisations have organised conferences on the subject to raise awareness. In the 1990s, factors such as the use of fossil fuels in energy supply and the greenhouse effect caused by gases released into the atmosphere brought the relationship between the environment and economic growth back to the top of the world agenda. Research on the relationship between economic growth and environmental pollution began to shift towards the Environmental Kuznets Curve (EKC) with the availability of data sets on many pollutants through the Global Environmental Monitoring Systems, established to monitor air quality in cities (Bo, 2011: 1322).

The concept of EKC was first used by Panayotou in 1993. Based on the relationship between per capita income and income inequality proposed by Kuznets in 1955, Panayotou argued for the existence of an inverted U-shaped relationship between environmental

pollution and economic growth (Panayotou, 1993: 14). The reason why this name refers to the relationship between economic growth and environmental pollution is that it reveals an inverted "U" shaped relationship, with low levels of income tending to increase income inequality, while high levels of income tend to reduce it.

The EKC theory posits that environmental degradation caused by increased production in the early stages of economic growth will be mitigated and that this growth will ultimately improve the environment, particularly in the economies of developed countries (Stern, 1998: 173).

The early stages of growth in developing economies are primarily focused on producing industrial products that generate greenhouse gas emissions. In this stage, people's disposable incomes are scarce. Similarly, businesses have almost no budget for measures to prevent environmental degradation. In the next stage of economic growth, the use of natural resources is expected to increase production volume again, and carbon emissions will also rise due to the waste generated by production. As the relevant country's GDP per capita and welfare level increase, environmentally friendly policies may become more prominent on the agenda (Panayotou, 1993: 14).

Subsequent studies have tried to determine the curve's shape using different variables. While some suggest that the curve may be "N," others have found it to be an inverted "U," similar to the first version.

2.1. Determinants of the EKC

Many factors determine the process described by the EKC theory. These factors also address many economic phenomena in nature. The factors affecting the formation of EKC can be listed as follows (Grossman & Krueger, 1991: 3-4; Dinda, 2004: 435-436):

- Scale Effect
- Composition Effect
- Technological Effect

2.1.1. Scale Effect

According to the scale effect, economic growth and environmental pollution exhibit a similar directional relationship. The technical impact of economic growth has limited ecological benefits. The composition effect of economic growth varies depending on the country's comparative advantage (Ang, 2009: 2659). The increasing part in the first stage of the EKC refers to the scale effect, while the decreasing part refers to the composition and technical effect (Başar & Temurlenk, 2007: 2).

According to the EKC theory, after a sufficient level of economic growth is reached, further economic growth leads to environmental degradation. Primary production is more prioritised in the early stages of economic development. Therefore, economic activities are

limited in scope. This results in a reduced amount of waste being produced. With the economic structure and industrialisation that emerge after primary production, excessive consumption of natural resources increases the amount of garbage. Therefore, at this stage, a same-directional relationship is observed between environmental degradation and income level (Kaika & Zervas, 2013: 1393).

Figure: 1
Scale Effect
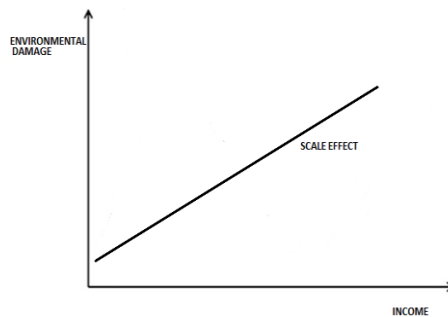
Source: Halkos, 2011: 9.

Figure 1 above shows the scale effect. At this stage of the EKC, environmental damage increases as income levels rise. The scale effect refers to the stage before the threshold point predicted by the theory.

2.1.2. Composition Effect

In contrast to the scale effect, the composition effect refers to the positive impact of economic growth on environmental degradation. The structural and fundamental changes made in the country under study exemplify this effect (Panayotou et al., 2000: 6). As is well known, a country's economic growth typically begins with the agricultural sector. Afterwards, economic growth is realised under the leadership of the industrial sector. However, this situation is different in countries where the capital factor is abundant. In these countries, economic growth shifts towards the service sector rather than the industrial sector. Along with the service sector, the information sector is also in a critical position (Başar & Temurlenk, 2007: 2). Since the inputs of these sectors are human-based resources such as ideas, human resources, etc., the resulting product does not cause any degradation on the environment (Panayotou et al., 2000: 6).

With the transition from agriculture to industry-based growth, migration from rural to urban areas is increasing. This can lead to environmental degradation. As a result of the increase in urbanisation, the rise in energy use causes ecological damage, and the increase in waste production also exacerbates environmental damage (Panayotou, 1993: 1). With the advancement of technology, continuous economic growth eventually increases the demand

for services in the sector. This shift from the industrial sector to the service sector results in a decrease in the use of natural resources and environmental degradation. In this respect, the composition effect refers to the part of the EKC that reaches the threshold point and enters a downward trend (Dinda, 2004: 435-436).

Figure: 2
Composition Effect
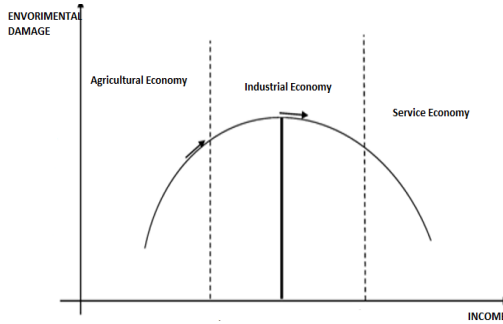
Source: Halkos, 2011: 9.

2.1.3. Technical Effect

Technical effect emerges at later stages of economic growth. Like the composition effect, it contributes positively to environmental degradation (Borghesi, 1999: 6-7). As economic growth, per capita income, and foreign trade increase, the demand for ecological improvement will also rise. The technical effect tries to prevent environmental degradation through environmentally friendly business models it creates (Cole & Elliott, 2003: 364). Increasing the level of R&D expenditure to generate innovation and understand efficient production can prevent environmental degradation. The fact that R&D expenditures adopt an environmentally friendly approach in production technology is vital to this (Ang, 2009: 2659).

Technical effect aims to create less input and less environmental pollution to achieve a specific output. In economies where per capita income exceeds a certain threshold, resources allocated to R&D expenditures and innovation studies are likely to yield new technological developments (Grossman & Krueger, 1991: 4). Environmental degradation is minimised through R&D expenditures and technological advancements (Karagöz-Domaç, 2022: 27).

As shown in Figure 3, in countries where the per capita income level has increased and reached a certain threshold, more can be achieved with fewer natural resources, thanks to R&D expenditures aimed at developing new technical innovations. This prevents environmental degradation.

Figure: 3
Technical Effect
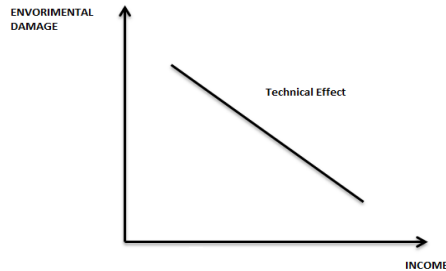
Source: Halkos, 2011: 9.

2.2. Different Views of EKC

Studies on the EKC hypothesis mainly focus on the curve's inverted "U" shape. On the other hand, other studies have also included different views of the curve (De Bruyn et al., 1998: 162). Thus, the new EKC theories that have emerged are referred to as N-shaped and M-shaped. The EKC hypothesis's N- and M-shaped tests indicate that more than one threshold point may occur in the long run. Unlike these two approaches, there is also a different version in the literature where the hypothesis is tested and the "race to the bottom theory" (Rasli et al., 2018: 3121).

2.2.1. "N" Shaped EKC

The addition of the mathematical third power of the national income per capita to the tests of the EKC hypothesis reveals that the relationship between environmental pollution and income may differ in the long term. This differentiation suggests that after a certain income level, environmental pollution may increase due to increased stimulation. The focus of this version, known as the "N"-shaped EKC theory, is that the scale effect outweighs the composition and technical effects by magnitude (Torras & Boyce, 1998: 157). Sources of this new situation include the lack of opportunities to increase the distribution of industries that improve environmental quality and decreasing returns experienced in technological changes. For the aforementioned reasons, instead of the EKC hypothesis with a single threshold point, which predicts an inverted U-shaped change, an N-shaped relationship with two threshold points emerges, and environmental pollution increases again in the long term (Allard et al., 2018: 5849).

Figure 4 illustrates the N-shaped Environmental Kuznets Curve (EKC). Accordingly, in addition to the inverted U-shape, it is assessed that a second threshold point will occur as national income per capita increases. Unlike the first one, this new threshold point suggests that environmental degradation will start to increase again. In this respect, a second threshold point is not a harbinger of good things for the environment.

Figure: 4
"N" Shaped EKC
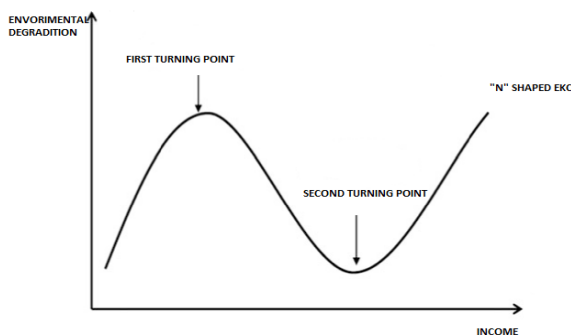
2.2.2. "M" Shaped EKC

In studies on the EKC theory, the M-shaped EKC was obtained by adding a fourth power to the mathematical power of three of national income per capita (Terrell, 2021: 164). The M-shaped and N-shaped EKC theories examine whether a third threshold point exists in the long term. It would not be wrong to say that the technological development expected to reduce environmental degradation is disrupted, and sectors are transformed with a third threshold point. It is also considered that fairness in income distribution and political instability may pave the way for a third threshold point. In addition to the mentioned factors, the M-shaped EKC hypothesis may also arise due to increasing agricultural production per acre and urbanisation (Terrell, 2021: 158-161).

2.2.3. Race Towards the Bottom EKC

Many economists have criticised the traditional EKC theory. Some economists have argued that the curve will shift from its current pollution level to a maximum straight line over time and that foreign trade and foreign investments will pressure environmental quality, leading to adverse environmental effects. The literature describes this situation as a race to the bottom (Dasgupta et al., 2002: 148).

Good environmental regulation standards impose significant costs on pollution producers. The opportunity to invest in foreign countries, which increases with globalisation, may lead to avoiding the costs of environmental regulations in high-income countries. As a result, investments in low-income countries with flexible environmental standards increase. Due to the increased capital outflows from high-income countries, these countries attempt to prevent capital outflows by making environmental standards more flexible. Flexible environmental standards can lead to a race to the bottom among countries as economic activities gradually increase environmental pollution (Wheeler, 2001: 226).

Figure: 5
Race to the Bottom EKC
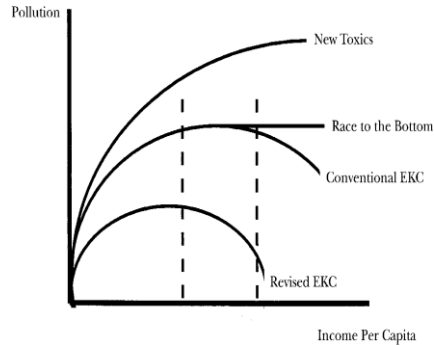
Source: Dasgupta et al., 2002: 148.

In Figure 5 above, four curves reflect the relationship between pollution and per capita income level. The top curve indicates that even as some pollution indicators decrease with increasing income levels, environmental pollution will continue to rise with the emergence of new toxins. The second curve, known as the race to the bottom, indicates that countries prioritise production over environmental values with globalisation, and environmental degradation tends not to decrease (Dasgupta et al., 2002: 148). The revised EKC at the bottom shows that the traditional level of EKC has declined and shifted to the left, as the pollution level has started to decrease at lower income levels (Pata, 2019: 70).

3. Literature Review

In today's world, societies are increasingly concerned about environmental issues, climate change, resource scarcity, and pollution, which are becoming significant challenges for people and major environmental problems in both the public and private sectors. The EKC is one of the most widely used theories to explain the relationship between economic growth and environmental conditions. It is emphasised that the environmental quality caused by increasing economic activities in developing countries should be improved at the maximum level. This literature review aims to compile studies that examine the relationship between the Environmental Kuznets Curve (EKC) Hypothesis and military expenditures, as well as nuclear energy use.

Wang et al. (2024) examine the environmental impact modelling and efficient use of renewable and nuclear energy by taking into account the effects of energy efficiency within the framework of the EKC and LCC hypotheses in BRICS countries from 1990 to 2018. Long-term forecasts are based on LM-Bootstrap Cointegration tests and Drisscoll-Kraay regressions. In this study, it is observed that financial development has a negative relationship with the load capacity factor, while it has a positive relationship with CO_2 emissions. These findings suggest the EKC and LCC hypothesis in BRICS countries.

Jaeger et al. (2023) reassess the EKC hypothesis, where pollution rises gradually and then takes an inverted U-shape with increasing income. This study supports this literature in two main ways. These are theoretical and empirical data. When the theoretical assumptions about changing populations are integrated with the empirical model formulation, the results show an inverted U-shaped relationship between increasing income and population density and emissions causing air pollution. These results offer an additional perspective on the EKC literature and the expectations and claims regarding the potential decoupling of economic growth from environmental damage.

Raihan (2023) examined the impact of FDI on the EKC in Bangladesh and confirmed its adverse effects on the environment, supporting the Pollution Haven Hypothesis (Raihan, 2023).

Using a panel dataset from 1990 to 2020, Baba (2023) tests the EKC with mean group (MG) and pooled mean group (PMG) estimation results to examine the long-term and short-term effects of renewable and non-renewable energy, economic growth (GDP) and carbon dioxide (CO2) emissions in 16 developing countries. The empirical results support the EKC hypothesis by providing evidence of a positive relationship between environmental degradation and economic development in the short and long run when environmental degradation is chosen as the dependent variable. The study concludes that the EKC suggests policymakers should consider reducing environmental degradation in both the short and long term, and use appropriately coordinated economic policies when making policy recommendations.

The impact of FDI on environmental pollution was also examined by Wu & Wang (2023), who found an Inverted U-shaped relationship in China, indicating the potential impact of FDI on regional air pollution, in line with the EKC hypothesis (Wu & Wang, 2023).

Józwik et al. (2023) aim to measure the validity of the N-shaped Environmental Kuznets Curve (EKC) hypothesis while reevaluating the impact of nuclear energy use and financial development on the environment within the framework of annual data available from 1993 to 2019, focusing on the 11 countries with the highest atomic energy consumption. The findings suggest a long-term cointegration relationship between the variables. According to the results of the PCSE model, in the first 11 countries, an increase in nuclear energy consumption is associated with a decrease in carbon emissions. Based on the results obtained and the literature analysis, it is emphasised that investments and subsidies for R&D studies should be increased within the framework of identifying and implementing innovative solutions to reduce carbon emissions and improve environmental quality.

Golpîra et al. (2023) investigate the validity of the EKC hypothesis for countries belonging to the Organization for Economic Cooperation and Development (OECD), which includes 37 countries, between 1960 and 2019. Panel Quantile Regressions (QR) are used in

these investigations. The findings indicate that cointegrated regressions reveal that economic growth, fossil fuel consumption, and population negatively impact the environment, while renewable energy consumption reduces carbon dioxide (CO2) emissions. Panel causality tests confirm these results, suggesting a feedback mechanism between CO2 emissions and the rest of the series.

A study by Sattar et al. (2022) has examined the relationship between military expenditures, foreign direct investment (FDI), and the EKC. Analysing the effects of China's FDI on environmental pollution in South Asian countries, Sattar et al. (2022) provided insights into the impact of FDI on environmental degradation. They provided a perspective on the environmental impact of FDI.

Cutcu et al. (2024) investigate the interaction of foreign trade and military spending with ecological concerns in the US economy using available time series techniques. The analysis utilizes annual data for the US economy between 1970 and 2018, incorporating variables such as military expenditures, ecological footprint, imports, and exports. In the methodology applied, it is explained that a long-term relationship exists between the variables, as indicated by the cointegration test results. This study aims to investigate the relationship between military expenditures and environmental degradation and to examine the role of economic progress in this process. The analysis employs various methods, including fixed effects estimation, Driscoll-Kraay, Lewbel (2SLS), Oster, structural VARs, and quantiles. The results show that military spending has a significant and positive impact on environmental indicators, including nitrous oxide, methane, and carbon dioxide. This suggests that although African countries do not produce weapons, their military spending still contributes to environmental degradation. Therefore, regulating military expenditures in the continent is of critical importance.

Ahmed et al. (2022) investigated the effects of defence expenditures on the environment for 22 OECD countries using data from 1971-2020. According to the results, defence expenditures increase carbon dioxide emissions.

Pirgaip et al. (2023) assess the role of government spending in environmental sustainability based on a framework that combines the EKC hypothesis with the Armey Curve hypothesis. The inverted U-shaped relationships between carbon (CO2) emissions and economic growth (EKC hypothesis) and between government spending and economic growth (Armey curve hypothesis) are analysed using a composite EKC model that is tested for cross-sectional dependence and heterogeneity, panel unit root, panel cointegration and augmented mean group estimation. The empirical results confirm that economic growth serves as a mediator between government spending and CO2 emissions in the US, UK, and Canadian governments.

As a result, the relationship between the EKC Hypothesis, military expenditures, and nuclear energy use is an inverted U-shape. Increased nuclear energy use reduces CO2 emissions and positively impacts environmental improvement, while a positive short- and

long-term relationship exists between economic development and environmental degradation.

This literature shows that governments have a critical role to play, according to the results obtained in the relevant studies. It also emphasises that governments can achieve better results if their economic policies are more sustainable and properly coordinated in both the short and long term to minimise environmental degradation.

Cole (2004) investigates the extent to which the EKC inverted U relationship can be interpreted in terms of trade, specifically the relocation or displacement of 'dirty' industries from developed to developing regions, known as the pollution haven hypothesis (PHH). Evidence for the PHH is assessed based on detailed data on north-south trade flows for highly polluting products. Emissions of 10 air and water pollutants are then estimated considering trade openness, structural change and dirty North-South trade flows. Evidence of pollution haven effects is obtained, but such effects are infrequent and relatively small compared to other explanatory parameters. This paper examines the arguments for the pollution haven hypothesis and assesses how trade contributes to the EKC relationship through pollution haven effects and structural change.

Dietz and Rosa (1994) discuss the need to better understand the linkages between population, resources, and environmental impacts, to continue developing structured research programs to investigate these linkages and to test conceptual models empirically, with a focus on anthropogenic environmental changes. The IPAT model is proposed to illustrate these issues, as it is considered an appropriate way to meet the requirements of statistical measurement. A brief historical account of the scientific discourse on the problems is described. It is noted that the social sciences, on the one hand, and the biological and environmental sciences, on the other, have addressed these issues in parallel but often separately and in opposition. It then describes the original IPAT model and the proposed modifications, assessing the strengths and weaknesses. Modifications, details, and instructions for further testing of the model are described, along with some recommendations for replacing the IPAT model.

Ehrlich and Holdren (1971) emphasise that as the intertwined crises of population, environment and resources have become the focus of numerous studies, articles and an ever-increasing number of publications, many claims have been made, the most important of which is the misunderstanding of facts such as the idea that the proportion of the US population, its growth rate, is a marginal contributor to the negative impact of the US on the local and global environment and that the issue should be revisited in this article because it has not gained a serious place in the literature. The discussion is structured around five theorems believed to have been proved and provides a setting for realist analysis. According to the findings obtained within the framework of the theorems, the problems faced by humanity are defined as "a storm of crisis problems", and it is emphasised that it is not enough to offer uniform solutions to these problems. It is argued that multifaceted strategies, such as population control, reorientation of technology, and equality of opportunity, are

necessary for the future. Ignoring the environmental impacts of population growth is dangerous, and this problem must be addressed.

Grossman and Krueger (1991) provide empirical evidence to assess the relative magnitude of these three effects of increased trade liberalisation in Mexico, as a reduction in trade barriers affects the environment by opening up economic activity, changing the patterns of economic activity, and creating a difference in production techniques. It utilises comparable measurements of three air pollutants in a sample of urban areas across 42 countries to examine the relationship between economic growth and air quality. It examines how pollution abatement costs in the US industry, which are significantly higher than those in other countries, affect international trade and investment patterns. We also use the results of a computable general equilibrium model to examine the impact of NAFTA on pollution in Mexico. The findings suggest that some aspects that could have been particularly beneficial for Mexico may have been overlooked. Interest in the US market, combined with a more liberalised trade regime, provides a potential revenue boost for Mexico. However, it also suggests that trade liberalisation could increase Mexican specialisation in sectors with a lower-than-average impact on environmental damage.

Holdren (2021) states that the IPAT equation, developed by Paul Ehrlich and John Holdren in 1972, explains that environmental impact (I) is a function of population (P), affluence (A), and technology (T). The equation is expressed as ($I = P \times A \times T$). As late as 1969, Holdren and Ehrlich, in their refutation of Commoner's claim that increasing material consumption with population growth is not a cause for concern, emphasised that all variables are important, that they interact, and that it is dangerous not to consider any of the relevant variables or their interactions. As a result, the critique explains that factors are interconnected and that the environmental consequences of population growth are considerable, thereby demonstrating that Commoner's arguments are flawed in logic and arithmetic.

Kornecki and Wise (2024) describe the opportunities and barriers to implementing advanced nuclear reactors and nuclear reactor-related fuel cycles, as described in the Two National Academies consensus report. It describes consensus propositions that these new technologies can achieve commercial success as part of a long-term decarbonisation strategy. It highlights that decarbonizing the economy to mitigate climate change presents a significant opportunity for advanced nuclear reactors, but that many challenges need to be overcome before they can benefit the low-carbon energy system in the future. Considerable effort and financial support from several institutions are required to overcome these challenges.

In this paper, Kuznets (1955) discusses the nature and causes of long-term changes in personal income distribution, examining whether inequalities in income distribution will increase or decrease with a country's economic growth and what factors will determine this outcome. Although the reliable information and empirical results presented in the article are considered to be insufficient, it is emphasised that accepting the subject as a heuristic method

that requires further research rather than purely empirical results will both provide an opportunity for the subject to be chosen as a subject of further research and shed light on future studies and research on the subject.

Panayotou (1993) empirically tests the hypothesis of an inverted U-shaped relationship between environmental degradation and economic development, emphasising policy implications for technology transfer, employment and development assistance. Using data on air pollution and deforestation from developed and developing countries, the findings support the hypothesis that the inverted U-shaped EKC called the EKC, resembles the inverted U-shaped relationship between development and inequality. He argues that part of the sharpness of the inverted U-shaped relationship between environmental degradation and growth is due to policy distortions, such as energy and agrochemical subsidies, industrial protection and undervaluation of natural resources, which have dire economic and environmental consequences, while another part is due to market failures, such as ill-defined property rights over natural resources and unaccounted and unpaid environmental externalities that lead to unnecessarily high levels of resource consumption and pollution per additional unit of output.

Pearce (2012) describes the research and analysis of the challenges that nuclear energy must overcome to be sustainable. The results indicate that nuclear energy cannot be considered a sustainable source. It is emphasised that it is not enough to develop innovative solutions to reduce the environmental burdens of atomic energy technology; the nuclear industry must also address fair sustainability issues for current and future generations. The study concludes that a sustainable nuclear energy system must achieve radical improvements in greenhouse gas emission intensity through improved technology and efficiency to replace fossil fuels, minimise the risks associated with nuclear power and eliminate nuclear mistrust, minimise the environmental impacts of radioactive waste disposal and mining activities, and restore public confidence in the nuclear industry through rapid improvements in the performance of renewable energy technologies.

Torras and Boyce (1998) apply the concept of 'political and social economy' to Kuznets' (1955) hypothesis on the relationship between per capita income and environmental pollution. They argue citizens' demands are important in promoting pollution-reducing policies and technological change. To do so, they emphasise Boyce's (1994) view that equitable power distributions are highly likely to result in better environmental quality, among other things.

Eylasov et al. (2024) investigate the impact of military expenditures and financial development on economic growth using data for BRICS+T countries (Brazil, Russia, India, China, South Africa and Türkiye) for the years 1992-2021 within the framework of the Benoit hypothesis. The stationarity of the variables is observed using ADF and Flexible Fourier ADF unit root tests. Then, the cointegration relationship between the variables is examined using Fourier Bootstrap ARDL and Bayer-Hanck methods. In Türkiye, only the FB-ARDL method finds a cointegration relationship. At the same time, according to the FB-

ARDL long-run estimation results, financial development has a positive effect on economic growth in Türkiye, while military expenditures have a negative effect. FMOLS long-run estimation results for BRICS countries show that the impact of financial development on economic growth is positive and significant in all countries except Brazil and South Africa. At the same time, military expenditures have no statistically significant effect on economic growth in Russia and China. In Brazil, India and South Africa, military expenditures have a negative impact on economic growth. In the study, the causality relationship between the criteria for all countries is analysed using the Fourier Toda-Yamamoto method and new policy recommendations are presented within the scope of the results.

(2024) integrate technological innovation, militarisation and environmental change into an integrated analytical framework to assess the potential impact of technological progress and military defense spending on the environment in BRICS countries. Based on CSD, unit root, and cointegration tests, they construct a CS-ARDL model to observe the long- and short-term relationships between different factors from 1990 to 2021. The results show that technological innovation, military spending and economic growth significantly increase the ecological footprint in the long run, while technological innovation and economic growth increase the ecological footprint in the short run, but military spending does not have a significant impact. It is recommended that BRICS countries focus on promoting low-carbon technology policies and R&D investments and using advanced technologies to improve military intelligence capabilities to minimise the negative impact of technological innovation and military activities on the environment.

Thomas et al. (2023) examine the relationship between military expenditures and income inequality in BRICS countries. Different sources such as the World Bank's World Development Indicators and Penn World Tables are utilised while using panel data. To explain the impact of military expenditures on income inequality, a pooled mean group (PMG) or panel autoregressive distributed lag (PARDL) approach is used for 1990-2017 in BRICS countries. The empirical result for the pooled sample reveals an inverse relationship between military expenditure and income inequality, whereas a percentage change in military spending leads to a reduction in the income inequality problem for the BRICS countries. The results of the empirical study suggest that policymakers should focus more on developing economic activities in the BRICS countries and on policies to minimise income inequality.

In addition, Hacıimamoğlu (2022) suggested in his study that the Environmental Pollution Haven Hypothesis has a positive relationship between environmental pollution and FDI and concluded that this relationship is valid for BRICS-T countries, pointing out the potential impact of FDI on environmental degradation (Hacıimamoğlu, 2022).

Erdogan et al. (2022) investigated the relationship between defense expenditures and environmental quality for Greece, France, Italy, and Spain from 1965 to 2019 and concluded that there was an interaction in these countries. The interaction arises from national military expenditures and the defense expenditures of other regional countries.

Elgin et al. (2022) investigated the relationship between defense expenditures and sustainable development indicators of 160 countries from 1950 to 2018. They concluded that there was a positive relationship between military spending and air pollution.

Üzar (2019) examined the relationship between foreign direct investment inflows and carbon dioxide emissions, an environmental indicator, in Türkiye between 1970 and 2014, using the "race to the bottom" methodology. He showed that the EKC hypothesis validates the relationship between foreign direct investment and the environment.

Huang et al. (2019) and Abdulsalam et al. (2021) examined the effects of FDI on carbon emissions and provided valuable insights into its potential impact on environmental degradation. They highlighted the non-linear relationship between GDP growth and emissions and the critical role of FDI in economic growth (Huang et al., 2019; Abdulsalam et al., 2021).

Noubissi Domguia and Poumie (2019) investigated the impact of 54 countries' military expenditures on carbon dioxide, NO2, and CH4 from 1980 to 2016 and concluded that defense expenditures positively affect environmental indicators.

Zhang & Guo (2017) empirically tested the factors affecting the ecological footprint and revealed the existence of the EKC and the positive impact of FDI on ecological footprint, emphasising the potential impact of FDI on environmental sustainability (Zhang & Guo, 2017).

Neila (2016) investigated the relationship between defense expenditures and environmental pollution in 121 countries from 1980 to 2011. The results show that defense expenditures have a positive effect on carbon emissions.

Apergis (2016) also discussed the relationship between economic growth and environmental pollution under the EKC hypothesis. They provided insights to further understand the relationship between economic growth and environmental degradation by emphasising the extensive international literature focusing on environmental pollutants and the relationship between output and carbon emissions (Apergis, 2016).

4. Econometric Analysis

4.1. Empirical Model and Data

The empirical studies examining the effects of various economic indicators on environmental impact factors can be said to have originated with the works of Ehrlich and Holdren (1971) and Holdren and Ehrlich (1972). In these studies, the authors proposed a new model abbreviated as IPAT. This abbreviation stands for environmental impact (I), population (P), affluence (A), and technology (T) and is expressed as follows (Holdren, 2021):

$$I = PAT \tag{1}$$

In equation (1), I represents environmental impact, which can be considered the total footprint of human activities on nature. P indicates the size of the population. A represents affluence per capita, typically measured by income or consumption levels per person. Finally, T represents the effects of technologies used in production processes and human life on the environment. The IPAT model is used as a tool in studies related to environmental sustainability and development policies. The model offers a valuable and straightforward roadmap for understanding the environmental impacts of population, affluence, and technology variables and for developing environmental policies. However, since this model addresses environmental impacts only through a multiplicative relationship, it cannot fully explain complex interactions. At this point, the literature introduced the Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) model, developed by Dietz and Rosa (1994). This model was initially proposed to evaluate the effects of population, affluence, and technology on environmental impacts in a more flexible and complex manner. The study by Dietz and Rosa (1994) expanded upon the critiques of the IPAT model, providing a more advanced framework for analysing environmental impacts. The STIRPAT model can be expressed as follows:

$$I = \alpha P^\beta A^\gamma T^\delta \qquad (2)$$

Unlike the equality in (1), the parameters α, β, γ and δ here are elasticity parameters that reflect the impact of population, wealth, and technology on environmental impact factors. While IPAT-type models continue to be developed, another model aiming to explain the relationship between environmental impact and economic indicators has begun to be discussed in the literature. The empirical model proposed by Kuznets (1955), which aimed to explain the relationship between income inequality and economic growth, has evolved into a model that seeks to explain the relationship between economic growth and environmental degradation by substituting the dependent variable with any environmental impact factors. The first study to achieve this transformation without referencing Kuznets by name and to apply it was Grossman and Krueger (1991). However, the study that transformed Kuznets' (1955) model to measure environmental degradation and named this new model the EKC was conducted by Panayotou (1993). The core of the EKC hypothesis model is as follows:

$$I = aY^b(Y^2)^c \qquad (3)$$

This mathematical expression assumes an inverted U-shaped relationship between the environmental impact factor (I) and growth or income (Y). In such a non-linear relationship pattern, the level of growth at the peak of the inverted U-shape gives the level of economic growth at which environmental degradation peaks in that country. This information is very important for policymakers. Knowing up to which level of growth the environment will be badly affected allows for robust policymaking. The EKC model differs positively from IPAT models with this extra information. This study uses the EKC model instead of the IPAT model since this specific growth level is to be estimated. After a two-sided logarithm transformation, the EKC model is transformed into one suitable for

econometric analysis. After this transformation, various control variables can be added to the basic variables of the model by the literature. For example, Panayotu (1993) extended the model with a population variable and a dummy variable representing tropical countries. Torras and Boyce (1998) included the GINI coefficient, literacy rate and political rights - civil liberties index as control variables in the estimated model. In Cole (2004), the share of the manufacturing industry in GDP, trade intensity and exports and imports of dirty industrial products are included in the EKC model. As seen from the prominent studies in the literature, the EKC model can be extended with economic and/or social variables that are thought to impact environmental degradation. In this study, defense expenditures, foreign direct investments and nuclear energy use variables are used as control variables in the EKC model for the research in the models created for the BRICS countries that can produce nuclear energy. In addition, the population variable, which has an important place in IPAT models, was also included as a control variable in one of the models to be analysed in this study. Accordingly, the environmental Kuznets models used in the study are as follows:

$$lnce_{it} = \beta_{11}lny_{it} + \beta_{12}lny_{it}^2 + \mu_i + \eta_t + \varepsilon_{it} \tag{4}$$

$$lnce_{it} = \beta_{21}lny_{it} + \beta_{22}lny_{it}^2 + \alpha_2 ne_{it} + \mu_i + \eta_t + \varepsilon_{it} \tag{5}$$

$$lnce_{it} = \beta_{31}lny_{it} + \beta_{32}lny_{it}^2 + \alpha_3 me_{it} + \mu_i + \eta_t + \varepsilon_{it} \tag{6}$$

$$lnce_{it} = \beta_{41}lny_{it} + \beta_{42}lny_{it}^2 + \alpha_4 fdi_{it} + \mu_i + \eta_t + \varepsilon_{it} \tag{7}$$

$$lnce_{it} = \beta_{51}lny_{it} + \beta_{52}lny_{it}^2 + \alpha_5 p_{it} + \mu_i + \eta_t + \varepsilon_{it} \tag{8}$$

Table: 1
Variables Used in the Empirical Analysis

Variable	Description	Data Source
$lnce_{it}$	Carbon emissions (Tons per capita, natural logarithm)	
lny_{it}	Gross Domestic Product per capita (2015=100, natural logarithm)	World Bank World Development Indicators (WDI)
me_{it}	Military expenditures (% share in GDP)	
fdi_{it}	Foreign direct investment (% share in GDP)	
lnp_{it}	Population, natural logarithm	
ne_{it}	Share of Nuclear energy in total energy consumption (%)	U.S. Energy Information Administration Database

4.2. Empirical Analysis

A series of econometric tests need to be applied to estimate the parameters of the models defined by Equations (1)-(4). Since the data is panel data, cross-sectional dependence should be tested first. Cross-sectional dependence, like the unit root, is a vital panel data feature that, if present, will change the analysis path to be followed in revealing the economic relationships of interest. Therefore, the existence of this effect should be tested statistically first. Table 2 presents the results of the Pesaran (2004) test, which was performed on the panel data used in this study.

Table: 2
Cross-Section Dependency Test

	$lnce_{it}$	lny_{it}	ne_{it}	me_{it}	fdi_{it}	lnp_{it}
CD Statistics	8.823	16.005	5.241	3.680	1.703	5.39
p-value	0.000***	0.000***	0.000***	0.000***	0.089*	0.000***

***, **, and * indicates statistical significance at 99%, 95%, and 90% confidence leves, respectively.

The results in Table 2 reveal that the null hypothesis of the Pesaran (2004) CD test, which asserts that there is no cross-section dependence at the accepted levels of significance (5% and 1%), can be rejected for all variables except fdi_{it}. For fdi_{it}, the relevant null hypothesis can also be rejected at a 10% significance level. Therefore, it can be said that there is empirical evidence for the existence of cross-sectional dependence for all variables in the panel data. In this case, it is essential to use methods that consider cross-section dependence in the ongoing analyses. In this context, Pesaran's (2007) CADF unit root test, which is robust to cross-sectional dependence, is used for the unit root tests of the variables. The results are summarised in Table 3.

Table: 3
Panel Unit Root Test Results

	$lnce_{it}$	lny_{it}	ne_{it}	me_{it}	fdi_{it}	lnp_{it}
Pesaran CIPS Test Statistics	-2.607 [0]	-2.786 [1]	-2.527 [4]	-3.135 [0]	-2.766 [0]	-3.783 [0]
p-value	0.025**	0.009***	0.039**	0.001***	0.010***	0.000***

The values in square brackets are the appropriate lag values selected according to the Akaike information criterion.
***, **, and * indicates statistical significance at 99%, 95%, and 90% confidence leves, respectively.

According to the unit root test results summarised in Table 3, $lnce_{it}$ and ne_{it} are stationary at a 5% significance level. The other variables are stationary at a 1% significance level and lower. Since all panel time series compiled for the analysed countries are stationary, the causality tests can be applied directly, and the parameter estimates of the models expressed in Equations (4), (5), (6), (7) and (8) can be estimated with robust methods for cross-sectional dependence. In addition to these methods, the test results of Dumitrescu and Hurlin (2012), which are also robust test statistics for Granger causality between economic variables, are summarised in Table 4.

Table: 4
Dumitrescu & Hurlin (2012) Granger Causality Test Results

Null Hypothesis	Lag	Test Statistics	p-Value
$lnce_{it}$ is not the Granger cause of lny_{it}	2	4.4068	0.0000***
lny_{it} is not the Granger cause of $lnce_{it}$	7	2.1643	0.0304**
$lnce_{it}$ is not the Granger cause of ne_{it}	7	2.8430	0.0045***
ne_{it} is not the Granger cause of $lnce_{it}$	1	1.3221	0.1861
$lnce_{it}$ is not the Granger cause of me_{it}	7	2.8430	0.0045***
me_{it} is not the Granger cause of $lnce_{it}$	7	4.2012	0.0000***
$lnce_{it}$ is not the Granger cause of fdi_{it}	7	5.0884	0.0000***
fdi_{it} is not the Granger cause of $lnce_{it}$	2	-0.0066	0.9947
$lnce_{it}$ is not the Granger cause of lnp_{it}	7	5.8255	0.0000***
lnp_{it} is not the Granger cause of $lnce_{it}$	7	10.3997	0.0000***
lny_{it} is not the Granger cause of ne_{it}	2	1.5919	0.1114
ne_{it} is not the Granger cause of lny_{it}	5	0.4654	0.6417
lny_{it} is not the Granger cause of me_{it}	2	4.8265	0.0000***
me_{it} is not the Granger cause of lny_{it}	2	1.1186	0.2633
lny_{it} is not the Granger cause of fdi_{it}	7	2.8597	0.0000***
fdi_{it} is not the Granger cause of lny_{it}	2	-0.9861	0.3241
lny_{it} is not the Granger cause of lnp_{it}	7	12.1432	0.0000***
lnp_{it} is not the Granger cause of lny_{it}	7	13.5308	0.0000***
ne_{it} is not the Granger cause of me_{it}	7	4.2090	0.0000***
me_{it} is not the Granger cause of ne_{it}	7	7.1254	0.0000***
ne_{it} is not the Granger cause of fdi_{it}	1	3.0531	0.0023***
fdi_{it} is not the Granger cause of ne_{it}	3	2.0075	0.0447**
ne_{it} is not the Granger cause of lnp_{it}	7	4.6201	0.0000***
lnp_{it} is not the Granger cause of ne_{it}	7	8.9757	0.0000***
me_{it} is not the Granger cause of fdi_{it}	1	13.0964	0.0000***
fdi_{it} is not the Granger cause of me_{it}	7	2.0428	0.0411**
me_{it} is not the Granger cause of lnp_{it}	7	-0.3984	0.6903
lnp_{it} is not the Granger cause of me_{it}	7	4.7092	0.0000***
lnp_{it} is not the Granger cause of fdi_{it}	7	6.1144	0.0000***
fdi_{it} is not the Granger cause of lnp_{it}	7	3.4789	0.0005***

***, **, and * indicates statistical significance at 99%, 95%, and 90% confidence leves, respectively.

The causality diagram summarising the results in Table 4 can be formed as in Figure 6.

Figure: 6
Granger Causality Relationships between Variables
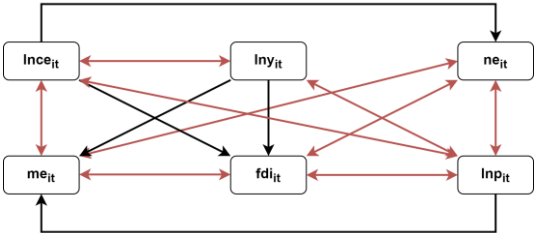
Note: The red line indicates bidirectional causality relationships.

The causality analysis findings provided important evidence about the existence of the economic relationships sought to be investigated and modelled using Equations (4), (5), (6), (7), and (8). Since all the variables in the panel data have cross-sectional dependence, the cross-sectional dependence-robust Common Correlated Effects Mean Group (CCEMG) and Common Correlated Effects Pooled Mean Group (CCEPMG) estimators recommended

by Pesaran (2006) could be used in the parameter estimation process. With this strategy, the Kuznets curve parameters, shaped by nuclear energy demand, military expenditures, foreign direct investment, and population, are estimated for five developing countries that can produce nuclear energy.

4.3. Findings

Two primary empirical analyses are conducted in this study. Firstly, as in all panel data econometrics applications, cross-section dependence and second-generation unit root tests are performed. According to the findings, it is concluded that all variables in the panel data exhibit cross-section dependence, and the series is stationary. Based on these findings, Dumitrescu and Hurlin (2012) employed the Granger causality test, which revealed significant causal relationships between the variables. Accordingly, when focusing on the carbon emission variable for the five countries analysed within the framework of the EKC hypothesis, it is revealed that income and military expenditure variables are the Granger cause of carbon emission per capita. This empirical analysis could also detect the income-environmental impact relationship emphasised in the EKC hypothesis. In addition, defence expenditures, a component of public spending, significantly affect the forecast accuracy of per capita carbon emissions (as defined by the Granger Causality), which is considered an environmental impact factor in this study. It should also be noted that there is a bidirectional causality relationship between carbon emissions, income, and military expenditures. The five countries examined for nuclear power are located in regions at risk of serious conflict or adjacent to such regions. This includes areas with ongoing international conflicts, such as the Russia-Ukraine war. These geopolitical tensions have significantly influenced their military expenditures, potentially creating a reciprocal causality between military spending and the surrounding environment. Another conclusion from the causality analysis is that the per capita carbon emission variable is the Granger cause of nuclear energy consumption. This finding suggests that the environmental situation influences atomic energy consumption in the five countries under consideration. Finally, the Granger causality analysis revealed a bidirectional causality relationship between the population variable and environmental degradation.

Following the causality analysis, the parameter estimates of various EKC models are also calculated. These results are summarised in Table 5. According to the literature, it is possible to estimate EKC in multiple ways (Leal & Marques, 2022: 11521). For the inverted U shape, which is generally used to explain the theory, the parameter estimate for the lny_{it} variable should be greater than zero, and the parameter estimate for the lny_{it}^2 variable should be less than zero. When the parameter estimates of the five models obtained using the CCEMG and CCEPMG methods are evaluated, this inverted U shape is only observed for the CCEPMG estimator of Model (1). For this calculation, the parameter estimate of lny_{it}^2 is not statistically significant, and the R^2 value is 0.56. The EKC examined in other models are always U-shaped. According to the estimated parameters, economic growth is observed in the five countries, and carbon emissions decrease until a certain income level is reached. Once this minimum level of emissions is attained, carbon emissions increase again as

economic growth continues. In the five Kuznets models analysed, the turning point (TP) value for BRICS countries is relatively low except for two values. The TP value is absurdly high in the results obtained with the CCEPMG estimator for Model (1). No country can reach a per capita income at the TP value. However, the model's explanatory power with this high TP value is relatively low. Therefore, this estimation value can be ignored. Another outlier TP value is obtained in the CCEMG estimation of Model (5). Although it represents a relatively reasonable level of per capita income, this TP value cannot be considered an accurate estimate since the control variable in the model is statistically insignificant. In light of all these findings, we can conclude that the EKC for the BRICS countries is U-shaped but has a very short left arm. In fact, according to the CCEMG estimates of Model (2), which is statistically the most successful model according to the estimation results, the Kuznets curve exhibits a shape similar to the one shown in Figure 7. These findings suggest that economic growth continues to exacerbate environmental degradation in the BRICS countries.

Table: 5
Kuznets Models Estimation Results

	Model 1		Model 2		Model 3		Model 4		Model 5	
	CCEMG	CCEPMG	CCEMG	CCEPMG	CCEMG	CCEPMG	CCEMG	CCEPMG	CCEMG	CCEPMG
lny_{it}	-0.601 [0.072*]	1.199 [0.029**]	-0.705 [0.089*]	-0.443 [0.087*]	-0.629 [0.065*]	-0.469 [0.001***]	-0.672 [0.040**]	-0.419 [0.089*]	-7.390 [0.049**]	-0.694 [0.989]
lny_{it}^2	0.088 [0.039**]	-0.044 [0.103]	0.094 [0.089*]	0.073 [0.020**]	0.091 [0.061*]	0.093 [0.000***]	0.103 [0.024*]	0.079 [0.006***]	0.433 [0.043**]	0.095 [0.977]
ne_{it}	-	-	0.073 [0.081*]	0.152 [0.058*]	-	-	-	-	-	-
me_{it}	-	-	-	-	-0.017 [0.719]	-0.191 [0.000***]	-	-	-	-
fdi_{it}	-	-	-	-	-	-	0.017 [0.603]	0.025 [0.706]	-	-
lnp_{it}	-	-	-	-	-	-	-	-	-5.704 [0.586]	0.600 [0.962]
TP	$30.410	$826536.913	$42.521	$20.785	$31.691	$12.447	$26.105	$14.181	$5082.137	$38.576
$MG\ R^2$	0.92	0.56	0.93	0.45	0.90	0.37	0.74	0.38	0.73	0.26
F Stat.	56.12 [0.000***]	3.00 [0.000***]	53.63 [0.000***]	5.42 [0.000***]	50.06 [0.000***]	4.96 [0.000***]	8.72 [0.000***]	4.95 [0.000***]	3.33 [0.000***]	1.21 [0.230]
CD Stat.	-0.77 [0.439]	-1.10 [0.270]	1.20 [0.231]	-1.55 [0.122]	-0.93 [0.352]	-1.59 [0.111]	-0.47 [0.635]	-0.21 [0.833]	-0.06 [0.953]	-1.71 [0.088*]

The dependent variable of all models is $lnce_{it}$.
The values in square brackets indicate the p-values of the z-statistics for the parameter estimates, as well as the F and CD statistics calculated for the models.
TP refers to the Turning Point level of income per capita, as outlined in the Kuznets Hypothesis.
***, **, and * indicates statistical significance at 99%, 95%, and 90% confidence leves, respectively.

Another critical finding indicated by the parameter estimates in Table 5 is that the CCEPMG estimator presents very low R^2 values in all four models. It is challenging to derive meaningful and reliable economic insights from these estimation results, which exhibit very low explanatory power. For this reason, focusing on the parameter estimates obtained with the CCEMG estimator, according to Model (1), a 1% increase in per capita income results in a decrease of approximately 0.6% in per capita carbon emissions. This decrease was found to be 0.7% in Model (2), 0.63% in Model (3) and 0.67% in Model (4). It is expected that all these values are close to each other. Another aim of the study's empirical analysis was to measure the effect of selected control variables on carbon emissions. In line with this aim, a 1% increase in the share of nuclear energy in total energy consumption results in a carbon emissions per capita increase of approximately 0.07% for

these five countries. In other words, the use of nuclear energy has a negative impact on the environment for these five developing countries. Examining military expenditures as a control variable reveals no statistically significant effect on carbon emissions when using the CCEMG estimator, which has high explanatory power. However, according to the parameter estimates from the CCEPMG estimator, which has a lower R², a 1% increase in military expenditures as a proportion of total income leads to an approximate 0.2% reduction in carbon emissions in the five countries studied. The parameter estimates of another control variable, FDI, were not found to be statistically significant for any model. In addition to these factors, the population variable, which is considered in IPAT models and included in the model as a control variable, did not have a statistically significant effect on the dependent variable, carbon emissions. Generally, it isn't easy to make structural interpretations for the control variables except for the nuclear energy consumption variable in total energy consumption. The empirical analysis yields two significant findings regarding environmental degradation and carbon dioxide emissions in BRICS countries. First, from very low per capita income levels, environmental degradation increases steadily with income. The second important finding is that only nuclear energy use statistically affects environmental degradation among the control variables added to the Environmental Kuznets model. The parameter estimates of the other control variables are either statistically insignificant or the explanatory power (R^2) values of the models in which they are significant are low.

Figure: 7
Shape of Kuznets Curve According to Estimated TP Value of Model (2) with CCEMG Method
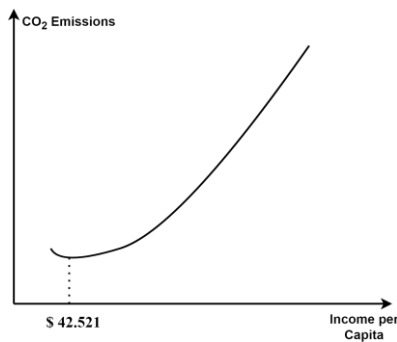
4.4. Robustness Check

This study employed environmental Kuznets models because they provide information on turning points. However, ignoring the IPAT model approach is challenging, as it enables the empirical analysis of the relationship between environmental impact factors and economic variables for the first time. For this reason, to better evaluate the findings of our study, the IPAT model was also estimated for the BRICS countries using the same

variables, and the results are summarised in Table 6. In the IPAT model, which is constructed and parameter estimates are performed here, the variable of nuclear energy utilisation, which we have already utilised in this study, is used as the technology variable. Countries capable of generating atomic energy have demonstrated the ability to master complex scientific principles, including nuclear chain reactions, radioactive decay, and the management of nuclear waste. Advanced nations with nuclear energy programs typically invest significantly in research and development (R&D) and strong educational and scientific institutions (Pearce, 2012; Kornecki & Wise, 2024).

Table: 6
IPAT Model Estimation Results

	lnp_{it}	lny_{it}	ne_{it}	$MG\ R^2$	F Stat.	CD Stat.
CCEMG	-2.619 [0.346]	0.696 [0.076*]	0.093 [0.045**]	0.95	1.970 [0.000***]	-1.600 [0.111]
CCPMG	-0.221 [0.003***]	0.653 [0.003***]	0.146 [0.014**]	0.56	6.73 [0.000***]	-1.45 [0.146]

The dependent variable of all models is $lnce_{it}$.
The values in square brackets indicate the p-values of the z-statistics for the parameter estimates, as well as the F and CD statistics calculated for the models.
***, **, and * indicates statistical significance at 99%, 95%, and 90% confidence leves, respectively.

When the IPAT model with parameter estimates for BRICS countries is analysed, it is observed that the Mean Group estimator provides a high R^2 value, but the population variable is not statistically significant. The Pool Mean Group estimator, on the other hand, finds all parameter estimates statistically significant but yields a very low R^2 value. The population variable was also statistically insignificant in the Kuznets model estimates. In this case, it can be said that the results of the IPAT model and the results of the Kuznets model support each other. Moreover, the parameter estimates of the population variable in the IPAT model and the Mean Group estimator of the Kuznets model are negative. These results contradict the hypothesis that the population contributes positively to ecological pollution proposed by the IPAT model. Therefore, the effect of the population variable on environmental degradation in the BRICS countries is insignificant due to the statistically negligible and negatively signed parameter estimates.

The effects of nuclear energy variables on environmental degradation, for which parameter estimates are made with the IPAT model, are estimated similarly to those in Kuznets models. The effect of nuclear energy use on carbon emissions is positive and statistically significant, albeit small in magnitude. The effect of another variable, income, should be interpreted carefully in the IPAT and Kuznets models. Both modelling approaches include income in different structural forms. While Kuznets adds the square of income and income to the model, aiming to calculate a turning point for income, the IPAT model directly includes income. For this reason, it is incorrect to make direct comparisons, especially regarding the signs of parameter estimates. However, it can be easily stated that both models reveal that income has a significant impact on environmental degradation. As a result, the IPAT model estimation for the robustness check does not reveal any new findings that contradict the findings of the Kuznets model.

5. Discussion and Conclusion

In the empirical analysis for BRICS countries, a prominent group of developing countries, three different model parameters were estimated, along with the classical Kuznets model (Equation (1)), to reveal the impact of military expenditures, nuclear energy use, and foreign direct investments on the environment. According to the findings, contrary to the prediction of the Kuznets theory, the relationship between environmental quality and economic growth was found to be U-shaped for BRICS countries that can produce nuclear energy and have significant defence budgets. Accordingly, the five countries examined do not harm the environment up to a certain level of economic growth; however, when the threshold level of economic growth is exceeded, these countries begin to fail in their environmental protection. Unfortunately, the shape of this relationship remains unchanged, regardless of the use of nuclear energy, defence expenditures, or foreign direct investments.

The findings should be evaluated within the framework of the primary policy issue addressed in our study, which is whether the defence expenditures and nuclear energy use of developing countries contribute to environmental degradation. The findings reveal that defence expenditures do not significantly impact the environmental quality indicator in BRICS countries. It is essential to note that the impact of defence expenditures on the environment remains relatively weak, particularly in this panel data, which also includes two countries, Russia and China, that have significantly invested in their military assets in recent years. It should also be noted that all BRICS countries, especially Russia and China, have their defence industries. Therefore, the defence expenditures of these countries primarily support their defence industries. In light of this fact, it can be inferred that the defence industry activities of the examined countries do not have a significant indirect impact on environmental degradation. It is an important finding that Russia's defence expenditures do not harm the environment, despite the ongoing conflicts with a certain continuity that Russia has experienced since the collapse of the Soviet Union (Chechnya Wars, 1994-2009; Georgia-Russia War, 2008; Ukraine-Russia War, 2020, etc.). In addition, China, which is constantly expanding its military assets due to the global power race, now has the largest navy in the world (US Department of Defense, 2023: 70). The fact that China, with its substantial mass production capacity, does not harm the environment while expanding its military (with the damage being negligible) is a positive empirical finding for the country. The reason for focusing on Russia and China so far is that these two countries meet almost all of their defence needs through their industries due to the embargoes they are subjected to. Other BRICS countries also face geopolitical challenges, although not to the same extent as Russia and China. In particular, India's border disputes with Pakistan and China necessitate the country maintaining its defence expenditures at a significant level. While Brazil faces more internal security challenges, South Africa is perhaps the most peaceful country among the BRICS nations. The relationship between defence expenditures and environmental degradation, which has not been extensively studied in the literature, is found to be quite weak, according to the findings of this study. As long as developing countries are not party to a nuclear war that will cause environmental damage, the environmental damage

of hot conflicts in which they will take part to protect their geopolitical interests will not reach serious levels.

Another finding of the empirical analysis is that the foreign direct investments of the developing economies do not have a statistically significant effect on the countries' carbon emissions. The fact that foreign investments do not impact carbon emissions has been analysed from different perspectives in the literature. For example, Zarsky (1999) emphasised the quality of investments and stated the importance of the industrial sectors to which foreign investments are directed. Foreign direct investments cannot be expected to reduce carbon emissions if investments are concentrated in industries with high fossil fuel consumption. This is likely to be the case for the countries we have analysed. Another reason for the lack of a significant relationship between foreign investments and carbon emissions is that governments often do not prioritise environmental regulations in their legal frameworks and lack a robust legal infrastructure to protect the environment. Eskeland and Harrison (2003) argue that countries with stringent environmental laws and regulations may attract foreign investments to areas with high environmental standards. However, developing economies, which rely heavily on foreign investment, may not prioritise whether the activities in areas where foreign investments will be directed are environmentally friendly. Finally, as stated by Zeng and Eastin (2012), investments in advanced economies can bring efficient technologies, which may, in turn, lead to reduced emissions. However, if the incoming technology is outdated or less efficient, it may not have a positive impact on reducing carbon emissions. From this perspective, it is evident that the five developing countries capable of producing nuclear energy, which we subjected to econometric analysis, were unable to achieve efficient technology transfer at a level that would reduce their emission values.

One of the study's significant findings is that the use of nuclear energy has a negative environmental impact in the five developing countries examined. The energy consumption distribution of the BRICS countries, which are capable of producing nuclear energy, may play a key role in this finding.

Figure: 8
Resource Distribution of Energy Consumption in Brazil
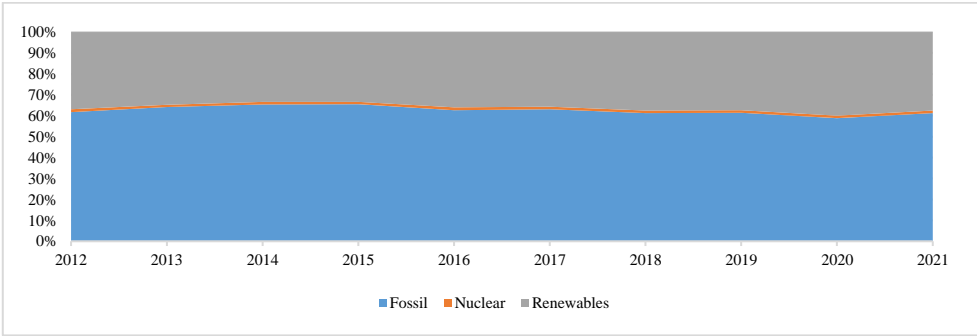
Source: Authors' calculation based on the U.S. Energy Information Administration Database.

Figure: 9
Resource Distribution of Energy Consumption in China
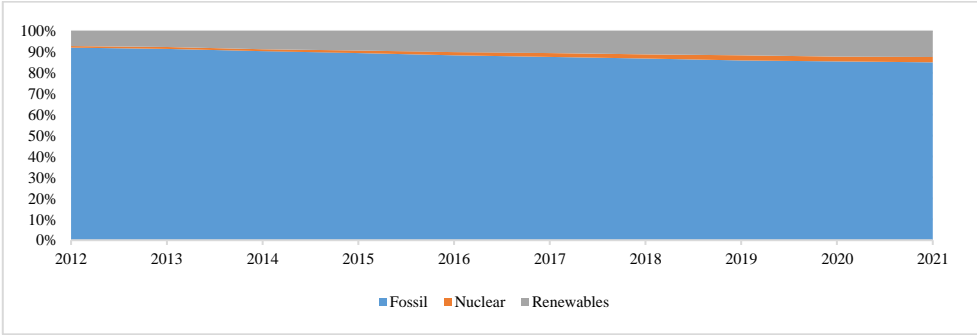
Source: Authors' calculation based on the U.S. Energy Information Administration Database.

Figure: 10
Resource Distribution of Energy Consumption in India
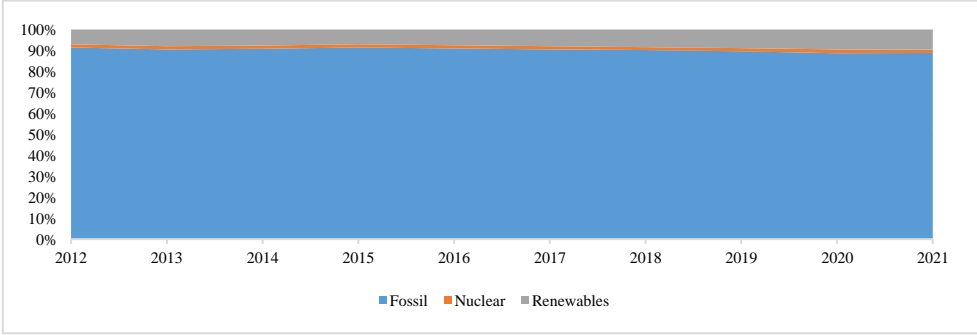
Source: Authors' calculation based on the U.S. Energy Information Administration Database.

Figure: 11
Resource Distribution of Energy Consumption in Russia
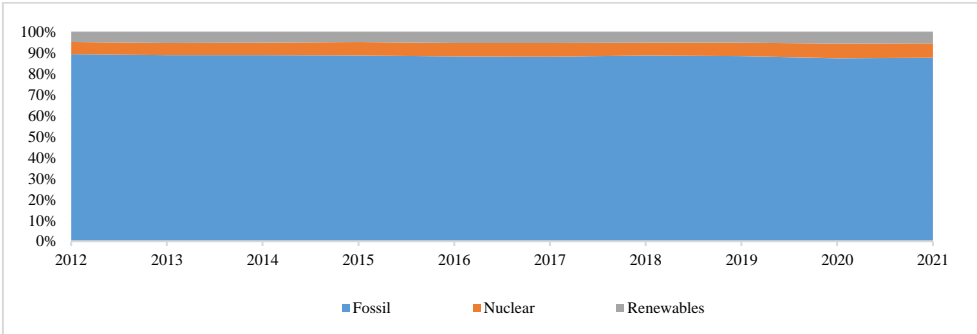
Source: Authors' calculation based on the U.S. Energy Information Administration Database.

Figure: 12
Resource Distribution of Energy Consumption in South Africa
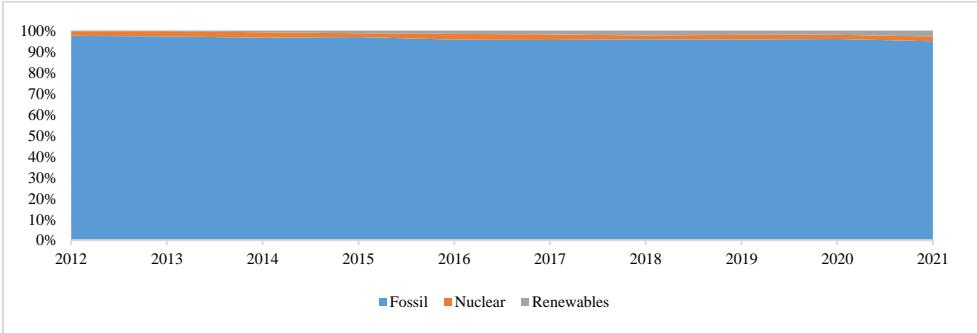
Source: Authors' calculation based on the U.S. Energy Information Administration Database.

As the graphs above show, when the energy resource distribution of BRICS countries is analysed, the dominant energy source is fossil fuels, which may lead to increased carbon emissions in these countries and, ultimately, to environmental degradation.

When the graphs of energy consumption distribution in BRICS countries using nuclear energy are analysed, fossil fuels are predominant in these countries. This situation means that the carbon emissions released into the atmosphere in these countries remain unchanged, which can lead to environmental deterioration.

It would not be wrong to say that the incomplete institutional structure of the BRICS formation is one of the reasons for this situation. The predominance of fossil fuels in the energy consumption composition of these countries suggests a lack of consensus among nations regarding standard action. Compared to the European Union, which has a similar structure, the BRICS require numerous structural reforms to enhance institutional

functioning. The lack of legal texts in the BRICS countries and the inability of the existing ones to function at the point of joint action may undermine the institutionalisation of the BRICS formation. At this point, "Green Keynesian Economics" will be able to develop practical solutions to overcome these shortcomings, providing a new reflection of Keynesian economic thought. Green Keynesian Economics is a combination of environmental economics and Keynesian macroeconomics. It proposes that the state actively intervene in the economy to reduce carbon emissions, the primary source of environmental problems (Harris, 2013: 3).

Considering the political, demographic, and economic structures of the BRICS countries, the active role of states in economic life may have practical consequences for environmental degradation in these countries. These policy recommendations are listed below:

- *Energy Efficiency*: Investing in technological innovations and energy-saving policies to increase energy production and consumption efficiency. By ensuring energy efficiency, unnecessary energy consumption and, thus, carbon emissions can be reduced.
- *Clean Transportation: Support the adoption of electric vehicles and public transportation to reduce dependence on fossil fuels in the transportation* sector. Expanding electric vehicle charging infrastructure is also an important policy.
- *Infrastructure Revision*: Reducing emissions requires developing low-carbon transportation systems, green buildings, and energy-efficient infrastructure. Public investments can finance such projects.
- *Privileging Environmentally Friendly Products in Public Procurement*: Granting privileges to environmentally friendly products in public procurement can reduce carbon emissions and create demand for these products, thereby indirectly encouraging their production.
- *Forest and Land Use*: Afforestation projects and sustainable land use policies can contribute to offsetting carbon emissions. Forests play an important role as carbon sinks.
- *Research and Development*: Support research and development efforts to develop and apply advanced technologies to reduce carbon emissions. Innovative solutions such as carbon capture and storage technologies (CCS) can be considered in this context.
- *Incentives and Subsidies*: Provide financial incentives and subsidies for clean energy technologies, energy efficiency and low-carbon practices. This can accelerate the adoption of innovative technologies.
- *Carbon Pricing*: Implementing mechanisms such as carbon taxes or emissions trading systems can be encouraged to reduce carbon emissions. Such pricing can encourage emitting sectors to develop more sustainable alternatives.

- *Sustainable Investments*: Increased cooperation between the public and private sectors can encourage investments in renewable energy, energy efficiency, and green infrastructure. The state can guide and encourage these investments.
- *Green Employment Programs*: Training and skills development programs can be organised to create new employment opportunities in sectors that reduce carbon emissions. In this way, the labour force is also integrated into the transformation process.
- *Research and Development Funds*: Financial support can be provided for research and development projects to encourage the development of innovative and sustainable technologies.

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Determining Digital Maturity Levels Within the Framework of Industry 4.0 in the Automotive Sector: Konya Example

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Otomotiv Sektöründe Endüstri 4.0 Çerçevesinde Dijital Olgunluk Düzeylerinin Belirlenmesi, Konya Örneği

Abstract

This study aims to determine the digital maturity levels of automotive enterprises in Industry 4.0 as they operate in Konya. In the study, analysis was conducted on data collected from nine enterprises engaged in mass production of automotive industry spare parts. Maturity model, ARAS, and SAW method analyses were performed based on data obtained from experts and managers working in the enterprises. In general, it has been observed that the Industry 4.0 maturity level of enterprises (3.50/5.00) is at a medium level. However, while it is seen that the level of enterprises for smart processes and smart products is better, it has been concluded that there are areas that need improvement in smart factories and organisational aspects.

Keywords : Automotive Industry, Industry 4.0, Digital Maturity, AHP, MCDM.

JEL Classification Codes : M50, O30, O40.

Öz

Bu çalışmada, Konya'da faaliyet gösteren otomotiv sanayi işletmelerinin Endüstri 4.0 dijital olgunluk düzeylerinin belirlenmesi amaçlanmıştır. Çalışmada, otomotiv sanayi yedek parça alanında seri üretim yapan 9 işletmeden toplanan veriler üzerinden analiz gerçekleştirilmiştir. İşletmelerde görevli uzmanlar ve yöneticilerden elde edilen veriler üzerinden de *Olgunluk modeli, ARAS* ve *SAW* yöntemi analizleri gerçekleştirilmiştir. Genel olarak işletmelerin Endüstri 4.0 olgunluk düzeylerinin (3,50/5,00) "orta seviye" olduğu görülmüştür. Bunula birlikte, işletmelerin *akıllı işlemler ve akılı ürünlere* yönelik seviyelerinin daha iyi olduğu görülürken, *akıllı fabrika* ve örgütsel yönlerinin geliştirilmesi gereken alanlar olduğu sonucuna ulaşılmıştır.

Anahtar Sözcükler : Otomotiv Sanayi, Endüstri 4.0, Dijital Olgunluk, AHS, ÇKKV.

1. Introduction

The First Industrial Revolution began in England around 1750-1760 and continued until approximately 1840. This period constitutes one of the most critical turning points in human history. In this process, human and animal-powered work was replaced by technological machinery; innovative machines, such as steam engines, spinning machines, and coke smelting, sludging, and rolling processes for iron production, were introduced (Mohajan, 2019: 377). In the 1870s, humanity started mass production with second-industry electricity, and the first production line was established in Cincinnati slaughterhouses. Processes such as the acceleration of the automation-based output in the 1970s, the development of information technologies, and the development of smart control devices are considered within the scope of the third industrial revolution (Kagerman, 2013: 13; Hermann et al., 2015: 5). *Industry 4.0*, which was introduced by Germany as the "Project of the Future" in January 2011 and aims to transition to production based on cyber-physical systems, is considered today as the fourth industrial revolution (Kagerman, 2013: 13).

Industry 4.0 is defined as a "*Digital Revolution*" that can be achieved with limited human intervention in the production phase due to digitalisation. The primary purpose of Industry 4.0 is considered to be the adaptation and improvement of existing production to better suit digital production needs and consumer expectations (Kumar & Nayyar, 2020: 2). The most important feature of Industry 4.0 is that it offers a smart production model diversified according to the demands of the people who buy products and services as a result of providing a real-time communication process between human, product and machine (Fırat & Fırat, 2017: 212-213). Industry 4.0, also known as the 4th Industrial Revolution, has distinct design principles that distinguish it from previous industrial revolutions. These principles are divided into 5: *Interoperability, Virtualization, Decentralization, Modularity and Real-Time Production. Interoperability* refers to the continuous interaction among all actors, including consumers and channels such as marketing, distribution, and logistics, during the production stage (Hermann et al., 2015: 11-13). *Virtualisation* is the principle of enables the derivation of a virtual twin from industry through machine-to-machine (M2M) monitoring and communication (Carvalho & Cazarini, 2020: 8). *Decentralization* refers in a centralised decision-making (CDM) process, a single decision centre (DC) is aware of all system information (Marques et al., 2017: 303). *Modularity* offers advantages such as shorter time-to-market, reduced production complexity and cost, higher product quality, longer product life, material and resource efficiency (Ghobakhloo, 2020: 11). *Real Time Production* is coordination of the production process depending on demand, minimising stock and production times throughout all value chains, and characterised by a high level of usage (Atik & Ünlü, 2018: 149).

The automotive industry is vital in today's business world, where the level of digital integration is high and constant change is experienced. Since the automotive industry is a major supplier to companies in the petrochemicals, iron and steel, plastics, glass, electronics, and textiles sectors, it has also been a driving force behind technological developments. On the other hand, it also supplies motor vehicles to the tourism, agriculture, transportation,

defence and construction sectors. Additionally, it is closely related to the dealers, marketing, fuel, service, finance, and insurance sectors, which ensure that the final products reach buyers through raw materials and various sub-industries (STB, 2020). According to the production, export, and market data of the Automotive Industry Association (OSD) for the January-July period of 2023, total automotive production in the first seven months of 2023 increased by 18% compared to the same period in 2022, reaching 870,600 vehicles. Export revenues increased by 17%, reaching 20.5 billion dollars (OSD, 2024).

In the automotive industry, digitalisation often initiates a disruptive and discontinuous transformation process, changing companies' traditional processes, products, services, and business models (Sommer et al., 2021: 295). For automakers, it is crucial to reshape their corporate strategies in line with digital transformation and to implement this process rapidly (Winkelhake, 2019: 37). Recent digital innovations such as driverless cars, connectivity, big data, and social networks are leading to fundamental changes in the automotive industry (Risanow et al., 2017: 3191). Regarding technological advances, several elements are involved in this sector, particularly the high level of automation and digitalisation. The automotive industry elements of Industry 4.0 include augmented reality, virtual assembly, 360-degree networking, autonomous robots and machines, Smart Factories, higher flexibility, increased efficiency, higher speed, smart logistics, and 3D printing (Sinay & Kotianova, 2018: 63).

This study aims to measure the level of digital maturity in the automotive industry by utilising the criteria and sub-criteria of the IMPULS Industry 4.0 digital maturity model. For this purpose, criteria weighting was conducted by considering expert opinions on six main criteria and 18 sub-criteria within the IMPULS Industry 4.0 digital maturity model. A pairwise comparison matrix suitable for AHP analysis was created using input from 10 experts with relevant field knowledge, and consistency tests were performed on these matrices. For the research, a questionnaire survey was conducted among experts and managers in 9 enterprises operating in Konya and engaged in mass production of automotive spare parts. In the study, companies operating in the automotive industry were ranked using the Weighted Maturity Score Calculation Model Approach and the ARAS and SAW methods, which are Multi-Criteria Decision-Making Methods. The results with different rankings were combined with the Borda Count Method. Additionally, the consistency of the results obtained from each of the four approaches was assessed using correlation analysis. In the conclusion section of the study, suggestions are presented to improve the maturity levels of the companies participating in the research.

2. Conceptual Framework

2.1. Digital Transformation and Digital Maturity

Although the concept of digital transformation is based on the term' digital' (TDK, 2023), the concepts of digitalisation and digitisation have distinct meanings, although they are closely related. According to the Cambridge English Dictionary, the term digital refers

to the digital recording or storage of data in 1s and 0s, i.e. the electronic representation of information. Digitalisation refers to the process of converting data into a series of 0s and 1s that computers can understand (Cambridge Dictionary, 2022). Digitalisation refers to adopting a broader philosophy of change that encompasses digital technologies, data and the workforce. This change aims to transform business models (Parida, 2018: 24). In this context, significant transformations have been experienced in existing business processes with technological developments. The era of digitalisation has begun in the business world. In the last decade, concepts such as Industry 4.0, digital transformation, and digitalisation have become increasingly prevalent. In particular, digital transformation has become an important topic of interest in academic circles and the professional business world (Alkış-Bayhan, 2022: 1497). This digital transformation process has reached a critical turning point as technological developments have led to radical changes in the business world.

Digital transformation has reached a critical turning point in the business world, driven by technological developments that are leading to radical changes in business processes. This transformation is "the holistic implementation of innovations that will provide speed and efficiency in the operating styles, processes, competencies, and models of businesses, in line with a specific strategic plan, together with digital technological developments" (Ballı, 2022: 253). In other words, digital transformation is the process of using digital technologies that help a business create more value for itself and its environment by developing digital business models (Sezen & Eren-Şenaras, 2022: 56). In a broad sense, digital transformation is a process used to restructure organisations, society and economies at a system level (Schumacher et al., 2016: 161). This transformation is realised through digital technologies, including mobile technologies, the Internet of Things, cloud computing, big data, cybersecurity, artificial intelligence, and robotics (Hoe, 2020: 55). Digital transformation aims to transform all internal and external processes into fully interconnected cyber-physical systems by integrating them with smart technologies. This transformation has the potential to increase efficiency by creating significant changes in business models, supply chains and business processes (Şener et al., 2022: 18). Digital transformation process has made it even more critical for businesses to adapt to digitalisation, which is why concepts such as digital maturity and digital transformation maturity level have started to be used frequently.

When the adaptation processes of businesses to digital transformation are evaluated, concepts such as digital maturity, digital transformation level, Industry 4.0 readiness level and digital readiness level are used together and mean the same thing (Ayyıldız & Demir, 2022: 67). Literature reviews indicate that there is no single generally accepted definition for the concept of "digital maturity" (Asiltürk, 2021: 650). In a general definition, digital maturity is "the readiness of firms to compete effectively with their competitors in an increasingly digitalised environment" (Kane et al., 2017: 5). In other words, digital maturity defines the achievements of a business in terms of realising digital transformation processes and its efforts to adapt to an increasingly digitalised environment to remain competitive (Teichert, 2019: 1675). In this context, digital maturity refers to the gradual integration of

organisational processes, human resources, and other resources into digital processes (Aslanova & Kulichina, 2020: 444).

There are models developed by various commercial organisations and academic studies that provide a closer understanding of digital maturity. Examples of models developed by commercial organisations include the IMPULS Industry 4.0 Readiness model by Lightblau et al. (2015), the Forrester model by Gill and Vanboskirk (2016), the ACATECH model by Schuh et al. (2017), and the Connected Enterprise Maturity Model by Rockwell Automation (2014). These models include the Bilgem Digital Maturity Model, developed by Tübitak, and the IZ&KA model, developed by the Izmir Development Agency. As for the models developed in academic studies, the models developed by Schumacher et al. (2016) for the manufacturing sector, Valdez De Leon (2018) for the telecommunications sector, Biby & Dehe (2018) for the defence industry, and Facchini et al., (2020) for the logistics sector are examples of academic-based models.

The IMPULS model was developed in 2015 by experts from the Mechanical Engineering Industry Association and some industry representatives. It utilises a web-based measurement to assess the level of adaptation of manufacturing companies to Industry 4.0. The model comprises six levels, six main criteria, and 18 sub-criteria (Lichtblau et al., 2015).

Figure: 1
IMPULS Industry 4.0 Readiness Model
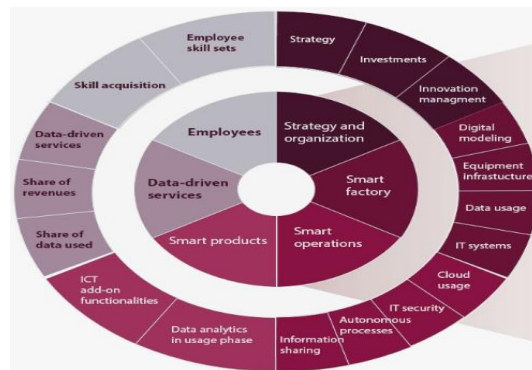
Source: < https://www.industrie40-readiness.de/?lang=en >, 25.05.2024.

Under the main criterion of smart operations, there are sub-criteria of IT security, autonomous processes, cloud use and information sharing. Under the main criterion of the smart factory, there are sub-criteria for equipment infrastructure, information utilisation, digital modelling, and IT systems. The primary criterion for smart products is ICT service functionalities, along with sub-criteria related to data usage. Under the main criterion of strategy and organisation, there are sub-criteria for strategy, innovation management and investments. The primary criteria for data-driven services include the level of data utilised and the proportion of revenues. Finally, under the main criterion of employees, there are

employee skill sets and skill acquisition sub-criteria (Lichtblau et al., 2015; Grufman &
Lyons, 2020). The levels used in the model are Level 0 - Foreign, Level 1 - Beginner, Level
2 - Intermediate, Level 3 - Experienced, Level 4 - Expert, and Level 5 - Best Performance.

Table: 1
IMPULS Digital Maturity Model Criteria

Criteria / Sub-criteria	Explanation
1. Strategy and Organization	
Strategy	Application status of Industry 4.0 strategy
Investments	Investment activities in the field of Industry 4.0
Innovation Management	Developing a strategy about the technologies and innovations that the company will create or add in the direction of Industry 4.0
2. Smart Factory	
Digital Modeling	Integration and digital modelling of production processes
Equipment Infrastructure	Integrated work with technological equipment such as sensor technology, actuators, machines and robots to collect data
Data Usage	Collection and use of information regarding all activities
IT Systems	Use of smart operation activities such as MES, ERP, and SCM directly in company systems
3. Smart Operations	
Cloud Usage	Usage level of cloud computing technology
IT Security	Protection of data used in information technology
Autonomous Processes	Production planned processes with self-controlling and decision-making work pieces.
Information Sharing	Sharing information about the operation of activities and processes between people, processes and objects so that company activities can be well monitored and coordinated
4. Smart Products	
Data Analytics in the Usage Phase	Self-reporting, integration, location determination, automatic identification and tracking functions with product status monitoring and optimisation
ICT Add on-Functionalities	Providing services based on Information Communication Technologies for the development of processes
5. Data-Driven Services	
Data-Driven Services	In addition to the services provided by companies, providing comprehensive after-sales services
Share of Revenues	Share of revenues obtained by the development of innovative business models or processes
Share of Data used	The level of data used regarding innovative business models and digitalised processes to increase customer benefit
6. Employees	
Skill Acquisition	Employees' acquisition of skills in new information technologies (technologies developed for data recording, transfer, manipulation, use and interpretation)
Employee Skill Sets	Skill sets of employees for new information technologies

Source: Baki & Serdar, 2020.

2.2. Literature

This section includes information about various studies that are believed to be related
to the subject, as identified through research conducted in Google Scholar, Web of Science,
and Scopus databases. First, Schumacher et al. (2016) measured the industry 4.0 maturity
level of a company that designs aviation and space materials in their study. Klotzer & Pflaum
(2017) also developed a digital maturity model for developing supply chains of
manufacturing industry companies. Kaltenbach et al. (2018) assessed the maturity levels of
three manufacturing companies operating in Germany in the context of smart services. Akdil
et al. (2018) measured the industry 4.0 maturity level of a company operating in the retail
sector. Sevinç et al. (2018) analysed and listed the difficulties in SMEs' adaptation to
Industry 4.0 with AHP and ANP (Analytic Network Process) methods. Mittal et al. (2018)
conducted a literature review of existing Smart Manufacturing (SM) and Industry 4.0
maturity models and analysed their suitability for Small and Medium Enterprises. Luthra &
Mangla (2018) prioritised and ranked the barriers to the Industry 4.0 transformation of the
Indian manufacturing industry supply chain with factor analysis and AHP methods. Santos
& Martinho (2019) developed a maturity model based on organisational strategy, structure,

culture, workforce, smart factories, smart processes, and smart products and services. In their study, Yılmaz Yalçıner and Çaylak (2020) suggested which sector Türkiye should start its Industry 4.0 transformation from. Sarı (2020) presented a sector-specific, technology-oriented maturity model based on the AHP method, which determines the importance of Industry 4.0 technologies in the food and beverage manufacturing sector. Ruggero et al. (2020) aimed to measure the industry 4.0 maturity level of companies in the automotive sector in Brazil. Baki & Serdar (2020) measured the Industry 4.0 maturity levels of enterprises in the logistics sector using AHP-based maturity, TOPSIS, and VIKOR methods. Rauch et al. (2020) developed an Industry 4.0 digital maturity assessment tool for small and medium-sized enterprises in the manufacturing sector.

Biby & Dehe (2021) developed an evaluation model centred on three dimensions to measure the level of implementation of Industry 4.0 technologies. Borstnar & Pucihar (2021) aimed to measure the digital maturity levels of SMEs in their study. For this purpose, they developed a multi-attribute digital maturity measurement model. Simetingern & Basl (2022) designed an Industry 4.0 maturity model for SMEs in the Czech Republic and at the universal level. Gökalp and Martinez (2022) proposed the Digital Transformation Capability Maturity Model (DX-CMM) to inform companies about their current maturity levels, conduct gap analyses, and create comprehensive improvement roadmaps. Pinto et al. (2023) identified the dimensions that characterise the digital maturity of retail companies in Brazil and determined the digital maturity levels of firms by cluster analysis method. Senna et al. (2023) developed an Industry 4.0 digital maturity model based on the Technology-Organization-Environment framework. They tested their model with a focus group study with 24 different companies.

To summarise, related studies have been conducted in various sectors, particularly the defence, automotive, logistics, and food sectors. In addition to parametric and non-parametric statistical methods and Multi-Criteria Decision-Making methods, maturity calculation methods proposed by various researchers were also utilised in the studies.

2.3. Methodology

Approximately 2000 companies operate in the automotive supply industry in Konya, one of Turkiye's most important industrial cities. Approximately 500 of these companies are exporting companies in international markets and are technologically engaged in mass production for spare parts manufacturers. This issue is why Konya was chosen as the research sample. Additionally, the automotive sub-industry ranks as the second-largest sector in Konya (KYDT, 2024).

This study aimed to measure the digital maturity levels of automotive industry companies in Konya. In the first phase of this study, which consisted of three stages, the digital maturity model developed by the IMPULS foundation was utilised as a result of the literature review. To weigh the criteria in the model with the AHS method, 10 expert opinions were consulted. The experts consulted consisted of five academicians from

management and organisation, as well as production management, and five sector representatives who were managers in mass production companies within the automotive industry. A survey form developed by Serdar (2019) and further refined by Baki and Serdar (2020) using the IMPULS digital maturity model was employed to assess the digital maturity levels of businesses. The digital maturity survey was administered to enterprises operating in Konya and engaged in the mass production of spare parts within the automotive industry. According to the researchers' findings, 14 companies were identified as engaging in mass production, and these companies were contacted in advance. Permission was requested from the businesses to do the research. Ten companies expressed interest in participating in the study, and although survey forms were delivered to the businesses, feedback was received from only nine companies. The research continued with data obtained from 9 companies.

In the second stage of the study, the maturity calculation method was planned to be used, and the ranking methods to be used in comparing the results were determined. Accordingly, the Weighted Maturity Approach method was adopted as the measurement method proposed in this study. This method, proposed by Schumacher et al. (2016), was also employed in the studies of Temur et al. (2019) and Baki and Serdar (2020). In this method, the criteria weights obtained through subjective criteria weighting methods and the data received from the firms are calculated using the equation proposed by Schumacher et al. (2016). Due to the limited number of main criteria and sub-criteria in the IMPULS model, AHP, a powerful method for weighting subjective criteria, was employed to evaluate the requirements. Using the AHP method, the pairwise comparison questionnaires distributed to obtain expert opinions were analysed, and the criteria were weighted. The weight of each calculated criterion and the responses in the questionnaires received from the enterprises were calculated according to the Maturity Model formula. In the next stage, businesses were ranked according to their digital maturity levels, first with the ARAS method and then with the SAW method. An integrated decision was obtained by combining the results of the applied methods with the Borda Count, a voting technique. In the final stage, the consistencies between the results of the four methods were analysed using "Correlation Analysis". Figure 2 illustrates the implementation flowchart of this research.

Figure: 2
Application Flowchart
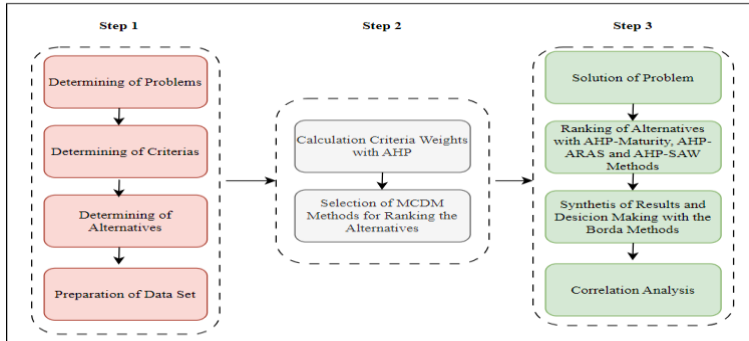
In AHP, the objective to be achieved is first determined. Then, the criteria and any sub-criteria are defined. At the lowest level are the alternatives. At this stage, a decision hierarchy is created to determine all the requirements that affect the decision-making process, and the opinions of experts in this field are taken into consideration. Then, pairwise comparison matrices are created, and decision-makers are asked to make comparisons (Saaty, 1990). It is checked whether these comparisons meet the consistency test, and if not, the decision maker is asked to review and correct their decision. If the consistency ratio of the comparisons is less than 0.1, it is considered that the comparisons are consistent. A re-evaluation should be made if the consistency ratio exceeds 0.1 (Önder & Önder, 2018). Then, the importance levels of the criteria are calculated from the pairwise comparison matrices.

When determining the criteria weights using the AHP method, experts compare the criteria in pairs. Saaty's (1990) 1-9 scale is usually used in this comparison. On the scale, 1/9 is considered the lowest value, one the equal value, and nine the highest (Önder & Önder, 2018). Table 1 shows the importance levels used when making comparisons in AHP.

Table: 2
Table of Importance Levels Used in Comparisons

Importance Levels	Definition	Explanation
1	Equally Important	Both factors are of equal importance.
3	A Bit More Important	Based on experience and judgment, one factor is more important than the other.
5	Strongly More Important	One factor is enormously more important than the other.
7	Highly Important	One of the factors is more important than the others.
9	Very Highly Important	One of the factors is significantly more important than the others.
2,4,6,8,	Intermediate Values (Settlement Values)	They represent intermediate values of the degrees in the above explanations, which involve a choice between two factors.

Source: Saaty, 1990.

2.4. Maturity Model

In this study, the Industry 4.0 maturity calculation method developed by Schumacher et al. (2016) and employed in the studies by Temur et al. (2019) and Baki & Serdar (2020)

was utilised. In the model, using a 5-point Likert scale, the importance level of each technology is multiplied by the company's application level of that technology, and then the results are summed. Finally, a total score is obtained. The method for calculating the maturity score is calculated using equation (1) below (Schumacher et al., 2016):

Table: 3
Sample Statement on Digital Maturity Level Measurement

Question	1	2	3	4	5
Does your business have a roadmap in place for Industry 4.0 activities during the planning process?					

1… Not Applied at All, 5… Applied at Advanced Level.

$$M_{D=} \frac{\sum_{i=1}^{n} M_{dli*g_{Dli}}}{\sum_{i=1}^{n} g_{Dli}} \tag{1}$$

M… Maturity
D… Dimension
I… Expression
g… Weighting factor
n… Maturity Level Number of Expressions

2.5. Aras Method

The ARAS (Additive Ratio Assesment) method was proposed by E.K. Zavadskas & Z. Turskis (2010) as a new approach to solving multi-criteria decision-making problems. The Aras Method shows the proportional similarity of all alternatives for the ideal alternative. In the Aras method, the utility function values of the other options examined are compared with the utility function value of the optimal alternative the researcher added to the decision problem (Shariati et al., 2014). The application stages of the Aras method are shown below (Zavadskas & Turskis, 2010; Ecer, 2016):

Step 1: Creating the decision matrix

First, the decision matrix is created. In an MCDM problem, the decision matrix consists of m alternatives (rows) and n criteria (columns).

$$X = \begin{bmatrix} x_{01} & x_{02} & \cdots & x_{0n} \\ x_{i1} & x_{12} & \cdots & x_{1n} \\ \vdots & \vdots & \cdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}; i = 0,1, \dots, m; j = 1,2, \dots, n \tag{2}$$

In the matrix, *m* is the number of alternatives, *n* is the number of criteria, x_{ij} is the performance value of alternative i according to criterion j and x_{0j} is the optimal value of criterion *j*.

$$X_{oj} = max_i \, x_{ij} \, Benefical \, Criteria \tag{3}$$

$$X_{oj} = min_i \, x_{ij} \, Cost \, Criteria \tag{4}$$

Step 2: Normalisation

Often, the evaluation criteria can vary in size and scale. This step standardises the criteria with varying dimensions by performing a normalisation process. Thus, all criteria have values in the range of [0, 1].

In normalisation, equity (5) is used for the criteria to be maximum and equity (6) is used for the criteria to be minimum.

$$\bar{x}ij = \frac{x_{ij}}{\sum_{i=0}^{m} x_{ij}} \tag{5}$$

$$\bar{x}_{ij} = \frac{1/x_{ij}}{\sum_{i=0}^{m} 1/x_{ij}} \tag{6}$$

After normalisation, the normalised decision matrix is formed as follows:

$$\bar{X} = \begin{bmatrix} \bar{x}_{01} & \bar{x}_{02} & \cdots & \bar{x}_{0n} \\ \bar{x}_{11} & \bar{x}_{12} & \cdots & \bar{x}_{1n} \\ \vdots & \vdots & \cdots & \vdots \\ \bar{x}_{mn} & \bar{x}_{m2} & \cdots & \bar{x}_{mn} \end{bmatrix}; i = 0,1,\ldots,m; j = 1,2,\ldots,n \tag{7}$$

Step 3: Constructing the weighted-normalised decision matrix

In this step, a weighted normalised decision matrix is obtained. Criteria weights take a value between 0 and 1. Additionally, the sum of the criterion weights equals 1. Since the weights directly affect the analysis results, it is crucial to determine them carefully and meticulously. Normalised weights are determined by Formula (8). In the formula, w_j is the weight (importance level) of criterion j and $\bar{x}_{ij}$ is the normalised value of criterion j.

$$x_{ij} = \bar{x}_{ij} w_j; i = 0,1,\ldots m \tag{8}$$

Thus, the weighted-normalized decision matrix is constructed as follows:

$$X = \begin{bmatrix} x_{01} & x_{02} & \cdots & x_{0n} \\ x_{11} & x_{12} & \cdots & x_{1n} \\ \vdots & \vdots & \cdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}; i = 0,1,\ldots,m; j = 0,2,\ldots,n, \tag{9}$$

Step 4: Calculation of the S_i Optimality Function

$$S_i = \sum_{i=1}^{n} x_{ij}; i = 0,1,\ldots,m \tag{10}$$

In formula (8), S_i is the optimality function of alternative i. It can be interpreted that the larger the S_i value is the better. Because, considering the calculation process, S_i is directly related to the values of x_{ij} and w_j that affect the final outcome. As a result, the alternative with a higher S_i value is the more efficient alternative.

$$K_j = \frac{S_i}{S_0}; i = 0,1,\ldots,m \tag{11}$$

2.6. Saw Method

The SAW (Simple Additive Weighting) method was developed by Churchman & Ackoff (1954) and is also known as the Weighted Sum Model in the literature. The SAW method is calculated by multiplying the cost and utility values of the alternatives by their corresponding criteria weights and then summing the resulting values for each criterion. This method ensures a consistent and proportional transformation of data. The algorithm of the SAW Method, which is one of the most preferred methods in the MCDM literature thanks to its ease of mathematical calculation, is as follows (Çakır & Perçin, 2013; Ömürbek et al., 2016):

Step 1: Creating the decision matrix

The decision matrix is created as given in Equation (1).

Step 2: Normalization of the decision matrix

In the next stage of the SAW Method, the decision matrix, consisting of m alternatives and n evaluation criteria, is normalised using Equation (12).

$$r_{ij} = \begin{bmatrix} \frac{x_{ij}}{max\ x_{ij}} & i = 1, \dots, j = 1, \dots, n\ Benefical\ Criteria \\ \frac{min x_{ij}}{x_{ij}} & i = 1, \dots, j = 1, \dots, n\ Cost\ Criteria \end{bmatrix} \tag{12}$$

Step 3: Calculation of Preference Values of Alternatives

The total preference values of the alternatives are calculated with the help of equation (13) below.

$$v_i = \sum_{j=1}^{n} w_j\ r_{ij}\ = 1, \dots, \dots, m \tag{13}$$

2.7. Borda Count Method

The "Borda Count" method, introduced as a voting technique by Jean-Charles de Borda in 1784, played a significant role in the development of modern election systems (Lamboray, 2007). This method is considered a measurement tool for determining the best option among findings obtained through multiple methods (Gök-Kısa & Perçin, 2020). With the Borda Count method, the rankings obtained by many classifiers are combined and turned into a single ranking (Wu, 2011). The algorithm used in the Borda method is as shown in equation (14) (Gök-Kısa & Perçin, 2020):

$$b_i = \sum_{k=1}^{n}(M - r_{ik}) \tag{14}$$

Here,

r_{ik}: under k criteria i. Rank of alternative

M: Total number of alternative

3. Findings

In this section, the geometric averages of the pairwise comparison results for the criteria obtained from 10 experts are calculated. The general weight (global weight) of the main criteria, sub-criteria, and all criteria is presented in Table 4. Then, using the criterion weights obtained by AHP, the maturity levels of the enterprises were measured in line with the data received from the enterprises and the companies were sequenced. In the next stage, in line with the data obtained from the enterprises, the findings of the AHP-ARAS and AHP-SAW methods were combined with the Borda Count Method, and a final sequence was made. In the last stage, the consistency of the findings obtained from the four methods was analysed by correlation analysis. Table 4 shows the results of the AHP method.

Table: 4
Weights of AHP Main Criteria and Sub-Criteria

Main Criteria	Main Criteria Weights	Sub Criteria	Subcriteria Weight	Global Weight
C1-Strategy and Organization	0,2175	C11-Strategy	0,5499	0,1196
		C12-Investments	0,2098	0,0456
		C13-Innovation Management	0,2402	0,0522
		Consistency: 0,04380		
C2-Smart Factory	0,2480	C21-Digital Modeling	0,1977	0,0490
		C22-Equipment Infrastructure	0,2093	0,0519
		C23-Data Usage	0,2477	0,0614
		C24-IT Systems	0,3453	0,0856
		Consistency: 0,04380		
C3-Smart Operations	0,1798	C31-Cloud Usage	0,1223	0,0219
		C32-IT Security	0,4236	0,0761
		C33-Autonomous Processes	0,2270	0,0408
		C34-Information Sharing	0,2270	0,0408
		Consistency: 0,00220		
C4-Smart Products	0,1271	C41-Data Analytics in Usage Phase	0,6667	0,0847
		C42-ICT Add-on- Functionalities	0,3333	0,0423
		Consistency: 0,00000		
C5-Data-Driven Services	0,1095	C51-Data-Driven Services	0,4000	0,0438
		C52-Share of Revenues	0,4000	0,0438
		C53-Share of Data Used	0,2000	0,0219
		Consistency:0,00000		
C6-Employees	0,1181	C61-Skill Acquisition	0,5000	0,0590
		C62-Employee Skill Sets	0,5000	0,0590
Consistency:	*0,02110*	*Consistency:0,00000*		

Table 4 shows the main criteria and sub-criteria weights from 10 expert evaluations. The main criteria are ranked according to their importance weights as follows: Smart Factory (0.2480), Strategy and Organization (0.2175), Smart Operations (0.1798), Smart Products (0.1271), Employees (0.1181), and Data-Driven Services (0.1095). The sub-criteria of the Smart Factory main criterion are listed in order of their importance weights: IT Systems (0.3453), Data Usage (0.2477), Equipment Infrastructure (0.2093), and Digital Modeling (0.1977). The main sub-criteria with the highest importance in the Strategy and Organization criteria were Strategy (0.5499), Innovation Management (0.2402), and Investments (0.2098). The sub-criteria of the Smart Operations main criterion are listed in order of importance as follows: IT Security (0.4236), Information Sharing (0.2270), Autonomous Processes (0.2270), and Cloud Utilization (0.1223). The Smart Products main criterion sub-

criteria are listed according to their importance levels: Data Analytic in Usage Phase 0,6667 > ICT Add on- Functionalities 0,3333 >. When Data-Driven Services were ranked according to their importance level, the Share of Revenues was 0.4000, Data-Driven Services was 0.4000, and Data Used was 0.2000. The Employees' main criterion sub-criteria are ranked according to their importance: Employee Skill Sets (0.5000) and Skill Acquisition (0.5000).

After establishing the criteria weight, an initial decision matrix was created to analyse the AHP-Based Maturity Model approach and AHP-ARAS and AHP-SAW methods using the enterprises' data. The initial decision matrix table is given in Table 5.

Table: 5
Initial Decision Matrix

Criteria / Alternative	A1	A2	A3	A4	A5	A6	A7	A8	A9
Criteria Direction	maks	maks	maks	maks	maks	maks	maks	maks	maks
C11-Strategy	3	5	4	3	2	2	3	4	2
C12-Investments	3	5	4	3	3	2	3	4	2
C13-Innovation Management	3	4	4	3	2	2	3	4	2
C21-Digital Modeling	3	2	4	3	2	3	3	4	3
C22-Equipment Infrastructure	2	4	4	3	2	3	3	4	3
C23-Data Usage	3	3	4	1	2	3	3	4	3
C24-IT Systems	4	5	4	3	2	3	3	4	3
C31-Cloud Usage	3	4	3	3	1	3	3	4	4
C32-IT Security	4	4	3	3	2	4	3	4	4
C33-Autonomous Processes	3	3	3	3	2	3	3	5	5
C34-Information Sharing	3	5	3	3	3	3	3	5	5
C41-Data Analytics in Usage Phase	3	4	4	3	2	4	3	4	3
C42-ICT Add-on- Functionalities	2	4	4	3	2	4	3	4	3
C51-Data-Driven Services	4	3	4	3	2	3	3	4	3
C52-Share of Revenues	2	4	4	3	3	3	3	4	3
C53-Share of Data Used	3	3	4	3	2	3	3	4	3
C61-Skill Acquisition	2	3	4	3	2	3	3	4	3
C62-Employee Skill Sets	3	3	4	3	3	3	3	4	4

3.1. AHP-Maturity Model Approach Results

In this section, using Equation (1) suggested by Schumacher et al. (2016), the maturity levels of 9 companies in Konya Province that engage in mass production of automotive spare parts were evaluated through a maturity level evaluation survey. In the equation, the results obtained by multiplying the criteria weights created by the AHP method and the scores given to the questions for all sub-criteria are summed and divided by the total weight values. The results of the Konya province automotive industry digital maturity level are calculated using Equation (1).

0,1196 X 3,11 +	0,0456 X 3,22 +	0,0522 X 3 +	0,0490 X 3 +	0,0519 X 3,11+	0,0614 X 2,88 +	
0,0856 X 3,44 +	0,0219 X 3,11 +	0,0761 X 3,44 +	0,0408 X 3,33 +	0,0408 X 3,66 +	0,0847 X 3,33 +	
0,0423 X 3,22 +	0,0438 X 3,22 +	0,0438 X 3,22 +	0,0219 X 3,22 +	0,0590 X 3 +	0,0590 X 3,33 +	= 3,50
			1			

Figure 3 illustrates the radar diagram of the digital maturity levels of automotive industry enterprises in Konya Province based on the primary criteria. As shown in the diagram, the digital maturity levels of enterprises are ranked as follows: smart operations > smart products > data-driven services > employees > strategy and organisation > smart factory.

Figure: 3
Radar Diagram of Digital Maturity Levels of Automotive Industry Enterprises in Terms of Main Criteria
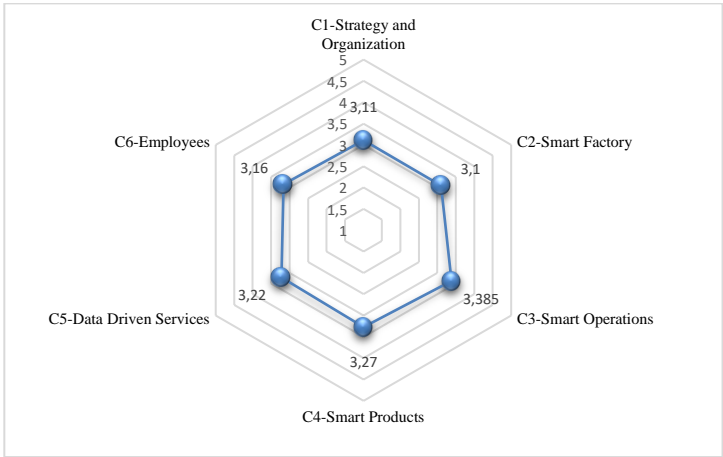
Figure: 4
Radar Diagram of Digital Maturity Levels of Automotive Industry Enterprises in Terms of Sub-Criteria
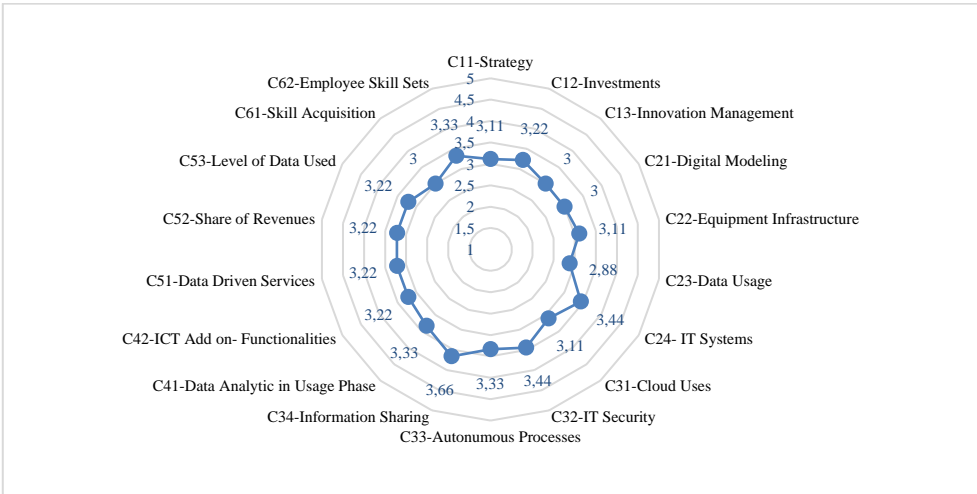

Figure 4 illustrates the radar diagram of the digital maturity levels of automotive industry enterprises in Konya Province, categorised by sub-criteria. As seen in the diagram, the digital maturity levels of firms in terms of sub-criteria are listed as follows: *information sharing > IT security > IT systems > autonomous processes > data use > employee skill*

sets > investments > bit service functions > data-driven services > share of revenues > level of data used > strategy > equipment infrastructure > cloud usage > skills acquisition > innovation management > digital modelling> information use.

Table: 6
AHP-Based Maturity Model Results of Enterprises in the Automotive Industry

A1						M	R
0,119 X 3 +	0,045 X 3 +	0,0522 X 3 +	0,0490 X 3 +	0,0519 X 2 +	0,0614 X 3 +		
0,0856 X 4 +	0,0219 X 3 +	0,0761 X 4 +	0,0408 X 3 +	0,0408 X 3 +	0,0847 X 3 +		
0,0423 X 2 +	0,0438 X 4 +	0,0438 X 2 +	0,0219 X 4 +	0,0590 X 2 +	0,0590 X 3 +	=3,03	5
1							
A2							
0,1196 X 5 +	0,0456 X 5 +	0,0522 X 4 +	0,0490 X 2 +	0,0519 X 4 +	0,0614 X 3 +		
0,0856 X 5 +	0,0219 X 4 +	0,0761 X 3 +	0,0408 X 3 +	0,0408 X 5 +	0,0847 X 4 +		
0,0423 X 4 +	0,0438 X 3 +	0,0438 X 4 +	0,0219 X 3 +	0,0590 X 3 +	0,0590 X 3 +	=3,82	2
1							
A3							
0,1196 X 4 +	0,0456 X 4 +	0,0522 X 4 +	0,0490 X 4 +	0,0519 X 4 +	0,0614 X 4 +		
0,0856 X 4 +	0,0219 X 3 +	0,0761 X 3 +	0,0408 X 3 +	0,0408 X 3 +	0,0847 X 4 +		
0,0423 X 4 +	0,0438 X 4 +	0,0438 X 4 +	0,0219 X 4 +	0,0590 X 4 +	0,0590 X 4 +	=3,81	3
1							
A4							
0,1196 X 3 +	0,0456 X 3 +	0,0522 X 3 +	0,0490 X 3 +	0,0519 X 3 +	0,0614 X 1 +		
0,0856 X 3 +	0,0219 X 3 +	0,0761 X 3 +	0,0408 X 3 +	0,0408 X 3 +	0,0847 X 3 +		
0,0423 X 3 +	0,0438 X 3 +	0,0438 X 3 +	0,0219 X 3 +	0,0590 X 3 +	0,0590 X 3 +	= 2,87	8
1							
A5							
0,1196 X 2 +	0,0456 X 3 +	0,0522 X 2 +	0,0490 X 2 +	0,0519 X 2 +	0,0614 X 2 +		
0,0856 X 2 +	0,0219 X 1 +	0,0761 X 2 +	0,0408 X 2 +	0,0408 X 3 +	0,0847 X 2 +		
0,0423 X 2 +	0,0438 X 2 +	0,0438 X 3 +	0,0219 X 2 +	0,0590 X 2 +	0,0590 X 3 +	=2,16	9
1							
A6							
0,1196 X 2 +	0,0456 X 2 +	0,0522 X 2 +	0,0490 X 3 +	0,0519 X 3 +	0,0614 X 3 +		
0,0856 X 3 +	0,0219 X 3 +	0,0761 X 3 +	0,0408 X 3 +	0,0408 X 3 +	0,0847 X 4 +		
0,0423 X 4 +	0,0438 X 3 +	0,0438 X 3 +	0,0219 X 3 +	0,0590 X 3 +	0,0590 X 3 +	=2,98	7
1							
A7							
0,1196 X 3 +	0,0456 X 3 +	0,0522 X 3 +	0,0490 X 3 +	0,0519 X 3 +	0,0614 X 3 +		
0,0856 X 3 +	0,0219 X 3 +	0,0761 X 3 +	0,0408 X 3 +	0,0408 X 3 +	0,0847 X 3 +		
0,0423 X 3 +	0,043 X 3 +	0,0438 X 3 +	0,0219 X 3 +	0,0590 X 3 +	0,0590 X 3 +	=2,99	6
1							
A8							
0,1196 X 4 +	0,0456 X 4 +	0,0522 X 4 +	0,0490 X 4 +	0,0519 X 4 +	0,0614 X 4 +		
0,0856 X 4 +	0,0219 X 4 +	0,0761 X 5 +	0,0408 X 5 +	0,0408 X 4 +	0,0847 X 4 +		
0,0423 X 4 +	0,0438 X 4 +	0,0438 X 4 +	0,0219 X 4 +	0,0590 X 4 +	0,0590 X 4 +	=4,11	1
1							
A9							
0,1196 X 2 +	0,0456 X 2 +	0,0522 X 2 +	0,0490 X 3 +	0,0519 X 3 +	0,0614 X 3 +		
0,0856 X 3 +	0,0219 X 3 +	0,0761 X 4 +	0,0408 X 5 +	0,0408 X 5 +	0,0847 X 3 +		
0,0423 X 3 +	0,0438 X 4 +	0,0438 X 4 +	0,0219 X 3 +	0,0590 X 3 +	0,0590 X 4 +	=3,10	4
1							

M = Maturity; R = Ranking.

Table 6 presents the maturity level scores calculated for each participating company in the research. According to this table, the maturity levels of businesses are listed from high to low as A8 > A2 > A3 > A9 > A6 > A7 > A1 > A4 > and A5.

3.2. AHP-ARAS Method Results

Table 7 presents the final ranking derived from the data collected from enterprises within the scope of the AHP-ARAS method.

Table: 7
Maturity Level Results of Enterprises According to the ARAS Method

Alternatives	K_i	%K_i	Ranking
A1	0,697	69,79	5
A2	0,898	89,87	2
A3	0,887	88,71	3
A4	0,663	66,32	8
A5	0,500	50,00	9
A6	0,689	68,9	7
A7	0,694	69,47	6
A8	0,943	94,35	1
A9	0,713	71,34	4

Using the ARAS method, the enterprises' digital maturity optimality function values were ranked from most significant to most minor. According to the analysis results, A8 ranked first, while A5, the alternative furthest from the optimum, ranked last. Ki values expressed as percentages measure how close all alternatives are to the optimum. In this context, alternative A8, which has the highest level of digitalisation, was determined to be the optimal value at 94.3%. The optimality function value of A5, which ranks last in terms of optimality, is 0.50, and its similarity to the optimum can be expressed as 50.00%.

3.3. AHP-SAW Method Results

Applying the SAW Method, the criteria were first normalised using Equation (12). Then, the sequences of the alternatives were calculated using Equation (13). The final ranking, based on the data obtained from the enterprises, is presented in Table 8.

Tablo: 8
Maturity Level Results of Enterprises According to the SAW Method

	Alternatives V_i	Ranking
A1	0,703	6
A2	0,897	2
A3	0,892	3
A4	0,669	8
A5	0,504	9
A6	0,704	5
A7	0,700	7
A8	0,949	1
A9	0,725	4

Using the SAW method, the digital maturity V_i values of the alternatives were evaluated from largest to smallest, and the other options were ranked accordingly. According to the analysis results, A8 ranked first, while A5 ranked last. V_i values, expressed as a percentage, indicate how close each alternative is to the optimal solution. The optimality function value of A5, which is the last in the sequence compared to the optimum, resulted in 50%.

When the AHP-Maturity and AHP-ARAS rankings of companies operating in the automotive industry in Konya province are examined, it is observed that all companies are in the same sequence. According to the AHP-Maturity Model and AHP-ARAS rankings, enterprises are sequenced as A8 >, A2 >, A3 >, A9 >, A1 >, A7 >, A6 >, A4 > and A5 in

terms of their digital maturity levels. When the results of the AHP-SAW method are analysed, it is seen that A1 ranks 6th, A6 ranks 5th, and A7 ranks 7th. Since the AHP-SAW method used in the study yielded a different result than the other methods, the Borda Count method was used to obtain the final sequence using Equation (14). According to the Borda count method, it is evident that the maturity levels of A6 and A7 are equal. According to the digital maturity level, enterprises are ranked as follows: A8 >, A2 >, A3 >, A9 >, A1 >, A6 and A7 >, A4 > and A5 >. Figure 5 illustrates the digital maturity performance scores of automotive industry firms in Konya.

Table: 9
Final Sequencing Results

Alternatives	AHP-Maturity Model Sequence	AHP-Maturity Score	Maturity Level	AHP-ARAS Method Sequence	AHP-SAW Method Sequence	AHP Maturity Model Borda Value	AHP-ARAS Borda Value	AHP-SAW Borda Value	Total Borda Scores	Borda Count Sequences
A1	5	3,03	Experienced	5	6	4	4	3	11	5
A2	2	3,82	Experienced	2	2	7	7	7	21	2
A3	3	3,81	Experienced	3	3	6	6	6	18	3
A4	8	2,87	Intermediate	8	8	1	1	1	3	7
A5	9	2,16	Intermediate	9	9	0	0	0	0	8
A6	7	2,98	Intermediate	7	5	2	2	4	8	6
A7	6	2,99	Intermediate	6	7	3	3	2	8	6
A8	1	4,11	Expert	1	1	8	8	8	24	1
A9	4	3,10	Intermediate	4	4	5	5	5	15	4

Figure: 5
Digital Maturity Performance Sequences of Konya Automotive Industry Enterprises
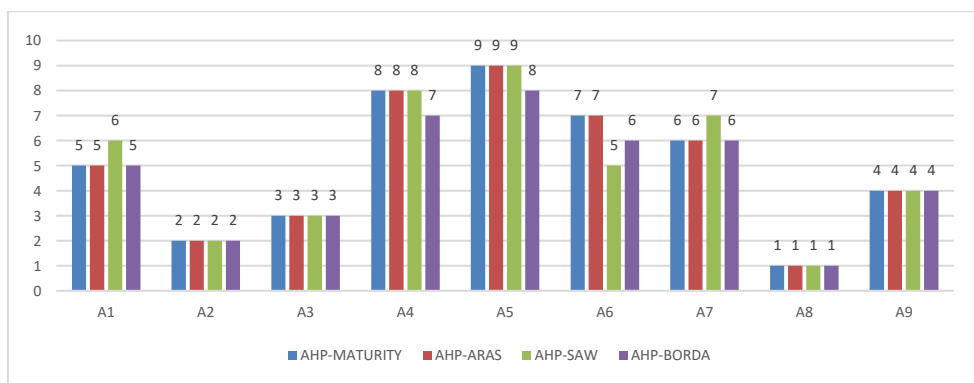
3.4. Correlation Analysis

Correlation analysis was performed using the results of the AHP-Maturity Model, AHP-ARAS, AHP-SAW and Borda Count method to determine whether there is a relationship between the results obtained regarding the sequence of automotive industry enterprises in Konya province according to the digital maturity level. As a result of the correlation analysis, similar results are observed across all methods in the sequence. Table

10 presents the results of the Spearman Correlation test, which was applied to assess the consistency of the AHP-based maturity model, ARAS, and SAW methods.

Table: 10
Correlation Analysis Results

			AHP-Maturity	AHP-Aras	AHP-Saw	Borda Count
Spearman's rho	AHP-Maturity	Correlation Coefficient	1,000	1,000**	,950**	,996**
		Sig. (2-tailed)		.	,000	,000
		N	9	9	9	9
	AHP-Aras	Correlation Coefficient	1,000**	1,000	,950**	,996**
		Sig. (2-tailed)	.		,000	,000
		N	9	9	9	9
	AHP-Saw	Correlation Coefficient	,950**	,950**	1,000	,971**
		Sig. (2-tailed)	,000	,000	.	,000
		N	9	9	9	9
	Borda Count	Correlation Coefficient	,996**	,996**	,971**	1,000
		Sig. (2-tailed)	,000	,000	,000	.
		N	9	9	9	9

Correlation is significant at the 0.01 level (two-tailed).

According to the correlation analysis findings given in Table 10, it is seen that the correlation coefficient of the AHP-Maturity Model and AHP-ARAS method is 1.00, the correlation coefficient of the AHP-Maturity and AHP-SAW method is 0,95, and the correlation analysis result of the AHP-Maturity and Borda Count method is 0,99. While the correlation coefficient of the AHP-ARAS and AHP-SAW method is 0,99, the correlation result of the AHP-ARAS and Borda Count method is 0,99, and the correlation result of the AHP-SAW and Borda Count method is 0,97. According to Ural & Kılıç (2013), the level of the relationship between variables can be interpreted as weak if the correlation coefficient is between 0 and 0,29, moderate if between 0,30 and 0,64, strong if between 0,65 and 0,84, and very strong if between 0,85 and 1,00. Therefore, it can be stated that these comparisons are statistically significant and that there is a high level of correlation between the various methods employed.

4. Conclusions and Recommendations

Industry 4.0 technologies create a significant competitive advantage for businesses in the automotive industry's spare parts production sector, enabling the production of high-quality, personalised products at low costs and high speed. In particular, the automotive industry is one of the sectors that gains the highest benefits from Industry 4.0, with opportunities to increase production quality and reduce waste, as well as the productivity advantage brought about by digital transformation in the field of spare parts production. In this context, this study measures the digital maturity levels of 9 automotive industry companies in Konya, one of the most important automotive industry cities in Türkiye. The average maturity scores of the companies were calculated over 5,00, and the average score was 3,50.

The Maturity calculation model proposed by Schumacher (2016) and the ARAS and SAW methods from Multi-Criteria Decision-Making Methods were used in the study. As a result of the research, the results obtained from both approaches were integrated with the

Borda Counting Method, and the results were compared with correlation analysis. When the
weights of the criteria are examined based on expert opinions, it is seen that Smart Factory
>, Strategy and Organization >, Smart Operations >, Smart Products >, Data-Driven Services
> and Employees. These findings support the findings of the studies conducted by Baki &
Serdar (2020) in the logistics sector, Nebati et al. (2023) in the defence industry, Kiraz et al.
(2019) in the study where they applied the cognitive mapping technique, Demir & Kocaoğlu
(2019) and Santos & Martinho (2019) in technology companies. In contrast to these findings,
the study by Akman & Kökümer (2023) on the white goods sector identified lean production
criteria, similar to the smart products criteria used in this study, as the most important.

In the study titled *"New Industrial Revolution Intelligent Manufacturing Systems
Technology Roadmap",* published by TÜBİTAK in February 2017, the stages of transition
to Industry 4.0 are described in detail under main headings and subheadings. In June 2016,
TÜBİTAK conducted comprehensive research using the survey method on approximately
1000 private sector organisations that received R&D support from TÜBİTAK in relevant
technological fields. According to the results of this research, the level of adaptation of the
Turkish industry to Industry 4.0 is 2.0-3.0. The sectors with the highest level of adaptation
are materials (rubber and plastic), computers, electronic and optical products, and
automotive and white goods sub-industries. The same study identified the automotive, white
goods, chemical, and food sectors as those that should be supported first (Tübitak, 2016).

Within the scope of the Eleventh Development Plan, a study was conducted to
contribute to shaping the future of the automotive industry over the 2019-2023 period, taking
into account the goals outlined in the 65th Government Program. This study presents various
perspectives on the future of Turkiye's automotive industry. The study notes that the
automotive industry is a key sector in Türkiye's economy, with significant exports, and has
become an integral part of the global industry. From this perspective, it can be directly
affected by emerging global developments (Cumhurbaşlanlığı, 2019). Turkiye needs to take
measures for sustainable growth in a highly competitive environment where developing and
developed countries are trying to regain their automotive industries.

In light of the study's findings, various contributions to the literature are evident.
First, this is the first study in the national literature to determine the level of digital maturity
in the automotive industry. Additionally, AHP is utilised in conjunction with the Weighted
Maturity Score Calculation Model Approach to evaluate the level of digital maturity.
Another study contribution is the combined application of AHP-ARAS and AHP-SAW
methods, which are *Multi-Criteria Decision-Making methods*, in sequencing Industry 4.0
maturity levels.

Small and medium-sized businesses can achieve a sustainable competitive advantage
with the IMPULS maturity model by reorganising their business processes along the lines
of Strategy and Organization, Smart Factory, Smart Operations, Smart Products, Employees,
and Data-Oriented Services in response to the realities of the digital world. Based on this
study, businesses can identify areas lacking in digitalisation and improve their business

processes. Digitalisation consists of multidimensional stages. A healthy digitalisation process can be realised by analysing all the main and sub-criteria that comprise the digital maturity criteria and implementing the necessary innovations.

The IMPULS digital maturity model, which is believed to play a significant role in measuring the digitalisation level of organisations, will guide researchers working in this field. In future studies on this subject, the criteria can also be weighted with other objective criteria weighting methods such as Best-Worst, Swara, Dematel and Fucom, which are other objective criteria weighting methods in the process of determining the Industry 4.0 maturity level of companies with the IMPULS model and ranking the companies, selecting the relationships between the criteria and weighting the criteria. It is also recommended that TODIM, EDAS, COPRAS, VIKOR, MULTI-MOORA, ELECTREE, PROMETHEE, and TOPSIS methods be used when comparing the ranking results of different companies.

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How Do Central Bank Policy Rates and Inflation Affect Stocks in Fragile-Five Economies? Evidence from Panel PMG-ARDL Approach

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Kırılgan Beşli Ekonomilerinde Merkez Bankası Politika Faizi ve Enflasyon Hisse Senetlerini Nasıl Etkilemektedir? Panel PMG-ARDL Yaklaşımından Elde Edilen Bulgular

Abstract

This study examines the dynamic relationship between the central bank policy rate, inflation, and stock exchange index in the Fragile Five economies (Brazil, India, Indonesia, South Africa, and Türkiye) using monthly data from July 2005 to March 2023. Employing the Panel PMG-ARDL approach, we find a positive and significant effect of inflation on stock exchange indices, while central bank policy rates exert a substantial and negative impact. The Error Correction Model confirms cointegration among the variables, corroborating the long-run relationships established in the Panel ARDL estimations. Both inflation and central bank policy rates emerge as significant joint Granger causes of stock exchange indices, highlighting their predictive power.

Keywords : Fragile Economies, Stock Market, Macroeconomy, Panel ARDL.

JEL Classification Codes : G12, G7, C32, E44.

Öz

Bu çalışmada Kırılgan Beşli ekonomilerinde (Brezilya, Hindistan, Endonezya, Güney Afrika ve Türkiye) merkez bankası politika faizi, enflasyon ve borsa endeksi arasındaki dinamik ilişki Temmuz 2005 - Mart 2023 dönemine ait aylık veriler kullanılarak araştırılmıştır. Panel PMG-ARDL yaklaşımını kullanarak, enflasyonun borsa endeksleri üzerinde pozitif ve anlamlı bir etkisi olduğunu, merkez bankası politika faizlerinin ise önemli ve negatif bir etkisi olduğu tespit edilmiştir. Hata Düzeltme Modeli, değişkenler arasındaki eşbütünleşmeyi doğrulamakta ve Panel ARDL tahminlerinde kurulan önemli uzun dönemli ilişkileri desteklemektedir. Hem enflasyon hem de merkez bankası politika faizleri, borsa endekslerinin önemli ortak Granger nedenleri olarak ortaya çıkmakta ve tahmin güçlerini vurgulamaktadır.

Anahtar Sözcükler : Kırılgan Beşli, Borsa, Makroekonomi, Panel ARDL.

1. Introduction

Recent developments in global financial markets have accelerated capital inflows into emerging economies, resulting in heightened volatility. The growing economic integration driven by globalisation has further enhanced financial mobility (Nasseh & Strauss, 2000). Among emerging economies, India, Brazil, Indonesia, Türkiye, and South Africa -collectively called the Fragile Five by Morgan Stanley- have experienced significant economic and financial impacts from various global dynamics over the past decade. While the Federal Reserve Bank's (FED) quantitative easing policies, including "tapering," have played a role in shaping the economic environments of these countries, this study focuses on the influence of domestic economic indicators, such as central bank policy rates and inflation, on stock market performance within these economies.

In a globalising world, capital and portfolio investments are gaining importance. Investing in the stock market contributes to stable economic growth by enabling companies to raise capital, repay debts, and maintain corporate expansion, in addition to meeting investors' return expectations (Tripathi & Arnav Kumar, 2015). Stock market investments can stimulate economic activity in developing countries, attract foreign investment, and offer opportunities for business growth and development. However, much of the scholarly literature has focused on developed markets, with less attention paid to emerging markets (Mauro, 2003). As a result, the impact of external disruptions stemming from the fluctuations in FED interest rates is expected to pose more serious risks to the financial stability of these countries. Therefore, prioritising these fragile five economies becomes a necessity.

In theory, a rise in inflation has a negative impact on stock prices, while a decline in inflation has a positive effect on stock prices. When inflation rises, central banks typically raise interest rates to curb it. This leads to higher company borrowing costs and lower profits and investment levels. The result can be a fall in share prices. Conversely, central banks can lower interest rates when inflation falls, stimulating economic activity and increasing stock prices (Modigliani & Cohn, 1979). However, there are different views in the literature on the impact of inflation on stock prices (Al-Khazali, 2003; Valcarcel, 2012). Humpe & McMillan (2020) demonstrate that short-term and long-term inflation increases have distinct effects on stock prices. While there is a negative relationship between inflation and stock prices in the short run, in the long run, stock prices rise in line with consumer prices and provide a hedge against inflation in G7 countries.

Previous studies have focused on the fragile five countries but primarily used time-series data. In contrast, our study utilises panel data to examine the impact of policy interest rates and inflation on stock market indices. We employ the Panel PMG-ARDL method to derive robust conclusions from our analysis, leveraging the extensive data set available. Additionally, the Panel ARDL analysis accounts for country-specific effects and accommodates variations in aggregate terms and short-run coefficients. This is particularly advantageous when studying a group of countries, as it offers flexibility that may not be

achievable through time-series analysis alone. Additionally, stock market performance is a key indicator of overall economic performance and a significant concern for policymakers, regulators, and investors. This study examines the relationship between the stock market and macroeconomics, providing policy recommendations for policymakers to ensure effective economic stability.

This study employs panel data analysis to investigate the short- and long-term impacts of central bank interest rates and inflation on stock market indices in the Fragile Five countries. The paper makes valuable contributions to the literature in several respects: (i) by emphasising the dependence of economic growth and financial stability in developing countries on global capital flows, it provides findings that will guide policymakers in these countries; (ii) while the existing literature has generally focused on advanced economies, this study aims to fill the gap in the literature by focusing on the Fragile Five countries and using panel data analysis; (iii) it adds a new perspective to the existing theoretical debates on the relationship between inflation and stock market indices and tests the theoretical frameworks with empirical findings; (iv) it provides valuable information for investors and market participants on how to act in emerging markets, leading to more informed investment decisions.

2. Literature

The impact of inflation and central bank policy rates on stock market indices remains a topic of debate in the literature, with inconclusive findings attributed to differences in research methodologies. Existing empirical studies generally exhibit differences due to the varying treatments of independent variables, country-specific analyses, a focus on advanced economies, and the application of diverse econometric methods. These differences, coupled with variations in the study periods, contribute to the lack of consensus on the relationship between inflation, central bank policy rates, and stock market indices.

The academic literature offers a wealth of insights into the impact of interest rates and inflation on stock prices. One prominent theory, put forth by Fisher (1930), posits that stocks can serve as a hedge against inflation. The theory maintains that to preserve the real return on stocks, the return should align with inflation. Conversely, Fama (1981) posits that the inverse correlation between actual stock returns and inflation observed after 1953 is attributable to indirect influences, whereby predictions of more salient real factors shape stock returns.

The nexus between long-run interest rates and stock returns, as posited by economic theory, underscores a more pronounced relationship when compared to short-run interest rates. Short-run interest rates are often used as proxies for expected inflation. Long-run interest rates influence stock prices through present value models and discount rates (Abdullah & Hayworth, 1993). Cotton (2022) finds that unexpected monetary policy shifts, specifically a one-basis-point increase in five-year interest rates, lead to a significant 3.56-basis-point decrease in stock prices across nine advanced economies. Using the ARDL

bounds test, Alzoubi (2022) finds that the central bank's increase in the policy rate to control inflation has had a negative impact on the Amman Stock Exchange, covering the years 1991 and 2020.

Although these studies provide insight into the effects of inflation and interest rates on stock prices, there is a lack of comprehensive research focusing on Fragile-Five economies. For example, Sumaryato et al. (2021) analysed the effect of inflation on the Indonesian Composite Index (IHSG). They showed that the increase in the amount of money supplied to IHSG was negligible. On the other hand, Sia et al. (2023) reveal that inflation has an asymmetric effect on the Indonesian stock market index in the short and long run. The findings demonstrate that both positive and negative alterations in inflation have deleterious consequences. Fahlevi (2019) examined the effects of macroeconomic factors on the stock prices of companies in Indonesia's LQ45 Index between 2013 and 2017. The study reveals that interest rates have a significant impact on stock prices, whereas inflation does not have a similar effect. Joshi and Giri 2015) found that exchange rates and inflation have a significant impact on stock price fluctuations in India. These results suggest that investors may consider stocks as long-term investments to offset the negative effects of inflation on purchasing power, which aligns with Fisher's (1930) hypothesis. Tursoy (2019) analysed the relationship between stock prices and interest rates using ARDL. It is found that interest rates have a negative impact on stock prices in Türkiye, which is consistent with the "expected cash flow hypothesis."

In summary, although studies have been conducted, more focused research is still needed to address the relationships between inflation, central bank policy rates, and stock exchange indices in Fragile-Five economies. Further research in these economies would significantly contribute to understanding the intricate dynamics of stock market behaviour in response to inflation and central bank policies.

3. Data and Model Estimation

3.1. Data

From July 2005 to March 2023, a panel dataset has been utilised to evaluate how the stock market index in fragile-five economies is impacted by both the central bank policy rate (R) and inflation (π). In exploring these dynamic relationships, this study examines the consumer price index (CPI) in conjunction with the closing prices of stock market indices across the fragile five economies[1]. Central bank policy rate and CPI data are obtained from Bank for International Settlement (BIS) reports, while stock market index data are obtained from the Yahoo Finance website. Stock market indices (SP) are calculated in logarithmic form. The transformation to a logarithmic form brings the data distribution closer to a normal distribution, an underlying assumption for many econometric models, including PMG-

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[1] *IBOVESPA, BSE Sensex, IDX Composite, JSE All Share Index, and BIST100, representing Brazil, India, Indonesia, South Africa, and Türkiye, respectively.*

ARDL. Table 1 summarises the descriptive statistics for each macroeconomic variable used in this study.

Table: 1
Descriptive Statistics

|	Mean	Std. Dev.	Median	Skewness	Kurtosis
R					
Brazil	10.29	3.8	11	-0.21	-0.19
India	6.56	2.16	6.5	0.88	0.81
Indonesia	6.42	1.35	6.5	-0.31	-0.89
South Africa	6.55	1.97	6.5	0.96	0.97
Türkiye	11.2	5.23	8.5	0.75	-0.48
π					
Brazil	0.0046	0.0034	0.0044	0.22	4
India	0.0044	0.0072	0.0029	6.61	69.1
Indonesia	0.0047	0.0067	0.0046	-0.06	4.2
South Africa	0.0046	0.0041	0.0038	0.53	3.2
Türkiye	0.0113	0.0158	0.0085	3.61	22.8
SP Return					
Brazil	11.07	0.35	11.03	0.09	-0.63
India	10.08	0.52	10.04	0.02	-0.73
Indonesia	8.26	0.52	8.46	-0.96	-0.22
South Africa	7.80	0.39	7.96	-0.51	-1.05
Türkiye	11.25	0.58	11.24	0.88	1.55

Note: Std. Dev. represents standard deviation.

Central bank policy rates show diverging averages, with Brazil and Türkiye recording relatively higher averages of 10.29% and 11.20%, respectively, compared with India, Indonesia and South Africa, which have lower averages of between 6.42% and 6.56%. This divergence underscores the different monetary policy stances in these economies. Similarly, examining inflation rates reveals significant differences, with Türkiye, in particular, having a significantly higher mean inflation rate (0.0113) than other countries. Skewness and kurtosis values further illuminate the distributional characteristics, indicating varying degrees of asymmetry and peakedness in these macroeconomic indicators.

Additionally, the descriptive statistics for stock market indices reveal distinct characteristics among these economies. Brazil and South Africa have higher mean stock values than India, Indonesia, and Türkiye, suggesting different market capitalisation or trading activity levels. The skewness and kurtosis measures reveal different shapes and distributional characteristics within stock market data, indicating the degree of deviation from the normal distribution observed in these financial measures.

Figure 1 illustrates the evolution of central bank policy rates in the fragile five economies. The size and frequency of policy rate adjustments vary across countries and show different patterns. In particular, Brazil and Türkiye tended to change their policy rates more sharply than the other countries surveyed. Notably, Türkiye's unorthodox monetary policy, implemented after 2018, stands out in the context of diverse global monetary strategies. In contrast, India and Indonesia gradually changed their policy rates. Notably, South Africa's policy rate remained relatively stable throughout the period, demonstrating a tendency towards consistency amidst global fluctuations in monetary policy adjustments.

Figure: 1
Central Bank Policy Rate (%)
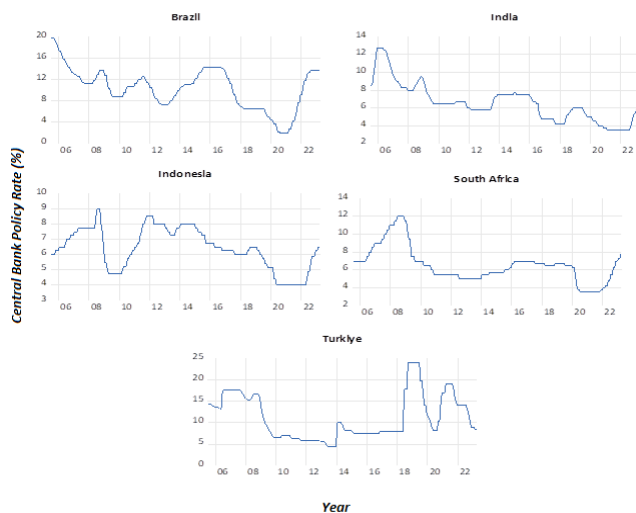
3.2. Model Estimation

This research comprises 1065 observations from the Fragile Five countries (N = 5) from September 2005 to March 2023 (T = 213). In panel data analysis, using the generalised moment method estimator is inappropriate when the sample size is less than the number of periods (N < T). Conversely, the panel ARDL technique is the preferred analysis method in this study, given that (T > N) (Akinsola & Odhiambo, 2020)[2].

Before performing the analysis, panel unit root tests are used to test whether cross-sectional dependence exists for similar fragile economic structures. The lag length was chosen using the Akaike information criterion (AIC) (See Appendix).

The results of the panel unit root tests are presented in Table 2. Both at the levels and in the first differences, there is evidence of no unit roots for some series, especially policy rates (e.g., LLC and IPS tests), while there is no strong evidence of unit roots for stocks and inflation in general. The first differences show strong evidence of no unit root for all series. The statistically significant results in all tests support this conclusion. In particular, the LLC, ADF, and PP tests show that the series are stationary in first differences. Generally, the

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[2] *The Variance Inflation Factor (VIF) was employed to evaluate the presence of multicollinearity between variables. First, the VIF values of the independent variables were calculated manually using the two-way fixed effects model. This method yielded a value of 1.14 for the π and R variables, respectively. Subsequently, the calculation based on the "pooling" model yielded a value of 1.003 for both variables. Both approaches remained within the acceptable range of VIF < 2, indicating no significant.*

variables show an integrated order of I(1), except for the central bank policy rate, which may demonstrate stationary behaviour at order I(0). This suggests that the variables are appropriate for panel data analyses.

Table: 2
First Generation Unit Root Test Results

Model	Level			1st difference		
	SP	R	π	SP	R	π
Trend and Intercept						
LLC	0.55	--1.87**	3.04	-5.30***	-6.96***	-9.99***
Breitung	-0.49	-0.67	-1.07	-3.84***	-4.36***	-3.88***
IPS	-1.87**	-2.88***	2.93	-11.97***	-7.78***	-11.86***

*Note: ** and *** indicate 5% and 1% significance levels.*

After confirming the panel ARDL's stationarity, the Hausman test was conducted to determine the choice between the MG and PMG models. The Hausman test results are in Table 3.

Table: 3
Hausman Test

	β			
	MG	PMG	Difference	SE
π	0.1764	0.5563	-0.3800	0.5137
R	0.0473	-0.0425	0.0900	0.1113
Hausman	0.54 (0.76)			

*Note: ** and *** indicate 5% and 1% significance levels.*

The test results reveal that the null hypothesis of long-run homogeneity is inadmissible. $(\chi^2(2) = 0.54, p-value = 0.76)$. Subsequently, the PMG is favoured as the estimator due to the non-systematic coefficient differences.

4. Empirical Results

The following model examines the long-term relationship between π, R and SP:

$$lnSP_{it} = \alpha_{0i} + a_{1i}ln\pi_{it} + \alpha_{2i}R_{it} + u_{it} \tag{1}$$

In Eq. (1), SP_{it} is the logarithm of the stock market indices in period t for country i. α_{0i} represents "the constant term", while (a_{1i}, α_{2i}) are the parameters specify π and R coefficients, and u refers to the error term.

Table: 4
Panel ARDL Coefficients Long-Run Estimation Results

	β	SE	t-Statistic	p-value
π	0.56	0.15	3.71	0.00***
R	-0.04	0.01	-3.19	0.00***

*Note: ** and *** indicate 5% and 1% significance levels.*

Table 4 presents the PMG's estimate of the long-run relationship between inflation, the central bank's policy rate, and stock market indices. Inflation's long-term impact on stock

market indices is significant and positive. For example, a 1% increase in π can be associated with a 0.56% increase in the logarithm of SP. Conversely, the long-term effect of the R on SP is negative and significant. A 1% increase in the R is associated with a 0.04% decrease in the logarithm of SP.

In Eq. (2), speed of adjustment $(\hat{\varphi})$ is the coefficient of the cointegrating equation and $(y_{i,t-1} + \beta_i' x_{i,t})$ is the error correction term (Wickens & Breusch, 1988). Short-run equation model as below:

$$\Delta SP_{it} = \sum_{k=1}^{p-1} \lambda_{ik}^* \Delta SP_{i,t-k} + \sum_{k=0}^{q-1} \delta_{ik}' \Delta x_{i,t-k} + \hat{\varphi}(SP_{i,t-1} + \beta_i' x_{i,t}) + \omega_i + \varepsilon_{it} \qquad (2)$$

PMG model's short-run estimation, as displayed in Table 5, reveals key relationships between variables. There is also a significant negative association with π_{t-1} in the short run, which implies a significant decline in stock market prices for each unit increase in the inflation rate. Conversely, both SP_{t-1} and R_{t-1} do not display statistically significant impacts on the SP in the short-run. These findings suggest that while inflation notably influences the stock exchange prices, the relationships with stocks and the R are not firmly established in the short run within this model's framework.

Table: 5
Panel ARDL Coefficients Short-Run Estimation Results

	β	SE	t-statistics	p-values
$\hat{\varphi}$	-0.03	0.01	-3.43	0.01**
SP_{t-1}	0.07	0.05	1.37	0.17
π_{t-1}	-0.92	0.41	-2.22	0.03**
R_{t-1}	0.01	0.01	1.08	0.28
C	0.27	0.13	2.09	0.04**

*Note: ** and *** indicate 5% and 1% significance levels.*

Moreover, $\hat{\varphi}$ has the correct sign (negative) and is significant. The coefficient value $(\hat{\varphi})$ of -0.03 suggests that stock prices respond very slowly to short-run shocks and that it will take time for stock prices to reach long-run equilibrium.

5. Concluding Remarks

This study finds that central bank policy interest rates negatively impact stock market indices, consistent with the "Expected Cashflow Hypothesis" in the literature. Additionally, inflation has a negative impact on stock indices in the short term but a positive effect in the long term. This result suggests the phenomenon known as the "Fisher effect," particularly in the long term.

These findings offer valuable insights into the influence of macroeconomic indicators on financial markets. Especially in emerging and fragile economies, the different short- and long-term effects of variables such as policy interest rates and inflation on market behaviour create a critical decision space for policymakers. Central banks should adopt an approach to understand investor behaviour and market reactions better when setting policy interest rates.

Likewise, inflation-targeting policies have significant implications for short-term market equilibrium, investor confidence, and long-term market stability.

The contributions of this study extend beyond policy recommendations; they also make significant contributions to the literature. By analysing the effects of macroeconomic variables on stock markets in the so-called fragile five countries, the study adds a unique perspective to the body of knowledge in this field. However, such analyses should be extended to different emerging markets to develop a more comprehensive perspective. For instance, by focusing on periods of economic shocks or specific crisis moments, the impact of macroeconomic indicators on markets could be examined in more detail.

Overall, this study sheds light on the intricate relationship between macroeconomic variables and financial markets in emerging markets. Suppose policymakers and market actors make decisions that consider the short-term and long-term dimensions of these relationships. In that case, it will create a more stable and secure financial environment.

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APPENDIX

Before the analysis, panel unit root tests are used to determine whether cross-sectional dependence exists among similar fragile economic structures. The lag length was selected using the Akaike Information Criterion (AIC). Table A and Fig. A show the results of the Akaike criterion.

Table: A
Model Selection Criteria

Model	LogL	AIC	BIC	HQ	Specification
5	1486.94	-2.7941	-2.6662	-2.7456	ARDL(2, 1, 1)
1	1478.52	-2.7876	-2.6833	-2.7481	ARDL(1, 1, 1)
9	1488.21	-2.7870	-2.6354	-2.7295	ARDL(3, 1, 1)
6	1493.21	-2.7870	-2.6117	-2.7205	ARDL(2, 2, 2)
13	1490.42	-2.7817	-2.6063	-2.7152	ARDL(4, 1, 1)
2	1485.01	-2.7809	-2.6292	-2.7234	ARDL(1, 2, 2)
10	1494.48	-2.7799	-2.5808	-2.7044	ARDL(3, 2, 2)
7	1498.25	-2.7775	-2.5548	-2.6930	ARDL(2, 3, 3)
14	1496.88	-2.7749	-2.5522	-2.6904	ARDL(4, 2, 2)
3	1491.11	-2.7734	-2.5744	-2.6979	ARDL(1, 3, 3)
11	1499.29	-2.7699	-2.5235	-2.6765	ARDL(3, 3, 3)
8	1503.80	-2.7690	-2.4989	-2.6665	ARDL(2, 4, 4)
4	1497.96	-2.7673	-2.5209	-2.6739	ARDL(1, 4, 4)
15	1501.69	-2.7649	-2.4948	-2.6625	ARDL(4, 3, 3)
12	1505.07	-2.7618	-2.4681	-2.6504	ARDL(3, 4, 4)
16	1507.90	-2.7577	-2.4402	-2.6373	ARDL(4, 4, 4)

Note: ** and *** denote 5% and 1% significance levels, respectively.

Figure: A
Akaike Information Criteria[3]

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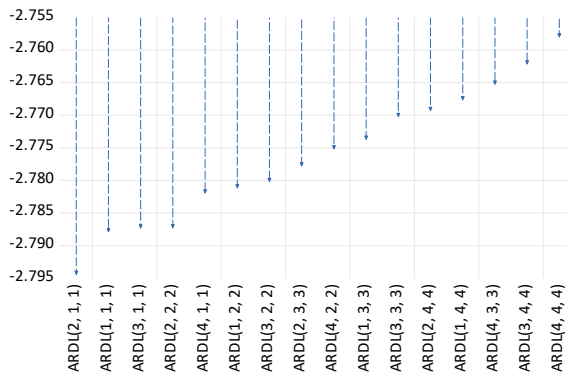
[3] *Fig. A and Table A present the results of model selection criteria for the ARDL (autoregressive distributed lag) model. The AIC and BIC are information criteria that penalise models for their complexity. A lower AIC or BIC indicates a better model. In this case, the model with the lowest AIC is the ARDL (2, 1, 1), which has an AIC of -2.7941. The model with the lowest BIC is the ARDL (1, 1, 1) model, which has a BIC of -2.6833. Log-likelihood is a measure of the fit of a model to the data. A higher log-likelihood indicates a better fit. In this case, the model with the highest log-likelihood is the ARDL(2, 1, 1) model, which has a log-likelihood of 1486.94. Based on the model selection criteria considered, the ARDL(2, 1, 1) model is the best model for the data in this case. This model has the highest log-likelihood, the lowest AIC, and the lowest HQ.*

Evaluation of Sustainability Performance of Insurance Companies with Global Fuzzy AHP-Based TOPSIS, CODAS and PIV Methods

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Küresel Bulanık AHP Tabanlı TOPSIS, CODAS ve PIV Yöntemleri ile Sigorta Şirketlerinin Sürdürülebilirlik Performansının Değerlendirilmesi

Abstract

This study will evaluate the sustainability performance of five leading insurance companies in Türkiye for 2021. Unlike other studies, this research employed sub-criteria and the three basic dimensions of sustainability. The criteria weights were determined using the Spherical Fuzzy AHP method, a novel approach in the literature. Thus, the importance of the basic dimensions of sustainability was determined. It was seen that environmental dimensions had the most impact, followed by social and economic dimensions, respectively. TOPSIS, CODAS and PIV methods were used to rank the companies. The results obtained with the three methods were combined with the Borda Counting method to get the final ranking. According to the results, the company with the highest sustainability performance was Euroko Insurance Company.

Keywords : Spherical Fuzzy AHP, Sustainability, PIV, TOPSIS, CODAS, Borda Counting Method.

JEL Classification Codes : C1, G22, Q1.

Öz

Bu çalışmanın amacı, Türkiye'deki önde gelen beş sigorta şirketinin 2021 yılına ait sürdürülebilirlik performansını değerlendirmektir. Sürdürülebilirliğin üç temel boyutu ile birlikte diğer çalışmalardan farklı olarak alt kriterler de kullanılmıştır. Kriter ağırlıkları, yine literatürde yeni bir yöntem olan Küresel Bulanık AHP yöntemi ile belirlenmiştir. Böylece sürdürülebilirliğin temel boyutlarının önemleri belirlenmiştir. Çevresel boyutların en fazla etkiye sahip olduğu, bunu sırasıyla sosyal ve ekonomik boyutların izlediği görülmüştür. Şirketlerin sıralanması için TOPSIS, CODAS ve PIV yöntemleri kullanılmıştır. Üç yöntemle elde edilen sonuçlar, Borda birleştirme yöntemiyle birleştirilerek nihai sıralama elde edilmiştir. Sonuçlar doğrultusunda, sürdürülebilirlik performansı en yüksek olan şirketin Euroko Sigorta Şirketi olduğu belirlenmiştir.

Anahtar Sözcükler : Küresel Bulanık AHP, Sürdürülebilirlik, PIV, TOPSIS, CODAS, Borda Yöntemi.

1. Introduction

The Industrial Revolution, a significant turning point in human history, has led to the emergence and increase in the number of industrial organisations capable of large-scale production on the one hand. On the other hand, it has led to the deterioration of the ecological balance and the emergence of environmental pollution problems due to people's desire for unlimited consumption. This problem, which poses a threat to humanity's future, has given rise to the concept of sustainable development. The concept of sustainability was first introduced in the book "Our Common Future," published by the World Commission on Environment and Development (WCED) in 1987. Sustainability is often defined as meeting our own needs without compromising the ability of future generations to meet their own needs. It is essential to know that resources are limited. The long-term consequences of how resources are used must also be evaluated wisely. (The World Commission on Environment and Development, 1987).

Increasing environmental risks due to population growth and industrialisation increase the importance of sustainability. Preventing the damage caused by human activities to nature and securing the world's future constitute the basis of sustainability. In addressing sustainability, the repercussions of developmental initiatives on prospective generations must be accentuated. For instance, prioritising economic gains over environmental and social values can culminate in irreversible global challenges, such as climate change and environmental degradation.

The multifaceted nature of sustainability, intersecting with economic, social, and environmental domains, renders unidimensional assessments invalid. Technological advancements have led to an increase in production and consumption levels. Concurrently, the environmental impact of human activities is increasing, and these developments occur within social structures. Many issues, such as income distribution, discrimination and equality of opportunity, reveal the importance of the social aspect of economic growth.

The three dimensions of sustainability have an intertwined structure. Although they are defined separately, they must be considered complementary elements. These dimensions can be briefly explained as follows.

Economic: An economically sustainable system must consistently produce goods and services, maintain manageable government and external debt levels, and avoid extreme sectoral imbalances that harm agricultural or industrial production.

Environmental: An environmentally sustainable system must maintain a stable resource base by avoiding overexploitation of renewable resource systems and consuming non-renewable resources only to the extent that investment is made as adequate substitutes. This includes maintaining biodiversity, atmospheric stability, and other ecosystem functions not generally classified as economic resources.

Social: A socially sustainable system should provide adequate social services, including distributional equity, health and education, gender equality, and political accountability and participation (Gedik, 2020).

Ensuring sustainable development requires this concept to be addressed at the level of enterprises, which are economic units that comprise a country's economy. The sustainability of enterprises depends on their economic, environmental and social sustainability (Heemskerk et al., 2002). Each of these three dimensions contains more than one indicator. Therefore, corporate sustainability performance measurement can be considered a multi-criteria decision-making (MCDM) problem (Alp et al., 2015). There are different views on the importance of dimension in Figure 1. The left image shows sustainability as three intersecting circles. In the top right, it is a nested approach. At the bottom right, there are three pillars. The schematic with nested ellipses emphasises a hierarchy of dimensions, placing the environment as the foundation for the other two (Purvis et al., 2019).

Figure: 1
Several Visual Representations of Sustainability and Its Three Dimensions
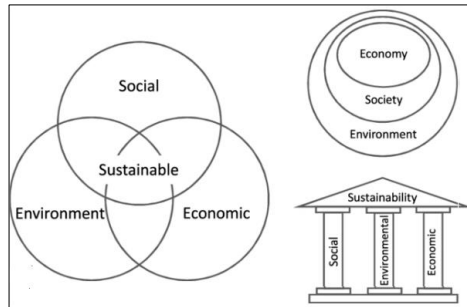
In recent years, achieving sustainable development has become an important goal in many areas. Sustainability in the insurance sector refers to companies achieving long-term value-creation goals and operating responsibly, considering environmental, social, and economic factors. While this includes measures such as the efficient use of natural resources, combating climate change, and reducing carbon footprint within environmental sustainability, social sustainability encompasses providing social benefits, reducing inequalities, and respecting human rights. In addition, the design of sustainable insurance products, sustainable investments and effective risk management strategies are important elements of sustainability in the sector. Insurance companies adopt a more responsible and future-oriented approach by considering sustainability factors and aim to provide both financial and environmental benefits. Insurance companies in the industry are placing an increasing emphasis on the concept of sustainability.

This study aims to evaluate the sustainability performance of five major insurance companies operating in Türkiye and engaging in sustainability activities. These companies held a significant market share and regularly published sustainability reports detailing their activities. The basic financial situations of these companies whose sustainability performance will be evaluated for 2021 are as follows. Türkiye Sigorta has a market share of 11.6% in total premium production and a net profit of 1,056 million TRY in 2021. Allianz Sigorta has a market share of 9.36% in total premium production and a net profit of 1,364 million TRY in 2021. Anadolu Sigorta has a market share of 10.9% in total premium production and a net profit of 522 million TRY in 2021. Eureko Sigorta has a market share of 2.5% in total premium production and a net profit of 162 million TRY in 2021.

The concept of sustainability includes three criteria and 11 sub-criteria. For this reason, company performance ranking is considered a multi-criteria decision-making (MCDM) problem. The spherical fuzzy analytic hierarchy process (AHP) method was used to determine the criterion weights. TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), CODAS (Combinative Distance-Based Assessment), and PIV (Performance Index Value) methods were used to rank companies. Ranking results were combined with the Borda Count method.

The other sections of the study continue as follows. A literature review on sustainability and the methods used is presented. In Section 3, the methods used and their application steps are presented, along with their corresponding mathematical representations.

Section 4 obtains the application results, including the performance evaluation of companies operating in the insurance sector. In Section 5, all results are evaluated, and their contribution to the literature is emphasised. Finally, suggestions for future studies are given.

2. Literature

There are many studies on MCDM problems in the literature. This study examines studies involving multi-criteria decision-making problems, particularly in the context of sustainability. Additionally, studies employing the spherical fuzzy AHP method, a relatively new approach compared to other methods, were evaluated. Finally, the studies, along with the various techniques used, are presented.

Sustainable development means meeting existing needs in the business environment without compromising future needs. The insurance industry plays a vital role by adopting sustainable development as a goal. What is now emerging in the current scenario is Sustainable Insurance, an approach to sustainability that aims to reduce risk and improve comprehensive solutions, business details, and concepts, thereby contributing to social and economic sustainability. Kanojia (2014) researched the role and contribution of insurance in sustainable development, revealing the problems and issues, as well as the canvas of the new era of sustainable insurance.

Taşçı (2024) evaluated sustainability performance by year using 2018-2022 data compiled from the annual sustainability reports of Anadolu Insurance Company. The study, conducted using the hybrid SWARA-MEREC-COBRA model, found that environmental factors were the most important criterion, followed by social and economic factors.

Onocak et al. (2022) examined the sustainability performance of insurance companies listed on the BIST through content analysis and emphasised the importance of publishing a sustainability report.

Lapinskaite and Radikaite (2015) analysed the sustainability indices of companies in Lithuania and the Baltic countries, as well as the main methods used to measure sustainability performance, including the Sustainability Indexes (Dow Jones Sustainability Index) and Sustainability Indicator Systems (Corporate Sustainability Grid). They found that sustainability performance will show different results depending on the method used.

Beiragh et al. (2020) proposed an integrated qualitative and quantitative approach to assessing sustainability performance. Their study evaluated fourteen insurance companies using eight economic, three environmental, and four social indices. They used principal component analysis (PCA) to reduce the number of sustainability performance assessment indices. They determined the weights of the criteria with the AHP method.

Fuzzy sets with three-dimensional membership functions, such as intuitionistic fuzzy sets (IFS), second-type intuitionistic fuzzy sets (IFS2), and neutrosophic fuzzy sets (NFS), offer decision-makers and experts a more nuanced way to express their judgments. In their study, Kutlu and Cengiz (2019) introduced generalised three-dimensional spherical fuzzy sets (SFS), which differ fundamentally from other fuzzy sets. They presented arithmetic operations for these new fuzzy sets based on spherical fuzzy distances and proofs, including addition, subtraction, and multiplication. They also developed addition operators and score and accuracy functions. Furthermore, the multi-criteria decision-making method TOPSIS is extended to global fuzzy TOPSIS, and an illustrative example is presented.

Kutlu and Kahraman (2020) extended the classical AHP to the spherical fuzzy analytic hierarchy process (SF-AHP) method. They demonstrated its applicability and validity through a comparative analysis between neutrosophic AHP and SF-AHP using the example of renewable energy site selection.

Acar et al. (2022) conducted a detailed sustainability assessment of fuel cells. Fuel cells are increasingly used in industry for their clean, quiet and flexible operation. Well-developed fuel cells will be necessary to convert the chemical energy stored in a gaseous form into valuable products, such as power and heat. İn their study, they compared the performance of selected fuel systems according to 4 main criteria and 15 sub-criteria. They obtained weights of economic, environmental, social and technical performance criteria using the spectral fuzzy AHP method.

Ozdemir (2022) presented a broad performance measurement model for Industry 4.0 in small and medium-sized manufacturing in her study. A hybrid global analytical solution process (SF-AHP)-weighted score methodology (WSM) is proposed for the performance characteristics and options process.

Kieu et al. (2021) proposed a hybrid MCDM model based on the Global Fuzzy Analytic Hierarchy Process (SF-AHP) and the CoCoSo Algorithm to solve the distribution centre selection problem for perishable agricultural products. They then demonstrated the model's applicability with a numerical example involving the distribution of sweet potatoes in the Mekong Delta region of Vietnam.

The literature review, which includes other multi-criteria decision-making methods used in the study, is presented below. Akgün and Temür (2016) evaluated the financial performance of companies listed in the BIST Transportation Index using the TOPSIS method. Wątróbski et al. (2022) assessed the sustainability presentation of 26 European cities and departments using the DARIA-TOPSIS method. Wu et al. (2022) aimed to select the most suitable agritourism location in Vietnam for their long-term investments using the Fuzzy AHP and TOPSIS methods. Jin et al. (2022) developed a methodology based on the hybrid fuzzy DEMATEL and TOPSIS method to help companies select the optimum business process modelling tool that is more efficient, economical and secure. Kumari and Acherjee (2022) employed the CRITIC and CODAS multi-criteria decision-making methods for selecting non-traditional machining processes. Badi et al. (2018) used the CODAS method to handle MCDM problems for a steel manufacturing company in Libya. Tuffour et al. (2023) employed an integrated approach that combined MEREC with the CODAS method to advance sustainable development goals through cross-sectoral engagement projects. Bączkiewicz and Wątróbski (2022) employed the CODAS and WASPAS methods to evaluate the sustainable utilisation of renewable energy sources across various sectors in 30 European countries. Goswami et al. (2022) selected the best of five alternative renewable energy sources for the proposed power plant, considering Indian climatic conditions with the aid of the PIV method. Erdoğan (2022) evaluated the financial performance of nine deposit banks operating in the BIST for the period 2016-2020 using the PIV method. Trung (2021a) compared five methods —EDAS, MARCOS, PIV, MOORA, and TOPSIS —for decision-making in the milling process. Trung (2021b) employed the TOPSIS and PIV methods, which were applied to multi-criteria decision-making in the arduous turning process. Khan et al. (2019) employed the PIV method to rank and select e-learning websites. In some studies where multiple multi-criteria decision-making methods were employed, the ranking results were combined using the Borda method (Akyüz & Aka, 2017; Biswas et al., 2022; Çakir & Perçin, 2013; Parlar & Palanci, 2020; Taddese et al., 2021).

3. Data and Methodology

3.1. Spherical Fuzzy Sets

Fuzzy sets were first introduced by Zadeh (1965). Many extensions of fuzzy sets have subsequently been developed. Several researchers have applied these extensions in the past few years to solve multi-criteria decision-making challenges. Some of these types of fuzzy extensions are as follows:

Sets with elements that have varying degrees of membership and non-membership are known as intuitionistic fuzzy sets (IFS). Krassimir Atanassov introduced intuitionistic fuzzy sets (Atanassov & Stoeva, 1986).

A Pythagorean fuzzy set (PFS) is a set of degrees of membership and non-membership that satisfy the requirement that the sum of their squares of degrees of membership and non-membership is less than or equal to 1 (Yager, 2013).

Smarandache (1999) defined neutrosophic logic. Neutrosophic logical status, enrollment status, non-membership rating, and score statuses can be used independently. Thus, a rational type for objective evaluations has been obtained.

Spherical Fuzzy Sets (SFS), another three-dimensional extension of fuzzy sets, were developed by Kutlu and Kahraman in 2019 [8, 9]. It takes its name from the membership degrees that can be expressed globally. The Euclidean distance determines the distance between two intuitionistic fuzzy sets (IFS), while the spherical arc distance measures the distance between the two SFS. The measurement differences between SFS, IFS, IFS2, and NFS, which share the same membership degrees, are illustrated in Figure 2.

Figure: 2
Representation of IFS, PFS, NS and SFS in Space Geometry
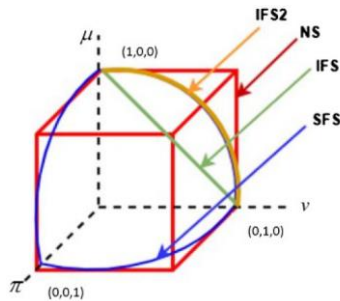
The definition of $\tilde{A}_s$', which is the Spherical Fuzzy Set defined on U, is given in Equations 1,2 and 3 (Kutlu-Gündoğdu & Kahraman, 2020).

$$\tilde{A}_s = \{u, (\mu_{\tilde{A}_s}(u)), (v_{\tilde{A}_s}(u))(\pi_{\tilde{A}_s}(u))|u \in U \} \tag{1}$$

$$\mu_{\tilde{A}_s}(u): U \to [0,1], \ v_{\tilde{A}_s}: U \to [0,1], \ \pi_{\tilde{A}_s}(u): U \to [0,1] \tag{2}$$

and

$$0 \leq \mu_{\tilde{A}_s}^2(u) + v_{\tilde{A}_s}^2(u) + \pi_{\tilde{A}_s}^2(u) \leq 1 \ \forall u \in U \tag{3}$$

for all $z \in Z$. Here $\mu_{\tilde{A}_s}^2(u)$, $v_{\tilde{A}_s}^2(u)$ ve $\pi_{\tilde{A}_s}^2(u)$ represent the membership, non-membership and hesaitancy degrees, respctively.

Definition: A spherical Fuzzy Value (SFV) λ is represented as $\lambda =$ (Mufazzal & S. M, 2018) where $\mu_\lambda, v_\lambda, \pi_\lambda \in [0,1]$ and satisfies $0 \leq \mu_\lambda^2 + v_\lambda^2 + \mu_\lambda^2 \leq 1$ (Kutlu-Gündoğdu & Kahraman, 2020).

3.1.1. Basic Operators in Spherical Fuzzy Sets

Let $\tilde{A}_s$ and $\tilde{B}_s$ be two SFSs, addition and multiplication in global fuzzy sets are defined as given in Equation (4) and Equation (5).

$$\tilde{A}_s \oplus \tilde{B}_s = \left\{ \left(\mu_{\tilde{A}_s}^2 + \mu_{\tilde{B}_s}^2 - \mu_{\tilde{A}_s}^2 \mu_{\tilde{B}_s}^2 \right)^2, v_{\tilde{A}_s} v_{\tilde{B}_s}, \left((1 - \mu_{\tilde{B}_s}^2)\pi_{\tilde{A}_s}^2 + \left(1 - \mu_{\tilde{A}_s}^2 \right)\pi_{\tilde{B}_s}^2 - \pi_{\tilde{A}_s}^2 \pi_{\tilde{B}_s}^2 \right)^{1/2} \right\} \tag{4}$$

$$\tilde{A}_s \otimes \tilde{B}_s = \left\{ \mu_{\tilde{A}_s} \mu_{\tilde{B}_s}, \left(v_{\tilde{A}_s}^2 + v_{\tilde{B}_s}^2 - v_{\tilde{A}_s}^2 v_{\tilde{B}_s}^2 \right)^{1/2}, \left((1 - v_{\tilde{B}_s}^2)\pi_{\tilde{A}_s}^2 + \left(1 - v_{\tilde{A}_s}^2 \right)\pi_{\tilde{B}_s}^2 - \pi_{\tilde{A}_s}^2 \pi_{\tilde{B}_s}^2 \right)^{1/2} \right\} \tag{5}$$

The product of this number of spherical constraints multiplied by a constant $\lambda \geq 0$ is given in Equation (6).

$$\lambda.\tilde{A}_s = \left\{ \left(1 - (1 - \mu_{\tilde{A}_s}^2)^\lambda \right)^{\frac{1}{2}}, v_{\tilde{A}_s}^\lambda, \left(\left(1 - \mu_{\tilde{A}_s}^2 \right)^\lambda - \left(1 - \mu_{\tilde{A}_s}^2 - \pi_{\tilde{A}_s}^2 \right)^\lambda \right)^{1/2} \right\} \tag{6}$$

The power of a spherical fuzzy number is given in Equation (7).

$$\mu_{\tilde{A}_s}^\lambda = \left\{ \mu_{\tilde{A}_s}^\lambda, \left(1 - \left(1 - v_{\tilde{A}_s}^2 \right)^\lambda \right)^{\frac{1}{2}}, \left(\left(1 - v_{\tilde{A}_s}^2 \right)^\lambda - \left(1 - v_{\tilde{A}_s}^2 - \pi_{\tilde{A}_s}^2 \right)^\lambda \right)^{1/2} \right\} \tag{7}$$

General Definitions: Let $\tilde{A}_s = (\mu_{\tilde{A}_s}, v_{\tilde{A}_s}, \pi_{\tilde{A}_s})$ and $\tilde{B}_s = (\mu_{\tilde{B}_s}, v_{\tilde{B}_s}, \pi_{\tilde{B}_s})$ the number of spherical fuzzy sets. For all $\lambda_1, \lambda_2, \lambda_3, \geq 0$ the properties in Equations 8, 9, 10, 11, 12 and 13 hold.

$$\tilde{A}_s \oplus \tilde{B}_s = \tilde{B}_s \oplus \tilde{A}_s \tag{8}$$

$$\tilde{A}_s \otimes \tilde{B}_s = \tilde{B}_s \otimes \tilde{A}_s \tag{9}$$

$$\lambda(\tilde{A}_s \oplus \tilde{B}_s) = \lambda \tilde{A}_s \oplus \lambda \tilde{B}_s \tag{10}$$

$$\lambda_1 \tilde{A}_s \oplus \lambda_2 \tilde{A}_s = (\lambda_1 + \lambda_2)\tilde{A}_s \tag{11}$$

$$\left(\tilde{A}_s \otimes \tilde{B}_s\right)^{\lambda} = \lambda.\tilde{A}_s \otimes \lambda.\tilde{B}_s \tag{12}$$

$$\tilde{A}_s^{\lambda_1} \otimes \tilde{A}_s^{\lambda_2} = \tilde{A}_s^{\lambda_1+\lambda_2} \tag{13}$$

SFSs are important in situations where viewpoints are not limited to agreement or disagreement, but also require some disapproval or abstention. For instance, a candidate's response in a human interview may be categorized as yes, abstained, no, or rejected.

Definition: Spherical Weighted Arithmetic Mean (SWAM) concerning δ is defined as Equation (14) (Kutlu-Gündoğdu & Kahraman, 2020).

$$\delta = \{\delta_1, \delta_2, \dots, \delta_n\}, \forall\, \delta_s \in [0,1] \text{ and } \sum_{s=1}^n \delta_s = 1.$$

$$SWAM_\delta\left(S_{A_1}, S_{A_2}, \dots, S_{A_n}\right) = \delta_1 S_{A_1} + \delta_2 S_{A_2}, \dots + \delta_n S_{A_n}$$

$$= \left\{\left[1 - \prod_{i=1}^n \left(1 - \mu_{S_{A_s}}^2\right)^{\delta_s}\right]^{1/2}, \prod_{s=1}^n v_{S_{A_s}}^{\delta_s}, \left[\left(1 - \mu_{S_{A_s}}^2\right)^{\delta_s} - \prod_{s=1}^n \left(1 - \mu_{S_{A_s}}^2 - \pi_{S_{A_s}}^2\right)^{\delta_s}\right]^{1/2}\right\} \tag{14}$$

Definition: The Spherical Weighted Geometric Mean (SWGM) concerning delta is defined as Equation (15) (Kutlu-Gündoğdu & Kahraman, 2020).

$$\delta = \{\delta_1, \delta_2, \dots, \delta_n\}, \forall\, \delta_s \in [0,1] \text{ and } \sum_{s=1}^n \delta_s = 1.$$

$$SWGM_\delta\left(S_{A_1}, S_{A_2}, \dots, S_{A_n}\right) = S_{A1}^{\delta_1} + S_{A2}^{\delta_2} + \dots + S_{An}^{\delta_n}$$

$$= \left\{\mu_{S_{A_s}}^{\delta_s}, \left[1 - \prod_{s=1}^n \left(1 - v_{S_{A_s}}^2\right)^{\delta_s}\right]^{1/2}, \left[\prod_{s=1}^n \left(1 - v_{S_{A_s}}^2\right)^{\delta_s} - \prod_{s=1}^n \left(1 - v_{S_{A_s}}^2 - \pi_{S_{A_s}}^2\right)^{\delta_s}\right]^{1/2}\right\} \tag{15}$$

3.2. Spherical Fuzzy Analytic Hierarchy Process

Steps to be followed for determining weights with spherical fuzzy AHP:

Step 1: All objectives, alternatives, parameters and sub-parameters are determined to form the construct of the multi-criteria decision-making problem. The scoring index is estimated based on a finite set of criteria $C=\{C_1, C_2,\dots,C_n\}$. A discrete set of m feasible alternative $X = \{x_1, x_2, \dots, x_m\}$ ($m \geq 2$) is defined.

Step 2: Constitute spherical fuzzy pairwise comparison matrices concerning the overall objective based on the linguistic terms. The fuzzy numbers corresponding to the linguistic variables used in pairwise comparisons in the method are given in Table 1 (Kutlu-Gündoğdu & Kahraman, 2020).

Table: 1
Linguistic Measures of Importance

Linguistic Significance Measure	(μ, v, π)	Score Index (SI)
Absolutely more importance (AMI)	(0.9, 0.1, 0.0)	9
Very high importance (VHI)	(0.8, 0.2, 0.1)	7
High importance (HI)	(0.7, 0.3, 0.2)	5
Slightly more importance (SMI)	(0.6, 0.4, 0.3)	3
Equally important (EI)	(0.5, 0.4, 0.4)	1
Slightly low importance (SLI)	(0.4, 0.6, 0.3)	1/3
Low importance (LI)	(0.3, 0.7, 0.2)	1/5
Very low importance (VLI)	(0.2, 0.8, 0.1)	1/7
Absolutely low importance (ALI)	(0.1, 0.9, 0.0)	1/9

Step 3: Score indices are calculated. While Equality (16) is calculated for AMI, VHI, HI, SMI, and EI, score indexes are calculated using Equality (17) for EI, SLI, LI, VLI, and ALI (Kutlu-Gündoğdu & Kahraman, 2020).

$$SI = \sqrt{\left|100 * \left[\left(\mu_{\tilde{A}_s} - \pi_{\tilde{A}_s}\right)^2 - \left(v_{\tilde{A}_s} - \pi_{\tilde{A}_s}\right)^2\right]\right|} \tag{16}$$

$$\frac{1}{SI} = \frac{1}{\sqrt{\left|100 * \left[\left(\mu_{\tilde{A}_s} - \pi_{\tilde{A}_s}\right)^2 - \left(v_{\tilde{A}_s} - \pi_{\tilde{A}_s}\right)^2\right]\right|}} \tag{17}$$

Step 4: A consistency check is performed on the pairwise comparison matrix. Score indices (SI) are used to measure the consistency of pairwise comparisons. Then, the classical consistency method is applied as in AHP. The calculation of the CR is performed in two steps. The Consistency Index (CI) value needs to be calculated in the first step. The formula for calculating the CI and CR is provided in Equation (18). If the calculated values are less than 0.1, the priorities, therefore, indicate that individual comparisons between factors are consistent. Used in the calculation of Randomness Indicators (RI) values.

$$CI = \frac{\lambda_{max} - n}{n-1}, CR = \frac{CI}{RI} \tag{18}$$

Step 5: Expert opinions are integrated using Equation (14). Then, calculate the spherical fuzzy local weights for each criterion. The SWGM operatör calculates the local weights for each criterion by Equation (19) (Alimohammadlou & Khoshsepehr, 2023).

$$\text{SWGM} = \left\{\mu_{S_{A_s}}^{\delta_s}, \left[1 - \prod_{s=1}^{n}\left(1 - v_{S_{A_s}}^2\right)^{\delta_s}\right]^{1/2}, \left[\prod_{s=1}^{n}\left(1 - v_{S_{A_s}}^2\right)^{\delta_s} - \prod_{s=1}^{n}\left(1 - v_{S_{A_s}}^2 - \pi_{S_{A_s}}^2\right)^{\delta_s}\right]^{1/2}\right\} \tag{19}$$

where w=1/n

Step 6: The local weights obtained in Step 5 are then defuzzified. The criteria weights are defuzzified using Equation (20) and normalised by Equation (21).

$$S(w_j) = \sqrt{\left|\left|100 * \left[\left(3\mu_{\tilde{A}_s} - \frac{\pi_{\tilde{A}_s}}{2}\right)^2 - \left(\frac{\nu_{\tilde{A}_s}}{2} - \pi_{\tilde{A}_s}\right)^2\right]\right|\right|} \tag{20}$$

$$w_j = \frac{S(w_j)}{\sum_{j=1}^n S(w_j)} \tag{21}$$

Step 7: Obtain global weights. At this stage, the global weights of the main criteria and sub-criteria are calculated.

3.3. Proximity Indexed Value (PIV) Method

PIV (Proximity Indexed Value) is one of the MCDM methods developed by Mufazzal and Muzakkir (2018) to determine the optimal choice. According to the method, the best alternative is the alternative whose score is closest to the ideal solution among the decision alternatives. This method includes the following steps (Khan et al., 2019);

Step 1: The available alternatives Ai (i=1,2,.....,m) and evaluation criteria Cj (i=1,2,.....,n) in the decision problem are defined.

Step 2: A decision matrix is created for the alternatives. The decision matrix (Y) is formed by Equation (22).

$$Y = \left[y_{ij}\right]_{mxn} = \begin{bmatrix} y_{11} & y_{12} & \cdots & y_{1j} & \cdots & y_{1n} \\ y_{21} & y_{22} & \cdots & y_{2j} & \cdots & y_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ y_{i1} & y_{i2} & \cdots & y_{ij} & \cdots & y_{in} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ y_{m1} & y_{m2} & \cdots & y_{mj} & \cdots & y_{mn} \end{bmatrix} i = 1,2,\dots,m \ ve \ j = 1,2,\dots,n \tag{22}$$

y_{ij}, j. represents the alternative performance value of the criterion. m represents the number of alternatives and n the number of criteria.

Step 3: The decision matrix is normalised. Normalisation is done using Equation (23).

$$R_i = \frac{y_{ij}}{\sqrt{\sum_{i=1}^m y_i^2}} \tag{23}$$

Step 4: The weighted normalised decision matrix is calculated. This matrix is done using Equation (24).

$$v_i = w_j x R_i \tag{24}$$

Step 5: The weighted proximity index u_i is calculated.

$$u_i = \begin{cases} v_{mak} - v_i \text{ if benefit criterion} \\ v_i - v_{min} \text{ if cost criterion} \end{cases} \tag{25}$$

The v_{max} value in Equation (25) represents the highest value of v_i calculated with the help of Equation (24), and the value of v_{min} represents the lowest value of v_i.

Step 6: General proximity values d_i are determined.

$$d_i = \sum_{j=1}^{n} u_i \tag{26}$$

Step 7: The alternative with the smallest di value from the di values calculated in the previous step will be determined as the most suitable alternative since it will show the least deviation. For this reason, d_i values are ranked from smallest to largest.

3.4. TOPSIS Method

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method is one of the most widely used multi-criteria decision-making methods developed by Yoon and Hwang in 1981. TOPSIS method aims to determine the decision points (alternatives) closest to the ideal solution by determining the positive and negative ideal solutions. The most appropriate alternative to be selected under specific criteria is the one closest to the positive solution and farthest from the negative solution. The TOPSIS method involves a solution process consisting of 6 steps. The steps of the TOPSIS method are described below.

Step 1: Create the Decision Matrix (Y). The matrix format is the same as in Equation (22).

Step 2: Normalized Decision Matrix *(R)* is created by Equation (27).

The decision matrix is obtained by dividing the values of each criterion by the square root of the sum of squares of those criteria, using the elements of matrix (A).

$$r_{ij} = \frac{y_{ij}}{\sqrt{\sum_{i=1}^{m} xy_{ij}^2}} \quad i = 1, 2, \ldots, m \quad j = 1, 2, \ldots, n \tag{27}$$

The R matrix obtained by the formula is as follows:

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

Step 3: The Weighted Normalized Decision Matrix (*V*) is generated using Equality (28).

$$v_{ij} = w_j \times r_{ij} \tag{28}$$

$$V = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \ldots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \ldots & w_n r_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ w_1 r_{m1} & w_2 r_{m2} & \ldots & w_n r_{mn} \end{bmatrix}$$

Step 4: Ideal (A^*) ve negatif ideal (A^-) solutions are calculated.

$$A^+ = \left\{ v_1^+, v_2^+, \ldots, v_j^+, \ldots, v_n^+ \right\} = \left\{ (\max_i v_{ij} \mid j \in J_1), (\min_i v_{ij} \mid j \in J_2, i = 1, 2, \ldots, m \right\}$$

$$A^- = \left\{ v_1^-, v_2^-, \ldots, v_j^-, \ldots, v_n^- \right\} = \left\{ (\min_i v_{ij} \mid j \in J_1), (\max_i v_{ij} \mid j \in J_2, i = 1, 2, \ldots, m \right\}$$

where J_1 benefit criteria sets, J_2 cost criteria sets.

Step 5: Calculate the distance values.

In the TOPSIS method, the Euclidean Distance Approach is used to find the deviations of the criterion value for each alternative from the positive and negative ideal solution set. The distances of the alternatives to the Positive ideal (S_i^+) and Negative ideal (S_i^-) solution points are calculated by Equation (29) and Equation (30), respectively.

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2} \qquad i = 1, 2, \ldots, n \tag{29}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2} \qquad i = 1, 2, \ldots, n \tag{30}$$

Step 6: The overall preference scores are calculated by using Equation (31).

Positive ideal and negative ideal distance measures are used to calculate the relative proximity (C_i^*) of each decision point to the ideal solution. The calculation of the relative closeness to the perfect solution is shown in the formula below.

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^+} \tag{31}$$

Here, the value (C_i^*) takes a value in the $0 \leq C_i^* \leq 1$ range. As the value of an alternative approaches 1, it approaches the positive ideal solution, and as the value approaches 0, it approaches the negative perfect solution of the relevant decision point. Alternatives are ranked according to their proximity coefficients.

3.5. CODAS Method

The CODAS method, which reaches a conclusion based on two different distance measurements, was introduced to the literature by Keshavarz Ghorabaee et al. (2016). It is summarised below.

Step 1: The CODAS method begins with creating a decision matrix consisting of alternatives and criteria. This matrix format is the same as in Equation (22).

Step 2: The values in the decision matrix are normalised using Equation (32) for benefit criteria and Equation (33) for cost criteria.

$$t'_{ij} = \frac{x_{ij}}{mak(x_{ij})} \tag{32}$$

$$t'_{ij} = \frac{min(x_{ij})}{x_{ij}} \tag{33}$$

Step 3: The normalised values are multiplied by the criteria weights to obtain a weighted normalised decision matrix. The Equation (34) below illustrates this process.

$$t_{ij}^* = t'_{ij} w_j \tag{34}$$

Step 4: The negative ideal solution for each criterion is calculated by Equation (35).

$$ns_j = min(t_{ij}^*) \tag{35}$$

Step 5: The Euclidean and Taxicab distances of the alternatives to the negative ideal solution are calculated using the following Equations (36-37).

$$P_i = \sqrt{\sum_{j=1}^{n}(t_{ij}^* - ns_j)^2} \tag{36}$$

$$Q_i = \sum_{j=1}^{n}|t_{ij}^* - ns_j| \tag{37}$$

Step 6: The relative evaluation matrix is calculated using the following Equation (38).

$$R_a = [u_{ib}]_{mxm}$$
$$u_{ib} = (P_i - P_b) + (\omega(P_i - P_b) \times (Q_i - Q_b)) \tag{38}$$

Shown in Equation (38) ω, is a threshold function. This function is used to determine the equality of the Euclidean distances between two alternatives and is expressed as;

$$\omega(x) = \begin{cases} 0, |x| < \tau \\ 1, |x| \geq \tau \end{cases} \tag{39}$$

The τ value in Equation (39) is the threshold parameter. Decision makers set this value to 0.01-0.05, which is taken as 0.02 in this study.

Step 7: The final performance score (AS_i) is calculated for each alternative using the following equation. The alternative with the highest performance score is identified as the best alternative.

$$AS_i = \sum_{b=1}^{n} u_{ib} \tag{40}$$

3.6. Borda Counting Method

There are numerous studies in the literature that employ multiple MCDM techniques in conjunction (Kartal & Özdil, 2024; Trung, 2021; Teker et al., 2024). These studies aim to achieve accurate results using various ranking methods. Identifying the best alternative with multiple methods is considered an efficiency measure. The Borda Counting method combines the rankings generated by such multiple classifiers and provides a single ranking (Wu, 2011). This method considers each class equally important for classification performance and is straightforward regarding applicability. Of the m alternatives in the class, the best alternative is given a decreasing value of m1, the second best alternative is given a decreasing value of m-2 and the worst alternative is scored as 0. Finally, the values assigned to the other options in all classes are summed to obtain the Borda score, and the ranking is based on this value. The relevant mathematical notations are given below.

Step-1: The Borda score is determined for each criterion by using Equation (41).

$$b_i = \sum_{j=1}^{n} (M - r_{ij}) \tag{41}$$

here, r_{ik} = rank of alternative i. according to method j., M = number of alternatives.

4. Case Study

The sustainability approach has become increasingly important in the world's insurance sector. The activities of the insurance sector facilitate the management of sustainability risks not only within their own sector but also across all sectors. Effective risk assessment and management are at the heart of sustainability issues. However, understanding and managing various types of risks requires specialised expertise in the insurance sector. This is why the link between sustainability issues and the insurance sector is growing more potent than ever. The most significant actors in the insurance sector are implementing various changes and innovations in their products and services to maintain their market presence, adopting the concept of sustainable development as a key goal. The

insurance sector contributes significantly to sustainable development by adopting sustainable business models in its investment preferences, preferring climate-friendly business lines, implementing paperless insurance, promoting sustainable insurance practices, and organising environmental awareness campaigns. The most significant impact of insurance companies is to offer sustainable options to all other business lines, providing products that facilitate the management of sustainability risks. Insurance companies in Türkiye have increased their efforts by adopting the sustainability approach in this area. Companies present their results to their investors and other stakeholders through sustainability reports.

This study used data from the 2021 sustainability reports of five companies operating in the insurance sector and regularly submitting sustainability reports. The relevant financial information, including the year of establishment and the year they started publishing sustainability reports, for these companies are presented in Table 2. The common variables in all reports were determined as criteria for the multi-criteria decision-making (MCDM) problem. These criteria and their corresponding sub-criteria are summarised in Table 3. Among them, cost criteria C11, C12, C13 and C34 were categorised as other benefit criteria. The hierarchical structure of the MCDM problem is shown in Figure 3. Three experts made comparisons to evaluate these criteria and sub-criteria. These experts consisted of an academician specialising in sustainability and two managers from the insurance sector. The experts were provided with separate forms to compare the main criteria and their sub-criteria in a pairwise manner. They assigned relative importance values to the criteria using the linguistic expressions in Table 1. MCDM methods were applied using the decision matrix presented in Table 4.

Table: 2
Starting Dates for Corporate Sustainability Activities of Alternatives

Companies	Establishment Date	First Report Date	Active Size (Million TRY)	Net Profit (Million TRY)
A1: Türkiye Sigorta	2020	2021	14,35	1,056
A2: Aksigorta	2021	2021	7,388	189
A3: Allianz Sigorta	2008	2016	37,38	1,364
A4: Anadolu Sigorta	2018	2018	16,775	522
A5: Eureko Sigorta	2020	2020	3,520	162

Table: 3
Criterias and Subcriterias in the MCDM Problem

Main Criteria	Sub-Criteria
C1: Environmental	C_{11}: Water Consumption (m^3)
	C_{12}: Electricity Consumption (kwh)
	C_{13}: Fuel Consumption (litres)
C2: Social	C_{21}: Total Number of Employees
	C_{22}: Total OHS Training Provided to Employees (hours)
	C_{23}: Female Employee Ratio (%)
	C_{24}: Ratio of Senior Female Executives (%)
C3: Financial	C_{31}: Shareholder's equity / total assets
	C_{32}: Net profit / equity
	C_{33}: Net profit / total assets
	C_{34}: Composite ratio

Figure: 3
Hierarchical Structure for the Problem
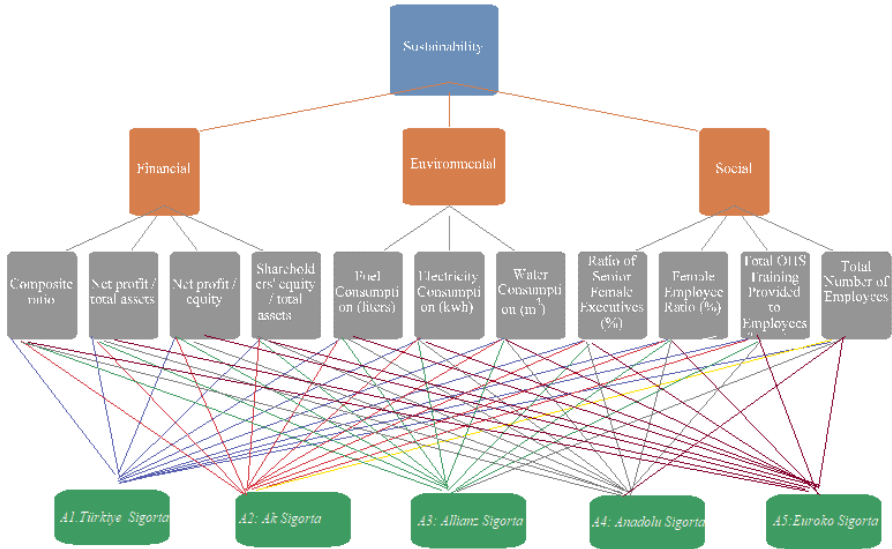
Table: 4
The Values for Input and Output Variables

Insurance Company	C1			C2				C3			
	C_{11}	C_{12}	C_{13}	C_{21}	C_{22}	C_{23}	C_{24}	C_{31}	C_{32}	C_{33}	C_{34}
Türkiye Sigorta	4,766	1,589,348	663,030	1,273	2,736	0.510	0.220	2.208	0.151	0.074	0.993
Ak Sigorta	554	561,236	101,990	665	859	0.510	0.220	6.092	0.046	0.026	1.130
Allianz Sigorta	21,963	4,076,255	294,987	2,325	12,640	0.600	0.150	2.039	0.046	0.026	1.061
Anadolu Sigorta	4,967	2,453,333	129,852	1,491	2,152	0.510	0.110	2.664	0.082	0.026	1.255
Euroko Sigorta	2,040	89,669.760	142,914	695	780	0.570	0.250	2.004	0.112	0.046	1.224

5. Results

For all main criteria, the weight values were obtained by applying the steps of the spherical fuzzy AHP method respectively. In the first stage, the main criteria were evaluated linguistically by the experts using Table (1). The results of the experts' linguistic evaluation are given in Table 5. Fuzzy values corresponding to these values are presented in Table 6.

Experts' evaluations may be integrated with either SWAM or SWAM operators. In this study, the SWAM operator has been used. Pairwise comparison matrices were obtained by combining the experts' evaluations using the SWAM operator in Equation (14) and are presented in Table 7.

CR values were calculated using Equation (18) to check the consistency of the pairwise comparison matrices. Since the consistency was ensured according to the obtained values, the following steps were taken.

The Spherical fuzzy weights of the criteria were calculated using the SWGM operator (Equation 19) from the pairwise comparison matrix. Then, the global values are defuzzi-fied with the score function given in Equation (20). In the last step, the column of the local weights was obtained by normalising the sum of the weights by dividing the sum by the column values (Equation 21).

Table: 5
Pairwise Linguistic Comparison of Main Criteria

Criteria	Expert 1			Expert 2			Expert 3		
	C1	C2	C3	C1	C2	C3	C1	C2	C3
C1: Environmental	EI	HI	VHI	EI	SMI	HI	EI	VHI	AMI
C2: Social	LI	EI	HI	SLI	EI	SMI	VLI	EI	VHI
C3: Financial	VLI	LI	EI	LI	SLI	EI	ALI	VLI	EI

Table: 6
Fuzzy Values of the Pairwise Comparison Matrix

		C1	C2	C3
Expert 1	C1	(0.5, 0.4, 0.4)	(0.7, 0.3, 0.2)	(0.8, 0.2, 0.1)
	C2	(0.3, 0.7, 0.2)	(0.5, 0.4, 0.4)	(0.7, 0.3, 0.2)
	C3	(0.2, 0.8, 0.1)	(0.3, 0.7, 0.2)	(0.5, 0.4, 0.4)
Expert 2	C1	(0.5, 0.4, 0.4)	(0.6, 0.4, 0.3)	(0.7, 0.3, 0.2)
	C2	(0.4, 0.6, 0.3)	(0.5, 0.4, 0.4)	(0.6, 0.4, 0.3)
	C3	(0.3, 0.7, 0.2)	(0.4, 0.6, 0.3)	(0.5, 0.4, 0.4)
Expert 3	C1	(0.5, 0.4, 0.4)	(0.8, 0.2, 0.1)	(0.9, 0.1, 0.0)
	C2	(0.2, 0.8, 0.1)	(0.5, 0.4, 0.4)	(0.8, 0.2, 0.1)
	C3	(0.1, 0.9, 0.0)	(0.2, 0.8, 0.1)	(0.5, 0.4, 0.4)

Table: 7
Integrated Spherical Fuzzy Pairwise Comparison Matrices and Criteria Weights

	C1	C2	C3	$\widetilde{w}^s$ (Spherical fuzzy weight)	$\bar{w}^s$ (Weight)
C1	(0.500, 0.400, 0.400)	(0.714, 0.288, 0.202)	(0.821, 0.182, 0.108)	(0.664, 0.306, 0.279)	0.463
C2	(0.313, 0.695, 0.222)	(0.500, 0.400, 0.400)	(0.714, 0.288, 0.202)	(0.482, 0.514, 0.287)	0.326
C3	(0.217, 0.796, 0.132)	(0.313, 0.695, 0.222)	(0.500, 0.400, 0.400)	(0.324, 0.677, 0.248)	0.211

CR: 0.0846

For example, in the calculation, Criterion C1 was evaluated by the experts as having a higher index (HI), a moderate index (SMI), and a very high index (VHI), respectively, compared to Criterion C2. These evaluations were combined with the SWAM operator as follows;

$$\text{SWAM} = \left\{ \left[1 - \prod_{i=1}^{n} \left(1 - \mu_{S_{A_s}}^2 \right)^{w_i} \right]^{1/2}, \prod_{s=1}^{n} v_{S_{A_s}}^{w_i}, \left[\left(1 - \mu_{S_{A_s}}^2 \right)^{w_i} - \prod_{s=1}^{n} \left(1 - \mu_{S_{A_s}}^2 - \pi_{S_{A_s}}^2 \right)^{w_i} \right]^{1/2} \right\}.$$

$$\left\{ \begin{array}{c} = \left[1 - \left[(1 - 0.7^2)^{\frac{1}{3}}.(1 - 0.6^2)^{\frac{1}{3}}.(1 - 0.8^2)^{\frac{1}{3}}\right]^{1/2}, \\ \left(0.3^{\frac{1}{3}}\right).\left(0.4^{\frac{1}{3}}\right).\left(0.2^{\frac{1}{3}}\right), \\ \left[(1 - 0.7^2)^{\frac{1}{3}}.(1 - 0.6^2)^{\frac{1}{3}}.(1 - 0.8^2)^{\frac{1}{3}}\right] - \\ \left[(1 - 0.7^2 - 0.2^2)^{\frac{1}{3}}.(1 - 0.6^2 - 0.3^2)^{\frac{1}{3}}.(1 - 0.8^2 - 0.1^2)^{\frac{1}{3}}\right] \end{array} \right\} = \{0.714, 0.288, 0.202\}$$

Then, the spherical fuzzy weight is calculated with the SWGM operator as follows:

$$\text{SWGM} = \left\{ \mu_{S_{A_s}}^{\delta_s}, \left[1 - \prod_{s=1}^{n}\left(1 - v_{S_{A_s}}^2\right)^{\delta_s}\right]^{1/2}, \left[\prod_{s=1}^{n}\left(1 - v_{S_{A_s}}^2\right)^{\delta_s} - \prod_{s=1}^{n}\left(1 - v_{S_{A_s}}^2 - \pi_{S_{A_s}}^2\right)^{\delta_s}\right]^{1/2} \right\}.$$

$$\left\{ \begin{array}{c} \left(0.500^{\frac{1}{3}}\right).\left(0.714^{\frac{1}{3}}\right).\left(0.821^{\frac{1}{3}}\right), \\ \left[1 - \left[(1 - 0.4^2)^{\frac{1}{3}}.(1 - 0.288^2)^{\frac{1}{3}}.(1 - 0.182^2)^{\frac{1}{3}}\right]^{1/2}, \\ \left[(1 - 0.4^2)^{\frac{1}{3}}.(1 - 0.288^2)^{\frac{1}{3}}.(1 - 0.182^2)^{\frac{1}{3}}\right] \\ - \left[(1 - 0.4^2 - 0.4^2)^{\frac{1}{3}}.(1 - 0.288^2 - 0.202^2)^{\frac{1}{3}}.(1 - 0.182^2 - 0.108^2)^{\frac{1}{3}}\right] \end{array} \right\}$$

$\widetilde{w}^s = \{0.664, 0.306, 0.279\}$

At the end, The local weight defuzzify and obtain weight for C1 as below:

$$S(w_j) = \sqrt{\left|100 * \left[\left(3\mu_{\tilde{A}_s} - \frac{\pi_{\tilde{A}_s}}{2}\right)^2 - \left(\frac{v_{\tilde{A}_s}}{2} - \pi_{\tilde{A}_s}\right)^2\right]\right|}$$

$$= \sqrt{\left|100 * \left[\left(3 * 0.306 - \frac{0.279}{2}\right)^2 - \left(\frac{0.306}{2} - 0.279\right)^2\right]\right|} = 18.489$$

$$w_j = \frac{S(w_j)}{\sum_{j=1}^{n} S(w_j)}, \quad w_j = \frac{18.489}{39.936} = 0.463$$

For all sub-criteria, all steps were applied similarly to the main criteria and the results obtained are given respectively Appendix 1. The local and global weights calculated for all criteria and sub-criteria are shown in Table 8.

According to Table 8, environmental factors have the most weight on sustainable development, followed by social and financial factors. Among environmental factors, water consumption has the most impact, followed by Electricity consumption and fuel consumption. While the number of senior female executives has the most impact on social factors, the total number of employees also has a high impact. Among the financial factors, net profit/equity has the most significant impact.

Table: 8
Local and Global Weights of Criteria

Criterias	Weights	Sub-Criterias	Local Weights	Global Weights
Environmental	0.463	Water Consumption (m³)	0.374	0.173
		Electricity Consumption (kwh)	0.342	0.159
		Fuel Consumption (liters)	0.283	0.131
Social	0.326	Total Number of Employees	0.279	0.091
		Total OHS Training Provided to Employees (hours)	0.228	0.074
		Female Employee Ratio (%)	0.192	0.062
		Ratio of Senior Female Executives (%)	0.301	0.098
Financial	0.211	Shareholder's equity / total assets	0.147	0.031
		Net profit / equity	0.348	0.074
		Net profit / total assets	0.311	0.066
		Composite ratio	0.193	0.041

After global weights were obtained for all weights, the alternatives were ranked using these weights. The PIV, TOPSIS, and Codas methods are listed as alternatives, respectively. Finally, those created by the Borda method were combined.

PIV Method Results

The decision matrix (Table 4) is normalised using Equation (23), and the weighted normalised decision matrix is calculated using Equation (24). The resulting matrices are given in Appendix 2.

The weighted proximity index u_i is calculated using Equation (25), and general proximity values di are determined using Equation (26). Table 9 gives all results and ranks the alternatives using the PIV method.

Table: 9
Weighted Proximity Index, Overall Proximity Index and Ranking Results

Weighted Proximity Index (u_i)											d_i	Rank
C_{11}	C_{12}	C_{13}	C_{21}	C_{22}	C_{23}	C_{24}	C_{31}	C_{32}	C_{33}	C_{34}		
0.030	0.056	0.005	0.007	0.032	0.047	0.097	0.016	0.000	0.000	0.000	0.289	3
0.047	0.067	0.005	0.007	0.000	0.015	0.000	0.000	0.036	0.032	0.002	0.210	2
0.000	0.000	0.000	0.022	0.160	0.125	0.033	0.017	0.036	0.032	0.001	0.427	5
0.024	0.059	0.005	0.031	0.033	0.074	0.005	0.014	0.024	0.032	0.004	0.305	4
0.046	0.067	0.002	0.000	0.011	0.000	0.007	0.017	0.013	0.019	0.004	0.186	1

Table 9 shows the ranking results of the PIV method. The alternatives are A5>A2>A1>A4>A3.

TOPSIS Method Results

The normalised decision matrix *(R)* is created by equation (27), and the weighted normalised decision matrix (*V*) is generated using equality (28). The resulting matrices are given in Appendix 3.

Positive ideal (A^*) and negative ideal (A^-) solutions are calculated and results are given Table 10.

Table: 10
Positive Ideal (A^*) and Negative Ideal (A^-) Solutions

	C$_{11}$	C$_{12}$	C$_{13}$	C$_{21}$	C$_{22}$	C$_{23}$	C$_{24}$	C$_{31}$	C$_{32}$	C$_{33}$	C$_{34}$
A-	0.019	0.004	0.026	0.024	0.165	0.128	0.115	0.008	0.016	0.017	0.020
A*	0.066	0.071	0.031	0.056	0.004	0.003	0.018	0.025	0.052	0.050	0.016

The distances of the alternatives to the Positive ideal (S_i^+) and Negative ideal (S_i^-) solution points are calculated by Equation (29) and Equation (30), The overall preference scores are calculated by equation (31). All results are given in Table 11.

Table: 11
Ranks of TOPSIS Method

	FPIC	FNIC	C_i^*	Rank
A1: Türkiye Sigorta	0.130	0.161	0.553	4
A2: Ak Sigorta	0.096	0.220	0.695	2
A3: Allianz Sigorta	0.214	0.104	0.328	5
A4: Anadolu Sigorta	0.116	0.168	0.590	3
A5: Eureko Sigorta	0.088	0.219	0.714	1

Table 11 shows the TOPSIS method's ranking results. The alternatives are A5>A2>A4>A1>A3.

CODAS Method Results

Equation (32) for benefit criteria and Equation (33) for cost criteria help normalise the values in the decision matrix. Then, the normalised values are multiplied by the criteria weights to obtain a weighted normalised decision matrix using Equation (34), and all results are given in Appendix 4.

The Euclidean and Taxicab distances of the alternatives to the negative ideal solution are measured with the help of the following Equations (36-37). The relative evaluation matrix is calculated with the help of the following Equations (38). The final performance score (AS_i) is calculated for each alternative using the Equation (39). All results are given in Table 12.

Table: 12
Ranks of the CODAS Method

	Pi	Qi	Relative Evaluation Matrix					Score (AS$_i$)	Rank
A1: Türkiye Sigorta	0.086	0.203	-0.241	0.150	-0.487	-0.019	0.017	-0.580	4
A2: Ak Sigorta	0.209	0.370	0.048	0.440	-0.198	0.271	0.370	0.931	2
A3: Allianz Sigorta	0.100	0.191	-0.239	0.153	-0.485	-0.005	0.083	-0.492	3
A4: Anadolu Sigorta	0.092	0.161	-0.277	0.115	-0.523	-0.013	0.046	-0.652	5
A5: Eureko Sigorta	0.189	0.384	0.043	0.435	-0.203	0.266	0.365	0.906	1

Table 12 shows the TOPSIS method's ranking results. The alternatives are A5>A2>A3>A1>A4.

The ranking results obtained according to the three methods were combined with the Borda method, and the results are given in Table 13.

Table: 13
Results of Integrated Ranks by Borda Method

Companies	PIV	b$_i$	TOPSIS	b$_i$	CODAS	b$_i$	Borda Score	Integrated Rank
A1: Türkiye Sigorta	3	2	4	1	4	1	4	3
A2: Aksigorta	2	3	2	3	2	3	9	2
A3: Allianz Sigorta	5	0	5	0	3	2	2	5
A4: Anadolu Sigorta	4	1	3	2	5	0	3	4
A5: Eureko Sigorta	1	4	1	4	1	4	12	1

Accordingly, the insurance companies' ranking is A5>A2>A1>A4>A3. Euroko Sigorta has the highest sustainability performance according to all methods, while Allianz Insurance has the lowest.

6. Conclusion

Sustainability aims to use resources in a controlled manner and ensure that they can be transferred to future generations. Sustainability has become increasingly important and adopted in recent years. Sustainable development aims to sustain the ecosystem on the one hand and to achieve human development goals on the other. Corporate sustainability is among the priority goals and agenda items of companies today. Today, only financial success is no longer considered a measure for businesses. Companies must be sensitive to the environment and human life to maintain their success. Sustainable development has become necessary not only in production sectors but also in all sectors. One of these sectors is the insurance sector. Insurance companies carry out sustainability activities and facilitate the implementation of sustainability in other sectors.

This study examined the sustainability performance of companies in the insurance sector, which is not widely included in the literature. Five major insurance companies operating in Türkiye and presenting their sustainability activity reports were ranked according to their performance. Along with the three basic dimensions of sustainability, different sub-criteria from other studies were used. Local and global criterion weights were determined using the Spherical Fuzzy AHP method, a new method in the literature. Thus, the importance of the basic dimensions of sustainability was determined. It has been observed that environmental dimensions have the most impact, followed by social and economic dimensions, respectively. In the study of Taşcı (2024), the importance weights of the criteria revealed similar results to our research. Three methods were used to rank insurance companies: PIV, TOPSIS and CODAS. The ranking results obtained support each other. Finally, the rankings were combined with the Borda Counting Method. According to the Borda merger method and the three methods, Eureko Insurance Company has been determined to have the highest sustainability performance. Ak Insurance is the company that ranks 2nd in terms of performance according to all methods. The rankings of Türkiye Sigorta, Anadolu Sigorta and Allianz Insurance companies show minor changes according to the methods. According to the final ranking results obtained from the Borda Counting method, Türkiye Sigorta is in 3rd place, Anadolu Sigorta is in 4th place, and Allianaz Insurance is in 5th place. Although Eureko Insurance Company is behind other companies financially, it is in a better position regarding sustainability performance. The most

important conclusion that can be drawn from here is that being financially superior is not enough on its own in terms of sustainability performance.

There are many companies in the insurance sector. This study selected five important companies that published sustainability activity reports in 2021. The criteria in the reports were weighted according to a subjective assessment. Future studies will conduct performance evaluations of more companies according to more comprehensive criteria. In these studies, objective evaluation methods will be included, along with new ranking methods in the literature. The findings obtained are thought to contribute to the insurance sector and literature.

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Appendix: 1

Pairwise Linguistic Comparison of Environmental Sub-Criterias

Criterias	Expert 1			Expert 2			Expert 3		
	C_{11}	C_{12}	C_{13}	C_{11}	C_{12}	C_{13}	C_{11}	C_{12}	C_{13}
C_{11}	EI	VHI	EI	EI	SMI	EI	EI	EI	SMI
C_{12}	VLI	EI	VHI	SLI	EI	EI	EI	EI	HI
C_{13}	EI	VLI	EI	EI	EI	EI	SLI	LI	EI

Fuzzy Values of the Pairwise Comparison Matrix for Environmental Sub-Criterias

Decision Makers	Criterias	EXpert 1 C_{11}	Expert 2 C_{12}	Expert 3 C_{13}
Expert 1	C_{11}	(0.5, 0.4, 0.4)	(0.8, 0.2, 0.1)	(0.5, 0.4, 0.4)
	C_{12}	(0.2, 0.8, 0.1)	(0.5, 0.4, 0.4)	(0.8, 0.2, 0.1)
	C_{13}	(0.5, 0.4, 0.4)	(0.2, 0.8, 0.1)	(0.5, 0.4, 0.4)
Expert 2	C_{11}	(0.5, 0.4, 0.4)	(0.6, 0.4, 0.3)	(0.5, 0.4, 0.4)
	C_{12}	(0.4, 0.6, 0.3)	(0.5, 0.4, 0.4)	(0.5, 0.4, 0.4)
	C_{13}	(0.5, 0.4, 0.4)	(0.5, 0.4, 0.4)	(0.5, 0.4, 0.4)
Expert 3	C_{11}	(0.5, 0.4, 0.4)	(0.5, 0.4, 0.4)	(0.6, 0.4, 0.3)
	C_{12}	(0.5, 0.4, 0.4)	(0.5, 0.4, 0.4)	(0.7, 0.3, 0.2)
	C_{13}	(0.4, 0.6, 0.3)	(0.3, 0.7, 0.2)	(0.5, 0.4, 0.4)

Integrated Spherical Fuzzy Pairwise Comparison Matrices and Criteria Weights Environmental Sub-Criteria

	C1	C2	C3	$\tilde{w}^s$ (Spherical fuzzy weight)	$\bar{w}^s$ (Weight)
C1	(0.500, 0.400, 0.400)	(0.666, 0.317, 0.270)	(0.537, 0.400, 0.367)	(0.563, 0.375, 0.353)	0.374
C2	(0.393, 0.577, 0.311)	(0.500, 0.400, 0.400)	(0.695, 0.288, 0.238)	(0.515, 0.446, 0.328)	0.342
C3	(0.470, 0.458, 0.374)	(0.363, 0.607, 0.285)	(0.500, 0.400, 0.400)	(0.440, 0.502, 0.352)	0.283

CR: 0.0917

Pairwise Linguistic Comparison of Social Sub-Criterias

Criterias	Expert 1				Expert 2				Expert 3			
	C_{21}	C_{22}	C_{23}	C_{24}	C_{21}	C_{22}	C_{23}	C_{24}	C_{21}	C_{22}	C_{23}	C_{24}
C_{21}	EI	VHI	HI	HI	EI	ALI	EI	ALI	EI	SMI	SMI	SMI
C_{22}	VLI	EI	HI	SLI	AMI	EI	EI	ALI	SLI	EI	HI	SLI
C_{23}	LI	LI	EI	LI	AMI	EI	EI	ALI	SLI	LI	EI	SLI
C_{24}	LI	SMI	HI	EI	AMI	AMI	AMI	EI	SLI	SMI	SMI	EI

Fuzzy Values of the Pairwise Comparison Matrix for Social Sub-Criterias

Decision Makers	Criterias	C_{21}	C_{22}	C_{23}	C_{24}
Expert 1	C_{21}	(0.5, 0.4, 0.4)	(0.8, 0.2, 0.1)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)
	C_{22}	(0.2, 0.8, 0.1)	(0.5, 0.4, 0.4)	(0.7, 0.3, 0.2)	(0.4, 0.6, 0.3)
	C_{23}	(0.3, 0.7, 0.2)	(0.3, 0.7, 0.2)	(0.5, 0.4, 0.4)	(0.3, 0.7, 0.2)
	C_{24}	(0.3, 0.7, 0.2)	(0.6, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.5, 0.4, 0.4)
Expert 2	C_{21}	(0.5, 0.4, 0.4)	(0.1, 0.9, 0.0)	(0.5, 0.4, 0.4)	(0.1, 0.9, 0.0)
	C_{22}	(0.9, 0.1, 0.0)	(0.5, 0.4, 0.4)	(0.5, 0.4, 0.4)	(0.1, 0.9, 0.0)
	C_{23}	(0.9, 0.1, 0.0)	(0.5, 0.4, 0.4)	(0.5, 0.4, 0.4)	(0.1, 0.9, 0.0)
	C_{24}	(0.9, 0.1, 0.0)	(0.9, 0.1, 0.0)	(0.9, 0.1, 0.0)	(0.5, 0.4, 0.4)
Expert 3	C_{21}	(0.5, 0.4, 0.4)	(0.6, 0.4, 0.3)	(0.6, 0.4, 0.3)	(0.6, 0.4, 0.3)
	C_{22}	(0.4, 0.6, 0.3)	(0.5, 0.4, 0.4)	(0.7, 0.3, 0.2)	(0.4, 0.6, 0.3)
	C_{23}	(0.4, 0.6, 0.3)	(0.3, 0.7, 0.2)	(0.5, 0.4, 0.4)	(0.4, 0.6, 0.3)
	C_{24}	(0.4, 0.6, 0.3)	(0.6, 0.4, 0.3)	(0.6, 0.4, 0.3)	(0.5, 0.4, 0.4)

Integrated Spherical Fuzzy Pairwise Comparison Matrices and Criteria Weights Social Sub-Criterias

	C_{21}	C_{22}	C_{23}	C_{24}	$\tilde{w}^s$ (Spherical fuzzy weight)	$\bar{w}^s$ (Weight)
C_{21}	(0.500, 0.400, 0.400)	(0.624, 0.416, 0.188)	(0.612, 0.363, 0.302)	(0.560, 0.476, 0.227)	(0.680, 0.370, 0.217)	0.279
C_{22}	(0.682, 0.363, 0.147)	(0.500, 0.400, 0.400)	(0.648, 0.330, 0.270)	(0.336, 0.687, 0.254)	(0.574, 0.455, 0.283)	0.228
C_{23}	(0.689, 0.348, 0.164)	(0.383, 0.581, 0.298)	(0.500, 0.400, 0.400)	(0.298, 0.723, 0.216)	(0.489, 0.531, 0.279)	0.192
C_{24}	(0.689, 0.348, 0.164)	(0.757, 0.252,0.203)	(0.777, 0.229, 0.172)	(0.500, 0.400, 0.400)	(0.736, 0.266, 0.254)	0.301

CR: 0.665

Pairwise Linguistic Comparison of Financial Sub-Criterias

Criterias	Expert 1				Expert 2				Expert 3			
	C_{31}	C_{32}	C_{33}	C_{34}	C_{31}	C_{32}	C_{33}	C_{34}	C_{31}	C_{32}	C_{33}	C_{34}
C_{31}	EI	VLI	VLI	VLI	EI	ALI	ALI	EI	EI	VLI	VLI	VLI
C_{32}	VHI	EI	VHI	VHI	AMI	EI	EI	AMI	VHI	EI	EI	VHI
C_{33}	VHI	VLI	EI	VHI	AMI	EI	EI	AMI	VHI	EI	EI	VHI
C_{34}	VHI	VLI	VLI	EI	EI	ALI	ALI	EI	VHI	VLI	VLI	EI

Fuzzy Values of The Pairwise Comparison Matrix for Financial Sub-Criterias

Decision Makers		Criterias			
		C$_{31}$	C$_{32}$	C$_{33}$	C$_{34}$
Expert 1	C$_{31}$	(0.5, 0.4, 0.4)	(0.2, 0.8, 0.1)	(0.2, 0.8, 0.1)	(0.2, 0.8, 0.1)
	C$_{32}$	(0.8, 0.2, 0.1)	(0.5, 0.4, 0.4)	(0.8, 0.2, 0.1)	(0.8, 0.2, 0.1)
	C$_{33}$	(0.8, 0.2, 0.1)	(0.2, 0.8, 0.1)	(0.5, 0.4, 0.4)	(0.8, 0.2, 0.1)
	C$_{34}$	(0.8, 0.2, 0.1)	(0.2, 0.8, 0.1)	(0.2, 0.8, 0.1)	(0.5, 0.4, 0.4)
Expert 2	C$_{31}$	(0.5, 0.4, 0.4)	(0.1, 0.9, 0.0)	(0.1, 0.9, 0.0)	(0.9, 0.4, 0.4)
	C$_{32}$	(0.9, 0.1, 0.0)	(0.5, 0.4, 0.4)	(0.5, 0.4, 0.4)	(0.9, 0.1, 0.0)
	C$_{33}$	(0.9, 0.1, 0.0)	(0.5, 0.4, 0.4)	(0.5, 0.4, 0.4)	(0.5, 0.1, 0.0)
	C$_{34}$	(0.5, 0.4, 0.4)	(0.5, 0.4, 0.4)	(0.1, 0.9, 0.0)	(0.5, 0.4, 0.4)
Expert 3	C$_{31}$	(0.5, 0.4, 0.4)	(0.2, 0.8, 0.1)	(0.2, 0.8, 0.1)	(0.2, 0.8, 0.1)
	C$_{32}$	(0.8, 0.2, 0.1)	(0.5, 0.4, 0.4)	(0.5, 0.4, 0.4)	(0.8, 0.2, 0.1)
	C$_{33}$	(0.8, 0.2, 0.1)	(0.5, 0.4, 0.4)	(0.5, 0.4, 0.4)	(0.8, 0.2, 0.1)
	C$_{34}$	(0.8, 0.2, 0.1)	(0.2, 0.8, 0.1)	(0.2, 0.8, 0.1)	(0.5, 0.4, 0.4)

Integrated Spherical Fuzzy Pairwise Comparison Matrices and Criteria Weights Financial Sub-Criterias

	C$_{31}$	C$_{32}$	C$_{33}$	C$_{34}$	$\tilde{w}^s$ (Spherical fuzzy weight)	$\tilde{w}^s$ (Weight)
C$_{31}$	(0.500, 0.400, 0.400)	(0.174, 0.832, 0.082)	(0.174, 0.832, 0.082)	(0.340, 0.635, 0.271)	(0.318, 0.716, 0.145)	0.147
C$_{32}$	(0.842, 0.159, 0.074)	(0.500, 0.400, 0.400)	(0.642, 0.317, 0.302)	(0.842, 0.159, 0.074)	(0.721, 0.271, 0.269)	0.348
C$_{33}$	(0.842, 0.159, 0.074)	(0.431, 0.504, 0.350)	(0.500, 0.400, 0.400)	(0.842, 0.159, 0.074)	(0.653, 0.340, 0.289)	0.311
C$_{34}$	(0.735, 0.252, 0.208)	(0.340, 0.635, 0.271)	(0.174, 0.832, 0.082)	(0.500, 0.400, 0.400)	(0.415, 0.611, 0.234)	0.193

CR: 0.785

Appendix: 2

Normalised Decision Matrices

C$_{11}$	C$_{12}$	C$_{13}$	C$_{21}$	C$_{22}$	C$_{23}$	C$_{24}$	C$_{31}$	C$_{32}$	C$_{33}$	C$_{34}$
0.399	0.208	0.421	0.500	0.206	0.315	0.875	0.292	0.701	0.756	0.390
0.208	0.065	0.421	0.500	0.024	0.111	0.135	0.805	0.215	0.263	0.444
0.729	0.960	0.496	0.341	0.950	0.807	0.389	0.269	0.215	0.263	0.417
0.467	0.164	0.421	0.250	0.215	0.486	0.171	0.352	0.381	0.263	0.494
0.218	0.059	0.471	0.568	0.088	0.018	0.189	0.265	0.521	0.471	0.482

Weighted Normalised Decision Matrix (v$_i$)

C$_{11}$	C$_{12}$	C$_{13}$	C$_{21}$	C$_{22}$	C$_{23}$	C$_{24}$	C$_{31}$	C$_{32}$	C$_{33}$	C$_{34}$
0.036	0.015	0.026	0.049	0.036	0.050	0.115	0.009	0.052	0.050	0.016
0.019	0.005	0.026	0.049	0.004	0.018	0.018	0.025	0.016	0.017	0.018
0.066	0.071	0.031	0.033	0.165	0.128	0.051	0.008	0.016	0.017	0.017
0.043	0.012	0.026	0.024	0.037	0.077	0.022	0.011	0.028	0.017	0.020
0.020	0.004	0.029	0.056	0.015	0.003	0.025	0.008	0.038	0.031	0.020

Appendix: 3

Normalised Decision Matrices

C$_{11}$	C$_{12}$	C$_{13}$	C$_{21}$	C$_{22}$	C$_{23}$	C$_{24}$	C$_{31}$	C$_{32}$	C$_{33}$	C$_{34}$
0.399	0.208	0.421	0.500	0.206	0.315	0.875	0.292	0.701	0.756	0.390
0.208	0.065	0.421	0.500	0.024	0.111	0.135	0.805	0.215	0.263	0.444
0.729	0.960	0.496	0.341	0.950	0.807	0.389	0.269	0.215	0.263	0.417
0.467	0.164	0.421	0.250	0.215	0.486	0.171	0.352	0.381	0.263	0.494
0.218	0.059	0.471	0.568	0.088	0.018	0.189	0.265	0.521	0.471	0.482

Weighted Normalised Decision Matrices

C$_{11}$	C$_{12}$	C$_{13}$	C$_{21}$	C$_{22}$	C$_{23}$	C$_{24}$	C$_{31}$	C$_{32}$	C$_{33}$	C$_{34}$
0.036	0.015	0.026	0.049	0.036	0.050	0.115	0.009	0.052	0.050	0.016
0.019	0.005	0.026	0.049	0.004	0.018	0.018	0.025	0.016	0.017	0.018
0.066	0.071	0.031	0.033	0.165	0.128	0.051	0.008	0.016	0.017	0.017
0.043	0.012	0.026	0.024	0.037	0.077	0.022	0.011	0.028	0.017	0.020
0.020	0.004	0.029	0.056	0.015	0.003	0.025	0.008	0.038	0.031	0.020

Appendix: 4

Normalised Decision Matrices

C₁₁	C₁₂	C₁₃	C₂₁	C₂₂	C₂₃	C₂₄	C₃₁	C₃₂	C₃₃	C₃₄
0.548	0.216	0.850	0.880	0.116	0.056	0.154	0.362	1.000	1.000	1.000
0.286	0.068	0.850	0.880	1.000	0.160	1.000	1.000	0.306	0.348	0.879
1.000	1.000	1.000	0.600	0.025	0.022	0.346	0.335	0.306	0.348	0.935
0.641	0.170	0.850	0.440	0.112	0.037	0.785	0.437	0.544	0.348	0.791
0.299	0.062	0.950	1.000	0.272	1.000	0.714	0.329	0.743	0.623	0.811

Weighted Normalised Decision Matrices

C₁₁	C₁₂	C₁₃	C₂₁	C₂₂	C₂₃	C₂₄	C₃₁	C₃₂	C₃₃	C₃₄
0.050	0.016	0.053	0.086	0.020	0.009	0.020	0.011	0.074	0.066	0.041
0.026	0.005	0.053	0.086	0.173	0.025	0.131	0.031	0.023	0.023	0.036
0.091	0.074	0.062	0.059	0.004	0.003	0.045	0.010	0.023	0.023	0.038
0.058	0.013	0.053	0.043	0.019	0.006	0.103	0.014	0.040	0.023	0.032
0.027	0.005	0.059	0.098	0.047	0.159	0.094	0.010	0.055	0.041	0.033

The Mediating Role of Online Trust and Perceived Risk in the Relationship between Website Design and Purchase Intention

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Web Sitesi Tasarımı ve Satın Alma Niyeti İlişkisinde Çevrimiçi Güven ve Algılanan Riskin Aracılık Rolü

Abstract

Due to the advancement of technology and the widespread use of the internet, the factors influencing purchase intention in online shopping continue to be an ongoing research topic. In this context, it is believed that one of the key factors affecting consumer purchasing behaviour is website design. A well-designed website is expected to play a crucial role in establishing perceived trust, a key factor in the online shopping experience that influences consumers' purchase intentions. This study examines the impact of website design on purchase intention in online shopping, with a focus on the mediating roles of trust and perceived risk. In this context, the findings obtained from 215 university students suggest that website design has a positive effect on consumers' purchase intentions. Moreover, while online trust reduces the perceived risk associated with website design, it is an important mediating variable in the relationship between perceived risk and increased purchase intention.

Keywords	:	Website Design, Online Trust, Purchase Intention, Perceived Risk, Marketing Strategy, Consumer Behaviour.
JEL Classification Codes	:	M10, M30, L31, M81.

Öz

Teknolojinin gelişmesi ve internet kullanımının yaygınlaşmasıyla birlikte, çevrimiçi alışverişte satın alma niyetini etkileyen faktörler günümüzde halen araştırma konusu olmaya devam etmektedir. Bu bağlamda, tüketici satın alma davranışlarını etkileyen temel faktörlerden birinin web sitesi tasarımı olduğu düşünülmektedir. İyi tasarlanmış bir web sitesinin, tüketicilerin satın alma niyetlerini etkileyen çevrimiçi alışveriş deneyiminde önemli bir faktör olan algılanan güvenin oluşmasında kritik bir rol oynaması beklenmektedir. Bu çalışma, web sitesi tasarımının çevrimiçi alışverişte satın alma niyeti üzerindeki etkisini; güven ve algılanan riskin aracılık rolleri çerçevesinde incelemektedir. Bu kapsamda, 215 üniversite öğrencisinden elde edilen bulgular, web sitesi tasarımının tüketicilerin satın alma niyetleri üzerinde olumlu bir etkisi olduğunu ortaya koymaktadır. Ayrıca, çevrimiçi güvenin web sitesi tasarımıyla ilişkili algılanan riski azalttığı ve algılanan risk ile artan satın alma niyeti arasındaki ilişkide önemli bir aracılık değişkeni olduğu belirlenmiştir.

Anahtar Sözcükler	:	Web Sitesi Tasarımı, Çevrimiçi Güven, Satın Alma Niyeti, Algılanan Risk, Pazarlama Stratejisi, Tüketici Davranışı.

1. Introduction

The rise of digital commerce and internet usage in recent years has made online purchasing a popular choice among consumers, creating a competitive environment for both consumers and businesses. In 2023, the volume of e-commerce, which had reached significant figures in Türkiye, increased by 115.15% and reached 1.85 trillion TRY (eticaret.gov.tr). Globally, large companies like Amazon achieve leadership in e-commerce by adopting customer-oriented strategies and prioritising consumer trust. This approach has a pivotal role in their achievement and market dominance. The rapid growth of e-commerce is steadily increasing the importance of online shopping. It has become crucial for businesses to develop effective strategies to thrive and gain a competitive edge in this vast market. Especially in e-commerce, websites -the digital face of companies -have become a crucial factor influencing consumers' purchasing behaviour. In this context, a website's design plays a significant role in attracting customers to online stores. Website design, which is perceived as a critical factor in reducing trust and risk, helps consumers feel more secure when shopping online (Cyr et al., 2009). It is also noted in the literature that factors such as design and information security have an impact on consumers' risk perceptions. Effective website design minimises customers' concerns about fraud (Kim & Stoel, 2004). According to Everard and Galletta (2005), their research indicates that a trust-oriented view of a website lowers consumers' perception of risk and encourages them to engage in purchasing activities. Additionally, a website serves as a crucial source of information that alleviates the uncertainties associated with online shopping for consumers and enhances their trust in the online buying process (Weisberg et al., 2011). The existence of a trustworthy area in the increasing online purchasing habits of consumers enhances the success of the business (Kim et al., 2008: 45). Website design plays a crucial role in establishing trust and loyalty. It also enhances a company's reputation, boosts competitiveness, and influences consumers to translate their purchase intentions into actual behaviour. Websites must provide a reliable environment with accurate information during the persuasion stage of consumers' purchasing decisions, as the website design is aimed at creating a trustworthy form to minimise consumers' online purchase fears (Constantinides, 2004). Customers may have concerns about online platforms and uncertainties that influence their purchasing decisions, which is also referred to as perceived risk and directly impacts the customer (Chellappa, 2005; Johnson et al., 2005; Chen et al., 2011).

Existing literature primarily investigates the direct impact of website design, trust, perceived risk, and purchase behaviour. McKnight et al. (2002) argue that consumer distrust in online shopping stems from perceived risk and lack of experience. Similarly, Hong and Cha (2013) examined the relationship between consumer trust and online purchase intention, confirming its positive effect. Demirdöğmez and Gültekin (2020) concluded that trust in the website, perceived value, e-loyalty, Customer satisfaction, repeat purchase intention, and perceived risk are only practical predictors of repurchase intention. Cesur and Tayfur (2015) found a significant inverse relationship between perceived risk and online shopping in their study. Yeniçeri et al. (2012) concluded that as consumers' risk perceptions increase, their tendency to shop online decreases. Peng and Kim (2014) showed that the design of the

website contributes to the reduction of perceived risk by affecting consumer perception. Ko et al. (2004) investigated the cultural variations in consumers' perceived risk related to web design and concluded that user-friendly websites reduce perceived risk. Lăzăroiu et al. (2020) examined the influence of user experience and web design on consumers' risk perceptions in online shopping.

This study examines the influence of website design on online purchasing intentions, as well as the roles of trust and perceived risk in this context. The literature review discusses website design, trust, perceived risk, and consumer purchasing behaviour. The methodology section describes the research approach, while the results section presents the findings. Finally, the conclusion interprets the results and provides recommendations for future research avenues.

2. Theoretical Background

The literature supports that a well-designed website enhances perceived quality, satisfaction, and positive attitudes toward the website, ultimately improving customer satisfaction (Chou et al., 2015). Cho and Park (2001) identified website design quality as a key determinant of customer satisfaction in the e-commerce landscape. Likewise, Wolfenbarger and Gilly (2003) observed that online shoppers tend to favour retailers with intuitive, easy-to-navigate interfaces rather than those requiring frequent assistance from customer service agents. These findings highlight the importance of a seamless, user-friendly website design in enhancing the online shopping experience and fostering customer loyalty. This highlights that a website's interface functions play a crucial role in shaping customer satisfaction (Cyr et al., 2010). Constantinides (2004) defines website design based on two key factors: usability and interaction. It is highlighted that website design encompasses a range of elements, including text, images, graphics, sound, layout, motion, and content. Website analysis is approached from two perspectives: process and architecture. The process is viewed as a sequence of systems, while the system is defined as the collection of documents contained within a web page (Kim & Lee, 2002).

Architectural design encompasses information, layout, engagement, and aesthetics, each serving a specific function. Layout refers to how data is organised, while aesthetics focuses on the emotional impact of the website. Cho and Park (2001) found that the quality of website design is a crucial factor influencing customer satisfaction in the e-commerce realm. Similarly, Wolfenbarger and Gilly (2003) noted that shoppers prefer online retailers with intuitive and easy-to-navigate interfaces over those that require customer service support. Navigation design focuses on the interactive features of a website, guiding users seamlessly through different sections with intuitive menus, links, and functional elements that enhance usability. Meanwhile, visual design encompasses the overall aesthetics, including layout, typography, colour schemes, and graphical elements, all of which contribute to shaping users' perceptions and engagement. Together, these design aspects play a crucial role in enhancing the user experience, fostering trust, and ultimately

influencing consumers' purchasing decisions in online shopping environments (Ganguly et al., 2010).

Studies highlight the significant impact of colour attractiveness on trust in website design. Cyr et al. (2010) emphasised the effect of attractive colour usage on building trust on a website, and Pengnate and Sarathy (2017) highlighted the positive impact of a visually compelling website on customer trust. Website design elements, such as style, colour, background, and text animations, are believed to positively influence the emotional state of consumers who prefer online shopping (Ha & Im, 2011). In their study, Cyr and Bonanni (2005) discuss the potential impact of the content of information and the quality of graphics used on the user experience on a website.

Trust is an essential emotion that significantly influences consumers' repeat purchase behaviour from a specific online seller (Ou & Sia, 2010). The literature offers various definitions of trust, particularly within the scope of online trust, which is recognised as a multidimensional concept. Online trust lacks a universally accepted definition but plays a crucial role in influencing customer purchasing decisions (Lee & Turban, 2001; Yoon, 2002). In contrast, online trust can be understood in terms of institutional trust, dispositional trust, and interpersonal trust (Tan & Sutherland, 2004). Generally recognised as an essential element in social and economic interactions, trust, according to Segovia et al. (2009), is characterised as a subjective evaluation directed towards the uncertainties that may arise in a buyer's expectations of the seller during the interaction process. With the increasing focus on digital commerce, trust is considered the most crucial factor influencing consumers' transactions. It directly influences consumers' perceptions of online shopping and has an indirect impact on their purchasing intentions. According to Tandon et al. (2020), factors such as convenience, reliability, confidentiality of information, and the content of web pages are believed to influence consumers' purchase intentions in online shopping. Hassanein, Head, and Ju (2009) found that designs equipped with socially compelling and rich visuals instil more trust in customers. Ou and Sia (2010) emphasised that website design features significantly affect customers' trust and distrust. Furthermore, Cyr et al. (2010) highlighted the effect of colour attractiveness on customers' trust and distrust, emphasising the importance of visually appealing website design (Pengnate & Sarathy, 2017). Studies in the literature recognise trust as one of the most critical factors in online shopping. Reducing trust issues and providing consumers with a more comfortable shopping experience is of great importance for businesses (Gambarov, 2014: 1-2). Trust, a fundamental factor in establishing and maintaining long-term relationships between buyers and sellers, is observed to be built upon various elements involving mutual individuals or organisations (Sharma, 2000: 471; Subaşı, 2012: 5-6). Numerous studies highlighting the significance of online shopping are presented in the literature. The relevant research emphasises that consumers' perceptions of trust in online shopping are associated with shared information and fulfilled promises (Yaşin et al., 2017; Alkibay & Demirgüne, 2016; Habiboğlu et al., 2021).

This study examines the influence and significance of trust in website design on purchase intention in online shopping. Accordingly, the H1 hypothesis has been formulated.

H1: Website design has a positive effect on purchase intention.

The concept of perceived risk, initially introduced by Baur (1960), refers to the doubts and uncertainties that consumers experience both before and after making a purchase. This uncertainty arises from the possibility that the anticipated outcome may not align with their expectations, leading to concerns about potential losses, dissatisfaction, or financial implications. Chellappa (2005) further elaborated on perceived risk as the challenges and uncertainties consumers face when they struggle to make informed purchasing decisions due to limited information or ambiguity.

In the realm of online shopping, perceived risk is significantly amplified due to the absence of physical interaction with both sellers and products. Unlike traditional retail settings, where consumers can physically examine products and engage with sales representatives for assurance, online platforms depend entirely on digital representations, customer reviews, and product descriptions. This lack of direct sensory experience heightens uncertainty, making consumers more vigilant and hesitant in their purchasing decisions. Additionally, concerns related to payment security, potential fraud, data privacy breaches, and the possibility of receiving products that deviate from their advertised quality further exacerbate this perceived risk, ultimately influencing consumer trust and purchase intention. Extensive research has emphasised the critical role of perceived risk in shaping consumer perception, decision-making, and purchasing behaviour across both online and offline environments. For instance, Johnson et al. (2005) and Chen et al. (2011) emphasise that high levels of perceived risk can lead to hesitation, reduced trust in online platforms, and lower purchase intentions. Additionally, research suggests that perceived risk plays a crucial role before the actual purchase behaviour occurs, influencing the decision-making process during the early stages of consumer intention formation.

Given its substantial influence, the perceived risk remains a critical factor in understanding consumer behaviour, particularly in digital marketplaces. Businesses and e-commerce platforms must address these concerns by implementing trust-building mechanisms, such as enhanced security measures, transparent return policies, user reviews, and robust customer support systems, to mitigate risk perceptions and improve consumer confidence.

Cox and Rich (1964) emphasised the influence of uncertainty on purchase decisions. Yoon (2002) highlighted that the absence of a salesperson, the distance between the seller and the customer in the trust process for online transactions, and the lack of physical interaction between them create a more intense risk environment. Establishing a trust relationship, however, can reduce the perceived risk.

Trust plays a critical role in shaping consumer behaviour in online transactions. A lack of confidence in internet-based purchases can lead to consumer hesitation, negatively impacting their willingness to purchase products or services. This distrust, in turn, disrupts the overall online shopping process (Martin et al., 2011). Perceived risk is a key factor

influencing online purchase intentions. Higher levels of perceived risk tend to discourage consumers from completing transactions. Concerns related to privacy and the potential misuse of personal information often deter users from sharing their data online.

Jarvenpaa et al. (2000) found that higher perceived risk significantly reduces the likelihood of purchase, highlighting its detrimental impact on consumer buying decisions. However, they also observed that consumers may still proceed with an online purchase if they perceive the risk to be low, even if they do not hold an exceptionally positive attitude toward the store. Furthermore, the perception that online businesses can securely manage transactions significantly affects purchase behaviour. When consumers lack trust in an online business, their willingness to make a purchase decreases. Therefore, trust is a fundamental factor that positively influences online purchase intention (Kuan & Bock, 2007). Trust is widely recognised as the most crucial factor influencing online shopping behaviours and repeated transactions. It plays a fundamental role in the success of electronic commerce by facilitating consumers' purchasing decisions (John, 2012). However, a lack of trust remains a significant barrier to online shopping, primarily due to consumers' perceived risk and limited experience. Perceived risk serves as a key mediator in the relationship between trust and purchase intention, making it an essential factor in understanding consumer behaviour in e-commerce (Qalati et al., 2021: 15).

The quality, design, and functionality of a website heavily influence consumers' perceived risk in online shopping. A well-structured, visually appealing, and user-friendly interface can enhance trust and mitigate uncertainty, whereas a poorly designed or dysfunctional website may amplify concerns regarding security, reliability, and overall shopping experience. According to the Perceived Risk Theory (PRT), individuals evaluate the potential for uncertainty and adverse outcomes before making a purchasing decision (Bauer, 1960). In this context, a professionally designed website that is easy to navigate and equipped with robust security features can significantly reduce perceived risk levels (Kim & Stoel, 2004).

Furthermore, within the framework of the Technology Acceptance Model (TAM), users are more inclined to interact with and utilise a website they perceive as trustworthy, user-friendly, and intuitively designed, as these factors enhance their overall experience and confidence in the platform. A positive perception of a website's usability reduces the perception of risk and increases purchase intention (Davis, 1989; Gefen et al., 2003). Empirical research supports this notion, demonstrating that a well-designed website fosters consumer trust and lowers perceived risk, ultimately encouraging online purchases (Chang & Chen, 2008; Pavlou, 2003). For example, Fang et al. (2011) found that the visual aesthetics and functional aspects of a website have a direct impact on consumers' risk perception. Similarly, Cyr et al. (2009) concluded that when a website is both visually appealing and functionally efficient, consumers perceive lower levels of risk and exhibit stronger purchase intentions.

These findings highlight the importance of website design in influencing consumer trust and reducing perceived risk. Businesses aiming to enhance customer confidence and encourage online transactions should prioritise the development of secure, user-friendly, and visually appealing e-commerce platforms.

In this context, H2, H3, and H4, hypotheses have been formulated as follows;

H2: Website design has a positive effect on online trust.

H3: Website design has a negative effect on perceived risk.

H4: Online trust and perceived risk sequentially mediate the effect of website design on purchase intention.

3. Data and Methodology

The study employed a convenience sampling method involving university students who voluntarily participated through an online survey platform. A total of 215 responses were collected and analysed using a quantitative approach. The sample included 83 female and 132 male participants. Regarding age distribution, 91 participants were aged 18-20, 113 were aged 20-25, and 11 were aged 25-30. The survey, comprising 21 statements, was conducted with university students voluntarily between January 1, 2022, and March 1, 2022.

To investigate the mediating influence of trust on the relationship between website design and purchasing behaviour, the website design scale developed by Cyr (2008) and used in Ganguly et al.'s (2010) study was employed to measure the participants' evaluations. For the trust scale developed by Chellappa (2005), Suh and Han (2003) used seven questions to measure the participants' trust perceptions, while the perceived risk scale developed by Chan and Lu (2004) consisted of four questions. For the last measurement, the purchase scale developed by Suh and Han (2003), composed of three questions, was used to measure purchase intention.

Figure: 1
Research Model
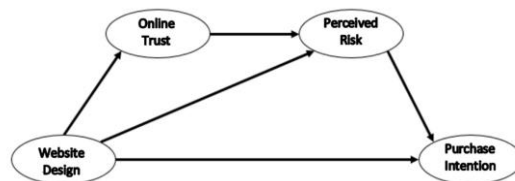
Within the research model, the effect of website design on buying intentions is examined in terms of online trust and perceived risk. While the website design effect is discussed, online trust and perceived risk are identified as mediators to determine whether they play a mediating role in influencing purchase intention. In the study, we also controlled demographic characteristics such as gender, age, and internet usage.

4. Findings

A confirmatory factor analysis (CFA) was performed using IBM AMOS 24 to assess the structural validity of the measurement tools. The fit indices reported (see Table 1) demonstrate a satisfactory model fit, consistent with the guidelines suggested by Hu & Bentler (1999). These findings validate the structural integrity of both the measurement model and the causal model, confirming their reliability and strength in evaluating the intended constructs.

Table: 1

The Goodness of Fit Indices for the Measurement Model and Causal Model

	X^2	sd	X^2/sd	CFI	SRMR	RMSEA
1. Measurement Model	279,44	170	1,64	0.92	0.06	0.06
2. Casual Model	336,94	200	1,685	0.90	0.07	0.06

n = 215, χ2/sd= chi-square degrees of freedom ratio, CFI = Comparative fit index, SRMR = Root mean square error of the standardized mean, RMSEA = Root mean square error of approximation.

To assess the reliability of the scales, composite reliability was calculated, and it was observed that the scales have acceptable levels of reliability. To examine the discriminant validity of the measurement instruments, HTMT (Heterotrait-Monotrait) analysis was conducted, and all values were found to be below the threshold of 0.85 (Henseler et al., 2015), indicating that each scale represents a distinct construct.

Table: 2

Reliability and Correlation Values of Research Variables

Variables	CR	1	2	3	4	5	6
1. Gender (1:F, 2:M)	-						
2. Age	-	0.01					
3. Year of Internet Use	-	0.27**	0.14*				
4. Website Design	0.86	-0.10	-0.04	0.06			
5. Online Trust	0.84	-0.12	-0.08	0.13	0.73**		
6. Perceived Risk	0.65	0.13	0.09	-0.09	-0.66**	-0.71**	
7. Purchase intention	0.67	-0.11	-0.11	0.18*	0.51**	0.47**	-0.75**

*n = 215, * p < 0.05, ** p < 0.01, CR= composite reliability.*

The results support Hypothesis H1, demonstrating that website design has a significant and positive influence on purchase intention (r = 0.51, p < 0.01). Similarly, hypothesis H2 received support, indicating a positive relationship between website design and online trust (r = 0.73, p < 0.01). Hypothesis H3 was confirmed in its original form, as the connection between website design and perceived risk was found to be negative (r = -0.66, p < 0.01). Additionally, hypothesis H4 was strongly supported, indicating that online trust and perceived risk serve as sequential mediators in the relationship between website design and purchase intention. A significant and negative correlation was found between online trust and perceived risk (r = -0.71, p < 0.01), as well as a positive relationship between online trust and purchase intention (r = 0.47, p < 0.01). Furthermore, a strong negative association exists between perceived risk and purchase intention (r = -0.75, p < 0.01), indicating that an increase in consumers' perception of risk is associated with a decrease in their intention to purchase.

A structural equation modelling (SEM) analysis was performed to test the research hypotheses. The direct effect values are presented in Table 3, while the indirect effect values are detailed in Table 4. To assess the significance of these effects, the bootstrap technique was applied with 5000 bootstrap resamples, using a 95% confidence interval (CI) approach (Preacher & Hayes, 2008; Shrout & Bolger, 2002). The results revealed that website design has a significant positive effect on online trust (B = 0.70, 95% CI [0.53, 0.92]), thereby supporting Hypothesis H2. However, website design did not exhibit a direct significant effect on perceived risk or purchase intention, leading to the rejection of Hypotheses H3 and H1.

Furthermore, online trust demonstrated a significant adverse effect on perceived risk (B = -0.40, 95% CI [-0.78, -0.21]), while perceived risk had a substantial adverse effect on purchase intention (B = -0.76, 95% CI [-1.26, -0.29]). These findings suggest that trust plays a crucial role in reducing perceived risk, which, in turn, influences consumers' purchasing decisions. Additionally, the number of years of internet usage was found to have a significant positive effect on purchase intention (B = 0.12, 95% CI [0.02, 0.20]), indicating that more experienced internet users are more likely to engage in online shopping. Conversely, gender and age did not have a statistically significant impact on purchase intention, suggesting that these demographic factors do not play a decisive role in shaping consumers' online purchasing behaviour. These findings underscore the significance of trust in mitigating perceived risk and emphasise the indirect role of website design in influencing purchase intention through trust-building mechanisms.

Table: 3
Direct Effect Estimates in Structural Equation Model Analysis

Direct Effects	B	SE	β	%95 CI	
				LL	UL
Online Trust ← Website Design	**0.70****	**0.91**	**0.74**	**0.53**	0.92
Perceived Risk ← Online Trust	**-0.40****	**0.12**	**-0.46**	**-0.78**	**-0.21**
Perceived Risk ← Website Design	-0.28	0.11	-0.33	-0.71	0.04
Purchase Intention ← Perceived Risk	**-0.76****	**0.18**	**-0.65**	**-1.26**	**-0.29**
Purchase Intention ← Website Design	0.06	0.13	0.06	-0.31	0.49
Purchase Intention ← Years of Internet Use	**0.12***	**0.05**	**0.16**	**0.02**	**0.20**
Purchase Intention ← Age	-0.12	0.08	-0.10	-0.28	0.04
Purchase Intention ← Gender	-0.11	0.09	-0.08	-0.29	0.08

n = 215, bootstrap sample=5000. * p < .05, ** p < .01, B = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient, 95% CI = 95% confidence interval.

An analysis of the indirect effects within the research framework revealed that website design indirectly reduces perceived risk through online trust, demonstrating a significant negative mediating effect (B = -0.28, 95% CI [-0.54, -0.02]). Additionally, online trust was found to play a crucial positive mediating role in the relationship between perceived risk and purchase intention (B = 0.43, 95% CI [0.16, 0.79]), highlighting its significant role in shaping consumer behaviour. Furthermore, the results confirm that online trust and perceived risk, as sequential mediators, effectively link website design to purchase intention (B = 0.43, 95% CI [0.16, 0.79]). These findings affirm the final hypothesis of the study, reinforcing the idea that a well-designed website fosters trust, mitigates perceived risk, and ultimately enhances consumers' purchase intentions.

Table: 4
Indirect Effect Estimates in Structural Equation Model Analysis

Indirect Effects	B	SE	β	%95 CI	
				LL	UL
Perceived Risk ← Website Design	-0.28	0.13	-0.33	-0.54	-0.02
Purchase Intention ← Online Trust	0.31	0.15	0.29	0.01	0.61
Purchase Intention ← Website Design	0.43	0.19	0.43	0.16	0.79

n = 215, bootstrap sample = 5000, B = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient, 95% CI = 95% confidence interval.

5. Discussion and Conclusion

The widespread use of technology, driven by globalisation and the emergence of trade beyond borders, has given e-commerce a new dimension in light of these developments, making it more popular among businesses. Today, websites, which are the customer-facing side of the companies that step into e-commerce, play a crucial role in achieving a competitive advantage. It is seen as a critical factor in converting visitors into potential customers, as the content and information on websites play a dual role in attracting customers and contributing to the success of businesses.

According to the results, it is observed that trust serves as an important mediator in purchase intention, which is defined as the creation of demand for purchasing in consumers. Accordingly, it is believed that a website designed to maintain an optimal experience by creating a positive impact on the customer reinforces a sense of trust. It is expected that a website that provides services to consumers in the shortest time and with the most accurate information by understanding their needs and wants also makes a positive contribution to purchase intention. Thus, according to previous research (Lee & Turban, 2001; Yoon, 2002; Ou & Sia, 2010), the results support the fact that online trust is a fundamental dimension of purchase intention.

Depending on the study's results, it has also been concluded that the duration consumers spend on the Internet is effective in influencing purchase intention and that related behaviour varies by gender and age. Variability depending on demographic factors, which is one of the important results of the study, can be considered a valuable output for businesses to set the right target. Businesses focusing on digital marketing strategies must understand the purchasing behaviour of customers, taking into account the time spent on internet usage, to access new customer groups.

The study's findings, which reveal a negative correlation between perceived risk and purchase intention, suggest that an increase in perceived risk directly reduces consumers' willingness to make a purchase. Since trust is recognised as a key driver in enhancing purchase intention (Sharma, 2000; Subaşı, 2012; Kuan & Bock, 2007; Gambarov, 2014), it becomes evident that heightened perceived risk acts as a barrier to building online trust, ultimately reducing the likelihood of completing a purchase.

Minimising risk factors on a website can significantly enhance the success of online purchasing behaviour. However, the findings do not indicate a direct relationship between

perceived risk associated with website design and purchase intention. Instead, research suggests that online trust has a negative impact on perceived risk, which in turn influences purchase intention (Johnson et al., 2005; Chen et al., 2011). This underscores the crucial role of trust for online service providers in retaining existing customers and attracting new ones. Additionally, an analysis of the mediating roles of online trust and perceived risk within the research model confirms that online trust serves as a key mediator in reducing the perceived risk associated with website design, thereby reinforcing its importance in fostering consumer confidence and engagement in digital commerce.

According to the research results, it was also concluded that online trust serves as an important mediating variable between perceived risk and the increase in purchase intention. Website designs, which play a crucial role in online shopping processes, significantly impact a business's competitiveness in the market. If the bond between the company and its consumers is based on a strong sense of trust, then sales increase as a result of this strong relationship.

It is hoped that the results of this study will facilitate a more profound understanding among practitioners of why and how web design is related to purchase intent. According to our findings, website design reduces the level of risk in the eyes of the customer by ensuring that users have confidence in the company's website. As the risk perception in the shopping environment is mitigated, customers are more inclined to exhibit heightened purchase intention. Accordingly, it can be suggested that companies that focus on designing websites that ensure they are perceived as trustworthy by their customers may increase the likelihood of customers making purchases.

It is noted that studies investigating the mediating role of trust in the relationship between websites and purchase intention have been limited. It is believed that the results capturing perceived risk and online trust have been first investigated in related research. However, Sultan et al. (2005) was the first scholarly work to test the trustworthiness of website design characteristics. However, our study is still limited, as other factors, such as cybersecurity issues and fintech operations, also affect online trust. It is recommended that subsequent research be conducted on the potential for enhancing the perceived reliability of business websites by improving their design and layout. Furthermore, brand equity, cultural factors or customer behaviours could be alternative variables to be investigated for future studies. Although the results could provide a framework on a scholarly basis, the research focus is particularly beneficial for marketing managers and firm strategies, as e-commerce and digitalization become increasingly important daily.

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The Importance of Non-Precarious Employment and Its Relationship with Broadly Defined Unemployment: Fourier-Shin Approach[1]

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Eğreti Olmayan İstihdamın Önemi ve Geniş Tanımlı İşsizlik ile İlişkisi: Fourier-Shin Yaklaşımı[2]

Abstract

This study aims to emphasise the importance of a skilled labor force within the context of Türkiye's Decent Work Policy. It examines the long-term relationship between non-precarious employment and broadly defined unemployment, using quarterly data from 2009 to 2023. The long-term relationship between the series, found to be stationary at the first difference, was analysed by using the Fourier-Shin cointegration test. Given the results of FMOLS, DOLS, and CCR estimators, all results were statistically significant. It was concluded that broadly defined unemployment caused a change between 0.66% and 0.69% in non-precarious employment in the long term, and the opposite effect occurred. The study's calculation of non-precarious employment and broadly defined unemployment variables, as well as the examination of the relationship between these two variables for the first time, makes the study original.

Keywords : Non-Precarious Employment, Broadly Defined Unemployment, Long-Term Relationship, Fourier-Shin Cointegration Test.

JEL Classification Codes : CO1, E20, E24.

Öz

Bu çalışmada, Türkiye'nin İnsana Yakışır İş Politikası kapsamında nitelikli işgücünün önemi vurgulanmakta ve 2009-2023 dönemine ait üç aylık veriler kullanılarak eğreti olmayan istihdam ile geniş tanımlı işsizlik arasındaki uzun dönemli ilişki incelenmektedir. Birinci farkta durağan olduğu bulunan seriler arasındaki uzun dönemli ilişki, Fourier Shin eşbütünleşme testi kullanılarak analiz edilmiştir. FMOLS, DOLS ve CCR tahmin edicilerinin sonuçlarına bakıldığında, tüm sonuçlar istatistiksel olarak anlamlıdır. Geniş tanımlı işsizliğin uzun dönemde eğreti olmayan istihdamda %0,66 ile %0,69 arasında, ters yönde değişime neden olduğu sonucuna varılmıştır. Çalışmada eğreti olmayan istihdam ve geniş tanımlı işsizlik değişkenlerinin yazarlar tarafından hesaplanması ve bu iki değişken arasındaki ilişkinin ilk kez inceleniyor olması çalışmayı özgün kılmaktadır.

Anahtar Sözcükler : Eğreti Olmayan İstihdam, Geniş Tanımlı İşsizlik, Uzun Dönem İlişki, Fourier-Shin Eşbütünleşme Testi.

1. Introduction

Before the 1970s, the employment market was dominated by standard employment characterised by security and stability. However, as a result of the restructuring and reorganisation of the capital accumulation regime brought about by the capitalist system in the 1980s, the flexibilisation of labor led to the proliferation of non-standard types of employment. The globalisation process, which accompanied the capitalist system, facilitated the segmentation of production, internationalisation, and the spread of multinational corporations, thereby increasing subcontracting and leading to a higher level of uncertainty, insecurity, and, consequently, precariousness in the labor market. This precarization also led to an increase in female employment, with women being employed in more cost-effective and easily dismissible jobs. Young people entering the labor market at an early age to earn income contributed to the spread of temporary and part-time jobs. Similarly, high unemployment rates forced individuals to take on part-time and temporary jobs reluctantly to sustain their livelihoods. The employment types proposed as solutions to unemployment, such as part-time and temporary employment, increased the potential for employment in precarious job types. Precarious employment types have continued to rise due to economic crises, government policies, and global factors.

The COVID-19 pandemic, which has led to numerous problems worldwide, has caused disruptions and uncertainties in the labor market. The Social Policy Implementation and Research Center (SPM) introduced the concept of "non-precarious employment," inspired by the idea of "precarious employment," which has limited use in the current literature, referring to those employed full-time in non-agricultural jobs and covered by social security. This concept was published in September 2020, highlighting anomalies in labor and unemployment dynamics caused by the pandemic, as reported by the Turkish Statistical Institute.

In the literature, researchers such as Rodgers (1989), Kalleberg (2000), Cranford et al. (2003), Temiz (2004), Hipp et al. (2015), and Kretsos and Livanos (2016) claim that precarious employment is common in part-time, temporary, or short-term jobs. Furthermore, Bosch (2004), Green and Livanos (2015), Alkan (2021), and Ferre (2021) argue that high unemployment forces individuals to reluctantly work in part-time, temporary, remote, hidden, or illegal jobs.

The present study examines non-precarious employment, which is characterised by quality and qualification, as often emphasised in sustainable development plans, as "decent work." Accordingly, this study examines the relationship between non-precarious employment and unemployment, building on the conclusion stressed in the literature that unemployment often leads to precarious employment. To comprehensively address

unemployment and incorporate the concept of precarious employment, this study employs a broadly defined unemployment variable, calculated by adding the potential labour force and time-related underemployment to the narrowly defined unemployment variable. The absence of studies using the concept of non-precarious employment and the calculation of variables by the authors makes this study unique. The quarterly data of the 2009-2023 period were used to calculate the variables of non-precarious employment and broadly defined unemployment. Considering the potential for structural breaks, tests incorporating Fourier functions to account for smooth breaks were used in the process.

2. The Concept and Importance of Non-Precarious Employment

Employment, a concept related to people, is defined as "*a person being employed in a job or task.*" It refers to the working-age population engaged in any activity to produce goods or provide services for a wage or profit during a short reference period (ILO, 2022: 8).

Precarious employment will be discussed before addressing non-precarious employment. Precarious employment is a broad concept with multiple definitions. The International Labour Organization (ILO) defines precarious employment as *a type of employment characterised by uncertainty regarding the duration of employment, lack of access to social protection and employment-related benefits, multiple potential employers or unclear/hidden employment relationships, low wages, and significant legal and practical barriers to union membership and collective bargaining* (ILO, 2012: 27). In the economic literature, Rodgers (1989) proposes four criteria to determine precarious employment. The first criterion is whether the job has a specified duration or involves a high likelihood of the worker losing their current job. The second criterion is the limited or nonexistent control that the worker has over their job. The third criterion is the lack of social assistance and social security packages as part of the worker's current job. The fourth and final criterion is that the worker's income creates a state of poverty. Rodgers (1989) defines precarious employment as characterised by instability, a lack of social rights, insecurity, and social and economic disadvantage (Rodgers, 1989: 3). Similarly, Amable et al. (2001) describe it in terms of instability, vulnerability, inadequate wages, uncertainty, and reduced social benefits. Vosko (2010) defines precarious employment as a significant global problem, where workers, unlike businesses and governments, bear the risks associated with employment and face job uncertainty, instability, and insecurity with limited social benefits and legal rights (Vosko, 2010: 2). Precarious employment is a multi-dimensional and multi-faceted concept with numerous different definitions. In this context, Fleury and Cahill (2018) argue that there is no standard definition and describe it as a "bad job".

In the 1980s, as a result of the restructuring and regulation brought about by the capital accumulation regime created by the capitalist system, the concepts of atypical employment, non-standard employment, and precarious employment, collectively referred to as flexible employment types, gained widespread recognition. The intensely competitive environment brought about by the global economy has compelled enterprises to be flexible

in both their production processes and work organisation. Flexible production has also brought labor market flexibility, which contradicts the concept of secure jobs. Labor market flexibility involves issues such as the fragmentation of the labor force, fewer regulations at workplaces, wage structures dependent on economic fluctuations, weaker union organisations and the resulting individualisation of collective bargaining, and lower social rights (Munck, 2003: 94-95, cited in Temiz, 2004: 63-64). Due to the flexible labor market, there was a significant increase in the number of women employed, particularly in the 1980s and 1990s. The rise in women's employment is also attributed to the desire to create a more flexible labor force that can be laid off more efficiently and at lower costs. Young people entering the labor market at an early age, especially while continuing their education, have led to an increase in temporary and part-time employment. Similarly, to avoid unemployment and make a living, individuals accept precarious, unstable, and suboptimal working conditions in temporary and fixed-term jobs (Temiz, 2003: 64-65). In other words, poverty directly drives individuals into precarious employment types, and thus, the phenomenon of poverty provides a basis for the existence of precarious employment. Developments in the manufacturing industry have also resulted in reduced employment opportunities in this sector, increasing the potential for precarious employment (Magdoff & Magdoff, 2004: 22). Part-time and temporary employment types proposed as a solution to unemployment also pave the way for precarious employment, thus increasing the potential for employment in precarious jobs (Korpi & Levin, 2001: 128). Government policies, when implemented in practice, can also directly lead to precarious employment (Gorz, 2001: 114). Economic crises, partly due to government policies and partly due to global factors, also have negative consequences in the labor market, which pave the way for temporary employment.

In Türkiye, labor force indicators are published by the Turkish Statistical Institute (TÜİK). TÜİK collects labor force data by international standards and calculates it using internationally recognised definitions. However, the COVID-19 pandemic has had unprecedented effects on the labor market, leading to anomalies in labor force and unemployment dynamics. Due to these anomalies, the official labor force indicators, traditionally calculated in Türkiye and some other countries, have become inadequate in accurately reflecting the picture of the labor markets. As a result, the Social Policy Implementation and Research Center (SPM) began calculating and publishing a new concept, termed "non-precarious employment," derived from the idea of precarious employment, which had limited use in existing literature as of September 2020. The concept of non-precarious employment refers to individuals working in non-agricultural jobs that are covered by social security and are employed on a full-time basis. Moreover, they calculate and publish the "non-precarious employment rate" by relating individuals in non-precarious employment to the non-institutional working-age population (SPM, 2020: 4). Accordingly, non-precarious employment and non-precarious employment rates are calculated as follows:

> Non-Precarious Employment = Total Employment - Employed in the Agricultural Sector - Informal Workers - Time-Related Underemployment

Non-Precarious Employment Rate = Non-Precarious Employment / Non-institutional Population Aged 15+

Figure 1 shows the trend of the employment rate and the non-precarious employment rate from 2009 to 2023.

Figure: 1
Proportional View of Employment / Non-Precarious Employment
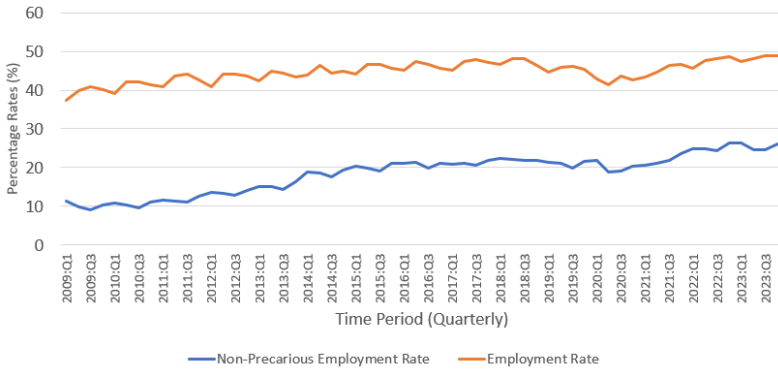
Source: Created by the author using the necessary data obtained from TÜİK.

As seen in Figure 1, there is a significant difference between employment and non-precarious employment. While the employment rate fluctuates between 40% and 50%, non-precarious employment ranges between 20% and 30%. This considerable gap between non-precarious employment rates and overall employment rates is noteworthy.

3. The Concept and Importance of Broadly Defined Unemployment

TÜİK, considering the ILO's guidelines, defines the unemployed population as "all non-institutional working-age individuals who were not employed during the reference period but had used at least one active job-seeking method in the last four weeks and were available to start work within two weeks". Additionally, as stated by TÜİK, individuals "who have found a job to start within three months or have set up their own business but are waiting to complete various deficiencies to start working" are also considered unemployed (TÜİK, 2022: 4).

It was emphasised at the 19th International Conference of Labour Statisticians (ICLS), held by the ILO, that the current unemployment rate alone is insufficient for measuring the labour market, necessitating the use of alternative indicators. Consequently, in addition to basic labor force indicators, alternative labor force indicators were defined as follows: "time-related underemployment, "potential labor force," and "unemployment" (TÜİK, 2024). Time-related underemployment is defined as "individuals who are employed during the reference week but have worked less than 40 hours in their main job or other jobs, express

a desire to work more hours, and are available to start additional work if possible". On the other hand, potential labor force is defined as "working-age individuals who are neither employed nor unemployed during the reference week, including those who are looking for work but are not able to start work in a short period and those who are not looking for work but are willing to work and can start work in a short period" (TÜİK, 2022: 4).

As part of the 19th ICLS, the ILO began publishing complementary labor force indicators, such as the combined rate of time-related underemployment and unemployment, the combined rate of unemployment and potential labor force, and the underutilised labor force. Unemployment, which is generally defined, can also be termed as narrowly defined unemployment. However, another type of unemployment is broadly defined unemployment, also known as the underutilised labor force, which includes the potential labor force and time-related underemployment in addition to narrowly defined unemployment. In this context, broadly defined unemployment considers and examines unemployment more comprehensively. Underutilised labor force/broadly defined unemployment is calculated as follows:

Underutilised labor force (Broadly Defined Unemployment) = Narrowly Defined Unemployment + Potential Labor Force + Time-Related Underemployment

The share of the unemployed population in the labor force is the unemployment rate, while the share of the underutilised labor force in the labor force and potential labor force is the underutilised labor force rate:

Underutilized labor force rate = [(Unemployed + Potential Labor Force + Time-Related Underemployment) / (Labor Force + Potential Labor Force)] * 100

Figure: 2
Proportional View of Unemployment / Broadly Defined Unemployment
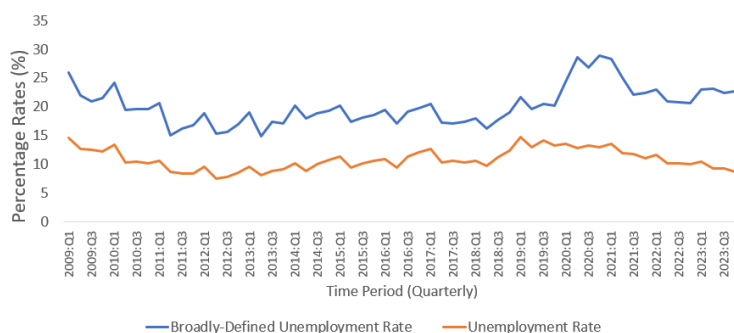
Source: Created by the author using the necessary data obtained from TÜİK.

Examining Figure 2, it can be seen that there is a significant gap between the unemployment rate and broadly defined unemployment (underutilised labor force). This gap has widened remarkably, especially since 2020. The effect of the COVID-19 pandemic

shows that the standard unemployment rate does not accurately reflect the disruptions in the labor market, which become more apparent when considering broadly defined unemployment. While the unemployment rate has recently decreased, ranging from 8% to 9%, the broadly defined unemployment rate remains between 22% and 23%. This 14% difference between the two unemployment calculation methods is significant and warrants further investigation. This gap originates from the potential underutilisation of labor due to time-related factors. Policymakers are advised to address them in conjunction with policies aimed at reducing unemployment.

4. Literature

Due to its novelty and originality, the concept of non-precarious employment, derived from the limitedly used concept of precarious employment, has not been directly studied in the existing literature. However, studies on precarious employment, which can also be referred to as insecure or atypical employment, will play a guiding role in the literature.

Rodgers (1989) examines the rise of precarious employment in Western European countries, arguing that various types of precarious employment, including temporary, part-time, concealed, or illegal work, as well as home-based work and self-employment, have become widespread. Rodgers emphasises that these types of employment vary from country to country, generally suggesting that women typically hold part-time and home-based jobs, whereas temporary and unregistered jobs are often held by youth and immigrants. In this context, the importance of policies aimed at promoting qualified employment is emphasised.

Cranford et al. (2003) analyse the level of precarious employment in the Canadian labor market. They indicate that the most common types of precarious employment include part-time, fixed-term or contractual, seasonal, and temporary jobs, as well as those with a foreseeable end. They also highlight that precarious employment is significantly more prevalent among women in comparison to men and suggest that studies should explore the impact of education on precarious employment.

Temiz (2004) emphasises the importance, reasons, and problems associated with precarious employment in the labor market. He argues that precarious employment arises due to the flexibilisation of the labor market brought about by the capitalist system, global feminisation, the entry of partial and temporary jobs into the labor market, high unemployment rates, the decline of employment opportunities in the manufacturing sector, government policies, poverty, and economic crises. He emphasises that precarious employment can lead to both mental and physical problems for individuals and advocates for the implementation of policies to increase non-precarious, qualified employment.

Bosch (2004), in his study, examined precarious employment, which can be described as insecure employment, in Western European countries between 1988 and 2000. Besides highlighting multiple causes of precarious jobs, he emphasises that high unemployment elevates the level of competition in the labor market and reduces workers'

bargaining power. In this context, he argued that many workers are unable to make their preferred choices and are thus forced to accept involuntary part-time or temporary employment. As unemployment rises, the availability of standard employment types decreases, and non-standard, insecure, and precarious forms of employment become more widespread. The study highlights that these issues can be addressed through the regulation of labor markets.

Green and Livanos (2015) analysed how involuntary non-standard employment in England, before the crisis (Q2 2006-2008) and after (end of 2010), was explained by socio-economic and regional factors. In this context, the Heckman probit model was used to describe non-standard employment. The analysis results indicated that having dependent children has a positive influence on participation in non-standard jobs. Additionally, non-white individuals, young people, married individuals, those with higher education levels, lower-skilled individuals, and women, compared to others, are more likely to participate in non-standard employment. Thus, it is concluded that due to high unemployment, individuals unable to secure their desired jobs are compelled to accept non-standard and precarious employment to avoid unemployment.

Alkan (2021) examined precarious employment in Türkiye within the framework of changing employment patterns in the modern world. She argues that non-standard forms of employment have become increasingly widespread globally since the 1980s, resulting in the predominance of precarious employment. She further claims that the job losses and unemployment caused by the COVID-19 pandemic, which affected Türkiye, have transformed many previously full-time jobs and altered working patterns. Additionally, she notes that high unemployment and informal employment in Türkiye have led to increased precariousness in the labor market. She also notes that a significant portion of jobs in the agricultural sector, which is mainly informal, has contributed to the precariousness of the labor market in Türkiye, alongside insufficient social policies, low wages, high youth unemployment, and inadequate female employment.

Ferre (2021) examined the extent of precarious employment in Argentina between 2003 and 2017, as well as the characteristics of workers that influence their employment in insecure jobs. A logistic probit model was used in this context. The analysis concluded that being young and female was associated with higher rates of precarious employment. Furthermore, in terms of education level, those who completed primary and secondary education had a 57% lower possibility of being in insecure jobs than those with no education, while those with university education had an 87% lower likelihood. Married individuals were found to have a higher probability of insecure employment than single individuals, and foreign nationals were more likely to be in insecure jobs compared to locals. The results indicate that, in the face of unemployment, individuals are often compelled to take on insecure jobs.

Reviewing the literature, studies carried out by Rodgers (1989), Kalleberg (2000), Cranford et al. (2003), Temiz (2004), Hipp et al. (2015), and Kretsos and Livanos (2016)

indicate that precarious employment is common in part-time, temporary, or fixed-term jobs. It is also concluded that high unemployment leads individuals to accept insecure employment involuntarily and that high unemployment, in this sense, triggers precarious employment. The results suggest that, due to life concerns, individuals accept insecure jobs to avoid unemployment. Therefore, it is considered essential to address the relationship between decent, quality and qualified employment, an important concept in sustainable development plans, and broadly defined unemployment, which includes the potential labor force and time-related underemployment.

5. Data and Methodology

This section provides information about the variables used in the analysis and discusses the econometric method applied to analyse these variables.

5.1. Data Set

The present study analyses the relationship between non-precarious employment and broadly defined unemployment, also referred to as underutilised labour, for the period from Q1 2009 to Q4 2023. The selection of this time frame is motivated by the International Labour Organization's (ILO) 16th Conference, where the concept of underemployment was more clearly delineated by introducing two subcategories: "time-related underemployment" and "inadequate employment". Consequently, both the concepts of non-precarious employment and broadly defined unemployment have been calculated using the time-related underemployment concept, making these calculations applicable only from 2009 onwards. Furthermore, the use of a quarterly time frame for the variables in the present study is justified by the fact that the Turkish Statistical Institute (TÜİK) has been publishing data on the potential labor force and informal employment quarterly since 2021, rather than monthly. Given that the potential labor force concept is used to calculate broadly defined unemployment and the informal employment concept is used to calculate non-precarious employment, the analysis is conducted using quarterly data. These two factors constitute the main constraints of this study. Table 1 presents the definitions and data sources of the variables used.

Table: 1
Information on Variables

Variable	Definition	Source
NPE	Non-Precarious Employment [Total Employment - (Informal Employment + Time-Related Underemployment + Agricultural Employment)]	Calculated by the authors
Templ	Total Employment	TÜİK
Iempl	Informal Employment	TÜİK
Tund	Time-Related Underemployment	TÜİK
BDE	Broadly-Defined Unemployment (Narrow Unemployment + Potential Labor Force + Time-Related Underemployment)	Calculated by the authors
Nunem	Narrow Unemployment	TÜİK
Plab	Potential Labor Force	TÜİK

In Table 1, Templ represents total employment, Iempl represents informal employment, Tund represents time-related underemployment, Nunem represents narrowly defined unemployment, and Plab represents the potential labor force. The variables for total employment, informal employment, time-related underemployment, narrowly defined unemployment, and the possible labor force are obtained from TÜİK. In the analysis, NPE is the dependent variable, representing non-precarious employment, which is calculated by subtracting informal employment, time-related underemployment, and agricultural employment from total employment. BDE is the explanatory variable representing broadly defined unemployment, also known as the slack labor force. It is calculated by adding time-related underemployment and potential labor force to narrowly defined unemployment. The variables in the analysis were used in their logarithmic transformations.

5.2. Econometric Method

This section introduces the econometric method to be used in the study.

5.2.1. Fourier Kwiatkowski, Phillips, Schmidt, Shin (F-KPSS) Unit Root Test

Stationarity (or unit root) analysis of the series is essential in econometric analyses. Examining the stationarity of the series is necessary for the subsequent stages of the analysis. Although there are multiple tests for stationarity analysis, each has its advantages and disadvantages. Economic crises, political changes, and natural disasters can cause sudden shocks that change the mean, trend, or both the mean and trend of a time series. The presence of structural breaks explains these situations. Conducting stationarity analysis of the relevant series using traditional unit root tests under these conditions may lead to inconsistent results. The disadvantage of traditional unit root tests is that they do not account for structural breaks (Mert & Çağlar, 2023: 131).

Starting with the study by Perron (1989), unit root tests that consider structural breaks aim to capture sharp breaks using break dummies. Perron (1989) developed the Dickey-Fuller test, allowing for a single break, assuming the location of the break is known. The Perron (1989) test employs three distinct models: "break in the intercept (Model A), "break in the slope (Model B)," and "break in both the intercept and slope (Model C)" (Perron, 1989: 1363-1364). Subsequent studies adopt an endogenous approach, where the break date is estimated using the model, leading to the development of tests that allow for multiple breaks. Zivot and Andrews (1992) criticised the approach of incorporating the break into the model using a priori information in Perron's unit root test. They developed a unit root test where the break date is estimated endogenously from the model (Zivot & Andrews, 1992: 27). Lumsdaine and Papell (1997) and Lee and Strazicich (2003) developed unit root tests allowing for the estimation of two potential breaks endogenously within the model, building on Zivot's study. Leybourne, Newbold, and Vougas (1998) and Kapetanios (2003) contributed to the literature with unit root tests allowing for breaks with a more gradual structure determined endogenously. Narayan and Popp (2010) introduced a unit root test allowing for two breaks determined endogenously. Carrion-i-Silvestre et al. (2009)

introduced a unit root test that allows for endogenously determined breaks and permits up to five breaks. The criticism of these tests is that the breaks are predetermined. Applying a test allowing for two breaks to a series that contains only one break, or vice versa, can lead to erroneous results. Not only the number of breaks but also their nature is predetermined in these tests, which can result in incorrect outcomes (Yılancı, 2017: 56). Additionally, it is known that structural breaks are not only sharp and sudden but also gradual, and these tests are criticised for ignoring gradual breaks (Mert & Çağlar, 2023: 183-184).

To eliminate these problems and minimise errors, Enders and Lee (2012a) developed unit root tests based on the Lagrange Multiplier (LM) method, and Rodrigues and Taylor (2012) developed the DF-GLS method. Unit root tests incorporating flexible Fourier functions, as developed by Gallant (1981), were designed to model gradual breaks. According to the tests developed by Enders and Lee, the date of the breaks, the number of breaks, and the functional form are determined through the test process rather than a priori. Enders and Lee applied structural break unit root tests using Fourier terms instead of dummy variables.

Becker, Enders, and Lee (2006) addressed the issue of controlling for unknown form and number of breaks by incorporating Fourier functions into the traditional KPSS unit root test, thereby developing the Fourier KPSS unit root test. Fourier functions detect not only sharp and sudden breaks but also gradual and subtle ones, providing more consistent results (Becker et al., 2006: 381-382). The model for this test is as follows:

$$y_t = x_t^{'}\beta + z_t^{'}\gamma + r_t + \varepsilon_t \tag{1}$$

$$r_t = r_{t-1} + \mu_t \tag{2}$$

In equations given above, ε_t refers to the stationary error term, μ_t to the fixed variance error term, and Z_t refers to the vector 3 incorporating trigonometric terms.

$$Z_t = [\sin(2\pi kt / T), \cos(2\pi kt / T)]' \tag{3}$$

In equation (3), t refers to the long-term trend, T to the sample size, and k to the frequency value. The Fourier Model is represented as in equation (4), where $\alpha(t)$ is a function of the unknown number and form of breaks:

$$\alpha(t) = \alpha_k + \sum_{k=1}^{n} \alpha_k \sin\left(\frac{2\pi kt}{T}\right) + \sum_{k=1}^{n} b_k \cos\left(\frac{2\pi kt}{T}\right); \ n < \frac{T}{2} \tag{4}$$

The equations that must be estimated to calculate the test statistic necessary to test the null hypothesis of stationarity ($H_0 = \sigma_{u}^2 = 0$) are formulated as in equations (5) and (6).

$$y_{t=\alpha_0} + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \varepsilon_t \tag{5}$$

$$y_t = \alpha_0 + \beta_1 + \gamma_1 sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 cos\left(\frac{2\pi kt}{T}\right) \tag{6}$$

While equation (5) addresses the level stationarity, equation (6) addresses the trend stationarity. In equations (5) and (6), the optimal frequency is reported as the one that minimizes the sum of squared residuals using all frequency values from 1 to 5, with the maximum frequency set to 5 (Becker et al., 2006: 309).

The test statistic that needs to be calculated from these equations is formulated in equation (7).

$$\tau_\mu(\alpha); \tau_\tau(k) = \frac{1}{T^2}\frac{\sum_{t=1}^{T}\tilde{S}_t(k)^2}{\tilde{\sigma}^2} \tag{7}$$

In Equation (7), with $\tilde{S}_t(k)^2 = \sum_{j=1}^{t}\tilde{e}_j$, $\tilde{e}_j$ refers to the LS residuals obtained from Equations 5 and 6. $\tilde{\sigma}^2$ obtained using the weights of the lag parameters l and w_j refers to the non-parametric estimation of long term variance and is formulised as in Equation 8:

$$\tilde{\sigma}^2 = \breve{\gamma}_0 + 2\sum w_j\tilde{\gamma}_j \tag{8}$$

where, $j=1,2,..,l$ refers to the weight series and l to the trimming lag parameter. Moreover, it also indicates the jth autocovariance of the residuals obtained from equation (5) or (6).

The test statistic in equation (7) will lead to the rejection of the null hypothesis if it exceeds the critical value tabularised by Becker et al. (2006), indicating the presence of a unit root in the series.

Furthermore, to determine whether the sine and cosine terms added to the model for the data generation process are necessary for the stationarity test, the F-statistic is calculated. The relevant F-statistic is computed as shown in equation (9).

$$F_\mu(k) = \frac{(SSR_0 - SSR_1)/q}{SSR_1(k)/(T-k)} \tag{9}$$

In Equation 9, the sum of squared residuals of the regression without trigonometric terms is denoted as SSR_0, whereas the sum of squared residuals of the regression with trigonometric terms is denoted as SSR_1. Here, k represents a specific frequency. If the calculated F-statistic is significant and exceeds the critical F-values provided by Becker et al. (2006), it suggests that the F-statistic is substantial. Consequently, it is considered appropriate to use the KPSS test with trigonometric terms (FKPSS). Conversely, if the calculated F-statistic is less than the critical F-values, then it is considered appropriate to use the KPSS test without trigonometric terms for the stationarity analysis.

5.2.2. Fourier Shin Cointegration Test

The concept of cointegration was first introduced by Engle and Granger (1987), who developed the Engle-Granger cointegration test, which has become a standard in the literature. Traditional cointegration tests have been criticised for not accounting for structural breaks, a limitation similar to that of conventional unit root tests. Tests considering structural breaks have been developed, including Gregory and Hansen (1996) for a single break, Hatemi-J (2008) for two breaks, and Maki (2012) for up to five breaks. In these tests, breaks are incorporated into the model using dummy variables, a similar approach to that employed in structural break tests. However, this condition applies only to sudden and sharp breaks, potentially overlooking gradual and smooth breaks. Moreover, the number and form of structural changes are pre-determined in these tests, which has been a point of criticism.

In this context, cointegration tests incorporating smooth breaks have been introduced into the literature, one of which is the Fourier Shin (FSHIN) cointegration test by Tsong et al. (2016). This test extends the Shin cointegration test by adding Fourier terms. Unlike other tests, the null hypothesis in this test is the presence of a cointegration relationship, not its absence. In this regard, it can be considered an adaptation of the Fourier KPSS unit root test for cointegration (Tsong et al., 2016: 1087).

The data generation process for the FSHIN cointegration test introduced by Tsong et al. (2016) is as follows:

$$y_t = d_t + x_t'\beta + \eta_t, \text{, t=1,2...,T} \tag{10}$$

In equation (10), $\eta_t = \gamma_t + \upsilon_{1t}, \gamma_t = \gamma_{t-1} + \mu_t$ and $x_t = x_{t-1} + \upsilon_{2t}$. Moreover, the error term μ_t is an independently and identically distributed error term with a mean of 0 and a variance of σ_u^2, whereas γ_t represents a random walk process with a mean of 0. Since the scalar υ_{1t} and the p-dimensional vector υ_{2t} are stationary, y_t and x_t are first-difference stationary processes.

In addition, the term d_t in Equation (10) can be represented in two ways depending on whether the model includes only a constant (intercept) term or both a constant term and a trend.

$$d_t = \delta_0 + f_t \tag{11}$$
$$d_t = \delta_0 + \delta_1 t + f_t \tag{12}$$

f_t in Equations (11) and (12) is Fourier function and expressed as follows:

$$f_t = \alpha_k sin\left(\frac{2\pi kt}{T}\right) + \beta_k cos\left(\frac{2\pi kt}{T}\right) \tag{13}$$

In equation (13), the Fourier function represents the frequency value k, the trend t, and the number of observations T. The F-Shin cointegration test introduced by Tsong (2016)

is an extension of the FKPSS stationarity test. When the variable x_t on the right side of the data-generating process in equation (10) for the F-Shin cointegration test is absent, it coincides with the data-generating process in equation (1) for the FKPSS test. Conversely, when $\alpha_k = \beta_k = 0$, the data-generating process for the Shin cointegration test can be obtained. Additionally, in the data-generating process for the FKPSS test, eliminating x_t from the right side of the equation and setting $\alpha_k = \beta_k = 0$ yields the data-generating process for the KPSS stationarity test. In this regard, the F-Shin test is an extension of the Shin test with Fourier terms and is also an adaptation of the FKPSS test for cointegration (Yılancı, 2017: 59).

In the F-Shin cointegration test, the null hypothesis indicating the presence of cointegration with structural breaks and the alternative hypothesis indicating the absence of cointegration are as follows:

$$H_0 = \sigma_u^2 = 0$$

$$H_1 = \sigma_u^2 > 0$$

To obtain the test statistic necessary to test the basic hypothesis of cointegration against the alternative hypothesis, the y_t series can be re-obtained based on equations (10) and (13):

$$y_t = \delta_0 + \alpha_k sin\left(\frac{2\pi kt}{T}\right) + \beta_k cos\left(\frac{2\pi kt}{T}\right) + x_t'\beta + v_{1t} \tag{14}$$

Based on equation (14), the F-Shin test statistic value can be calculated as follows:

$$CI_f^m = T^{-2}\hat{\omega}_1^{-2}\sum_{t=1}^{T}S_t^2 \tag{15}$$

In equation (15), $S_t = \sum_{t=1}^{T}v_{1t}$ represents the partial sum of the OLS residuals obtained from equation (14), and $\hat{\omega}_1^2$ represents the consistent estimator of the long-term variance of v_{1t}.

Tsong et al. (2016) followed the process suggested by Becker et al. (2006) for selecting the appropriate frequency value k. According to this process, $(k_{max} = 3)$ k= 1, 2, 3 values (with a maximum value of k being 3) are substituted into equation (14). The frequency value k* that yields the minimum sum of squared residuals is determined (Tsong et al., 2016: 1090-1091). If the calculated CI_f^m statistic value exceeds the relevant critical values provided in Tsong et al. (2016), the null hypothesis is rejected, indicating no cointegration with structural breaks. If the calculated statistic value is less than the relevant critical value, the null hypothesis cannot be rejected, indicating the presence of cointegration with structural breaks.

In addition, Tsong et al. (2016) examined the conditions under which the Fourier roots are significant and whether they should be included in the cointegration process.

Following Becker et al. (2006), they calculated the F statistic. The relevant F statistic value is as follows:

$$F^m(k^*) = max_{k \in (1,2,3)} \ F^m(k)$$

$$F^m(k) = \frac{(SSE_0^m - SSE_1^m(k))/2}{\frac{SSE_1^m(k)}{(T-q)}} \tag{16}$$

In equation (16), SSE_0^m represents the sum of squared residuals of the regression without trigonometric terms, $SSE_1^m(k)$ represents the sum of squared residuals of the regression with trigonometric terms, and q represents the number of parameters in the regression equation with trigonometric terms. If the F-statistic value calculated is greater than the relevant table critical values, the null hypothesis is rejected, indicating that Fourier components should be included in the model.

6. Results

Whether the variables contain unit roots was first examined using traditional unit root tests, including the Augmented Dickey-Fuller (ADF) and KPSS tests. Table 2 presents the unit root/stationarity test results obtained using the ADF and KPSS tests.

Table: 2
Traditional Unit Root-Stationarity Test Results

Model	Variables	Method	Test Statistic	Critical Values		
				1%	5%	10%
Constant	lnNPE	ADF	-1.0599	-3.5461	-2.9117	-2.5935
		KPSS	0.8754 (6)	0.7390	0.4630	0.3470
	ΔlnNPE	ADF	-6.6992	-3.5483	-2.9126	-2.5940
		KPSS	0.1907 (2)	0.7390	0.4630	0.3470
	lnBDE	ADF	-0.7795	-3.5461	-2.9117	-2.5935
		KPSS	0.7723 (6)	0.7390	0.4630	0.3470
	ΔlnBDE	ADF	-8.5612	-3.5483	-2.9126	-2.5940
		KPSS	0.1495 (2)	0.7390	0.4630	0.3470
Constant and Trend	lnNPE	ADF	-1.0617	-4.1213	-3.4878	-3.1723
		KPSS	0.2054 (6)	0.2160	0.1460	0.1190
	ΔlnNPE	ADF	-6.8427	-4.1243	-3.4892	-3.1731
		KPSS	0.1054 (1)	0.2160	0.1460	0.1190
	lnBDE	ADF	-2.8936	-4.1213	-3.4878	-3.1723
		KPSS	0.1222 (5)	0.2160	0.1460	0.1190
	ΔlnBDE	ADF	-8.6011	-4.1243	-3.4892	-3.1731
		KPSS	0.0753 (3)	0.2160	0.1460	0.1190

Note: The term "ln" indicates that the variables have undergone a logarithmic transformation. The term "Δ" denotes that the first difference of the variables has been taken. The values in parentheses represent the bandwidths obtained using the Newey-West method.

As shown in Table 2, according to the ADF unit root test results for the models with constant and constant and trend, the variables lnNPE and lnBDE exhibit unit roots at their levels. Similarly, according to the KPSS unit root test results for the models with constant and constant and trend, it is observed that the variables lnNPE and lnBDE contain unit roots at their levels. According to the unit root test results applied to the differenced series, the variables are found to be stationary. In this case, considering the traditional unit root tests, it is found that the variables lnNPE and lnBDE are stationary at their first difference, i.e., I(1).

After examining stationarity using traditional unit root tests, the Fourier KPSS unit root/stationarity test was also employed for further analysis. Table 3 presents the Fourier KPSS unit root/stationarity test results for the models with a constant and those with a continuous and trend.

Table: 3
Fourier KPSS Stationarity Test Results

Model	Variable	MinRSS	k	FKPSS	F-Statistic	Critical Values		
						%10	%5	%1
Constant	lnNPE	3.6501	1	0.4004 (6)	34.4759*	0.1318	0.1720	0.2699
	ΔlnNPE	0.0875	1	0.1395 (4)	2.2920	0.1318	0.1720	0.2699
	lnBDE	0.9136	1	0.2445 (5)	69.2069*	0.1318	0.1720	0.2699
	ΔlnBDE	0.2959	3	0.2534 (9)	1.8447	0.3393	0.4480	0.7182
Constant and Trend	lnNPE	0.1781	1	0.0613 (5)	111.8835*	0.0471	0.0546	0.0716
	ΔlnNPE	0.0835	1	0.0528 (6)	3.4172	0.0471	0.0546	0.0716
	lnBDE	0.5520	3	0.1758 (5)	19.5158*	0.1141	0.1423	0.2103
	ΔlnBDE	0.2913	3	0.1329(12)	1.8937	0.1141	0.1423	0.2103

Note: For the constant model, the critical values for the F-statistic at the 10%, 5%, and 1% significance levels are 4.133, 4.929, and 6.730, respectively. For the model with both constant and trend, the critical values for the F-statistic at the 10%, 5%, and 1% significance levels are 4.162, 4.972, and 6.873, respectively. An asterisk (*) indicates significance at the 1% level for the F-statistic values. The values in parentheses represent the bandwidth determined using the Bartlett-Kernel method. The term "ln" indicates that the variables have undergone a logarithmic transformation. The symbol "Δ" denotes the first differences of the variables. MinRSS stands for the minimum residual sum of squares, k represents the reference value, and FKPSS denotes the Fourier KPSS test statistic.

As shown in Table 3, for both models, the F-statistic values of the lnNPE and lnBDE variables exceed the F-table critical values, indicating that they are statistically significant. This means that the trigonometric terms are substantial, suggesting that the stationarity of the variables can be determined using the Fourier KPSS unit root test. It can be seen that the level values of the lnNPE and lnBDE series exceed the table critical values for both models, and thus the null hypothesis can be rejected, indicating that the series contain unit roots at their levels. Considering the unit root test results applied to the differenced series, it is observed that the test statistic values are smaller than the table's critical values; in this case, the null hypothesis can be accepted, indicating that the variables are stationary in their first difference, i.e., [1].

To examine the long-term relationship of the series, which were determined to be stationary at their first difference, Shin and Fourier-Shin cointegration tests were used. Table 4 shows the Shin and Fourier-Shin cointegration test results.

Table: 4
Shin and Fourier-Shin Cointegration Test Results

Model	MinSSR	k	F-Shin Test	Critical Values			Shin Test	F-Statistic
				10%	5%	1%		
lnNPE=*f*(lnBDE)	0.7300	1	0.1603* (4)	0.095	0.124	0.198	0.3107 (5)	23.874*
lnBDE=*f*(lnNPE)	0.4578	1	0.0530* (5)	0.095	0.124	0.198	0.2416 (5)	12.815*

Note: The critical values of the F-statistic table for the 10%, 5%, and 1% significance levels are 3.352, 4.066, and 5.774, respectively. The asterisk "*" denotes significance at the 1% level. The notation "ln" indicates that the variables have undergone a logarithmic transformation. MinSSR represents the minimum residual sum of squares, k is the reference value, and F-Shin denotes the Fourier-Shin Cointegration test statistic. The values in parentheses indicate the bandwidth determined using the Bartlett-Kernel method.

As seen in Table 4, the F-statistic value is statistically significant at the 1% significance level. This indicates the significance of the trigonometric terms, demonstrating

that the cointegration relationship can be examined using the Fourier-Shin test. If the F-statistic value was statistically insignificant and the Fourier roots were found to be negligible, the Shin test would be used instead of the Fourier-Shin test. The Fourier Shin cointegration test statistic values are smaller than the table critical values, indicating that the null hypothesis cannot be rejected and the variables have a cointegration relationship. This suggests a long-term relationship between non-precarious employment and broadly defined unemployment.

Given the Fourier-Shin test result, there is evidence of a long-term relationship between the variables, necessitating the examination of long-term coefficients. Table 5 presents the long-term coefficients obtained using FMOLS, DOLS, and CCR tests.

Table: 5
Long-Term Coefficient Estimation by FMOLS, DOLS, and CCR Tests

Variables	Coefficient	Standard Error	T-statistic	Probability Value
FMOLS Results				
lnBDE	-0.6732	0.1716	-3.9234	0.0002*
C	14.3780	1.4456	9.9458	0.0000*
Sin	-0.0714	0.0315	-2.2649	0.0276**
Cos	0.0606	0.0293	2.0692	0.0433**
DOLS Results				
lnBDE	-0.6941	0.1944	-3.5714	0.0008*
C	14.5393	1.6341	8.8970	0.0000*
Sin	-0.0645	0.0305	-2.1108	0.0399**
Cos	0.0691	0.0300	2.2979	0.0259**
CCR Results				
lnBDE	-0.6649	0.1607	-4.1374	0.0001*
C	14.3098	1.3567	10.5476	0.0000*
Sin	-0.0716	0.0316	-2.2683	0.0273**
Cos	0.0613	0.0294	2.0847	0.0418**

Note: "" and "**" indicate significance at the 1% and 5% levels, respectively. The term "ln" denotes that the variables have undergone a logarithmic transformation.*

As seen in Table 5, the trigonometric roots (sin and cos) are significant for the FMOLS, DOLS, and CCR tests. This validates the use of Fourier roots in the analysis and supports the consistency of the analysis. Given the FMOLS, DOLS, and CCR estimator results, all results are statistically significant. It is concluded that a 1% increase in broadly defined unemployment decreases non-precarious employment by approximately 0.67% according to FMOLS findings, by approximately 0.69% according to DOLS findings, and by approximately 0.66% according to CCR findings. Therefore, it is concluded that broadly defined unemployment has a long-term impact on non-precarious employment, with a change ranging from 0.66% to 0.69%, and this change is in the opposite direction.

7. Conclusion and Suggestions

In this study, the relationship between non-precarious employment and broadly defined unemployment in Türkiye was analysed by considering the "decent work" policy that is frequently emphasised in sustainable development plans. A time series analysis was conducted using quarterly data from the period between 2009 and 2023. For this purpose, tests incorporating Fourier functions, which account for smooth structural breaks, were

employed. Initially, the stationarity of the series was tested using the KPSS and F-KPSS tests. The long-term relationship of the series, which were determined to be stationary at their first differences, was analysed using the F-Shin cointegration test. According to the results of the F-Shin cointegration test, it is concluded that the variables move together in the long term, indicating they are cointegrated. Considering the cointegration results, coefficient estimates for the variables were made using FMOLS, DOLS, and CCR tests. Given the coefficient estimation results, a 1% increase in broadly defined unemployment reduces non-precarious employment by approximately 0.67% based on FMOLS, approximately 0.69% based on DOLS, and approximately 0.66% based on CCR results. It has been established that broadly defined unemployment has a negative long-term impact on non-precarious employment. This result aligns with the results reported by Rodgers (1989), Temiz (2004), Bosch (2004), Green and Livanos (2015), and Işıl Alkan (2021), which indicate that unemployment contributes to the problem of precarious employment.

Within the framework of the "decent work policy," which plays a crucial role in sustainable development plans and complements efforts to reduce poverty, quality and skilled employment hold significant importance. In this context, it is recommended that policymakers implement policies aimed at reducing and controlling informal employment, an element of non-precarious employment. Moreover, policies should be developed to regulate "time-related underemployment" (part-time, half-time, etc.) within both non-precarious employment and broadly defined unemployment frameworks, aiming to reduce the elements of low-quality and unskilled employment. Policies should also aim to reduce the potential labor force, which constitutes a significant part of broadly defined unemployment, and attract it to quality, skilled employment. As seen in the literature, it is recommended that policies be developed to promote the transition of women and youth, who constitute a significant portion of precarious employment, to non-precarious, quality employment. It is recommended to conduct awareness-raising activities to enhance job search skills and adapt to the working environment. The reasons for brain drain from our country abroad should be analysed, and efforts should be made to retain skilled labor in Türkiye. Overall, it is recommended to implement policies that increase the number of individuals employed in high-quality employment, which indeed bears the economic burden. Researchers are also advised to conduct both time series and panel studies and analyses on factors affecting skilled labor, which is crucial for implementing decent work policies.

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Yenilenebilir Enerji Difüzyon Patikası ve Bilgi Difüzyonu Temelinde Sosyoekonomik Etkileşimler: Türkiye'de Fotovoltaik Sistem[1]

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Diffusion Pathways of Renewable Energy and Socioeconomic Interactions Based on Knowledge Diffusion: Photovoltaic Systems in Türkiye[2]

Abstract

This study investigates the diffusion process of photovoltaic (PV) systems and the role of social interactions that facilitate knowledge diffusion in Türkiye. Policy changes and the diffusion process under different scenarios are examined through a hybrid model that consists of econometric and agent-based modelling. According to the findings, the adoption of PV systems by interacting households has a positive influence on the adoption of these systems by other households. Policies such as reducing payback periods would enhance renewable energy production. Yet, a mandatory transition to PV systems may be necessary to increase the share of renewable energy in total energy.

Keywords : Photovoltaic Systems, Renewable Energy, Knowledge Economy, Simulation Modelling.

JEL Classification Codes : O13, O33, Q28, C63.

Öz

Bu çalışmanın amacı Türkiye'de fotovoltaik (PV) sistem difüzyon sürecinin ve bu süreçte bilgi difüzyonunu sağlayan sosyal etkileşimlerin rolünün araştırılmasıdır. Çalışmada politika değişiklikleri ve farklı senaryolar altında difüzyon süreci ekonometrik modelleme ile ajan bazlı modelleme kombinasyonundan oluşan hibrit bir modelle incelenmektedir. Elde edilen bulgulara göre etkileşim içerisinde bulunan hanelerin PV sisteme geçişi, diğer hanelerin adaptasyonunu pozitif yönde etkilemektedir. Geri ödeme sürelerinin azaltılması gibi politikalar yenilenebilir enerji üretimini artırsa da yenilenebilir enerjinin toplam enerji içerisindeki payının artırılması için zorunlu PV sisteme geçiş uygulamalarına ihtiyaç duyulmaktadır.

Anahtar Sözcükler : Fotovoltaik Sistem, Yenilenebilir Enerji, Bilgi Ekonomisi, Simülasyon Modelleme.

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1. Giriş

Avrupa Yeşil Mutabakatı ve pandemi süreci döngüsel ekonomilere yapılan vurguyu artırmaktadır. Mutabakat çerçevesinde oluşacak yeni iş çevrimlerine adaptasyon için ülkeler farklı politikalar geliştirmektedir. Bu dönüşüm sürecinde ülkeler kendi iç dinamiklerine göre stratejiler geliştirseler de yenilenebilir enerji politikalarına verilen önemin arttığı açıkça görülmektedir (Kuzmin et al., 2024). Diğer yandan piyasalardaki dijital dönüşüm enerji sektörünü de yapısal olarak değiştirirken, performans artışlarından maliyetin azalmasına kadar pek çok avantaj sunarak (Olabi et al., 2023) yenilenebilir enerji kaynaklarının ileride daha cazip bir alternatif olmasını vaat etmektedir (Nazari & Musilek, 2023).

Türkiye, 2023 yılında yenilenebilir enerji kaynaklarının elektrik üretimi içerisindeki payını %30'a çıkarmayı hedeflemekteydi (Enerji ve Tabii Kaynaklar Bakanlığı, 2010: 16). Bu hedef doğrultusunda 29/12/2010 tarihinde 6094 sayılı Yenilenebilir Enerji Kaynaklarının Elektrik Enerjisi Üretimi Amaçlı Kullanımına İlişkin Kanun uygulamaya konulmuştur. Türkiye bulunduğu coğrafik konum sebebiyle pek çok Avrupa ülkesinin üzerinde güneşlenme süresi ve güneşlenme şiddetine sahip olduğu için güneş enerjisinde avantaja sahiptir. 6094 sayılı kanunda yer alan sabit fiyat alım politikalarıyla birlikte 2011-2017 yıllarında lisanslı ve lisanssız kurulu güneş enerjisi kapasitesi önemli ölçüde artırılmıştır. Bu politikalar sayesinde Türkiye Ulusal Yenilenebilir Enerji Eylem Planı'nda 5 GW olarak belirlenen 2023 yılı hedefine (Enerji ve Tabii Kaynaklar Bakanlığı, 2014: 22) 2018 yılında ulaşılmıştır (Owid, 2021). Enerji ve Tabii Kaynaklar Bakanlığı'nın 2019-2023 yılları stratejik planında 2023 yılı yeni güneş enerjisi hedefi ise 10 GW olarak belirlenmiştir (Enerji ve Tabii Kaynaklar Bakanlığı, 2019: 76).

Türkiye'de önemli miktarda kullanılabilir çatı alanı olmasına rağmen uygulanan sabit fiyat alım politikaları, çatı sistemlerine geçişi istenilen seviyelere çıkarmaya yetmemiştir. Bu sebeple 2018 yılı itibariyle 'çatı mevzuatı' olarak bilinen yeni bir mevzuat uygulamaya konulurken, 2019 yılında aylık mahsuplaşma düzenlemesi yapılmıştır. Türkiye'de PV sistemin hanehalkı için getirisi 2018 yılına kadar sadece kullanılan elektrikken, mahsuplaşma politikasıyla kullanılmayan elektrikten gelir elde etmenin önü açılmıştır. Bu mevzuatla birlikte çatı alanlarının güneş enerjisi üretimi için kullanımının artırılması planlanmaktadır. Yapılan düzenlemeyle AVM, hastane, eğitim kurumları gibi çatı alanı fazla olan konutların yüksek güçte güneş enerjisi üretiminin önü açılmaktadır. Daha önce uygulanan sabit fiyat alım tarifeleri 13,3 sent iken, yeni mevzuatla birlikte birim elektrik fiyatına düşürülmüştür. Dolayısıyla uygulamaya konulan yeni mevzuatın, kısıtlı üretim kapasitesi olan hanehalkı üzerindeki etkileri tartışılmaktadır.

Bu çalışmanın amacı Türkiye'de PV sistem difüzyon sürecinin ve bu süreçte bilgi difüzyonunu sağlayan sosyal etkileşimlerin rolünün araştırılmasıdır. PV sistem, güneş enerjisini elektrik enerjisine dönüştüren sistemleri nitelerken, PV sistem difüzyonu bu sistemlerin yayılımı anlamına gelmektedir. Çalışmada ekonometrik modelleme ile ajan bazlı modelleme kombinasyonundan oluşan hibrit bir model kullanılmaktadır. Hibrit model ise iki veya daha fazla modelin veya tekniğin bir arada kullanıldığı modelleri belirtmektedir.

Çalışma kapsamında uygulanan politika değişikliklerinin etkileri araştırılırken, farklı senaryolar altında difüzyon sürecinin nasıl seyredeceği incelenmektedir.

Türkiye'de PV sistemi araştıran kısıtlı çalışma (Cebeci, 2017) içerisinden çok az bir bölümü konutlarda PV sisteme odaklanmaktadır (Dinçer, 2011; Güngül vd., 2018; Flora et al., 2019; Acar vd., 2020; Duman & Güler, 2020). Konutlarda PV sistemi araştıran çalışmaların ise temel araştırma sorusu PV sistem yatırım kararının ekonomik olarak değerlendirilmesidir. Bu çalışmalarda Türkiye'de konutlarda PV sistem için kesit değerlendirmeler yapılmıştır. Bildiğimiz kadarıyla Türkiye'de konutlarda PV sistem difüzyonunu olası senaryolar altında araştırarak kamu politikalarını değerlendiren bir çalışma bulunmamaktadır.

Konutlarda PV sistem difüzyonunun ekonometrik tahmin ve ajan bazlı modellemeden oluşan hibrit bir model ile araştırılması çalışmanın ilk özgün değerini oluşturmaktadır. Oluşturulan hibrit modelle literatüre yöntemsel olarak katkı sağlanmaktadır. Çalışmanın ikinci ve temel özgün değeri ise Türkiye'de konutlarda PV sistem difüzyon patikasının ortaya konmasıdır. Türkiye'de yıllar itibariyle PV sistem adaptasyon oranlarının belirlenmesi ve uygulanan kamu politikalarının etkisinin ortaya konması gerek döngüsel ekonomiler kapsamında politik değerlendirmelerin yapılabilmesi gerekse belirlenen kurulu kapasite hedeflerine ulaşılabilmesi açısından büyük öneme sahiptir. Çalışmanın üçüncü ve son özgün değeri ise Türkiye'de uygulanan kamu politikalarındaki değişimin PV sistem difüzyon patikasında yarattığı etkinin ortaya konmasıdır.

Çalışmanın ikinci kısmında yenilenebilir enerji difüzyon sürecini belirleyen unsurlar ve bu süreçte sosyal etkileşimlerin rolüne ilişkin bilgi verilmektedir. Çalışmanın üçüncü kısmında ajan bazlı model sunulmaktadır. Çalışmanın dördüncü ve beşinci kısımlarında sırasıyla logit model ve simülasyona yer verilirken, altıncı kısmında simülasyon değerlendirmesi yapılmaktadır. Çalışmanın yedinci ve son kısmında ise sonuç bölümü yer almaktadır.

2. Literatür

2023 yılında Dünya'daki elektrik üretiminin yaklaşık %30'u yenilenebilir enerji kaynaklarından karşılanmıştır (Owida, 2024). Dünya'da toplam yenilenebilir enerji kapasitesi 2023 yılında 3864 GW'tır ve bu kapasitenin 1418 GW'ı güneş enerjisidir (IRENA, 2024). Artan güneş enerjisi kapasitesinin PV sistem maliyetlerini azaltması böylelikle güneş enerjisi kapasitesindeki ivmenin artması beklenmektedir. Dahası döngüsel ekonomi vurgusuyla birlikte tüketicilerin kendi ihtiyaç duydukları enerjiyi üretmelerini hedefleyen politikalara verilen önem artmıştır. Bu gelişmeler ışığında konutlarda PV sistem difüzyonunu araştıran çalışma sayısı da artmıştır (Boumaiza et al., 2018; Pearce & Slade, 2018; Stavrakas et al., 2019).

İnovasyon difüzyonu ajanlar arası etkileşimler ve etkileşimler neticesinde bilginin ajanlar arasında difüzyonu temelinde ortaya çıkar (Garcia & Jager, 2011: 148). Ajanlar arası etkileşimleri temel alan bir yöntem olarak ajan bazlı modelleme, inovasyon difüzyon sürecinin doğasına en uygun modeller arasında yer alır. Bilgisayar teknolojilerinde ortaya çıkan gelişmelerle birlikte özellikle son yıllarda ajan bazlı modelleme çalışmalarına ilgi artmıştır (Macal & North, 2010).

Literatürdeki çalışmalar incelendiğinde enerji alanında da çok sayıda ajan bazlı modelleme çalışması bulunmaktadır (Xu et al., 2020; Karimi & Vaez-Zadeh, 2021; Fouladvand et al., 2022). Bu çalışmaların bazılarında enerji piyasası (Ma & Nakamori, 2009; Chappin & Dijkema, 2010) ve piyasadaki yeni ürünlerin özellikle de bir fenomen olarak elektrikli araçların difüzyonu (Eppstein et al., 2011; Shafiei et al., 2012; Tran, 2012; McCoy & Lyons, 2014; Plötz et al., 2014; Huang et al., 2021) araştırılmıştır. Bazı çalışmalarda ise yenilenebilir enerji başlığı altında konutlarda PV sistem difüzyonu incelenmiştir (Zhao et al., 2011; Iachini et al., 2015; Palmer et al., 2015; Rai & Robinson, 2015; Pearce & Slade, 2018; Stavrakas et al., 2019; Ramshani et al., 2020; Peralta et al., 2022).

Konutlarda PV sistem difüzyonunu araştıran ajan bazlı modelleme çalışmalarında hanelerin özellikleri ve tutumlarının adaptasyon kararı üzerindeki etkisi ele alınmıştır. Ekonometrik yöntemlere dayalı çalışmalarda hane temsilcisinin cinsiyeti, yaşı ve eğitimi gibi farklı hane özellikleri dikkate alınırken (Ameli & Brandt, 2015; Rahut et al., 2017; Bashiri & Alizadeh, 2018), ajan bazlı modelleme çalışmaları gelir etkisi üzerinde yoğunlaşmıştır. Literatürde gelir ve yenilenebilir enerji adaptasyonu arasında pozitif ilişki olduğunu savunan çalışmaların (Kwan, 2012: 337; Dharshing, 2017: 121; Tian & Chang, 2020; Menyeh, 2021) yanı sıra gelirin etkisinin bulunmadığını (Korcaj et al., 2015: 411) veya negatif etkisinin bulunduğunu gösteren çalışmalar (Bashiri & Alizadeh, 2018: 3137; Van der Kam et al., 2018: 76; Best & Chareunsy, 2022; Mahn et al., 2024) da yer almaktadır.

Türkiye'de konutlarda PV sistemi araştıran çalışma sayısı oldukça kısıtlıdır (Dinçer, 2011; Bhattacharjee et al., 2018; Güngül vd., 2018; Flora et al., 2019; Acar vd., 2020; Duman & Güler, 2020). Bu çalışmalarda ise PV sistemin finansmanı, ekonomik getirisi veya bu ekonomik getirinin bir ölçüsü olan geri ödeme süresi üzerinde durulmuştur. Çalışmaların önemli bir bölümünde anlık kesit görüntü değerlendirmesi yapılmış, olası senaryolar altında geleceğe ilişkin tahminler belirlenmemiştir (Dinçer, 2011; Güngül vd., 2018). Bildiğimiz kadarıyla literatürdeki çalışmalarda konutlarda PV sistem difüzyonu ekonomik etkiler dışında incelenmemiştir. Türkiye'de konutlarda PV sistemi araştıran çalışmalar da Türkiye'nin önemli bir potansiyele sahip olduğunu ortaya koymuştur (Bhattacharjee et al., 2018; Acar vd., 2020). Bununla birlikte hanehalkın PV sisteme geçişinde ek teşvik, kredilendirme gibi PV sistemin ekonomik getirisini artıracak başka bir deyişle yatırımın geri ödeme süresini düşürecek politikaların önemine vurgu yapılmıştır (Flora et al., 2019; Acar vd., 2020; Duman & Güler, 2020). Bu potansiyelin hayata geçirilebilmesi için politika değerlendirmelerinin yapılmamış olması önemli bir eksiklik oluşturmaktadır.

PV sistem adaptasyonunda öne çıkan davranış ve tutumların içerisinde en önemli unsurlardan birisi çevresel yaklaşımlardır. Çevreye karşı duyarlılık ve çevresel problemlerin farkındalığı arttıkça PV sistem adaptasyon olasılığı da artar (Chen, 2014; Korcaj et al., 2015: 413). Ajan bazlı modelleme çalışmalarında hanelerin çevreye karşı tutumlarının bir ölçüsü olarak çevresel fayda tanımlanmıştır (Iachini et al., 2015: 143-144; Palmer et al., 2015: 112).

Tutum ve davranışları belirleyen temel unsurlardan birisi sosyal ağlar içerisinde hangi sosyal statüde yer alındığı ve ağ içerisindeki aktörlerin birbirleri üzerindeki etkisidir. Dolayısıyla sosyal yapı ve sosyal etkileşimler PV sistem adaptasyonda belirleyici role sahip diğer bir unsurdur (Pearce & Slade, 2018: 101; Stavrakas et al., 2019: 7). Sosyal etkileşimler aracılığıyla ortaya çıkan bilgi difüzyonu sayesinde PV sisteme ilişkin farkındalık ve bilgi artar. Bilgi ve farkındalığın artması ise PV sistem difüzyonunu hızlandırır (Ameli & Brandt, 2015: 10; Bashiri & Alizadeh, 2018: 3137).

Çalışmaların yoğunlaştığı araştırma konularından bir diğeri PV sistem geri ödeme süresidir (Sun et al., 2013; Muhammad-Sukki et al., 2014; Sow et al., 2019; Duman & Güler, 2020). Yenilenebilir enerji politikalarının temel amacı geri ödeme sürelerini azaltarak yenilenebilir enerji adaptasyonunu artırmaktır. Ajan bazlı modelleme çalışmalarında ise geri ödeme sürelerine göre belirlenen PV sistemin ekonomik faydası araştırılmıştır. Literatürde yer alan çalışmaların tamamı geri ödeme süreleri ile yenilenebilir enerji adaptasyonu arasında ters yönlü bir ilişkinin var olduğu üzerinde uzlaşmıştır.

3. Model

Çalışmada hanelerin adaptasyon kararı altı aşamadan meydana gelen ekonometrik yöntem ile ajan bazlı modellemenin kombinasyonundan oluşan hibrit bir model ile araştırılmaktadır. Modelin aşamaları Şekil 1'de gösterilmektedir.

Birinci aşamada 2010-2019 yılları için hanelerin sosyoekonomik sınıflandırılması yapılarak, ağ yapısı ve her hane için komşuluk bilgisi oluşturulmaktadır. Bu bilgiler kullanılarak, hanelerin PV adaptasyonundan beklenen kısmi faydaları hesaplanmaktadır. İkinci aşamada logit modeli kullanılarak, kısmi faydaların adaptasyon kararı üzerindeki etkisi belirlenmektedir. Üçüncü aşamada 2010 yılı veri seti kullanılarak ağ bilgisi ve başlangıç koşulları oluşturulmaktadır. Dördüncü aşamada dolaylı kalibrasyon yöntemi (Fagiolo et al., 2007: 208-210) kullanılarak eşik değerler belirlenmektedir. Beşinci aşamada hanelerin adaptasyon olasılığı kümülatif lojistik olasılık fonksiyonu kullanılarak hesaplanmaktadır. Altıncı ve son aşamada ise haneler sıralı olarak adaptasyon kararını değerlendirmektedirler. Bu aşamada hanelerin adaptasyon olasılığı ile PV sistem yatırımının beklenen maliyeti olarak tanımlanan eşik değer karşılaştırılmaktadır. Adaptasyon olasılığı, eşik değere eşit veya büyük olan haneler PV sistem yatırımı yapmaya karar vermektedirler.

Şekil: 1
Hibrit Model
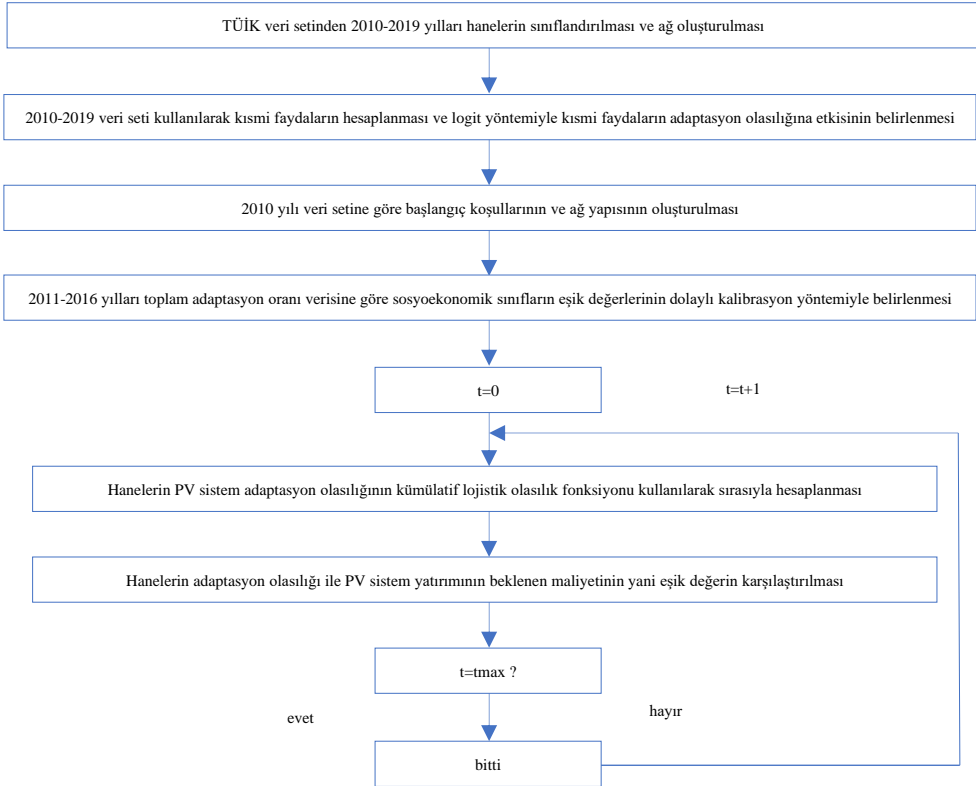
3.1. Ajanların Karar Mekanizması

Ajan bazlı modelleme, heterojen ajanların, ajanlar ve ajanlarla çevre arasındaki etkileşimlerin bulunduğu kompleks adaptif sistemlerin incelenmesine imkân veren bir simülasyon tekniğidir (Macal & North, 2010). Ajan bazlı modelleme özellikle teknoloji difüzyonu gibi kompleks sistemlerin kendiliğinden düzenlendiği durumlarda iyi bir alternatif oluşturmaktadır. Bilgisayar teknolojilerindeki ilerlemeler ajan bazlı modellemeye ilgiyi artırmış ve araştırmalarda kullanımı yaygınlaşmıştır.

Güneş enerjisine adaptasyon söz konusu olduğunda fotovoltaik (PV) sistem yatırımından tüm hane etkilendiği ve tüm hanenin kullanımına yönelik bir ürün olarak karşımıza çıktığı için bu çalışmada ajanlar haneleri temsil eder.

Şekil: 2
Karar Mekanizması Akış Diyagramı
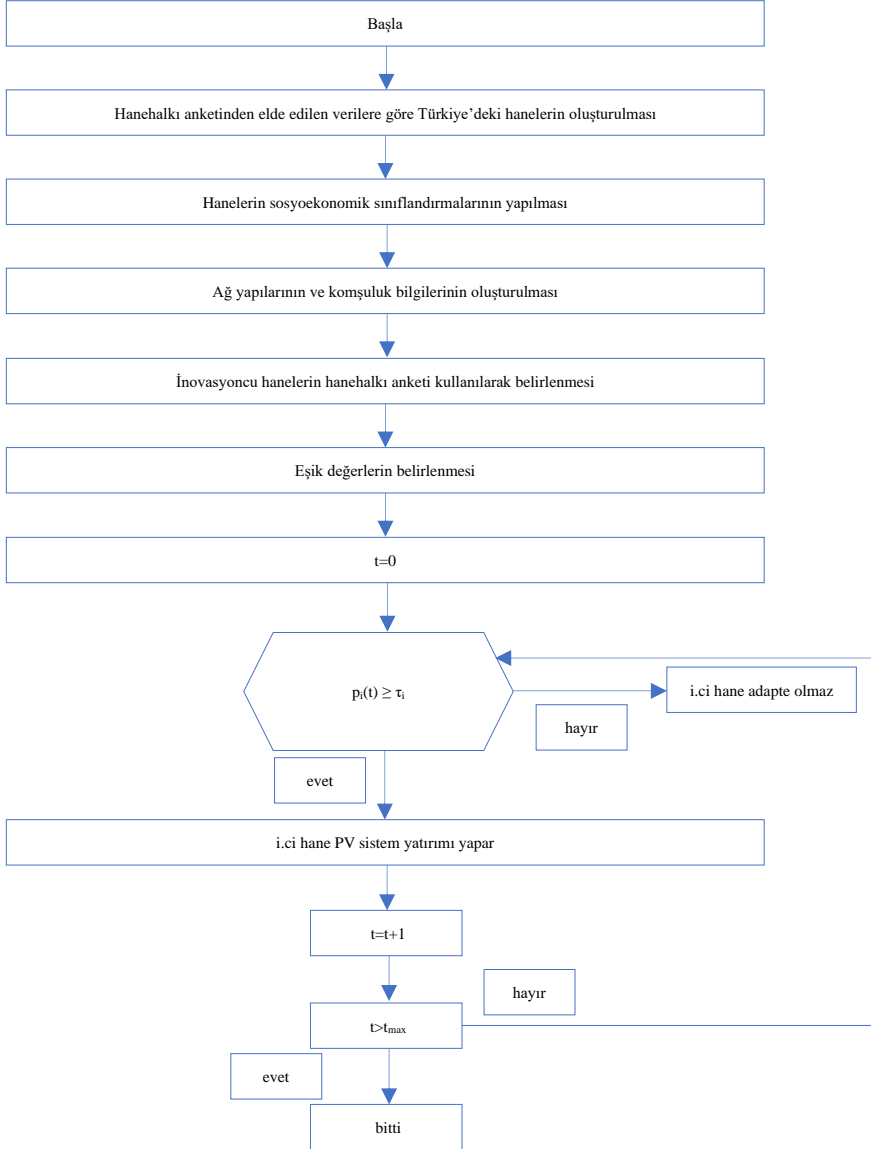
Hanelerin PV sistem adaptasyon kararı x ile gösterilen iki değerli bir değişken ile temsil edilir. Bu değişken hane PV sistemine yatırım yapmaya karar verdiyse 1, vermediyse 0 değerini alır.

$$x_i(t+1) = \begin{cases} 1, & \text{Denklem 2 (t) anında sağlanıyorsa} \\ 0, & \text{diğer durumlarda} \end{cases} \tag{1}$$

Ajanların adaptasyon kararı Denklem 2'ye göre belirlenir ve temelde fayda maliyet analizine dayanır.

$$p_i(t) \geq \tau_i \tag{2}$$

$p_i(t)$ i ajanının t anında PV sistem adaptasyon olasılığını ve τ_i i ajanının eşik değerini yani yatırımdan beklenen maliyetini temsil eder. Haneler, PV sistem yatırım olasılığının beklenen maliyete eşit veya büyük olduğu durumlarda güneş enerjisine adaptasyon kararı verirler.

Hanelerin karar mekanizmasına ilişkin akış diyagramı Şekil 2'de yer almaktadır. Analizin yapıldığı tüm yıllarda modelde yer alan tüm haneler için bu akış diyagramı sırayla yinelenir.

3.2. Fayda Fonksiyonu

PV sistem yatırımından beklenen fayda U ile temsil edilmekte ve Denklem 3'te gösterildiği gibi beş bileşenden meydana gelmektedir. Bu bileşenler sırasıyla ekonomik fayda, çevresel fayda, gelir faydası, iletişim faydası ve sosyal normlar olarak tanımlanmaktadır (Iachini et al., 2015; Palmer et al., 2015; Pearce & Slade, 2018).

$$U_i(t) = F\{U_{ekonomik,i}(t), U_{çevre,i}(t), U_{gelir,i}(t), U_{iletişim,i}(t), U_{sosyal}(t)\} \tag{3}$$

Ekonomik fayda, iletişim faydası ve sosyal normlar 0 ile 1 arasında değer alan doğrusal (lineer) fayda fonksiyonu olarak ele alınır. Çevresel fayda ve gelir faydası ise teknoloji difüzyon süreçlerinin S-şekilli yapısıyla uyumlu olarak S-şekilli fayda fonksiyonu şeklinde tanımlanır. S-şekilli fayda fonksiyonlarının hem teoride hem de uygulamada kullanımı bulunur (Rogers, 2003; Modis, 2007; Phillips, 2007; Zhao et al., 2011; Iachini et al., 2015; Palmer et al., 2015).

3.2.1. Ekonomik Fayda

PV sistemlerin ekonomik analizinde net bugünkü değer (NBD), kârlılık endeksi, fayda maliyet oranı, iç kârlılık oranı, düzenlenmiş iç kârlılık oranı, geri ödeme süresi, fatura tasarrufları ve indirgenmiş enerji maliyeti gibi farklı değişkenler kullanılır (Drury et al., 2011: 6-11). Çalışmalarda en fazla yer verilen değişkenlerden birisi NBD ve geri ödeme süresidir (Iachini et al., 2015; Palmer et al., 2015 ; Güngül vd., 2018; Flora et al., 2019).

Geri ödeme süresi yatırımdan elde edilen getirinin yatırımın maliyetine eşit olduğu süreyi ifade eder. Çalışmada ekonomik fayda geri ödeme süresi kullanılarak Denklem 4'teki gibi hesaplanır. Denklemde gs geri ödeme süresini temsil ederken, PV sistemin ortalama ekonomik ömrü 20 yıl olduğundan maksimum geri ödeme süresi 21, minimim geri ödeme süresi ise 1 olarak alınır (Iachini et al., 2015: 143; Palmer et al., 2015: 110). Geri ödeme süresi 20 yılın üzerinde hesaplanan haneler için ekonomik fayda sıfır olarak kabul edilir.

$$U_{ekonomik,i}(t) = \frac{maksimum(geri\ ödeme\ süresi) - gs(i)}{maksimum(geri\ ödeme\ süresi) - minimum(geri\ ödeme\ süresi)} \tag{4}$$

$$U_{ekonomik,i}(t) = \frac{21 - gs(i)}{20} \tag{5}$$

Geri ödeme süresi, NBD negatiften pozitife döndüğü yıl olarak tanımlanır. NBD, yatırımın bugüne indirgenmiş değerini ifade eder. PV sistem maliyetleri azaldıkça, hücre ve panel verimliliği arttıkça NBD artar. NBD sıfıra eşit olduğunda güneş enerjisi üretmenin maliyeti elektrik maliyetine eşit olur ve bu şebeke paritesine ulaşmak olarak adlandırılır (Denholm et al., 2009: 1). Denklem 6'da $I_0(t)$, $R(t)$ ve $i(t)$ sırasıyla PV sistem yatırımının t anındaki maliyeti, yatırımdan beklenen getiriler ve indirgeme oranını temsil eder. İndirgeme oranı ağırlıklı ortalama sermaye maliyeti (Weighted Average Cost of Capital - WACC) yöntemi kullanılarak Denklem 7'deki gibi belirlenir (Cebeci, 2017: 112). Ağırlıklı ortalama sermaye maliyeti, yatırımda kullanılan kaynakların getirileri ilgili kaynağın yatırım içerisindeki oranı ile çarpılarak elde edilir (Farber et al., 2006: 215; Mian & Vélez-Pareja, 2008: 24; Bal, 2009: 223; Güzel & Cingöz, 2016: 39). Denklem 7'de E öz kaynak miktarını, K_E öz kaynak sermaye maliyetini, D yabancı kaynak miktarını yani yatırım için kullanılan kredi miktarını, K_D kredi faiz oranını, T ise vergi oranını temsil eder. K_E, 1 yıl ve üzeri vadeli TL mevduat faiz oranı olarak alınır. K_D ise TL üzerinden tüketici ihtiyaç kredisi faiz oranına eşittir. Öz kaynak miktarının ilk yatırım maliyetine oranı kişi başına ortalama kullanılabilir gelire sahip haneler için %50 olarak kabul edilir (Flora et al., 2019: 10). Diğer haneler için öz kaynak miktarının ilk yatırım maliyetine oranı kişi başına ortalama kullanılabilir gelir ile doğru orantılı olacak şekilde belirlenir.

$$NBD\ (i,t) = -I_0(t) + \sum_{t=1}^{20} \frac{R(t)}{(1+i(t))^t} \tag{6}$$

$$WACC = (E/I_0)\ K_E + (D/I_0)\ K_D\ (1-T) \tag{7}$$

PV sistem yatırım maliyeti, maksimum pik gücü (P_{max}) ile PV sistem yatırımının kW başına fiyatının (p_{GP}) çarpımından oluşur. P_{max} Denklem 9 kullanılarak hesaplanmaktadır. Denklem 9'da G, A_{GP}, η_C ve $\eta_{GP}(t)$ sırasıyla normal koşullarda ışıma şiddeti, PV sistemi için kullanılabilir çatı alanı, hücre verimliliği ve yatırım anındaki PV sistem verimliliği olarak adlandırılır. Çalışmada G değeri 1 kW/m² (Palmer et al., 2015: 110) ve çekirdek verimliliği %16 (EPIA, 2011: 25) olarak alınır.

Türkiye'de hane başına ortalama kullanılabilir çatı alanı yaklaşık olarak 72 m²'dir (Bhattacharjee vd., 2018:8). Kullanılabilir çatı alanı, PV sistem yatırım maliyetini ve PV

sistemin kurulu gücünü belirleyen temel unsurlardan birisidir. Yaygın kullanıma sahip olan silikon PV sistem için kW başına gerekli çatı alanı ortalama 7-8 m^2 civarındadır (EPIA, 2011: 25). Çalışmada hanelerin kullanılabilir çatı alanının müstakil konutlarda hanenin konut alanının 1/3'ü, diğer konutlarda ise hanenin konut alanının 1/5'i olduğu kabul edilir. Kullanılabilir çatı alanı değerleri kW başına gerekli alan olan 8'e bölünerek, en yakın tam sayıya yuvarlanır. Bu varsayımlar altında oluşturulan başlangıç veri setine göre hanelerin sahip olduğu çatı alanı ortalama 3,4 kW PV sistem kurulumuna izin verir. Bu değer ise bir hanenin elektrik ihtiyacını karşılayan ortalama bir değer olan 3 kW'a (Dinçer, 2011: 13; Güngül vd., 2018: 140) yakındır.

PV sistem verimliliğinin 2010 yılındaki başlangıç değerinin %13 (EPIA, 2011: 25) olduğu ve her yıl %1,5 verimlilik artışı (Kost et al., 2012; Palmer et al., 2015: 122) olduğu kabul edilir. PV sistem yatırımının kW başına t anındaki fiyatı Denklem 10'a göre hesaplanır. Denklem 10'da $p_{GP}(t_0)$ PV sistem yatırımının kW başına baz alınan yıldaki fiyatını, $TKK(t)$ t anında küresel düzeyde toplam kurulu PV sistem kapasitesini, $TKK(t_0)$ baz yıldaki küresel düzeyde toplam kurulu PV sistem kapasitesini ve b tecrübe parametresini simgeler. Tecrübe parametresi, öğrenme oranından faydalanılarak elde edilir. Öğrenme oranı 2020 yılına kadar %20, 2030 yılına kadar %18 ve 2040 yılına kadar ise %16 olarak alınır (EPIA, 2011: 70).

$$I_0(t) = P_{max}(t)\, p_{GP}(t) \tag{8}$$

$$P_{max}(t) = G\, A_{GP}\, \eta_Ç\, \eta_{GP}(t) \tag{9}$$

$$p_{GP}(t) = p_{GP}(t_0)\left(\frac{TKK(t)}{TKK(t_0)}\right)^{-b} \tag{10}$$

$$ÖO = 1 - 2^{-b} \tag{11}$$

PV sistem yatırımından beklenen ekonomik getiriler, elektrik tasarruflarından elde edilen getiriler ($R_{tasarruf}$), kamu destekleri (R_{kamu}), idari ödemeler (R_{idari}), bakım ve ön yatırım maliyetleri ($R_{bakım}$) ve amortisman ödeneği olmak üzere beş bileşenden oluşur.

$$R(t) = R_{tasarruf}(t) + R_{kamu}(t) - R_{idari}(t) - R_{bakım}(t) - R_{amortisman}(t) \tag{12}$$

Elektrik tasarruflarından elde edilen getiriler hanelerin ürettikleri elektriğin ne kadarını tükettiklerine başka bir deyişle öz tüketim oranına ve kamu politikalarına göre değişir. Elektrik tasarruflarının hesaplanmasında 2018 yılına kadar Denklem 13 kullanılırken, bu yıldan itibaren Denklem 14 kullanılır. Aşağıdaki Denklemlerde $E_{GP}(t)$, $x_{öztüketim}$, $p_{elek,alış}$, $p_{elek,satış}$, $\mu_{elek,alış}$ ve $\mu_{elek,satış}$ sırasıyla PV sisteminin ürettiği elektrik miktarı, öz tüketim oranı, elektriğin şebekeden satın alınma bedeli, tüketim fazlası elektriğin şebekeye satış bedeli, elektrik satış fiyatı artış oranı ve elektrik alış fiyatı artış oranı olarak tanımlanır. Denklemde yer alan öz tüketim oranı %50 olarak alınır (Flora et al., 2019: 10). 2010-2020 yılları elektrik alış ve satış fiyatları EPDK'nın belirlediği tutarlara eşit olarak belirlenirken[1], sonraki yıllar için denklemlerde yer alan elektrik fiyatı ortalama artış oranına göre hesaplanır. PV sisteminin ürettiği elektrik miktarı ise Denklem 4.15'e göre hesaplanır. Denklemde $E_{güneş}$ güneş ışınım şiddetini ve γ PV sistem aşınımını temsil eder. GEPA

verilerine göre Türkiye'de yıllık güneş ışınım şiddeti 1527 kWh/m²'dir. PV sistem aşınım değeri ise %0,40 olarak alınır (Flora et al., 2019: 10).

$$R_{tasarruf}(t) = E_{GP}(t) \; x_{öztüketim} \; p_{elek,alış} \; (1+\mu_{elek,alış})^{t-1} \tag{13}$$

$$R_{tasarruf}(t) = E_{GP}(t) \; [\; x_{öztüketim} \; p_{elek,alış} \; (1+\mu_{elek,alış})^{t-1} + (1-x_{öztüketim}) \; p_{elek,satış} \; (1+\mu_{elek,satış})^{t-1} \tag{14}$$

$$E_{GP}(t) = E_{güneş} \; P_{max}(t) \; (1-\gamma)^{t-1} \tag{15}$$

Türkiye'de 2018 yılına kadar mahsuplaşma yapılmadığı için bu yıla kadar elektrik tasarruflarından elde edilen getiriler sadece öz tüketimden kaynaklanır. 2018 yılında uygulamaya konulan mahsuplaşma düzenlemesiyle birlikte kullanılmayan elektrik miktarı şebekeye satılır. Yapılan düzenlemeye göre kullanılmayan elektrik miktarının şebekeye satış fiyatının şebekeden elektrik alış fiyatına eşit olduğu kabul edilir.

Kamu destekleri PV sistem yatırımlarında uygulanan teşvik ve sübvansiyon politikalarının bir ürünüdür. Kamu desteği Denklem 4.16 kullanılarak hesaplanır. Denklemde $E_{GP}(t)$, $x_{öztüketim}$ ve p_{FIT} sırasıyla PV sisteminin ürettiği elektrik miktarı, öz tüketim oranı ve tarife garantili fiyattır. Türkiye'de 2018 yılına kadar uygulanan tarife garantili fiyat (feed-in tariff - FIT) politikası kapsamında hanelerin öz tüketim fazlası elektrik üretimi 13,3 cent/kWh tarife (p_{FIT}) fiyatı üzerinden satın alınır.

$$R_{kamu}(t) = E_{GP}(t) \; (1-x_{öztüketim}) \; p_{FIT} \tag{16}$$

İdari ödemeler, tedarikçiye şebeke kullanım karşılığında yapılan dağıtım sistemi kullanım bedeli ve yıllık sistem işletim bedelinden oluşur. Üretimi 10 kW'ın altında kalan lisanssız üretim tesislerinden yıllık sistem işletim bedeli alınmadığı için çalışmada idari ücretler dağıtım sistemi kullanım bedeline eşittir. Çalışmada kullanılan dağıtım bedelleri ($\varphi_{dağıtım}$) EPDK'nın belirlediği dönemlik tarifelerin her yıl için ortalama değerleri alınarak belirlenir. İdari ödemeler ise sisteme verilen net elektrik miktarı üzerinden Denklem 4.17'ye göre hesaplanır.

$$R_{idari}(t) = E_{GP}(t) \; (1-x_{öztüketim}) \; \varphi_{dağıtım} \tag{17}$$

Bakım ve ön yatırım maliyetleri, ilk yatırım maliyetinin belirli bir oranından oluşur. Çalışmada lisanssız üreticiler için ön yatırım maliyetlerinin başlangıç maliyetlerinin yaklaşık %1,6'sı olduğu kabul edilir (Cebeci, 2017: 107). PV sistem bakım giderlerinin ise başlangıç maliyetlerinin yaklaşık %1'i olduğu kabul edilir. Bakım maliyetlerinin yıllık %2 oranında artış gösterdiği varsayılır (Kost et al., 2012; Palmer et al., 2015: 122).

$$R_{bakım}(t) = \begin{cases} (\beta_{bakım} + \beta_{önyatırım})I_0, \, t = 1 \\ \beta_{bakım}I_0, \, t \neq 1 \end{cases} \tag{18}$$

Amortisman ödeneği, PV sisteminin ekonomik ömrü boyunca güneş paneli başlangıç yatırım maliyetinin eşit olarak dağıtılması ile oluşur. Başka bir ifadeyle ekonomik ömrünün sonunda güneş paneli yatırım değeri sıfır olacak şekilde amortisman ödemesi ayrılır.

$$R_{amortisman}(t) = I_0(t)/20 \tag{19}$$

3.2.2. Çevresel Fayda

PV sistem yatırım kararlarında en etkili unsurlardan birisi ajanların çevreye karşı tutumlarıdır (Zhai & Williams, 2012: 351; Iachini et al., 2015: 143-144; Bashiri & Alizadeh, 2018: 3133). PV sistem yatırımlarının erken aşamalarında yatırım kararı ekonomik olmasa bile çevresel kaygılarla adaptasyon kararı alındığını gösteren çalışmalar da bulunmaktadır (Van Benthem et al., 2008; Rai & McAndrews, 2012). PV sistem yatırımlarının çevresel faydası panelin sağladığı CO_2 emisyonu azalması ile temsil edilebilir. Çalışmada kolaylık sağlaması için PV sistem yatırımlarının çevresel faydası panelin ürettiği temiz enerji ile orantılı olarak alınır ve sistemin güneş enerjisi üretmek için ihtiyaç duyduğu elektrik miktarı görece çok küçük olduğundan ihmal edilir (Palmer et al., 2015: 112).

Çevresel fayda Denklem 20, 21 ve 22 kullanılarak hesaplanır. Denklemlerde $P_{max}(t_0)$ yatırım yılındaki maksimum pik gücünü, $E_{GP,i}$ PV sisteminin beklenen ömür boyu elektrik üretimini, $E_{GP,toplam}$ ise yatırım esnasında diğer tüm PV sistemlerinin beklenen ömür boyu elektrik üretim ortalamasını ifade eder. Çevresel faydanın bu formda gösterimi, PV sistemden beklenen elektrik üretimi azaldığında hanelerin CO_2 tasarruflarını daha fazla göz önünde bulundurmalarını yansıtır. $E_{GP,toplam}$ bir kırılma noktası oluşturur ve $E_{GP,i}$ bu ortalama değerin altında iken ajanların PV sisteminden elektrik üretmesi pozitif marjinal etki yaratırken, üzerinde olduğu durumlarda PV sisteminden enerji üretmenin marjinal etkisi azalır (Palmer et al., 2015: 112).

$$U_{çevre,i}(t) = \frac{\exp\left(\frac{E_{GP,i}(t) - E_{GP,toplam}(t)}{10000}\right)}{1 + \exp\left(\frac{E_{GP,i}(t) - E_{GP,toplam}(t)}{10000}\right)} \tag{20}$$

$$E_{GP,i}(t) = \sum_{t=1}^{20} E_{güneş} P_{max}(t_0)(1-\gamma)^{t-1} \tag{21}$$

$$E_{GP,toplam}(t) = \frac{\sum_{j=1}^{N} x_i(t) E_{GP,i}}{\sum_{i=1}^{N} x_i(t)} \tag{22}$$

3.2.3. Gelir Faydası

Gelir faydası, hanehalkının yıllık kullanılabilir gelirinin adaptasyon kararı üzerindeki etkisini tanımlar. Denklem 23'te yer alan w_i i.ci ajanın her bir hane üyesine düşen yıllık kullanılabilir gelirini, w ise toplumda her bir hane üyesine düşen yıllık ortalama kullanılabilir geliri ifade eder (Palmer et al., 2015). Hane başına yıllık kullanılabilir gelir ve hane üyesi başına yıllık ortalama kullanılabilir gelir aritmetik ortalamalar alınarak hesaplanır. N ve h_i sırasıyla toplumdaki hane sayısını ve i. ajanın hanehalkı sayısını temsil eder.

$$U_{gelir,i}(t) = \frac{\exp\left(\frac{w_i - w}{10000}\right)}{1 + \exp\left(\frac{w_i - w}{10000}\right)} \tag{23}$$

$$w_i = \frac{\sum_{j=1}^{h_i} w_j}{h_i} \tag{24}$$

$$w = \frac{\sum_{i=1}^{N} w_i}{N} \tag{25}$$

3.2.4. İletişim Faydası

Çalışmada ajanlar arası etkileşimler iletişim faydası ve sosyal normlar olmak üzere iki farklı şekilde temsil edilir. İletişim faydası iki veya daha fazla ajan arasında etkileşim olduğu durumda ortaya çıkar (Zhao et al., 2011: 2195; Iachini et al., 2015: 144; Palmer et al., 2015: 114; Pearce & Slade, 2018: 101). İletişim faydası, ajanların sahip olduğu bilgi ve tecrübenin etkileşime girdikleri ajana yayılması sonucunda ortaya çıkar. Başka bir ifadeyle ajanlar diğer ajanlar ile etkileşime girdiklerinde onların tecrübe ve bilgilerini öğrenerek elde ettikleri bilgiden de fayda sağlarlar. Aynı sosyoekonomik sınıftan ajanlar arasındaki iletişim etkisi daha güçlüdür (Rogers, 2003: 5).

İletişim faydası ajanların etkileşim içerisinde oldukları ajanlar ile ilişkilerinden sağladıkları fayda düzeyini temsil eder ve ajanların PV sistemine adaptasyon sağlamış olan komşularının oranı ile hesaplanır (McCoy & Lyons, 2014). Denklem 26'da $A_{i,j}$ simgesi ile gösterilen komşuluk matrisi ajanların iletişim kurdukları ajanları başka bir deyişle komşularını, k_i ise i.ci ajanın komşu sayısını tanımlar.

$$U_{\text{iletişim},i}(t) = \frac{\sum_{j=1}^{N} A_{ij} x_j(t)}{k_i} \tag{26}$$

$$A_{i,j} = \begin{cases} 1, & \text{i ajanı j ajanı üzerinde etkiye sahipse} \\ 0, & \text{i ajanının j ajanı üzerinde etkisi yoksa} \end{cases} \tag{27}$$

3.2.5. Sosyal Normlar

Sosyal normlar, toplumun inovasyona karşı yaklaşımının bir ölçüsüdür. Toplumun yenilenebilir enerjiye ilişkin tutumunu göstermenin yanı sıra toplumun kültürünü de yansıtan bir olgu olarak karşımıza çıkar. Aynı zamanda tıpkı iletişim faydasında olduğu gibi, ajanların toplumda yer alan bilgiyi toplum ile etkileşimleri sayesinde almaları ve bu bilgiden fayda sağlamaları sonucunda ortaya çıkar. Sosyal normlar, tüm nüfus içerisinde PV sisteme yatırım yapan hane oranına eşittir ve aşağıdaki denklemle hesaplanır (McCoy & Lyons, 2014: 7).

$$U\_sosyal(t) = \frac{1}{N} \sum_{i=1}^{N} x_i(t) \tag{28}$$

3.3. Veri Seti

Hanehalkı tüketim harcamaları deseni ve gelir dağılımını araştıran anketlerden ilki 1994 yılında hanehalkı gelir ve tüketim harcamaları anketi başlığı altında ortaya çıkar. Bu yıldan sonra ise 2002 yılından itibaren düzenli olarak her yıl gerçekleştirilen hanehalkı bütçe anketi uygulanmıştır. Çalışmada hanehalkı bütçe araştırması verileri TÜİK tarafından izin alınarak kullanılmaktadır (TÜİK, 2020). Kamu politikalarındaki önemli değişiklikler göz önünde bulundurularak çalışmada 2010-2019 yılları arasındaki veri setinden yararlanılır.

PV sistem yatırımlarını belirleyen en önemli unsurlardan birisi PV sistem maliyetlerini belirleyen sistemin kW başına fiyatıdır. PV sistem kW başına fiyatı baz alınan yıldaki fiyat ve toplam kurulu kapasiteye göre belirlenir. PV sistemin 2010 yılı kW başına vergiler hariç fiyatı ortalama bir değer olarak 2.5 € kabul edilir (EPIA, 2011; Dinçer, 2011). Küresel düzeyde toplam kurulu PV sistem kapasitesi, 2010-2019 yılları için Owid (our world in data) gerçek verilerine ve 2020-2024 yılları için simülasyon tahminlerine (ESP, 2020) göre alınır. 2025 yılından itibaren toplam kurulu PV sistem kapasitesi ortalama büyümeler dikkate alınarak hesaplanır.

Çalışmada kullanılan tüm değişkenler EK 1'de yer almaktadır. EK 1'de değişkenlerin simgeleri ve nasıl belirlendiği kısaca özetlenmektedir.

3.4. Sosyoekonomik Sınıflandırma

Türkiye'de Veri Araştırma, Televizyon İzleme Araştırmaları Kurulu, Türkiye Araştırmacılar Derneği, MAYAK Araştırma gibi kuruluşlar ve araştırmacılar (Kalaycıoğlu vd., 2010) tarafından gerçekleştirilen bazı sosyoekonomik sınıflandırmalar bulunmaktadır. Türkiye'ye özgü sosyoekonomik sınıflandırma endeksleri incelendiğinde çoğu endekse göre istatistiki olarak daha güvenli olması ve neredeyse tamamına göre daha güncel olması sebepleriyle çalışmada Kalaycıoğlu vd. (2010)'nin sınıflandırması temel alınmıştır.

Şekil: 3
Sosyoekonomik Sınıfların Oranları
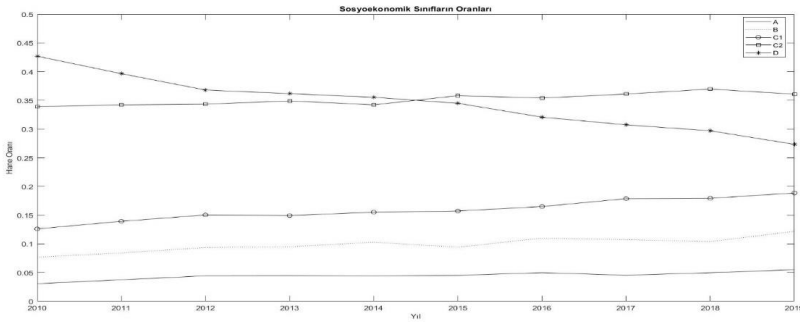
Sosyoekonomik sınıflandırmanın belirlenmesinde hane üyelerinin eğitim düzeyi, kişi başına düşen ortalama hane geliri, hane iş gücünün meslek statüsü, hanenin sahip olduğu mülkler başka ifadeyle hanenin servet bilgisi ve hanenin sahip olduğu eşya bilgisi kullanılmaktadır (Kalaycıoğlu vd., 2010). Bu sınıflandırmaya göre Türkiye'de en yüksek sınıf grubu A olmak üzere, A, B, C1, C2 ve D olarak isimlendirilen beş farklı grup bulunur.

Şekil 3'e göre A, B, C1 ve C2 gruplarının nüfus içerisindeki oranı zamanla düşük bir ivmeyle artarken, D grubunun oranı azalmıştır. Şekil 4'e göre ise C1, C2 ve D gruplarında

PV sistem yatırımları zamanla artmıştır ve toplam adaptasyon oranının yükselmesinde bu grupların adaptasyon kararı etkilidir.

Şekil: 4
Sosyoekonomik Sınıfların Adaptasyon Oranları
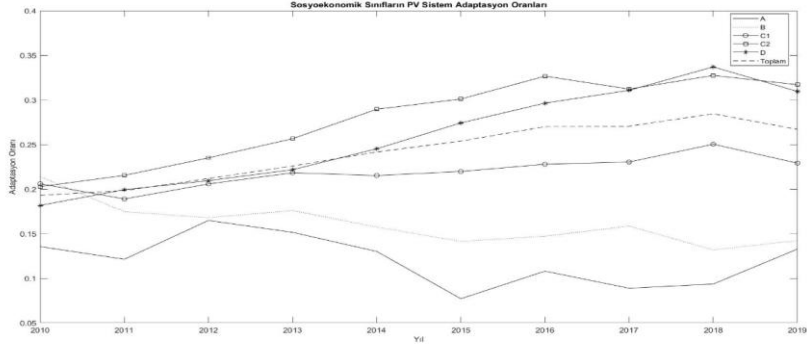
3.5. Ağ Yapısı

Küçük dünya ağları gerçek dünya ile daha uyumludur ve teknoloji difüzyon süreçlerini daha iyi yansıtır (Watts & Strogatz, 1998). Çalışmada yer alan ağ yapısının küçük dünya ağları özelliklerini taşıdığı kabul edilir (Palmer et al., 2015; Rai & Robinson, 2015; Stavrakas et al., 2019). Oluşturulan ağ için dışsal komşuluk oranının bir ölçüsü olan bağlanma olasılığı (β) değeri 0.1 ve komşu sayısının ölçüsü olan K değeri 4 olarak alınır (McCoy & Lyons, 2014). Ağ için başlangıç koşulları 2010 yılı veri setine göre oluşturulmuştur.

4. Tahminler

4.1. PV Sistem Adaptasyon Olasılığının Hesaplanması

Hanelerin inovasyona karşı tutumunu gösteren herhangi bir ölçüt mevcut anketlerde yer almamaktadır. İnovasyona karşı tutumu belirten bir değişken olarak hanelerin PV sistem yatırımı yapma olasılığı, gözlenebilir bağımsız değişkenler kullanılarak ikili adaptasyon modeli ile belirlenir (Schreinemachers et al., 2009: 521). İnovasyon difüzyon eğrilerinin S-şekilli yapısını iyi bir şekilde tanımladığı için lojistik fonksiyon kullanılır (Meade & Islam, 2006; Plötz et al., 2014). Kümülatif lojistik olasılık fonksiyonunda p_i adaptasyon olasılığını gösterirken, α, ξ_j ve U_j, sırasıyla sabiti, katsayıları ve bağımsız değişkenleri temsil eder.

$$p_i = \frac{1}{1+e^{-(\alpha+\sum_{j=1}^{5}\xi_j U_j)}} \tag{29}$$

Çalışmada yer alan bağımsız değişkenler, ekonomik fayda, çevre faydası, gelir faydası ve iletişim faydası olmak üzere fayda bileşenlerini temsil eder. Logit model

kullanılarak fayda bileşenlerinin PV sistem adaptasyon kararı üzerindeki etkisi araştırılır başka bir ifadeyle kümülatif lojistik olasılık fonksiyonundaki katsayılar belirlenir. Logit modelinde katsayılar, bağımsız değişkenin bağımlı değişkenin gerçekleşme olasılığını hangi yönde etkilediğini ifade eder. Bu çalışmada logit modelden elde edilen katsayılar PV sistem adaptasyon olasılığının katsayılarını temsil eder. Logit tahmininde bağımlı değişken PV sistem yatırım kararının verilmesi başka bir deyişle yeni teknolojiye adaptasyonun sağlanmasıdır. Bağımlı değişken PV yatırım kararının alındığı durumlarda 1, adaptasyonun olmadığı durumlarda ise 0 değerini alır.

Logit tahmininde kullanılan veri seti 2010-2019 yılları TÜİK hanehalkı bütçe anketinden faydalanılarak hazırlanır. Bu yıllarda sıcak su elde etmek için güneş enerjisi kullanan hanelerin bağımlı değişkeni 1 değerini alır. Hanelerin ekonomik faydası, çevre faydası, gelir faydası ve iletişim faydası model bölümünde belirtildiği gibi hesaplanır. İletişim faydasının hesaplanabilmesi için her yıla özgü hane sayısına göre küçük dünya ağları meydana getirilir. Çevre faydasının hesaplanmasında kullanılan kişilerin ürettiği güneş enerjisi miktarı, simülasyon başlangıç koşulları oluşturulurken benimsenen varsayımla benzer şekilde son on yılın ortalama verimlilik değeri alınarak hesaplanır. Değişkenlerin tanımlayıcı istatistikleri ve korelasyon matrisi Tablo 1 ve Tablo 2'de yer almaktadır.

Tablo: 1
Değişkenlerin Tanımlayıcı İstatistikleri

Değişkenler	Ortalama	Standart Hata	Minimum	Maksimum
X (Adaptasyon Kararı)	0.2439	0.4294	0	1
Ekonomik Fayda	0.4431	0.1761	0	1
Çevre Fayda	0.7132	0.0887	0.3968	1
Gelir Fayda	0.4842	0.1438	0.2722	1
İletişim Fayda	0.2439	0.2602	0	1
Sosyal Normlar	0.2439	0.0308	0.1929	0.2844
Gözlem Sayısı: 109271				

Tablo: 2
Korelasyon Matrisi

Değişkenler	X (Adaptasyon Kararı)	Ekonomik Fayda	Çevre Fayda	Gelir Fayda	İletişim Fayda	Sosyal Normlar
X (Adaptasyon Kararı)	1					
Ekonomik Fayda	0.0354	1				
Çevre Fayda	0.2773	0.0025	1			
Gelir Fayda	-0.1186	0.2529	-0.0386	1		
İletişim Fayda	0.5538	0.0684	0.2000	-0.1446	1	
Sosyal Normlar	0.0718	0.8801	0.0088	-0.0057	0.1182	1

Logit tahmin sonuçları ise Tablo 3'te gösterildiği gibidir. Logit tahminine göre gelir faydasının katsayısı negatiftir. Literatürde gelirle yenilenebilir enerji arasında genel olarak kabul edilen pozitif yönlü ilişkinin sadece varsayımlardan kaynaklandığını, doğrusal olmayan etkiler veya servet etkilerine göre ilişkinin yönünün değiştiğini gösteren çalışmalar bulunmaktadır (Best & Chareunsy, 2022; Mahn et al., 2024). Gelir faydasının negatif katsayıya sahip olması, ilgili dönem için Türkiye'de gelirle yenilenebilir enerji adaptasyonu arasında ters yönlü bir ilişki olduğunu gösterir. Gelirle yenilenebilir enerjiye geçiş arasındaki negatif yönlü ilişki literatürdeki çalışmalarla uyumludur (Bashiri & Alizadeh, 2018: 3137;

Van der Kam et al., 2018: 76; Best & Chareunsy, 2022; Mahn et al., 2024). Logit tahmininde kullanılan örneklem 2010-2019 yılları TÜİK hanehalkı bütçe anketinden elde edilmiştir. Türkiye'de 2011-2017 yıllarında ise PV sistem yatırımlarını teşvik etmek amacıyla 13,3 sent sabit fiyat alım tarifesi uygulanmıştır. Dolayısıyla ilgili yıllarda PV yatırımının avantajlı olması, düşük gelirli haneler için PV sistemlerin gelir kaynağı olarak değerlendirilmesine yol açmış olabilir. Ek gelir kaynağı motivasyonu ise gelirle PV sisteme geçiş arasında ters yönlü bir ilişkiyi doğurmuş olabilir. Bununla birlikte yüksek gelirli haneler için PV sisteme geçişin çevreyi koruma motivasyonundan ziyade bir prestij kaybı olarak algılanması da ters yönlü ilişkiyi destekleyebilir.

Tablo: 3
Logit Tahmin Sonuçları

Bağımsız Değişken	Katsayı	Standart hata
Ekonomik Fayda	0.3495***	0.1246
Çevre Fayda	6.8316***	0.1018
Gelir Fayda	-1.2392***	0.0754
İletişim Fayda	5.1779***	0.037
Sosyal Normlar	0.0854	0.6806
Sabit	-7.3222***	0.158
Gözlem Sayısı: 109271		
Wald chi2: 24179.41		
Prob > chi2: 0.0000		

Standart hatalar robust değerlerdir. *, ** ve *** sırasıyla %10, %5 ve %1 anlamlılık düzeyini ifade etmektedir.

Logit modelden elde edilen katsayılara göre hanelerin PV sistem adaptasyon olasılığı Denklem 29 aracılığıyla hesaplanır. Tahmin sonuçlarına göre sosyal normlar dışında fayda bileşenlerinin tamamı adaptasyon kararı üzerinde %1 anlamlılık düzeyinde etkiye sahiptir. Şekil 5'te yer alan ROC eğrisi, modelin PV adaptasyon kararını açıklamaktaki yeterliliğini göstermektedir. ROC eğrisine göre model yaklaşık %87 oranında doğru tahmin üretmektedir.

Şekil: 5
ROC Eğrisi
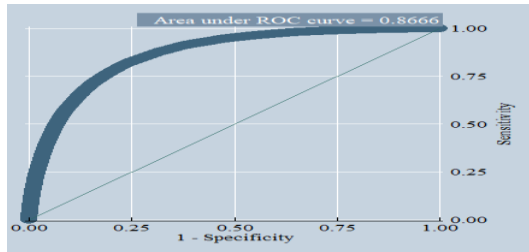
4.2. Sosyal Etkileşimlerin Etkinliğinin Belirlenmesi

Fayda fonksiyonu bileşenlerinin PV sistem adaptasyonu üzerindeki etkisi, standardize edilmiş değişkenler kullanılarak elde edilen logit tahminine göre karşılaştırılır. Standardize edilmiş değişkenler ile logit tahminindeki marjinal etkiler, bağımsız değişkenlerdeki bir standart sapmalık değişimin bağımlı değişken üzerinde yarattığı

değişimi gösterir. Marjinal etkiler incelendiğinde, PV sistem difüzyon sürecinin temel belirleyicisinin iletişim faydası olduğu görülmektedir. Başka bir ifadeyle iletişim faydası, PV sistem yatırım kararında diğer fayda bileşenlerine göre daha fazla etkiye sahiptir.

Tablo: 4
Standardize Edilmiş Logit Tahmin Sonuçları

Bağımsız Değişken	Katsayı	Standart Hata
Ekonomik Fayda	0.0615	0.0219***
Çevre Fayda	0.6058	0.009 ***
Gelir Fayda	-0.1782	0.0108***
İletişim Fayda	1.3474	0.0096***
Sosyal Normlar	0.0026	0.021
Sabit	-1.6111	0.0096***
Gözlem Sayısı: 109271		
Wald chi2: 24179.41		
Prob > chi2: 0.0000		

*Standart hatalar robust değerlerdir. *, ** ve *** sırasıyla %10, %5 ve %1 anlamlılık düzeyini ifade etmektedir. Marjinal etkiler, ortalamada değerlerdir.*

4.3. Kalibrasyon ve Doğrulama

Sosyoekonomik sınıfların eşik değerlerinin belirlenmesinde dolaylı kalibrasyon yöntemi benimsenir (Fagiolo et al., 2007: 208-210). Bu yönteme göre sosyoekonomik sınıfların eşik değerlerinin belirlenmesinde farklı değerler yazar tarafından kullanılır ve gerçek veri ile en uyumlu olan değerler eşik değer olarak belirlenir (Palmer et al., 2015: 118). Çalışmada kullanılan eşik değerler 2011-2016 yılları arasındaki veri setine göre yazar tarafından belirlenmiş, modelin ve parametrelerin doğrulaması ise 2017-2019 yılları toplam adaptasyon oranı verisi kullanılarak yapılmıştır. Çalışmadaki tüm modeller için belirlenen eşik değerler Tablo 5'te listelenmektedir. Eşik değerler, PV sisteme geçişin maliyetinin bir ölçüsü olarak değerlendirilebilir.

Tablo: 5
Sosyoekonomik Sınıfların Eşik Değerleri

| Sosyoekonomik Sınıf	A	B	C1	C2	D
Eşik Değer	0.96	0.95	0.79	0.49	0.57

Şekil: 6
Dinamik Ağ
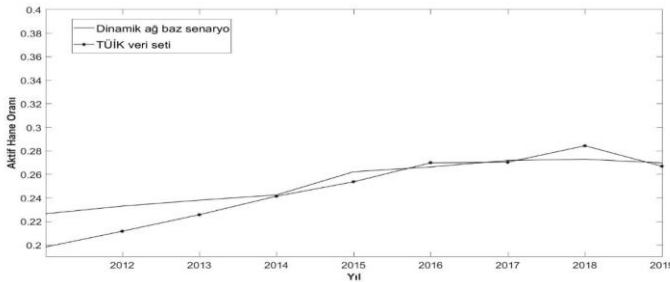
2011-2019 yılları baz senaryo ve anket verilerinden oluşturulan PV sistem adaptasyon oranları Şekil 6'da yer alır. 2011-2016 ve 2017-2019 yılları simülasyon sonuçları anket verileri ile uyumlu olduğundan modellerin ve parametrelerin doğrulandığı kabul edilir. Şekil 6 incelendiğinde, anket verilerinden elde edilen adaptasyon oranının yukarı yönlü ivmesi 2018 yılında artarken, simülasyon sonuçları bu artışı yakalayamaz. Bu fark, 2018 yılındaki politika değişikliğine ilişkin beklentilerin 2017 yılında ortaya çıkmasına ve kurulumu 2018 yılında olsa da 2017 yılı sonuna kadar alınan izinler için sabit fiyat tarifesi uygulamasının geçerli olmasına dayanabilir.

4.4. Duyarlılık Analizi

Çalışmada duyarlılık analizi parametre kalibrasyonuyla ele alınır. Modelin parametre değerlerine duyarlılığı farklı eşik değerlerindeki adaptasyon oranlarına göre araştırılır. Duyarlılık analizi aynı zamanda modelin doğruluğunun da araştırılmasına olanak tanır. PV sistem adaptasyonunun maliyetini temsil eden eşik değer arttığı zaman PV sistem adaptasyonunun azalması beklenir. Eşik değer azaldığı zaman ise PV sistem adaptasyonunun artması gerekir.

Şekil: 7
Dinamik ağ Modeli (Eşik Değer Duyarlılığı)
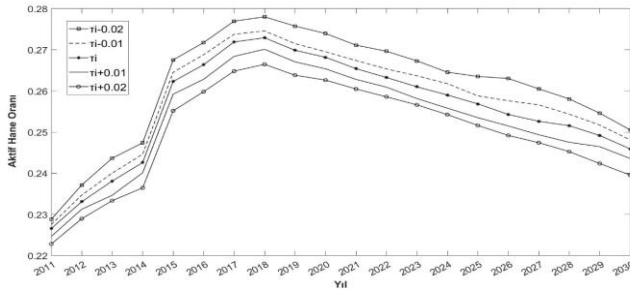
Şekil 7 incelendiğinde, modelin eşik değer duyarlılığı beklendiği gibidir. Eşik değerin arttığı durumlarda adaptasyon oranı (aktif hane oranı) azalırken, azaldığı durumlarda adaptasyon oranı (aktif hane oranı) artar.

5. Simülasyon

Çalışmada ele alınan modelin duyarlılığı ve doğruluğu yedi farklı senaryo altında incelendi. Bunlardan ilki baz senaryo olarak nitelendirilir ve mevcut mahsuplaşma politikasının devam ettiği varsayımı altında PV sistem adaptasyonu araştırılır. Baz senaryo simülasyonlarının ardından iki farklı durum için difüzyon süreci incelenir.

Bunlardan ilki PV sistem ilk yatırım maliyetlerinin değişmesidir ve senaryo2 olarak adlandırılmıştır. İlk yatırım maliyetlerini belirleyen temel unsur kW başına PV sistem

fiyatlarıdır ki bu da kümülatif kurulu kapasite ile orantılıdır. Yüksek senaryoda kümülatif kurulu kapasitenin beklenenden %20 fazla olduğu durumdaki PV sistem ilk yatırım maliyetleri, düşük senaryoda ise kümülatif kurulu kapasitenin beklenenden %20 düşük gerçekleştiği maliyetler dikkate alınmaktadır.

İkinci durum ise PV sistem yatırımlarını teşvik eden kamu politikalarıdır. PV sistem yatırımlarını teşvik eden ve Avrupa'da yaygın olarak kullanılan en önemli politikalardan birisi sabit fiyat alım garantileridir. Sabit fiyat alım garantilerinin uygulanması senaryo3 olarak nitelendirilmiştir. Mahsuplaşma politikaları kapsamında öz tüketim fazlası elektriğin şebeke tarafından satın alınmasında uygulanan tarife şebekenin sattığı elektrik fiyatlarına eşittir ve ortalama 8 sent civarındadır. Önceki yıllarda uygulanan 13,3 sent sabit fiyat alım tarifesinin uygulanması yüksek senaryo tahminidir. Yüksek senaryoda son yıllardaki ortalama kur değişimi (2010-2020 yılları kur değerlerine göre ortalama %17 artış) de göz önünde bulundurularak tarife oluşturulur (Merkez Bankası, 2021). Tarifenin mahsuplaşma politikasına göre belirlenen fiyatlamanın %10 üstünde uygulanması orta senaryo, %10 altında olması ise düşük senaryo tahminidir.

PV sistem yatırımlarını belirleyen ikinci bir politika olarak PV sistem yatırımı için gerekli finansmanın sağlanması araştırılmış ve senaryo4 olarak isimlendirilmiştir. Hanelerin PV sistem yatırımları için ihtiyaç duydukları kredilere tüketici kredisine göre daha düşük faiz oranlarına sahip konut kredisi faiz oranlarının uygulandığı varsayımı yüksek senaryoyu oluşturur. PV sistem finansman maliyetinin indirilmesi PV sistemden beklenen getirilerin bugüne indirgenmiş değerinin artması anlamına gelir. Dolayısıyla sistemin geri ödeme süresi indirgenerek, ekonomik faydası artırılır. Düşük senaryoda ise mevcut tüketici kredisi faiz oranlarının %5 arttığı kabul edilmektedir.

PV sistem yatırımlarına ilişkin kamu politikalarının temel amacı geri ödeme süresinin kısaltılmasıdır. Türkiye'nin PV sistem yatırımlarını artırmasının geri ödeme sürelerinin kısaltılmasına bağlı olduğunu vurgulayan çalışmalar yer almaktadır (Flora et al., 2019: 8; Duman & Güler, 2020: 709). Alternatif bir senaryo olarak, uygulanan kamu politikasının içeriğine bakılmaksızın, geri ödeme sürelerinin kısalması senaryo5 başlığı altında incelenmiştir. PV sistem yatırımlarının geri ödeme sürelerinin 7 yıla ve 3 yıla düşürülmesi durumunda adaptasyon oranları araştırılmıştır.

Çalışmada ele alınan bir diğer senaryo, hanelerin PV sistem adaptasyonunu zorunlu hale getiren düzenlemelerin uygulanmasıdır ve senaryo6 olarak isimlendirilmiştir. Bu senaryo iki aşamada incelenir. Birinci aşamada daha önce PV sistem adaptasyonu olmayan haneler tespit edilir. Bu hanelerden rassal olarak belirlenen hanelerin zorunlu olarak PV sistem yatırımı yaptıkları varsayılır. Zorunlu PV sistem yatırımı yapacak hane sayısı, daha önce PV sistem kullanmayan haneler içerisinden 50 hane, 100 hane ve 150 hane olarak alınır. İkinci aşamada, bu politikanın farklı sosyoekonomik statülerde uygulanmasının etkileri araştırılır. A, B, C1, C2 ve D statülerinde bulunan ve daha önce PV sistem adaptasyonu olmayan hanelerden 50 tanesi rassal olarak seçilir.

Son olarak kamu politikasındaki farklılaşmanın etkisini araştırmak için senaryo7 incelenmiştir. Senaryo7'de PV sistemlerinde 2018 yılına kadar uygulanmakta olan sabit fiyat alım politikasının devam etmesi durumu araştırılır. Böylelikle kamunun PV sistemler için belirlediği mahsuplaşma politikası ile sabit fiyat alım tarifesi politikası karşılaştırılır başka bir ifadeyle kamu politikasındaki değişim incelenir.
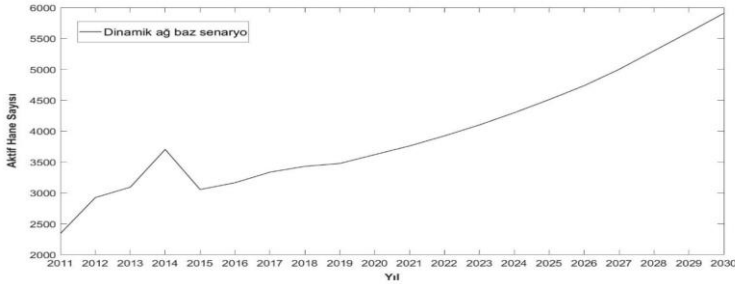
5.1. Baz Senaryo

2020-2030 yılları arasındaki PV sistem ortalama geri ödeme süresi 13,8 yıl olarak hesaplanmaktadır (Geri ödeme süresinin hesaplanma aşamaları Bölüm 3.2.1'de yer almaktadır). Hesaplanan geri ödeme süreleri literatürde yer alan çalışmalarla uyumludur (Güngül vd., 2018; Acar vd., 2020: 27-28).

Şekil: 8
Baz Senaryo Adaptasyon Oranı
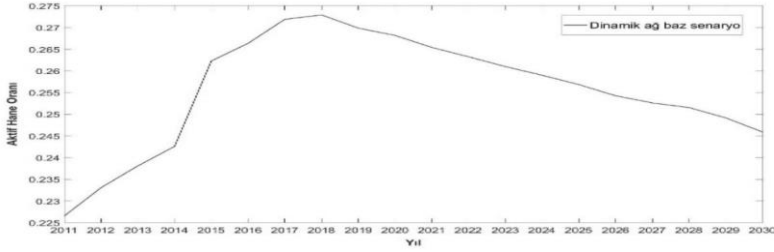
Şekil: 9
Baz Senayo PV Sisteme Adaptasyon Sağlayan Toplam Hane Sayısı

Baz senaryodaki mahsuplaşma politikalarına göre belirlenen geri ödeme sürelerinin PV sistem yatırımını ekonomik açıdan cazip kılan seviyenin altında olduğu açıktır (Flora et al., 2019: 2). Baz senaryoya göre belirlenen adaptasyon oranı grafikleri de hanehalkının PV sistem yatırımı konusundaki isteksizliğini desteklemektedir. PV sistem adaptasyon oranları zamanla düşmektedir. PV sistem yatırımları cazibesini kaybettiği için yeni adaptasyon sayısı düşerken, zamanla hane sayısı arttığı için adaptasyon oranlarında düşüş gözlenmektedir.

Şekil 9 göz önünde bulundurulduğunda, Şekil 8'deki adaptasyon oranlarındaki azalmanın temel sebebi PV sistem adaptasyon sayısının yeni hane sayısından çok daha az kalmasıdır. Şekil 9'da yıllar itibariyle hanelerin PV sistem adaptasyonunun devam ettiği daha açık bir şekilde görülmektedir. Bununla beraber 2011-2018 yıllarında PV sistem adaptasyonunun kazandığı ivme sonraki yıllarda devam ettirilemez.
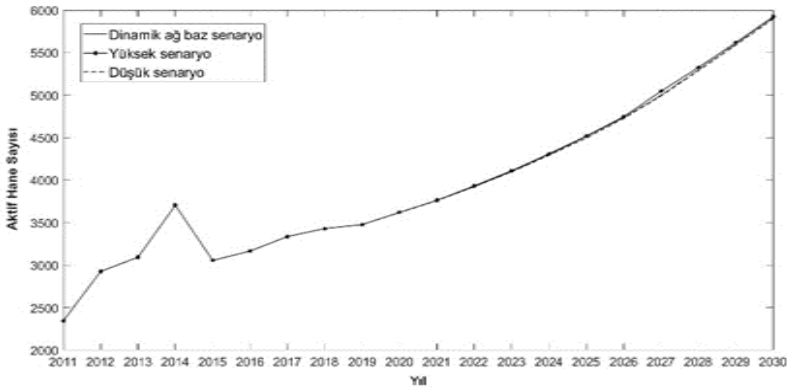
5.2. İlk Yatırım Maliyetleri

İlk yatırım maliyetleri, kümülatif kurulu kapasite ile ters orantılıdır. Başka bir ifadeyle küresel düzeyde toplam kurulu kapasite artarsa ilk yatırım maliyetleri düşer, küresel düzeyde toplam kurulu kapasite azalırsa ilk yatırım maliyetleri artar. Yüksek senaryoda kümülatif kurulu kapasitenin beklenenden fazla olması, düşük senaryoda ise beklenenden az olması değerlendirilmektedir.

Şekil: 10
Senaryo2 (İlk Yatırım Maliyetleri)
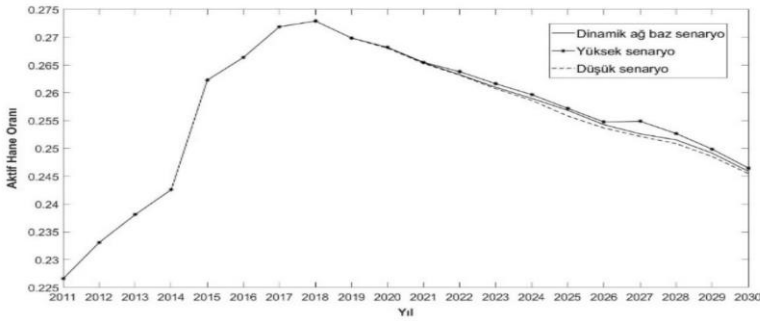
Şekil: 11
**Senaryo2 PV Sisteme Adaptasyon Sağlayan Toplam Hane Sayısı**

İlk yatırım maliyetlerindeki değişiklikler göz önüne alındığında baz senaryo, yüksek senaryo ve düşük senaryonun neredeyse aynı sonuçları ürettiği Şekil 10 ve Şekil 11'de görülmektedir. Baz senaryoya göre nispi değişiklikler çok az olsa da yüksek senaryoda beklendiği gibi adaptasyon oranları artarken, düşük senaryoda azalır. Bunula birlikte difüzyon patikasının yöneliminde herhangi bir değişiklik meydan gelmez. Adaptasyon oranlarındaki değişimin küçük olmasının temelinde küresel toplam kurulu kapasiteye göre belirlenen PV sistem fiyatlarının Euro üzerinden belirlenmesi yer almaktadır. Türkiye'de ortalama Euro kuru artışının yaklaşık %15 olarak belirlendiği göz önünde bulundurulduğunda PV sistem fiyatlarındaki düşüşün hanehalkını yatırıma yönlendirememesi anlaşılır hale gelir.

Şekil: 12
Senaryo3 (Sabit Fiyat Alım Tarifeleri)
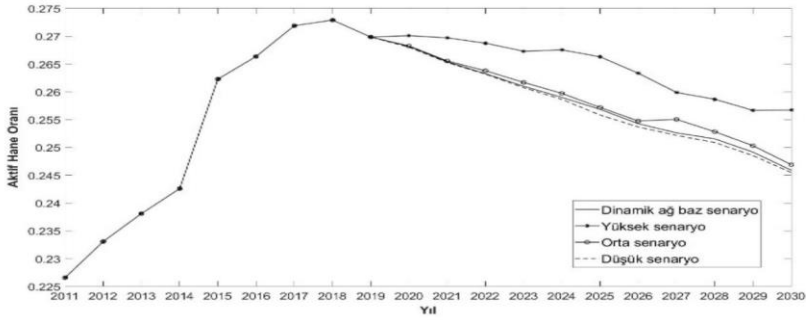
Şekil: 13
Senaryo3 PV Sisteme Adaptasyon Sağlayan Toplam Hane Sayısı
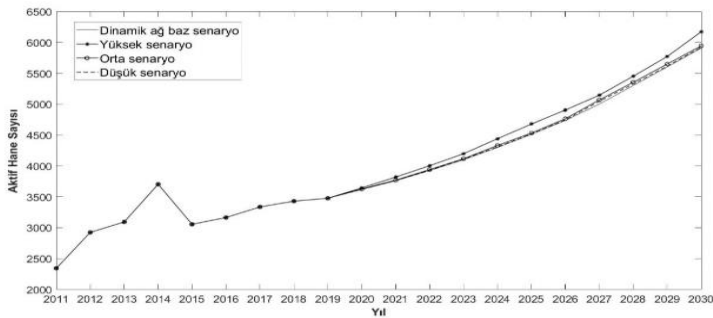

5.3. Sabit Fiyat Alım Tarifeleri

Sabit fiyat alım tarifelerinin değerlendirildiği simülasyon sonuçları Şekil 12'de yer almaktadır. Grafikler açıkça göstermektedir ki hanehalkı PV sistem yatırımı yapmak için

teşvike ihtiyaç duymaktadır. Yüksek senaryoda uygulanan tarifeler mevcut politikanın çok üzerinde olduğu için PV sistem adaptasyon oranlarında baz senaryoya göre önemli bir artış olur. Orta ve düşük senaryolar ise hanehalkını yatırıma ikna etmekte yetersiz kalmaktadır. Bununla birlikte yüksek senaryoda bile 2011-2018 yılları arasındaki difüzyon hızına erişilemez.
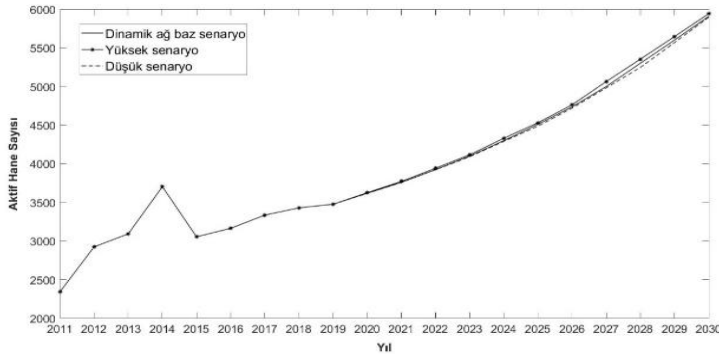
5.4. PV Sistem Finansmanı

Geri ödeme süresini belirleyen unsurlardan bir diğeri de PV sisteminden elde edilen getirilerin net bugünkü değerinin hesaplanmasında kullanılan indirgeme oranıdır. Çalışmada indirgeme oranları her hane için heterojen olarak ve reel faiz oranları kullanılarak oluşturulmaktadır. Dolayısıyla PV sistem finansmanında uygulanan farklı faiz oranları da yatırım kararı üzerinde belirleyici role sahiptir.

Şekil: 14
Senaryo4 (PV Sistem Finansmanı)
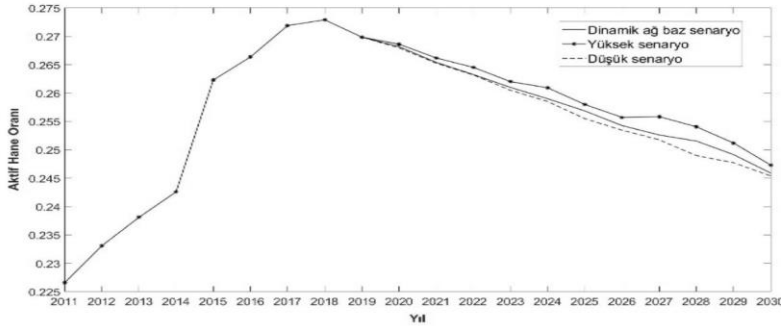
Şekil: 15
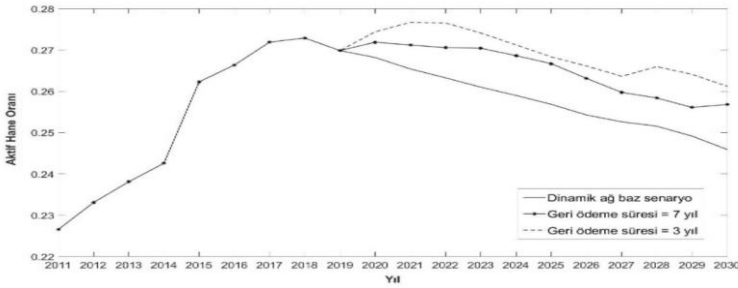**Senaryo4 PV Sisteme Adaptasyon Sağlayan Toplam Hane Sayısı**

Farklı faiz oranlarının adaptasyon üzerindeki etkisi Şekil 14 ve Şekil 15'te yer almaktadır. Yüksek senaryoda adaptasyon oranları yüksek, düşük senaryoda ise düşük olarak tahmin edilir. PV sistem yatırımı için ihtiyaç duyulan finansmanın daha düşük faiz oranlı krediyle fonlanması PV sistemine geçişi hızlandırırken, daha yüksek faiz oranlı krediler PV sisteme geçişin önünde bariyer oluşturacaktır. Bununla birlikte uygulanan faiz oranlarının birbirine oldukça yakın olması sebebiyle difüzyon patikalarının ve PV sisteme adapte olan toplam hane sayısının baz senaryoya çok benzer olduğunu belirtmek gerekir.
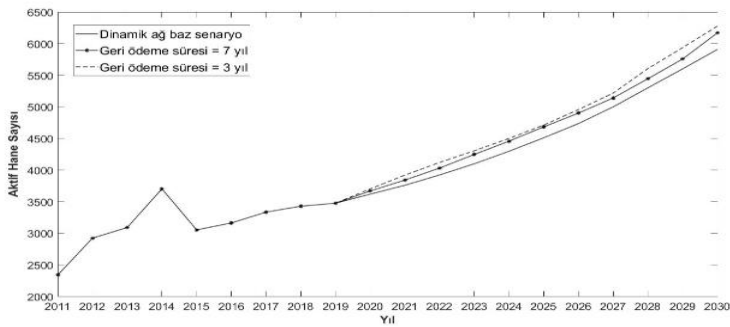
5.5. Geri Ödeme Süreleri

Şekil 16'da açıkça görülmektedir geri ödeme sürelerinin düşürülmesi PV sistem yatırımlarının 2011-2018 yıllarında kazandığı ivmeyi kazanabilmesi için gereklidir. PV sistem yatırımının geri ödeme süresi yatırımın rasyonel hale geldiği seviyelere düşerse adaptasyon oranı baz senaryoya göre artmaktadır.

Şekil: 16
Senaryo5

Şekil: 17
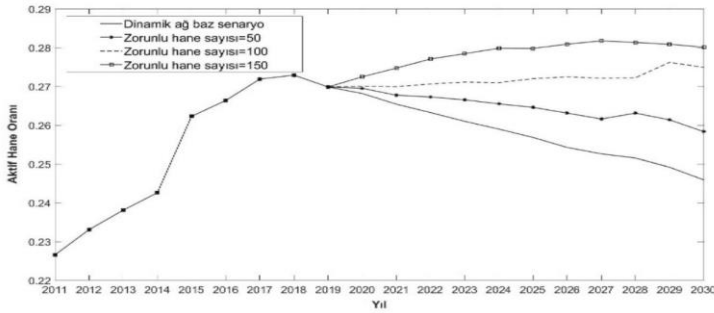**Senaryo5 PV Sisteme Adaptasyon Sağlayan Toplam Hane Sayısı**

PV sistem geri ödeme süresinin 7 yıla düşürülmesi, sabit fiyat alım tarifelerinin 13,3 sente çıkarılmasına oldukça benzer sonuçlar üretmektedir. Geri ödeme süresinin 7 yıla düşürülmesi baz senaryoya göre önemli artışlar olmasını sağlasa da 2011-2018 yıllarındaki difüzyon ivmesinin yakalanmasına yetmez. Geri ödeme süresinin 3 yıla düşürülmesi ise yukarı yönlü ivmenin birkaç yıl daha devam etmesini sağlarken, sonraki yıllarda baz senaryoya benzer şekilde adaptasyon oranında azalış trendini ortaya çıkarmaktadır. Bununla beraber adaptasyon hızını artırdığı açık bir şekilde görülmektedir. Şekil 16'ya göre geri ödeme süresinin 7 yıla düşürülmesinin etkisi daha fazla iken, 3 yıla düşürülmesi adaptasyon hızını artırsa da bu artış hızı zamanla azalmaktadır.
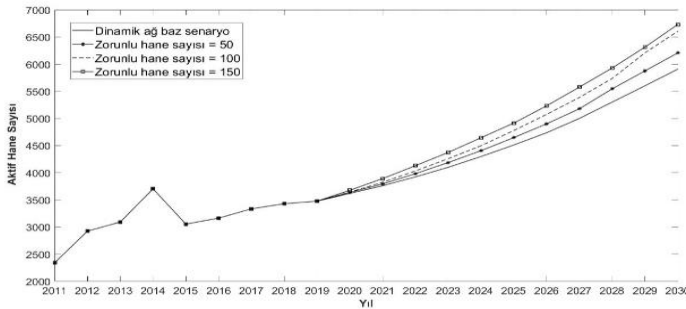
5.6. Zorunlu PV Sistem Adaptasyonu

PV sisteme getirilecek zorunlu yatırım düzenlemeleri sadece hanelerin bir kısmının adaptasyonunu sağlamayacak aynı zamanda sosyal etkileşimler aracılığıyla daha fazla sayıda hanenin adapte olmasını beraberinde getirecektir. Başka bir ifadeyle pozitif dışsallık etkisi ortaya çıkacaktır. Şekil 18 ve Şekil 19'da da bu durum açıkça görülmektedir.

Şekil: 18
Senaryo6

Şekil: 19
Senaryo6 PV Sisteme Adaptasyon Sağlayan Toplam Hane Sayısı

İkinci aşamada zorunlu PV sistem adaptasyon politikası hangi sosyoekonomik statüdeki hanelere uygulanmalı sorusunun cevabı aranmaktadır. Elbette ki böyle bir kamu politikasının hanelerin sosyoekonomik statüleri tespit edilerek bu statülere göre düzenlenmesi mümkün değildir. Nitekim hanelerin yerleşim yeri (yaşanılan bölge) seçimleri ile sosyoekonomik statüleri arasındaki sıkı ilişki oldukça açıktır. Dolayısıyla bu senaryoda aranan cevap zorunlu PV sistem yatırımı düzenlemesinin hangi sosyoekonomik statüye hitap eden yerleşim yerlerine uygulanması gerektiğidir.

Simülasyonlardan elde edilen sonuçlara göre zorunlu PV yatırım düzenlemesi D sosyoekonomik statüdeki hanelere uygulandığında en fazla etki ortaya çıkmaktadır. D sosyoekonomik statüyü C1 ve C2 statüsü takip eder. Üçüncü sırada A statü yer alırken düzenlemenin B statüye uygulanmasının en az etkiyi yarattığı görülmektedir. Şekil 4'e göre Türkiye'de A sosyoekonomik statüdeki hanelerin PV sisteme adaptasyon oranı düşüktür. A sosyoekonomik statüdeki hanelerin küçük bir bölümü zaman içerisinde PV sisteme geçiş sağladığı için, zorunlu PV sistem uygulaması B grubundan daha fazla etki yaratmaktadır. Her ne kadar en fazla sonuç D sosyoekonomik statüde sağlansa da böyle bir düzenlemenin uygulanmasının haneler üzerinde yaratacağı gelir eşitsizliği açısından da ayrıca değerlendirilmesi gerektiği açıktır.
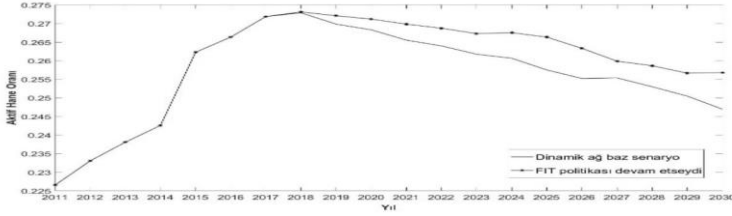
Şekil: 20
Senaryo6 Sosyoekonomik Statüye Göre Zorunlu PV Yatırım Düzenlemesi
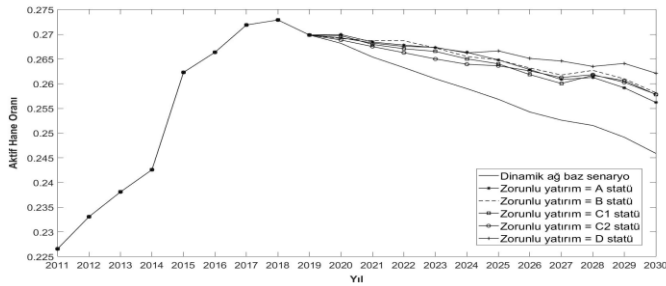

5.7. Kamu Politikaları Farklılaşması

Kamu politikalarındaki değişikliğin PV sistem adaptasyon eğrisini önemli ölçüde belirlediği görülmektedir. Şekil 21'e göre sabit fiyat alım tarifesi uygulanmaya devam edilseydi de PV sistem adaptasyon oranlarında azalma ortaya çıkacaktı. Başka bir ifadeyle sabit fiyat alım tarifesinin devam ettirilmesi, PV sistem yatırımlarını baz senaryoya göre önemli ölçüde artırsa da hane sayısındaki artışı karşılamaya yetmediği için adaptasyon oranındaki düşüşü engelleyemez. Şekil 22'de de sabit fiyat alım tarifesinin devam ettirildiği durumda adaptasyon hızının dolayısıyla PV sisteme adapte olan toplam hane sayısının arttığı görülmektedir.

Şekil: 21
Kamu Politikaları Karşılaştırması

Şekil: 22
Kamu Politikaları Karşılaştırması PV Sisteme Adaptasyon Sağlayan Toplam Hane Sayısı
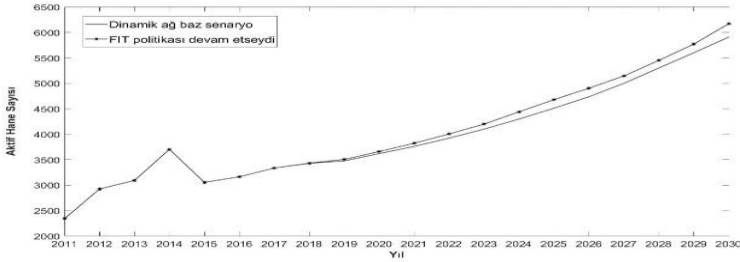
6. Simülasyon Değerlendirmesi

Türkiye'de 2011-2017 yıllarında uygulanan sabit fiyat alım tarifleri PV sistem yatırımlarının geri ödeme sürelerini önemli ölçüde azaltmıştır. Bu yıllarda yatırımın ekonomik etkisi hanehalkı adaptasyon kararlarında da açıkça görülmektedir. 2018 yılında uygulanmaya başlanan mahsuplaşma politikasıyla birlikte PV sistem yatırımları önceki yıllarda kazandığı ivmeyi kaybetmektedir. Her ne kadar TÜİK veri setinden elde edilen 2018 yılı adaptasyon oranlarında artış devam ediyor gözükse de bunun sebebi farklıdır. 2018 yılında yapılan mevzuat değişikliği 2017 yılında tartışılmaya başlanmıştır. Daha önemlisi 2017'de onay alan ve 2018'de kurulacak olan PV yatırımları da 13,3 sent sabit fiyat alım tarifesine tabii tutulmuştur. Dolayısıyla 2018 yılında difüzyon hızı azalsa bile küçük bir artış olmasının temelinde bunlar yer alır.

Simülasyon sonuçlarına göre 2018-2019 yıllarında uygulanan mahsuplaşma politikasının düzenlenmesi sonucunda hanelerin PV sistem adaptasyonu önemli ölçüde azalsa da devam etmektedir. Nitekim hane sayısındaki artışa göre yeni adaptasyon kararı çok az olduğundan hanehalkı adaptasyon oranları zamanla azalmaktadır. Bununla beraber 2011-2018 yıllarında adaptasyon eğrisinin kazandığı ivmeye erişilemediği de açık bir şekilde görülmektedir.

PV sistem adaptasyon oranlarının incelenmesinde kullanılan ilk yatırım maliyetleri, sabit fiyat alım tarifeleri ve faiz oranları yatırımın geri ödeme süresini belirlemektedir. Simülasyon sonuçları açıkça göstermektedir ki bu değişkenlerde meydana gelen nispi değişiklikler, PV sistem yatırımını teşvik etmeye yetmemektedir ve adaptasyon oranlarında önemli değişiklikler yaratmaz.

Difüzyon patikasının aşağı yönlü eğiliminin kırılması ancak geri ödeme süresinin 7 yıl, 3 yıl gibi önemli ölçüde indirgendiği veya 13,3 sent sabit fiyat alım tarifelerinin yeniden uygulanmaya başlandığı radikal politikalarla mümkündür. Nitekim bu politikalar bile 2011-2018 yıllarında kazanılan ivmeye ulaşılmasına ve yukarı yönlü difüzyon eğrilerinin elde edilmesine yetmez. Kamu politikalarının farklılaştırılmadan, 13,3 sent sabit fiyat alım tarifesinin uygulandığı durumda bile her ne kadar adaptasyon oranı baz senaryonun çok üzerinde olsa dahi, difüzyon hızında azalma trendi gözlenmektedir. Başka bir ifadeyle PV sisteme yatırım yapan hane sayısı topluma eklenen yeni hane sayısının gerisinde kaldığı için adaptasyon oranları azalmaya devam eder.

PV sistem adaptasyon oranlarının artırılması ve hatta 2011-2018 yılların adaptasyon hızının aşılması ancak zorunlu PV sistem yatırımı düzenlemesi ile mümkün olmaktadır. Çalışmada yeni konut sayıları dikkate alınmamış olmakla birlikte, hane sayılarındaki artışların konut taleplerini ve yeni konut sayısını artırdığı göz önünde bulundurulursa dolaylı da olsa çıkarımlar yapmak mümkündür. Yeni konutlara PV sistem zorunluluğunun getirilmesi hem ağ dışsallıkları sayesinde iletişim faydasını artırarak eski binalardaki hanelerde de adaptasyonu sağlayacak hem de dışsal bir şok gibi difüzyon patikasının ivmesini artıracaktır.

7. Sonuç

Türkiye'de PV sistem adaptasyonuyla ekonomik fayda, çevresel fayda, iletişim faydası ve sosyal normlar arasında pozitif bir ilişki bulunurken, gelir faydası ile adaptasyon olasılığı arasında negatif bir ilişki bulunmaktadır. Fayda fonksiyonu bileşenlerinin etkileri incelendiğinde, adaptasyon kararında en belirleyici unsurun iletişim faydası olduğu görülmektedir. Dolayısıyla Türkiye'de PV sistem difüzyon patikasını şekillendiren en önemli unsur tüketiciler arasındaki etkileşim başka bir ifadeyle ağ dışsallığının bir ürünü olan tüketiciler arasındaki bilgi difüzyonudur.

Türkiye'de 2011-2017 yılları arasında uygulanan 13,3 sent sabit fiyat alım tarifesi, PV sistem adaptasyonunu önemli ölçüde hızlandırmıştır. Mahsuplaşma politikasının uygulanmasıyla PV sistem geri ödeme süreleri uzarken, yatırımın ekonomik faydası düşmektedir. Her ne kadar 'çatı mevzuatı' uygulaması adaptasyon oranlarını azaltmış olsa da simülasyon sonuçları 13,3 sent sabit fiyat alım tarifesinin devam ettirildiği durumda da ilerleyen yıllarda difüzyon patikasının aşağı yönlü eğiliminin engellenemediğini göstermektedir. Dolayısıyla literatürde yer alan çalışmalar PV sistem adaptasyon oranlarının artırılması için geri ödeme sürelerinin azaltılması gerektiğini savunsa da geri ödeme süresini

azaltmaya yönelik politikalar adaptasyon sayısını artırsa da Türkiye'de difüzyon patikasının pozitif ivmeli bir trende sahip olmasına yetmez.

Türkiye'de PV sistem difüzyon patikası adaptasyon oranları açısından incelendiğinde difüzyon eğrisinin literatürle uyumlu olarak pik yaptıktan sonra azaldığı ve farklı senaryolar altında da pozitif ivme kazanamadığı görülmektedir (Palmer et al., 2015). Sabit fiyat alım tarifelerinin uygulanması, dönemsel olarak yenilenebilir enerji yatırımlarını hızlandırsa da uzun dönemde nüfus artışıyla beraber eski denge noktasına doğru dönülmektedir. Yenilenebilir enerji üretiminin nüfus artışı ve bu artışa eşlik eden enerji ihtiyacıyla birlikte oransal olarak artması için alternatif kamu politikaları geliştirilmelidir. Toplumun enerji bağımlılığı ve bu bağlamda yenilenebilir enerjinin önemi konusunda bilinçlendirilmesi gerekmektedir. Türkiye'de gelire ve sosyoekonomik statüye bakılmaksızın, yenilenebilir enerjiye atfedilen önemin toplumsal düzeyde içselleştirilmediği gözlenmektedir. Toplumun yenilenebilir enerjinin çevreye faydası, nüfus artışlarının bir sonucu olarak enerji bağımlılığındaki artış, Dünya'nın artan enerji ihtiyacı karşısında kaynakların sınırlı olmasının yarattığı riskler gibi konularda ivedilikle bilinçlendirilmesi gerekmektedir.

Difüzyon patikasının aşağı yönlü eğiliminin temel sebebi PV sistemine geçiş yapan hane sayısının nüfus artışlarına bağlı olarak toplam hane sayısında ortaya çıkan artışı yakalayamamasıdır. Nüfus hızlı bir şekilde artarken PV sisteme yatırım yapan hane sayısı az kalır. Başka bir ifadeyle alternatif politikalarla üretilen yenilenebilir enerji miktarı artırılsa da toplumun ihtiyaç duyduğu toplam enerji miktarındaki artış dikkate alındığında yetersiz kalır.

Üretilen yenilenebilir enerji miktarının artırılması sürdürülebilir ekonomiler için önemli olsa da enerjide bağımlılığın azaltılması ve kendine yetebilirlik açısından ele alındığında toplam enerji ihtiyacının ne kadarının üretilebildiği önem arz eder. Üretilen yenilenebilir enerji miktarının toplam enerji tüketimi içerisindeki payının artırılması için difüzyon patikasının pozitif yönlü bir ivmeye sahip olması gerekmektedir. Difüzyon patikasının yukarı yönlü ivmeli bir patikaya sahip olması ise zorunlu PV sistem yatırımı düzenlemesinin uygulanmasıyla mümkündür. Türkiye'de PV sistem adaptasyon olasılığını belirleyen unsurlar göz önünde bulundurulduğunda adaptasyon oranlarının hızlı bir şekilde yükselmesini sağlamak için geri ödeme süreleri azaltılırken zorunlu PV sistem düzenlemelerinin de yapılması gerekmektedir.

Bu çalışmanın kapsamı alternatif senaryolar altında Türkiye'de PV sistem difüzyonunun araştırılması ile sınırlandırılmıştır. Çalışma veri seti kısıtlamalarından ötürü PV sisteme geçişin göstergesi olarak sadece PV panel ele alınmıştır. Nitekim PV sisteme geçiş için PV batarya, PV ev aletleri, PV aydınlatma gibi farklı göstergeler de yer almaktadır. Çalışmada incelenen alternatif senaryolar yenilenebilir enerjiye geçişte belirleyici olan yenilenebilir enerjinin ekonomik getirisi ve finansmanına yönelik olarak belirlenmiştir. Bununla birlikte enerji bağımlılığının azaltılması için yenilenebilir enerjiye geçişi zorunlu tutacak düzenleme etkisi farklı sosyoekonomik statüye sahip gruplar için araştırılmıştır. Elde edilen bulgular enerji bağımlılığının azaltılması için zorunlu PV sisteme geçiş

düzenlemelerine ihtiyaç olduğunu ortaya koysa da detaylı olarak araştırılması gerekmektedir. Çalışmanın temel araştırma sorusu böyle bir düzenlemenin etkileri ve uygulama yöntemleri olmadığı için detaylandırma yapılmamıştır. Zorunlu PV sisteme geçiş düzenlemeleri, sadece PV sisteme geçiş oranları değil gelir eşitsizliği gibi temel unsurlar dikkate alınarak sonraki çalışmalarda incelenmelidir.

Yenilenebilir enerjiye geçişte önemli role sahip unsurlardan birisi de bölgesel özelliklerdir. Bölgesel özellikler, PV sistemlerine yatırımdan beklenen getiriyi başka bir ifadeyle geri ödeme süresini değiştirmektedir. Enerji ihtiyacında beklenen artışın bir göstergesi olan hanelerdeki artış oranı da bölgesel dinamiklerden etkilenmektedir. Bu çalışmada hanelerin coğrafik dağılımı veri kısıtlamaları sebebiyle dikkate alınmamıştır. Bölgesel dağılım dikkate alınarak, hanelerin yatırım kararının gözlenecek şekilde uzun periyodlar için takip edildiği veri setlerinin oluşturulması gerekmektedir. Dahası elde edilen veri setlerinin coğrafik bilgi sistemleriyle entegrasyonu gerçek Dünya koşullarına uyumlu simülasyon çevresi yaratacaktır. Bu veri setleri kullanılarak yapılacak bölgeye özgü analizler ve alternatif kamu politikaları bölgelerin gelişimine katkı sağlayacaktır.

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EK-1
Tablo: 6
Çalışmada Kullanılan Değişkenler

Değişkenler	Simgesi	Belirlenme Yöntemi
Zaman	t	Başlangıçta t=0, tmax=21
Adaptasyon kararı	$x_i(t)$	Hane PV yatırımı yaptıysa 1, yapmadıysa 0 değerini alır.
Kümülatif lojistik olasılık (Adaptasyon olasılığı)	$p_i(t)$	Logit modele göre hesaplanmaktadır.
Eşik değer	τ_i	Yazar tarafından dolaylı kalibrasyon yöntemiyle belirlenmektedir.
Beklenen fayda	$U_i(t)$	$F\{U_{ekonomik,i}(t),\ U_{cevre,i}(t),\ U_{gelir,i}(t),\ U_{iletişim,i}(t),\ U_{sosyal,i}(t)\}$ Çalışmada hesaplanmamaktadır. Beş kısmi faydanın fonksiyonu olarak tanımlanmaktadır.
Ekonomik fayda	$U_{ekonomik,i}(t)$	Denklem 4'e göre hesaplanmaktadır.
Çevre faydası	$U_{cevre,i}(t)$	Denklem 20'ye göre hesaplanmaktadır.
Gelir faydası	$U_{gelir,i}(t)$	Denklem 23'e göre hesaplanmaktadır.
İletişim faydası	$U_{iletişim,i}(t)$	Denklem 26'ya göre hesaplanmaktadır.
Sosyal normlar	$U_{sosyal}(t)$	Denklem 28'e göre hesaplanmaktadır.
Geri ödeme süresi	gs	Denklem 6'ya göre hesaplanmaktadır.
Net bugünkü değer	NBD	Denklem 6'ya göre hesaplanmaktadır.
PV yatırım maliyeti	I_0	Denklem 8'e göre hesaplanmaktadır.
PV yatırımdan beklenen getiri	R(t)	Denklem 12'ye göre hesaplanmaktadır.
İndirgeme oranı	i(t)	Denklem 7'ye göre hesaplanmaktadır.
PV yatırım öz kaynak oranı	E/I_0	Ortalama gelire sahip olanlar için %50, gelirle doğru orantılı olarak belirlenmektedir.
PV yatırım kredi oranı	K/I_0	Öz kaynak oranına göre belirlenmektedir.
1 yıl ve üzeri TL mevduat faiz oranı	K_E	2010-2020 yılı Merkez Bankası verisi 2021-2030 yılı için 2010-2020 yılları ortalama değeri
İhtiyaç kredisi faiz oranı	K_D	2010-2020 yılı Merkez Bankası verisi 2021-2030 yılı için 2010-2020 yılları ortalama değeri
Maksimum pik gücü	P_{max}	Denklem 9'a göre hesaplanmaktadır.
PV sistem kW başına fiyat	$p_{GP}(t)$	Denklem 10'a göre hesaplanmaktadır.
Normal koşullarda ışıma şiddeti	G	1 kW/m² olarak alınmaktadır.

Kullanılabilir çatı alanı	A_{GP}	Müstakil konutlarda konut alanın 1/3'ü, Diğer konutlarda 1/5'i olarak hesaplanır ve birim kW için gerekli 8 m² veya katlarına en yakın tamsayı olarak belirlenmektedir.
Çekirdek verimliliği	η_C	%16
PV sistem verimliliği	$\eta_{GP}(t)$	Başlangıçta %13, her yıl %1.5 arttığı kabul edilmektedir.
Toplam kurulu kapasite	$TKK(t)$	2010-2019 - Owid (our World in data) veri seti 2020-2024 - ESP tahminleri 2025-2030 - Yıllık %15 artış varsayılmaktadır.
Tecrübe parametresi	b	Denklem 11'e göre hesaplanmaktadır.
Öğrenme oranı	$ÖO$	2020 yılına kadar %20, 2030 yılına kadar %18 ve 2040 yılına kadar ise %16 olarak alınmaktadır.
Elektrik tasarruf getirisi	$R_{tasarruf}(t)$	Denklem 13 ve 14'e göre hesaplanmaktadır.
Kamu getirisi	$R_{kamu}(t)$	Denklem 16'ya göre hesaplanmaktadır.
İdari ödemeler	$R_{idari}(t)$	Denklem 17'ye göre hesaplanmaktadır.
Bakım ve ön yatırım maliyetleri	$R_{bakım}(t)$	Denklem 18'e göre hesaplanmaktadır.
Amortisman ödeneği	$R_{amortisman}(t)$	Denklem 19'a göre hesaplanmaktadır.
PV sisteminin ürettiği elektrik miktarı	$E_{GP}(t)$	Denklem 15'e göre hesaplanmaktadır.
PV sisteminin beklenen ömür boyu elektrik üretimi	$E_{GP,i}$	Denklem 21'e göre hesaplanmaktadır.
Yatırım esnasında diğer tüm PV sistemlerinin beklenen ömür boyu elektrik üretim ortalaması	$E_{GP,toplam}$	Denklem 22'ye göre hesaplanmaktadır.
Öz tüketim oranı	$x_{öztüketim}$	%50
Elektriğin şebekeden satın alınma bedeli	$p_{elek,alış}$	EPDK yıllık ortalama fiyatlarına eşittir.
Tüketim fazlası elektriğin şebekeye satış bedeli	$p_{elek,satış}$	EPDK yıllık ortalama fiyatlarına eşittir.
Elektrik satış fiyatı artış oranı	$\mu_{elek,satış}$	2010-2020 yılları arasındaki ortalama artış oranı olarak hesaplanır (%10,67).
Elektrik alış fiyatı artış oranı	$\mu_{elek,satış}$	2010-2020 yılları arasındaki ortalama artış oranı olarak hesaplanır (%10,67).
Güneş ışınım şiddeti	$E_{güneş}$	GEPA verisi - 1527 kWh/m²
PV sistem aşınma oranı	γ	%0.40
Tarife garantili fiyat	p_{FIT}	13,3 cent/kWh (Yeni düzenlemeye göre tarife garantili fiyat, satın alınan birim elektrik fiyatına eşittir.)
Dağıtım bedeli	$\varphi_{dağıtım}$	EPDK yıllık ortalama fiyatlarına eşittir. 2020 sonrası için %10.67 artış oranı kabul edilerek hesaplanmaktadır.
Ön yatırım maliyetleri oranı	$\beta_{önyatırım}$	Başlangıç maliyetlerinin %1.6'sı
Bakım maliyetleri oranı	$\beta_{bakım}$	Başlangıç maliyetlerinin %1'i ve yıllık %2 oranında artmaktadır.
Hane üyesi başına düşen yıllık kullanılabilir gelir	w_i	TÜİK veri setinden belirlenmektedir.
Toplumdaki hane sayısı	N	TÜİK veri setinden belirlenmektedir.
Hanehalkı sayısı	h_i	TÜİK veri setinden belirlenmektedir.
Toplumda hane üyesine düşen yıllık ortalama kullanılabilir gelir	w	TÜİK veri setinden belirlenmektedir.
Komşuluk matrisi	$A_{i,j}$	Küçük dünya ağları paket program ile yazar tarafından oluşturulmaktadır.
Komşu sayısı	k_i	Küçük dünya ağları paket program ile yazar tarafından oluşturulmaktadır.
Adaptasyon olasılığı sabiti	α	Logit tahminine göre belirlenmektedir.
Adaptasyon olasılığı katsayıları	ξ_j	Logit tahminine göre belirlenmektedir.

Yurtiçi Tasarruf Oranları Üzerine Bir Mekânsal Etki İncelemesi: AB-15 Ülkeleri ve Türkiye

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A Spatial Impact Study on Domestic Savings Rates: EU-15 Countries and Türkiye

Abstract

The study, employing the Spatial Durbin Error Model (SDEM), focuses on a comparative analysis of two periods, distinguished by the 2008 global financial crisis. In this context, findings from the 1987-2008 period showed that government expenditures, income inequality, and increases in the dependent population reduced domestic savings. It has been demonstrated that increases in net migration and trade openness levels have a positive impact on savings. The spatial impact results of this period were positive for openness and the dependent population ratio. According to the results from 2009 to 2021, the variables with statistical significance were identified as government expenditures and openness. The spatial effects during the 2009-2021 period were in the same direction as those in the first period, regarding the dependent population. In addition, the increases in government expenditures of neighbouring countries in the post-crisis period led to a rise in savings rates.

Keywords : Savings, Income Distribution, Migration, Openness.

JEL Classification Codes : E21, O15, C12.

Öz

Mekânsal Durbin Hata Modelinin (SDEM) kullanıldığı çalışmada, 2008 küresel krizi baz alınarak ayrıştırılan iki döneme ait bir karşılaştırma analizi üzerinde odaklanılmıştır. Bu kapsamda ulaşılan 1987-2008 dönemine ait bulgular, kamu harcamaları, gelir eşitsizliği ve bağımlı nüfus artışlarının yurtiçi tasarrufları azalttığını; net göç ve ticari dışa açıklık düzeyi artışlarının ise tasarruflar üzerinde pozitif yönlü bir etki gücüne sahip olduğunu göstermiştir. Bu dönemin mekânsal etki sonuçları ise dışa açıklık ve bağımlı nüfus oranı için pozitif olarak bulunmuştur. 2009-2021 dönemi sonuçlarına göre, istatistiki anlamlılığa sahip olan değişkenler kamu harcamaları ve dışa açıklık olarak belirlenmiştir. 2009-2021 dönemindeki mekânsal etkiler ise bağımlı nüfus açısından ilk dönem ile aynı yönde gerçekleşmiştir. Ayrıca kriz sonrası dönemde komşu ülkelerin kamu harcamaları oranında yaşanan artışlar tasarruf oranlarının artmasına neden oluşturmuştur.

Anahtar Sözcükler : Tasarruf, Gelir Dağılımı, Göç, Dışa Açıklık.

1. Giriş

Ekonomik kalkınmanın finansmanı ve temel makroekonomik faktörler ile ilişkileri bakımından önem arz eden yurtiçi tasarruf oranları, özellikle dış finansman ihtiyacı açısından yakından izlenen bir göstergedir. Ülkelerin sahip oldukları yurtiçi tasarruf oranları büyüme dinamiği olan yatırımlar için gereken kaynakların temelini oluşturmaktadır. Bu anlamda, yetersiz iç tasarruflar dış kaynaklara başvurulmasına yönelik eğilimin artmasına bağlı olarak pek çok sorunu beraberinde getirebilmektedir. Dolayısıyla özellikle tasarruf yetersizliğinin yol açabileceği sorunların önlenebilmesi ve daha yüksek iç tasarruf oranları ile sağlanabilecek avantajlardan faydalanılabilmesi açısından tasarrufları etkilemesi muhtemel değişkenlerin sıklıkla incelenmesi önem arz etmektedir. Bu nedenle ampirik analizlerin güncellenmesi ve ilgili politikaların mevcut duruma göre revize edilmesi gerekmektedir. İktisadi literatürde yer alan çalışmalar incelendiğinde gelir, faiz, enflasyon, kamu harcamaları, bütçe dengesi, ihracatın ithalatı karşılama oranı, ticari ve finansal açıklık, finansal piyasaların gelişmişlik düzeyi, kentleşme oranı, nüfus yapısı ve bileşenleri, cari işlemler dengesi, dış ticaret hacmi ve yatırım gibi pek çok değişkenin tasarruf oranları açısından değerlendirildiği görülmektedir.

Ülkelerin yüksek oranlı yatırım düzeyine ulaşmak için gerekli olan tasarruf düzeyine erişmeleri yurtiçi ve/veya yurt dışı finansman ile mümkündür. Ancak bu noktada dış tasarruflarla sağlanan yatırım finansmanının sürdürülebilirliği ve boyutu önem kazanmaktadır. Nitekim, uzun dönemde yabancı sermaye hareketliliğinin doğasında bulunan kaçış riski, tasarruflar ve dolayısıyla yatırımlar açısından tehlikeli görülmektedir. Bu nedenle yurtiçi tasarrufların yüksekliği özellikle uzun dönemde yatırım finansmanı açısından daha istikrarlı bir yapının sağlanmasına katkıda bulunmaktadır. Sonuç olarak yatırım artışına yönelik hedefler tasarruf artışının sürekliliğini gerektirmekle birlikte iç ve dış tasarrufların miktarına bağlı olarak değerlendirilmelidir (Gavin, 1997: 4). Bu bağlamda yurtiçi tasarruflar üzerindeki etkileri sıklıkla incelenen ve çalışmada ele alınan kamu harcamaları, net göç, ticari dışa açıklık, yaş bağımlılık oranı ve gelir eşitsizliği değişkenlerine ilişkin teorik beklentilere değinilmesi yerinde olacaktır.

Analizde ele alınan ilk konu kamu harcamaları ile tasarruf oranı arasındaki ilişkidir. Konuya ilişkin temel bakış açısı Keynesyen teoriye dayanmaktadır. Teori, tüketim ve tasarruf arasındaki değiş-tokuş ilişkisine vurgu yapmakta ve tamamlayıcı bir etki mekanizması üzerinde yoğunlaşmaktadır. Buna göre, artan kamu harcamaları çarpan etkisi altında gelir artışı yaratarak özel tüketim artışının bir nedenini oluşturmakta ve dolayısıyla tasarruflarda azalma beklenmektedir (Ambler et al., 2008: 1). Fatás & Mihov (2001), Hjelm (2002), Blanchard & Perotti (2002), Schclarek (2007) ve D'Alessandro (2010) söz konusu görüşü destekleyen bulgulara ulaşan çalışmalardan bazılarıdır. Benzer şekilde ikiz açık hipotezi kapsamında açık bütçe politikası izlenen ekonomilerde artan kamu harcamalarının yurtiçi tasarrufları azaltacağı savunulmaktadır (Nickel & Vansteenkiste, 2008: 6). Bununla birlikte, kamu harcamalarının vergilerle ya da borçlanma yoluyla finanse edilmesi durumunda farklı sonuçlarla karşılaşılabilmektedir. Buna göre, borçlanma ile finanse edilen kamu harcamalarının tasarruflar üzerinde herhangi bir etki oluşturmaması mümkündür.

Başka bir ifadeyle, borçlanan bireylerin geri ödeme sürecinde karşılaşılacakları faiz yükü ve anapara ödemeleri nedeniyle tüketim artışının yaşanmaması gündeme gelebilecektir. Dolayısıyla gelecek dönemle ilgili olası mali güçlükler tasarruf oranlarının artmasına neden olabilecektir (Barro, 1974). Ayrıca kamu harcamalarının niteliğine bağlı olarak da farklı sonuçlarla karşılaşılabilmesi mümkündür. Nitekim, sağlık ve eğitim ağırlıklı kamu harcamalarının artması hanehalkı tüketiminin azalmasına ve tasarrufların artmasına neden olabilir. Ancak yapılan harcamalar nakit şeklinde olduğunda devlet tarafından oluşturulan bu güven ortamı ihtiyat güdüsüyle daha fazla tasarruf yapma eğiliminde olan hanehalkının tasarruflarını azaltabilecektir (Grigoli et al., 2018: 11). Diğer taraftan Giavazzi & Pagano (1990), kamunun tüketim harcamalarında yaşanan artışların özel tüketimler üzerinde negatif yönde bir etki yaratacağını vurgulamaktadırlar. Bu görüşte aynı zamanda daraltıcı maliye politikasının vergi oranlarının düşük olmasına ilişkin bir beklenti yaratarak gelir artışı etkisiyle tüketim harcamalarını artırması beklenmektedir. Benzer şekilde, kamu tüketim harcamalarının özel tüketim harcamaları üzerinde dışlama etkisi yaratarak tasarruf oranlarının artacağına ilişkin bulgulara ulaşan pek çok çalışmanın olduğu görülmektedir. Barro (1981), Aschauer (1985), Ho (2001), Kwan (2006), Düzgün & Bilgili (2008), Dahmardeh vd. (2011) bu çalışmalardan bazılarıdır.

İkinci olarak incelenen net göç olgusunun tasarruf oranı üzerindeki etkisinin işçi dövizlerinin transferi açısından değerlendirilmesi mümkündür. Bu kapsamda göçmen işçilerin kendi ülkelerine gönderdikleri döviz miktarındaki artışlar göç veren ülkelerdeki tasarruf oranlarının artması anlamına gelmektedir. Dolayısıyla göç veren ülkelerin genellikle gelişmekte olan ülkelerden oluştuğu düşünüldüğünde bu ülkelerin yetersiz yurtiçi tasarruflarına katkı sağlanabilmektedir. Bununla birlikte göçmenler tarafından kendi ülkelerine aktarılan dövizlerin tasarruflardan ziyade tüketime yönelmesi ise enflasyonist baskı oluşturabilecektir (De Haas, 2010: 229). Ayrıca sermaye piyasaları gelişmiş olan ekonomiler için göçmen işçiler tarafından aktarılan dövizleri yatırımlara dönüştüren mutlak bir mekanizmanın işleyip işlemeyeceği belirsizdir (Bajaras et al., 2009: 6).

Ülkelere gelen göçmen sayısının giden göçmen sayısından az olması durumunda negatif olan net göç olgusu, nicelik bakımından değerlendirilebileceği gibi niteliksel olarak da değerlendirilmesi gereken bir konudur. Örneğin pozitif net göç miktarında sahip bir ülkede gelen göçmenlerin genç olması işgücü piyasasına yapacakları katkı ile ekonomik büyüme üzerinde pozitif etkiler yaratabileceği gibi genç nüfusun sahip olduğu yüksek marjinal tüketim eğilimleri nedeniyle tasarruf oranlarını olumsuz yönde etkileyebilecektir. Ayrıca göç eden nüfusun genellikle düşük gelir düzeyindeki bireylerden oluşması elde edecekleri geliri kullanırken daha düşük tasarruf eğilimi sergilemelerine neden olabilir. Diğer taraftan göçmen olarak gelen nüfusun nitelikli işgücü olması durumunda göç alan ülkedeki sosyo-ekonomik imkânlara da bağlı bir şekilde tasarruf oranları açısından iyileşmeler beklenebilir. Sonuç olarak, net göç ve tasarruf oranı ilişkisinin yönü kapsamında bir belirsizlik olduğunu söylemek mümkündür. Çünkü göç alan ülkelerdeki yaşam koşulları, göçmen kişilerin aileleriyle olan ilişkileri, yaş, ülkelerine geri dönme süreleri, sosyal güvenlik imkânları ve göçmen politikaları gibi pek çok etken göç eden bireylerin tasarruf

davranışlarını etkilemektedir. Osili (2007), Balde (2011) ve Bett (2013) göç vermenin yurtiçi tasarrufları pozitif yönde etkilediğini tespit eden çalışmalara örnek olarak gösterilebilir.

Dış ticaret hacminin GSYİH'ye oranlanması ile ölçülebilen ticari dışa açıklık düzeylerinin yüksekliği, bir ülkenin dış dünyayla olan entegrasyon derecesinin göstergesi olarak değerlendirilmektedir (Alcalá & Ciccone, 2004: 613). Ticari açıklık ile tasarruf oranları arasındaki ilişkiler ise ihracat ve ithalat özelinde değerlendirilebileceği gibi yabancı sermaye, dış ticaret politikaları ve dış ticaret dengesi gibi çeşitli açılardan incelenebilir. Bu çerçevede ihracat ve ithalat miktarları açısından bakıldığında artan ihracatın döviz girişi, artan ithalatın ise döviz çıkışı nedeniyle yurtiçi tasarruf oranlarını etkileyeceği açıktır. Örneğin artan ihracat dolayısıyla tasarruf oranlarının artması beklenirken ithalat artışları nedeniyle ortaya çıkabilecek yurtiçi talep artışları tasarrufların azalmasına neden olabilecektir. Benzer şekilde, dış ticaret fazlası verilmesi durumunda tasarruflar üzerinde pozitif bir etki mekanizmasının işleyeceği düşünülmektedir. Bununla birlikte, ülkelerin ekonomi politikalarının korumacı nitelikte olması ithalatın azalmasına neden olabilecektir. Ticari dışa açıklık düzeyinin azalmasına neden olabilen bu durum ülke içi talebin artmasına bağlı olarak tasarruflar üzerinde negatif etkiler yaratabilecektir. Ayrıca dışa açıklık düzeyi arttıkça küresel entegrasyonun yaygınlaşması ile sermaye hareketlerinde artışlar gözlenebilir. Bu durumda yabancı sermayenin ev sahibi ülkedeki pozisyonuna bağlı olarak yurt içi tasarruf oranlarında pozitif veya negatif etkilerin oluşması beklenebilecektir. Ayrıca ticari açıklık düzeyinin tasarruflar üzerindeki etkisine değinen Sachs & Warner (1995), çalışmalarında yüksek ticari açıklığa sahip gelişmiş ülkelerde nispeten yüksek olmayan açıklık oranına sahip olan gelişmekte olan ülkelerden daha düşük düzeyde büyüme oranlarının olduğu bulgusuna ulaşmışlardır. Benzer şekilde Bahmani-Oskooee & Chakrabarti (2005) tarafından yapılan çalışmada açıklık ve tasarruf düzeyi ilişkisinin yüksek gelirli ülkelerde daha yüksek olduğu vurgulanmakla birlikte orta ve düşük gelirli ülkelerin belirli bir seviyeden sonra bu ülkelerin önüne geçen bir performans sergiledikleri belirlenmiştir.

Analiz kapsamında incelenmek istenen yaş bağımlılık oranı ise bakmakla yükümlü olunan kişilerin (15 yaş altı veya 64 yaş üstü) çalışma çağındaki 15-64 yaş arası nüfusa oranıdır. Bağımlılık oranının yükselmesi çalışma çağındaki 100 nüfus başına bakmakla yükümlü olunan kişilerin artması anlamına gelmektedir. Bu artış aynı zamanda tasarruf yapmayan nüfusun artmasını ifade etmekte ve yurtiçi tasarruf oranı azalışlarının bir nedeni olarak görülmektedir (Grigoli et al., 2018: 258). Genç ve yaşlılardan oluşan bağımlı nüfusun her iki kısmı için de harcama miktarının daha fazla olacağı beklenmektedir. Nitekim artan genç bağımlılık oranı aileleri daha fazla tüketim harcamasına yönelttiği gibi 64 yaş üstü nüfusun artması sosyal güvenlik sistemi sorunları ve emek piyasasından çekilme benzeri nedenlerle tasarruf eksikliğinin sebebini oluşturabilmektedir (Horioka, 2010: 46-47). Bununla birlikte güçlü ve gelişmiş bir sosyal güvenlik sistemi ile bireysel tasarrufların erimesine engel olunması mümkündür. Hükümetlerin eğitim ve sosyal güvenlik politikalarının etkinliği bağımlı nüfus yapısına bağlı olarak bireysel tasarruflarda gözlenen zorunlu harcama eğilimini engelleyebilecektir. Diğer taraftan artan bağımlı nüfusun çalışma çağındaki nüfus üzerinde daha fazla bir baskı oluşturması ve bireylerin gelecekle ilgili

endişelerindeki artış sosyal ve psikolojik faktörlerin de etkisiyle tasarruf eğiliminin artmasına neden olabilir. Dolayısıyla bağımlılık oranı ve tasarruflar arasındaki etkileşim ülkelerin demografik, ekonomik ve sosyal niteliklerine göre farklılık gösterebilecektir.

Keynesyen bakış açısına göre yüksek gelir düzeylerindeki bireylerin tasarruf eğilimi düşük gelir düzeylerindeki bireylere göre daha yüksektir (Mankiw, 1992: 393). Buna göre, gelirin artan bir fonksiyonu olarak ifade edilen tasarrufların yüksek gelir düzeylerinde daha fazla olmasına yönelik beklenti genel olarak kabul edilebilir. Ancak yapılan çalışmalar bu durumun tam tersi bulgulara ulaşıldığını göstermektedir. Bu noktada üzerinde durulan gelir adaletsizliği kavramı tasarruf oranları açısından önem kazanan göstergelerden biri olarak değerlendirilmektedir. Örneğin gelirin zengin nüfus lehine dağıldığı bir ekonomide düşük gelir sahibi bireylerin daha fazla tasarruf yaptıklarına dair kanıtlara rastlanmıştır (Furman & Stiglitz, 1998: 226). Ayrıca tasarrufların daha çok orta gelir düzeyine sahip bireyler tarafından yapıldığını gösteren pek çok ampirik kanıt bulunmaktadır (Venieris & Gupta, 1986: 882). Bunlara ek olarak, artan gelir adaletinin tasarrufları olumlu yönde etkilediğine ilişkin güçlü kanıtlara da ulaşılmıştır. Brady & Friedman (1947) ve Bunting (1991) tarafından yapılan analizler bu çalışmalara örnek olarak verilebilir. Bununla birlikte gelir eşitsizliği sonucu artan belirsizlik ve güvensizlik ortamı tasarrufların azalmasına neden olabilecektir (Schmidt-Hebbel & Serven, 1996: 14). Bu durumda, gelir adaletsizliğindeki artışların düşük gelir gruplarının tasarruflarını daha da azaltacağı düşünülebileceği gibi yüksek gelir gruplarında da benzer bir durumla karşılaşılması mümkündür. Diğer taraftan gelir eşitsizliğinin artması durumunda koruma ve korunma güdüsüyle tasarruf oranlarının arttığına dair bulgulara da ulaşıldığı gözlenmektedir (Koo & Song, 2016: 899). Ayrıca, Musgrove (1980) ve Schmidt-Hebbel & Serven (2000) gibi eşitsizlik ve tasarruf oranları arasında ilişki olmadığını tespit eden çalışmalara da rastlamak mümkündür.

Çalışmanın bu bölümünde Avrupa Birliği'nin 2004 yılındaki genişlemesinden önce birliği oluşturan üyeleri kapsayan AB-15 ülkeleri (Avusturya, Belçika, Danimarka, Finlandiya, Fransa, Almanya, Yunanistan, İrlanda, İtalya, Lüksemburg, Hollanda, Portekiz, İspanya, İsveç ve İngiltere) ve Türkiye kapsamındaki yurtiçi tasarruf oranı gerçekleşmeleri hakkında bir bakış açısına sahip olabilmek amacıyla Dünya Bankası'ndan temin edilen verilerden derlenen Şekil 1'de yer verilmiştir.

Şekil: 1
Yurt İçi Tasarruflar/GSYİH (%)
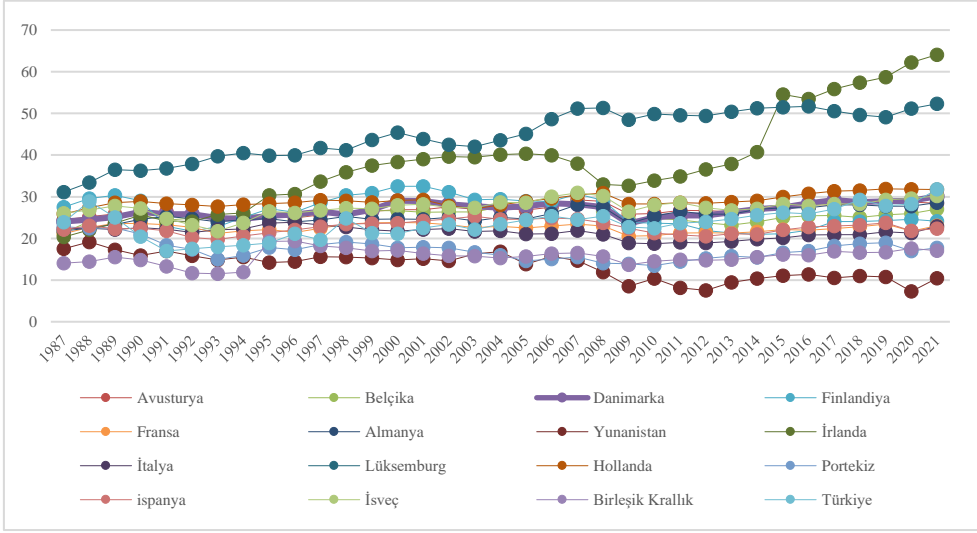
Şekil 1 incelendiğinde en yüksek yurtiçi tasarruf oranına sahip olan ülkenin Lüksemburg olduğu açık bir şekilde görülmektedir. Bu oran ortalama olarak %45 düzeyindedir. İrlanda ise ortalama olarak %38 düzeyine kadar ulaşmıştır. Söz konusu ortalamaların gerçekleşmesinde küresel kriz sonrası oranların etkili olduğunu söylemek mümkündür. Bununla birlikte en düşük tasarruf oranına sahip ülkeler Yunanistan (%13), Birleşik Krallık (%16) ve Portekiz (%17) olmuştur. Diğer ülkelere bakıldığında ise tasarruf oranlarının ortalama olarak %21 ila %29 arasında değiştiği ve 2008 küresel krizinde yaşanan kırılmaya rağmen kriz sonrası dönemde bir toparlanma sürecinin yaşandığı gözlenmektedir. Dünya Bankası tarafından açıklanan verilere göre, küresel kriz öncesi ve sonrası dönem kıyaslaması yapıldığında da ortalama olarak en düşük ve en yüksek tasarruf oranlarına sahip olan ülkelerin değişmediği izlenmiştir. Ancak kriz sonrası dönemdeki en düşük orana Covid-19 pandemi dönemi olan 2020 yılında rastlanmış ve Yunanistan ekonomisi için %7 olarak hesaplanmıştır. Bununla birlikte, İrlanda'nın 2021 yılında %64 düzeyine kadar ulaşan tasarruf oranı kayda değer bir nitelik taşımaktadır. Türkiye ekonomisi incelendiğinde ise 1995 yılına kadar dalgalı ve oldukça düşük düzeylerde olan tasarruf oranlarının 1996-2008 döneminde %20-25 aralığında olmasına rağmen nispi olarak daha istikrarlı olduğu söylenebilecektir. Ayrıca küresel kriz sonrası döneme bakıldığında, 2016 yılına kadar olan ciddi bir artış trendi yakalanamamış olsa da 2017 yılından sonra bir yükselme eğilimin olduğu gözlenmektedir. Bu kapsamda, Türkiye ekonomisinde tasarruf oranının 2021 yılında %32 ile en yüksek seviyesine ulaşmasında uygulanan ekonomi politikalarının yanı sıra küresel gelişmeler veya krizlerin etkisinin olduğunu söylemek mümkündür.

Bu bilgiler ışığında, söz konusu gerçekleşmeler üzerinde etkili olduğu düşünülen temel makroekonomik değişkenlerin birbirleri ile sınır komşuluğu olan örneklem grubundaki mekânsal etkilerin de dikkate alınarak değerlendirilmesi iktisat literatüre önemli katkılar sağlayabilecektir. Örneğin, SWIID (2023) tarafından sağlanan 1987-2021 dönemi verileri kullanılarak hesaplanan ortalama Gini katsayısının %31 olduğu İrlanda ekonomisinde, tasarruf oranlarının komşu ülkelerden etkilenmesi mümkündür. Bu nedenle olası etkileşimlerin ampirik analizlere dahil edilmesi gerekmektedir.

2. Literatür Özeti

Yurtiçi tasarruflar ile ilgili ekonomi literatürü oldukça geniştir. Makroekonomik değişkenlerin tasarruf oranı üzerindeki etkileri, ekonomik planlama ve öngörülerin rasyonellik taşıması için takip edilmek zorundadır. Bu kapsamda birim ve zaman boyutuna göre farklılık arz eden bilimsel tespitlerin yakından izlenmesi politika yapıcılar ve hanehalkı açısından yol gösterici niteliktedir. Analize konu olan kamu harcamaları, göç, ticari dışa açıklık, yaş bağımlılık oranı ve gelir eşitsizliği özelindeki seçili ampirik çalışmaların bir özeti Tablo 1'de yer almaktadır.

Tablo 1: Literatür Özeti

Yazar	Ülke/ Dönem	Yöntem	Bulgu
Corbo & Schmidt-Hebbel (1991)	13 Gelişmekte Olan Ülke 1980-1987	İki Aşamalı EKK, Sabit Etkiler Panel Regresyon ve Görünürde İlişkisiz Regresyon (SUR) Analizi	Vergi artışı ile finanse edilen kamu harcamalarının ve kamu harcaması kısıtlamalarıyla sağlanan kamu tasarruflarının özel tasarrufları olumsuz yönde etkileyeceği bulgusuna ulaşılmıştır.
Edwards (1996)	Seçilmiş Latin Amerika ve Batı Asya Ülkeleri (36 Ülke) 1970-1992	Yatay Kesit ve Sabit Etkiler Panel Regresyon Analizi	Kamu tasarrufları ve bağımlı nüfus artışlarının özel tasarrufları azaltacağı belirlenmiştir.
Callen & Thimann (1997)	21 OECD Ülkesi 1975-1995	Yatay Kesit ve Sabit Etkiler Panel Regresyon Analizi	Artan kamu harcamalarının vergilerle finanse edilmesinde dolaylı vergilere ağırlık verilmesi durumda tasarruf oranlarında artış yaşanacağı tespit edilmiştir.
Schmidt-Hebbel & Serven (2000)	62 Gelişmekte Olan ve 20 Gelişmiş Ülke 1965-94	Yatay Kesit, EKK ve Genelleştirilmiş Momentler Yöntemi (GMM) Analizi	Gelir eşitsizliği ve tasarruflar arasında tutarlı bir ilişki olmadığı sonucuna ulaşılmıştır.
Loayza et al. (2000)	69 ülke (20 Gelişmiş ve 49 gelişmekte olan) 1966-1995	GMM Yöntemi	Bağımlı nüfus oranında yaşanan artışların özel tasarrufları büyük ölçüde olumsuz yönde etkilediği belirlenmiştir.
Berube & Cote (2000)	Kanada 1965-1996	Eşbütünleşme ve Vektör Hata Düzeltme (VECM) Modeli	Bağımlı nüfus oranında yaşanan artışların özel tasarrufları artırdığı tespit edilmiştir.
Athukorala & Sen (2004)	Hindistan 1954-1998	GMM	Artan kamu tasarruflarının özel tasarrufları olumsuz yönde etkileyeceği bulgusuna ulaşılmıştır.
Bhandari et al. (2007)	Sri Lanka, Bangladeş, Pakistan Hindistan ve Nepal 1976-2001	Granger Nedensellik ve Johansen EşBütünleşme Analizi	Kamu harcamalarında yaşanan artışların özel tasarrufları olumsuz yönde etkileyeceği bulgusuna ulaşılmıştır.
Gutiérrez (2007)	9 Latin Amerika ülkesi 1990-2003	Havuzlanmış EKK, Sabit ve Tesadüfi Etkiler Modelleri	Gelir adaleti ile yurtiçi tasarruflar arasında bir ilişki tespit edilememiştir.
Tagkalakis (2008)	19 OECD ülkesi 1970-2002	ARIMA Modeli	Kamu harcamalarının vergilerle finanse edilmesinde vergilere odaklanılması durumda tasarruf oranlarının azaldığı ve bu negatif yönlü etkinin durgunluk dönemlerinde daha belirgin olduğu tespit edilmiştir.
Effiom & Samuel (2012)	Nijerya 1970-2008	VECM	Ticari açıklığın uzun dönemde tasarrufları olumlu yönde etkilediği bulgusuna ulaşılmıştır.
Ismail & Rashids (2013)	Pakistan 1975-2011	Johansen EşBütünleşme ve Hata Düzeltme Analizi	65 yaş üstü bağımlı nüfus oranlarındaki artışların kısa ve uzun dönemde özel tasarrufları artırdığı tespit edilmiştir.
Jilani et al. (2013)	Pakistan 1973-2011	Johansen EşBütünleşme ve Hata Düzeltme Analizi	Kamu harcamalarında yaşanan artışların tasarrufları artıracağı bulgusuna ulaşılmıştır.
Koo & Song (2016)	48 Ülke 1991-2010	Sabit Etkiler Model	Gelir adaletideki kötüleşmelerin tasarrufları artırdığı sonucuna ulaşılmıştır.

Gani (2016)	Asya Ülkeleri 2002-2011	Yatay Kesit, Sabit ve Tesadüfi Etkiler Modelleri	Göçmen işçiler tarafından aktarılan döviz gelirlerinin yurtiçi tasarrufları pozitif yönde etkilediği bulgusuna ulaşılmıştır.
Çakmaklı & Öztürk (2017)	Türkiye 1980-2014	ARDL sınır testi ve Granger nedensellik testi	Net göç ile yurtiçi tasarruf oranı arasında negatif yönlü bir ilişki olduğu bulunmuştur
Grigoli et al. (2018)	165 Ülke 1981-2012	EKK ve GMM Analizi	Artan gelir eşitsizliğinin tasarruf oranlarını olumsuz yönde etkilediği belirlenmiştir.
Al Nagar & Gadallah (2023)	Mısır ve Filipinler 1981-2019	ARDL Sınır Testi	Mısırlı göçmen işçilerin kendi ülkelerine getirdikleri dövizlerin kısa ve uzun vadede yurtiçi tasarruflarda bir artış etkisi yarattıkları tespit edilmiştir. Ancak Filipin için anlamlı bir bulguya rastlanmamıştır.

Tablo 1, konuya ilişkin literatürün oldukça geniş ve kapsamlı olması nedeniyle çalışmada kullanılan değişkenlere ilişkin bulgular ile sınırlandırılmış bir özet niteliğindedir. Özetlenen bulgular genel olarak değerlendirildiğinde çalışmada kullanılan her bir değişken için sabit bir etkileşim yönünün olmadığını söylemek mümkündür. Bu bağlamda bir görüş birliği olmasa da ulusal dinamiklere ve gelişmişlik düzeyine bağlı olarak değişen bir yapının olduğu net bir şekilde görülmektedir.

3. Yöntem

Coğrafi uzaklık ve komşuluk ilişkilerine bağlı olarak ortaya çıkabilen mekânsal etkilerin incelenebilmesi amacıyla sıklıkla yararlanılan mekânsal ekonometri analizleri pek çok açıdan klasik yöntemlerden farklılaşan güncel yaklaşımlardır. Mekânsal etki olarak ifade edilen bu ilişkiler, mekânsal içerikli bir bağımlılık ve heterojenlik şeklinde oluşabilmektedir (Anselin et al., 2008: 625). Mekânsal bağımlılık, bir bölgedeki gözlem değerlerinin komşu bölgelerdeki değerlerle ilişki içinde olması durumunu ifade eder (Ergüt & Çilingirtürk, 2022: 68). Mekânsal heterojenlik ise model katsayılarında ya da değişken hata varyansında ortaya çıkan istikrarsızlığı ifade etmektedir (Anselin & Bera, 1998: 241). Dolayısıyla komşu bölgelerdeki ekonomik yayılmayı etkileyen mekânsal bağımlılığın ve değişkenlerin farklı coğrafyalardaki etkilerinin farklılaşmasına neden olabilen heterojenliğin dikkate alınması önem arz etmektedir. Aksi durumda, bölgesel dinamiklerin ihmal edilmesi, tahmin hataları ve politika etkilerinin hatalı yorumlanması gibi problemler ile karşılaşılabilir. Bu kapsamda, yatay kesit ve panel veriler için kullanılabilen mekânsal ekonometrik yöntemler ile fonksiyonel ilişkilerin açıklanmasına önemli katkılar sağlanabilmektedir.

Mekânsal etkileşimlerin analizinde ilk adım, bir ağırlık matrisi oluşturmaktır. Bu matris, n*n boyutuna sahip ve bölgesel etkileşim durumunu ifade eden bir yapıdadır. Başka bir ifadeyle, incelenen birimlerin birbirine komşu olması durumunda "1", tersi durumda ise "0" değerini alan bir matristir (Anselin et al., 2008: 628). Söz konusu matrisin analize dahil edilmesiyle uygun model seçimi için ilk adım atılmış olmaktadır. Bununla birlikte, mekânsal etkilerin regresyona dahil edilme biçimleri farklılık göstermektedir. Nitekim mekânsal etkiler, bağımlı ve/veya bağımsız değişkenden kaynaklanabileceği gibi hata terimleri ile ilgili olabilecektir (Yerdelen-Tatoğlu, 2022: 51). Bu çerçevede, mekânsal bağımlılığın varlığının ve kaynağının sınanması amacıyla Moran I, LM hata (LM Error) ve LM gecikme (LM Lag) testlerinden yararlanılmaktadır. Moran I testi ile birimlerin komşuları ile olan korelasyon ilişkisi ölçülmekte ve genel bir sonuç elde edilmektedir. Ulaşılan sonuç,

istatistiki olarak anlamlı olduğunda bölgenin mekânsal bir etkileşim içerisinde olduğu kabul edilmektedir (Fischer & Wang, 2011). LM hata ve LM gecikme testleri ise sırasıyla mekânsal hata ve mekânsal gecikmenin olup olmadığının belirlenmesini sağlamaktadır (Kosfeld, 2015). Ayrıca birim etkinin tespit edilmesi durumunda mekânsal bağımlılığı dikkate alan sabit ve tesadüfi etki modellemelerinden yararlanılabilmektedir. Bu kapsamda etkin modelin tespit edilmesi amacıyla Hausman (1978) testine başvurulabilmektedir. Söz konusu tespitlerin yapılması, mekânsal panel veri modellerinin seçimi için önem arz etmekte, elde edilen sonuçlara göre mekânsal hata ve/veya mekânsal gecikmenin olup olmamasına bağlı olarak farklı yöntemlere başvurulması gerekmektedir.

Analizde kullanılan SDEM (Mekânsal Durbin Hata Modeli) yöntemi, mekânsal etkilerin hatadan kaynaklandığı korelasyon durumunda önerilen SEM (Mekânsal Hata Modeli) metodundan yola çıkılarak türetilen bir modellemedir (Anselin, 1988). SEM modeli şu şekilde ifade edilmektedir:

$$Y = X\beta + \varepsilon \tag{1}$$

$$\varepsilon = \lambda W_\varepsilon + \upsilon \tag{2}$$

(1) nolu denklemde yer alan β katsayısı, X bağımsız değişken matrisinin Y bağımlı değişkeni üzerindeki doğrudan etkisini ifade ederken modele ait hata terimi ε parametresi ile belirtilmiştir. Hata terimlerinden kaynaklı dolaylı etkiyi açıklamak için öngörülen (2) nolu denklemdeki eşitliğe göre, bağımlı değişkeni ifade eden ε parametresi λ ile simgelenen mekânsal hata katsayısı ve W ağırlık matrisi ile açıklanmaktadır (Ord, 1975: 120-126). Denklemdeki υ simgesi ise SEM modeline ait hata terimidir. SDEM modeli ise bu denkleme mekânsal gecikmeli bağımsız değişkenlerin dâhil edilmesi ile türetilmiş bir modeldir. Bu modellemede mekânsal gecikmeli bağımlı değişken kapsam dışı tutulmuştur. Bu çerçevede;

$$Y = X\beta + WX\theta + \varepsilon \tag{3}$$

$$\varepsilon = \lambda W_\varepsilon + \upsilon \tag{4}$$

Şeklinde ifade edilen denklemler ile modele dâhil edilen $WX\theta$ ağırlık matrisi mekânsal gecikmeli bağımsız değişkenlerin etkisini belirlemek amacıyla oluşturulan ağırlık matrisini ve etki katsayısını ifade etmektedir (Yerdelen-Tatoğlu, 2022: 56). Her iki modeldeki temel vurgu, birimlerin hata terimleri arasındaki etkileşimdir. Buna göre, model dışındaki bir mekânsal otokorelasyon ya da öngörülmeyen bir şok etkisinin dikkate alınması önem arz etmektedir (Elhorst, 2014: 7-8). Bununla birlikte, SDEM modelinin mekânsal bağımlılık etkisini hata terimlerinin yanı sıra bağımsız değişkenleri de içeren bir formda ölçme imkânı tanıması önemli avantaj olarak değerlendirilebilir. Nitekim, SEM modelinde bağımsız değişkenlerden kaynaklanan olası mekânsal yayılma etkilerinin doğrudan yakalanması söz konusu değildir. SDEM modelinin sahip olduğu bu avantaj, politika etkilerinin bir bölge ile sınırlı kalmayıp komşu bölgeler üzerindeki sonuçlarının da analiz edilebilmesi açısından kritik bir öneme sahiptir.

4. Ampirik Analiz

AB-15 ülkeleri (Avusturya, Belçika, Danimarka, Finlandiya, Fransa, Almanya, Yunanistan, İrlanda, İtalya, Lüksemburg, Hollanda, Portekiz, İspanya, İsveç ve İngiltere) ve Türkiye kapsamında yapılan çalışmada, yurtiçi tasarruf oranlarına ait 2008 küresel krizi öncesi ve sonrası dönem görünümlerinin mekânsal etkiler altında incelenerek karşılaştırılması amaçlanmaktadır. Türkiye'nin örneklem grubuna dahil edilmesinin temel sebebi, uzun süredir ortak politika, düzenleme ve entegrasyon süreçlerinden geçmiş olan bu ülkeler ile Türkiye arasında mekânsal bir yayılma etkisinin olup olmadığını analiz etmeye olanak sağlamasıdır. Birlik kapsamında aday ülke statüsünde olan Türkiye'nin belirli bir mali ve iktisadi istikrar düzeyine ulaşmış olan bu ülkelerle olan ekonomik ilişkileri önem taşımaktadır. Bunula birlikte çalışmada, Türkiye'nin mekânsal bağımlılık ilişkileri kapsamında bölgesel ekonomik dinamiklerin bir parçası olup olmadığının ve bölgesel etkileşimlerin tasarruf dinamikleri üzerindeki olası etkilerinin tespit edilmesi hedeflenmektedir. Bu amaçla, tasarruf oranı değişkenini açıklamak üzere kamu harcamaları, net göç, ticari dışa açıklık, yaş bağımlılık oranı ve gelir eşitsizliği göstergelerinden yararlanılmıştır. Çalışma örnekleminde yer alan Avusturya'ya ait gelir eşitsizliği verilerinin 1987-2021 dönemi ile sınırlı olması çalışmanın zaman kısıtını oluşturmuştur. Bu doğrultuda öngörülen karşılaştırmalı analiz ile 1987-2008 ve 2009-2021 olmak üzere iki ayrı dönemde mekânsal etki mekanizmasının işlerliği test edilerek ampirik değerlendirmelere katkıda bulunulması amaçlanmıştır. Söz konusu dönemsel ayrım ve veri ulaşabilirliği dönemlere ait gözlem sayılarındaki farklılaşmanın temel nedenini oluşturmuştur. STATA programı kullanılarak yürütülen analiz kapsamında yararlanılan ve yıllık verilerden oluşan değişkenlere ait açıklamalar Tablo 2'de sunulmuştur.

Tablo: 2
Veri Seti ve Özet İstatistikler

Değişken	Açıklama					Kaynak	
taso	Yurt İçi Tasarruflar/GSYİH (%)						
kho	Hükümet Nihai Tüketim Harcamaları/ GSYİH (%)						
ng	Net Göç					World Bank (2023)	
tdao	Ticari Dışa Açıklık Oranı (%) (Mal ve Hizmet)						
bao	Yaş Bağımlılık Oranı (Çalışma Çağındaki Nüfusun Yüzdesi)						
gini	Gini Katsayısı (%)					SWIID (2023)	
Tanımlayıcı İstatistikler							
1987-2008 Dönemi							
Gözlem	Gösterge	taso	kho	ng	tdao	bao	gini
352	Ortalama	25,013	19,346	62947,07	81,054	50,449	29,435
	Maks.	51,356	27,377	774489	307,485	72	42,800
	Min.	11,522	7,613	-110940	30,476	43	20,566
	Std. Sapma	6,762	3,497	129880,2	50,820	4,556	5,163
	Çarpıklık	0,950	-0,310	2,951	2,065	1,675	0,644
	Basıklık	4,838	3,141	12,780	7,713	7,075	2,983
2009-2021 Dönemi							
Gözlem	Gösterge	taso	kho	ng	tdao	bao	gini
208	Ortalama	26,135	20,903	75407,88	108,908	53,034	30,059
	Maks.	64,095	27,935	703144	388,120	63	40,5
	Min.	7,267	12,014	-261813	45,419	44	24,141
	Std. Sapma	10,623	3,710	131373,3	73,686	4,297	3,835
	Çarpıklık	1,370	-0,406	1,309	2,079	-0,059	0,977
	Basıklık	5,258	2,480	5,973	6,953	2,701	3,665

Tablo 2'de belirtilen Gini katsayısı, gelir eşitsizliği göstergesi olup çalışmada kullanılabilir gelir üzerinden hesaplanan katsayı değerlerinden yararlanılmıştır. Söz konusu tercihin temel sebebi, vergi ve sosyal transferlerin etkisini dikkate alan kullanılabilir gelir kavramının gelir adaleti açısından daha gerçekçi bir ölçüt olarak değerlendirilmesidir. Bu kapsamda Gini katsayısında yaşanan artışlar gelir eşitsizliğinin arttığını göstermektedir. Tablo 2'de özetlenen analiz değişkenlerinin oransal (ng değişkeni dışında) olması, yapılan grafiksel incelemelerde aşırı bir sapmaya rastlanmaması ve maks.-min değerleri arasında çok ciddi bir fark olmaması nedeniyle logaritmik dönüşüme başvurulmamıştır. Ek olarak, değişken seçimi aşamasında yararlanılan korelasyon matrisi ve varyans büyütme faktörü (VIF) verilerine yer verilmesi uygun olacaktır. İlgili veriler Tablo 3 ve Tablo 4'te belirtilmiştir.

Tablo: 3
Korelasyon Matrisi ve VIF Değerleri

1987-2008 Dönemi -Korelasyon Matrisi					
Değişken	taso	kho	ng	tdao	bao	gini
taso	1					
kho	-0,041	1				
ng	-0,121	0,017	1			
tdao	0,821	-0,092	-0,199	1		
bao	-0,213	-0,167	-0,302	-0,189	1	
gini	-0,456	-0,709	0,004	-0,345	0,398	1
2009-2021 Dönemi -Korelasyon Matrisi					
Değişken	taso	kho	ng	tdao	bao	gini
taso	1					
kho	-0,376	1				
ng	-0,114	-0,073	1			
tdao	0,836	-0,274	-0,219	1		
bao	-0,375	0,542	0,015	-0,446	1	
gini	-0,272	-0,598	0,105	-0,367	-0,273	1

Tablo 3'te özetlenen sonuçlara göre, bağımsız değişkenler arasındaki korelasyon katsayılarının yüksek olmaması önemli olmakla birlikte gini ve kho değişkenleri arasındaki %70 oranındaki katsayı dikkat çekmektedir. Ancak bu durum regresyon etkileşimleri ile ortadan kalkabilecek ve sınama testleri ile herhangi bir risk unsurunun olup olmadığı test edilecektir.

Analiz kapsamında incelenecek olan fonksiyonel ilişkiler, mekânsal etkilerden bağımsız olarak aşağıdaki şekilde ifade edilebilecektir:

$$taso_{it}= \beta_0+ \beta_1 kho_{it} + \beta_2 gini_{it} + \beta_3 ng_{it} + \beta_4 tdao_{it} + \beta_5 bao_{it} + \varepsilon_{it} \qquad (5)$$

Tablo: 4
VIF Değerleri

1987-2008 Dönemi -VIF Değerleri		
Değişken	VIF	1/VIF
kho	2,80	0,357
ng	1,20	0,836
tdao	1,62	0,617
bao	1,39	0,718
gini	3,50	0,286
VIF ortalama	2,10	
2009-2021 Dönemi VIF Değerleri		

Değişken	VIF	1/VIF
kho	2,93	0,341
ng	1,10	0,912
tdao	2,75	0,364
bao	1,77	0,566
gini	3,26	0,307
VIF ortalama	2,36	

(5) nolu eşitlikte yer alan "t" zaman, "i" yatay kesit birimlerini ve ε hata terimini ifade etmektedir. Ek olarak, tahmin edilecek olan fonksiyonun bağımsız değişkenlerine ait varyans büyütme faktörünün (VIF) incelenmesi olası bir sahte regresyon problemi açısından önem arz etmektedir. VIF değerinin 1-5 arasında olması orta düzeyde bir ilişkiye işaret ederken, 5-10 arasında olması bağımsız değişkenlerle ilgili yüksek düzeyde bir çoklu doğrusal bağıntının olduğunu göstermektedir (Belsley, 1991: 159). Başka bir ifadeyle, bağımsız değişkenlerin birbirinden yeterli düzeyde bağımsız olması durumunda katsayı tahminlerinde bir sapma ve güvenilirlik problemi yaşanması beklenmemektedir. Bu nedenle analize başlamadan önce ilgili durumun regresyonun sağlığını tehdit edebilecek bir risk oluşturup oluşturmadığının belirlenmesi amacıyla test edilmesi gerekmektedir. Söz konusu incelemelere Tablo 4'te yer verilmiştir.

Tablo 4'te belirtilen VIF değerlerinin gerek birim gerekse ortalama bazda 10'dan küçük olması korelasyona ve/veya çoklu doğrusal bağlantıya dayalı bir risk probleminin beklenmediğini göstermektedir. Bununla birlikte incelenecek olan örneklemin aynı zamanda coğrafi ilişkiler içerisinde olması mekânsal etkilerin araştırılması gerektiğinin bir göstergesi olarak değerlendirilmelidir. Dolayısıyla bu aşamadan sonra incelenecek olan fonksiyonel ilişkilerin mekânsal bir etki altında olup olmadığının tespiti ve niteliksel olarak uyumlu analizler yardımıyla tahmin edilmesi amacıyla çeşitli sınama işlemlerinin yapılması önem arz etmektedir. Bu nedenle öncelikle olası ilişkilerin mekânsal bir bağımlılık içerip içermediğinin tespit edilmesi gerekmektedir. Söz konusu etkilerin analiz edilmesi amacıyla 16 ülkeden oluşan örneklem için 16*16 boyutunda oluşturulan ve standardize edilen mekânsal ağırlık matrisinden yararlanılmıştır. İlgili sınama işlemlerine ilişkin rapor Tablo 5'te sunulmuştur.

Tablo: 5
Mekânsal Bağımlılık Testleri

Test	Dönem: 1987-2008	Dönem: 2009-2021
Global Moran I	0,131 (0,009)	0,160 (0,013)
Global Geary C	0,731 (0,004)	0,604 (0,005)
Global Getis-Ords	-0,278 (0,009)	-0,339 (0,013)
LM Error (Burridge)	5,632 (0,018)	4,504 (0,034)
LM Error (Robust)	5,634 (0,018)	4,529 (0,033)
LM Lag (Anselin)	0,006 (0,940)	0,003 (0,954)
LM Lag (Robust)	0,008 (0,930)	0,028 (0,867)

Tablo 5'te raporlanan sonuçlar incelendiğinde hesaplanan Global Moran I, Global Geary C ve Global Getis-Ords test değerlerinin istatistiki anlamlılığa sahip olması oluşturulan modelin her iki dönem kapsamında mekânsal bağımlılık etkisi altında olduğunu göstermektedir. Sonuçlara göre, LM hata test sonuçlarının %5 düzeyinde istatistiki olarak anlamlı olması her iki dönemde mekânsal hata etkisinin olduğunu göstermektedir. Bununla

birlikte mekânsal gecikmenin varlığına ilişkin bilgi veren LM gecikme testlerine ait sonuçların herhangi bir istatistiki anlamlılık taşımaması ise her iki dönem için de mekânsal gecikmeye ilişkin bir etkileşimin olmadığını ifade etmektedir. Bu durum, modelde yer alan ve açıklanamayan mekânsal etkilerin hata terimlerinden kaynaklandığını göstermektedir. Başka bir ifadeyle, bağımlı değişkenin komşu birimler üzerinde bir etkisi olmasa da modele dahil edilmeyen ancak mekânsal olarak dağılan faktörlerin hata terimlerinde yarattığı sistematik bir bağımlılığın varlığı söz konusudur. Sonuç olarak, her iki dönem kapsamında mekânsal etkilerin varlığına ilişkin göstergelerin olması analizin derinleştirilmesini ve niteliksel olarak uygun mekânsal panel veri modelinin belirlenmesini gerekli kılmaktadır. Bu kapsamda öncelikle söz konusu ilişkilerin birim etki içerip içermediğinin tespit edilmesi faydalı olacaktır. İlgili sonuçlar Tablo 6'da belirtilmiştir.

Tablo: 6
Mekânsal Hata ve Gecikme Sınamaları

Test	Dönem: 1987-2008	Dönem: 2009-2021
Breusch-Pagan LM Test -Two Side	1559,019 (0,000)	863,035 (0,000)
Breusch-Pagan ALM Test -Two Side	1276,337 (0,000)	678,966 (0,000)
Sosa-Escudero-Yoon LM Test -One Side	39,484 (0,000)	29,378 (0,000)
Sosa-Escudero-Yoon ALM Test -One Side	35,726 (0,000)	26,057 (0,000)
Baltagi-Li LM Autocorrelation Test	323,276 (0,000)	190,139 (0,000)
Baltagi-Li ALM Autocorrelation Test	40,595 (0,000)	6,0700 (0,014)
Baltagi-Li LM AR(1) Joint Test	1599,613 (0,000)	869,105 (0,000)
Rho	-0,523 (0,000)	0,179 (0,004)

Tablo 6'da belirtilen bulgulara göre, analize konu her iki dönem için de birim etkinin varlığı reddedilememiştir. Birim etkinin önem derecesi hakkında bilgi veren Rho katsayısına ait değerler, ilk dönem için %52 olarak hesaplanırken ikinci dönem için %18 düzeyinde bir gerçekleşme göstermiştir. Buna göre, ilk dönem birim etki derecesinin kuvvetli, ikinci dönem ise zayıf ilişki olarak görüldüğünü belirtmek gerekmektedir (Davis, 1971). Bu durumda yürütülecek olan regresyon için klasik modelin kullanılması mümkün görülmemektedir. Söz konusu aşamada sabit veya tesadüfi etkiler modellerinden hangisinin uygun olduğuna karar verilmesi için Hausman testine başvurulmuştur. Tablo 7'de model seçimine yön veren test sonuçları özetlenmektedir.

Tablo: 7
Hausman Testi

Test	Dönem: 1987-2008	Dönem: 2009-2021
Hausman LM Test	39,769 (0,000)	40,251 (0,000)

Tablo 7'de belirtilen sonuçlara göre, Hausman testi kapsamında tesadüfi etkilerin uygun olduğunu ifade eden temel hipotezin reddedilmesi modelin her iki dönem için sabit etkiler yöntemi kullanılarak yürütülmesi gerektiğine işaret etmektedir. Bu nedenle çalışmada mekânsal gecikmenin olmadığı ancak mekânsal hata içeren mekânsal panel veri analiz yöntemlerinden SDEM modelinin sabit etkiler yöntemi ile çözümlenmesi uygun görülmüştür. İlgili sonuçlar Tablo 8'de yer almaktadır.

Tablo: 8
SDEM Tahmin Sonuçları

Değişken	Dönem: 1987-2008					Dönem: 2009-2021				
	Katsayı	Std. Hata	P>z	%95 Güven Aralığı		Katsayı	Std. Hata	P>z	%95 Güven Aralığı	
kho	-1,231	0,069	**0,000**	-1,366	-1,096	-1,795	0,131	**0,000**	-2,051	-1,538
gini	-0,125	0,046	**0,006**	-0,215	-0,035	-0,139	0,154	0,368	-0,441	0,163
ng	2,145	7,325	**0,004**	7,027	3,576	-1,286	1,396	0,354	-4,001	1,436
tdao	0,098	0,006	**0,000**	0,087	0,110	0,048	0,013	**0,000**	0,022	0,073
bao	-0,311	0,027	**0,000**	-0,364	-0,257	-0,121	0,083	0,144	-0,283	0,041
w1x_kho	-0,132	0,082	0,108	-0,292	0,029	0,381	0,163	**0,019**	0,061	0,700
w1x_gini	-0,060	0,068	0,377	-0,193	0,073	0,060	0,196	0,762	-0,325	0,445
w1x_ng	9,715	8,046	0,227	-6,066	2,556	-6,317	1,426	0,657	-3,426	2,156
w1x_tdao	0,022	0,008	**0,007**	0,006	0,039	0,000	0,023	0,996	-0,044	0,044
w1x_bao	0,074	0,029	**0,011**	0,017	0,131	0,489	0,085	**0,000**	0,322	0,655
S.lambda	0,113	0,022	**0,000**	0,069	0,157	0,095	0,032	**0,003**	0,032	0,158
sigma2_e	1,510	0,116	**0,000**	1,283	1,736	2,949	0,293	**0,000**	2,375	3,523
R^2	within =0,779					R^2	within =0,685				

Tablo 8'de yer alan bulgulara göre, her iki dönem için hesaplanan R^2 değerleri modellerin açıklama gücünün yeterli olduğunu göstermektedir. Modellerde yer alan mekânsal gecikmeli bağımsız değişkenlerin ise dönemlere göre farklılık göstermesi kriz sonrası yaşanan kırılmanın bir göstergesi olarak değerlendirilebilecektir. Analiz edilen 1987-2008 dönemine ait sonuçlar incelendiğinde en yüksek etkiye sahip değişkenin net göç olması dikkat çekmektedir. Sonuçlara göre, net göç miktarında yaşanan 1 kişilik artış tasarruf oranını %214 düzeyinde artırmaktadır. Bu dönem için elde edilen bulgulara göre, kho değişkeninde meydana gelen her yüzde 1'lik artış taso bağımlı değişkenini %1,2 düzeyinde azaltmaktadır. Gini katsayısının taso değişkeni üzerindeki etkisinin %0,1 düzeyinde gerçekleşmesi ise oldukça düşük bir etkileşim olarak değerlendirilebilir. Bununla birlikte ilgili ülkelerdeki gelir eşitsizliğinin çoğunlukla düşük düzeylerde seyretmesi bu sonucun bir nedeni olarak düşünülebilir. Nitekim gelir adaletinin sağlanmış olması tasarruf davranışları üzerinde etkili olan diğer faktörlerin ağırlıklarının artması ile sonuçlanabilecektir. Benzer şekilde ticari dışa açıklık oranı için elde edilen katsayı değeri de %0,1 düzeyinde ve pozitif olarak gerçekleşmiştir. Bununla birlikte, nüfus bağımlılık oranlarında yaşanan %1 düzeyindeki artışlar %0,3 oranında ve negatif yönde bir etki yaratmaktadır. Analiz sonucunda istatistiki olarak anlamlı olduğu belirlenen gecikmeli bağımsız değişkenler ise tdao ve bao göstergeleri olmuştur. Buna göre komşu ülkelerin tdao ve bao değerlerinde yaşanan %1 oranındaki artışlar tasarruf oranlarında sırasıyla %0,02 ve %0,07 düzeyinde artışa neden olmaktadır. Modele ait mekânsal hatayı ifade eden Lambda katsayısının anlamlı olması ise komşu ülkeler için hesaplanan hata terimlerinin %11 oranında birlikte hareket ettiğini göstermektedir.

2009-2021 dönemine ait sonuçlara göre, ilk dönemde en yüksek etkiye sahip olan net göç değişkeni, Gini katsayısı ve bao değişkenlerine ilişkin istatistiki olarak anlamlı bir bulguya rastlanmamıştır. Bulgular, kho değişkeninde meydana gelen her yüzde 1'lik artışın taso bağımlı değişkenini %1,8 düzeyinde azalttığını göstermektedir. Tdao değişkeni için elde edilen sonuçlara göre, açıklık düzeyinde ortaya çıkan her yüzde 1'lik artış tasarruf oranını %0,05 düzeyinde artırmaktadır. Ayrıca, kho ve tdao değişkenlerine ait bulguların incelenen her iki dönem için de aynı yönde olduğu tespit edilmiştir. İkinci dönem için istatistiki olarak anlamlı olduğu belirlenen gecikmeli bağımsız değişkenler ise kho ve bao

göstergeleri olmuştur. Buna göre komşu ülkelerin kho ve bao değerlerinde yaşanan %1 oranındaki artışlar tasarruf oranlarında sırasıyla %0,38 ve %0,49 düzeyinde artışa neden olmaktadır. Bu modele ait mekânsal hata katsayısı ise komşu ülkeler için hesaplanan hata terimlerinin %10 oranında birlikte hareket ettiğini göstermektedir. Hata terimleri varyansını ifade eden sigma2_e katsayı değerlerinin istatistiki olarak anlamlı ve yüksek düzeylerde olmaması ise modelin mekânsal etkileşimleri büyük ölçüde yakaladığının bir göstergesi olarak değerlendirilebilir.

5. Sonuç

Ekonomilerin temel büyüme dinamiği olan yurtiçi tasarruf düzeyini etkileyen değişkenlerin ve etki boyutlarının belirlenmesi ilgili politikaların türetilmesinde yüksek düzeyde yol gösterici niteliktedir. Özellikle serbest ekonomi uygulamalarının yaygınlaşması ile birlikte kendi kendine yeterli ekonomilerin önem kazanması ve dış tasarruflar ile ilgili ekonomik riskler ülkelerin kendi tasarruflarını artırmaya yönelik politikalara olan ihtiyaç düzeylerinin artmasına neden olmuştur. Bu kapsamda dünya genelinde oldukça geniş bir literatüre sahip yurtiçi tasarruflar çok sayıda araştırmacı ve karar birimi tarafından yakından izlenmeye devam etmektedir.

Bu çalışmada, AB-15 ülkeleri ve Türkiye'nin 1987-2021 dönemine ait verileri kullanılarak 2008 küresel krizi öncesi ve sonrası süreçte ortaya çıkan yurtiçi tasarruf oranı gerçekleşmelerinin mekânsal etki dâhilinde incelenmesi hedeflenmektedir. Bu kapsamda SDEM modeli kullanılarak yapılan mekânsal panel veri analizinde bağımsız değişken olarak kamu harcamaları, net göç, ticari dışa açıklık, yaş bağımlılık oranı ve gelir eşitsizliği değişkenlerinden yararlanılmıştır. Yapılan analiz ile ulaşılan kriz öncesi (1987-2008) dönem sonuçları, kamu tüketim harcamaları oranı, gelir eşitsizliği ve bağımlı nüfus oranlarında yaşanan artışların yurtiçi tasarrufları azalttığını; net göç ve ticari dışa açıklık düzeyi artışlarının ise tasarruflar üzerinde pozitif yönlü bir etki gücüne sahip olduğunu göstermiştir. Ayrıca mekânsal etkileşim kapsamında belirlenen ilişkilere göre dışa açıklık ve bağımlı nüfus oranından tasarruf oranlarına doğru pozitif yönlü bir mekanizmanın işlediği tespit edilmiştir. Kriz ve sonrası (2009-2021) dönem sonuçlarına göre, istatistiki anlamlılığa sahip olan değişkenlerin kamu harcamaları oranı ve ticari dışa açıklık olduğu belirlenmiştir. Ayrıca bu değişkenlerin etki yönlerinde herhangi bir değişikliğe rastlanmamıştır. Bu döneme ait mekânsal etki sonuçları bağımlı nüfus açısından ilk dönem ile aynı yönde gerçekleşmiştir. Dönemsel olarak farklılaşan bir başka sonuç ise komşu ülkelerin kamu harcamaları oranında yaşanan artışların tasarruf oranlarını artırmasıdır. Bu durum, kriz sonrası dönemde uygulanan genişletici maliye politikaları ve kurtarma paketlerinin etkisiyle azalan kamu tasarruflarının etkisini barındırabilecektir. Söz konusu koşullarda hükümetlerin daha fazla vergi alacağına ilişkin bir beklentinin oluşması hanehalkının ihtiyatî olarak daha fazla tasarruf etme güdüsünü harekete geçirmiş olabilecektir. Ayrıca ilk dönemde etki düzeyi en yüksek olan değişkenin net göç olması ve bu değişken için kriz sonrası dönem kapsamında anlamlı bir bulguya rastlanmaması dikkat çekmektedir. Söz konusu durum kayıt dışı göçmen sayısında gözlenen artışlardan kaynaklanmış olabilir. Özellikle 2011 yılında başlayan Suriye savaşının yol açtığı göç akımının etkisinin ölçülemediğini belirtmek gerekmektedir. Ayrıca

Yunanistan'ın 2009-2021 döneminde sürekli negatif net göç ile karşılaşan tek ülke olarak küresel kriz yanında iç ekonomik problemlerle de yoğun bir şekilde mücadele ettiği bu süreç, gerçekleşen tasarruf oranlarının oldukça düşük olduğu bir döneme işaret etmektedir. Ancak bu durumun içsel faktörlerle birlikte ülke özelinde analiz edilmesi bir başka çalışmanın konusunu oluşturabilecektir.

Çalışmadan elde edilen sonuçlar değerlendirildiğinde, bu analiz ile AB üyeliği halen gündemde olan Türkiye için yüksek yurt içi tasarruf oranlarının temin edilmesi amacıyla örnek teşkil edebilecek yakın coğrafyanın bu anlamdaki etkilerinin önemine odaklanılmasının literatüre katkı sağladığı düşünülmektedir. Ayrıca uzun dönemli bir yaklaşımla hareket edilmesi ve tasarruf oranlarına yönelik belirleyicilerin küresel kriz etkisi bağlamında derinleştirilmesi önem arz etmektedir. Bu kapsamda yapılan analiz sonuçları, tasarruf oranlarının mekânsal olarak dışa açıklık, bağımlı nüfus oranı ve kamu harcamaları gibi değişkenler üzerinden farklılaştığını göstermektedir. Kriz sonrası dönemde, özellikle komşu ülkelerdeki kamu harcamalarındaki artışın tasarruf oranlarını artırıcı etkisi öne çıkarken, net göç değişkeninin mekânsal yayılma etkisinin zayıfladığı gözlemlenmiştir. Bu sonuçlar, tasarruf oranlarının yalnızca içsel faktörlere değil, bölgesel ekonomik gelişmelere ve politika farklılıklarına bağlı olarak değişebileceğini ortaya koymaktadır. Elde edilen bulgular doğrultusunda öngörülen temel öneriler; maliye politikalarının uzun dönemde sürdürülebilir kamu tasarruflarını destekleyecek biçimde yapılandırılması, göç politikalarının tasarruf eğilimleri üzerindeki etkisinin dikkate alınması, dış ticarete yönelik entegrasyon süreçlerinin ve ihracat odaklı büyüme politikalarının desteklenmesi, uzun vadeli tasarruf araçlarının teşvik edilmesi, sosyal güvenlik sistemlerinin güçlendirilmesi ve gelir eşitsizliğinin azaltılmasına yönelik politikaların artırılması olarak sıralanabilir. Ayrıca bölgesel kalkınma stratejilerinin tasarruf artışını destekleyen bir yapıda şekillendirilmesi küresel kriz, savaş ve salgın benzeri süreçlerde sağlıklı yönetim süreçlerinin temin edilebilmesine katkı sağlayabilecektir. Bu kapsamda, sonraki çalışmalar için 2019 küresel pandemi sonrasındaki görünümün izlenmesi ve mekânsal etki boyutlarının değerlendirilmesi önerilmektedir.

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Tek Ebeveynli Aile Örüntüsündeki Üniversite Öğrencilerinin Aile Algısı ve Sosyal Hizmet Gereksinimlerinin Belirlenmesi

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Determination of Family Perception and Social Work Needs of University Students in Single-Parent Family Pattern

Abstract

Children and young people are affected mainly by single-parent family structures. This study was conducted to determine the family perceptions and social work needs of university students in single-parent families, and to implement new policy and practice recommendations based on the data obtained. In the study, face-to-face interviews were conducted using a snowball sampling method and a semi-structured interview form. The data obtained were analysed using the MAXQDA program. According to the study results, it was found that single-parent families face economic, psychological, and social difficulties. It was determined that socioeconomic difficulties negatively affect family relationships and create psychological problems. In addition, the participants emphasised the expectation of healthier family relationships and a fairer environment.

Keywords : Family, Single Parent Individual, Social Work, Socioeconomic Support.

JEL Classification Codes : I22, I23, I31, J12, J13.

Öz

Tek ebeveynli aile yapısından daha çok çocuklar ve gençler etkilenmektedir. Bu çalışma tek ebeveynli aile örüntüsündeki üniversite öğrencilerinin aile algısı ve sosyal hizmet gereksinimlerinin belirlenmesi ve elde edilen veriler doğrultusunda yeni politika ve uygulama önerilerinin ortaya konulması amacıyla gerçekleştirilmiştir. Araştırmada, yarı yapılandırılmış görüşme formu kullanılarak kartopu örnekleme yöntemiyle yüz yüze görüşmeler gerçekleştirilmiş ve elde edilen veriler MAXQDA programı aracılıyla analiz edilmiştir. Araştırma sonuçlarına göre; tek ebeveynli ailelerin ekonomik, psikolojik ve sosyal güçlüklere sahip olduğu anlaşılmıştır. Yaşanan sosyoekonomik güçlüklerin aile içi ilişkileri olumsuz etkilediği ve psikolojik olarak zorluklar yarattığı belirlenmiştir. Ayrıca daha sağlıklı aile ilişkilerinin olması ve daha adil bir ortam beklentisi katılımcılar tarafından vurgulanmıştır.

Anahtar Sözcükler : Aile, Tek Ebeveynli Birey, Sosyal Hizmet, Sosyoekonomik Destek.

1. Giriş

Toplumsal değişme süreci hız kesmeden devam etmekte ve birçok değişken toplumun yaşantısında, rutinlerinde ve işleyişinde farklılaşmalara neden olmaktadır. Toplumsal değişme süreci devam ederken toplumsal kurumların da sürecin dışında kal(a)madığı ifade edilebilir. Bu değişimin dışında kal(a)mayan toplumsal kurumların başında da aile gelmektedir.

Toplumsal bir olgu olarak ele alınan aile, benzer şekillerde tanımlansa da tanımı ve bileşenleri kültürel farklılıklara göre değişiklik göstermektedir. Bu kültürel farklılıklar nedeniyle aileye yüklenen anlamlar toplumdan topluma, kültürden kültüre değişiklik göstermektedir (Sütçü, 2021: 141). Başından beri bazı toplumlar aileyi kutsal bir kurum olarak görürken (Duman, 2021: 24; Bayam, 2022: 4), bazıları ise aynı bakış açısını benimsememiştir. Bu durum geçerliliğini halen korumaktadır. Bunun yanı sıra toplumsal değişme süreciyle birlikte aile formlarının değişim yaşadığı anlaşılmaktadır.

Geleneksel bir bakış açısıyla aile ele alındığında; anne, baba ve çocuklardan oluşan toplumsal bir örgütlenme olarak nitelenmektedir (Tekin-Epik vd., 2017). Geleneksel olarak yapılan tanımlamada ailenin eşlerin her ikisinin de var olduğu ve çocuk sahibi olunarak tamamlandığına işaret edilmektedir. Anne, baba ve çocuklardan oluşan bu tip aileler aynı zamanda çekirdek ailenin en bilinen formu olarak da karşımıza çıkmaktadır.

Değişen aile yapılarına bakıldığında geniş ailenin yerini çekirdek ailelerin aldığı ve bu süreçte kır-kent aile farklılıklarının büyük ölçüde ortadan kalktığı söylenebilir. Çekirdek aile yapısının ise sadece geleneksel boyutta ele alınmadığı aynı zamanda çocuksuz ve sadece bir ebeveynin bulunduğu çekirdek aile örgütlenmelerini de kapsadığı ifade edilmektedir. Çalışmanın kapsamında ise çekirdek aile formlarından biri olan, dünyada ve Türkiye'de giderek yaygınlaşan tek ebeveynli aile örgütlenmesi yer almaktadır. Tek ebeveynli aile; aile örgütlenmesinde tek bir ebeveynin ve yanında en az bir çocuğun bulunduğu aile tipini ifade etmektedir (Aydıner-Boylu & Öztop, 2013: 207). Tek ebeveynli aile örgütlenmesinin oluşumu ise; boşanma, eşlerden birinin ölümü, eşlerden birinin tutuklu veya hükümlü olması, evlat edinilmesi ve evlilik bağı olmaksızın çocuk sahibi olunması şeklindedir. Buna ek olarak iş yeri nedeniyle uzak mesafeli çalışan eşler ve ayrı yaşamayı tercih eden eşler de bulunmaktadır. Toplumdan topluma değişmekle birlikte yapay döllenme ve taşıyıcı annelik uygulamalarının da tek ebeveynli aile örgütlenmesinin oluşumunda etkili olduğu bilinmektedir (Van den Akker, 2017; Zadeh, 2020; Ellenbogen et al., 2021; Pereira & Beatriz, 2023).

Tek ebeveynli aile örgütlenmesinin oluşumu farklı nedenlere bağlı olsa da en temelde yaşanan sürecin, sorunların ve gereksinimlerin benzer olduğunu söylemek yanlış olmayacaktır. Öne çıkan temel gereksinimlerin; psikolojik, ekonomik, sosyal destek yoksunluğu ve yalnızlaşma, hukuksal ve çocuk (çocuk bakımı) ile ilgili olduğu anlaşılmaktadır (Weng, 2018; Demirel & Buz, 2021; Shorey & Pereira, 2023). Buna ek olarak özellikle damgalanma açısından eşin ölümüne, boşanmaya ve tutuklu veya hükümlü

olmaya göre sosyal çevreden gelen tepkilerin kısmi farklılıklar gösterdiği söylenebilir (Demirel, 2022).

Tek ebeveyn bireyler açısından sürecin daha fazla güçlükler barındırdığı yapılan araştırmalarda ortaya konulmaktadır (McLanahan & Sandefur, 1994; Demir & Çelebi, 2017; John & Shimfe, 2020; Nugroho et al., 2023). Özellikle tek ebeveyn olarak yaşamını sürdürenlerin çoğunun anne olması, süreçteki güçlüklere ek toplumsal cinsiyete dayalı olarak kadın olmanın güçlüklerini de beraberinde getirmektedir (Kotwal & Prabhakar, 2009; Kavşut, 2015; Karaca-Aydın, 2019).

Çalışma kapsamında ele alınan üniversite öğrencileri için de tek ebeveynli ailede büyümenin etkileri ve sonuçları olduğu değerlendirilmektedir. Ayrıca aile algılarının da bir dönüşüm geçirmiş olabileceği muhtemel bir durum olarak değerlendirilmektedir. Literatürde yer alan çalışmalar doğrultusunda; tek ebeveynli hanelerdeki çocukların-ergenlerin birçok açıdan tam ailedeki çocuk ve ergenlere kıyasla risk altında olduğu sonuçlarına yer verilmektedir. Buna göre; yoksulluk riski ve beraberinde refah kaybının bu tür ailedeki çocuk ve ergenlerde daha sık olduğu aktarılmaktadır (Cheung, 2015). Ruh sağlığı üzerinde de olumsuz etkilerin var olduğu ve iyilik halini düşüren bir durum olarak tek ebeveynli ailede büyüme süreci tarif edilmektedir (Moilanen & Rantakallio, 1988). Eğitime odaklanma ve akademik başarıda düşüşlerin yaşanması bu aile türünde çok daha yaygın olarak kendini gösterebilmektedir (de Lange et al., 2009). Buna ek olarak çocuk ve ergenler üzerinde özellikle psikolojik ve sosyal etkiler doğurduğu hatta bu çocuk ve ergenlerin gelecek yaşamındaki aile ilişkileri ve ebeveynlik rollerini etkilediğine yer verilmektedir (Stephen & Udisi, 2016). Obezite gibi olumsuz fiziksel sonuçlara da neden olacak nitelikte çocuk ve ergenler bu süreçten etkilenebilmektedir (Duriancik & Goff, 2019).

Tek ebeveynli ailede çocuk ve ergen olmanın olası dezavantajlı durumlar açısından risk oluşturduğunu ifade etmekle birlikte çocuğu ya da ergeni tek ebeveynli aile örüntüsüne götüren sürecin de olası olumsuzluklar üzerinde etkili olacağı değerlendirilmektedir. Bu doğrultuda her ne olursa olsun bu süreci deneyimleyen çocuk ve ergenlerin hatta geçmişte bu süreci deneyimleyerek günümüzde yetişkin olarak yaşamını sürdüren bireylerin çeşitli sosyal hizmet gereksinimlerinin olabileceği anlaşılmaktadır. Tek ebeveynli ailelere yönelik Avrupa Birliğinin temel istatistiksel verilerine bakıldığında 25-54 yaş aralığındaki yetişkin kadınların %5,5'inin tek ebeveyn olduğu; yetişkin erkeklerin ise %1,1'inin tek ebeveyn olduğu aktarılmaktadır. Ayrıca Avrupa Birliğinde çocuklu haneler arasında en yüksek tek ebeveynli aile oranlarının %25 ve üzerindeki oranlarda Estonya, Litvanya ve Letonya'da olduğu paylaşılmaktadır. Tüm Avrupa Birliği genelinde ise tek ebeveynli hanelerin oranının %12,4 olduğu bilgisine ulaşılmaktadır (EUROSTAT, 2023). Türkiye açısından bakıldığında ise 2014'te %7,6'lık orana sahip olan tek ebeveynli aile oranının 2023'te %10,6'ya yükseldiği görülmektedir (TÜİK, 2024).

Tek ebeveynli aile oranlarının giderek artması bu konuya daha fazla özen gösterilmesi gerekliliğini vurgulamaktadır. Aktarılan bilgiler ışığında bu çalışmada, tek

ebeveynli aile örüntüsündeki üniversite öğrencilerinin aile algısı ve sosyal hizmet gereksinimlerinin belirlenmesi hedeflenmektedir.

2. Yöntem

Bu araştırmada, üniversite eğitimine devam eden tek ebeveynli öğrencilerin aile algısını ve sosyal hizmet gereksinimlerini belirlemek amaçlanmıştır. Araştırma, tek ebeveynli ailelerin yapısını ve öğrencilerin bu aile yapılarından kaynaklanan deneyimlerini derinlemesine inceleyerek, aile algısını ve öğrencilerin sosyal hizmet gereksinimlerini araştırmaktadır. Bu çalışmanın, özellikle tek ebeveynli üniversite öğrencilerinin aile algısını ve sosyal hizmet alanındaki gereksinimlerini anlamak ve uygun destek hizmetlerinin sağlanmasına yönelik politika önerileri sunmak amacıyla önemli bir katkı sağlayacağı öngörülmektedir.

Bu araştırmanın amacına daha uygun olarak nitel araştırma yöntemi tercih edilmiştir. Nitel yöntemle yapılan araştırmalarda, incelenen konuyu derinlemesine anlamak için araştırmaya katılanların kişisel görüşleri ve değerlendirmeleri son derece önemlidir. Bu kapsamda tek ebeveynli üniversite öğrencilerinin aile algısını ve tek ebeveynli aile yapısı içerisinde yaşadıkları güçlükleri ve bu güçlüklerle baş edebilmeleri için gereksinim duydukları sosyal hizmet uygulamalarını anlayarak politika önerileri geliştirmek amacıyla uzman görüşü alınarak veri toplama aşamasında kullanılmak üzere 8 (sekiz) sorudan oluşan yarı yapılandırılmış görüşme formu hazırlanmıştır.

Tablo: 1
Katılımcı Tek Ebeveynli Üniversite Öğrencilerine Yönelik Temel Bilgiler

Katılımcı	Cinsiyet	Yaş	Ebeveyn Durumu	Kardeş sayısı
Katılımcı 1	Kadın	20	Anne Baba Ayrı	-
Katılımcı 2	Kadın	21	Baba Vefat	2
Katılımcı 3	Kadın	20	Baba Vefat	4
Katılımcı 4	Kadın	18	Anne Baba Ayrı	-
Katılımcı 5	Kadın	19	Anne Baba Ayrı	1
Katılımcı 6	Erkek	21	Anne Vefat	3
Katılımcı 7	Kadın	21	Anne Baba Ayrı	3
Katılımcı 8	Erkek	19	Anne Baba Ayrı	1
Katılımcı 9	Erkek	19	Baba Vefat	2
Katılımcı 10	Erkek	19	Anne Baba Ayrı	1
Katılımcı 11	Erkek	20	Anne Baba Ayrı	1
Katılımcı 12	Erkek	18	Anne Baba Ayrı	1
Katılımcı 13	Kadın	19	Anne Baba Ayrı	1
Katılımcı 14	Kadın	19	Anne Baba Ayrı	1
Katılımcı 15	Erkek	21	Anne Baba Ayrı	2
Katılımcı 16	Kadın	20	Anne Baba Ayrı	1
Katılımcı 17	Kadın	24	Baba Vefat	1
Katılımcı 18	Kadın	22	Baba Vefat	1
Katılımcı 19	Erkek	19	Anne Baba Ayrı	1

Araştırma veri toplama süreci için Hitit Üniversitesi Girişimsel Olmayan Araştırmalar Etik Kurulundan (07/12/2023 tarih ve 2023-19 karar numaralı) gerekli etik izin alınmıştır. Araştırma veri toplama sürecinde, Hitit Üniversitesinde öğrenim gören öğrencilerin uygun olduğu tarih ve saatlerde uygun bir görüşme ortamı sağlanmış, ardından katılımcılardan bilgilendirilmiş onam formları aracılığıyla onayları alınarak kartopu

örnekleme yoluyla 19 farklı tek ebeveynli üniversite öğrencisi ile derinlemesine yüz yüze görüşmeler gerçekleştirilmiştir. Veriler 02.01.2024-20.04.2024 tarihleri arasında toplanmıştır.

Görüşmelerden elde edilen veriler araştırmacılar tarafından MAXQDA programı kullanılarak tematik analiz teknikleriyle değerlendirilmiştir. Araştırma kapsamında elde edilen veriler katılımcıların isimleri gizli tutularak kodlanmıştır.

3. Bulgular

Araştırmanın bulguları, tek ebeveynli aile örüntüsündeki üniversite öğrencilerinin aile algısı ve sosyal hizmet gereksinimlerini anlamak için derinlemesine bir bakış sunmaktadır. Araştırma kapsamında yarı yapılandırılmış görüşme formu aracılığı ile 19 farklı tek ebeveynli gençle yapılan görüşmelerden elde edilen bulgular *"Aile Algısı", "Anne Algısı", "Baba Algısı", "Güçlükler ve Gereksinimler", "Aile Yaşamında Değiştirmek İstenilen Durumlar", "Yararlanılan Sosyal Hizmet Uygulamaları" ve "Sosyal Hizmet Gereksinimleri"* olmak üzere yedi ana tema altında ele alınmıştır. Araştırma bulguları doğrultusunda hazırlanan ana tema ve alt temalar aşağıdaki tabloda verilmektedir (Bkz. Tablo 2).

Tablo: 2
Ana Tema ve Alt Temalar

ANA TEMA	ALT TEMALAR
Aile Algısı	
Anne Algısı	
Baba Algısı	
Güçlükler ve Gereksinimler	Ekonomik Güçlükler Psikolojik Güçlükler Sosyal Güçlükler
Aile Yaşamında Değiştirmek İstenilen Durumlar	
Yararlanılan Sosyal Hizmet Uygulamaları	Ekonomik Destek Psikolojik Destek Herhangi Bir Sosyal Hizmet ve Destek Programına Başvurabileceğini Bilmeyenler İnformel (Resmi Olmayan) Destek
Sosyal Hizmet Gereksinimleri	Ekonomik Destek Gereksinimi Psikolojik Destek Gereksinimi Hem Ekonomik Hem de Psikolojik Destek Gereksinimi

Araştırmanın bulguları, tek ebeveynli ailelerin iç dinamiklerini ve aile üyelerinin yaşadığı deneyimleri anlamak için önemli göstergeler sunmaktadır. Bu bulgular, sosyal hizmet profesyonellerinin ve politika yapıcıların, tek ebeveynli ailelere ve bu ailelerde yer alan çocuk ve gençlere daha etkili destek sağlamak için stratejiler geliştirmelerine yardımcı olacaktır.

3.1. Aile Algısı

Tek ebeveynli ailelerde yer alan üniversiteli öğrencilerin görüşlerine göre, aile kavramı, geleneksel tanımın dışında, esnek ve çeşitli bağlara sahip bir yapıya dönüşmektedir. Aile, sadece biyolojik bağlardan değil, sevgi, destek ve koruma gibi duygusal ve sosyal bağlardan da oluşmaktadır. Katılımcı gençlere göre, aile sadece kan

bağıyla değil, sevilen herhangi biriyle de kurulmaktadır. Tek ebeveynli gençlere göre özellikle aile üyeleri arasındaki sorumluluk ve dayanışma, derin ve güçlü bir bağın varlığını ortaya koymaktadır. Bu anlayışla, aile kavramı sadece biyolojik bağlarla sınırlı değil, aynı zamanda sevgi, destek ve dayanışma gibi değerlerle de şekillenmektedir. Bu kapsamda öne çıkan katılımcıların ifadeleri aşağıdaki gibidir:

> *"Aile sadece anne babadan oluşan bir yapı değildir. Bana göre baba olmadan da anne ile aile olunabilir (Katılımcı 1, K)"*
> *"Aile benim için her şeydir. Sevdiğin insanlarla aynı ortamda barınmaktır (Katılımcı 2, K)"*
> *"Aralarında kan bağı olan, aile içerisinde üyelerin birbirlerine her zaman destek olup, yardımda bulunması, aile bireylerinin aralarında güçlü bağ bulunması durumuna aile denir. Aile her bir bireyini tüm tehlikelere karşı her zaman koruyup kollayan bir kalkandır (Katılımcı 4, K)"*
> *"Kan bağı olan anne baba ve çocuklardan oluşan bir yapıdır. İyi günde kötü günde sürekli birbirini koruyup kollayan destekleyen bir yapıdır (Katılımcı 10, E)"*

Katılımcı gençler, aileyi duygusal bağlarla birleşmiş, karşılıklı destek ve dayanışma içinde olmakta olan bir bütün olarak tanımlamaktadır. Ailede, kan bağına bakılmaksızın, her üyenin diğerine yardım etmekte ve desteklemekte olduğu vurgulanmaktadır. Aile, her durumda birbirlerine yardımcı olmakta ve birlikte zorlukları aşmaktadır. Bu anlayışla, aile sadece biyolojik bağlarla değil, aynı zamanda sağlam destek ve bağlılıkla da tanımlanmaktadır. Bu kapsamda öne çıkan katılımcıların ifadeleri ise şöyledir:

> *"Birbirine destek olan, birbirinin her koşulda yanında olan aile, sığındığın limandır. Bir çınar ağacı gölgesi gibidir o gölgeye sığınmak güven verir (Katılımcı 3, K)"*
> *"Aile bir bütündür. İnsanların bir arada yaşadığı duygusal bağlarda birleşmiş birlikte kararlar aldığı ve birbirine destek olan demektir (Katılımcı 5, K)"*
> *"Koşullar ne olursa olsun kan bağı olan kişiye her zaman yardıma koşan, onları destekleyen bireylerden oluşan bir yapıdır (Katılımcı 9, E)"*
> *"Aile her şeydir, ne olursa olsun aile bireyleri birbirine destek çıkmalıdır. Kan bağı olan herkes aile değildir, aile olmak için iyi günde kötü günde her zaman birbirlerinin yanında olması gerekir (Katılımcı 11, E)"*

Katılımcılar, ailede birbirine sahip çıkma, birbirini yalnız bırakmama ve güvende hissetme gibi unsurların temel taşlar olduğunu belirtmektedir. Aile, hem maddi hem de manevi olarak huzur ve güvence sağlayan bir birlik olarak nitelendirilmiştir. Ailede, belirli bir düzen ve saygı içinde, çocukların psikolojik olarak olumlu bir ortamda yetişmeleri ve güvenli bir atmosferde sorumluluk alabilmeleri önemsenmektedir. Katılımcılar aşağıda yer alan ifadeleriyle ailenin sadece biyolojik bağlardan ziyade, bir arada oluşturulan güven, saygı, huzur ve destek ile şekillenen bir yapı olduğunu ortaya koymaktadır:

> *"Aile bence ne olursa olsun birbirine sahip çıkmak, birbirini ne olursa olsun bırakmamaktır (Katılımcı 7, K)"*

"Aile beraberlik içerisinde maddi manevi huzurlu yaptığımız işlerle birlikte oturup huzurlu bir akşam yemeği yiyebildiğimiz bir ortamdır (Katılımcı 14, K)"

"Anne ve babadan oluşan saygı ve güven ortamının bulunduğu sorumluluk isteyen bir ortamdır. Dış çevreye karşı mutlu olduğun tek ortamdır (Katılımcı 17, K)"

"Aile sadece anne babadan oluşmaz. Anne varsa babanın eksikliğini, baba varsa annenin eksikliğini hissettirmemelidir. Eğer bir eksiklik varsa aile değildir (Katılımcı 19, E)".

3.2. Anne Algısı

Katılımcılar, "anne" kavramını çeşitli açılardan değerlendirirken, annenin çocuğun temel ihtiyaçlarını karşılayan, sevgi dolu, sorumlu ve destekleyici bir figür olduğunu belirtmektedir. Anne, çocuğuna duygusal olarak bağlı, ona anlayışla yaklaşan, öğreten ve hatalarını konuşarak düzelten bir rol üstlenmektedir. Ayrıca, annenin her şeyini sorunsuzca paylaşabilen, çocuğuyla sürekli iletişim halinde olan, empati kurabilen ve karşılıklı ilişki içinde olan biri olduğu ifade edilmektedir. Anne, çocuğunun özgürlüğünü kısıtlamayan, ona güven veren, dostça bir yaklaşım sergileyen ve onun dertlerini dinleyen bir figür olarak da tanımlanmaktadır. Bu kapsamda katılımcıların öne çıkan ifadeleri aşağıdaki gibidir:

"Anne sadece çocuğu doğuran değil çocuğun temel ihtiyacı olan her şeyi elinden gelebildiğince giderendir. Sorumluluk sahibi, önceliği çocukları olan bireylerdir (Katılımcı 1, K)"

"Her zaman çocuğuna sevgisini gösteren destekleyen, onları anlayan, çocuğuna her şeyi öğreten (sevgi, saygı, hoşgörü vb.), yanlışlarını konuşarak düzelten, sorunlarını çözmeye çalışandır (Katılımcı 5, K)"

"Anne aslında her şeyini sorunsuz bir şekilde paylaşıp seni anlayan her şekilde her durumda koşulsuz olarak seni seven ve yanında olan birlikte güzel aktiviteler yapabildiğin biridir (Katılımcı 14, K)"

"Anne kendi yaşadıklarıma göre çocuğunu kısıtlamayan, çocuğuna her zaman sevgisini gösteren yeri geldiğinde arkadaş gibi derdini dinleyen, güvendiğini hissettirendir (Katılımcı 18, K)"

Katılımcılar, ideal bir anne figürünün nasıl olması gerektiğini çeşitli yönlerden ele almakta, bir annenin çocuğun yanında olması, destek sağlaması ve güvenilir bir liman olması gerektiğini ifade etmektedirler. Katılımcılar, annenin dürüst ve açık olması, güvendiğini hissettirmesi ve doğru yolu göstermesi gerektiğini vurgulamaktadır. Bu görüşler, annenin çocuğa sağladığı destek, güven ve sevginin hayatımızdaki önemini belirtmektedir:

"Anne hastalığında, sağlığında, mutluluğunda, üzgün olduğunda hiçbir karşılık beklemeden yanımda hissettirmelidir (Katılımcı 2, K)"

"Anne, her zaman evladının yanında olan ona destek olan, ona yanında olduğunu hissettiren, kimsenin annesine özendirmeyen biri olmalı, sırtını yaslayıp derdini rahatça anlatabileceğin birisi olmalıdır (Katılımcı 3, K)"

"Bana göre bir anne çocuğuna zaman ayırmalı, çocuğuna karşı bazen arkadaşı gibi yaklaşmalıdır. Bir kız çocuğu olarak anne benim için bütün sorunlarımı anlatacağım bir dert arkadaşıdır. Her zaman sığınacağım bir liman olmalıdır. Bir yardım isteyecekken acaba bana yardım eder mi etmez mi diye düşünmeden yardım isteyeceğin kişidir. Anne çocuğuna karşı her zaman sevgi dolu ve şefkatli olmalıdır. Çocuğuna karşı anne her zaman dürüst olmalıdır (Katılımcı 4, K)"

"Bence anne, hem anne hem de en yakın arkadaş olduğunu hissettirmeli, çocuğuna, sevgisini hep göstermeli, çocuğuna olan sevgisini sınırlandırmamalı, güvendiğini her zaman belli etmelidir. Anne çocuğu yanlış yaptığı zaman bile ona doğruyu göstermelidir (Katılımcı 6, E)"

Katılımcılar, tek ebeveynli ailelerde annenin rolünü ve sorumluluklarını çeşitli açılardan ele alırken, annenin zorluklara karşın çocuklarına destek olması ve her zaman yanlarında olması gerektiğini belirtmektedir. Annenin, çocuklarının mutluluğu için çaba gösteren, babanın yokluğunda hem annelik hem de babalık görevini üstlenen bir figür olması beklenmektedir. Güvenilir ve saygılı bir anne olması, sorunları açıkça konuşması ve görevleri paylaşması gerektiği vurgulanmaktadır. Bu kapsamda öne çıkan katılımcıların ifadeleri şu şekildedir:

"Bir anne eşi olsun ya da olmasın yaşadığı zorluklara, güçlüklere rağmen mücadele edip çocuklara her daim destek olmalıdır (Katılımcı 11, E)"

"Anne şefkatli ve merhametli bir varlıktır, anneler çok kıymetlidir. Baba olmasa da babanın yokluğunu hissettirmeyendir (Katılımcı 8, E)"

"Anneler çocuklarının mutluluğu için canla başla çalışan insanlardır. Babalar hayatlarını kaybedince anneler hem anne hem baba oluyor (Katılımcı 9, E)"

"Anne eşi olmadan da çocuğuna her zaman yanında olduğunu, sevdiğini hissettirmeli çocuğuna yanlış yaptığı zaman konuşarak doğruyu göstermelidir (Katılımcı 19, E)".

3.3. Baba Algısı

Katılımcılar, "koruyup kollayan" bir baba figürünü çeşitli açılardan ele alırken, baba figürünün çocuğunu koruyup kollayarak, her zaman yanında olan, destekleyen ve ailesine değer veren biri olduğunu vurgulamaktadır. Ayrıca baba kavramını çocuğuna sevgisini her zaman açıkça gösteren ve çocuklarının sırtını yaslayabileceği bir destek olması gerektiği şeklinde ifade etmektedir. Bunların yanında katılımcılara göre özellikle baba, ailesine destek olmalı, onları sevip kollamalı, sürekli ilgilenmeli ve eksiklikleri olduğunda ya da sıkıntıları olduğunda yardımlarına koşmalıdır. Bu görüşler, baba figürünün ailesine karşı sorumluluk sahibi, sevgi dolu ve destekleyici olması gerektiğini vurgulamaktadır. Bu kapsamda katılımcıların öne çıkan ifadeleri aşağıdaki gibidir:

"Sorumluluklarını bilen, ailesine düşkün ve ailesini her şartta koruyup kollayan, aile üyelerine eşit davranan ve ailesine değer verendir (Katılımcı 2, K)"

"Bana göre bir baba çocuğunu koruyup kollayan; her zaman yanında olup çocuğunu destekleyen, herkese karşı çocuğunun sırtını yaslayabileceği kocaman bir dağ olmalıdır. Bir babanın çocuğuna sevgisini her zaman her şekilde göstermesi gerekiyor, benim için baba kelimesinin anlamı budur (Katılımcı 4, K)"

"Benim için baba ailesine destek olup arkalarında durmalı onları sevip kollamalıdır (Katılımcı 12, E)"

"Eşiyle çocuklarıyla ayrı olsa da onlarla sürekli ilgilenmeli ve eksikleri olduğunda ya da bir sıkıntıları olduğunda her zaman yardımlarına koşmalıdır (Katılımcı 13, K)"

Katılımcılar, bir babanın çocuğuna yanlarında olduğunu hissettirmesinin önemini vurgulamakta; babanın her zaman sevgisini göstermesi, çocuğunu başkalarıyla kıyaslamadan yaklaşması ve hata yaptığında çocuğunun yanında olduğunu belirtmesi gerektiğini ifade etmektedir. Babanın çocuklarına ve ailesine zaman ayırması, onları her zaman desteklemesi ve zor zamanlarında yanlarında olması gerektiğini belirtmesi, babanın sorumluluklarını fark etmesi, ailesine sahip çıkması, sevgisini göstermesi ve iletişimde olması gerektiğini aktarmaktadır. Özellikle baba ile ayrı yaşayan gençler, babanın çocuğunu yalnız bırakmaması ve her zaman yanlarında olması gerektiğini vurgulamaktadır. Bu kapsamda öne çıkan ifadeler şu şekildedir:

"Her zaman sevgisini göstermeli, çocuğunu başkalarıyla kıyaslamamalı, onu görmeli her zaman yanında olduğunu hissettirmelidir. Hata yaptığında çocuğunun yanında olduğunu güvende olduğunu hissettirmelidir (Katılımcı 5, K)"

"Baba çocuğuna her zaman yanında olduğunu hissettirmelidir. Çocuklarına karşı ailesine karşı her zaman sevgisini belli etmeli ve onlardan ayrı yaşasa bile uzakta da olsa her zaman zor zamanlarında yanlarında olmalı, onları kimseye muhtaç etmemelidir (Katılımcı 6, E)"

"Baba sorumluluklarının farkında olmalı ve her zaman ailesine sahip çıkmalı, ailesinin her konuda arkasında durmalı, ailesine, çocuklarına her zaman sevgisini göstermelidir (Katılımcı 7, K)"

"Baba çocuğunu sevdiğini göstermeli, çocuğunun her zaman arkasında olduğunu hissettirmeli, her zaman iletişim halinde olmalıdır, çocuğunu asla yalnız bırakmamalıdır (Katılımcı 19, E)"

Katılımcılar, aile içinde saygı ve güvenin ne kadar kritik olduğunu belirtmekle beraber bir babanın saygılı, güvenilir, çocuklara sevgi ve ilgi gösteren bir karaktere sahip olması gerektiğini vurgulamaktadır. Ayrıca, babanın kötü alışkanlıklardan uzak durması ve ev içinde iş birliği yapması gerektiği üzerinde durulmaktadır. Babanın ailenin güvenliğini sağlaması ve potansiyel dış tehditlere karşı koruyucu bir rol üstlenmesi gerektiği aktarılmaktadır. Bu düşünceler, babanın aile içindeki rolünün yanı sıra aile içinde güven ve saygının sürdürülmesinin önemini vurgulamaktadır. Bu kapsamda öne çıkan ifadeler şu şekildedir:

"Bu konuda detaylı düşüncelerim yok. Baba, aileye karşı olan sorumluğunu bilmeli, dışarıdaki tehlikelere karşı koruyan olmalıdır (Katılımcı 1, K)"

"Saygılı, güvenilir, çocuklara karşı saygı ve sevgi gösteren ilgili, kötü alışkanlıklara bağımlı olmamalı, evdeki işlerde iş birliği yapmalıdır (Katılımcı 15, E)"

"Ailede babanın da belli sorumlulukları vardır. Özellikle ailede güveni sağlaması çok önemli, dışarıdan gelebilecek tehlikelere engel olmalıdır (Katılımcı 16, K)"

Katılımcılar, babanın maddi ve manevi anlamda destek sağlayan bir figür olduğunu belirterek, babanın çocuklarıyla sürekli bir ilişki sürdürmesi ve onlara destek olması gerektiğini vurgulamaktadır. Tek ebeveynli birey olarak anne yanında yaşamını sürdüren gençler, boşanma gibi durumlar olsa dahi, babanın çocuklarıyla olan bağının ömür boyu devam etmesi gerektiği üzerinde durmaktadır. Babanın, çocuklarına maddi ve manevi destek vermesi ve onların yanında olduğunu hissettirmesi gerekliliği kritik öneme sahip olarak ifade edilirken; babanın ayrıca çocuklarına destek olması ve onlara örnek teşkil etmesi gerektiği vurgulanmaktadır. Bu kapsamda öne çıkan katılımcı ifadeleri aşağıdaki gibidir:

"Baba dediğin eşinden boşanmış olsa da çocuklarıyla ilgilenen onları arayıp soran, ihtiyaçları olduğunda koşup yanlarına gelen olmalıdır. Babalar eşleriyle boşanabilir ama çocuklarıyla bağları bir ömür devam eder (Katılımcı 8, E)"

"Babamın olması bize güç verirdi sanki o olsaydı ailemizde yanlış giden bir durumda hemen müdahil olurdu ve sorunlarımızı çözmemize yardımcı olurdu (Katılımcı 10, E)"

"Baba dediğin eşiyle ne yaşamış olursa olsun gerek maddi gerekse manevi olarak her daim çocuklarının yanında olmalı, onlara her zaman desteğini hissettirmelidir. Uzaktan bakarak sadece çocuğu doğurmakla baba olunmaz. Eşler boşandıktan sonra sanki çocuklarla da boşanıyorlar öyle bir şey olabilir mi? Olamaz (Katılımcı 11, E)"

"Erkek kız demeden çocuk ayırt etmeyen ve onların örnek alabileceği bir kişi olmalıdır. Çocukların aldığı kararlarda onların destekçisi olmalıdır (Katılımcı 17, K)".

3.4. Güçlükler ve Gereksinimler

Katılımcılar, tek ebeveynli olmanın ekonomik, psikolojik ve sosyal açıdan çeşitli zorluklar yarattığını belirtmektedir. Özellikle, tek ebeveynli olmanın gençler üzerindeki psikolojik etkileri ve aile içi ilişkilerdeki dinamikler üzerinde durulmaktadır. Katılımcıların ifadeleri, tek ebeveynli ailelerin yaşadığı duygusal boşlukları, eksiklik hissini ve güven sorunlarını açıkça ortaya koymaktadır. Ayrıca, sosyal zorluklar ve aile içindeki değişikliklerin çocuklar üzerindeki etkileri vurgulanmaktadır. Güçlükler ve gereksinimler ana teması altında "ekonomik güçlükler", "psikolojik güçlükler" ve "sosyal güçlükler" olmak üzere üç alt tema aracılığıyla süreç ele alınmıştır.

3.4.1. Ekonomik Güçlükler

Tek ebeveyn ile yaşamını sürdüren üniversiteli gençler, tek ebeveyn üzerindeki maddi sorumluluğunun arttığını ve tek ebeveynli ailelerin ekonomik sorunlar yaşadığını

belirtmektedir. Ekonomik sorunlarla beraber aile içindeki zorlukların da arttığı belirtilmektedir. Bu durumun genç bireyler açısından özellikle zor olduğu ve aylık gelirin yetersiz kaldığı ifade edilmektedir. Tek ebeveynli ailelerin bu ekonomik zorluklarla daha fazla mücadele ettiği ve bu durumun sevgisizlik ve ilgisizlik gibi olumsuzluklara yol açabileceği vurgulanmaktadır. Bu görüşler, tek ebeveynli ailelerin ekonomik güçlüklerin aile içi ilişkilere ve gençlerin yaşantısına nasıl etki ettiğini ortaya koymaktadır. Bu kapsamda öne çıkan katılımcıların ifadeleri aşağıdaki gibidir:

> *"Tek ebeveynli olunca tek kalanın üzerinde maddi yük artıyor. Ailece maddi olarak daha fazla zorlanmaya başlıyorsunuz (Katılımcı 2, K)"*
>
> *"20 yaşındayım ve tek ebeveynli bir ailede büyüdüm. Bu durum ekonomik açıdan bazen zorlanmama neden oluyor, çünkü dört kardeşiz, eve sadece 7.500 TL aylık giriyor ve yetmiyor. Annem çalışmak zorunda kalıyor, ablalarım ihtiyaçlarımı karşılamak için çalışmak zorunda kalıyor, aldığımız aylık yetmiyor, çoğu zaman ay sonunda cebimizde beş kuruş kalmıyor (Katılımcı 3, K)"*
>
> *"Özellikle tek ebeveynli ortamda sevgisizlik ve ilgisizlik görüyorsunuz. Annem, babamın yapması gereken ev geçindirme, eve ekmek getirme derdine düştüğü için aslında bir ebeveynin gittiğinde diğeri de yarı hayalet gibi oluyor, var mı yok mu anlamıyorsunuz. Kadın başıyla annem sürekli çalışmak zorunda bu nedenle ister istemez bizimle ilgilenmekte zorlanıyor. Anneniz ya da babanız yoksa birisinin yokluğunda diğeri kalmıyor yani ikiden bir çıktığı zaman sıfır ebeveyniniz kalıyor (Katılımcı 8, E)*
>
> *"Tek ebeveynli bir aile olmak, aile bireylerinin diğer aile bireylerinden daha fazla ekonomik zorluklarla karşılaşılmasına neden oluyor, hayatta karşılaştığınız her sorunla daha fazla mücadele etmeniz gerekiyor (Katılımcı 9, E)"*

3.4.2. Psikolojik Güçlükler

Katılımcılar, tek ebeveyn olmanın beraberinde getirdiği duygusal zorlukları paylaşmaktadır. Katılımcılardan birisi ailesinde sevdiklerinin kendisini terk edecekmiş gibi hissetmesiyle ortaya çıkan yalnızlık korkusuyla mücadele ettiğini dile getirirken, diğer bir katılımcı tek ebeveyn olmanın kendisini yalnız hissettirdiğini ve bazen duygularını paylaşmak istese de annesinin tüm sorumluluğu üstlenmesi nedeniyle içini dökmekte zorlandığını ifade etmektedir. Eğer diğer ebeveyni yanlarında olsaydı, duygularını ve endişelerini daha rahat bir şekilde ifade edebileceklerini düşünmektedirler. Bu görüşler, tek ebeveyn olmanın duygusal olarak bireyi zorlayabileceğini ve destek alamama durumunda yalnızlık hissinin yaşanabileceğini vurgulamaktadır. Bu kapsamda öne çıkan ifadeler şu şekildedir:

> *"Kendimi yalnız kalmış, mutsuz gibi hissediyorum. Ailemdeki sevdiklerim beni bırakıp gidecekmiş de ben yapayalnız kalacakmışım gibi geliyor. Sevdiklerimin yanından gitmek ya da onlardan ayrılmak istemiyorum bu yüzden hayatta karşılaştığım sorunlarda kendimi cesaretsiz, hiçbir şeyi başaracak gücü olmayan birisi gibi hissediyorum (Katılımcı 4, K)"*

"Tek ebeveynli olmak bana en çok zorluğu ifade ediyor. Çünkü kolay bir konuda bile tek ebeveynli olmak insanın kendisini yalnız hissetmesine neden oluyor. Bazen bir derdim oluyor annemle paylaşayım diyorum ama sonra tüm sorumluluğumuzun annemde olduğu aklıma geliyor, annemin derdi anneme yeter diyorum ve susuyorum. Ama babam da yanımızda olsaydı ve ev geçimine yardımcı olsaydı birisinden birisine hissettiklerimi, dertlerimi, endişelerimi her şeyimi içimde tutmak zorunda olmadan paylaşabilirdim (Katılımcı 6, E)"

Katılımcılar, ailelerindeki en büyük zorlukların iletişimsizlik ve güven eksikliği olduğunu ve bu durumun aile birliğini parçalayıcı etkileri olduğunu vurgulamaktadır. Özellikle annenin baba tarafından aldatılma olayı sonrasında ciddi bir güven sorunu yaşandığı belirtilmektedir. Maddi ve manevi zorlukların sınırsız olduğunu belirten katılımcı bu durumu, kendisini çok yalnız hissettiğini ve ihtiyaçlarını karşılayamadığı için kimse tarafından sevilmeyeceğini düşündüğünü aktararak ortaya koymaktadır. Herkesin kendisine kötü davranacağı endişesiyle sosyal hayattan ve arkadaş çevresinden uzaklaşmakta, içine kapanık bir şekilde hayatını sürdürmektedir. Katılımcının ifadeleri, ailedeki iletişimsizlik ve güven eksikliğinin bireyler üzerindeki olumsuz etkilerini açıkça yansıtmaktadır. Bu kapsamda öne çıkan ifadeler aşağıdaki gibidir:

"Ailemdeki en önemli güçlüklerden birisi iletişimsizlik, diğeri ise güven problemi aslında. İletişim ve güvenin olmaması aileyi parçalayan bir şeydir. Annemin aldatılma yüzünden babamdan ayrılmasından dolayı ciddi bir güven problemi var, annem de ben de artık her şeye şüpheyle bakıyoruz (Katılımcı 6, E)"

"Özellikle maddi ve manevi olarak zorlukların sınırı yok, iki bakımdan da çok zorlandım. İhtiyaçlarımı karşılayamadım, bu durumda kendimi çok yalnız hissettim aile dışında kimsenin de beni sevmeyeceğini düşündüm. Herkesin bana kötülük ile yaklaşacağını düşündüm, sosyal hayattan, arkadaş çevresinden uzaklaştım ve yalnız içime kapanarak bir birey olarak hayatıma devam ediyorum (Katılımcı 14, K)"

Tek ebeveynli üniversiteli gençler, çevrelerindeki insanların, özellikle akrabalarının, düşüncesiz ve yersiz acıma duygusuyla söylemlerde bulunmakta olduğunu, bu durumun da psikolojik olarak olumsuz etkiler yarattığını ifade etmişlerdir. Söz konusu koşullar, gençlerin güven sorununun yanı sıra duygusal eksiklik yaşamalarına da neden olmaktadır. Bu ifadeler, tek ebeveynli ailelerin ve aile içindeki bireylerin önemli psikolojik güçlüklerle mücadele etmekte olduğunu göstermektedir. Bu kapsamda öne çıkan ifadeler şu şekildedir:

"Bazı duygularımda eksiklik hissettim, zorlandım. Sevgi kelimesi uzaktı, bir erkeğe karşı güven problemim çoktu, güçsüz görünen tarafım olduğunu hissediyordum. Başkalarının acıma duygusu ile çok fazla karşı karşıya kaldım (Katılımcı 1, K)"

"İnsanların özellikle akrabaların yersiz ve düşüncesiz acıma duygusuyla söylemler içerisinde bulunması psikolojik olarak olumsuz etkiliyor (Katılımcı 16, K)"

Araştırmaya katılım sağlayan gençler, tek ebeveynli olmanın sonucu olarak, anne ya da babanın varlığının bazen yetersiz hissettirdiğini ifade etmektedir. Tek ebeveynli olmanın

sürekli bir eksiklik hissi yarattığını ve mutlu olmalarına rağmen bir yanlarının her zaman eksik kaldığını belirtmektedirler. Bir katılımcı, babasını küçük yaşta kaybettiği için onu yakından tanıma fırsatı bulamadığını ifade etmektedir. Ancak abilerinin ve annesinin babalarının yokluğunu hissettirmemeye çalıştıklarını belirtmektedir. Diğer arkadaşlarının babalarıyla olan ilişkilerini gördükçe içlerinin buruklaştığını dile getirmektedir. Bu ifadeler, tek ebeveynli ailelerde büyüyen bireylerin, ailenin diğer ebeveyninin yokluğunun yarattığı duygusal boşluğu ve özlemini açıkça ifade etmektedir. Bu kapsamda öne çıkan katılımcı ifadeleri aşağıdaki gibidir:

> *"Anne ya da baba birisinin olması bazen yetmiyor, her ikisiyle beraber yaşamayı çok isterdim. Tek ebeveynli olmak sürekli bir şeyler eksik gibi hissettiriyor, mutlu olsan da bir yanın her zaman biraz buruk kalıyor (Katılımcı 4, K)"*
> *"Babamı çok küçük yaştayken kaybetmişim, o yüzden babamı yakından tanıma fırsatım olmadı. Abilerim ve annem, babamın yokluğunu hissettirmemeye çalıştılar ama arkadaşlarımın babalarıyla olan ilişkilerini görünce içim buruk oluyor (Katılımcı 10, E)"*

Katılımcılar, tek ebeveynli aile olmanın bir ebeveyn eksikliği ve bu eksikliğin sorumluluğun tek kişiye yüklendiği bir durum olduğunu belirtmektedir. Bu durum da, çocukların eksiklik hissettiğini ve sorumluluğun paylaşılması gerektiğini yansıtmaktadır. Tek ebeveynli aile olmanın güvenlik ve destek açısından eksiklik hissettirdiği ve psikolojik olarak güçlükler barındırdığını vurgulayan gençler, aile içinde bu durumun düşmanlık, gelecek endişesi ve zorluklarla başa çıkma dinamiklerini yarattığını belirtmektedirler. Bu kapsamda öne çıkan ifadeler şöyledir:

> *"Tek ebeveynli aile olmak, çınar ağacının dallarında eksikliğin var olması demektir. Kendini tam anlamıyla güvende hissedememek, içinde her zaman bir eksiklik olduğunu hissetmek demektir (Katılımcı 3, K)"*
> *"Tek kişinin üstüne kalan yüklerden kaynaklı psikolojilerinin bozulması, aile bireyinin diğerine karşı düşmanlık hissetmesi ve zorlukları olan ama iyi bir şekilde toparlanması gereken örüntüdür (Katılımcı 15, E)"*
> *"Tek ebeveynli olmak benim için ekstra sorumluluk demektir. Yanınızda olmayan ebeveynin sorumluluğu kalan ile çocukların paylaştığı bir yapıdır (Katılımcı 17, K)"*

Tek ebeveynli olarak yaşamını sürdüren Katılımcı 14 (K) ebeveynlerden birinin olmamasının, hayatlarını daha fazla endişeli ve kaygılı bir şekilde sürdürmelerine neden olduğunu belirtmektedir. Sürekli bir eksiklik hissi yaşadığını ve her şeyin yolunda giderken aniden her şeyin tepe taklak olabileceği endişesi taşıdığını dile getirmektedir. Çoğunlukla ihtiyaçlarını kendi başına halletmek zorunda kaldığını vurgulamaktadır. Bu ifadeler, tek ebeveynli ailelerde büyüyen bireylerin, eksiklik hissi, endişe ve sorumlulukların yükü altında yaşadığı zorlukları açıkça ortaya koymaktadır. Bu kapsamda öne çıkan ifade aşağıdaki gibidir:

"Tek ebeveynli olmak, hayat işleyişinde zorluk çıkartıyor. Hayatı her zaman daha fazla endişeli, daha kaygılı yaşamamıza sebep oluyor. Sanki hep bir şeyler eksik, bir şeyler yolunda giderken bir anda her şey tepe taklak olacak gibi geliyor. Çoğunlukla ihtiyaçlarını bir şekilde kendin halletmek zorundasın (Katılımcı 14, K)"

3.4.3. Sosyal Güçlükler

Katılımcıların en önemli ortak noktası, tek ebeveynli ailelerde yaşanan zorlukların vurgulanmasıdır. Anne veya babanın eksikliğinin, hem tek ebeveynin hem de çocukların üzerinde ağır sorumluluklar doğurduğu belirtilmektedir. Maddi zorluklar, erken olgunlaşmak zorunda kalma, yalnızlık hissi ve ağır ev içi sorumluluklar, tek ebeveynli ailelerin sıkça karşılaştığı sorunlar arasındadır. Bu durum, çocukların normal yaşamlarını sürdürmelerini zorlaştırırken, aynı zamanda aile içi iletişimsizliği ve güven sorunlarını da tetikleyebilmektedir. Katılımcılar, tek ebeveynli aile dinamiklerinin aile üyeleri üzerindeki etkilerini açık bir şekilde ifade etmektedir. Öne çıkan ifadeler aşağıdaki gibidir:

"Tek ebeveynli olmak bana kendimi yalnız hissettiriyor. İnsanın üzerine daha fazla sorumluluk yüklüyor. Evimizin geçimini sağlamak için annem sürekli çalışmak zorunda kalıyor. Annem çalıştığı için evin sorumluluğunu üstlenmek zorunda kalıyordum (Katılımcı 5, K)"

"Tek ebeveynli olmak annemin üzerindeki sorumluluğu çok artırıyor. Babamın olmaması annemin sürekli çalışmak, evi geçindirmek derdinin olması nedeniyle çocuk kalmanız mümkün olmuyor, mecbur çocukluktan çıkıp çabuk olgunlaşmak zorunda kalıyorsunuz. Sürekli başkalarından daha fazla mücadele etmek zorunda kalıyorsunuz. Fırsat buldukça ortaokuldan beri her yaz çalışmak zorunda kalıyorum (Katılımcı 9, E)"

"Tek ebeveynli ailede sorumluluk tek kişide toplandığından, sorumluluklar hem anne için hem de çocuklar için oldukça zorlayıcıdır. Çocukların eksik olduğu konular artıyor (Katılımcı 16, K)"

"Evdeki tüm sorumluluğun yarısı bendedir. Bazen yorulduğumu çok hissediyorum. Evdeki her konuda bana sorulur, benden onay alınmadıkça yapılmaz. Aileme karşı aldığım sorumluluk bazen beni yoruyor ve yıpratıyor (Katılımcı 17, K)"

Katılımcılar, aile içindeki değişikliklerin ve tek ebeveynli yaşamın sosyal zorluklarına dikkat çekmektedir. İlk katılımcı, toplumun bakış açısının değiştiğini ve bu durumun kendilerini nasıl etkilediğini vurgulamaktadır. İkinci katılımcı ise, ailedeki ayrılığın ardından akrabalarıyla yaşamaya başlamanın zorluklarını dile getirmekte ve özellikle yengesiyle anlaşamadığını ve babasının yokluğunun kendisini sahipsiz hissettirdiğini belirtmektedir. Ayrıca, akrabalarının onları görmezden gelmesinin ve babalarının eksikliğinin ailelerinde bir burukluk yarattığını ifade etmektedir. Bu ifadeler, tek ebeveynli ailelerin yaşadığı duygusal ve sosyal zorluklara ışık tutmaktadır:

"İlk olarak ortamın değişmesine sebep oluyor. Toplumun size bakışının değiştiğini hissediyorsunuz (Katılımcı 2, K)"

"Annemle babam ayrıldıktan sonra dedem, annem, dayılarım, yengelerim ve kuzenlerimle yaşamaya başladık. Yengemle hiç anlaşamıyoruz, nedense sürekli olarak babamın yanımızda olmamasından dolayı kendimi kötü hissetmeme sebebiyet veriyor. Eğer babam bizimle ilgilense tek başımıza bırakmasaydı, kimseye muhtaç olmadan hayatımıza devam edebilirdik. Annemle dede evinde de olsak sanki eksikmişiz gibi geliyor, kendimi onların yanında sığıntı gibi hissediyorum (Katılımcı 4, K)"

"Sahipsiz olduğumuzu hissediyoruz. Akrabalarım ile aynı yerde yaşıyoruz ama tek ebeveynli olmamızdan dolayı bizi görmezden gelmeleri beni rahatsız ediyor. Babam ekonomik olarak bizleri desteklese de onun başımızda olmaması ailemizde en mutlu günlerimizde bile bir bukluk olmasına neden oluyor. Bir yanımız sürekli eksik gibi hissediyoruz (Katılımcı 7, K)"

"Annemle birlikte yaşadığım için babamın yokluğunu her zaman hissediyorum. Babamın yanımızda olmamasının zorluklarını hem maddi hem de manevi olarak hissediyorum. Bu durum beni duygusal olarak örseliyor. Özellikle diğer çocukların babalarıyla olan ilişkilerini gördüğümde onların hayatlarına özeniyorum (Katılımcı 11, E)"

Katılımcı 13 (K), tek ebeveynli olmanın özellikle manevi zorluklara neden olduğunu ifade etmektedir. Her iki ebeveynin çalışıyor olmasının maddi olarak ihtiyaçlarını karşılamak için yeterli olmasına rağmen, ayrı yaşamaları ona kötü hissettirmektedir. Bu yaklaşım, tek ebeveynli ailelerde hem maddi hem de duygusal açıdan yaşanan zorlukları ve çocuğun aile ile bağlarını güçlendirmenin önemini vurgulamaktadır. Bu kapsamda öne çıkan ifade aşağıdaki gibidir:

"Güçlük çektiğim tarafım genel olarak manevi tarafım. Annemle babam ikisi de çalışmak zorunda olduğu için maddi olarak paramı eksik etmeseler de ayrı yaşamaları beni kötü hissettiriyor, onlarla yeterince zaman geçiremediğimi düşünüyorum (Katılımcı 13, K)"

3.5. Aile Yaşamında Değiştirmek İstenilen Durumlar

Tek ebeveynli olarak üniversite eğitimine devam eden gençler özellikle "*annelerinin hayatlarını değiştirmek*" istediklerini ifade etmiştir. Bazıları annelerinin daha bağımsız olmasını, kendi gereksinimlerini tek başına giderebilmelerini ve ekonomik olarak kimseye muhtaç olmamalarını arzulamaktadır. Diğerleri ise annelerinin yaşam kalitesini artırmayı istemektedir. Bir kısmı, annelerinin daha rahat etmesi ve daha güzel bir hayat sürmesi için çaba sarf etmek istediklerini belirtmektedir. Bu ifadeler, annelere olan sevgi ve saygıyla birlikte, onların yaşamlarını iyileştirmeye yönelik bir arzuyu yansıtmaktadır. Bu kapsamda öne çıkan ifadeler şu şekildedir:

"Pek bir şeyi değiştirmek istemezdim. Sadece annemin üniversiteden mezun olup kendi mesleği olsun isterdim (Katılımcı 5, K)"

"Annemin kendi ayakları üzerinde durmasını, maddi olarak kimseye muhtaç olmadan ayakları üzerinde durmasını isterdim (Katılımcı 7, K)"

"Anneme daha güzel bir hayat sunmak isterdim. Annemin çabasına, dertlerine daha fazla ortak olup onun kalan hayatında rahat etmesini çok isterdim (Katılımcı 9, E)"

"Annemin yaşam kalitesini artırmayı isterdim. Çocukluğumuzdan beri her şeyimizle o ilgileniyor, o da olmasaydı ne yapardık bilmiyorum. Anneme hayatım boyunca borçlu hissedeceğim. Okulum bittikten sonra onun hayatını değiştirmeyi, ona destek vermeyi çok istiyorum (Katılımcı 10, E)"

Bazı katılımcılar özellikle babalarının davranışlarını değiştirmek istediklerini ifade etmektedirler. Bazıları babalarının yanlarında olmasını, ailelerine destek olmasını ve bağlılık göstermesini isterken, diğerleri babalarının ailelerine sadık kalmasını ve ikinci evlilik yapmamasını temenni etmektedir. Bu ifadeler, babalarının rolünü ve davranışlarını değiştirerek aile yaşamlarının daha iyi olabileceği beklentisini yansıtmaktadır:

"Babamın ailemize bağlı olmasını ve bize değer vermesini isterdim. Eğer babam ailesine bağlı birisi olsaydı annemle ayrılmak zorunda kalmazlardı. Annem ve babam sırt sırta verip bize daha iyi bir yaşam sunabilirlerdi (Katılımcı 6, E)"

"Babamın anneme sadık kalmasını isterdim. İkinci evliliğini yapmamasını isterdim. Onun yerine başımızda bizi kimseye muhtaç etmeden dursun isterdim (Katılımcı 7, K)"

"Babamın davranışlarını değiştirmek isterdim, yanımızda olmasını, bizimle yaşamasını, destek çıkmasını isterdim. O zaman aile yaşamımız farklı olabilirdi (Katılımcı 12, E)"

Özellikle boşanma nedeniyle tek ebeveynli olarak yaşamlarını sürdüren katılımcılar, anne ve babalarının ilişkilerini değiştirmek istediklerini belirtmektedir. Bazıları, ebeveynlerinin sorunlarını çözmek ve boşanmalarını engellemek istemektedir. Diğerleri anne ve babalarının daha bilinçli ve eğitimli olmalarını arzulamaktadır. Bazı katılımcılar ise geçmişte yapılan hataları düzeltmek ve ailenin sağlıklı bir ortama sahip olmasını sağlamak için çaba göstermek istemektedir. Bu ifadeler, katılımcıların aile dinamiklerini iyileştirmek ve ailelerinin daha mutlu bir birliktelik yaşamasını sağlamak için çaba harcamak istediklerini göstermektedir. Öne çıkan ifadeler şu şekildedir:

"Eğer imkanım olsaydı annemle babamın arasındaki sorunları baştan çözmek isterdim. Bu hayatta çözümlenmeyecek hiçbir sorun yok. Her ikisinin de haksız olduğu noktalar var, bu haksızlıkların farkında olmalarını sağlayıp sorunlarını boşanmaya kadar gitmesine mani olmak isterdim. Boşanmasaydılar belki kardeşlerim de olur, birlikte daha mutlu bir hayat sürebilirdik (Katılımcı 4, K)"

"Eğer ki olanağım olsaydı annemle babamın ayrılmamalarını sağlardım. Birisinin olmaması tüm geçim derdini diğerine yıkıyor, bu durumda herkesin hayatı perişan oluyor, herkes farklı çıkmazlara girip o çıkmazlarda kayboluyor (Katılımcı 8, E)"

"Annemin de babamın da daha bilinçli ve eğitimli insanlar olmasını sağlardım. Öyle olsaydı bu durumda olmazdık. Onların yaşadıklarının sonuçlarına kardeşlerimle ben

katlanmak zorunda kalıyorum. Keşke onlar evliliklerini devam ettirseydiler biz de diğer insanlar gibi sağlıklı bir aile hayatına sahip olsaydık. Olanağım olsaydı annemle babam arasında yaşanan sorunları çözer, gerekirse onları psikoloğa gönderir sorunlarını çözer, çekirdek ailemin dağılmasını önlerdim (Katılımcı 11, E)"
"En başta güven sorununu, aldatma tarzı şeyleri engellerdim. Saygı ve sevginin olması, anne ya da babamın akraba lafı dinleyip kavga çıkarmamasını sağlar ve sağlıklı bir aile ortamım olması için çabalardım (Katılımcı 15, E)"

Katılımcılar, aile içi zorlukları aşmak ve hayatlarını şekillendirmek için kararlı olduklarını göstermektedir. Maddi sorunlar ve aile içi gerilimlere rağmen, her iki katılımcı da yaşamlarını daha iyiye götürmeye kararlıdır. Kendi başlarına huzurlu bir yaşam tarzı benimseme isteklerini belirten katılımcılar, yaşam kalitelerini iyileştirmek için çaba sarf etmek istediklerini yansıtmaktadır. Öne çıkan ifadeler aşağıdaki gibidir:

"Babam hayatını kaybettikten sonra ekonomik anlamda çok zorlandık. Olanağım olsaydı özellikle ekonomik anlamda bağımsız olarak yaşamak isterdim. Konfor alanımı değiştirmek isterdim (Katılımcı 2, K)"
"Evimi değiştirmek isterdim aslında. Aile yapım beni kendinden çok soğuttu aileye dair bir şey değiştirmek istemezdim. Kendime güzel bir iş bulup küçük sessiz sakin bir eve çıkmak isterdim. Aile yaşamında anne babamı arkada bırakıp kendi hayatım için bir şeyler yapmak isterdim (Katılımcı 14, K)"

Katılımcı 17 (K), babasının ölümünden sonra aile içinde yaşadığı dışlanma ve ayrımcılık sorunlarına dikkat çekmektedir. Ailedeki cinsiyet eşitsizliğine karşı çıkarak, kız ve erkek çocukların eşit olduğunu vurgulayarak, akrabalarının bu konuda farkındalık kazanmasını istemektedir. Aile içinde daha adil ve eşitlikçi bir atmosfer yaratmayı hedefleyen katılımcı, akrabalarının düşüncelerini değiştirerek daha kapsayıcı bir aile dinamiği oluşturmayı amaçlamaktadır. Bu kapsamda öne çıkan ifade şöyledir:

"Akraba ilişkilerimi değiştirmek isterdim. Babam vefat ettikten sonra anneme ve bana karşı ayrımcılık, dışlama söz konusu oldu. Baba tarafından nefret ediyorum. Akrabalarımın da kafa yapılarını değiştirmek isterdim. Kız ve erkek çocuğun eşit olduğunu anlatmak isterdim (Katılımcı 17, K)"

3.6. Yararlanılan Sosyal Hizmet Uygulamaları

Katılımcılar, karşılaştıkları sorunlarla mücadele etmek için sosyal hizmetler ve çeşitli yardım kuruluşlarından ekonomik ve psikolojik destek aldıklarını ifade etmiştir. Ancak, bazı katılımcılar aldıkları yardımların yetersiz olduğunu belirtmiştir. Ayrıca, bazıları da annelerinin işe başlamasıyla bu yardımların kesildiğini ve ailenin ekonomik durumunun daha da zorlaştığını ifade etmiştir. Diğer yandan, bazı katılımcılar aile içinde yaşanan travmatik olaylar sonrasında psikolojik destek aldıklarını belirtmektedir. Bu destek sayesinde zorlu süreçleri atlatmada yardım aldıklarını ve duygusal iyiliklerini sağlamak için profesyonel yardımın önemine vurgu yapmışlardır. Bu durumlar, ailelerin hem ekonomik hem de duygusal olarak zorlu süreçlerden geçtiğini; sosyal hizmetlerin ve psikolojik destek

hizmetlerinin önemli bir rol oynadığını göstermektedir. Resmi kurum ve kuruluşlar haricinde tek ebeveynli ailelerin akrabaları gibi yapıların da resmi olmayan önemli destekler sağladığı görülmektedir. Araştırma katılımcılarından bazıları karşılaştıkları sorunlar karşısında herhangi bir destek programına başvurabileceklerini bilmediklerini ifade etmiştir. Yararlanılan sosyal hizmet uygulamaları ana teması "Ekonomik Destek", "Psikolojik Destek", "Herhangi Bir Sosyal Hizmet ve Destek Programına Başvurabileceğini Bilmeyenler" ve İnformel Destek" başlığı altında 4 alt temada ele alınmıştır.

3.6.1. Ekonomik Destek

Üniversite hayatına devam eden tek ebeveynli gençler, ailelerinin ekonomik zorluklarla karşı karşıya kalıp farklı kaynaklardan yardım talep ettiklerini ifade etmektedir. İlk katılımcı, ilkokul ve ortaokul yıllarında mali destek alırken, üniversite yıllarında bu yardımın kesilmesinden bahsetmektedir. Diğer katılımcılar ise ailelerinin boşanma sonrası sosyal hizmetlerden destek aldıklarını paylaşmaktadır. Ancak bu yardımların yetersiz olduğunu ve daha büyük yardımlara ihtiyaç duyduklarını belirtmektedirler. Bu durumlar, aile içindeki ekonomik dengesizliği ve sosyal yardım sistemlerinin yetersiz olduğunu göstermektedir:

> *"Annem eğitim ve diğer ihtiyaçlarımın karşılanması konusunda ekonomik olarak çok zorlandı. Bu yüzden ekonomik destek alma gereksinimi duydu. Sosyal ve ekonomik destek (SED) biriminden birkaç yıl her ay ekonomik yardım aldık (Katılımcı 1, K)"*
> *"Annemle babam boşandıktan sonra bir süre babamla hiç görüşmedik. O süreçte özellikle ekonomik yardıma çok ihtiyaç duyduk. Sosyal hizmetlerin ekonomik yardımlarından faydalandık. Annem hala liseye giden kardeşim adına ekonomik yardım alıyor ancak yetmiyor (Katılımcı 8, E)"*
> *"Süreç içerisinde maddi manevi desteğe çok ihtiyacımızın olduğu dönemler oldu. Sosyal hizmetlerden ekonomik destek aldık, bazı ihtiyaçlarımızı gidermemiz adına iyi oluyordu ama yardım parasının daha fazla olmasını isterdim (Katılımcı 10, E)"*

Katılımcılar, ailelerinin boşanma süreci ve sonrasında çok fazla maddi zorluklarla karşılaştıklarını ifade etmektedir. Boşanma sürecinin uzunluğu nedeniyle babanın sağladığı nafakanın yetersiz olduğunu belirten bir katılımcı, ailenin ihtiyaçlarını karşılamak için Kaymakamlığın Sosyal Yardımlaşma ve Dayanışma Vakfından kömür ve gıda yardımı aldıklarını ifade etmektedir. Diğer bir katılımcı ise boşanmanın ardından annesinin bir fabrikada çalışmaya başlamasıyla bu yardımların kesildiğini ve annesinin gündelik temizlik işlerinde çalışmak zorunda kaldığını aktarmaktadır. Bu durumlar, ailelerinin maddi sorunlarla mücadele etmek zorunda kaldığını ve sosyal yardımların sürekliliğinin önemli olduğunu göstermektedir. Öne çıkan ifadeler şu şekildedir:

> *"Annemle babam ayrıldıktan sonra vakıftan kömür, gıda malzemesi gibi yardımlar aldık, sonrasında annem bir fabrikada çalışmaya başlayınca o yardımlar da kesildi (Katılımcı 5, K)"*

"Kaymakamlık sosyal yardımlaşma ve dayanışma vakfından kömür ve gıda yardımı aldık, annemle babamın boşanma süreçleri biraz uzun geçti. Babam nafaka verse de o verdiği para bizim hiçbir ihtiyacımızı karşılamıyordu (Katılımcı 7, K)"

"Sosyal yardımlaşma ve dayanışma vakfından aldığımız yardımlar oldu ama onlar da sürekli değildi, dönem dönem verdiler ama bizim sürekli ihtiyacımız vardı. Annem dulluk maaşı alıyor ama o da yetmiyor mecburen gündelik temizlik işlerinde çalışmak zorunda kalıyor (Katılımcı 9, E)"

3.6.2. Psikolojik Destek

Katılımcılar, özellikle ebeveynlerinin vefatı ve aile içindeki sorunlar nedeniyle psikolojik olarak zor zamanlar geçirdiklerini ifade etmektedir. Birinci katılımcı, babasının vefatı sonrasında psikolojik destek aldığını belirtmektedir. İkinci katılımcı ise annesinin ve kendisinin, boşanma sürecinden sonra sosyal hizmetlerden psikolojik destek aldıklarını ve bu desteğin kendilerine iyi geldiğini paylaşmaktadır. Her iki katılımcı da zorlu süreçlerinde psikolojik destek almanın önemine vurgu yapmaktadır; bu da kişilerin psikolojik iyiliklerini sağlamak için profesyonel yardımı önemsediklerini göstermektedir. Öne çıkan ifadeler şöyledir:

"Özellikle yaşadığım ailevi sorunlardan dolayı sosyal hizmetlere gereksinim duydum. Babamın vefat etmesinden sonra psikolojik olarak çok etkilendim. Süreç içerisinde psikolojik sorunlarımın üstesinden tek başıma gelemedim. O yüzden bu sorunlarımın üstesinden gelmek için uzun süre psikolojik yardım aldım (Katılımcı 3, K)"

"Annem ve babam boşandıktan sonra sosyal hizmetlerden süreç içerisinde annem de ben de psikolojik destek aldık. Tek başımıza aşamadığımız, akrabalarımıza anlatamadığımız durumları psikolojik destek alarak aştık. Bize iyi gelmişti (Katılımcı 15, E)"

3.6.3. Herhangi Bir Sosyal Hizmet ve Destek Programına Başvurabileceğini Bilmeyenler

Katılımcılardan bazıları herhangi bir sosyal hizmet veya destek programından yararlanmadıklarını belirtmektedirler. Bazıları ise böyle bir hizmetten haberdar olmadıklarını veya başvurmadıklarını ifade ederken, diğerleri aile dışından gelen yardımların dışında resmi bir kurumdan yardım almadıklarını belirtmektedirler. Bu durum, katılımcıların belirli bir süreçte sosyal hizmetlerden haberdar olmama, bu hizmetlere başvurma veya bu hizmetlerden yararlanma konusunda farklı deneyimlere sahip olduklarını göstermektedir. Bu kapsamda öne çıkan ifadeler aşağıdaki gibidir:

"Bu süreçte sosyal yardımlara çok ihtiyaç duyduk; fakat yaşımın küçük olmasından dolayı bu tarz yerlere başvurmadım. O yüzden herhangi bir yardım alamadım. Ama nerde hangi yardımlar olduğunu bilseydim çok konuda destek almak isterdim. (Katılımcı 4, K)"

"Hiçbir yerden yardım almadık, bazen akrabalarımız yardım etti. Nerede hangi kurum yardım veriyor bilmiyorduk (Katılımcı 11, E)"

"Herhangi bir destek almadım. Bir yere başvurulacağını bilmiyordum (Katılımcı 13, K)"

"Sosyal hizmetlere başvurup yararlandığım bir destek olmadı (Katılımcı 19, E)"

3.6.4. İnformel (Resmi Olmayan) Destek

Katılımcılar, yaşadıkları zorluklara rağmen aile bağlarının güçlü olduğunu ve birlikte mücadele ederek bu zorlukların üstesinden geldiklerini ifade etmektedir. Özellikle annenin çabaları ve kardeşler arasındaki dayanışma önemli bir rol oynamaktadır. Bazı katılımcılar, aile içindeki desteği yeterli bulurken, diğerleri dış desteklerden de faydalandıklarını belirtmektedir. Aile büyüklerinin ve arkadaşların sağladığı destekler de katılımcıların yaşamlarında önemli bir yer tutmaktadır. Bu durumlar, aile içindeki dayanışmanın ve dış desteklerin önemini vurgulamaktadır. Öne çıkan ifadeler şu şekildedir:

"Bu konuda şanslı olduğumu hissediyorum; çünkü böylesi bir ebeveyne sahibim. Birçok zorlukların üstesinden gelebildik, zorlandığımız zamanlarımız fazlasıyla oldu ama bununla beraber sabretmeyi de öğrendik (Katılımcı 1, K)"

"Artık çok fazla güçlük çekmiyoruz, başlarda zorlandık ama yazları ben de çalışıp anneme maddi açıdan destek oluyorum ve bu şekilde birbirimize olan bağlılığımız artıyor, maddi açıdan da rahatlıyoruz. Annem ve kardeşlerimle bir olup babamın olmamasının boşluğunu kapatıyoruz (Katılımcı 12, E)"

"Annem gündelik işlerde çalışıp harçlık göndermeye çalışıyor. Anneme ve kardeşime de dedem destek veriyor. Babam ile pek fazla görüşmüyorum (Katılımcı 16, K)"

"Zorlandığım dönemlerde hem maddi hem de manevi olarak arkadaşlarımdan destek aldım (Katılımcı 19, E)"

Katılımcılar, aileleriyle yaşadıkları zorlu süreçlerde maddi ve manevi destek arayışında olduklarını ifade etmektedir. Ancak, bazıları bu desteği akrabalarından gördüklerini belirtirken, diğerleri sosyal hizmetlerden yardım almaya çalışmış ancak belirli koşullar nedeniyle bu desteği elde edememişlerdir. Özellikle dede ve anneanne gibi aile büyüklerinin sağladığı destek önemli bir rol oynamıştır. Bu durum, aile büyüklerinin öneminin altını çizmektedir. Ancak, bazı katılımcılar için sosyal yardımlardan yararlanma konusunda belirli engellerle karşılaşılması, yardım sistemlerinin eksikliklerini ve iyileştirilmesi gereken yönlerini ortaya koymaktadır. Bu kapsamda katılımcıların öne çıkan ifadeleri aşağıdaki gibidir:

"…Süreçte iyi ki anneannem ve dedem vardı, onlar bize çok destek oldular. Sosyal hizmetlere ekonomik destek almak için başvurduk; ancak anneannem ve dedemle yaşadığımızdan, dedemin de aylığı olduğu için herhangi bir yardım uygulamasından yararlanamadık (Katılımcı 2, K)"

"Dedemler, dayımlar süreçte maddi ve manevi açıdan bize destek olmaya çalıştılar. Ancak biz yine dönüp dolaşıp evde sıkıntılarımızla baş başa kaldık (Katılımcı 12, E)"

3.7. Sosyal Hizmet Gereksinimleri

Araştırmaya katılım sağlayan tek ebeveynli üniversite öğrencisi gençler, özellikle ekonomik ve psikolojik destek gereksinimleri üzerinde durmaktadır. Anne ya da babanın vefatı, boşanma gibi travmatik deneyimler sonrası tek ebeveynli olarak yaşamını sürdürmek zorunda kalan gençler sosyal yardımların ve ekonomik desteklerin önemli olduğunu vurgulamaktadır. Ancak, bazı katılımcılar aldıkları ekonomik desteklerin yetersiz olduğunu veya erişimde zorluklar yaşadıklarını belirtmektedir. Ayrıca, katılımcılar yaşadıkları travmatik deneyimler sonrasında özellikle psikolojik desteğe ihtiyaç duyduklarını bu süreçte psikolojik destek almanın önemli olduğunu vurgulamışlardır. Bazı katılımcılar ise süreç içerisinde hem ekonomik hem de psikolojik destek ihtiyacı duyduğunu ifade etmektedir.

3.7.1. Ekonomik Destek Gereksinimi

Katılımcılar aile içi sorunlar, boşanma gibi travmatik deneyimler ve ekonomik zorluklarla karşı karşıya kaldıklarını, bu dönemde sosyal yardımların ve ekonomik desteklerin önemini vurgulamışlardır. Ancak, bazı katılımcılar sosyal yardım kaynaklarına erişimde zorluklar yaşamış veya bu desteklerin yetersiz olduğunu belirtmişlerdir. Bu durum, sosyal yardım sistemlerinin daha etkin ve kapsamlı hale getirilmesi gerektiğini göstermektedir. Genel olarak, katılımcılar yaşadıkları zorluklara rağmen dayanıklılık ve çözüm bulma becerilerini geliştirmişlerdir. Ancak daha iyi bir destek sisteminin varlığı bu süreçleri daha kolay atlatmalarına yardımcı olmaktadır. Öne çıkan ifadeler aşağıdaki gibidir:

"Eğitim ihtiyaçlarımı karşılamak, hakkımı savunmak, özel ihtiyaçlarımı karşılamakta ekonomik ve sosyal desteğe gereksinim duydum (Katılımcı 4, K)"

"Süreç içerisinde en çok ekonomik desteğe ihtiyaç duyduk, çünkü her şey maddiyata dayalı, ekonomik durumunuz iyiyse bir şekilde diğer sorunları atlatıyorsunuz ama yoksa her şey üst üste geliyor. Bence her boşanma sürecinde mahkeme nafaka haricinde bir uzman gönderip ailelerin durumlarına göz atıp ona göre yardım bağlanmasına yardımcı olmalıdır (Katılımcı 8, E)"

"Özellikle sosyal yardımlara çok ihtiyaç duyduk eş dost akraba bir süre destekledi ama sonra annemle baş başa kaldık. Abim okulu bırakıp çalışmak zorunda kaldı eğer babam vefat ettikten sonra devlet anneme hem benim hem abimin ihtiyaçlarını karşılayacak bir maaş bağlasaydı abim okuluna devam edebilirdi, annem de sürekli nasıl geçineceğiz derdinde olmazdı. Devlet anne ya da babasını kaybeden çocukları okulları bitene kadar, bir iş, meslek sahibi olana kadar ekonomik olarak desteklemelidir (Katılımcı 9, E)"

"Boşanma sürecinde annemin babamdan şiddet görmesi sebebiyle annemi kadın konukevine kardeşimle beni de çocuk evlerine götürdüler. Bir süre sonra oradan çıktık. SED yardımı aldık, sosyal yardımlaşma ve dayanışma vakfından gıda ve kömür yardımı aldık. Ama bir süre sonra kestiler keşke üniversite bitene kadar kendi işimizi elimize alana kadar ekonomik yardım devam etseydi (Katılımcı 15, E)"

Katılımcılar, üniversite hayatlarında ekonomik destek almanın önemini vurgulamaktadır. Birinci katılımcı, düzenli bir burs hizmeti alarak üniversite sürecini daha rahat geçirmeyi arzuladığını belirtirken, ikinci katılımcı da üniversiteye başladıklarında ekonomik zorluklar yaşadıklarını ve bu nedenle burs almak için çaba gösterdiklerini ifade etmektedir. Her iki durumda da, ekonomik destek sağlanmasıyla üniversite hayatının daha kolay ve başarılı bir şekilde geçirilmesi amaçlanmaktadır. Bu durum, katılımcıların eğitimlerine odaklanabilmeleri ve maddi zorluklarla mücadele etmek zorunda kalmamaları için önemli bir gereksinimi yansıtmaktadır. Bu katılımcıların öne çıkan ifadeleri aşağıdaki gibidir:

"Üniversite hayatım süresince düzenli bir burs hizmeti almak isterdim. Üniversite hayatım boyunca kimseye muhtaç olmadan kendime yetecek kadar bir ekonomik yardım almayı isterdim (Katılımcı 1, K)"

"Yardımlardan faydalanmaya ihtiyacımız vardı. Özellikle üniversiteye gelince ilk başlarda çok zorlandık. Allah'tan yurt falan çıktı. Burs almak için birkaç yere başvurdum ama çıkmadı (Katılımcı 16, K)"

3.7.2. Psikolojik Destek Gereksinimi

Katılımcılar, yaşadıkları zorlu süreçlerde psikolojik destek almanın önemini vurgulamaktadır. Özellikle boşanma süreci, ebeveynlerin sağlık sorunları veya aile içi travmatik deneyimler sonrasında psikolojik desteğe ihtiyaç duyduklarını belirtmişlerdir. Ancak, bazı durumlarda bu desteği almakta zorlandıklarını veya ailelerinin destek almak istemediğini ifade etmişlerdir. Psikolojik destek almanın, bu tür stresli ve travmatik dönemlerde süreci daha kolay atlatabilecekleri ve duygusal iyiliklerini sağlayabilecekleri bir kaynak olduğu vurgulanmıştır. Ayrıca, bir katılımcı öz annesinin sağlık durumu ve bakımıyla ilgili olarak da psikolojik destek talep etmiştir. Bu durumlar, psikolojik desteğin, bireylerin yaşadıkları zorluklarla başa çıkma sürecinde önemli bir rol oynadığını göstermektedir. Öne çıkan ifadeler aşağıdaki gibidir:

"Özellikle psikolojik olarak destek almayı isterdim. Babamın vefatı sonrasında psikolojik destek alsaydık belki süreci daha kolay atlatabilirdik (Katılımcı 2, K)"

"Hem annem hem de ben boşanma sürecinde psikolojik desteğe ihtiyaç duydum. Kardeşim küçüktü o daha bir şeylerin farkında değildi ama ben farkındaydım (Katılımcı 6, E)"

"...annemin boşanma sürecinde psikolojisi hiç iyi değildi, kesinlikle annemin psikolojik desteğe ihtiyacı vardı ama destek almak istemedi (Katılımcı 7, K)"

"Öz annemin sağlığı pek iyi olmadığı için kendine bakamıyor. Huzurevinde yaşamasını isterdim. Psikolojik olarak desteğe ihtiyacım vardı. Uzun süre boyunca psikolojik destek almak isterdim (Katılımcı 18, K)"

3.7.3. Hem Ekonomik Hem de Psikolojik Destek Gereksinimi

Araştırmaya katılan bazı katılımcılar, yaşadıkları süreçlerde hem ekonomik hem de psikolojik destek ihtiyacı duymuştur. Özellikle babanın vefatı sonrasında ekonomik

zorluklarla karşılaşılmış ve psikolojik desteğe de ihtiyaç duyulmuştur. Ancak, bazıları, bu desteği alamamış ve bu durumdan dolayı hayal kırıklığına uğramıştır. Bu katılımcılar, devletten, özellikle anne veya babasını kaybeden öğrencilere yönelik hem ekonomik hem de psikolojik destek hizmetlerinin olmasını talep etmektedir. Bu durumlar, yaşanan zorlukların tek boyutlu olmadığını; hem ekonomik hem de psikolojik açıdan desteklenmenin önemini vurgulamaktadır. Bu kapsamdaki ifadeler şu şekildedir:

> *"Devletin anne ya da babasını kaybeden öğrencilere yönelik destek hizmetlerinin olmasını isterdim. Hem ekonomik hem de psikolojik olarak destekleri olsa güzel olurdu (Katılımcı 10, E)"*
>
> *"Hem ekonomik açıdan hem de psikolojik açıdan zorluk çektiğimiz dönemler oldu. Annemin benim hatta kardeşlerimin o süreçte psikolojik destek almasını isterdim. Ekonomik açıdan da kiramız, temel ihtiyaçlarımızı karşılamak için bir yardım almak bizim için çok iyi olurdu (Katılımcı 11, E)"*
>
> *"... ekonomik yardım, sağlık yardımı bir de psikolojik destek almayı çok isterdim (Katılımcı 14, K)"*
>
> *"Babam vefat ettikten sonra birkaç yıl özellikle ekonomik olarak çok zorluk çektik. Psikolojik olarak da desteğe ihtiyacımız vardı (Katılımcı 17, K)"*

4. Tartışma ve Sonuç

Bu araştırma kapsamında boşanma, ayrılma, terk etme, eşin vefatı gibi nedenlerle tek ebeveynli aile örüntüsünde yaşamını sürdüren 18 yaş üstü üniversite öğrencilerinin aile algısı ve sosyal hizmet gereksinimleri ele alınmıştır. Gerçekleştirilen görüşmelerden elde edilen veriler MAXQDA programı aracılıyla analiz edilmiş ve araştırma bulguları yedi ana tema olarak derinlemesine incelenmiştir. Bu bulgular doğrultusunda öne çıkan temel sonuçlar şu şekildedir:

Araştırmaya katılan tek ebeveynli gençlerin aile algısında; aile duygusal bağlarla birleşmiş, karşılıklı destek ve dayanışma içinde olan bir bütün olarak görülmektedir. Bu perspektif, ailenin biyolojik bağlardan ziyade duygusal ve sosyal bağlarla şekillenen bir yapı olduğunu vurgulamaktadır. Duman (2021) tarafından yapılan çalışmada da özellikle Z kuşağı olarak nitelendirilen gençlerin aile algısındaki farklılaşmaya yer verilmiştir. Şahbaz (2023) tek ebeveynli hanelerdeki ergenler üzerinde yaptığı çalışmasında ise sağlıklı ailenin; mutlu, saygılı, huzurlu ve karşılıklı "sağlıklı iletişimin sürdürüldüğü yapı" olarak nitelendirildiğine yer vermektedir. Ayhan ve Pekğöz-Çeviker (2023) ise 18 yaş dönemindeki gençlerin aile bütünlüğüne, diğer yaş gruplarına kıyasla daha fazla önem verdiğini vurgulamaktadır. Özellikle aile algısı ve tek ebeveynlik sürecinin kültürel değerlerle de şekillendiği değerlendirildiğinde literatürde yakın zamanda yapılan çalışmalar ile bu çalışmanın benzer bulgulara sahip olduğu anlaşılmaktadır. Özellikle herhangi bir nedenle ebeveyn yoksunluğu yaşayan bireylerde ailenin, bütünlük ve sağlıklı aile özelliklerini barındıran bir bağlama sahip olarak algılandığı belirlenmiştir.

Katılımcılar anneyi sevgi dolu, destekleyici ve iletişime açık bir figür olarak; babayı ise koruyucu ve destekleyici bir rol üstlenen konumunda görmektedir. Bu bakış açısının toplumsal cinsiyet rolleri çerçevesinde kadın ve erkeğe yüklenen rol ve sorumluluklarla uyumlu olduğu anlaşılmaktadır. Dolayısıyla bu çalışmada yaşanan ebeveyn yoksunluğunun sonuçları katılımcılar tarafından toplumsal cinsiyet rolleri bağlamında değerlendirilmiştir. Li (2020), Çin'de babaların rol ve sorumluluklarını araştırdığı çalışmasında geçmişe kıyasla özellikle çocuk bakımında babaların daha aktif rol aldığını ifade etmiş ancak hala anneler kadar bu alanda etkin olamadıklarını paylaşmıştır. Yaffe (2023)'nin çalışmasında anneler babalara kıyasla daha kabul edici, duyarlı ve destekleyici olarak algılanırken; babanın da daha otoriter bir yapıya sahip olduğu aktarılmaktadır. Katılımcıların anne algıları dikkate alındığında bu durumun geleneksel rollerle ilişkili olmasına ek özellikle ebeveyn yoksunluğunun olumsuz etkilerini en aza indirmek için daha fazla ön plana çıkarıldığı değerlendirilmektedir. López-León ve arkadaşları (2021) tarafından kanser hastalıklı çocuklara sahip ebeveynlerle yapılan çalışmada da bakım yeterliliği ve artan hoşgörü sürecine dikkat çekilmektedir. Dolayısıyla çocukların ya da gençlerin kendini eksik hissetme olasılığı olan durumlarda ebeveynlerin veya tek ebeveynin daha hoşgörülü bir tutum sergilediği anlaşılmıştır.

Tek ebeveynli ailelerin karşılaştığı güçlükler ve gereksinimler; ekonomik zorluklardan psikolojik ve sosyal güçlüklere kadar çeşitli boyutları kapsamaktadır. Sosyoekonomik güçlüklerin aile içi ilişkileri olumsuz etkilediği ve psikolojik olarak zorluklar yaşandığı anlaşılmaktadır. Ayrıca, gençlerin diğer aile üyesinin yokluğunu hissetmeleri ve bu eksikliğin yaşamın çeşitli alanlarında zorluklar çıkardığına yer verilmektedir. Üniversite öğrencilerinin sosyal destekler alması, üniversite yaşamının zorluklarıyla başa çıkmada ve stresin olumsuz etkilerine karşı direnç göstermede önemli bir rol oynamaktadır (Aydıner-Boylu vd., 2019: 218). Bu noktada, sosyal hizmet uygulamalarının ve destek sistemlerinin önemi ortaya çıkmaktadır. Araştırmada bazı katılımcılar özellikle sosyoekonomik ve psikolojik desteklerin yetersiz olduğunu veya erişimde zorluklar yaşadıklarını hatta desteklerin varlığını ve herhangi bir destek alınıp alınmayacağını dahi bilmediklerini ifade etmektedir. Bu durum, sosyal hizmet uygulamalarının bilinirliği, etkililiği ve erişilebilirliği açısından önemli bir sorun olarak değerlendirilmektedir. Tek ebeveynli ailelerin yaşadığı güçlükler ve gereksinimlerin dünya genelinde ortaklaştığını söylemek yanlış olmayacaktır. Özellikle ekonomik, psikolojik ve sosyal açıdan yaşanan güçlükler ve gereksinimlere birçok benzer çalışmada da yer verilmiştir (Glasser & Navarre, 1965; Duncan & Rodgers, 1987; Greeff & Fillis, 2009; Kotwal & Prabhakar, 2009; Burgund et al., 2013; Aydıner-Boylu, 2014; Maurya et al., 2015; Demirel & Buz, 2021; Boztilki, 2022; Dharani & Balamurugan, 2024). Değişen toplumsal koşullar ve artan tek ebeveynli aile oranları bu alandaki sosyal hizmet gereksinimini daha görünür kılmaktadır. Özpolat ve Özkan (2022: 1096) da araştırmalarında özellikle risk altındaki aile yapılarında ekonomik risklerin yoğun olarak hissedildiğini bu nedenle gereksinimlerinin en fazla ekonomik temelli destekler olduğunu ifade etmiştir.

Aile yaşamında değiştirmek istenilen durumlar incelendiğinde, gençlerin daha sağlıklı aile ilişkileri ve daha adil bir ortam talep ettikleri görülmektedir. Özellikle boşanma

sonrasında tek ebeveynli aile döngüsünde sağlıklı aile ilişkilerinin tesis edilememesi bu sürecin temel etkenidir. Tek ebeveynli aile örüntüsündeki ebeveyn ve gençlerin zaman zaman sosyal ve çevresel açılardan yaşadıkları dışlanma ve damgalanma durumu daha adil bir ortam talebini de anlaşılır kılmaktadır.

Ortaya konan birçok çalışma ile bu çalışmanın sonuçlarının benzerlik gösterdiğini söylemek yanlış olmayacaktır. Çünkü genel itibariyle tek ebeveynli aile örüntüsündeki bireylerin sorunlar yaşadıkları, psikososyal ve ekonomik gereksinimlerinin bulunduğu ve bu bağlamda destek beklentisi içinde oldukları anlaşılmıştır.

Bu araştırma tek ebeveynli aile örüntüsüne sahip üniversiteli gençlerin aile algısı ve sosyal hizmet gereksinimleriyle ilgili yaşadığı deneyimleri ve bu ailelerin ihtiyaçlarını anlamak için önemli bir kaynak sunmaktadır. Bu çalışmanın ilgili paydaşlara, politika yapıcılara ve sosyal hizmet uzmanlarına, tek ebeveynli ailelerin ihtiyaçlarını daha iyi anlama ve destekleme konusunda rehberlik edeceği değerlendirilmektedir. Araştırma sonuçları doğrultusunda aşağıdaki önerilere yer verilmektedir:

- Tek ebeveynli aile yapısına sahip üniversiteli gençlerin süreç içerisinde karşılaştığı ekonomik, psikolojik ve sosyal sorunlar, mevcut sosyal hizmet uygulamalarının yetersiz kaldığını göstermektedir. Bu nedenle özellikle psikolojik ve sosyoekonomik destek boyutlarıyla sosyal hizmetlerin bilinirliğini artırmak için kapsamlı çalışmalar yapmalıdır.
- Tek ebeveynli ailelerdeki bireylerin sosyal hizmetlere erişimini kolaylaştırmak için çeşitli platformlar geliştirilerek; başvuru süreçlerini basitleştirilmeli ve ailelerin daha hızlı erişimleri sağlamalıdır.
- Tek ebeveynli ailelerin ekonomik, psikolojik ve sosyal sorunlarına yönelik özelleştirilmiş çözümler, programlar geliştirilmelidir.
- Tek ebeveynli ailelere yönelik sosyal hizmet uygulamalarının çeşitlendirilmesi ve erişilebilirliğin artırılması için çaba gösterilmelidir. Özellikle tek ebeveynli üniversite öğrencileri reşit olsa bile bu kesimin farklı ihtiyaçlarına ve yaşam koşullarına uygun sosyal ve ekonomik destek/yardım programları geliştirilmeli ve bu programlara erişim kolaylaştırılmalıdır.
- Gençlerin aile algısının ve aile içi ilişkilerin önemli bir rol oynadığı göz önüne alındığında, aile içi iletişimi güçlendirmeye yönelik programlar ve destek grupları oluşturularak aile üyelerinin birbirlerini daha iyi anlamalarını ve desteklemelerini sağlayarak aile içi uyumu artırıcı çalışmalar yapılmalıdır.
- Tek ebeveynli ailelerin karşılaştığı güçlükler ve gereksinimler konusunda özellikle üniversiteler, uygulama ve araştırma merkezleri aracılığıyla gençleri yakından takip ederek eğitim süreçlerinde aile içi ilişkiler, duygusal sağlık ve sosyoekonomik destek konularında eğitim ve bilinçlendirme programları düzenlenmeli ve profesyonel danışmanlık hizmetleri sunulmalıdır.

- Tek ebeveynli aileleri önceleyen bir bakış açısıyla kamu sosyal politikaları inşa edilmeli ve tek ebeveynli ailelere yönelik hizmet birimleri, merkezi idare ve yerel yönetimler düzeyinde yaygınlaştırılmalıdır.

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Aşırı İş Yükünün, İş-Aile Çatışmasının Aracılığında ve İş Becerikliliğin Düzenleyiciliğinde Görev Performansına Etkisi[1]

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The Effect of Work Overload on Task Performance Mediated by Work-Family Conflict and Moderated by Job Crafting[2]

Abstract

The study aims to investigate the effect of work overload on task performance mediated by work-family conflict and moderated by job crafting. The research was conducted using a quantitative research design, analysing the data collected through a face-to-face survey. The questionnaires were completed by accounting professionals registered with the Chamber of Accountants in all districts of Rize Province. Data were collected from 109 professional members. The collected data were analysed using SPSS and Smart PLS 4 statistical programs. As a result of the analysis, it was determined that work overload negatively affected task performance. Contrary to expectations, the work-family conflict did not mediate this effect. Job crafting was found to play a moderating role in this effect. The moderator role of job crafting is a novel and unique contribution to the literature.

Keywords : Work Overload, Work-Family Conflict, Job Crafting, Task Performance.

JEL Classification Codes : M10, M12.

Öz

Araştırmanın amacı, aşırı iş yükünün, iş-aile çatışmasının aracılığında ve iş becerikliliğin düzenleyiciliğinde görev performansına etkisini araştırmaktır. Araştırma nicel araştırma tasarımında, yüz yüze anket tekniği aracığıyla toplanan verilerin analizi ile gerçekleştirilmiştir. Anketler, Rize ili tüm ilçelerindeki, muhasebeciler odasına kayıtlı muhasebe meslek mensuplarına doldurtulmuştur. 109 meslek mensubundan veriler alınmıştır. Toplanan veriler, SPSS ve SmartPLS 4 istatistik programları aracılığıyla analiz yapılmıştır. Yapılan analizler sonucunda; aşırı iş yükünün görev performansını negatif olarak etkilediği tespit edilmiştir. İş-aile çatışmasının, beklentinin aksine bu etkileme üzerinde aracılık rolü tespit edilememiştir. İş becerikliliğinin ise bu etkide, düzenleyicilik rolünde bulunduğu ortaya konulmuştur. İş becerikliliğinin düzenleyicilik rolü ilgili yazın açısından yeni ve özgündür.

Anahtar Sözcükler : Aşırı İş Yükü, İş-Aile Çatışması, İş Becerikliliği, Görev Performansı.

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[1] *Bu çalışmanın bir kısmı "Aşırı İş Yükünün Görev Performansına Etkisinde İş Becerikliliğinin Düzenleyicilik Rolünün İncelenmesi: Rize İlindeki Muhasebe Meslek Mensupları Üzerine Bir Araştırma" başlığıyla 9-11 Mayıs 2024 tarihinde Kocaeli'nde düzenlenen 23. Uluslararası İşletmecilik Kongresi'nde bildiri olarak sunulmuştur.*

[2] *A part of this study was presented at the 23rd International Business Congress held in Kocaeli on May 9-11, 2024, "Examining the Moderating Role of Job Crafting in the Effect of Work Overload on Task Performance: A Study on Accounting Professionals in Rize Province".*

1. Giriş

Bir ölçme ve raporlama bilgi sistemi olan muhasebe, tüm ekonomik faaliyetlerin temelinde yer almaktadır (Okolie & Amos, 2014: 129). Bu bakımdan muhasebe meslek mensuplarının ekonomide icra ettikleri roller hem hizmet sunulan işletmeler, firma ortakları, yatırımcılar gibi çeşitli tarafların finansal kararlarının şekillenmesinde hem de kamu sektörü ile mükellef ilişkisinin belirlenen kurallar çerçevesinde sürdürülebilirliğinin sağlanmasında büyük bir öneme sahiptir (Yanık vd., 2023: 220; Yürekli & Gönen, 2015: 303). Bu doğrultuda muhasebe mensuplarının sundukları hizmetin kalitesi, taraflarla yürütülecek olan ilişkilerin devamlılığı açısından gerekli bir konudur. Ancak söz konusu hizmetin sunulmasında muhasebe mensuplarının çeşitli sorunlarla karşılaştığı, bunlardan birinin de aşırı iş yükü olduğu; meslek mensuplarının iş yüklerinin fazla olduğuna ilişkin bir soruya %69,2 oranında "kesinlikle" (Kalaycı & Tekşen, 2006: 92-96), başka bir çalışmada da %42,1 oranında "her zaman" ve "çoğu zaman" seviyesinde katıldıklarına yönelik (Öztürk vd., 2011: 91) algılamaları da bu durumun tespitini desteklemektedir. Ayrıca aşırı iş yükünün, neredeyse bütün sektörlerde görülen önemli bir problem olduğu da ifade edilmektedir (Altaf & Awan, 2011: 93).

Meslek mensuplarının zaman baskısı altında işlerini eksiksiz olarak yerine getirmek zorunda olmaları önemli bir sorumluluğu yüklenmelerine yol açarken, sıradan sayılabilecek beyanname ve bildirgelerin hazırlanması/sisteme girilmesi gibi muhasebe iş ve işlemlerin gelişen elektronik uygulamalar aracılığıyla kolayca yapılabilmesine rağmen (Atabay, 2016: 730) paydaş beklentilerindeki yükselmeler; toplumsal, teknolojik, ekonomik, finansal alanlarda gerçekleşen değişim ve gelişmeler (Yanık vd., 2023: 222) iş yüklerinin artışına neden olmuştur. Bununla birlikte mesleğin zihinsel bir aktiviteyi ve sürekli biçimde dikkatli olmayı gerektirmesi, hata kabul etmemesi nedeniyle yorucu ve yıpratıcı da olması (Yıldırım vd., 2004: 11) icracıları üzerinde iş yüklerinin artması sonucunu beraberinde getirebilmektedir.

Aşırı iş yükü, meslek mensubunun işteki sorumluluğunun normalden yüksek ve yoğun olduğuna dair algılamasıdır (Keser, 2006: 105). Aşırı iş yükü algısı, meslek mensubunun belirli bir zamanda görevini tamamlaması için kendisinden beklenilen iş taleplerinin iş kaynaklarını ve kapasitesini aşması halinde ortaya çıkmaktadır (Baker et al., 2007: 275). İş taleplerinin iş kaynaklarından yüksek olması, başka bir deyişle, aşırı iş yükü algılamasının varlığı halinde, ortaya çıkacak olumsuz stres ve artan kaygı çalışan performansını zayıflatabilmektedir (Korkmazer, 2021: 2770-2773).

Aşırı iş yükünün performansa (bu çalışmada performansın bir boyutu olan görev performansı incelenmektedir) beklenen olumsuz etkisi, meslek mensuplarının yaşayabilecekleri iş-aile çatışması üzerinden ortaya çıkabilir. Meslek mensuplarının taraflara olan yükümlülüklerini eksiksiz olarak yapabilmeleri, zaman temelli olarak sisteme girmeleri gereken çeşitli beyanname ve bildirgelerin olması, mevzuatta sıklıkla yapılan düzenlemelerin iş süreçlerini uzatması gibi iş ve işlemlerin çokluğu, onları daha fazla çalışmaya itebilmektedir. Bu durum, meslek mensuplarının ailelerine ayıracakları zamanı

azaltmalarına, iş stresini ailelerine taşımalarına, iş-aile çatışması yaşamalarına neden olabilecektir (Tayfur & Arslan, 2012: 154). Yapılan çeşitli çalışmalarda, aşırı iş yükünün iş-aile çatışmasını artırdığına ilişkin sonuçlar mevcuttur (Ganewatta & Hiroshima, 2023; Dodanwala & Santoso, 2022; Yalçın, 2022; Korkmazer & Aksoy 2020; Turgut, 2011). İş ile aile arasında beklenen rollerin sergilenememesi, rol dağılımındaki dengesizlik hali çalışanın işteki performansını aşağıya çekebilmektedir. İlgili yazında, iş-aile çatışması ile performans arasında negatif ilişki olduğuna dair çalışma sonuçları vardır (Zainal et al., 2020; Karatepe & Kılıç, 2007). Dolayısıyla aşırı iş yükü, iş-aile çatışmasına yol açarak görev performanslarını düşürebilecektir. Ganewatta ve Hiroshima (2023) yaptıkları çalışmada, aşırı iş yükü ile işten ayrılma niyeti arasındaki ilişkide, Yalçın (2022) yaptığı çalışmada, aşırı iş yükü ile tükenmişlik arasındaki ilişkide, Turgut (2011) yaptığı çalışmada, iş yükü ile çalışmaya tutkunluk arasındaki ilişkide ve Korkmazer ve Aksoy (2020) yaptığı çalışmada, aşırı iş yükü ile yaşam kalitesi arasındaki ilişkide iş-aile çatışmasının aracılık rolü üstlendiğini tespit etmişlerdir. Bahsedilen çalışmalarda, iş yükünün yol açtığı olumsuz sonuç iş-aile çatışmasının yaşanması ile ortaya çıkmıştır. Dolayısıyla iş-aile çatışmasının aracılık görevinde bulunduğu görülmüştür. Bu çalışmada da aşırı iş yükünün görev performansını olumsuz etkilemesinin iş-aile çatışması aracılığında gerçekleşebileceği düşünülmektedir.

Aşırı iş yükünün ortaya çıkarabileceği stres, kaygı, yorgunluk, sıkıntı gibi olumsuz sayılabilecek duygu temelli sonuçlar (Çiftçi, 2022: 16; Korkmazer, 2021: 2770; Turgut, 2011: 160) çalışanlar tarafından doğru bir şekilde yönetilememeleri halinde, başta çalışanın kendisi ve örgütü aleyhine çeşitli sonuçlar doğurabilmektedir. Çalışanlar bu duygu temelli sonuçların iş çıktılarına olumsuz etkilerini, sahip oldukları ya da örgütleri tarafından sağlanan çeşitli iş kaynakları ile yönlendirebilmektedir. Örneğin, Zainal ve diğerlerinin (2020) çalışmasında, iş-aile çatışması ile iş performansı arasında ilişkiyi sosyal desteğin düzenlediği tespit edilmiştir. Dolayısıyla aşırı iş yükü ve iş-aile çatışması gibi çalışanlar üzerinde olumsuz sonuçlara yol açan örgütsel davranış değişkenlerinin zararlı etkileri azaltılabilir. Bu çalışma kapsamında, iş becerikliliğinin (job crafting) söz konusu ilişkide (aşırı iş yükü ile görev performansı) düzenleyici bir rol üstlenebileceği beklenmektedir.

İş becerikliliği, çalışanların motivasyon seviyelerini artırmada işlerini fiziksel, bilişsel ve ilişkisel unsurları açısından değiştirmesi, genişletmesi ve kendi kişisel özellikleriyle uyumlu hale getirmesi şeklinde tanımlanabilir (Kerse, 2017: 284). İş becerikliliği sayesinde meslek mensupları, işin içeriğinde yapacakları yeniden yapılandırmalarla icra ettikleri işin algılamasını değiştirebilecek (Berg et al., 2010: 165), böylece olumsuz etkilerini hafifletebilecektir. Hakanen, Seppälä ve Peeters (2017) yaptıkları çalışmada, iş becerikliliğinin aşırı iş yükü ile sinizm arasındaki pozitif ilişkiyi tamponladığını (azalttığını) ortaya koymuşlardır. Benzer bir ilişkide iyi oluş halinin düzenleyicilik rolünün incelendiği çalışmada (Moreira et al., 2023), yüksek iyi oluş halinin iş-aile çatışması ile görev performansı arasındaki olumsuz ilişkiyi ılımlaştırdığı, başka bir ifadeyle yüksek seviyeli iş-aile çatışması halinde görev performansı sürdürülmüş ya da çok az artmıştır. İyi oluş hali, çatışmanın zararlı etkisini önleyerek performansın sürdürülmesine kolaylık sağlamıştır. Dolayısıyla aşırı iş yükünün hangi değişkenlerin varlığında çalışanlar üzerindeki olumsuz etkisinin yönetilebileceğinin araştırılması önem arz etmektedir. Yazın

taraması yapılabildiği kadarıyla, iş becerikliliğinin söz konusu ilişkiyi nasıl yönlendirdiğine dair yapılan çalışmalar az sayıdadır (Delice, 2019). Delice'nin (2019) iş becerikliliğin düzenleyici olarak ele aldığı çalışmasında, aşırı iş yükü ile görev performansı arasında bir ilişki saptanamamıştır. Yapılan bu çalışmada ise, aşırı iş yükünün görev performansı üzerindeki olumsuz etkinin iş becerikliliğin farklı seviyelerinde farklılaşabileceği öngörülmektedir.

Bu çalışmanın amacı, aşırı iş yükünün, iş-aile çatışmasının aracılık ve iş becerikliliğin düzenleyicilik rolünün varlığında görev performansına etkisinin incelenmesidir. Çalışma kapsamında, aşırı iş yükü algılamasının muhasebe meslek mensuplarında iş-aile çatışması yaşanmasına yol açarak görev performanslarının düşmesine yol açabileceği ve örgütsel davranış yazınında nispeten yeni bir çalışan özelliği olarak kavramsallaştırılan iş becerikliliğinin ise aşırı iş yükü algılamasının görev performansına olumsuz etkisinde bir tampon görevi üstlenebileceği düşünülmektedir. Araştırmanın verileri, muhasebe meslek mensuplarından elde edilmiştir. Örneklem olarak seçilmesinin nedeni ise, muhasebe meslek mensuplarının aşırı iş yükünü yoğun tecrübe eden meslek gruplarından biri olarak ekonomik sistem içerisindeki rollerinin önemli olmasıdır. Bununla birlikte muhasebe meslek mensuplarının iş becerikliliği konusunda, işlerini yaparken işin fiziksel, bilişsel ve ilişkisel unsurlarında yapılandırmalar yapabilmelerinin yüksek olmasıdır. Başka bir deyişle, kendi bürolarında çalışan muhasebe meslek mensuplarının işlerini yaparken örgütsel hiyerarşik sınırlamalar içerisinde bir emre tabi olmayıp, bizzat işleri kendilerinin yapmaları, işlerin içeriğinde kendilerine uygun şekilde biçimlendirmeler yapabilmeleri, esnek çalışma saatleri uygulayabilmeleri gibi gerekçelerden ötürü iş becerikliliği konusunda rahat davranabilecekleri ifade edilebilir.

2. Hipotezlerin Geliştirilmesi

2.1. Aşırı İş Yükünün Görev Performansına Etkisi

Aşırı iş yükü, çalışma saatlerinin uzun olması, fazla çalışılması yönündeki baskıların artması, sınırlı sürede ve sunulan iş kaynakları ile işin başarılması yönündeki gerçekçi olmayan işveren beklentilerinin oluşturduğu koşulların varlığı olarak nitelendirilmektedir (Altaf & Awan, 2011: 93). Aşırı iş yükü, çalışanın, verilen zaman süresinde yapmak zorunda olduğu iş yükünün/miktarının fazla olduğuna ilişkin algılamasıdır (Greenberg et al., 1995: 12). Karasek'in (1979) geliştirdiği İş Yükü-Kontrolü Teorisi'ne göre, çalışanın fazla iş yükü ile az kontrol sorumluluğu arasında kalması halinde stresi artabilecektir (Demiral vd., 2007: 12). Dolayısıyla ortaya çıkan stresin ve artan kaygının çalışan performansı üzerinde olumsuz etkide bulunabileceği ifade edilmektedir (Korkmazer, 2021: 2770-2773).

Yazında, aşırı iş yükü, nitel ve nicel iş yükü olarak incelenmektedir. Nitel iş yükü, çalışanın gerekli bilgiye, donanıma ve tecrübeye sahip olmadığı için verilen işin zorluğuna dair algısı; nicel iş yükü ise, çalışanın gerekli yeteneğe sahip olması halinde bile sınırlı bir zaman diliminde kendisinden daha fazla iş miktarının istenmesi halidir (Çiftçi, 2022: 18; Anam et al., 2020: 15). Bu çalışmada kullanılan ölçekte ise her iki iş yükünü içeren ifadeler

söz konusudur. Çalışmada kullanılan aşırı iş yükü ölçeğinde, *yetersizlik duygusu* ve *aşırı çalışma* boyutları ortaya çıkmış olup, yetersizlik duygusu boyutunun nitel, aşırı çalışma boyutunun ise nicel iş yüküne karşılık geldiği söylenebilir.

Yazında performans ise, görev ve bağlamsal performans olarak çoklu boyutta ortaya çıkmakta olup (Borman & Motovidlo, 1997: 99-100), bu çalışmada *görev performansı* ele alınmaktadır. Görev performansı, resmi iş tanımlarında belirlenen faaliyetlerin yerine getirilmesine yönelik performans olup, işin mesleki ve ustalık yönüne vurgu yapmaktadır (Bağcı, 2014: 61). Bir muhasebe meslek mensubu için, muhasebe bilgisine sahip olma, bildirgelerin hazırlanması ve sisteme girilmesi, katma değer vergisinin, geçici verginin beyan edilmesi, bilanço ve gelir tablosu gibi finansal tabloların hazırlanması, dijitalleşmeyle birlikte E-uygulamalar görev performansının içeriğine örnek olarak verilebilir. Dolayısıyla işin yapısal özelliklerinden ve yasa ile yönetmeliklerin ve hızlıca değişmesinden kaynaklanan iş miktarının fazlalığı ile bu işlerin yetiştirilmesi için gereken zaman arasındaki dengesizlik hali meslek mensuplarının hayal kırıklığı ve kızgınlık duygularını da artırabilmektedir (Greenberg et al., 1995: 12). Bozdoğan ve Aslan (2020) ile Çiftçi'nin (2022) çalışmalarında, aşırı iş yükünün strese neden olduğu tespit edilmiştir. Zhang, Xu, Li ve Xu'nun (2022) çalışmasında, aşırı rol yüklemesinin görev performansını azalttığı sonucuna ulaşılmıştır. Korkmazer (2021) ile Anam ve diğerlerinin (2020) çalışmalarında, iş yükü fazlalığı ile çalışan performansı arasındaki ilişkinin negatif olduğu ortaya konulmuştur. Bununla birlikte Töngür (2016: 551-552) çalışmasında, söz konusu değişkenler arasındaki ilişkinin karmaşık olduğunu, iş yükü fazlalığının performans üzerindeki olumsuz etkisinin birçok deneysel çalışmada ortaya konulduğunu ve iş yükünün çalışanlarda baskı, engelleyici stres (hindrance) neticesinde iş performansını olumsuz etkilediğini, aynı zamanda iş yükünün mücadele edici (challenge) strese yol açarak performansı artırabileceğini de söylemiştir. Nitekim yaptığı (2016) çalışmada, iş yükü ile performans arasındaki ilişkinin pozitif olduğunu ortaya koymuştur. Delice'nin (2019) çalışmasında ise aşırı iş yükü-görev performansı arasında ilişki tespit edilememiştir. Bu bakımdan, yazındaki gerekçelere dayanarak ilişkinin yönü belirtilmeden aşağıdaki hipotez oluşturulmuştur:

H1: Aşırı iş yükü algılaması görev performansı üzerinde anlamlı bir etkiye sahiptir.

H1a: Aşırı iş yükü algılamasının yetersizlik duygusu boyutu görev performansı üzerinde anlamlı bir etkiye sahiptir.

H1b: Aşırı iş yükü algılamasının aşırı çalışma boyutu görev performansı üzerinde anlamlı bir etkiye sahiptir.

2.2. Aşırı İş Yükünün, İş-Aile Çatışmasının Aracılığında Görev Performansına Etkisi

İş ve aile etkileşimi, modern toplumun işleyişinden etkilenen karmaşık bir süreç olarak, hem iş (zihinsel iş yükü artması, çalışma saatlerinin fazlalığı, iş güvencesizliği) hem de aile (bakım zorunluluğu olan kişiler varlığı) rollerinden kaynaklanan beklentilerin etkileşimiyle şekillenmektedir (Moreira et al., 2023: 2). Dolayısıyla ortaya çıkan iş ve aile rollerindeki etkileşimin yönetilememesi hali, iş-aile çatışması, çalışma yaşamının zorluğunu

artıran önemli bir örgütsel davranış konusu olarak yazında sıklıkla incelenmektedir (Turgut, 2011: 159). Greenhaus ve Bettel (1985: 77) iş-aile çatışmasını, iş ve aile yaşamındaki rol gereklerinin bazı yönlerden uyumsuzluk içerisinde olduğu, rollerin birbiriyle çatışması olarak tanımlamıştır. İş-aile çatışması, bir tarafa ilişkin yükümlülük ve talebin diğer tarafa ilişkin sorumluluğu engellemesi şeklinde çift yönlü biçimde ortaya çıkmaktadır (Ganewatta & Hiroshima, 2023: 112). İşin talepleri aile yaşamını, ailenin talepleri de iş yaşamını etkilemektedir (Koçak vd., 2019: 4). Nart ve Batur (2013: 73) uzun, düzensiz ve fazla mesainin, düşük ücretlerin, yönetimin olumsuz tutumlarının, terfi isteğinin, aile beklentileri gibi pek çok bireysel ve örgütsel faktörün iş-aile çatışması ortaya çıkardığını ifade etmiştir.

Greenhaus ve Bettel'e (1985: 77) göre iş-aile çatışması; zaman temelli, davranış temelli ve gerilim temelli çatışma biçiminde ortaya çıkmaktadır. Zaman temelli çatışmada, çalışanın görevine ayırdığı zamanın diğer rolünün sorumluluğunu yerine getirmesine engel olma halidir (örn., meslek mensubunun, bürosunda daha fazla mesaiye kalarak ailesine ayırması gereken zamanı azaltmasıdır). Davranış temelli çatışma, bir rolün davranışı ile diğer rolün davranışının uyumsuzluğu durumunda ortaya çıkar (örn., meslek mensubunun daha fazla kazanmak için sergilediği sert yaklaşımları ile ailenin beklediği yumuşak yaklaşımların çatışmasıdır). Gerilim temelli çatışma ise, bir rolün gereklerini yerine getirirken yaşanılan yorgun ve sinirli olma, gerilim gibi duygu durumlarının diğer rolün ifa edilmesini zorlaştırmasıdır (örn., meslek mensubunun aşırı iş yükünden kaynaklı aşırı fiziksel yorgunluk, duygusal çöküş hallerinin aile üyeleri ile konuşmasına, onlara neşeli görünmesine engel olmasıdır) (Koçak vd., 2019: 4; Tayfur & Arslan, 2012: 151; Turgut, 2011: 158).

Çalışanların daha fazla görev yüklenmeleri, mesai saatlerinin uzunluğu ve zorlu olması, mesai içerisindeki dinlenmelerin azalması, iş miktarı ve verilen süre arasındaki dengesizliğin artması halinde ortaya çıkan (Koçak vd., 2019: 6) aşırı iş yükü algılaması, çalışanda başta sıkıntı, gerginlik, stres duygu durumlarına yol açarak, çalışanın söz konusu sıkıntıları aile tarafına da yansıtmasına ve rol çatışması yaşamasına yol açacaktır. Stresini ailesine yansıtacak meslek mensubunun görev performansının düşebileceği beklenebilir. Diğer taraftan ailesine karşı çeşitli sorumluluklara sahip bir çalışanın, aynı zamanda işyerindeki sorumlulukları yerine getirmeye çalışması da sorumlulukların yerinde getirilmesinde dengesizlik hali ortaya çıkarabilecektir (Turgut, 2011: 157). Bu durum da çalışanın performansını olumsuz etkileyebilecektir. Aşırı iş yükünün görev performansına etkisi doğrudan olabileceği gibi, iş-aile çatışmasının varlığında da ortaya çıkabilir. Yapılan çalışmalarda, iş-aile çatışmasının iş stresini (Nart & Batur, 2013), aşırı iş yükünün iş-aile çatışmasını, aşırı iş yükü algılamasının iş-aile çatışması aracılığıyla da duygusal tükenmeyi ve işe karşı duyarsızlaşmayı artırdığı (Tayfur & Arslan, 2012) tespit edilmiştir. Dodanwala ve Santoso (2022) bina inşaat projelerinde çalışanlar üzerinde yaptığı çalışmasında, aşırı iş yükü ile iş stresi arasındaki ilişkide iş-aile çatışmasının aracılık rolüne sahip olduğunu ortaya koymuştur. Çalışmada, zaman ve gerginlik temelli iş-aile çatışmasının aracılık rolü ortaya çıkmıştır. Korkmazer ve Aksoy (2020) sağlık sektörü örnekleminde yaptığı çalışmasında, iş yükü fazlalığı ile çalışanın yaşam kalitesi algılaması ilişkisinin negatif olduğunu, bu ilişkide iş-aile çatışmasının tam aracılık rolünde bulunduğunu bulgulamıştır. Çalışmada, iş-aile

çatışmasının yaşam kalitesine etkisi güçlü şekilde oluşmuştur. Turgut (2011) hizmet sektörü çalışanları üzerinde gerçekleştirdiği çalışmasında, iş yükünün tutkunluğun dinçlik ile adanmışlık boyutlarını olumsuz etkilediğini, bu etkinin zaman ve duygu temelli iş-aile çatışması üzerinden gerçekleştiğini ortaya koymuştur. Çalışmada, tutkunluğun önündeki engellerden iş-aile çatışmasının azaltılması, iş-aile çatışmasının azaltılması için ise iş yükünün uygun bir düzeyde tutulması gerektiği ifade edilmiştir. Ganewatta ve Hiroshima (2023: 112) da artan iş taleplerinin iş ile aile arasında denge kurmada zorluklar çıkardığını, bu durumun işten ayrılma niyetine yol açabileceğini ileri sürmüştür. Makine operatörü olarak çalışanlar üzerinde yaptığı çalışmasında, aşırı iş yükünün işten ayrılma niyetine pozitif etkisinin bir kısmının iş-aile çatışmasının aracılığında ortaya çıktığını tespit etmiştir. Yapılan çalışmaların sonuçlarından ve açıklanan gerekçelerden hareketle aşağıdaki aracılık hipotezi oluşturulmuştur:

H2: Aşırı iş yükü algılamasının görev performansına etkisinde iş-aile çatışmasının aracılık rolü vardır.

H2a: Aşırı iş yükü algılaması yetersizlik duygusu boyutunun görev performansına etkisinde iş-aile çatışmasının aracılık rolü vardır.

H2a1: Aşırı iş yükü algılaması yetersizlik duygusu boyutunun görev performansına etkisinde işten aileye çatışmanın aracılık rolü vardır.

H2a2: Aşırı iş yükü algılaması yetersizlik duygusu boyutunun görev performansına etkisinde aileden işe çatışmanın aracılık rolü vardır.

H2b: Aşırı iş yükü algılaması aşırı çalışma boyutunun görev performansına etkisinde iş-aile çatışmasının aracılık rolü vardır.

H2b1: Aşırı iş yükü algılaması aşırı çalışma boyutunun görev performansına etkisinde işten aileye çatışmanın aracılık rolü vardır.

H2b2: Aşırı iş yükü algılaması aşırı çalışma boyutunun görev performansına etkisinde aileden işe çatışmanın aracılık rolü vardır.

2.3. Aşırı İş Yükünün, İş Becerikliliğinin Düzenleyiciliğinde Görev Performansına Etkisi

Yaşanan hızlı teknolojik, ekonomik gelişmeler nedeniyle işin tasarımında sürekli biçimde ortaya çıkan değişiklik yapma ihtiyacı, çalışanları iş becerikliliğe sürüklemekte ve işin içeriğinin kişisel ihtiyaç ve özelliklerle uyumlu hale gelmesi de işin verdiği anlamı ve tatmini artırmaktadır (JunçaSilva et al., 2022: 2). Yazında, Wrzesniewski ve Dutton'un (2001) çalışması ile yerini alan iş becerikliliği kavramı, çalışanların yaptıkları işin içeriğini, uygulamalarını, başka bir ifadeyle fiziksel, bilişsel ve ilişkisel unsurlarında birtakım değişiklikler yaparak kişisel özellikleriyle (ilgi, değer, ihtiyaç, yetenek gibi) uyumlaştırması şeklinde ifade edilmektedir (Kerse, 2017: 284-285; Wrzesniewski & Dutton, 2001: 179). Başka bir tanımlamada ise iş becerikliliği, çalışanların yaptıkları işlerin fiziksel, bilişsel ve sosyal taraflarında değişiklikler yapma konusunda aktif rol almasıdır (Slemp & Vella-Brodrick, 2013: 126). İş becerikliliği, işlerinin tasarımında çalışanların kendi tercihleriyle

yaptıkları informal değişikliklerle ilgilidir (Hur et al., 2021: 3153; Tims et al., 2016: 45). Bu özelliği taşıyan çalışanlar, işi etkin biçimde yönetmede, işin özelliklerini kendisine uyarlamada (Seyrek, 2023: 160), görevlerinin kapsamında ve arkadaşları ile etkileşimlerinde aktif değişiklikler yapma konusunda beceriklidir (İnce & Bozkurt, 2019: 72). Dolayısıyla çalışan, çeşitli değişimler yapabilmesi nedeniyle işin kontrolünün kendisinde olduğunu hissedecektir (Kerse, 2017: 285). Bu kontrol, Karasek'in (1979) İş Yükü-Kontrolü Teorisi'ndeki iş kontrolüne benzemektedir. Çalışan becerilerini kullanabilmekte, karar alma süreçlerine katılmakta ve kontrol hissi artmaktadır. Kontrolün yüksek olması halinde çalışanın motivasyonu yükselmekte, ustalık hissi gelişmekte ve artan iş yükünün stres oluşturması söz konusu olmamaktadır (Demiral vd., 2007: 12). Dolayısıyla kontrol hissine sahip olma, aşırı iş yükünün olumsuz sonuçlarını engelleyebilecek/azaltabilecektir.

İş becerikliliğinin boyutlarına ilişkin çeşitli sınıflandırmalar olmakla birlikte, bu çalışmada Slemp ve Vella-Brodrick'in (2013) sınıflandırması ele alınmıştır. Sınıflamaya göre çalışanların işlerindeki becerikliliği görev, ilişkisel ve bilişsel olarak üç boyutta ortaya çıkmaktadır. *Görev becerikliliği*, resmi işin niceliksel özelliklerinde içerik ekleme ya da azaltma, beceri ve ilgiye uyan görev ekleme, ayrılan süre ve katlanılan çabada değişiklikler yapma becerikliliğini ifade etmektedir (örn., meslek mensuplarının e-dönüşüm uygulamalarındaki becerileri, zaman yönetimini kolaylaştırabilir). *Bilişsel becerikliklik*, çalışanın işini kişisel olarak daha anlamlı hale getirmek için bilişsel düzeyde işini yeniden değerlendirme ve algılama biçimini ve işini nasıl gördüğünü değiştirme becerikliliği anlamına gelmektedir (örn., meslek mensubunun, sunulan hizmetin taraflara sağlayacakları yararın yüksek olacağı düşüncesine sahip olması işin anlamlılığını artırabilir). *İlişkisel becerikliklik ise*, işlerin icra edilmesinde çalışanların diğerleriyle etkileşim kurma biçimlerinde (yeni ilişki kurmada proaktiflik, ilişkiyi sonlandırma ya da kaliteli şekilde devam ettirme, kimlerle etkileşimde bulunacağı konusunda takdir hakkını kullanması) değişiklikler yapma becerikliliğidir (örn., meslek mensubu işlerinde daha etkin olmak için mükellefleriyle kuracakları etkileşimlerin sayısında ve süresinde değişiklikler yapabilir) (Junça-Silva et al., 2022: 3; Slemp & Vella-Brodrick, 2013: 126-127). Söz konusu boyutlar aynı zamanda birbiri ile ilişkili olabilmekte, birbirlerini güçlendirebilmekte ve tetikleyebilmektedir (Berg et al., 2010: 165).

İş becerikliliği konusu, Bakker ve Demerouti'nin (2007) İş Talepleri-İş Kaynakları Modeli'ne de dayandırılmaktadır. İş becerikliliği, modeldeki işin fiziksel, örgütsel veya sosyal açıdan beklediği talepler (aşırı iş yükü, zaman kısıtı) ile iş kaynakları (sosyal destek, özerklik, geri bildirim) arasında denge hali oluşturmak amacıyla değişimleri gerçekleştirmektedir. İş becerikilik özelliği, iş talepleri ile iş kaynaklarını çalışanın kendi ilgi ve ihtiyaçlarıyla uyumlu hale getirerek yaptığı değişikliklerdir (Yeşiltaş, 2021: 207-208; Kerse, 2017: 285). Dolayısıyla iş becerikliliği, çalışanın işindeki kaynakları artırmakta ve aşırı iş talebinin (daha fazla çalışma, zaman ayırma) ortaya çıkardığı stresi asgaride tutmada ya da yenmede önemli bir kaynak olmaktadır (Kerse, 2017: 285). Ayrıca iş becerikliliği gösteren çalışanların işin çerçevesini kendi yetenek, farkındalık ve ihtiyaçlarına göre yeniden tasarlayarak daha çalışılabilir çalışma koşulları oluşturabilmeleri (Yeşiltaş, 2021: 209) nedeniyle aşırı iş yükünün ortaya çıkardığı aşırı iş taleplerini yönetebilirler. Dolayısıyla

beklenen iş talepleri, çalışanın üstesinden gelebileceği çerçeveye dönüştürülebilir. İş becerikliliğine sahip çalışanların, aşırı iş yükünün ortaya çıkarabileceği olumsuz duygu, tutum ve davranışlarının kendisine olabilecek etkilerini yönetmedeki maharetleri nedeniyle, iş becerikliliği düzenleyicilik rolü üstlenebilir.

Yazın taraması yapılabildiği kadarıyla, aşırı iş yükü-görev performansı ilişkisinde iş becerikliliğin düzenleyicilik rolünün incelendiği sınırlı sayıda çalışma söz konusudur. Delice'nin (2019) yaptığı çalışmada da aşırı iş yükü-görev performansı ilişkisinde iş becerikliliğinin düzenleyicilik rolü ortaya çıkmamıştır. İnce ve Bozkurt (2019), Anam ve diğerleri (2020) ile Hur ve diğerlerinin (2021) çalışmasında, iş becerikliliği ile iş performansı arasındaki ilişkinin pozitif olduğu tespit edilmiştir. Junça-Silva ve diğerlerinin (2022) çalışmasında, iş becerikliliğinin görev ve bilişsel boyutları ile iş performansı ilişkisi pozitif olarak ortaya çıkmıştır. Dongwon (2017) yaptığı çalışmada, iş becerikliliğinin performansın hem görev hem de bağlamsal boyutları üzerinde pozitif etkide bulunduğunu ortaya koymuştur. Çalışmaların sonuçları ve yapılan gerekçelerin istikametiyle aşağıdaki düzenleyicilik hipotezi öne sürülmüştür:

H3: Aşırı iş yükü algılamasının görev performansına etkisinde iş becerikliliği düzenleyicilik rolüne sahiptir.

H3a: Aşırı iş yükü algılaması yetersizlik duygusu boyutunun görev performansına etkisinde iş becerikliliği düzenleyicilik rolüne sahiptir.

H3a1: Aşırı iş yükü algılaması yetersizlik duygusu boyutunun görev performansına etkisinde görev becerikliliği düzenleyicilik rolüne sahiptir.

H3a2: Aşırı iş yükü algılaması yetersizlik duygusu boyutunun görev performansına etkisinde bilişsel beceriklilik düzenleyicilik rolüne sahiptir.

H3a3: Aşırı iş yükü algılaması yetersizlik duygusu boyutunun görev performansına etkisinde ilişkisel beceriklilik düzenleyicilik rolüne sahiptir.

H3b: Aşırı iş yükü algılaması aşırı çalışma boyutunun görev performansına etkisinde iş becerikliliği düzenleyicilik rolüne sahiptir.

H3b1: Aşırı iş yükü algılaması aşırı çalışma boyutunun görev performansına etkisinde görev becerikliliği düzenleyicilik rolüne sahiptir.

H3b2: Aşırı iş yükü algılaması aşırı çalışma boyutunun görev performansına etkisinde bilişsel beceriklilik düzenleyicilik rolüne sahiptir.

H3b3: Aşırı iş yükü algılaması aşırı çalışma boyutunun görev performansına etkisinde ilişkisel beceriklilik düzenleyicilik rolüne sahiptir.

Değişkenler arasındaki öngörülen ilişkileri gösteren araştırmanın modeli Şekil 1'de görülmektedir.

Şekil: 1
Araştırmanın Modeli
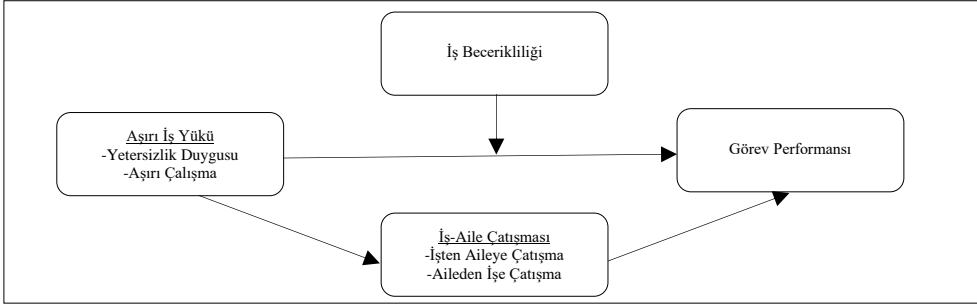
3. Yöntem

3.1. Veri Toplama Süreci ve Demografik Bilgiler

Çalışmanın verileri, Rize ili serbest muhasebeci mali müşavirler (SMMM) odasına kayıtlı tüm ilçelerindeki meslek mensuplarından yüz yüze anket tekniği uygulanarak toplanmıştır. Odaya kayıtlı tüm meslek mensupları anket sorularını cevaplamıştır. Evrenin küçük olması nedeniyle meslek mensuplarının tamamına ulaşılmıştır. Örnekleme tekniği kullanılmamıştır. Toplanan anketlerde herhangi bir veri kaybı söz konusu olmamıştır. Yüz yüze anket yönteminin kullanılması, anket sorularının eksiksiz olarak toplanmasını kolaylaştırmıştır.

Toplanan anket sayısı, 109 olmuştur. Anket verilerinin, unvan dağılımına bakıldığında serbest muhasebeci (SM) 6, serbest muhasebeci mali müşavir (SMMM) 100 ve yeminli mali müşavir (YMM) 3 olmuştur. Meslek mensuplarının %79,80'i (87 kişi) erkek ve yaş ortalaması, 49,83'tür (ss:12,33). Ortalama 98,80 mükellefe hizmet vermektedirler. Meslekteki deneyim süresi ortalaması, 24,31'dir (ss:13,64). %89,90'ı (98 kişi) evli, %67,90'ı (74 kişi) üniversite mezunu ve %73,40'ının (80 kişi) eşi çalışmaktadır. Çocuk sayısı ortalaması ise 2,07'dir.

3.2. Çalışmada Kullanılan Ölçekler, Veri Analiz Yöntemleri ve Ölçek İzinleri

Anket formunda, meslek mensuplarına demografik bilgilerini öğrenmeye yönelik kişisel ve mesleğine ilişkin bilgileri içeren dokuz adet soru sorulmuştur.

Meslek mensuplarının aşırı iş yükü algılamalarının ölçümünde Peterson, Smith, Akande ve Ayestaran'ın (1995) geliştirmiş oldukları, Derya'nın (2008) Türkçe'ye uyarladığı 11 adet sorudan oluşan "Aşırı İş Yükü Ölçeği"nden yararlanılmıştır. Ölçek tek boyutludur. Ölçek ifadelerine örnek olarak, "İşlerimi yetiştirebilmek için özel hayatımdan fedakârlık yapmam gerekiyor" verilebilir. Ölçekte yer alan bir madde ters kodlanmıştır (İşlerimi rahat ve zamanında yetiştirebiliyorum). Ölçeğin uyarlamasının yapıldığı çalışmada, Cronbach Alpha güvenirlik katsayısı 0,86 olarak hesaplanmıştır.

Meslek mensuplarının iş-aile çatışması seviyelerinin ölçümünde Netemeyer, Boles ve McMurrian'ın (1996) geliştirmiş oldukları, Apaydın'ın (2004) Türkçe'ye uyarladığı ve Çıngı ve Şantaş'ın (2023) çalışmalarında kullandıkları işten aileye çatışma ve aileden işe çatışma olarak 2 boyut ve 10 adet sorudan oluşan "İş-Aile Çatışması Ölçeği"nden yararlanılmıştır. Ölçek ifadelerine örnek olarak, "İşimin yarattığı gerginlik ve yük nedeniyle aile yaşantımla ilgili yapmak istediğim şeyleri yapamıyorum" verilebilir. Çıngı ve Şantaş'ın (2023) çalışmasında, ölçeğin Cronbach Alpha güvenirlik katsayısı 0,87 olarak hesaplanmıştır.

Meslek mensuplarının iş becerikliliğine ilişkin algılamalarının ölçümünde Slemp ve Vella-Brodrick'in (2013) geliştirmiş olduğu, Kerse'nin (2017) Türkçe'ye uyarladığı çalışmasındaki görev, ilişkisel ve bilişsel beceriklilik olarak 3 boyut ve 19 adet sorudan oluşan "İş Becerikliliği Ölçeği"nden yararlanılmıştır. Ölçek ifadelerine örnek olarak, "Yeteneğime ve ilgi alanıma uygun görevler üstlenmeyi tercih ederim" verilebilir. Kerse'nin (2017) çalışmasında, ölçeğin bütünü için Cronbach Alpha güvenirlik katsayısı 0,91 olarak hesaplanmıştır.

Meslek mensuplarının görev performansı algılamalarının ölçümünde ise Goodman ve Svyantek'in (1999) geliştirmiş olduğu, Bağcı'nın (2014) çalışmasında kullandığı 9 adet sorudan oluşan "Görev Performansı Ölçeği"nden yararlanılmıştır. Ölçek ifadelerine örnek olarak, "İşimin tüm gerekliliklerini yerine getiririm" verilebilir. Polatcı ve Sobacı'nın (2021) çalışmasında ölçeğin geçerlemesi yapılmıştır. Polatcı ve Sobacı'nın (2021) çalışmasında ölçeğin Cronbach Alpha güvenirlik katsayısı 0,92 hesaplanırken, Bağcı'nın (2014) çalışmasında, 0,88 olarak hesaplanmıştır.

Ölçeklerin tamamında, 5'li likert tipi derecelendirmeden faydalanılmıştır (1: Tamamen Katılmıyorum, 2: Katılmıyorum, 3: Kararsızım, 4: Katılıyorum, 5: Tamamen Katılıyorum). Verilerin analizi SPSS istatistik programında, Process makro uzantısı kullanılarak, regresyon ve korelasyon analizleri kullanılarak yapılmıştır.

Bu araştırmada kullanılan ölçekler için Recep Tayyip Erdoğan Üniversitesi Sosyal ve Beşerî Bilimler Etik Kurulu'ndan 20/03/2024 tarih ve 2024/095 toplantı karar sayısı ile izin alınmıştır.

4. Bulgular

4.1. Ölçeklerin Geçerlilik ve Güvenilirlik Sonuçları

Doğrulayıcı faktör analizi (DFA) yapılarak ölçeklerin geçerlilikleri, Cronbach Alpha katsayıları, hesaplanan ortalama varyans (AVE) ve bileşik güvenirlik (CR) hesaplanarak ölçeklerin güvenilirlikleri test edilmiştir. Faktör analizi için eldeki verilerin yeterli olup olmadığının kararı, KMO değerlerinin asgari değer olan 0,50'ye göre verilmektedir (Field, 2000). Hesaplanan KMO değerleri asgari değerin üzerindedir. Bununla birlikte değişkenlerin faktör yükleri, 0,50 olan asgari değeri karşılamıştır. Hesaplanan AVE (≥0,50) ve CR (≥0,70) değerleri de asgari değerlerin üzerinde gerçekleşmiştir. Cronbach Alpha

katsayının 0,60 ile 0,80 arasında olmasının "oldukça güvenilir" ve 0,80 ile 1,00 arasında olmasının ise "yüksek güvenilir" şeklinde olduğu ifade edilerek (Yıldız ve Uzunsakal, 2018:20), değişkenlerin hesaplanan güvenirlik değerleri bu kriteri de sağlamıştır. Ayrışma geçerliliğinde ise değişkenlerin AVE değerinin karekökünün değişken çiftleri arasındaki korelasyonlardan yüksek olması gerekmektedir (Fornell & Lacker, 1981: 45-46; Hair et al., 2010: 686-688). Tablo 1'de parantezde yer alan değerler de ayrışma geçerliliğine dair değerlerdir. Aşırı iş yükü ölçeği için hesaplanan 0,884 KMO değeri (Bartlett sınama testi, yaklaşık ki-kare değeri: 580,563; serbestlik derecesi: 55; anlamlılık düzeyi: 0,000), iş-aile çatışması ölçeği için hesaplanan 0,894 KMO değeri (Bartlett sınama testi, yaklaşık ki-kare değeri: 898,572; serbestlik derecesi: 45; anlamlılık düzeyi: 0,000), iş becerikliliği ölçeği için hesaplanan 0,737 KMO değeri (Bartlett sınama testi, yaklaşık ki-kare değeri: 294,760; serbestlik derecesi: 45; anlamlılık düzeyi: 0,000) ve görev performansı ölçeği için hesaplanan 0,848 KMO değeri (Bartlett sınama testi, yaklaşık ki-kare değeri: 507,267; serbestlik derecesi: 28; anlamlılık düzeyi: 0,000) eşik değeri geçmesi nedeniyle ölçeklerin faktör analizi yapılmıştır.

Aşırı iş yükü ölçeği, ilgili yazında yapılan bazı çalışmalarda (Çiftçi, 2022; Tayfur & Arslan, 2012; Derya, 2008) tek boyutlu, bazı çalışmalarda (Bozdoğan & Aslan, 2020; Bir vd., 2021) iki alt boyutlu olarak ele alınmıştır. Bu çalışmada, iki boyutlu olarak yetersizlik duygusu ve aşırı çalışma şeklinde kullanılmıştır. On bir ifadenin üçü yetersizlik duygusu, sekizi ise aşırı çalışma boyutu ile ilgilidir. Aşırı iş yükü ölçeğinin DFA neticesinde yetersizlik duygusu alt boyutunun faktör yükleri 0,693 ile 0,835 arasında, AVE değeri 0,574 ve CR değeri 0,674 (hesaplanan CR değeri eşik değer olan 0,70'e yakın olması nedeniyle kabul edilmiştir) olarak hesaplanmıştır. Cronbach Alpha güvenirlik değeri ise 0,637'dir. Boyutun üç ifadesi toplam varyansın % 18,85'ini açıklamıştır. Aşırı çalışma boyutunun faktör yükleri 0,669 ile 0,857 arasında, AVE değeri 0,620 ve CR değeri 0,910 olarak hesaplanmıştır. Cronbach Alpha güvenirlik değeri ise 0,897'dir. Boyutun sekiz ifadesi toplam varyansın % 41,24'ünü açıklamıştır.

İş-aile çatışması ölçeğinin DFA neticesinde işten aileye çatışma alt boyutunun faktör yükleri 0,915 ile 0,930 arasında, AVE değeri 0,853 ve CR değeri 0,944 olarak hesaplanmıştır. Cronbach Alpha güvenirlik değeri ise 0,943'tür. Boyutun beş ifadesi toplam varyansın %45,18'ini açıklamıştır. Aileden işe çatışma alt boyutunun faktör yükleri 0,790 ile 0,871 arasında, AVE değeri 0,715 ve CR değeri 0,917 olarak hesaplanmıştır. Cronbach Alpha güvenirlik değeri ise 0,901'dir. Boyutun beş ifadesi toplam varyansın %34,82'sini açıklamıştır.

İş becerikliliği ölçeğinin DFA neticesinde görev becerikliliği alt boyutunun faktör yükleri 0,641 ile 0,799 arasında, AVE değeri 0,501 ve CR değeri 0,706 olarak hesaplanmıştır. Cronbach Alpha güvenirlik değeri ise 0,675'tir. Boyutun üç ifadesi toplam varyansın %17,32'sini açıklamıştır. Bilişsel beceriklilik boyutunun faktör yükleri 0,769 ile 0,843 arasında, AVE değeri 0,636 ve CR değeri 0,834 olarak hesaplanmıştır. Cronbach Alpha güvenirlik değeri ise 0,811'dir. Boyutun üç ifadesi toplam varyansın %21,63'ünü açıklamıştır. İlişkisel beceriklilik boyutunun faktör yükleri 0,684 ile 0,749 arasında, AVE

değeri 0,530 ve CR değeri 0,779 olarak hesaplanmıştır. Cronbach Alpha güvenirlik değeri ise 0,778'dir. Boyutun dört ifadesi toplam varyansın %23,04'ünü açıklamıştır.Görev performansı ölçeğinin DFA neticesinde faktör yükleri 0,680 ile 0,842 arasında, AVE değeri 0,592 ve CR değeri 0,904 olarak hesaplanmıştır. Cronbach Alpha güvenirlik değeri ise 0,898'dir. Ölçeğin sekiz ifadesi toplam varyansın %59,25'ini açıklamıştır.

Basıklık (kurtosis) ve çarpıklık (skewness) değerleri hesaplanarak verilerin normal bir dağılıma sahip olup olmadıkları tespit edilmiştir. İlgili yazında söz konusu değerlerin, -1.5 ile +1.5 olmasının gerekliliği söylenmesine rağmen, -2,00 ile +2,00 arasında olması halinde de normal dağılım için kabul edilebileceği belirtilmektedir (Yazıcı ve Akyol, 2021:95). Bu çalışmada, değişkenlerin basıklık değerleri en az -1,067, en çok 1,598; çarpıklık değerleri en az -0,984, en çok 0,720 olup, verileri normal dağılım gösterdikleri söylenebilir. Yapılan analizlerin tümü değerlendirildiğinde, ölçekler geçerlilik ve güvenirlik kriterlerini yerine getirmiştir.

4.2. Hipotez Testleri

Korelasyon analizi sonuçlarına bakıldığında (Tablo 1); mükellef sayısı ile aşırı iş yükünün boyutlarından hem yetersizlik duygusunun (r=0,234, p<0,05) hem de aşırı çalışmanın (r=0,293, p<0,01) pozitif ve anlamlı bir ilişkisi vardır. Yetersizlik duygusunun görev performansıyla (r=-0,267, p<0,01) negatif ve anlamlı bir ilişkisi vardır. Yetersizlik duygusunun hem işten aileye çatışma (r=0,474, p<0,01) hem de aileden işe çatışmayla (r=0,423, p<0,01) arasında pozitif ve anlamlı bir ilişkisi vardır. Yetersizlik duygusu ile iş becerikliliğinin ilişkisel beceriklilik boyutu (r=-0,310, p<0,01) arasında negatif ve anlamlı bir ilişki vardır. Aşırı iş yükünün boyutlarından aşırı çalışma ile hem işten aileye çatışma (r=0,741, p<0,01) hem de aileden işe çatışma (r=0,357, p<0,01) arasında pozitif ve anlamlı bir ilişki vardır. İş becerikliliğinin boyutlarından görev becerikliliği (r=0,214, p<0,05), bilişsel beceriklilik (r=0,463, p<0,01) ve ilişkisel beceriklilik (r=0,703, p<0,01) ile görev performansı arasında pozitif ve anlamlı bir ilişki vardır. Çalışmada, meslek mensuplarının demografik özellikleri ile değişkenler arasındaki ilişkiler analizlere katılmamıştır.

Tablo: 1
Korelasyon, Ortalama, Standart Sapma ve Ayrışma Geçerliliği Değerleri

Değişkenler	1	2	3	4	5	6	7	8	9
(1) Mükellef Sayısı	-								
(2) Yetersizlik Duygusu	0,234*	(0,757)							
(3) Aşırı Çalışma	0,293**	0,545**	(0,787)						
(4) İşten Aileye Çatışma	0,154	0,474**	0,741**	(0,924)					
(5) Aileden İşe Çatışma	-0,041	0,423**	0,357**	0,545**	(0,845)				
(6) Görev Becerikliliği	0,055	-0,098	-0,046	0,050	0,151	(0,736)			
(7) Bilişsel Beceriklilik	-0,003	-0,125	-0,070	-0,099	0,073	0,201*	(0,797)		
(8) İlişkisel Becerikliliği	0,070	-0,310**	-0,070	-0,012	-0,076	0,351**	0,379**	(0,728)	
(9) Görev Performansı	0,088	-0,267**	-0,071	-0,027	-0,047	0,214*	0,463**	0,703**	(0,769)
Ort.	98,79	2,48	3,49	3,32	2,46	3,43	4,07	4,11	4,22
Ss.	62,53	0,92	0,89	1,13	0,94	0,79	0,72	0,54	0,56

N=109, *p < 0,050, **p < 0,010.

Hipotez testlerine geçmeden önce, bağımlı değişken dışındaki tüm değişkenlerin arasında çoklu bağlantı (multicollinearity) probleminin var olup olmadığının kontrolüne

gerek vardır. Bu konuda, hesaplanan VIF (varyans büyütme faktörü) değerlerinin 10'dan küçük olması istenmektedir. Ayrıca veriler arasında otokorelasyonun var olup olmadığının kontrolü gerekmekte, bu konuda Durbin-Watson değerlerinin hesaplanması ve bulunan değerin 1,50-2,50 arasında olması gerekmektedir (Uslu ve Aktaş, 2017). Dolayısıyla Tablo 2 ve Tablo 4'teki değerlerden VIF ve Durbin-Watson değerlerinin beklenen referans aralıklarında olduğu görülmektedir.

Aşırı iş yükünün görev performansına etkisinin incelendiği Tablo 2'deki modelin, istatistiki açıdan anlamlılığı görülmüş (R^2=0,079; F=4,546; p=0,013); sadece yetersizlik duygusu boyutunun görev performansına etkisi negatif biçiminde ortaya çıkmıştır (β=-0,198; t=-2,917; p=0,004). Dolayısıyla alt hipotezlerden H1a desteklenirken, H1b desteklenmemiş (β=0,066; t=0,950; p=0,950) olup; H1 hipotezi kısmen desteklenmiştir.

Tablo: 2
Aşırı İş Yükünün Görev Performansına Etkisi

Model	β	t	p	% 95 Güven Aralıkları		VIF
				Alt Sınır	Üst Sınır	
Yetersizlik Duygusu	-0,198	-2,917	0,004	-0,332	-0,063	1,423
Aşırı Çalışma	0,066	0,950	0,344	-0,072	0,205	1,423
Modelin F İstatistiği (p-değeri) 4,546			(0,013)			
R-Kare			0,079			
Düzeltilmiş R-Kare			0,062			
Bağımlı Değişken: Görev Performansı						

Durbin-Watson=2,005.

Aşırı iş yükünün (yetersizlik duygusu), iş-aile çatışmasının aracılığında görev performansına etkisi Hayes'in (2012, 2013) oluşturduğu SPSS Process makrosu kullanılarak test edilmiştir. Aracılık rolünde Baron ve Kenny (1986) süreci takip edilmiştir. Buna göre, a) bağımsız değişkenin (yetersizlik duygusu) aracı değişkene (işten aileye çatışma ile aileden işe çatışma) etkisinde, b) aracı değişkenin (işten aileye çatışma ile aileden işe çatışma) bağımlı değişkene (görev performansına) etkisinde ve c) bağımsız değişkenin (yetersizlik duygusu) bağımlı değişkene (görev performansına) etkisinde anlamlılığa gerek vardır. Hem bağımsız hem de aracının beraber bağımlı değişkene etkisi incelendiğinde ise ya bağımsızın etkisinde bir düşüş ya da etkisinde bir sıfırlanma olması halinde, aracılık rolünün ortaya çıktığı ifade edilebilecektir.

Tablo 3'teki Process makrosu ile yapılan aracılık analizinde, aşırı iş yükünün boyutlarından yetersizlik duygusunun görev performansını (β=-0,163; p<0,05) negatif ve istatistiki olarak anlamlı bir şekilde etkilediği ortaya çıkmıştır (c yolu). Bununla birlikte, yetersizlik duygusunun işten aileye çatışmayı (β=0,579; p<0,05) pozitif ve istatistiki olarak anlamlı bir şekilde etkilediği görülmüştür (a yolu). Ancak aracı değişken işten aileye çatışmanın bağımlı değişken görev performansına (β=0,064; p>0,05) anlamlı bir etkisi istatistiki olarak ortaya çıkmamıştır (b yolu). Ayrıca yetersizlik duygusunun görev performansına işten aileye çatışma üzerinden etkisi (X→Y dolaylı etki) bootstrap güven aralığının alt ve üst sınırlarının (-0,022-(0,105)) sıfırın (0) aynı yönünde olması ile karar verildiği için (bu çalışmada sıfır değerini içermektedir), istatistiki açıdan işten aileye

çatışmanın aracılık etkisi ortaya çıkmamıştır. Dolayısıyla aracılık test işlemlerine dair süreç tam olarak ortaya çıkmamış, H2a1 alt hipotezi desteklenmemiştir.

Tablo: 3
Aşırı İş Yükünün (Yetersizlik Duygusu) Görev Performansına Etkisinde İş-Aile Çatışmanın Aracılık Rolü

a yolu (X→M1)		b yolu (M1→Y)		c yolu (X→Y Toplam Etki*)		c' yolu (X→Y Doğrudan Etki)		(X→Y) Dolaylı Etki)	
β	(LLCI-ULCI)	β	(LLCI-ULCI)	β	(LLCI-ULCI)	β	(LLCI-ULC)	β	BootLLCI-BootULCI
0,579	(0,373-0,786) p=0,000	0,064	(-0,041-(0,168)) p=0,228	-0,163	(-0,275-(-0,050)) p=0,005	-0,200	(-0,327-(-0,072)) p=0,002	0,037	(-0,022-(0,105)
a yolu (X→M2)		b yolu (M2→Y)		c yolu (X→Y Toplam Etki*)		c' yolu (X→Y Doğrudan Etki)		(X→Y Dolaylı Etki)	
β	(LLCI-ULCI)	β	(LLCI-ULCI)	β	(LLCI-ULCI)	β	(LLCI-ULC)	β	BootLLCI-BootULCI
0,430	(0,254-0,607) p=0,000	0,048	(-0,075-(0,1170)) p=0,441	-0,163	(-0,275-(-0,050)) p=0,005	-0,183	(-0,308-(-0,059)) p=0,004	0,021	(-0,040-(0,077)

*Bağımsız Değişken: Yetersizlik Duygusu (X), Bağımlı Değişken: Görev Performansı (Y), Aracı Değişken: İşten Aileye Çatışma (M1), Aileden İşe Çatışma (M2). *Toplam etkiye (c yolu) ait değerler, Process Model 4 kullanılarak hesaplanmıştır.*

Aileden işe çatışmanın aracılık rolüne ilişkin ortaya çıkan sonuçların Tablo 3'te görüleceği gibi, yine c yolu anlamlıdır. Ayrıca, yetersizlik duygusunun aileden işe çatışmayı (β=0,430; p<0,05) pozitif ve istatistiki olarak anlamlı bir şekilde etkilediği görülmüştür (a yolu). Ancak, aracı değişken aileden işe çatışmanın bağımlı değişken görev performansına (β= 0,048; p>0,05) anlamlı bir etkisi istatistiki olarak ortaya çıkmamıştır (b yolu). Yetersizlik duygusunun görev performansına aileden işe çatışma üzerinden etkisi (X→Y dolaylı etki) bootstrap güven aralığının alt ve üst sınırları ((-0,040-(0,077)) sıfır değerini içermesi nedeniyle istatistiki açıdan aileden işe çatışmanın aracılık etkisi ortaya çıkmamıştır. Dolayısıyla aracılık test işlemlerine dair süreç bu kısımda da tam olarak ortaya çıkmamış, H2a2 alt hipotezi desteklenmemiştir.

Tablo 2'de, aşırı iş yükünün aşırı çalışma boyutunun görev performansına etkisinin (β=0,066; t=0,950; p=0,950) istatistiki olarak anlamlı çıkmaması ve başka bir deyişle, Baron ve Kenny'nin (1986) de aracılık test koşullarını sağlamaması nedeniyle, bu etkide ne işten aileye çatışmanın ne de aileden işe çatışmanın aracılık rolüne bakılmamıştır. Dolayısıyla H2b1 ve H2b2 alt hipotezleri de desteklenmediği için iş-aile çatışmasının aracılık rolünün olabileceğine dair öne sürülen H2 temel hipotezi desteklenmemiştir. İş-aile çatışmasının aracılık rolüne dair istatistiki olarak bir sonuca ulaşılamamıştır.

Aşırı iş yükünün, iş becerikliliğinin düzenleyicilik rolünde görev performansına etkisi, SPSS Process makrosu kullanılarak ile test edilmiştir.

Tablo 4'teki, iş becerikliliğinin düzenleyicilik rolünün incelendiği regresyon modeli-1 (R^2=0,109; F=4,301; p=0,00), modeli-2 (R^2=0,299; F=14,939; p=0,000) ve modeli-3 (R^2=0,500; F=35,057; p=0,000) istatistiki olarak anlamlıdır. Ancak sadece model-2'de, bilişsel becerikliliğin (β=0,218; p<0,05), yetersizlik duygusunun görev performansına etkisinde düzenleyicilik etkisinin istatistiki olarak anlamlı olduğu ortaya çıkmış (β=0,105;

p<0,05); H3a2 alt hipotezi desteklenmiştir. Diğer alt hipotezlere ilişkin destek ise, yapılan analizlerde istatistiki olarak ortaya çıkmamıştır (H3a1, H3a3, H3b1, H3b2, H3b3). Dolayısıyla H3 hipotezi kısmen desteklenmiştir.

Tablo: 4
Aşırı İş Yükünün (Yetersizlik Duygusu) Görev Performansına Etkisinde İş Becerikliliğin Düzenleyicilik Rolü

Değişkenler	Model-1	Model-2	Model-3
Bağımlı Değişken: Görev Performansı			
Regresyon Sabiti	4,220**	4,236**	4,231**
Bağımsız Değişken			
Yetersizlik Duygusu	-0,139**	-0,135**	-0,029
Düzenleyici Değişkenler			
Görev Becerikliliği	0,108*		
Bilişsel Becerilik		0,218**	
İlişkisel Becerilik			0,379**
Etkileşim Değişkenleri			
Yetersizlik Duygusu x Görev Becerikliliği	-0,026		
Yetersizlik Duygusu x Bilişsel Becerilik		0,106*	
Yetersizlik Duygusu x İlişkisel Becerilik			0,029
F	4,301	14,939	35,057
R	0,330	0,546	0,707
R-Kare	0,109	0,299	0,500
p	0,006	0,000	0,364
Etkileşim Sonucunda R-Kare			
R-Karedeki Değişim	0,003	0,041*	0,003
F	0,317	6,122	0,828
p	0,575	0,015	0,364

*p<0,050, **p<0,010, Hesaplamalarda standartlaştırılmamış beta katsayıları kullanılmıştır. Durbin-Watson=1,902.

Bilişsel becerikliliğin düzenleyicilik etkisi, bilişsel becerikklik seviyesi düşük (β=-0,240; p<0,050) ve orta (β=-0,135; p<0,050) olanlarda daha güçlüdür. Söz konusu etki, bilişsel becerikklik seviyesinin yüksek olduğu çalışanlarda, anlamlılığını istatistiki olarak kaybetmektedir (β=-0,110; 029; p>0,050).

Şekil: 2
Bilişsel Becerikliliğin Düzenleyicilik Rolü
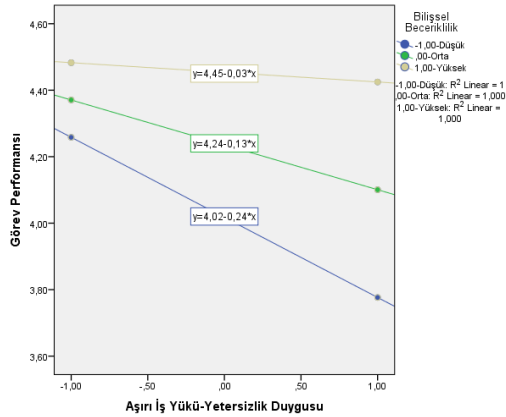
Şekil 2'de bilişsel becerikliliğin düzenleyicilik etkisine bakıldığında, yetersizlik duygusunun görev performansına etkisinin gücü bilişsel becerikliliğin en düşük seviyesinde en güçlü iken, orta düzeye çıkıldığında kısmen zayıfladığı görülmektedir.

5. Sonuç ve Tartışma

Aşırı iş yükü, tüm sektörlerin önemli bir sorunu olarak görülmektedir. Bu sorun hem çalışanlar (örn., iş-aile çatışmasında, tükenmişlikte, stres ve kaygıda, işten ayrılma niyetinde, sinizm tutumunda artışlar ile çalışmaya tutkunluk ve performansta azalışlar) hem de örgütler (çalışanların yaşadıkları bu sorunlar yüzünden performanslarında ve dolayısıyla verimliliklerinde azalış) açısından çeşitli olumsuz sonuçları doğurabilmektedir. Dolayısıyla aşırı yükünün olumsuz sonuçlara hangi faktörlerin varlığında neden olduğunun ve hangi faktörlerin varlığında olumsuz sonuçların tamponlanabileceğinin/azaltılabileceğinin araştırılması önem kazanmaktadır. Bu çalışmada, aşırı iş yükünün yoğun olarak tecrübe edildiği meslek gruplarından muhasebe meslek mensupları ele alınmış ve öncelikle sorunun varlığı, sonrasında sonuçlara etkisi, sonuçlara nasıl yol açabileceği ve etkisinin nasıl azaltılabileceği ele alınmıştır. Araştırmanın amacını gerçekleştirmek amacıyla ileri sürülen hipotezlerin test edilmesinde kullanılacak veriler Rize ilindeki SMMM'lerden toplanmıştır. Toplanan verilere çeşitli analizler uygulanarak, aşırı iş yükünün, iş-aile çatışmasının aracılığında ve iş becerikliliğinin düzenleyiciliğinde görev performansına etkisi incelenmiştir.

Meslek mensuplarının aşırı iş yükü ölçeğindeki ifadelere katılım derecelerine bakıldığında, yetersizlik duygusu boyutu algılamasının orta derecede, aşırı çalışma boyutu algılamasının ise kısmen daha yüksek olduğu ortaya çıkmıştır. Meslek mensupların aşırı çalışma içerisinde oldukları rahatlıkla söylenebilir (Tablo 1). Meslek mensuplarının, iş-aile çatışması ölçeğindeki ifadelere katılım derecelerine bakıldığında ise, daha çok işten aileye çatışma algılaması (daha az aileden işe çatılma) içerisinde oldukları, başka bir ifadeyle işinden kaynaklı pek çok sorunu ailesine yansıttığı belirtilebilir. Bununla birlikte, iş becerikliliği, muhasebe meslek mensupları açısından önemli bir özellik olarak ortaya çıkmıştır. Meslek mensuplarının iş becerikliliği ölçeğindeki ifadelere katılım derecelerine bakıldığında, her üç beceriklilik boyutlarında ortalamanın üzerinde, özellikle bilişsel ve ilişkisel boyutlarında algılamalarının yüksek olduğu ifade edilebilir.

Yapılan analizler neticesinde, aşırı iş yükünün sadece yetersizlik duygusu boyutunun görev performansına etkisi istatistiki açıdan anlamlı çıkmış, etkisi negatif şeklinde tespit edilmiştir. Meslek mensuplarının işine dair yetersizlik duygusu hissetmeleri, başka bir ifadeyle işin taleplerinin (beceri seviyesi, iş yükü miktarı, sorumluluk düzeyi gibi) yapabileceklerinden daha fazla olduğuna ilişkin görevin altından kalkamayacakları algısı görev performanslarında azalmayı beraberinde getirmiştir. Bu sonuç yazındaki, Korkmazer'in (2021) iş yükü fazlalığı ile çalışan performansı arasında negatif bir ilişki olduğuna dair çalışmasındaki sonuç ile uyumludur. Korkmazer de çalışmasında, aşırı iş yükü ile ortaya çıkabilecek kaygı halinin performans üzerinde etkili olabileceğini ifade etmiştir. Zhang ve diğerlerinin (2022) aşırı rol yüklemesinin görev performansını azalttığına, Anam

ve diğerlerinin (2022) iş yükü fazlalığı ile çalışan performansı arasındaki ilişkinin negatif olduğuna ilişkin çalışma sonuçları ile de uyumluluk söz konusudur. Yazında bu çalışma sonuçlarından farklı olarak iş yükü ile performans arasında pozitif ilişkinin olduğuna dair çalışma sonuçları mevcuttur (Töngür, 2016). Ancak, hipotez ileri sürülürken gerekçelerle birlikte etkinin negatif olabileceği ifade edilmişti. Dolayısıyla ilgili hipotez desteklenmiştir. İlgili yazındaki aşırı iş yükünün performansa hem olumlu hem olumsuz etkileri düşünüldüğünde, ulaşılan sonuç önemlidir. Aşırı iş yükü performansı azaltan bir faktör olarak ortaya çıkarak, benzer sonuçlara nicelik olarak destek sağlamıştır. Ayrıca yazına teorik katkısı yanında pratik açısından katkısı söz konusudur. İnsan kaynakları yöneticilerinin, çalışanların üstesinden gelebilecekleri ve özelliklerine uygun iş yüklerini belirlemeleri gerekmektedir. Bununla birlikte iş yükü miktarının performans artışı sağlayabilecek seviyede olmasına özen göstermeleri, çalışanların iyi oluş seviyelerini artırarak örgüt açısından yararlı sonuçları beraberinde getirecektir.

İlgili yazında, aşırı iş yükünün iş-aile çatışmasının aracılığında tükenmeye, yaşam kalitesi algılamasına etkileri olduğuna dair çalışma sonuçları mevcuttur (Korkmazer & Aksoy, 2020; Tayfur & Arslan, 2012). İş yükünün, iş-aile çatışmasının aracılığında çalışmaya tutkunluk üzerinde etkisinin olduğu tespit edilmiştir (Turgut, 2019). Artan iş yükü ile işten ayrılma niyeti arasındaki pozitif ilişkide, iş-aile çatışmasının aracılığı ortaya çıkmıştır (Ganewatta & Hiroshima, 2023). Ayrıca, aşırı iş yükünün ortaya çıkardığı aşırı çalışma saatleri, aşırı sorumluluk ve özel hayattan fedakârlık gereği gibi artan iş talepleri olumsuz stresi ve kaygıyı artırabilmekte, bu durum meslek mensubunun ailesine zaman ayıramamasına ya da daha az ayırmasına, ailesinin beklediği rol gereklerini yerine getirememesine yol açabilmektedir. Dolayısıyla aile ve rol gereklerinin uyumsuzluğu, çatışması meslek mensuplarının görev performansı algılamalarını olumsuz etkileyebilmektedir. Bu çalışmada, iş-aile çatışmasının aracılık rolüne ilişkin beklentinin aksine bir sonuç ortaya çıkmıştır. Şöyle ki, aracılık test işlemlerinde takip edilen Baron ve Kenny'nin (1986) prosedürü bütünüyle ortaya çıkmamıştır. Yetersizlik duygusunun işten aileye çatışmaya etkisi (bağımsız ile aracı değişken ilişkisi) ile yetersizlik duygusunun görev performansına negatif etkisinin (bağımsız ile bağımlı değişken ilişkisi) anlamlı olmasına rağmen, işten aileye çatışma ile görev performansı ilişkinin (aracı ile bağımsız değişken ilişkisi) negatif yönlü görünmesi (Tablo 1) ancak istatistiki olarak anlamlı olmaması nedeniyle aracılık rolüne ilişkin beklenti karşılanmamıştır. Bu sonuç, iş-aile çatışmasının aracılığının olmadığı şeklinde yorumlanmamalıdır. Başka örneklem ve ölçeklerin kullanılması halinde aracılık rolü ortaya çıkabilir.

Çalışmadaki düzenleyicilik etkisine bakıldığında ise bilişsel becerikliliğin, aşırı iş yükünün yetersizlik duygusu boyutu ile görev performansı arasındaki ilişkide önemli bir düzenleyicilik rolü oynadığı görülmüştür. Düşük bilişsel beceriklilik seviyesine sahip meslek mensuplarında, yetersizlik duygusunun görev performansına negatif etkisinin daha güçlü olduğu, bilişsel beceriklilik seviyesi orta düzeylere doğru çıktıkça bu etkinin zayıfladığı tespit edilmiştir. Bu bakımdan iş becerikliliğin hem ilgili yazın hem de insan kaynakları yöneticileri açısından önemli sonuçları ortaya çıkmıştır. Ayrıca ulaşılan bu sonucun daha büyük örneklemlerde ve farklı değişkenlerin ilişkisinde tekrar edilmesi, iş

becerikliliğin düzenleyicilik rolünün açıklanabilmesini kolaylaştıracaktır. Bu bakımdan elde edilen sonuç, yeni çalışmalara başlangıç olarak değerlendirilebilir. Bireysel bir özellik olarak iş becerikliliğin, aşırı iş yükünün görev performansına olumsuz etkisinin azaltılmasında önemli engelleyici olabileceğinin ortaya konulmuş olması yeni ve özgün bir sonuçtur. Çünkü yazın taraması yapılabildiği kadarıyla, iş becerikliliğinin söz konusu değişkenler arasında düzenleyicilik rolüne dair sınırlı sayıda çalışmaya rastlanmıştır. Delice'nin (2019) çalışmasında, düzenleyicilik rolüne ilişkin istatistiki olarak bir sonuca ulaşılamamıştır. Dolayısıyla düzenleyicilik rolü, başka çalışmalarda olumsuz etkilerin azaltılmasında ya da olumlu etkilerin artırılmasında kullanılabilir.

Ulaşılan sonuç uygulama açısından önemlidir. İş becerikliliği konusunun nasıl uygulanacağı farklı sektörlere ve iş kollarına göre değişecektir. Hizmet, teknoloji, üretim, sağlık, eğitim gibi sektörlerde iş becerikliliğinin uygulanması farklılık gösterecektir. İnsan kaynakları yöneticilerinin kendi örgütlerinin spesifik özelliklerini dikkate almaları yanında, örgüt çalışanlarının beceriklilik seviyelerini artırmak için, ilk olarak, yönetimin iş becerikliliği uygulamalarının yararları ve uygulanması gerektiği düşüncesinde olması elzemdir. Hizmet sektöründe çalışanların inisiyatif kullanmaları, onları eğitim ve gelişim programlarına göndererek bilişsel ve teknik bilgi ve becerilerle donatılmaları sağlanmalıdır. Çalışanlara farklı roller verilerek, esneklik ve çok yönlülük kazandırılabilir. Ayrıca gösterilen performanslarının sonuçlarına ilişkin yöneticilerin geribildirimleri, ödüllendirme ve teşvik programları, yeni becerilerin öğrenilmesi ve mevcutların iyileştirilmesinde yöneticilerin mentörlükleri ve koçlukları çalışanların iş becerikilik özelliklerini güçlendirecektir. Yöneticilerin çalışanlarla güçlü iş birlikleri ve yakın iletişim içerisinde olmaları, örgütün sürekli bir öğrenme kültürüne sahip olması çalışanların bu konudaki algılamalarını güçlendirecektir.

Yapılan çalışmanın tek bir meslek grubunda ve sadece Rize ilinde gerçekleştirilmiş olması önemli bir sınırlandırmadır. Meslek mensupları, anket sorularında kendi kendilerini değerlendirmiş olup, sosyal beğenirlik etkisine bağlı ölçüm sorunları olabilmektedir. Çalışmada sadece anket tekniği kullanılmış ve cevaplar tek bir zaman kesitinde toplanmıştır. Ulaşılan sonuçların genellenmemesi ve sadece çalışmanın yapıldığı il özelinde değerlendirilmesi gerekmektedir. Çalışmanın ulaşılan sonuçları bu kısıtlar içinde değerlendirilmeli ve yorumlanmalıdır. Gelecekte çalışma yapacaklara, bu çalışma tasarımını başka örneklemler özelinde tekrar yapabilecekleri; aşırı iş yükünün, iş becerikliliğinin düzenleyiciliğinde performansın diğer türlerine (bağlamsal, örgütsel vatandaşlık davranışı, çalışan sesliliği gibi) etkilerini inceleyebilecekleri ve boylamsal bir çalışmada ise, çalışanlara çeşitli eğitim ve geliştirme programları uygulanarak farklı zaman dilimlerinde becerikliliğin gelişim seviyesi ve bu seviyelerde aşırı iş yükünün olumsuz etkilerinin seyrini araştırabilecekleri önerilebilir.

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Türkiye'de Ekonomik Politika Belirsizliği ve Vergi Gelirleri Arasındaki İlişki: DOLS, FMOLS ve CCR Zaman Serisi Eşbütünleşme Yaklaşımı

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The Relationship Between Economic Policy Uncertainty and Tax Revenues in Türkiye: DOLS, FMOLS and CCR Time Series Cointegration Approach

Abstract

Tax revenues are considered the most significant source of public income when implementing fiscal policy within a country. Whether positive or negative, changes in tax revenue can lead to various shifts in states' economic, social, and political dynamics, making tax revenues highly critical for governments. On the other hand, taxes, as a significant expenditure for businesses, can be substantially influenced by economic and political factors. Considering these factors, this study examines the relationship between economic policy uncertainty and total tax revenues in Türkiye. The relationship between uncertainty and tax revenues was tested using Johansen Cointegration, Dynamic Ordinary Least Squares (DOLS), Fully Modified Ordinary Least Squares (FMOLS), and Canonical Cointegrating Regression (CCR) statistical model analyses. In addition to uncertainty and tax revenue, the econometric model included interest rates, unemployment rates, exchange rates, and industrial production indices as control variables. The analysis utilised quarterly time series data spanning from 2008Q1 to 2023Q4. The Johansen test indicated a long-run cointegration relationship between total tax revenue and political and economic uncertainty in Türkiye. Furthermore, the regression coefficient results derived from DOLS, FMOLS and CCR methods revealed that uncertainty significantly reduces total tax revenues. In conclusion, the study found that economic policy uncertainty has a negative impact on tax revenues due to the adverse effects it creates within the economic system.

Keywords : Economic Political Uncertainty, Tax Revenues, DOLS, FMOLS, CCR.

JEL Classification Codes : D89, M21, M40, H26.

Öz

Vergi gelirleri bir ülkede maliye politikalarının yürütülmesinde, kamu gelirleri içerisinde en önemli gelir kaynağı olarak gösterilmektedir. Vergi gelirlerinin pozitif ya da negatif yönde değişimi devletlerin ekonomik, sosyal, siyasi konjonktürlerinde farklı değişimler meydana getirebileceğinden vergi gelirleri devletler için büyük önem arz etmektedir. Öte yandan işletmeler açısından da önemli harcama kaynaklarından biri olan vergi, ekonomik ve politik etkenlerden önemli ölçüde etkilenebilmektedir. Bu etkenler dikkate alınarak yapılan bu çalışmada, Türkiye'de ekonomik politika

belirsizliği ile toplam vergi gelirleri arasındaki ilişki araştırılmıştır. Belirsizlik ile vergi gelirleri arasındaki ilişki Johansen eşbütünleşme, DOLS, FMOLS ve CCR istatistiksel model analizleri ile test edilmiştir. Belirsizlik ve vergi gelirlerinin yanı sıra, oluşturulan ekonometrik modelde faiz, işsizlik oranı, döviz kuru ve sanayi üretim endeksi kontrol değişkeni olarak kullanılmıştır. Yapılan analizlerde değişkenlerin 2008Q1-2023Q4 dönemine ait çeyreklik zaman serisi verileri kullanılmıştır. Johansen testinde Türkiye'de toplam vergi gelirleri ile politik ve ekonomik belirsizlik arasında uzun dönemli bir eşbütünleşmenin olduğu ve DOLS, FMOLS ile CCR yöntemlerinden elde edilen regresyon katsayı sonuçlarında belirsizliğin toplam vergi gelirleri üzerinde önemli düzeyde azaltıcı bir etkiye sahip olduğu görülmüştür. Sonuç olarak, ekonomik politika belirsizliğinin, ekonomik sistemde oluşturduğu negatif etkiye bağlı olarak vergi gelirlerini azalttığı tespit edilmiştir.

Anahtar Sözcükler : Ekonomik Politika Belirsizliği, Vergi Gelirleri, DOLS, FMOLS, CCR.

1. Giriş

Salgınlar, finansal krizler, savaşlar ve geniş çaplı sonuçları olan siyasi kararların ekonomi politikalarında büyük etkileri olmakla birlikte bu gibi faktörler aynı zamanda ekonomik politika belirsizliğine de yol açabilmektedir. Bu ekonomik politika belirsizliği refah dönemlerinde azalmaktayken, durgunluk ve kriz dönemlerinde artmaktadır (Baker et al., 2016; Baker et al., 2022; Ahir et al., 2022; Güçeri & Albinowski, 2021). Dolayısıyla ekonomik politika belirsizliği, gelecekteki hükümet politikaları ve düzenlemeler ile ilişkili ekonomik riski ifade etmektedir. Bu risk, bir piyasada oluşan belirsizlik algısıyla ticaret politikalarını ve buna bağlı olarak hem bireylerin hem de firmaların harcama ve yatırım davranışlarını etkilemektedir. Bu harcama ve yatırımlara ilişkin kararlar alınırken, bir erteleme yoluna gidilebilmekteyken aynı zamanda harcamaların azaltılması için de birtakım kararlar alınabilmektedir (Al-Thaqeb & Algharabali, 2019: 2; Van Bergeijk, 2019: 95). Bu açıdan ekonomik politika belirsizliğinin çok yönlü etkileri bulunmaktadır. Örneğin belirsizlik, gelecek dönemlere ilişkin nakit akışlarına yönelik riskleri arttırmakta, bu da hisse senedi fiyatlarını olumsuz etkilemektedir. Bu durum aynı zamanda hisse senedine yönelik bilgi kalitesinin düşmesine, dolayısıyla da bilgi asimetrisinin artmasına ve piyasa etkinliğinden uzaklaşılmasına neden olmaktadır (Drobetz et al., 2018: 30-31; Sadeghzadeh-Emsen & Aksu, 2020).

Bu nedenle belirsizliğin piyasaya yönelik oldukça geniş etkileri bulunmaktadır. Bu etkiler aynı zamanda kamu kesimine de hem doğrudan hem de dolaylı olarak yansımaktadır. Bunlara, çevre sorunları (Wen & Zhang, 2022), hisse senetleri, döviz kurları ve faiz oranları (Arbatli et al., 2022), sermaye maliyeti ve yatırımlar (Gulen & Ion, 2016; Drobez et al., 2018; Chen et al., 2020; Kang et al., 2014), konut fiyatları (El-Montasser, 2020), şirket birleşmeleri ve satın almalar (Bonaima et al., 2018), kamu harcamaları ve büyüme (Jerow & Wolff, 2022; Darby et al., 2004), yolsuzluk (Afzali et al., 2021), sıcak para hareketleri (Bulut & Yılmaz, 2022) ve hisse senedi fiyatı oynaklığı (Baker, 2016) örnek olarak gösterilebilir.

Bu noktada ekonomik politika belirsizliğinin, teorik boyuttan çıkarılarak bir ölçüt olarak ortaya konulması Baker vd. (2016) tarafından yapılan çalışma ile mümkün olmuştur. Bu çalışma, araştırmacıların bu konu üzerine artan bir ilgiyle yaklaşmalarını sağlamıştır. Çalışmada belirlenen politik belirsizlik endeksi (Economic Policy Uncertainty-EPU), ilk olarak Amerika Birleşik Devletleri (ABD)'nde kullanılmıştır. O dönemin gazetelerinde yer alan ekonomik (veya ekonomi), belirsizlik (veya belirsiz), kongre, bütçe açığı, federal rezerv, mevzuat, yönetmelik ve Beyaz Saray ifadelerinin üç kategoriye (ekonomi, politika ve belirsizlik) ayrılması ile değişkenler oluşturulmuştur. Endeks, bu ifadelerin kullanım sıklığına göre tasarlanmıştır. Daha sonrasında ise bu endeks birçok gelişmiş ve gelişmekte olan başka ülkelere de uyarlanmıştır. Türkiye'nin aralarında bulunduğu ve bu endekste yer almayan ülkelere ilişkin bir belirsizlik endeksi ise Baker vd. (2016) çalışmasından yola çıkılarak Ahir vd. (2022) tarafından oluşturulmuştur.

Öte yandan ekonomik politika belirsizliğinin firmaların vergi davranışları üzerinde de etkili olduğu birçok çalışmada (Nguyen & Nguyen, 2020; Shen et al., 2021; Benkraiem et al., 2022; Clance et al., 2021; Li et al., 2021a; Kang & Wang; 2021; Afzali et al., 2021) ortaya konulmaktadır. Bu çalışmalar değerlendirildiğinde; belirsizliğin vergi davranışları üzerinde çeşitli etkileri gözlenmekteyken, bunlar içerisinde öncelikle gözlemlenen noktalardan biri vergiden kaçınma davranışları olmaktadır. Vergiden kaçınma davranışları, vergi gelirleri açısından oldukça önemli bir yer tutmaktadır. Çünkü vergiden kaçınmadaki artışın birçok ülkede kamu bütçelerini etkileyecek düzeyde olduğu görülmektedir. Vergiden kaçınmadan kaynaklı vergi kaybının uluslararası düzeyde yıllık 500 milyar doların üzerinde olduğu bilinmektedir. Belirsizlik dönemlerinde bunun, toplam vergi payı içerisindeki oranı daha fazla olabilmektedir. Bununla birlikte belirsizlik dönemlerinde kamu otoriteleri, vergi kanunlarının uygulanmasında sıkı önlemleri almaktan imtina edebilmektedirler. Bu durum, firmaları vergiden kaçınma politikalarında daha agresif davranmaya teşvik edebilmektedir (Benkraiem et al., 2022: 1-7).

Vergiden kaçınma ile belirsizlik arasındaki ilişkiye yönelik ampirik kanıtlar sunan Nguyen ve Nguyen (2020) ekonomik politika belirsizliğinin yüksek olduğu dönemlerde, firmaların vergilendirilebilir gelirlerine kıyasla, ödedikleri vergi miktarının düştüğünü öne sürmüşlerdir. Ayrıca çalışmada, vergiden kaçınma için firmaların başvurdukları yöntemlerde artışa işaret edilmektedir. Bu noktada artan belirsizlik, daha fazla finansal kısıtlamaları beraberinde getirirken, bu durum firmaları da vergiden kaçınmaya teşvik etmektedir. Bir diğer çalışmada da Delis vd. (2020) çok uluslu firmaların, vergiye ilişkin belirsizlik ortamlarında, transfer fiyatlandırması ve borç aktarımı gibi mekanizmaları kullanarak, daha az vergi ödeyecekleri yerlere gelirlerini aktardıklarını ortaya koymaktadırlar. Vergiden kaçınmayı, firmaların halka arz kararlarıyla birlikte değerlendiren Lu ve Yang (2023) ise belirsizliğin, halka arz politikalarında etkili olduğunu ve belirsizliğin artmasıyla halka arzların askıya alınması arasında bir ilişki bulunduğunu değerlendirmektedirler. Halka arzlarını askıya alan firmaların daha fazla vergiden kaçınma faaliyetlerinde bulundukları söz konusu çalışmada ortaya konulmaktadır.

Öte yandan politika belirsizliğini etkileyen en önemli faktörlerden birinin, seçimler ve seçimler neticesinde potansiyel hükümet değişikliği olduğu bilinmektedir. Bu noktada, hükümetlerin vergi uygulamalarına ilişkin politikalarında da doğal bir belirsizlik ortaya çıkmaktadır. Firmaların süreçteki beklentileri finansal açıdan bazı tedbirlere olan ihtiyacı doğuracaktır. Buradan hareketle Li vd. (2022a) daha önce bahsedilen çalışmalara uyumlu bir şekilde, seçim dönemlerindeki belirsizlik ortamının firmaların vergiden kaçınma davranışlarını arttırdığını ortaya koymuşlardır. Julio ve Yook (2012) ise bu seçim sonuçlarına ilişkin olarak firmaların beklentilerinin ve politik belirsizliğin, firmaların yatırım kararlarında önemli bir payı olduğuna işaret etmektedirler. Firmaların vergilendirme, para veya başka makroekonomik politikalara yönelik belirsizlik ortamlarına göstereceği tepkilerden biri, yatırımların ertelenmesi olacaktır. Yatırım kararları ve sonuçlarının da vergiye yönelik etkileri de azımsanmayacak bir seviyede bulunmaktadır.

Vergiden kaçınma dışında belirsizliğin, vergi davranışları ve sonuçlarına yönelik başka etkileri de bulunmaktadır. Örneğin Clance vd. (2021) belirsizlik dönemlerinde, hükümetlerin kurumlar vergisi oranını arttırma eğiliminde olduklarını ortaya koymuşlardır. Çünkü ekonominin çeşitli sebeplerle yavaşladığı dönemlerde, vergi gelirleri önemli bir sorun olarak görülürken, bu sorunun önüne geçmek için alınan ilk tedbirlerden biri vergi oranını arttırmaktır. Ancak bu artışlar, aynı zamanda ek bir belirsizlik doğururken, üretim maliyetleri aracılığıyla firma kârlarını ve yeni yatırım kararlarını da etkilemektedir. Benzer şekilde vergi oranlarına odaklanan başka bir çalışmada Li vd. (2022b) COVID-19 salgınının olduğu döneme ilişkin olarak ortaya çıkan belirsizlik ile vergi oranlarındaki artış arasında bir ilişki tespit etmişlerdir. Ancak çalışmada bu artışa karşın gayri safi milli hasılada bir azalışın olduğu ortaya konulmaktadır. Bu sonuçlar Laffer eğrisi etkisinden kaynaklı olabileceği gibi, salgından kaynaklı olarak meydana gelen gelir kaybıyla ilişkili olabileceği de değerlendirilmektedir. Öte yandan belirsizlik dönemlerinde vergi oranlarındaki artışın yatırımlar üzerinde olumsuz etkisi bulunmaktadır. Firmaların alacakları yatırım kararları hem belirsizlik hem de bu dönemlerdeki vergi artışlarından etkilenmektedir. Dolayısıyla bu yatırımlardaki düşüşün vergi ve diğer faktörler üzerinde çeşitli etkileri olacaktır (Alvarez & Koskela, 2007; Azevedo et al., 2021; Güçeri & Albinowski, 2021).

Belirsizliğin vergi yüküne olan etkisini inceleyen bir diğer çalışmada ise Dang vd. (2019) belirsizliğin vergi tahsilatını güçlendirdiğini bu nedenle de hükümetlerin, kurumların vergi yüklerini arttırma yoluna gittiklerini tespit etmişlerdir. Benzer şekilde Kang ve Wang (2021) ekonomik belirsizliğin vergi yükünü arttırdığını belirtmektedirler. Burada vergi yükünün firmalar üzerindeki etkileri kademeli olmaktadır. Kısa vadede efektif vergi oranı artmaktayken, sonrasında politika belirsizliği ve buradan kaynaklı vergi yükünün efektif vergi oranına negatif etkisi belirmektedir.

Belirsizliğin bir başka etkisi, popülizmin artması şeklinde olmaktadır. Belirsizlik dönemlerinde siyasetçilerin popülist eylemleri artarken, seçmenlerin de oy davranışlarında popülizmin etkisi artmaktadır. Popülist siyasetçilerin bu yöndeki eylemleri de vergi politikalarına yönelik ekonomik belirsizliği artırmaktadır (Gözgor, 2021: 240). Bu belirsizlik daha önce ifade edilen vergiden kaçınma davranışlarını arttırmaktayken, vergiye

yönelik hile ve manipülasyonlarda da artışa sebep olmaktadır. Bu durumu destekleyecek şekilde, Afzali vd. (2021) daha az vergi ödemek isteyen özel sektör firmalarının belirsizlik dönemlerinde ödenecek olan vergileri hedef alan hile davranışlarını ortaya koymaktadırlar. Ayrıca çalışmada politik belirsizliğin yüksek olduğu dönemlerde daha fazla rüşvetin ve etkisiz vergi yönetiminin söz konusu olduğuna yönelik sonuçlara işaret edilmektedir. Benzer şekilde Bempei vd. (2021) vergi politikalarına yönelik belirsizliğin daha yüksek olduğu dönemlerde, politik açıdan hassas olan firmaların artan vergilendirmeyle karşılaşmaları halinde, firma kârlarını aşağı doğru manipüle etmeye daha eğilimli olduklarını değerlendirmektedirler.

Bütün bu faktörler neticesinde ekonomik politika belirsizliğinin yüksek olduğu dönemlerde, firmaların vergiden kaçınma ve vergi kaçırma davranışları ile kârlarını düşürmeye yönelik manipülasyonlarının artması, yatırımların azalması, maliyetlerinin artması ve buna bağlı olarak satın alma ve tüketim eğilimlerinin azalabilmesi gibi faktörlerin kamu açısından daha az vergi geliri doğurması doğal bir sonuç olacaktır. Buradan yola çıkarak, bu çalışmada temel olarak Ahir vd. (2018) tarafından hazırlanan ekonomik politika belirsizliğinin vergi gelirleri üzerindeki etkisi incelenmektedir. Türkiye örnekleminin ele alındığı bu çalışma kapsamında yer alan değişkenlerin 2008Q1-2023Q4 aralığındaki çeyreklik (Quarterly-Q) verileri kullanılmıştır. Analizlerde zaman serisi özelliğine sahip DOLS, FMOLS ve CCR'nin çoklu eşbütünleşme regresyon modeli benimsenmiştir. Bu yöntemler kullanılarak yapılan ekonometrik analizlerde Türkiye'ye özgü olarak hesaplanan ekonomik politika belirsizliğinin kamu vergi gelirlerini önemli düzeyde negatif etkilediği görülmüştür.

Çalışma toplamda 4 bölümden oluşmaktadır. İlk bölümü oluşturan giriş kısmında ekonomik politika belirsizliğinin ticari aktivite üzerinde olası etkileri teorik olarak ele alınmıştır. İkinci bölümde alanda yapılan çalışmalardan elde edilen bulgular ve yorumlar kısaca özetlenmiştir. Üçüncü bölümde çalışmada kullanılan ekonometrik analiz yöntemi ve elde edilen bulgulara yer verilmiştir. Son olarak çalışma genel olarak değerlendirilerek elde edilen bulgular doğrultusunda çeşitli politika önerileri sunularak tamamlanmıştır.

2. Literatür İncelemesi

Belirsizlik ve vergi gelirleri ilişkisine yönelik akademik çalışmalar, bu ilişkiyi çeşitli yönlerden değerlendirmektedir. Özellikle vergiden kaçınma, ekonomik büyüme, kalkınma, tüketim davranışları ve ekonomik reformlar gibi faktörler aracılığıyla belirsizliğin doğrudan ve dolaylı olarak vergi gelirlerini etkilediği kabul edilmektedir. Örneğin ekonomik politika belirsizliği vergi tahsilatını güçleştirmekte (Dang et al., 2019), yeni yatırımlara ilişkin işletmelerin güvenini düşürmekte (Montes & Nogueira, 2022), ekonomik büyümeyi azaltmakta (Darby, 2004) ve firmaların vergiyi ertelemelerine sebep olmaktadır (Kang & Wang, 2021). Bu etkenler de vergi gelirlerine kısa, orta ve uzun vadede doğrudan ve dolaylı olarak negatif etki edebilmektedir.

Vergi gelirlerine belirsizliğin doğrudan etkilerine ilişkin bir çalışmada Gnangnon (2022) COVID-19 pandemi krizinin yol açtığı makroekonomik belirsizlikten kaynaklı olan çeşitli alanlardaki istikrarsızlığın vergi geliri kayıplarına işaret etmektedir. Belirsizliği jeopolitik risk açısından değerlendiren ve bu ilişkiyi jeopolitik risk ile kurumların vergi davranışları açısından inceleyen Ramesh ve Athira (2024) jeopolitik risklerin artmasının vergiden kaçınmayı arttırdığı ve bunda finansal kısıtlamaların da rolünün olduğunu ortaya koymuşlardır. Ayrıca çalışma, yönetişimin ve kurumsallığın bu ilişkinin zayıflamasında payının olduğunu belirtmektedir. Belirsizliği, seçim dönemleri çerçevesinde gözlemleyen Li vd. (2022a) benzer bir şekilde firmaların vergiden kaçınma davranışlarının belirsizlik dönemlerinde arttığını 36 ülke ve 158 seçim dönemi örneklemi kapsamında ortaya koymaktadırlar. Özellikle seçim sonuçlarına ilişkin belirsizliğin fazla olduğu ve diğerlerine kıyasla denetleme mekanizmasının daha az olduğu ülkelerde bu ilişki daha da güçlenmektedir. Dolayısıyla belirsizliğin vergi kaybı için en önde gelen etkilerinden biri vergiden kaçınma davranışları şeklinde olmaktadır. Bu açıdan politika belirsizliğine yaklaşan bir başka çalışmada Nguyen ve Nguyen (2020) ABD'de faaliyet gösteren firmaların temettü ödemelerini yapmayarak elde edilen karı firma bünyesinde tuttuklarını tespit etmişlerdir. Bu sayede firmalar belirsizliğin arttığı dönemlerde vergiden kaçınmaktadırlar. Ancak dış kontrol mekanizmalarının ve firmalar arasında gerçekleştirilen rekabet gibi etkilerin söz konusu ilişkiyi zayıflattığı da çalışmada belirlenmiştir.

Vergi gelirlerini, vergiden kaçınmaya kıyasla daha dolaylı etkileyen birçok etken de bulunmaktadır. Örneğin finansal performans, firma kârlarını ve dolayısıyla ödenecek olan vergileri belirlemektedir. Buna yönelik bir çalışmada Doan vd. (2020) orta ölçekli firmaların ekonomik belirsizlik dönemlerinde daha kötü finansal performans gösterdiklerini 25 ülke üzerine yaptıkları çalışmada ortaya koymuşlardır. Ayrıca çalışmada yabancı ortaklığa sahip firmaların, yerli ortaklığa sahip olanlara kıyasla bu dönemlerde daha yüksek bir firma performansına sahip oldukları görülmüştür.

Belirsizliğin en sık gözlenen etkilerinden biri de yatırımlara yönelik olmaktadır. Belirsizlik dönemlerinde firmaların yeni yatırımlar yapmakta ve mevcut yatırımları arttırmakta çekinceler gösterdiği literatürde yaygın olarak vurgulanan konulardan biri olmuştur. Buna yönelik olarak Drobetz vd. (2018) tarafından yapılan çalışmada belirsizlik dönemlerinde, yatırılan sermaye maliyeti ile yatırımlar arasında negatif ilişkinin daha fazla arttığını vurgulamışlardır. Dolayısıyla yatırımların sermaye maliyetine olan duyarlığının, belirsizlik ile birlikte daha yüksek olmasının yatırımlara yönelik olumsuz yansımaları olmaktadır. Çin'de yapılan bir araştırmada ise Liu ve Zhang (2020) ekonomik politika belirsizliğinin reel yatırımların önüne geçtiğini aynı zamanda özel şirketlerin net borç ihracında azalmaya yol açtığını ortaya koymuşlardır.

Chen vd. (2019) ABD'de yaptıkları araştırmada benzer şekilde, kısa, orta ve uzun vadeli yatırımların belirsizliğin yüksek olduğu dönemlerde azaldığını ortaya koymuşlardır. Belirsizliğin yatırımlara yönelik bir diğer etkisi de doğrudan yabancı yatırımcı girişine yönelik olmaktadır. Bu açıdan Canh vd. (2020) 21 ülke için yaptıkları çalışmada yatırımcıların bir ülkeye yatırım yapmadan önce hem kendi ülkelerindeki hem de yatırım

yapacakları ülkelerdeki belirsizliği dikkate aldıklarını ve böylece belirsizliğin artmasının yatırım kararlarını olumsuz etkilediğini değerlendirmişlerdir. Demir ve Ersan (2017) ise firmaların nakde yönelmeleri açısından konuya yaklaşarak, BRIC ülkelerinde (Brezilya, Rusya, Hindistan, Çin) ekonomik politika belirsizliğinin arttığı periyotlarda, firmaların daha fazla nakit bulundurduklarını gözlemlemişlerdir. Benzer sonuçları birçok farklı çalışmada da (Bloom, 2009; Suh & Yang, 2021; Hsieh et al., 2019; Choi et al., 2020; Jackson & Orr, 2019) görmek mümkündür.

Belirsizliğin bir diğer etkisi tüketim harcamalarına ilişkin olmaktadır. Ekonomik politika belirsizliği arttıkça firmaların ve hane halkının tüketim harcamaları azalmaktadır. Mian vd. (2015) belirsizliğe sebep olan etkene bağlı olarak farklılaşan bulgulara dikkat çekerek, hane halkının harcamalarının düşük miktarda olmakta beraber, belirsizlik dönemlerinde azaldığını ortaya koymuşlardır. Belirsizliğin vergiye dolaylı olarak bir başka etkisi firmaların kârlarına yönelik müdahaleleriyle gerçekleşmektedir. Yasal sınırlar içerisinde kârı, daha aşağıya doğru manipüle ederek yapılan birtakım işlemler ile hile gibi yasal sınırların dışına çıkılarak yapılan işlemler, daha az vergi ödemek isteyen firmaların belirsizlik dönemlerinde başvurdukları yöntemler olabilmektedir. Afzali vd. (2021) 93 ülke için yaptıkları çalışmada Dünya Bankası'nın yapmış olduğu anket çalışmasını kullanarak, yolsuzluk ve belirsizlik ilişkisini incelemişler ve politika belirsizliği arttıkça yöneticilerin vergiye yönelik usulsüzlükler gibi eylemlerinde artışların olduğunu gözlemlemişlerdir.

Belirsizliğin doğrudan veya dolaylı olarak vergi gelirlerini hangi kanallarla etkilediğine yönelik olarak yapılan literatür incelemesinde Türkiye ekonomisine dair böyle bir çalışmanın yapılmadığı görülmüştür. Dolayısıyla bu çalışmanın gerek yükselen bir piyasa ekonomisine sahip bir ülkede yapılması gerekse üç farklı ekonometrik metodoloji kullanılarak yapılması çalışmamızı özgün kılarak alan literatürüne önemli katkı sunacağını düşünmekteyiz.

3. Ekonometrik Analiz

Türkiye ekonomisine ait veriler kullanılarak belirsizliğin toplam vergi gelirleri üzerindeki uzun dönem etkisi ve aralarındaki eşbütünleşmenin varlığını incelemek çalışmanın temel amacını oluşturmaktadır. Vergiler, bir toplumda hem ekonomik hem de sosyal açıdan çok önemli etkilere sahiptir. Uygulanan vergi politikaları ekonomik birimlerin (hane halkı, işletme, devlet) tasarruf, tüketim, üretim ve yatırım kararlarına yön vermektedir. Bu açıdan kamu otoritesi tarafından alınan vergi politikaları aynı zamanda istihdam, ekonomik kalkınma ve Gayri Safi Yurtiçi Hasıla (GSYİH) üzerinde de belirleyici bir maliye politikası aracıdır. Kamu gelirleri arasında en önemli kısmı oluşturan vergi gelirleri kamu harcamalarının da finansmanı içinde kritik bir etkiye sahiptir (Yüce & Keleş, 2021: 151). Zira son zamanlarda oluşan kamusal ihtiyaçlar doğrultusunda bütçe açığı sorunu ortaya çıkmış ve bu sorunun giderilebilmesi için etkin bir araç olan vergi gelirleri önemini arttırmıştır (Akbulut & Yereli, 2016: 115). Maliye politikası için önemli bir gelir kalemini oluşturan vergi gelirleri hükümetler açısından da önemli bir harcama kaynağını temsil etmektedir. Vergi politikaları, harcama kalemlerinin finansmanı için en uygun vergi

dizaynını oluşturmaya çalışırken farklı vergi çeşitleri de verginin mali iktisadi ve sosyal fonksiyonlarının hayata geçirilmesinde önemli araçlar olarak ekonomik sistemde yer almaktadır. Çalışmanın kullanılan değişkenler Tablo 1'de sunulmuştur.

Tablo: 1
Çalışmanın Değişkenleri

Değişken	Açıklama	Kaynak
vergi	Toplam vergi gelirleri	TCMB
bel	Ahir vd. (2018) tarafından Türkiye için hesaplanan belirsizlik endeksi	WUI
faiz	Ticari kredi faiz oranı	TCMB
io	İşsizlik oranı	TCMB
redk	Reel efektif döviz kuru	TCMB
süe	Sanayi üretim endeksi	TCMB

Tablo 1'de yer alan göstergelerden toplam vergi gelirleri, ticari kredi faiz oranı, işsizlik oranı, reel efektif döviz kuru ile sanayi üretim endeksi verileri Türkiye Cumhuriyet Merkez Bankası (TCMB) kurumsal internet sayfasından alınmıştır. Dünya belirsizlik endeksi (World Uncertainty Index-WUI) ise Ahir vd. (2018) tarafından 143 ülke ekonomisi için çeyreklik olarak hesaplamış oldukları ve Economist Intelligence Unit (EIU) firması tarafından rapor haline getirilerek kurumsal internet sayfasında (https://worlduncertaintyindex.com/data/) kamuoyu ile paylaşılan Türkiye'ye ait dünya belirsizlik endeksinin üç çeyrek ağırlıklı hareketli ortalamasını içeren endeks verileri (T6) kullanılmıştır. Ekonomik ve politik belirsizlik dikkate alınarak hesaplanan söz konusu belirsizlik endeksi zaman serisinin uzun olması, çeyreklik hesaplanması, dünyada önemli ekonomik ve politik kırılmaların olduğu Körfez Savaşı, Avrupa Borç Krizi, İngiltere'de yaşanan Brexit süreci, küresel ölçekte etkisi hissedilen COVID-19 pandemi krizinin de dikkate alınması bu endeksi öne çıkarmaktadır. Çalışmanın regresyon modelinde toplam vergi gelirleri bağımlı değişken, belirsizlik endeksi bağımsız değişken, diğer değişkenler ise kontrol değişkenleridir. Ampirik analizin tahmin gücünü artırmak için modele dahil edilen kontrol değişkenlerinin aynı zamanda doğrudan veya dolaylı olarak vergi gelirlerini etkileyen göstergeler olmasına dikkat edilmiştir. Yapılan analizlerde bu değişkenlerin 2008Q1-2023Q4 dönemine ait çeyreklik verileri kullanılmıştır. Tablo 1'de sunulan tüm değişkenlere ait zaman serisi verilerinin önce doğal logaritmaları alınmış daha sonra "Moving Average" metoduyla mevsimsellikten arındırılarak analizlerde kullanılmıştır.

3.1. Tanımlayıcı İstatistikler ve Birim Kök Analizi

Ekonometrik tahminleyicide kullanılan değişkenlerin 2008Q1-2023Q4 zaman serisine ait tanımlayıcı istatistiksel özellikler Tablo 2'de rapor edilmiştir.

Tablo 2'de rapor edilen tanımlayıcı istatistiksel değerler incelendiğinde, ortalamadan sapmanın en fazla vergi gelirlerinde (vergi) olduğu, daha sonra sırasıyla belirsizlik (bel), ticari kredi faiz oranı (faiz), sanayi üretim endeksi (süe), reel efektif döviz kuru (redk) ve işsizlik oranı (io) olduğu görülmektedir. Çalışmanın değişkenlerine ait çarpıklık (skewness) ve basıklık (kurtosis) değerlerine göre zaman serisinin normal dağılım gösterdiğini söylemek mümkündür. Eşbütünleşme testleri için modelde kullanılan değişkenlerin zaman

serisinde birim kök olup olmadığının test edilmesi gerekmektedir. Yapılacak birim kök analizi sonucuna göre hangi ekonometrik test veya testlerin kullanılacağına karar verilecektir. Genişletilmiş Dickey-Fuller (ADF) ve Phillips-Perron (PP) testleri yapılan birim kök analiz değerleri ve entegrasyon seviyesi sonuçları Tablo 3'te özetlenmiştir.

Tablo: 2
Tanımlayıcı İstatistiksel Değerler

	vergi	bel	faiz	io	redk	süe
Ortalama	18,630	-2,223	-1,874	2,390	4,528	4,282
Medyan	18,497	-2,167	-1,910	2,364	4,566	4,308
Maksimum	20,426	-1,447	-1,202	2,671	4,711	4,657
Minimum	17,481	-3,131	-2,446	2,141	4,212	3,745
Standart sapma	0,823	0,413	0,324	0,132	0,128	0,255
Çarpıklık	0,697	-0,231	0,211	0,356	-0,520	-0,273
Basıklık	2,669	2,331	2,426	2,060	2,309	2,106
Gözlem (N)	64	64	64	64	64	64

Tablo: 3
Birim Kök Değerleri

Değişken	Augmented Dickey Fuller (ADF)			Phillips-Perron (PP)			Entegrasyon
	Sabitli	Trendli & Sabitli	Trendsiz & Sabitsiz	Sabitli	Trendli & Sabitli	Trendsiz & Sabitsiz	
vergi	-7,725***	-8,061***	-3,525***	-7,725***	-8,059***	-6,358***	I(1)
bel	-8,427***	-8,384***	-8,500***	-8,824***	-8,780***	-8,614***	I(1)
faiz	-5,520***	-5,564***	-5,556***	-5,188***	-5,246***	-5,239***	I(1)
io	-5,552***	-5,637***	-5,586***	-5,607***	-5,689***	-5,640***	I(1)
redk	-9,596***	-9,563***	-9,623***	-9,820***	-9,821***	-9,654***	I(1)
süe	-9,537***	-9,463***	-9,101***	-9,537***	-9,463***	-9,033***	I(1)

Not: *** %1 düzeyinde anlamlılığı ifade etmektedir.

Ekonometrik analizlerde kullanılan değişkenlerin entegrasyon (durağanlık) seviyelerini tespit etmek için Augmented Dickey-Fuller (1979) ve (Phillips-Perron, 1988) durağanlık testleri kullanılmıştır. Tablo 3'te rapor edilen sonuçlarda ADF testinde Schwarz Bilgi Kriteri (SIC) (Schwarz, 1978), PP testinde ise Bartlett Kernel ve Newey ve West (1994) yöntemi dikkate alınarak zaman serisinin entegrasyon seviyesi sınanmıştır. Tablo 3'teki ADF ve PP değerlerine göre sabitli, trendli ve sabitli, trendsiz ve sabitsiz test denklemlerinde tüm veri setinin birinci farkında I(1) entegre olduğu tespit edilmiştir. Tablo 3'teki sonuçlar, modelde kullanılan değişkenlerin birinci farkında entegre olmalarından dolayı önce Johansen eşbütünleşme testi, daha sonra DOLS (Dynamic Ordinary Least Squares), FMOLS (Fully Modified Ordinary Least Squares) ve CCR (Canonical Cointegrating Regression) yöntemlerini kullanmanın uygun olduğunu göstermektedir.

3.2. Korelasyon ve VIF Analizi

Çalışmanın ekonometrik yöntem ve modelini belirlemeden önce bağımsız değişkenler arasındaki ilişki, başka bir ifade ile var olan korelasyon katsayısının kurulacak regresyon modelinde doğrusal bağlantı problemi için bilinmesi önemlidir. Tüm değişkenlere ait Pearson korelasyon katsayısı (r) ve önemlilik (anlamlılık) (p) katsayı değerleri Tablo 4'te tarafımızca özetlenmiştir.

Tablo: 4
Korelasyon ve VIF Değerleri

Değişken		vergi	bel	faiz	io	redk	süe
vergi		1					
bel	r	0,176	1				
	p	0,164		1			
faiz	r	0,541	0,111				
	p	0,000***	0,384		1		
io	r	-0,072	-0,533	0,046		1	
	p	0,570	0,000***	0,719			1
redk	r	-0,715	0,091	-0,556	-0,279		
	p	0,000***	0,477	0,000***	0,026**	-0,794	
süe	r	0,938	0,268	0,542	-0,109	0,000***	
	p	0,000***	0,032**	0,000***	0,393		
VIF Değerleri							
DOLS Modeli			1,649	1,522	1,769	4,953	4,693
FMOLS Modeli			1,655	1,570	1,771	4,884	4,856
CCR Modeli			1,738	1,552	1,895	6,055	5,116

Not: *** ve ** sırasıyla %1 ve %5 düzeyinde anlamlılığı ifade etmektedir.

Tablo 4'te yer alan Pearson korelasyon analizi sonuçlarında vergi ile faiz, reel efektif döviz kuru ve sanayi üretim endeksi arasındaki korelasyon katsayısının %1 düzeyinde anlamlı olduğu görülmektedir. Bağımsız değişkenler arasındaki korelasyonlarda ise belirsizlik ile işsizlik ve sanayi üretim endeksi arasında sırasıyla %1 ve %5 ile anlamlı, faiz ile reel efektif döviz kuru ve sanayi üretim endeksi arasında %1 düzeyinde anlamlı, işsizlik oranı ile arasında %5 düzeyinde anlamlı, son olarak reel efektif döviz kuru ile sanayi üretim endeksi arasında %1 düzeyinde anlamlı bir korelasyon bulunmuştur. Tablo 4'te yer alan korelasyon matrisinde bağımsız değişkenler arasında en yüksek korelasyon %79,4 ile reel efektif döviz kuru ile sanayi üretim endeksi arasında gerçekleşmiştir.

Kennedy (2008) bağımsız değişkenler arasında yapılan korelasyonda elde edilen mutlak değer katsayısının %80 veya %90'dan büyük olması durumunda yüksek korelasyon olduğunu vurgulamaktadır. Bu açıdan çoklu regresyon modellerinde olası çoklu doğrusal bağlantı problemi için korelasyon analizinin en kolay yöntemlerden biri olduğunu söyleyebiliriz. Pearson korelasyon matrisinde bağımsız veya açıklayıcı değişkenler arasında en yüksek korelasyonun %80'in altında olması değişkenler arasında çoklu doğrusallık problemi olmadığına işaret etmektedir. Regresyon katsayılarımızın güvenirliliği için korelasyon analizinden sonra VIF (Variance Inflation Factors) değerleri de incelenmiştir. Çünkü çoklu regresyon modellerinde açıklayıcı değişkenler arasındaki doğrusallık düzeyinin varlığını görebilmenin bir diğer yöntemi de regresyon modelinde elde edilen VIF katsayılarıdır. Hair vd. (1995), Midi vd. (2010) Potters ve Li (2023) yapılan çoklu regresyon analizlerinde açıklayıcı değişkenlere ait VIF katsayılarının 10'dan büyük olması modelde önemli düzeyde çoklu doğrusallık problemi olduğunu ifade etmektedirler. DOLS, FMOLS ve CCR çoklu regresyon modellerine ait rapor edilen VIF değerlerinin yer aldığı Tablo 4'te göre en yüksek değerin 6,055 olduğu görülmektedir. Bu sonuç, her üç modelimizde de çoklu doğrusallık problemi olmadığını göstermektedir.

3.3. Ekonometrik Model

Zaman serisi verilerinin ekonometrik analizinin yapılabilmesi için ilk koşul, ilgili serinin durağanlık (veya entegre) seviyelerinin test edilmesidir. Tablo 3'teki birim kök sonuçlarında tüm değişkenlerin I(1) seviyesinde %1 düzeyinde entegre olması çalışmanın uzun dönem analizlerinde eşbütünleşme özelliğine sahip Johansen, DOLS, FMOLS ve CCR ekonometrik modellerin kullanılması için uygun olduğu görülmüştür. Johansen testi, Johansen (1988) ve Johansen ve Juselius (1990), DOLS tahmincisi (Dinamik Sıradan En Küçük Kareler) yöntemi Stock ve Watson (1993), FMOLS tahmincisi (Tamamen Değiştirilmiş Sıradan En Küçük Kareler) Phillips ve Hansen (1990), CCR tahmincisi (Kanonik Eşbütünleşik Regresyon) Park (1992) tarafından geliştirilmiştir. DOLS, FMOLS ve CCR tahmincilerinin kullanılabilmesi için regresyon modelinde yer alan değişkenler arasında uzun dönemde eşbütünleşik ilişkinin varlığı gerekmektedir.

DOLS tahmincileri yansız ve asimptotik olarak verimli olan en küçük kareler tahminlerinden elde edilmektedir (Camba, 2020). DOLS prosedürü, içselliği kontrol etmek ve otokorelasyona toleranslı hataları kullanarak standart hataları hesaplamak için erken fark ifadelerinin öncüleri ve gecikmelerini içermektedir. (Pattak et al., 2023). DOLS tahmincisi, modele dinamik öğeler katarak modeli statik denklem sorunlarına karşı dayanıklı hale getirmektedir. Bu tahmin aracı özellikle heterojen özellikler ve sınırlı sayıda gözlem söz konusu olduğunda öne çıkmaktadır (Naimoglu et al., 2024). Bu yaklaşım, her açıklayıcı değişkenin ne zaman ölçüldüğüne ilişkin bilgileri birleştirerek daha kısa örnek yanlılığı, endojenite ve otokorelasyon zorluklarını ortadan kaldırır (Begum et al., 2020). FMOLS tahmincisi, bağımlı değişken hariç tüm değişkenler ve kalıntı değerler arasındaki ilişkilerden kaynaklanan potansiyel komplikasyonları ve potansiyel içsellik kaygılarını etkili bir şekilde ele alan bir modele sahiptir (Naimoglu et al., 2024).

FMOLS tahmincisi, örneklem yanlılığından kaynaklanan hataları, otokorelasyon ve içsellik problemlerini düzeltebilme özelliğine sahiptir (Narayan & Narayan, 2005). FMOLS, uzun vadeli parametreleri tahmin etmek için yarı parametrik bir yaklaşımdır. Küçük örneklem boyutunda bile tutarlı parametreler vermektedir. Ayrıca içsellik, seri korelasyon, ihmal edilen değişken önyargısı ve ölçüm hataları sorunlarının üstesinden gelen bir yaklaşımdır. (Camba, 2020). FMOLS tekniği, eşbütünleşme ve bunun açıklayıcı faktörlerdeki otokorelasyon ve endojenlik üzerindeki etkileri sebebiyle en küçük kareler yöntemini değiştirmektedir. Belirlenen faktörlerin güçlü regresyonu, birim kök problemleri ve entegre prosedürlerden kaynaklanan zorluklar azaltılmıştır. Veriler bu şekilde dönüştürüldüğünde, eşbütünleşme modeli tarafından oluşturulan eşbütünleşme bağlantısı değişmeden kalmaktadır (Pattak et al., 2023).

CCR tahmincisi, etki katsayılarını tahmin etmek için güçlü bir araç görevi görmekte ve iç korelasyon potansiyelinin olduğu durumlarda bile en ideal sonuçlar üretir (Naimoglu et al., 2024). CCR yöntemi, I(1)'in entegre süreçlerine sahip bir modelde eşbütünleşme vektörlerini test etmek için kullanılabilir. Tek denklemli regresyon olan bu yöntem, çok değişkenli regresyonda değişiklik yapılmadan ve etkinliğini kaybetmeden uygulanabilme

özelliğine sahiptir (Camba, 2020). CCR tahmincisi yalnızca veri dönüşümü üzerinde çalışırken, FMOLS hem veri hem de parametre dönüşümüne odaklanmaktadır (Camba, 2020). Bu araştırmada belirsizliğin toplam vergi gelirleri üzerindeki etkisini incelemek için oluşturulan ekonometrik modele ticari kredi faiz oranı, işsizlik oranı, reel efektif döviz kuru ve sanayi üretim endeksi değişkenleri dahil ederek genişletilmiştir. Denklem 3 ampirik araştırma için benimsenen ekonometrik modele ait fonksiyonel denklem, denklem 4 ise ampirik modelin temel denklemini sunmaktadır.

Fonksiyonel denklem:

$$vergi_t = f(bel_t, faiz_t, io_t, redk_t, süe_t) \tag{3}$$

Temel denklem:

$$vergi_t = \gamma_0 + \gamma_1 bel_t + \gamma_2 faiz_t + \gamma_3 io_t + \gamma_4 redk_t + \gamma_5 süe_t + \mu_t \tag{4}$$

Denklem 4'te yer alan "γ" simgesi regresyon sabit katsayısı, "$\gamma_{1.................}\gamma_5$" simgeleri regresyon modelinde yer alan bağımsız değişkenlerin etki katsayısı, "t" zaman trendi, "μ" sembolü ise modelin hata terimidir. Kurulan modelin sonuçlarını ölçmek için DOLS, FMOLS ve CCR çoklu regresyon metodolojilerine ait matematiksel denklem aşağıda 5 no'lu formülde sunulmuştur (Zimon et al., 2023: 10; Pattak et al., 2023: 10).

$$\Delta vergi_t = \omega_0 + \sum_{i=1}^{t} \emptyset_1 \Delta vergi_{t-i} + \sum_{i=1}^{t} \emptyset_2 \Delta bel_{t-i} + \sum_{i=1}^{t} \emptyset_3 \Delta faiz_{t-i} +$$
$$\sum_{i=1}^{t} \emptyset_4 \Delta io_{t-i} + \sum_{i=1}^{t} \emptyset_5 \Delta redk_{t-i} + \sum_{i=1}^{t} \emptyset_6 \Delta süe_{t-i} + \varphi_1 vergi_{t-1} +$$
$$\varphi_2 bel_{t-1} + \varphi_3 faiz_{t-1} + \varphi_4 io_{t-1} + \varphi_5 redk_{t-1} + \varphi_6 süe_{t-1} + \mu_t \tag{5}$$

Model 5'te yer alan "ω" regresyon sonucuna ait sabit terim, "$\emptyset$" kısa dönem, "φ" uzun esnekliğin derecesine ait katsayı, "t" zaman trendi, "μ" modelin hata terimidir.

3.4. Johansen Eşbütünleşme Analizi

DOLS, FMOLS ve CCR analizlerinin ürettiği eşbütünleşme sonuçlarının güvenilir olduğunun varlığını doğrulamak için önce Johansen eşbütünleşme testi yapılmalıdır. Johansen testi modelde optimal gecikme uzunluğunun saptanmasına olanak tanıyan VAR (Vector Autoregression) modeli kurularak yapılmaktadır. VAR modeli çoklu zaman serisi değişkenlerinde hem kendi gecikmeleri hem de diğer değişkenlerin gecikmeleri arasındaki gelişimi ve bağımlılığı hesaplayan ekonometrik bir modeldir. VAR model sonuçlarında yer alan Akaike Bilgi Kriteri (AIC), Schwarz Bilgi Kriteri (SIC) Hannan-Quinn Bilgi Kriteri (HQC) Nihai Tahmin Hatası (FPE) ve Ardışık Modifiye (LR) test istatistik katsayı değerleri Tablo 5'teki gibidir.

Tablo: 5
Optimal Gecikme Değerleri

Lag	LogL	LR	FPE	AIC	SC	HQ
0	226.2937	NA	2.82e-11	-7.2642	-6.8416	-7.0993
1	445.9586	379.7597	5.63e-14	-13.4902	-11.7999*	-12.8303*
2	483.3656	57.06157	5.62e-14	-13.5378	-10.5780	-12.3832
3	513.8736	40.33255	7.57e-14	-13.3517	-9.1262	-11.7022
4	566.4312	58.79328*	5.39e-14	-13.9129	-8.4198	-11.7686
5	614.7424	44.21703	**5.26e-14***	**-14.3303***	-7.5695	-11.6911

* Kriter tarafından seçilen gecikme sırasını gösterir.

Vektör otoregresyon (VAR) tahmin modelinde optimal gecikme değerlerinin saptanması için Akaike Bilgi Kriteri (Akaike, 1974), Schwarz Bilgi Kriteri (Schwarz, 1978), Hannan-Quinn Bilgi Kriteri (Hannan & Quinn, 1979), Nihai Tahmin Hatası (Akaike, 1969) ve Ardışık Modifiye test istatistik sonuçlarına göre en uygun gecikmenin 5 olduğu tespit edilmiştir. Çalışmamızın modelinde yer alan tüm veri kümesi için VAR'da 5 gecikmenin model ölçümü için en ideal olduğu anlaşıldıktan sonra Otoregresif Karakteristik (AR) Polinomunun Ters Köklerine ait çember sonuçları incelenmiştir.

Şekil: 2
Otoregresif Karakteristik (AR) Polinomunun Ters Kökleri
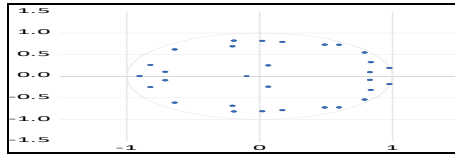
Modelin uyum iyiliği ve istikrarı için VAR modelinin Otoregresif Karakteristik (AR) Polinomunun Ters Köklerine (Inverse Roots of AR Characteristic Polynomial) ait sonuçların yer aldığı Şekil 2'de görüldüğü üzere veri kümesine ait ters köklerin hepsi çember içinde yer almaktadır. Bu da modelin durağan ve istikrarlı bir yapı sergilediğini göstermektedir. Modelin istikrarı için daha ileri giderek Ek 3'te yer alan VAR gecikme spesifikasyonuna ait modül değerlerinin 1'in altında olması da karakteristik polinomuna ait köklerin birim çemberin içinde olduğunu göstermektedir. VAR gecikme sayısı seçim sonuçlarına dayanarak zaman serisi değişkenleri arasında uzun dönemli eşbütünleşik ilişkinin varlığı Johansen yöntemi ile tahmin etmeye karar verilmiştir. Sonuçlar Tablo 7'de rapor edilmiştir.

Tablo: 7
Eşbütünleşme Test Değerleri

Unrestricted Cointegration Rank Test (Trace)				
Hypothesised No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.6428	149.1146	95.7537	0.0000***
At most 1 *	0.4734	88.3764	69.8189	0.0008***
At most 2 *	0.3468	50.5380	47.8561	0.0274***
At most 3	0.2213	25.4131	29.7971	0.1472
At most 4	0.1380	10.6557	15.4947	0.2336
At most 5	0.0316	1.8933	3.8415	0.1688
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesised No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.6428	60.7383	40.0776	0.0000***
At most 1*	0.4734	37.8384	33.8869	0.0159***
At most 2	0.3468	25.1249	27.5843	0.1000
At most 3	0.2213	14.7574	21.1316	0.3063
At most 4	0.1380	8.7623	14.2646	0.3065
At most 5	0.0316	1.8933	3.8415	0.1688

** MacKinnon-Haug-Michelis (1999) p değerleri. *** %1 anlamlılığı ifade etmektir.

Johansen (1988) ve Johansen ve Juselius (1990) tarafından geliştirilen Johansen eşbütünleşme testinde, bağımlı ve bağımsız değişkenler arasındaki uzun dönemli ilişkinin varlığı için maksimum öz değer (Max Eigen Statistic) ve iz istatistik (Trace Statistic) değerleri dikkate alınmaktadır. Johansen eşbütünleşme testi, düzeyde durağan olmayan, birinci farkları alındığında durağan hale gelen az iki seri arasındaki eşbütünleşmeyi test etmek amacıyla kullanılmaktadır. Farklı durağanlık seviyelerinde Johansen eşbütünleşme testi uygulanamaz. Maksimum öz değer sonuçları 6 no'lu formül, iz istatistik değerleri ise 7 no'lu formül ile hesaplanmaktadır (Özcan & Arı, 2013: 112; Sümerli-Sarıgül & Altay-Topçu, 2021: 50).

$$J_{iz} = -N \sum_{i=r+1}^{m} \ln(1 - \vartheta_i) \tag{6}$$

$$J_{mak} = -N \ln (1 - \vartheta_{r+1}) \tag{7}$$

Maksimum öz değer ile iz istatistik değerlerini hesaplarken kullanılan 6 ve 7 no'lu formüllerde "N" örneklem büyüklüğüdür. "δ" matrise ait en büyük "i." kanonik korelasyon ilişkidir. İz istatistik değerinin hesaplanmasında en fazla "r" eşbütünleşme vektörünün varlığı, en az r+1 eşbütünleşme vektörünün varlığını savunan alternatif hipoteze karşı test edilir. Maksimum öz değer istatistiğinde ise en fazla "r" eşbütünleşme vektörünün varlığı, r+1 eşbütünleşme vektörlerinin varlığını savunan alternatif hipoteze karşı test edilmektedir (Özcan & Arı, 2013: 112; Sümerli-Sarıgül & Altay-Topçu, 2021: 50). Johansen eşbütünleşme tahmin sonuçlarında maksimum öz değer ve iz istatistiklerinde sıfır hipotez (H_0) ile alternatif hipotez (H_1) sahip oldukları koentegre vektör (r) sayısına göre açıklanarak değişkenler arasında uzun dönemli ilişkinin varlığı sınanmaktadır. Johansen testlerinde değişkenler arasındaki eşbütünleşme vektörlerin sayısını belirlerken olası bir eşbütünleşme için en az bir eşbütünleşme vektörünün bulunması gerekmektedir. Johansen testinde uygun model seçiminden sonra elde edilen öz değer ve iz istatistik değerlerine ait kritik değerler (Critical Value) olasılık (Prob.) değerleri ile %5 anlam düzeyinde karşılaştırılmaktadır. Olasılık değerinin düşük çıkması halinde (Prob < 0,05) H_0 reddedilirken alternatif hipotez kabul edilmektedir. Johansen testine ait hipotezler aşağıdaki şekilde kurulmaktadır.

H0: r = 0, modelde koentegre vektör yoktur, değişkenler uzun dönemde eşbütünleşik değildir.

H1: r ≤ 1, modelde en az 1 koentegre vektör vardır, değişkenler uzun dönemde eşbütünleşiktir.

Tablo 7'de yer alan Johansen uzun dönemli eşbütünleşik tahmininin iz testinde 3, maksimum öz değer testinde ise iki eşbütünleşik denklemin %5 düzeyinde anlamlı olduğu görülmektedir. Johansen test sonuçlarına göre değişkenler arasında uzun dönemde eşbütünleşik bir ilişkinin olmadığını savunan boş hipotez (H0) reddedilirken, alternatif hipotez (H1) kabul edilmiştir. Johansen bulgularında değişkenlerimiz arasında eşbütünleşmenin olduğu görüldükten sonra bağımsız değişkenlerin bağımlı değişkenler üzerindeki uzun dönem katsayıların tahmininde DOLS, FMOLS ve CCR eşbütünleşik yöntemlerin kullanımını mümkün kılmaktadır.

3.5. Uzun Dönem Katsayı Tahminleri: DOLS, FMOLS ve CCR

Çalışmada kullanılacak ekonometrik model belirlenirken metodolojik sıralama şu şekilde takip edilmiştir. İlk önce kullanılan verilerin durağanlığını kontrol etmek için ADF ve PP birim kök testleri kullanılmıştır. İkinci adımda Johansen testi ile değişkenlerin uzun dönemde eşbütünleşik olup olmadığı kontrol edilmiştir. Üçüncü adımda, belirsizliğin toplam vergi gelirleri üzerindeki etkisini analiz etmek için DOLS, FMOLS ve CCR regresyon yöntemleri ile analiz edilmiştir. Belirsizliğin toplam vergi gelirleri üzerinde uzun dönem etki katsayılarını tahmin etmek DOLS, FMOLS ve CCR yöntemi kullanılarak yapılan analizlerden elde edilen katsayı sonuçları Tablo 8'de özetlenmiştir.

Tablo: 8
DOLS, FMOLS ve CCR Uzun Dönem Katsayı Değerleri

Bağımlı değişken = $\Delta vergi_t$						
	DOLS Modeli		FMOLS Modeli		CCR Modeli	
Bağımsız değişken	Katsayı	t-istatistik	Katsayı	t-istatistik	Katsayı	t-istatistik
bel	-0,2797	-2,6867***	-0,4271	-2,8736***	-0,4616	-2,8764***
faiz	0,2038	1,5972	0,3711	2,0159**	0,3881	2,0734**
io	0,3220	0,9561	0,3588	0,7497	0,3773	0,7319
redk	1,7725	3,0445***	2,6364	3,1775***	2,9062	3,0709***
süe	3,7312	13,1122***	4,0052	9,9030***	4,1208	9,4676***
C	-6,3821	-1,5329	-11,527	-1,9493*	-13,3338	-2,0016*
R^2	0,9037		0,8952		0,8922	
Düzeltilmiş R^2	0,8954		0,8860		0,8827	

Not: ***, ** ve * sırasıyla %1, %5 ve %10 düzeyinde anlamlılığı ifade etmektedir.

Eşbütünleşme testleri ile değişkenlerin uzun dönemde dengeye sahip olduğuna dair önemli kanıtlar belirlendikten sonra seriler arasında uzun dönem regresyon katsayısının önemliliği belirlenmiştir. Bu amaçla, seriler arasındaki uzun dönemli regresyon katsayısının önemini tahmin etmek için ekonometrik analizlerde yaygın bir yöntem olarak kullanılan DOLS, FMOLS ve CCR benimsenmiştir. Tablo 8'den de anlaşılacağı üzere regresyon testlerindeki tüm değişkenlere ait etki katsayılarının önem ve işaret yönelimi açısından genel olarak uyum içerisinde olduğu görülmüştür. Analiz katsayı değerlerine göre her üç modelde de, Türkiye'de ekonomik politika belirsizliği (bel) arttığında toplam vergi gelirlerinin (vergi) azaldığı görülmektedir. Gelişmekte olan bir ekonomide uzun dönemde belirsizlik ile toplam

vergi gelirleri arasındaki ilişkinin varlığı DOLS, FMOLS ve CCR regresyon yöntemleri ile doğrulanmaktadır. Tablo 8'de yer alan DOLS, FMOLS ve CCR etki katsayıları incelendiğinde, Ahir vd. (2018) tarafından Türkiye için hesaplanan ekonomik ve belirsizlik endeksinde meydana gelen 1 birimlik bir artışın toplam vergi gelirlerini sırasıyla %0,2797, %0,4271 ve %0,4616 birim azalttığını göstermektedir. Diğer tarafta modelde kontrol değişkenleri olarak yer alan reel efektif döviz kuru (redk) ile sanayi üretim endeksinin vergi gelirleri üzerindeki etkisi her üç modelde de %1 düzeyinde pozitif ve anlamlı, faizin etkisi ise sadece FMOLS ve CCR'de %5 düzeyinde pozitif ve anlamlı bulunmuştur. Bu sonuçlar, araştırmanın temel sorusunu oluşturan Türkiye'de ekonomik ve politik belirsizliğin artması toplam vergi gelirlerini olumsuz etkileyeceği sorusu DOLS, FMOLS ve CCR bulguları ile doğrulanmıştır. Ekonometrik analizlerin sağlamlılığı için ilgili bölümlerde yer alan öncü testler ile birlikte, modelde otokorelasyon (Ek 1) ve normal dağılım (Ek 2) sorunu da mevcut değildir.

4. Sonuç ve Değerlendirme

Maliye politikasının önemli bir aracı olan vergiler, kamu gelirleri içerisinde en önemli gelir kaynağını oluşturmaktadır. Kamu otoritesini temsilen genellikle hükümetler tarafından herhangi bir hizmete veya isteğe bağlı olmadan ülke vatandaşlarına getirilen mali bir yükümlülükle ile alınan vergiler, kamu hizmetlerini finanse etmenin önemli aracı olarak kabul edilmektedir. Bu açıdan genel olarak vergi gelirleri, ekonomik büyüme, kalkınma, istihdam, istikrar, adil bir kaynak arzı ve gelir eşitliği gibi birçok değişkeni dolaylı veya dolaysız bir şekilde etkilemektedir.

Vergi gelirlerinin yukarıda bahsedilen kamu hizmetlerinin finansmanı için en önemli araç konumunda olmasından dolayı vergi sisteminde meydana gelecek bir istikrarsızlık tüm ekonomik birimlerin gelir, yatırım ve tasarruf mekanizmaları üzerinde geniş bir sistematik krize yol açabilme potansiyeline sahiptir. Bu açıdan, ekonomik gelişme ve kalkınma için yapılacak yatırımların finansmanında önem arz eden vergi gelirlerinde meydana gelecek azalışlar ülkenin makroekonomik görünümü açısından önemlidir. Vergi gelirleri ile ekonomik politika belirsizliği arasındaki ilişkinin analiz edildiği bu çalışmada, Türkiye için hesaplanan ekonomik politika belirsizliği endeksi ile vergi gelirleri üzerindeki etki incelenmiştir. Ayrıca çalışmada, belirsizliğin dışında vergi gelirlerini etkilediği düşünülen ve akademik yazında kabul gören bazı makroekonomik göstergeler de kontrol değişkeni olarak modele alınmıştır. Ampirik analizlerde Johansen eşbütünleşme, DOLS, FMOLS ve CCR metodları kullanılmıştır. Analiz sonuçlarında, vergi gelirleri ile belirsizlik, faiz, işsizlik, döviz kuru ve sanayi üretim endeksi arasında uzun dönemde eşbütünleşmenin olduğu ve her üç modelde de Türkiye'de ekonomik politika belirsizlikteki artışın vergi gelirleri üzerinde %1 önem düzeyinde negatif etkilemektedir. Ayrıca analiz bulgularımız, literatür bölümünde kısa özetlerine yer verilen çalışmalarda belirsizliğin doğrudan veya dolaylı olarak vergi gelirlerini olumsuz etkilediğine yönelik elde edilen ampirik sonuçlar ile de uyumludur.

Ekonomik politika belirsizliğinin olduğu dönemlerde, verginin konusu olan işlem, ürün, hizmet, gelir, harcama gibi unsurlar, ekonomik hareketlerin yavaşlamasına bağlı olarak düşüşler gösterebilmektedir. Belirsizlik dönemlerinde meydana gelen istihdamda ve gelirdeki düşüşlerin etkisi ile birlikte vergilerin düşüşü beklenen bir durumdur. Yine farklı makroekonomik göstergelerin negatif yönde seyir izlemesine bağlı olarak oluşan kaotik durum firmaların maliyetlerinin artmasına ve karlılığın azalmasına yol açabilmektedir. Bu durum ise vergilerin düşmesine neden olan başka bir unsur olarak göze çarpmaktadır.

Vergi gelirlerinin ekonomik politika belirsizliğinden en az şekilde etkilenmesi için politika yapıcıların farklı hamleler yapması gerekmektedir. Kriz öncü göstergelerinin oluşması ile beraber bu alanda çalışmalar yapılarak ekonomik ve politik istikrarsızlığın büyümeden bertaraf edilmesi sağlanabilir. Ayrıca vergi denetiminin belli bir standartta getirilmesi, kayıt dışılığının azaltılmasını sağlayarak kayıt dışı ekonominin de önüne geçilmesini de destekleyecektir.

Sonuç olarak DOLS, FMOLS ve CCR gibi çoklu regresyon modellerinin kullanılmasıyla elde edilen sonuçlar vergi politikası otoritelerine vergi gelirlerinin belirsizlik dönemlerindeki seyri hakkında önemli ipuçları vermektedir. Bu çalışma, vergi gelirlerini istikrarsızlaştıran belirsizlik ortamında rasyonel politikaların üretilebilmesi içinde farkındalık kazandıracak bir çalışma hükmündedir. Ayrıca, Türkiye'de kamu yatırımlarında önemli bir itici güç olan vergi gelirlerindeki artışlar, maliye politikasının sorunsuz ve istikrarlı sürdürülebilmesi ile finansal istikrarına da katkı sağlayacaktır. Son olarak, toplam veya sınıflandırılmış vergi gelirleri ile farklı risk göstergeleri, para veya maliye politikası araçları arasındaki ilişkinin özellikle gelişmekte olan ekonomilerde farklı metodolojik yaklaşımlar kullanarak incelenmesi araştırmacılara tavsiye edilmektedir.

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EKLER:

Ek Tablo: 1
VAR LM Testi

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	36.14703	36	0.4618	1.002262	(36, 73.0)	0.4838
2	44.01351	36	0.1686	1.279008	(36, 73.0)	0.1857
3	44.11522	36	0.1660	1.282747	(36, 73.0)	0.1829
4	37.48554	36	0.4009	1.047660	(36, 73.0)	0.4231
5	33.44979	36	0.5905	0.912804	(36, 73.0)	0.6106

Ek Tablo: 2
VAR Normal Dağılım Testi

Component	Skewness	Chi-sq	df	Prob.*
1	-0.419870	1.733525	1	0.1880
2	0.016163	0.002569	1	0.9596
3	0.064601	0.041038	1	0.8395
4	0.718500	5.076379	1	0.0243
5	0.338294	1.125355	1	0.2888
6	-0.251278	0.620881	1	0.4307
Joint		8.599747	6	**0.1974**
Component	Kurtosis	Chi-sq	df	Prob.
1	3.124173	0.037905	1	0.8456
2	2.946779	0.006963	1	0.9335
3	2.665258	0.275462	1	0.5997
4	4.167742	3.352236	1	0.0671
5	2.822708	0.077272	1	0.7810
6	3.321759	0.254508	1	0.6139
Joint		4.004346	6	**0.6761**

Component	Jarque-Bera	df	Prob.
1	1.771430	2	0.4124
2	0.009532	2	0.9952
3	0.316500	2	0.8536
4	8.428616	2	0.0148
5	1.202627	2	0.5481
6	0.875388	2	0.6455
Joint	12.60409	12	**0.3985**

Ek Tablo: 3
Karakteristik Polinomun Köklerine Ait Modül Değerleri

Root	Modulus
0.980579 - 0.187865i	0.998413
0.980579 + 0.187865i	0.998413
0.794073 - 0.543461i	0.962238
0.794073 + 0.543461i	0.962238
0.603279 - 0.724835i	0.943043
0.603279 + 0.724835i	0.943043
0.840331 - 0.320778i	0.899474
0.840331 + 0.320778i	0.899474
-0.899364	0.899364
-0.635585 + 0.615350i	0.884661
-0.635585 - 0.615350i	0.884661
0.492721 - 0.727076i	0.878301
0.492721 + 0.727076i	0.878301
-0.817523 + 0.256165i	0.856717
-0.817523 - 0.256165i	0.856717
-0.190040 - 0.820509i	0.842230
-0.190040 + 0.820509i	0.842230
0.835664 - 0.089046i	0.840395
0.835664 + 0.089046i	0.840395
0.025407 + 0.814632i	0.815029
0.025407 - 0.814632i	0.815029
0.174856 + 0.791438i	0.810524
0.174856 - 0.791438i	0.810524
-0.200354 - 0.687067i	0.715683
-0.200354 + 0.687067i	0.715683
-0.704796 - 0.097934i	0.711568
-0.704796 + 0.097934i	0.711568
0.069493 + 0.245390i	0.255041
0.069493 - 0.245390i	0.255041
-0.093950	0.093950

Türkiye'de Çevresel Sürdürülebilirliği Artırmada Yenilenemeyen Enerji Verimliliğinin Rolü, EKC ve LCC Hipotezleri: Kesirli Fourier ARDL Yaklaşımı ile Bulgular

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The Role of Non-renewable Energy Efficiency in Enhancing Environmental Sustainability in Türkiye, EKC and LCC Hypotheses: Evidence with Fractional Fourier ARDL Approach

Abstract

This study analyses the relationship between non-renewable energy efficiency, renewable energy use, economic growth and environmental quality within the Environmental Kuznets Curve (EKC) and Load Capacity Curve (LCC) hypothesis framework. In this direction, data for the period 1982-2022 are analysed. ADF, PP, Kapetanios unit root tests, Fractional Fourier ARDL bounds test and Fourier Toda-Yamamoto causality test are applied to analyse the data. According to the findings, non-renewable energy efficiency and renewable energy use have a negative impact on CO2 and EF, but a positive impact on LCF. Considering the economic growth variable, the EKC and LCC hypotheses are valid in Türkiye.

Keywords : Ecological Footprint, CO_2 Emissions, Load Capacity Factor, Renewable Energy, Non-renewable Energy Efficiency, Fourier ARDL Cointegration Test.

JEL Classification Codes : C32, F64, Q43, Q53, Q57.

Öz

Bu çalışma, yenilenemeyen enerji verimliliği, yenilenebilir enerji kullanımı, ekonomik büyüme ile çevresel kalite arasındaki ilişkiyi Çevresel Kuznets eğrisi (EKC) ve Yük Kapasite Eğrisi (LCC) hipotezi çerçevesinde incelemektedir. Bu doğrultuda 1982-2022 dönemindeki veriler kullanılarak analiz edilmiştir. Verilerin analiz edilmesinde ADF, PP, Kapetanios birim kök testleri, Kesirli Fourier ARDL sınır testi ve Fourier Toda-Yamamoto nedensellik testi uygulamaktadır. Bulgulara göre yenilenemez enerji verimliliği ile yenilenebilir enerji kullanımı CO_2 ve EF üzerinde negatif, LCF üzerinde ise pozitif etkiye sahiptir. Ekonomik büyüme değişkeni dikkate alındığında Türkiye'de EKC ve LCC hipotezleri geçerlidir.

Anahtar Sözcükler : Ekolojik Ayak İzi, CO_2 Emisyonları, Yük Kapasitesi Faktörü, Yenilenebilir Enerji, Yenilenemeyen Enerji Verimliliği, Fourier ARDL Eşbütünleşme Testi.

1. Giriş

Ülkelerin en önemli amaçlarından biri ekonomik büyümeyi sağlamaktır. Ancak ekonomik büyüme için kaynakların aşırı kullanılması küresel ısınma, iklim değişikliği ve çevresel bozulma gibi çevresel sorunlar gündeme getirmektedir. Ülkelerin ekonomik büyümelerini gerçekleştirmek için kömür, doğalgaz, petrol gibi yenilenemeyen enerjiye (fosil kaynaklı enerji) olan taleplerini artırması, karbondioksit (CO2) emisyonları başta olmak üzere sera gazı emisyonlarının artmasına neden olmaktadır (Kamacı, 2024: 250). Sera gazı emisyonlarındaki artış insan yaşamı için ciddi sonuçlar doğurmaktadır. Bu nedenle ülkeler, temiz ve sürdürülebilir enerji arzını sağlamak için çeşitli stratejiler geliştirmektedirler. Dünyadaki çevresel kötüleşmenin önüne geçebilmek için 1997'de Kyoto ve 2015'te Paris İklim Anlaşması (PCA) gibi küresel organizasyonlar gerçekleştirilmiştir. Bu organizasyonlar, gelecek nesillere temiz ve yeşil bir çevre sağlamayı amaçlamaktadır (Usman et al., 2022: 91-92). Yapılan anlaşmalar kapsamında, ülkelerin sıkı önlemler alarak CO2 emisyonlarını azaltmaları gerekmektedir. Üzerinde durulan en önemli adım ihtiyaç duyulan enerjinin yenilenebilir enerjilerle karşılanması ve fosil kaynaklara dayalı yenilenemez enerji verimliliğinin artırılmasıdır. Bu bağlamda ekonomik faaliyetlerin çevre üzerindeki etkisinin ölçülmesi önem kazanmaktadır.

Araştırmacılar ekonomik faaliyetlerin çevre üzerindeki etkisini ortaya koyabilmek için çeşitli göstergeler geliştirmişlerdir. Çok sayıda ampirik çalışma, çevresel bozulmayı ölçmek için CO2 emisyonlarını ve ekolojik ayak izini (Ecological Footprint - EF) gösterge olarak kullanmıştır. CO2, çevre kirliliğini dar kapsamlı olarak hava kalitesi açısından ele almaktadır. Rees (1992) arazi dönüşümü, orman örtüsü kaybı, su tüketimi ve karbon emisyonları gibi farklı yönleri dikkate alarak doğal kaynakların kullanımı ve bozulmasına ilişkin daha kapsamlı ekolojik ayak izini geliştirmiştir. Ancak EF çevrenin talep tarafındaki durumları dikkate aldığı ve doğanın insan ihtiyaçlarını karşılama kabiliyetini gösteren biyolojik kapasiteyi dikkate almadığı için literatürde eleştirilmiştir. Bu bağlamda, Siche vd. (2010) yük kapasitesi faktörünü (Load Capacity Factor - LCF) önermiştir. Pata (2021), LCF belirleyicileri için ilk ampirik analiz sonuçlarını sunmuştur. LCF çevresel kaliteyi çevrenin hem arz yönünü temsil eden biyolojik kapasiteyi hem de talep yönünü temsil eden EF'yi dikkate alarak hesaplanmaktadır. LCF, biyolojik kapasiteyi ekolojik ayak izine bölerek, çevrenin kaldırabileceği sınırlar içinde mi çalıştığını yoksa kapasitesini aşıp aşmadığını ortaya koymaya yardımcı olur. Eğer oran 1'den küçükse doğanın biyolojik kapasitesine göre daha fazla kaynak tüketildiğini ve ekolojik açık meydana getirdiğini gösterir. Eğer oran 1'den büyükse doğanın biyolojik kapasitesine göre daha az kaynak tüketildiğini ve ekolojik fazla meydana getirdiğini gösterir (Siche et al., 2010: 3184-3186). Grafik 1'de Türkiye'nin çevresel kalite göstergeleri sunulmaktadır.

Grafik: 1
Türkiye'nin Çevresel Kalite Göstergeleri
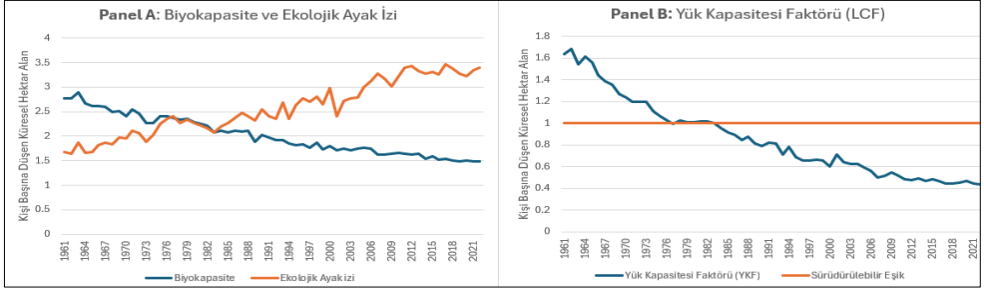
Grafik 1'de Panel A'da gösterildiği gibi, Türkiye'nin biyokapasitesi 1982'li yıllara kadar ekolojik ayak izinin üzerindedir. 1982'li yıllardan sonra ise tam tersi durum gerçekleşmekte, biyokapasite ekolojik ayak izinin altında kalmaktadır. Bu duruma paralel olarak Panel B'de gösterildiği gibi LCF 1961'de 1.6, 1983'te sürdürülebilir eşiğin altına düşerek 0.99 değerini almakta ve düşüş devam ederek 2022'de 0.43 değerini almıştır. LCF'nin 1982'li yıllardan itibaren sürdürülebilir limitin (biyokapasite = ekolojik ayak izi) altına düşmesinde, Türkiye'nin 1980'li yıllardan itibaren uygulanmaya başlanan dışa açık sanayileşme politikasının etkili olduğu düşünülmektedir (Can & Kılıç: 67). LCF istatistikleri, Türkiye'de yıllar içinde çevre kalitesinde herhangi bir iyileşme olmadığını, hatta Türkiye'nin doğal kaynaklarının yaklaşık 2,3 kat fazlasının tüketildiğini göstermektedir. Bu durum, Türkiye'de çevresel kaliteyi düşüren faktörlere yönelik olarak ampirik çalışmalar yapılmasını gerekli kılmaktadır.

Bu araştırma, yenilenemez enerji verimliliğinin, yenilenebilir enerji kullanımının ve ekonomik büyümenin çevresel bozulma üzerindeki etkisine EKC ve LCC hipotezine odaklanmaktadır. Bu doğrultuda çalışma bazı soruların cevaplarını aramaktadır: (1) Yenilenemeyen kaynaklardan sağlanan enerjinin verimli kullanılması çevre kalitesi üzerindeki etkisi nasıldır? CO2, EF ve LCF'yi ne derece etkiler? (2) Yenilenebilir enerji kaynaklarının kullanılması çevresel kaliteyi artırmanın itici bir gücü müdür? (3) Kişi başına düşen milli gelirdeki değişmeler çevresel kaliteyi nasıl etkiler? (4) EKC ve LCC hipotezi Türkiye'de geçerli mi? Çalışma bu sorulara cevaplar arayarak CO2, EF ve LCF sürdürülebilir eşiğin altında olan Türkiye'de çevresel kalitenin artırılmasına yönelik olarak öneriler sunmaktadır.

Bu araştırmanın amacı, Türkiye'de yenilenemez enerji verimliliği, yenilenebilir enerji kullanımı, ekonomik büyüme ile CO2, EF, LCF arasındaki ilişkiyi incelemek ve EKC ile LCC hipotezlerinin geçerliliğini kesirli Fourier ARDL metoduyla test etmektir. Çalışmanın özgünlüğü, Türkiye'ye özgü olarak yapılan kıyaslamalı EKC ile LCC hipotezleri ile ilgili çalışmaların az olmasıdır. Ayrıca ulusal literatürdeki çalışmalar fosil kaynaklara dayalı yenilenemez enerji tüketiminin çevresel kalite üzerindeki etkisini incelemektedir. Ulusal literatürde yenilenemez enerji verimliliğini LCF bağlamında ele alan bir çalışmaya

rastlanmamıştır. Bu bağlamda çalışma yenilenemez enerji verimliliğinin çevre kalitesi üzerindeki etkisini ele almaktadır. Söz konusu etki kesirli Fourier ARDL eşbütünleşme testi ve Fourier Toda-Yamamoto nedensellik testi ile araştırılmıştır. Kullanılan ekonometrik yöntemler güncel yöntem olup, ele alınan konu ile ilgili literatürün genişletilmesine katkı sunacağı düşünülmektedir.

Çalışmanın ikinci kısmında incelenen konuya ilişkin teorik çerçeve ortaya konulmuş ve Türkiye'ye ait verilere yer verilmiştir. Üçüncü kısımda ise ulusal ve uluslararası literatürdeki çalışmalara yer verilmiştir. Dördüncü bölümde çalışmada ele alınan veri setine yer verilmiş ve çalışmada kullanılan model gösterilmiştir. Beşinci kısımda ise çalışmada kullanılan ekonometrik yöntemden bahsedilmiştir. Altıncı kısımda ampirik bulgular ortaya konulmuştur. Yedinci kısımda ise ampirik bulgular değerlendirilmiştir.

2. Teorik Çerçeve

Son yıllarda, Grossman ve Krueger (1991, 1995) tarafından önerilen Çevresel Kuznets Eğrisi (EKC), çevre ekonomisi alanında büyük önem kazanmış ve ekonomik büyüme seviyeleri ile çevresel bozulma arasındaki ilişkiyi anlamak için çok önemli bir araç haline gelmiştir. EKC hipotezi, ekonomik büyümenin başlangıçta ölçek etkisiyle çevresel kaliteyi düşürdüğünü, daha sonra kompozisyon ve teknik etki nedeniyle çevresel kaliteyi artırdığını öne sürmektedir. EKC teorisine göre, çevresel kirleticiler (CO_2, EF gibi) ile ekonomik büyüme arasında ters U şeklinde bir ilişki vardır. Pata ve Kartal (2023) çalışmalarına göre hem LCF ve EF'yi hem de biyolojik kapasiteyi bir araya getiren çevresel sürdürülebilirliğin bir ölçüsüdür. EKC hipotezinin tersine LCF ile ekonomik büyüme arasındaki ilişki U şeklinde olabilir. Bu doğrultuda Doğan ve Pata (2022) çalışmalarında yük kapasitesi eğrisi (LCC) hipotezini öne sürmüşlerdir. LCC hipotezi, çevrenin hem talep tarafını (EF) hem de arz tarafını (Biyokapasite) dikkate alarak çevresel kaliteye daha geniş bir perspektiften değerlendirme yapma imkânı sağlamaktadır. EKC ve LCC hipotezlerini karşılaştırmalı olarak gösteren iki eğri Grafik 2'de sunulmaktadır.

Grafik: 2
EKC ve LCC Hipotezlerini Karşılaştırma
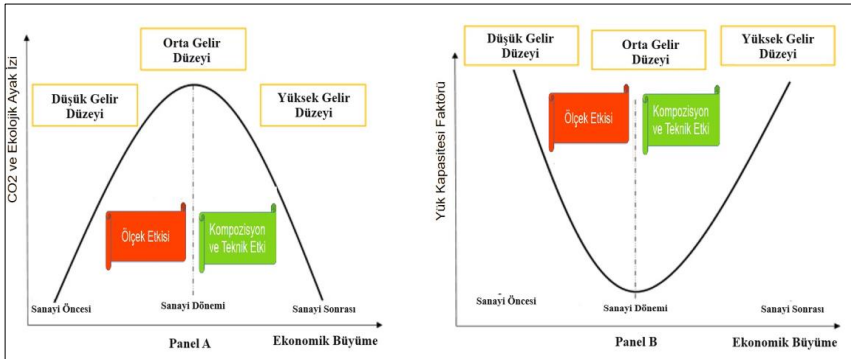
Grafik 2 incelendiğinde, Panel A'da EKC hipotezi gösterilmektedir ve çevresel kirleticiler olan CO2 ve EF ile çevresel kalite arasında ters U şeklinde ilişki vardır. Bu ilişki sırası ile "Ölçek Etkisi, "Kompozisyon Etkisi" ve "Teknik Etki" olmak üzere üç etkiye dayanmaktadır (Grossman & Krueger, 1991). Ölçek etkisi, ekonomik büyümenin çevresel kaliteyi azalttığını ifade eder. Kalkınmanın ilk aşaması düşük gelirle karakterize edilir. Bu aşamada politika yapıcılarının öncelikli amacı çevresel koşullardan ziyade istihdamı artırarak gelir yaratmaktır. Bu durum fosil kaynaklara dayalı enerji tüketiminin artmasına yol açarak çevresel kirleticilerin çevresel kaliteyi düşürmesine yol açar. Dolayısıyla sanayi öncesinde tarımdan sanayiye geçiş aşamasında çevresel baskının arttığını ifade etmektedir (Koçak, 2024b: 657). Ekonomik büyümenin sonucunda belirli bir gelir eşiğine ulaşıldığında, ülkeler "Kompozisyon ve Teknik Etki" aşamasına geçerler. Bu aşamada ülkeler, çevreyi kirleten ekonomik büyümeden çevreye daha duyarlı bir ekonomik büyümeye geçiş için gerekli olan sermayeye sahip olurlar. Ülkeler, enerji verimliliği politikalarına sermaye ayırmaya başlarlar ve yenilenemeyen enerji kaynaklarına kıyasla çok daha maliyetli olan teknolojilere yatırım yaparlar. Dolayısıyla sanayi sektöründen hizmet sektörüne geçiş aşamasında hizmet sektörü çevre teknolojilerinin gelişimini destekleyerek çevresel kalitenin artmasına katkıda bulunur (Polat vd., 2023: 112). Panel B, LCC hipotezini göstermektedir. LCC hipotezi, EKC'nin tam aksine LCF ile ekonomik büyüme arasında U şeklinde bir ilişkinin var olduğunu ifade etmektedir. LCC hipotezi, kalkınmanın ilk aşamalarında çevreden ziyade ekonomik büyümeyi artırmak önemli olduğu için EF artmakta ve biyolojik kapasite azalmaktadır. Bu durum çevresel kaliteyi olumsuz etkilediğinden dolayı LCF azalmaktadır. Belli bir gelir düzeyine ulaştıktan sonra çevreye karşı duyarlılık arttığı için EF azalmakta ve biyolojik kapasite artmaktadır. Bu durum çevresel kaliteyi olumlu etkilediğinden dolayı LCF artmaktadır. Dolayısı ile LCC hipotezi, EKC, EF ve biyolojik kapasiteyi aynı anda ele alması bakımından farklıdır.

EKC ve LCC hipotezlerinin geçerliliği Türkiye için önemlidir. Bu hipotezlerden herhangi biri geçerliyse belirli bir eşiği geçtikten sonra ekonomik büyüme çevresel kaliteyi artırmak için bir araç olarak kullanılabilir. Birim enerji kullanımı başına üretkenlikteki artışı ifade eden yenilenemeyen enerji verimliliğindeki ve yenilenebilir enerji kullanımındaki artış ekonomik büyümeyi olumlu etkileyebilir, doğal kaynak kullanımını düşürebilir, enerji tüketimini azaltabilir ve çevresel kalitenin artmasına yardımcı olabilir. Dolayısıyla yenilenebilir enerji kullanımındaki ve yenilenemez enerji verimliliğindeki artış enerji yapısını daha çevre dostu bir yapıya dönüştürerek çevresel kalitenin iyileşmesine katkıda bulunabilir. Grafik 3'te, FEV, YEK, EB ve EBK'nın çevre üzerindeki etkilerine ilişkin teorik beklentileri göstermektedir.

Grafik: 3
Değişkenlerin İşaretlerine İlişkin Teorik Beklentiler
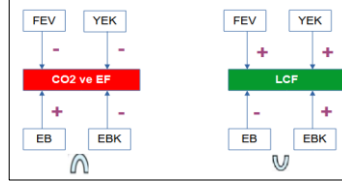
Kaynak: Pata vd., 2023a: 5.

Grafik 3'te FEV, fosil kaynaklarına dayalı yenilenemez enerji verimliliğini ve YEK ise yenilenebilir enerji kullanımını göstermektedir. FEV ve YEK'teki artışlar CO2 ve EF çevre kirleticilerini azaltmaları beklenebilir. Bu beklenti doğrultusunda EKC hipotezi gereği CO2 ve EF'in bağımlı değişkenler olduğu modeller için ekonomik büyüme ile çevresel kirleticiler arasında ters U şeklinde bir ilişki beklenmektedir. LCC hipotezi altında FEV ve YEK pozitif işaretli olması LCF'yi artırması beklenebilir. LCF ile ekonomik büyüme arasında U şeklinde bir ilişki beklenmektedir.

3. Literatür

Literatürde, ülkelerin çevresel kalitesini ortaya koyabilmek için CO2 emisyonları çevresel bir gösterge olarak kullanılmıştır. Çevresel sorunların öneminin artmasıyla CO2 çevresel göstergesi dahada genişletilerek EF literatürde kullanılmaya başlamıştır. EF ve CO2 çevresel göstergeler çevresel tüketimi dikkate aldığı için eksik bulunmuş ve biyolojik kapasiteyi de dikkate alan LCF literatürde kullanılmaya başlanmıştır. Bu çalışmada çevresel göstergelerin üçünü de (CO2, EF, LCF) dikkate alarak Türkiye'nin durumunu net bir şekilde ortaya koymaya çalışmaktadır. CO2 emisyonları ve EF üzerine yapılan çalışmalar EKC hipotezine dayanmaktadır.

Literatürde EKC hipotezinin geçerliliğini destekleyen çok sayıda çalışma yapılmıştır. Örneğin, Türkiye için Haug ve Ucal (2019), Pata (2019), Cetin vd. (2018), Bölük ve Mert (2015), Seker vd. (2015), Halicioglu (2009), Bangladeş için Voumik vd. (2022), Hasan vd. (2022), Murshed vd. (2021), Hindistan için Uche vd. (2023), Sreenu (2022), Çin için Aslam vd. (2021), Jiang vd. (2021), Usman vd. (2019), Sinha ve Shahbaz (2018), Dong vd. (2018), Jalil ve Mahmud (2009), Pakistan için Ali vd. (2021), Nadeem vd. (2020), Ullah ve Khan (2020), Malik vd. (2020), Ahmed ve Long (2012), Shahbaz vd. (2012), Nasir ve Rehman (2011), Malezya için Mehraaein vd. (2021), Suki vd. (2020), Lau vd. (2014), Saboori vd. (2012), İspanya için Balaguer ve Cantavella (2016), Esteve veTamarit (2012) çalışmalarda EKC hipotezinin geçerli olduğunu test etmişlerdir. Ancak Türkiye için Ozturk ve Acaravcı (2010), Akbostancı vd. (2009), Lise (2006), Bangladeş için Islam vd. (2023), Bulgaristan için Tsiantikoudis vd. (2019), Suudi Arabistan için Raggad (2018), 25 Afrika ülkesi için Zoundi (2017), 21 Kyoto ek ülkeleri için Mert ve Bölük (2016) çalışmalarında EKC hipotezinin geçerli olmadığını tespit etmişlerdir.

EKC hipotezinin geçerliliğini araştıran çalışmaların yanında CO2 emisyonunu ve EF'yi etkileyen faktörleri de araştıran çalışmalar yapılmıştır. Bu bağlamda çalışmalara yenilenebilir enerji kullanımı ve fosil yakıtlara dayalı yenilenemez enerji verimliliği gibi değişkenlerde dahil edilmiştir. Literatürde, enerji verimliliğinin çevre kalitesi üzerindeki etkisini inceleyen çok sayıda araştırma yapılmıştır. Çalışmalarda genellikle enerji yoğunluğu veya milli gelirin enerji tüketimine oranlanması enerji verimliliğinin göstergesi olarak kullanılmıştır. Özbuğday ve Erbas (2015) çalışmalarında OECD ülkelerinde enerji verimliliği ve yenilenebilir enerjinin CO2 emisyonları üzerindeki etkisini araştırmışlardır. Araştırmacılar 36 ülkede enerji verimliliği endeksleri oluşturmuşlar ve enerji verimliliğindeki %1'lik bir artışın CO2 emisyonlarını %0,55 oranında azalttığı sonucuna varmışlardır. Tajudeen vd. (2018) çalışmalarında 30 OECD ülkesinde enerji verimliliğinin (enerji verimliliğini temsilen enerji yoğunluğu) CO2 emisyonları üzerindeki etkisi incelemişlerdir. Sonuçlar enerji verimliliğinin çevresel kaliteyi artırdığını tespit etmişlerdir. Akram vd. (2020) çalışmalarında gelişmekte olan 66 ülkede EKC modelini kullanarak enerji verimliliğinin CO2 emisyonları üzerindeki etkisini incelemişlerdir. Enerji yoğunluğu ve regresyon sonuçları ile ortaya konan enerji verimliliği, CO2 emisyonlarını azaltabileceğini ve enerji verimliliği katsayısının yenilenebilir enerjiden daha büyük olduğunu göstermişlerdir. Kazemzadeh vd. (2022) çalışmalarında 16 gelişmekte olan ülkede enerji verimliliğinin ekolojik ayak izi üzerindeki etkisini araştırmışlardır. Bulgular, enerji verimliliğinin ekolojik ayak izini azaltabileceğini göstermişlerdir. Shokoohi vd. (2022) çalışmalarında enerji yoğunluğunu enerji verimliliğinin göstergesi olarak ele almışlardır. Ekonomik büyümenin enerji verimliliğinden önemli ölçüde etkilendiği, ancak sera gazı emisyonlarının enerji verimliliği ile önemli ölçüde ilişkili olmadığını tespit etmişlerdir. Jahanger vd. (2023) çalışmalarında enerji verimliliğinin çevre üzerindeki etkisini 29 Avrupa ülkesinde incelemiştir. Enerji verimliliğini enerji tüketiminin GSYİH'ye bölünmesi elde etmişlerdir. FMOLS, DOLS ve Granger nedensellik testlerinin sonuçları enerji verimliliğinin sera gazlarıyla mücadelede etkili bir araç olduğunu ortaya koymuşlardır. Fakher vd. (2023) çalışmalarında enerji verimliliğini temsil etmek üzere enerji yoğunluğunu seçmişlerdir. Çalışmalarında, BRICS ülkelerinde enerji verimliliği ve yenilenebilir enerjinin CO2 emisyonları üzerindeki etkisini incelemiştir. Sonuçlar enerji verimliliğinin çevresel kirliliği azalttığını ve uzun vadeli parametrenin kısa vadeli parametreden daha büyük olduğunu ortaya koymuşlardır. Zhou vd. (2023) çalışmalarında enerji verimliliğinin CO2 emisyonları üzerindeki etkisini ve Çin'de EKC'nin geçerli olup olmadığını incelemişlerdir. Enerji verimliliğini enerji tüketiminin GSYİH'ye bölünmesi elde etmişlerdir. Ulaştıkları bulgulara göre enerji verimliliği çevresel kaliteyi artırmaktadır. Chen vd. (2024) çalışmalarında enerji verimliliğinin göstergesi olarak enerji yoğunluğu seçilmiş ve enerji verimliliği en yüksek 10 ülke incelenmiştir. Bulgulara göre uzun dönemde enerji verimliliğinin CO2 emisyonları ve EF ile temsil edilen çevresel bozulmayı azalttığını ortaya koymuşlardır. Enerji verimliliğinin su kullanımını, sera gazı emisyonlarını ve diğer kirleticileri azalttığını tespit edilmiştir. Ayrıca Bataille ve Melton (2017), Xu ve Xu (2022), Akbar vd. (2022), Awan vd. (2022), Pata vd. (2023b) çalışmalarında benzer sonuçlara ulaşmışlardır. Bazı çalışmalarda yenilenebilir enerji tüketimi değişken olarak kullanılmıştır. Örneğin, MENA ülkeleri için Saadaoui (2022), Joof vd. (2023), BRICS ülkeleri için Bashir

vd. (2020), Türkiye için Özpolat ve Özsoy (2021), Karaaslan ve Çamkaya. (2022), Acaroğlu vd. (2023) çalışmalarında yenilenebilir enerjinin CO2 emisyonlarını azalttığını, 24 OECD ülkeleri için Destek ve Sinha (2020), G7 ülkeleri için Ahmed vd. (2021), Türkiye için Alnour ve Atik (2021), Acaroğlu vd. (2023), Koçak (2024a) ise çalışmalarında EF'yi azalttığını tespit etmişlerdir. Abou Houran ve Mehmood (2023), 25 Afrika ekonomisi bağlamında yenilenebilir enerjinin CO2 emisyonları üzerinde olumsuz bir etkisi olduğunu ortaya koymuşlardır. Saqib vd. (2023) çalışmalarında 1990'dan 2013'e kadar 107 ekonomide yenilenebilir enerji kullanımı ile CO2 emisyonları arasındaki korelasyonu incelemek için panel eşbütünleşme testi ile test etmişlerdir. Düşük gelirli ekonomiler için yenilenebilir enerji ile CO2 emisyonları üzerinde pozitif bir etkiye sahip olduğunu ortaya koydu. Ancak, yüksek gelirli ekonomiler için bu etki etki negatiftir. Ayrıca MENA ülkeleri için Nathaniel vd. (2021), Türkiye için Pata (2018) yenilenebilir kaynakların etkili bir şekilde kullanılmadığı için çevresel bozulmayı önlemeye yardımcı olmadığı sonucuna varmışlardır.

Literatürde EKC, EF ve biyolojik kapasiteyi aynı anda ele alan LCC hipotezinin geçerliliğini destekleyen sınırlı sayıda çalışma yapılmıştır. Örneğin Türkiye için, Dam ve Sarkodie (2023), Afshan ve Yagoob (2023), Güneysu (2023), 26 OECD ülkesi için Güloğlu vd. (2023), BRICS için Çağlar vd. (2023), Meksika için Huilan vd. (2024). ASEAN ülkeleri için Dai vd. (2023), G7 ülkeleri için Doğan ve Pata (2022) çalışmalarında LCC hipotezinin geçerli olduğunu ortaya koymuşlardır. Ancak En İyi Turizm Destinasyonu Olan İlk On Ülke için Pata ve Tanriover (2023), Hindistan için Alola vd. (2023), G20 ülkeleri için Liv d. (2023) çalışmalarında LCC hipotezinin geçerli olmadığını tespit etmişlerdir. Pata vd. (2023) çalışmalarında Almanya için 1974-2018 yıllarını kapsayan dönemde CO2 Emisyonu, EF, LCF, ekonomik büyüme, yenilenebilir enerji ve nükleer enerji Ar-Ge harcamaları arasındaki ilişkileri FADL eşbütünleşme, FMOLS, DOLS yöntemleri ile araştırmışlardır. Bulgulara göre Almanya da EKC hipotezi geçerli ancak LCC hipotezi geçersizdir. Ayrıca yenilenebilir enerji çevresel kaliteyi artırdığını tespit etmişlerdir.

Genel olarak literatürü özetlemek gerekirse, mevcut literatürde aynı çalışmada yenilenemez enerji verimliliğini LCF kavramı içerisinde ele alan sınırlı sayıda çalışma yapılmıştır. Ancak yenilenebilir enerji tüketimi ve ekonomik büyümenin etkisi çok daha fazla araştırmaya konu edildiği görülmektedir. Ulusal literatürde yenilenemez enerji verimliliğinin çevresel bozulma üzerindeki etkilerini LCF bağlamında inceleyen bir çalışmaya rastlanılmaması bir araştırma açığıdır. Dolayısıyla bu çalışma, kapsamlı bir yaklaşımla Türkiye'ye odaklanarak mevcut literatüre katkıda bulunmayı, yenilenebilir enerji kullanımı ve yenilenemez enerji verimliliğinin enerji krizine karşı bir seçenek olarak kullanılmasını düşünenler için çıkarımlar sunmayı amaçlamaktadır.

4. Veri Seti

Çalışma, Türkiye'de yenilenemez enerji verimliliğinin ve ekonomik büyümenin yük kapasitesi faktörü üzerindeki etkisini araştırmak için 1982'den 2022'ye kadar yıllık verileri kullanmaktadır. Kişi başına düşen fosil enerji tüketim verileri 1982 yılından itibaren mevcut olduğu ve son dönem verileri olmadığı için zaman aralığı bu şekilde oluşturulmuştur. EKC

ve LCC hipotezlerinin geçerli olup olmadığını ortaya koyabilmek için ekonomik büyümenin karesi (EBK) çalışmaya eklenmiştir. Tablo 1'de çalışmada kullanılan seriler ve serilerin hangi kaynaklardan elde edildiği sunulmaktadır.

Çalışmada kullanılan tüm serilerin, heteroskedastisite sorununu önlemek, seriler arasındaki boyut farklılığını azaltmak ve esneklikleri hesaplamalarını daha iyi bir şekilde yapabilmek için logaritmik dönüşümleri yapılmıştır. Çalışmada 1 ABD doları gelir elde etmek için ne kadar yenilenemeyen enerji kullanmak gerektiğini ortaya koyan yenilenemeyen enerji verimliliğini değişken olarak kullanılmıştır. Yenilenemeyen enerji verimliliğini $\frac{GDP}{\text{Yenilenemeyen Enerji Tüketimi}}$ formülü yardımı ile hesaplanmıştır (Alola et al., 2023). Ekonomik büyüme değişkenini temsil eden 2015 yılı baz alınarak hesaplanan kişi başına düşen GSYH dikkate alınmıştır.

Tablo: 1
Çalışmada Kullanılan Değişkenler

Kısaltmalar	Açıklama	Kaynak
lnLCF	Yük Kapasitesi Faktörü (Kişi başına düşen Küresel hektar alan)	Global Footprint Network
lnEF	Ekolojik Ayak İzi (Kişi Başına Düşen Küresel Hektar Alan)	Global Footprint Network
lnCO2	CO2 Emisyonları (Kişi Başına Düşen Ton)	Our World in Data
lnFEV	Yenilenemeyen Enerji Verimliliği ($/kWh)	Our World in Data, World Bank
lnYEK	Yenilenebilir Enerji kullanımı (Kişi Başına kWh)	Our World in Data
lnEB	Ekonomik Büyüme (Kişi Başına GSYH)	World Bank
lnEBK	Ekonomik Büyümenin karesi (Kişi Başına GSYH Karesi)	-

Çalışmada EKC ve LCC hipotezlerini analiz etmek için üç farklı model kullanılmıştır. Modeller Denklem (1), Denklem (2) ve Denklem (3)'te sunulmaktadır.

$$\text{Model 1: } \ln CO2_t = \rho_0 + \rho_1 \ln FEV_t + \rho_2 \ln YEK_t + \rho_3 \ln EB_t + \rho_4 \ln EBK_t + e_t \tag{1}$$

$$\text{Model 2: } \ln EF_t = \tau_0 + \tau_1 \ln FEV_t + \tau_2 \ln YEK_t + \tau_3 \ln EB_t + \tau_4 \ln EBK_t + u_t \tag{2}$$

$$\text{Model 3: } \ln LCF_t = \beta_0 + \beta_1 \ln FEV_t + \beta_2 \ln YEK_t + \beta_3 \ln EB_t + \beta_4 \ln EBK_t + w_t \tag{3}$$

Denklemlerde t zamanı, ρ_0, τ_0 ve β_0 sabit terimleri, $\rho_{1,2,3,4}$, $\tau_{1,2,3,4}$ ve $\beta_{1,2,3,4}$ bağımsız değişkenlerin katsayılarını, e_t, u_t ve w_t ise hata terimlerini göstermektedir. EKC hipotezi geçerliyse lnEB değişkenlerinin katsayıları olan ρ_3, τ_3'ün değerleri pozitif, lnEBK değişkenlerinin katsayıları olan ρ_4, τ_4'ün değerleri ise negatif olmalıdır. LCC eğrisinin geçerliliği için ise lnEB değişkeninin katsayısı olan β_3'ün değeri negatif, lnEBK değişkeninin katsayısı olan β_4'ün değeri ise pozitif olmalıdır. Bu bağlamda LCC hipotezinin geçerliliği için lnEB ve lnEBK değişkenlerinin esnekliklerinin işaretleri yer değiştirmekte ve ekonomik büyüme ile çevre kalitesi arasında U şeklinde bir ilişki beklenmektedir.

Grafik: 4
Değişkenlerin Zaman Yolu Grafikleri
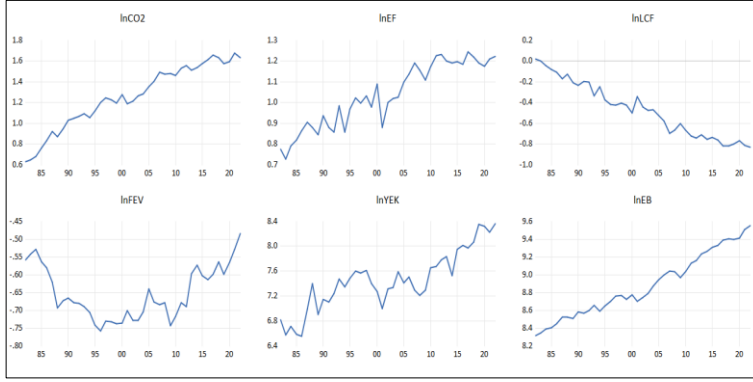
Analize başlamak için ilk adım, makalede kullanılan zaman serilerinin (değişkenlerin) görsel olarak zaman grafiği özelliklerini (trend, sapmalar, yapısal kırılmalar, mevsimsellik vs.) kontrol etmektir. Çünkü değişkenlerin zaman grafiği özellikleri dikkate alınmazsa regresyon sonuçları yanıltıcı olabilir. Grafik 4'te değişkenlerin zaman yolu grafikleri raporlanmıştır.

Grafik 4'te zaman yolu grafikleri incelendiğinde tüm serilerin birim kök içerdikleri söylenebilir. Serilerin birim kök içerip içermediğinin birim kök testleriyle sınanması gerekir.

Tablo 2'de değişkenlere ilişkin tanımlayıcı istatistikler sunulmaktadır.

Tablo: 2
Değişkenlere İlişkin Tanımlayıcı İstatistikler

	lnCO2	lnEF	lnYKF	lnFEV	lnYEK	lnEB	lnEBK
Ortalama	1.256507	1.035869	-0.469366	-0.651690	7.451245	8.878563	78.95277
Medyan	1.264360	1.026482	-0.471449	-0.679109	7.412511	8.772544	76.95753
Maksimum	1.675230	1.245956	0.019510	-0.484833	8.366657	9.550741	91.21665
Minimum	0.629233	0.727493	-0.831418	-0.758214	6.553187	8.317860	69.18679
Standart Sapma	0.303979	0.154202	0.263862	0.073513	0.477008	0.356358	6.365490
Çarpıklık	-0.458097	-0.265731	0.232005	0.453138	0.058050	0.291724	0.339704
Basıklık	2.176769	1.746326	1.788712	2.024667	2.570407	1.898838	1.921239
Jarque-Bera	2.591749	3.167506	2.874312	3.028212	0.338300	2.652990	2.776588
Olasılık	0.273658	0.205204	0.237603	0.220005	0.844382	0.265406	0.249501
Gözlem Sayısı	41	41	41	41	41	41	41

Tablo 2'ye göre, beklendiği gibi, EBK'nin ortalaması en büyüktür. Bunu LNEB ve LNYEK değişkeni takip etmektedir. Ayrıca, değişkenlerin standart sapma değerleri bakımından LNEBK'nin büyük olduğunu göstermekte, bu da bu değişkenin oldukça oynak olduğunu ve diğer değişkenlerin daha az oynaklığa sahip olduğunu ortaya koymaktadır. Tüm değişkenlerin basıklık değerleri pozitiftir. Çarpıklık değerleri ise lnCO2 ve lnEF değişkenleri dışındaki değişkenler ise pozitiftir. Sonuç olarak tüm değişkenlerin Jarque-Bera

istatistiklerinin ve olasılıklarının değerleri normal dağılıma sahip olmadıklarını göstermektedir.

5. Ekonometrik Yöntem

5.1. Birim Kök Testleri

Birim kök testleri serilerin durağanlığını incelemek için kullanılmaktadır. Eğer durağan olmayan seriler kullanılırsa model, sahte regresyon sorunuyla karşı karşıya kalabilir. Dolayısıyla ekonometrik metodolojinin ilk aşaması olarak araştırmaya dahil edilen serilerin birim kök özellikleri ortaya koyulacaktır. Bu doğrultuda, serilerin birim kök özelliklerinin incelendiği bu çalışmada Augmented Dickey ve Fuller (1979) ve Phillips ve Perron (1988) birim kök testleri kullanılmıştır. Ancak, geleneksel birim kök testleri birim köklerdeki yapısal değişiklikleri açıklayamamaktadır. Zaman serilerinde yapısal kırılmalar yaşandığında birim kök içeren seriler birim kök içermemiş gibi görülebilir (Aytaç & Duran, 2010: 141). Bu nedenle, analiz dönemi yapısal kırılmalar yaratabilecek deprem, ulusal ve uluslararası krizler gibi olayları içerdiğinden dolayı, yapısal kırılmaları içeren Kapetanios (2005) testi de kullanılmıştır. Birim kök testleri çalışmada ele alınan serilerin en fazla I(1) mertebesinde entegre olduğunu gösteriyorsa, bu durum çalışma değişkenleri arasında uzun dönem denge ilişkilerinin varlığına işaret etmektedir.

5.2. Kesirli Fourier ARDL

Pesaran vd. (2001) tarafından geliştirilen ARDL yaklaşımı, farklı bütünleşme mertebelerine sahip serilerin analizine izin verdiği için araştırmacılar tarafından yaygın olarak kullanılmaktadır. Bunun temel nedeni testin bağımsız değişkenlerin entegrasyon derecesine bakılmaksızın ARDL sınır testi kullanılabilir ve test küçük örneklerde bile iyi boyut ve güç özelliklerine sahiptir (Narayan, 2005). ARDL Sınır testini uygulamak için Denklem (4)'teki model tahmin edilir:

$$\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta Y_{t-i} + + \sum_{i=0}^{q} \delta_i \Delta X_{t-i} + e_t \qquad (4)$$

Eşitlik (4)'te β_0 sabit terimi, p ve q bilgi kriterlerine göre belirlenen optimal gecikme uzunluklarını, φ_i ve δ_i kısa dönem katsayılarını, β_1 ve β_2 uzun dönem katsayılarını, e_t hata terimini göstermektedir. Peseran vd. (2001)'e göre bir eş bütünleşmenin varlığı F-test (FA) ve t-test (t) kullanılarak Eşitlik (5)'te gösterilen boş hipotezlerin reddedilmesi gerektiğini ifade etmişlerdir.

$$\text{FA test için } H_0: \beta_1 = \beta_2 = 0 \text{ ve t test için } H_0: \beta_1 = 0 \qquad (5)$$

FA hipotezi bir F-testi kullanılarak test edilebilirken, t test hipotezi bir t-testi kullanılarak incelenebilir. McNown vd. (2018), bağımsız değişkenlerin anlamlılığını birlikte test etmek için Eşitlik (6)'daki FB hipotezini önererek bu testleri tamamlamaktadır:

$$\text{FB test için } H_0: \beta_2 = 0 \qquad (6)$$

Bir eşbütünleşme ilişkisinin geçerli olabilmesi için üç testin (FA, t, FB) boş hipotezi reddedilmelidir. Herhangi bir testin boş hipotezi reddedilemezse, iki dejenere durum ortaya çıkar.

Dejenere Durum 1: FA ve FB testleri anlamlı, t testi anlamsız ise dejenere (1) gerçekleşir.

Dejenere Durum 2: FA ve t testleri anlamlı, FB testi anlamsız ise dejenere (2) gerçekleşir.

Her iki dejenere durumda seriler arasında eşbütünleşme ilişkisi yoktur. ARDL Sınır testi, yapısal değişikliklerin modele dahil edilmemesi ve uzun dönemli ilişkide yapısal bir kırılmanın fark edilmemesi gibi durumlarda yanlış çıkarımlara yol açabilir. Bu noktada Solarin (2019), Pata ve Aydin (2020) ile Yılancı ve Pata 2020), Fourier yaklaşımını kullanarak bootstrap ARDL modelini yapısal kırılmaları içerecek şekilde genişletmişlerdir. Ancak Solarin (2019), Pata ve Aydin (2020) frekansları tam sayı [k =1..., 3..., 5] olarak kabul etmiştir. Tamsayı frekanslar geçici kırılmaları, kesirli frekanslar ise kalıcı kırılmaları temsil etmektedir (Christopoulos & Leon-Ledesma, 2011). Yılancı ve Pata (2020) ARDL yöntemindeki Fourier fonksiyonlarını kesirli frekansları [k =0.1, ..., 0.3 ..., 4.8, ..., 5] dikkate alarak kalıcı kırılmaları hesaba katacak şekilde uyarlamıştır. Kesirli Frekans Fourier ARDL yöntemi için, Denklem (7)'ye Fourier yaklaşımları eklenerek model aşağıdaki gibi düzenlenebilir.

$$\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-1} + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_1 \cos\left(\frac{2\pi kt}{T}\right) + \sum_{i=1}^{p} \varphi_i \Delta Y_{t-i} + \sum_{i=0}^{q} \delta_i \Delta X_{t-i} + e_t \tag{7}$$

Denklem (7)'de sin sinüsü, cos kosinüsü, k kesirli frekansı, π=3.1416'yı, t trendi ve T gözlem sayısını göstermektedir.

5.3. Fourier Toda-Yamamoto Nedensellik Testi

Araştırmacılar değişkenler arasındaki nedensellik ilişkisi incelerken genellikle VAR modeline dayanan Granger'ın (1969) nedensellik yöntemini kullanırlar. Bu testin kullanılabilmesi için serilerin durağan olması gerekmektedir. Nedensellik, durağan olmayan veriler üzerinde fark alma işlemi gerçekleştikten sonra test edilir. Ancak, farkın alınması uzun vadeli bilgi kaybına yol açabilir. Toda-Yamamoto (1995) nedensellik testi (TY) ile bilgi kaybının önüne geçilerek Granger Nedensellik Testinin eksiklikleri giderilmiştir. TY (1995), (p + d) dereceden bir VAR modeli kurulmasını önermektedir. Nazlıoğlu vd. (2016) çalışmalarında, TY nedensellik testine Fourier fonksiyonlarını eklemiş ve kırılmaların sayısı, tarihi ve şekline ilişkin ön bilgiye gerek olmadığını belirtmiştir. Bu çalışmada, Nazlıoğlu vd. (2016) çalışmalarını takip ederek, gecikmesi artırılmış VAR modeli Eşitlik (8), Eşitlik (9)'daki gibi tahmin edilmektedir.

$$\Delta Y_t = \beta_0 + \beta_1 \sin\left(\frac{2\pi kt}{T}\right) + \beta_2 \cos\left(\frac{2\pi kt}{T}\right) + \sum_{i=1}^{m+d\,max} \theta_i Y_{t-i} + \sum_{i=1}^{m+d\,max} \varphi_i X_{t-i} + u_t \tag{8}$$

$$\Delta X_t = \delta_0 + \delta_1 \sin\left(\frac{2\pi kt}{T}\right) + \beta_2 \cos\left(\frac{2\pi kt}{T}\right) + \sum_{i=1}^{m+d\,max} \varphi_i Y_{t-i} + \sum_{i=1}^{m+d\,max} \theta_i X_{t-i} + v_t \tag{9}$$

Eşitlik (8) ve Eşitlik (9)'da m ve $d$max parametreleri değişkenlerin optimal gecikme uzunluğunu ve maksimum bütünleşme mertebesini göstermektedir. Modele bu parametrelerin dahil edilmesinin nedeni durağan olmama durumunda değişkenlerin farkları alınırken uzun dönem bilgi kaybı sorununu ele almaktadır. Çalışmada Pata ve Yılancı (2020) çalışmalarındaki önerisini izlenerek, [0.1, 0.2, 0.3, ...,5] aralığındaki tüm kesirli değerler için VAR modelini tahmin edilerek ve karesel artıkların toplamını en aza indiren değeri optimal frekans değerini (k) olarak belirlenmektedir. X'ten Y'ye nedensellik olmadığını test etmek için, Eşitlik (8)'deki θ_i 'lerin anlamlılığı bir Wald testi kullanılarak test edilmektedir. Eşitlik (9)'daki φ_i 'nin anlamlılığını incelenerek ve bootstrap simülasyonları ile gerekli kritik değerler elde edilerek Y'den X'e nedenselliğin olmadığı boş hipotezini test edilmektedir.

6. Bulgular

Çalışmanın bu bölümünde ekonometrik analizler sonucu ulaşılan bulgular paylaşılmaktadır.

6.1. Birim Kök Testleri

ARDL sınır testi yaklaşımına göre değişkenlerin tümü ya birinci farkta (I(1)), ya düzeyde (I(0)) ya da her iki durumun kombinasyonundan (I(0,1)) oluşmalıdır. Bu model, 1'den daha yüksek mertebeden (I(2) veya üzeri) entegrasyona sahip seriler için kullanılamaz. ARDL modelini tahmin etmeden önce verilerin bütünleşme sırasını araştırmak üzere üç farklı birim kök testi uygulanmaktadır. Çalışmanın değişkenleri üzerinde yapılan DF ve ADF birim kök testlerinin sonuçları Tablo 3'te raporlanmaktadır.

Tablo: 3
ADF ve PP Birim Kök Sonuçları

Değişkenler	ADF Test İstatistiği		PP Test İstatistiği	
	Sabitli	Sabitli Trendli	Sabitli	Sabitli Trendli
LNYKF	-1.599762	-3.190582	-1.525939	-3.124532
LNFEV	-0.842868	-1.105621	-0.895259	-0.849350
LNYEK	-1.085147	-3.068897	-0.644104	-3.063926
LNEB	0.398827	-2.064988	1.102921	-2.064988
LNEBK	0.604314	-1.830240	1.456824	-1.855903
ΔLNYKF	-6.989494*	-7.183076*	-10.94801*	-16.67066*
ΔLNFEV	-5.680857*	-6.558541*	-5.660943*	-7.409848*
ΔLNYEK	-8.109267*	-7.995710*	-9.383299*	-9.232504*
ΔLNEB	-6.566220*	-6.576359*	-6.906350*	-7.589923*
ΔLNEBK	-6.443735*	-6.590560*	-6.562228*	-7.498713*
Kritik Değerler				
%1	-3.616	-4.205	-3.616	-4.205
%5	-2.941	-3.527	-2.941	-3.527

*Not: * ve ** sırasıyla %1, %5 anlamlılık seviyelerini ifade etmektedir. Δ sembolü birinci mertebeden farkı alınmış seriyi ifade eder.*

Tablo 3'teki sonuçlar, tüm değişkenlerin seviyelerinde birim köklere sahip olduğunu göstermektedir. Değişkenlerin birinci farkta birim kök içerip içermediğini test etmek için birinci farkları alınmıştır ve seriler birim kök içermediği görülmüştür. Birinci farkları alınmış değişkenlerin önüne delta (Δ) konulmuştur. Ayrıca, serilerdeki olası yapısal kırılmaları değerlendirmek için 5 yapısal kırılmaya kadar izin veren Kapetanios (2005) birim kök testi yapılmıştır. Sonuçlar Tablo 4'te raporlanmaktadır.

Tablo: 4
Kapetanios (2005) Çoklu Yapısal Kırılmalı Birim Kök Testi (5 Kırılmalı)

Değişkenler	Test İstatistiği	Kritik Değerler		Kırılma Sayısı	Kırılma Tarihleri
		%1	%5		
LNYKF	-10.1011*	-9.039	-8.343	5	1987, 1994, 2000, 2006, 2016
LNFEV	-8.32459*	-8.243	-7.736	4	1987, 1994, 2004, 2012
LNYEK	-5.92273	-8.243	-7.736	4	1988,1998, 2006, 2013
LNEB	-6.01539	-9.039	-8.343	5	1987, 1993, 2000, 2007, 2014
LNEBK	-5.9561	-9.039	-8.343	5	1987, 1993, 2000, 2007, 2014
ΔLNYEK	-10.8759*	-9.039	-8.343	5	1988, 1995, 2001, 2009, 2014
ΔLNEB	-8.90523**	-9.039	-8.343	5	1989, 1994, 2001, 2009, 2017
ΔLNEBK	-8.86647	-9.039	-8.343	5	1989, 1994, 2001, 2009, 2017

*Not: * ve ** sırasıyla %1, %5 anlamlılık seviyelerini ifade etmektedir.*

Tablo 3 ve 4'teki birim kök analiz sonuçları değerlendirildiğinde, tüm değişkenler ya düzeyde I(0) ya da birinci farkla I(1) durağan oldukları, ikinci farkta I(2) durağan olmadıkları tespit edilmiştir. Seriler durağanlıkla ilgili koşulu sağladığı için sonraki aşama olan eş bütünleşme aşamasına geçilmiştir.

6.2. Eşbütünleşme Analizi

Serinin durağanlığı belirledikten sonra, değişkenler arasında uzun dönemde eş bütünleşme ilişki olup olmadığını ortaya kayabilmek için Kesirli Fourier ARDL Sınır Testi kullanılmıştır. Model 1, Model 2 ve Model 3 için optimal gecikme uzunlukları, uygun frekans değerleri, üç testin (FA, FB, t) istatistik değerleri ve kritik değerleri Tablo 5'te raporlanmaktadır.

Tablo: 5
Fourier Terimleri ile Eş Bütünleşme Test Sonuçları

Modeller	Gecikme Uzunluğu	K*	Test İstatistikleri		Üst Kritik Değerler I(1)		
					%1	%5	%10
Model 1 lnCO2 = f(lnFEV, lnYek, lnEB, lnEBK)	1, 0, 0, 0, 1	1.33	FA	35.120**	6.25	4.54	3.83
			t	-9.22**	-4.60	-3.99	-3.66
			FB	34.07**	6.39	4.54	3.76
Model 2 lnEF = f(lnFEV, lnYek, lnEB, lnEBK)	1, 0, 0, 1, 0	3.69	FA	14.853**	5.72	4.57	4.06
			t	-7.89**	-4.96	-4.36	-4.04
			FB	11.794**	6.55	4.54	3.72
Model 3 lnLCF = f(lnFEV, lnYek, lnEB, lnEBK)	2, 0, 2, 2, 2	3.61	FA	8.137**	6.25	4.54	3.84
			t	-4.728**	-4.60	-3.99	-3.66
			FB	7.587**	6.63	4.67	3.82

*Not: * Model 1 ve Model 3 AIC bilgi kriterine göre, Model 2 SC bilgi kriterine göre belirlenen uygun frekans değerini, ** %1 düzeyinde anlamlılığı ifade etmektedir.*

Tablo 5'teki verilere göre, uygun frekans değerleri Model 1, Model 2 ve Model 3 için kesirli olarak hesaplanmıştır. Frekans değerinin kesirli olarak bulunması kırılmaların kalıcı olduğunu göstermektedir. Tam eş bütünleşme olabilmesi için her üç test istatistiğinin de üst sınır kritik değerlerini aşması gerekmektedir. Her üç model içinde FA, t, FB test istatistikleri kritik değerlerden mutlak olarak büyük olduğu tespit edilmiştir. Buna göre her üç model için de, FA, t ve FB test istatistiğinin %1 düzeyinde istatistiki olarak anlamlı olduğunu ortaya koymaktadır. Dolayısıyla bu sonuç değişkenler arasında uzun dönemde eşbütünleşme ilişkisi olduğunu kanıtlamaktadır. Diğer bir ifade ile Türkiye ekonomisinde lnFEV,lnYEK, lnEB ve lnEBK bağımsız değişkenlerinin lnCO2, lnEF ve lnLCF bağımlı değişkenleri

üzerindeki etkisini doğrulamaktadır. Bu ampirik bulgular, politika yapıcılarının yenilenemez enerji verimliliğini artırmaya yönelik önlemler almasına, yenilenebilir enerji tüketimini teşvik etmesine ve çevresel sürdürülebilirliği artırmak için yenilikçi enerji politikası yol haritaları oluşturmasına yardımcı olabilir.

Tablo: 6
Diagnostik Testler

	CO2	EF	LCF	Karar*
Serial Correlation	0.056321 (0.9453)	0.157078 (0.8554)	0.905197 (0.4190)	✓
Ramsey Reset	2.343032 (0.1363)	2.618927 (0.1164)	4.578802 (0.0532)	✓
Jargue-Bera	5.438107 (0.0660)	3.739328 (0.1541)	0.172369 (0.91743)	✓
White	1.096476 (0.3919)	0.557267 (0.8204)	0.727130 (0.7286)	✓
ARCH	1.528889 (0.2241)	0.093338 (0.7617)	0.969942 (0.3313)	✓
Cusum**	İstikrarlı	İstikrarlı	İstikrarlı	✓
Cusumsq**	İstikrarlı	İstikrarlı	İstikrarlı	✓

Not: Parantez içerisindeki rakamlar olasılık değerlerini ifade etmektedir.
*: ✓işareti tanı testlerinin sorunsuz olduğunu göstermektedir.
**: Grafik 5'e bakınız.

ARDL modeli, sonuçların doğruluğunu ve güvenilirliğini sağlamak için bir dizi tanısal test sonuçları Tablo 6'da raporlanmıştır. Tablo 6'daki veriler değerlendirildiğinde, kurulan modelin tanı testlerinden geçtiği görülmektedir. ARDL modellerinde katsayıların kararlılığı Brown vd. (1975) tarafından geliştirilen CUSUM ve CUSUM-SQ testleri kullanılarak analiz edilmektedir. Grafik 5'te CUSUM ve CUSUM-SQ sunulmaktadır.

Grafik: 5
CUSUM ve CUSUM-SQ

Kesirli Fourier fonksiyonlu ARDL modelinde sınır testi sonuçlarına göre seriler arasında eş bütünleşik bir ilişki var olduğu için, seçilen ARDL modelinin kısa ve uzun dönem tahminlerinin sonuçları Tablo 7'de sunulmuştur.

Tablo: 7
Kısa ve Uzun Dönem Katsayılar (Fourier Terimleriyle Birlikte)

Seriler		CO2		EF		LCF	
		Katsayı	Olasılık	Katsayı	Olasılık	Katsayı	Olasılık
Uzun Dönem	lnFEV	-1.032*	0.000	-0.269**	0.048	0.694*	0.000
	lnYEK	-0.204*	0.000	-0.077*	0.000	0.104*	0.000
	lnEB	5.738**	0.014	6.227*	0.000	-3.640*	0.007
	lnEBK	-0.258**	0.043	-0.308*	0.001	0.156**	0.036
	Dönüm Noktası	67,440 $		24,532 $		116,477 $	
Kısa Dönem	ECT$_{t-1}$	-0.846*	0.000	-0.985*	0.000	-0.889*	0.000

*Not: *, ** ve *** yıldız işaretleri sırasıyla %1, %5 ve %10 düzeyinde anlamlılığı temsil etmektedir.*

Tablo 7'deki veriler incelendiğinde, uzun dönem katsayılarına göre, EKC hipotezi CO2 ve EF için geçerlidir. Gelir düzeyi ile bu iki çevresel kirletici arasında ters U şeklinde bir ilişki vardır. Çalışmanın sonuçları Haug ve Ucal (2019), Pata (2019), Cetin vd. (2018), Bölük ve Mert (2015), Halicioglu (2009). Seker vd. (2015) çalışmaları ile uyumludur. Çevresel kalite, kişi başına düşen gelir yıllık olarak CO2 için 67.440 $, EF için 24.532 dolara

ulaşana kadar azalması, söz konusu değerlere ulaştıktan sonra ise çevresel kalite artması beklenmektedir. Dolayısı ile söz konusu değerler dönüm noktası olarak ifade edilmektedir. TÜİK verilerine göre Türkiye'de 2023 yılı itibari ile kişi başına düşen milli gelir 13.110 $ ile dönüm noktası değerlerinin oldukça gerisinde kalmaktadır. Diğer bir ifade ile Türkiye henüz çevresel kaliteyi artıracak gelir düzeyine ulaşamamıştır. Ayrıca çalışmada ulaşılan bulgular lnEB katsayısının pozitif, lnEBK katsayısı negatif ve anlamlı olduğu için LCC hipotezinin geçerli olduğunu ortaya koymaktadır. Çalışmanın sonuçları Dam ve Sarkodie (2023), Afshan ve Yagoob (2023), Güneysu (2023) çalışmaları ile örtüşmektedir.

Yenilenemez enerji verimliliği, Türkiye'nin CO_2 ile EF'sini azaltmak ve LCF'yi artırmak için etkili bir politika aracıdır. Kesirli Fourier ARDL modeli sonuçları, yenilenemez enerji verimliliğindeki %1'lik artışın uzun dönemde CO_2 ve EF'yi sırasıyla %1.032 ve %0.376 oranında azaltabileceğini göstermektedir. Aynı şekilde yenilenemez enerji verimliliğindeki %1'lik artışın uzun dönemde LCF'yi 0.694 oranında artırabilir. Çalışmanın sonuçları Özbuğday ve Erbas (2015), Tajudeen vd. (2018), Akram vd. (2020), Kazemzadeh vd. (2022), Jahanger vd. (2023), Zhou vd. (2023), Chen vd. (2024) çalışmaları ile uyumludur.

Yenilenebilir enerji kullanımının uzun vadede CO_2, EF, LCF göz önünde bulundurulduğunda çevre kalitesi üzerinde etkisinin olduğu görülmektedir. Kesirli Fourier Genişletilmiş ARDL modeli sonuçları, yenilenebilir enerji kullanımındaki %1'lik artışın uzun dönemde CO_2 ve EF'yi sırasıyla %0.204 ve %0.0830 oranında azaltabileceğini göstermektedir. Aynı şekilde yenilenebilir enerji kullanımındaki %1'lik artışın uzun dönemde LCF'yi 0.104 oranında artırabilir. Yenilenebilir enerjinin CO_2, EF ve LCF açısından çevre kalitesi üzerinde uzun vadeli bir etkisi düşük düzeydedir. Türkiye'nin toplam enerji tüketiminde yenilenebilir enerjinin payı 1982 yılında %24.37 iken fosil bazlı enerji tüketimindeki artışın etkisiyle azalarak 2020 yılında %13.72 düzeyine düşmüştür (WDI, 2022). Türkiye, yenilenebilir enerjinin toplam enerji kullanımındaki payını 2035 yılına kadar %23,7'ye çıkarmak istemektedir (UEP, 2022: 19). Araştırmanın sonuçları, Türkiye'de yenilenebilir enerjinin çevre kalitesi üzerinde pozitif etkisi olduğunu göstermektedir ve bu sonuç Türkiye gibi gelişmekte olan pek çok ülkenin sonuçlarıyla da örtüşmektedir.

Araştırma, Hata Düzeltme Teriminin (ECT) test edilen tüm modellerde istatistiksel olarak anlamlı ve negatif olduğunu göstermektedir. Bu da çevresel göstergeler ile diğer sistem faktörleri arasında uzun dönem ilişkisinin varlığına işaret etmektedir. Özellikle, CO_2, EF ve LCF'nin bağımlı değişkenler olarak eklendiği modellerde ECT 0 ile -1 arasında değişmektedir. Bu, uzun dönem denge seviyesinden herhangi bir sapmanın, sistem farklı değişkenler arasındaki dengeyi yeniden kurmak için ayarlandıkça kısa dönemde düzeltilebileceğini göstermektedir.

CCR ve DOLS yöntemlerini kullanarak uzun vadeli katsayıların sağlamlığı test edilmektedir. Sonuçlar Tablo 8'de raporlanmaktadır.

çevresel gösterge ile nedensel bir ilişkisi yoktur. Bu durum yenilenebilir enerji tüketiminin çevresel kalite göstergelerini düşük düzeyde etkilediğini ifade etmektedir. Bu da mevcut yenilenebilir enerji tüketiminin Türkiye'deki çevre sorunlarını çözmek için yeterli olmadığını göstermektedir.

7. Sonuç

Çalışmada, EKC ve LCC hipotezlerinin Türkiye için geçerli olup olmadığı çeşitli zaman serisi yöntemleri kullanılarak incelenmiştir. Bu bağlamda, yenilenebilir enerji kullanımı ve gelirin çevresel göstergeler üzerindeki etkisini analiz etmek için Fourier genişletilmiş ARDL modeli uygulanmıştır.

Analiz sonuçlarına göre yenilenemeyen kaynaklardan sağlanan enerjinin verimli kullanılması uzun dönemde çevre kalitesini iyileştirmektedir. Yenilenemeyen enerji verimliliğinin %1 artması CO_2'yi %1.032, EF'yi %0.269 azaltmakta, LCF'yi ise %0.694 artırmaktadır. Fourier Toda-Yamamoto Nedensellik Testi Sonuçlarına göre yenilenemez enerji verimliliğinden ekolojik ayak izine doğru tek yönlü, yük kapasitesi faktörüne doğru çift yönlü nedensellik ilişkisinin olması yenilenemez enerji verimliliğinin çevre kalitesinde önemli bir rol oynadığını göstermektedir. Yenilenebilir enerji kaynaklarının kullanılması uzun dönemde çevresel kaliteyi olumlu etkilemektedir. Yenilenebilir enerji kaynaklarının kullanımı %1 arttığında CO_2'yi %0.204, EF'yi %0.077 azaltmakta, LCF'yi ise %0.104 artırmaktadır. Ancak yenilenebilir enerji kullanımı ile CO_2, EF ve LCF arasından bir nedensellik ilişkisi tespit edilememiştir. Bu durum, mevcut yenilenebilir enerji tüketiminin Türkiye'nin çevre sorunlarının çözümünde yetersiz olduğunu ve yenilenebilir enerji kullanımının çevre kalitesinin iyileştirilmesinde itici bir güç olmadığını göstermektedir. Ayrıca Türkiye'de kişi başına düşen gelirin çevresel bozulmayı azaltabileceği tespit edilmiştir. Bu tespit EKC ve LCC hipotezlerinin Türkiye için geçerli olduğunu ortaya koymaktadır. CO_2 emisyonları ve EF için dönüm noktaları sırası ile yıllık olarak kişi başına 67.440 $ ve 24.532 $ dolar olarak hesaplanmıştır. Yük kapasitesi faktörü için bu değer 116.477 $ olarak hesaplanmıştır. Tüm dönüm noktaları Türkiye'nin kişi başına düşen gelir seviyesinin (2023 yılı itibarıyla 13.110$) üzerinde olduğundan, ülke ekonomisi büyüdükçe kirlilik artmaya devam etmektedir. CO_2 ve EF'nin azalması kişi başına düşen milli gelirin artmasına bağlı olarak sonraki yıllarda mümkün olacaktır. Tam aksine LCF hem CO_2'yi hem EF'yi hem de biyokapasiteyi de kapsadığı için diğer iki çevresel göstergeye göre daya yüksek gelir seviyesi gerekmektedir. Yenilenemez enerji verimliliğinin ve yenilenebilir enerji kullanımının artması çevre kalitesini iyileştirebilecek enerji kaynaklarıdır. Ancak yenilenebilir enerji kullanımı fosil yakıtlara dayalı yenilenemez enerji verimliliğine göre çevre kalitesini artırma etkisi düşük düzeyde kalmaktadır.

Ulaşılan ekonometrik bulgular politika yapıcıları için yol gösterici olabilir. Bu doğrultuda çalışma politika yapıcılarına bazı öneriler sunmaktadır.

- Ekonomik büyüme çevresel sürdürülebilirliği bozmaktadır. Bu nedenler politika yapıcılar, yeşil büyümeye geçiş için yeşil teknolojilere yapılan yatırımları teşvik

etmelidirler. Dolayısıyla ekonomik faaliyetler uygun teşviklerle daha çevre dostu girişimlere kaydırılmalıdır.

- Türkiye çevresel kaliteyi artırmak için gerekli olan dönüm noktalarındaki kişi başına düşen milli gelir seviyelerinden uzak olduğu ülkenin için gelir düzeyini artıracak çevreye duyarlı kalkınma stratejileri geliştirilmelidir.

- Yenilenebilir enerji Türkiye'de çevresel kalitenin artırılmasında ve çevresel bozulmanın önlenmesinde etkili bir araçtır. Sürdürülebilir bir çevre elde etmek için yenilenebilir enerjinin toplam enerji içerisindeki payı artırılmalıdır. Bunu yapmak için politika yapıcılar, yenilenebilir enerji yatırımlarını çekmek için yerli ve yabancı yatırımcılara sübvansiyonlar, vergi teşvikleri, gibi etkili politikalar uygulamalıdır.

- Bulgular yenilenemeyen enerji verimliliğinin artırılmasının çevresel kaliteyi artırarak çevresel sürdürülebilirliği desteklemeye yardımcı olabileceğini göstermektedir. Bu nedenle, politika yapıcılar, yenilenemeyen enerjinin verimli kullanımını teşvik etmeyi amaçlayan politikalar oluşturmalıdırlar. Bu, farkındalık kampanyaları ve ülke enerjisinin son kullanıcıları olan hane halklarının, işletmelerin ve endüstrilerin eğitilmesi yoluyla gerçekleştirilebilir.

- Çevresel kalitenin artması için çevreyi kirleten fosil kaynaklı enerjiye alternatif kaynaklar geliştirilmelidir. Bu bağlamda yenilenebilir enerjinin yanında çevresel kaliteyi artıran nükleer enerji santrallerine yapılan yatırımlar artırılmalıdır. Bu alanlarda yapılan yatırımlar Türkiye'nin artan enerji ihtiyacının yenilenebilir enerji ve nükleer enerji ile karşılanması, bu enerjilerin fosil yakıtların yerine kullanılması enerji ithalatına olan bağımlılığın azalmasına yardımcı olabilir. İthalata bağımlılığın azalmasıyla sağlanacak kaynakları yeşil ekonomik kalkınma stratejilerin geliştirilmesinde kullanılabilir.

Araştırmanın politika açısından önemine rağmen zayıf yönleri gelecekteki çalışmalarda geliştirilebilir. Bu çalışmanın bulguları, kullanılan değişkenler, uygulanan ekonometrik yöntemler, zaman dilimi ve farklı ekonomik özellikler nedeniyle gelişmiş ve gelişmekte olan ülkeler için uygun olmayabilir. Bu nedenle, benzer çalışmaların hem gelişmiş hem de gelişmekte olan diğer ülkeler için de yapılması önerilmektedir. Bu sayede, yenilenemeyen ve yenilenebilir enerji verimliliğinin dünya çapında çevresel sürdürülebilirliği sağlamaya yönelik nasıl çalıştığına dair kapsamlı bulgular elde edilebilir.

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Kâr Tahmininde Yapay Sinir Ağlarının Kullanılmasında ESG Skorları ve Finansal Göstergelerin Etkisi

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The Influence of ESG Scores and Financial Indicators When Using Artificial Neural Networks in Profit Forecasting

Abstract

This study aims to estimate the net profit before extraordinary items, as determined by the accounting information system of companies using artificial neural networks, a method of artificial intelligence, and compare it with the actual value. In this context, the results and error rates for the estimation of net profit before extraordinary items were determined using the ESG (environmental, social, governance) score, environmental support score, social support score, administrative support score, total assets, total revenue, total debt and net profit before extraordinary items of 28 companies operating in the industrial sectors of 9 countries between 2013 and 2022. It has been established that there is a parallelism between the real value and the estimated value of the net profit before extraordinary items.

Keywords	:	Accounting Information System, Profit-Influencing Factors, Artificial Intelligence, Artificial Neural Networks.
JEL Classification Codes	:	M40, M20, C45.

Öz

Çalışmada, şirketlerin muhasebe bilgi sistemi aracılığıyla belirlenen olağanüstü kalemler öncesi net kârın yapay zekâ yöntemlerinden yapay sinir ağları kullanılarak tahmin edilmesi ve gerçek değeri ile karşılaştırılması amaçlanmıştır. Bu doğrultuda 2013-2022 yılları arasında 9 ülkenin endüstri sektöründe faaliyet gösteren 28 şirketin ESG skoru (çevresel, sosyal, yönetimsel), çevresel destek skoru, sosyal destek skoru, yönetimsel destek skoru, toplam varlıklar, toplam hasılat, toplam borç ve olağanüstü kalemler öncesi net kâr verileri kullanılarak olağanüstü kalemler öncesi net kâr tahmin sonuçları ve hata oranlarına ulaşılmıştır. Olağanüstü kalemler öncesi net kârın gerçek değeri ile tahmin edilen değeri arasında paralellik olduğu bulgusuna ulaşılmıştır.

Anahtar Sözcükler	:	Muhasebe Bilgi Sistemi, Kârı Etkileyen Faktörler, Yapay Zekâ, Yapay Sinir Ağları.

1. Giriş

Yapay zekâ kullanımının artması çeşitli alanlarda değişimi ve dönüşümü beraberinde getirmiştir. Yapay zekânın bilgileri öğrenmesi, bu bilgiler hakkında akıl yürütmesi ve bağımsız hareket edebilme becerisi ile ulaşımdan sağlık hizmetlerine ve finansa kadar çeşitli sorunlara etkili çözümler sunmaktadır (Schweitzer, 2024: 68). Bu durum muhasebe alanında da kendini göstermektedir. Özellikle muhasebede yapay zekânın kullanımı konusunda birçok çalışma yapılmıştır. Söz konusu bu çalışmalarda daha çok yapay zekâ uygulamalarının muhasebenin iş süreçlerine etkileri üzerinde durulduğu görülmüştür (Küçüker, 2023: 876). Ayrıca yapay zekânın gelişmesiyle bir kısım geleneksel muhasebe işlemlerinin yerini yapay zekâ teknolojisine sahip olan işlemlere bırakacağı söylenebilir (Gacar, 2019: 390). Örneğin, Küçüker (2023), yapay zekâ uygulaması olan ChatGPT'yi muhasebe alanında sınava tabi tutmuştur. Yapılan sınavda muhasebenin çeşitli konularından temel seviyede sorular sorulmuştur. Sınav sonuçlarına bakıldığında ChatGPT uygulamasının eksik taraflarının olduğu ancak geliştirilerek ileride muhasebe işlemlerinde önemli roller üstlenebileceği sonucuna varılmıştır. Das (2021: 22), yapay zekânın muhasebe personelleri için bir fırsat olduğunu, yapay zekâ ile bilgi birimlerini geliştirerek daha donanımlı ve üst düzey personel olabileceğini ifade etmiştir. Muhasebede yapay zekâ uygulamalarının kullanılması ile bu alandaki verimsizlik ve düşük katma değer sorunları çözüme kavuşturularak, muhasebe personellerinin şirkete daha fazla değer katmaları sağlanabilir (Luo et al., 2018: 851). Yapılan çalışmalarda daha çok yapay zekânın muhasebe alanına etkisi ve muhasebe verilerinin düzenlenmesinde kullanılması şeklindedir. Muhasebe, verilerin düzenlenmesi, kullanılması ve ilgili kişilere bu bilgilerin ulaşılmasını sağlayan bir bilgi sistemi olarak tanımlanabilir. Dolayısıyla muhasebe alanında yapay zekânın kullanılmasıyla muhasebede ilgili kişi veya kuruluşlar olarak adlandırılan muhasebe bilgisi kullanıcılarının da lehine olacağı söylenebilir. Muhasebe verilerine daha çok ihtiyaç duyan muhasebe bilgisi kullanıcıları şirketler veya işletmelerdir. Söz konusu şirketler ya da işletmeler muhasebe verilerine göre faaliyetlerini yönetmek, yönlendirmek ve sürdürmek durumundadır. Aynı zamanda şirketler, muhasebe bilgi sistemi ile bir muhasebe dönemi içinde şirketin gerçekleştirmiş olduğu faaliyetlerden kaynaklanan mali olayların kaydedilmesi, sınıflandırılması gibi işlemlerden sonra temel mali tablolardan biri olan gelir tablosunu oluşturarak dönem sonunda elde edilen net kârı belirleyebilmektedir. Dolayısıyla şirketlerin devamlılığının sağlanmasında kârı tespit eden muhasebe bilgi sisteminin önemli bir rol üstlendiğini söylemek mümkündür.

Bu çalışmada yapay zekâ yöntemlerinden yapay sinir ağları (YSA) kullanılarak şirketlerin olağanüstü kalemler öncesi net kârları tahmin edilmeye çalışılmıştır. Çalışmada net kârın değil de olağanüstü kalemler öncesi net kârın tahmin edilmek istenmesinin nedeni normalin dışında şirkette gerçekleşen felaketler (yangın, su baskını gibi) doğrudan tahmin sonucunu fazlaca etkileyebiliyor olmasıdır. Bundan dolayı çalışmada felaketler, pandemi ve kriz gibi olağanüstü durumlar kapsam dışı bırakılmıştır. Bu doğrultuda Datastream Veri Tabanında yer alan şirketlerin kârını etkileyen bir takım faktörler belirlenmiştir. Söz konusu faktörler ESG skoru (çevresel, sosyal, yönetimsel skoru), çevresel destek skoru, sosyal destek skoru, yönetimsel destek skoru, toplam varlıklar, toplam hasılat, toplam borç, yapay

zekâ yöntemlerinden YSA kullanılarak olağanüstü kalemler öncesi net kârın tahmini ve hata oranları tablo şeklinde sunulmuştur.

2. Literatür

ESG skorları, finansal göstergeler ile şirket kârı arsındaki ilişkiyi konu edinen çok sayıda bilimsel çalışma literatürde mevcuttur. Söz konusu bilimsel çalışmaların literatür özeti aşağıda verilmiştir.

Babalola (2013), Nijerya Menkul Kıymetler Borsası'nda işlem gören imalat şirketlerinin büyüklüklerinin (toplam varlıklar ve net satışlar) kârlılık (varlık getirisi) üzerindeki etkisini belirlemek amacıyla bu şirketleri 2000-2009 dönemini bir panel veri seti kullanarak analiz etmiştir. Analiz sonuçlarına göre firma büyüklüğünün kârlılık üzerinde olumlu etkiye sahip olduğu belirlenmiştir.

Okuyan (2013), tarafından yapılan çalışmada sanayi işletmelerinde kârlılığı etkileyen faktörler belirlenmeye çalışılmıştır. Bu amaçla 1000 işletmeye ait veriler panel veri analizine tabi tutulmuştur. Sonuç olarak kârlılık oranı ile borçlanma ve büyüklük arasında negatif bir ilişkinin varlığı saptanmıştır.

Şişman vd. (2016), tarafından yapılan ve tedarik zinciri yönetimi bakımından kurumsal sürdürülebilirliğin şirketlerin performansı üzerindeki etkisini belirlemeyi amaç edinen çalışmada, Borsa İstanbul Sürdürülebilirlik Endeksinde işlem gören 50 şirketin sürdürülebilirlik raporları incelenerek 2013 yılındaki sürdürülebilirlik faaliyetlerin 2014 yılındaki finansal performansına etkisi korelasyon ve regresyon analizine tabi tutulmuştur. Analiz sonuçlarına göre ekonomik faaliyetlerin varlık kârlılığı ile öz sermaye kârlılığı arasında pozitif ve anlamlı bir ilişki tespit edilmiştir. Çevresel ve sosyal faaliyetler ile varlık kârlılığı ve öz sermaye kârlılığı arasında anlamlı bir ilişkinin olmadığı belirlenmiştir.

Özkan vd. (2018), tarafından yapılan ve amacı kurumsal sosyal sorumluluğun şirketlerin finansal performanslarını etkileyip etkilemediğini tespit etmek olan çalışmada Borsa İstanbul Sürdürülebilirlik Endeksinde yer alan 35 şirket araştırmanın örneklemini oluşturmaktadır. Veriler içerik analizi, oran analizi ve panel veri analizine tabi tutulmuştur. Elde edilen bulgulara göre kurumsal sosyal sorumluluğun şirketlerin kârlılık oranı üzerinde pozitif etkiye sahip olduğu belirlenmiştir.

Albeyrathna & Priyadarshana (2019), tarafından yapılan çalışmada firma büyüklüğünün (toplam varlıklar ve net satışlar) şirketlerin kârlılığı üzerindeki etkisi belirlenmeye çalışılmıştır. Bu doğrultuda Colombo Menkul Kıymetler Borsasında işlem gören 20 işletme örneklem olarak seçilmiştir. İşletme verileri korelasyon ve çoklu regresyon analizine tabi tutulmuştur. Elde edilen verilere göre Sri Lanka'da örneklem olarak seçilen işletmelerin büyüklüklerinin karlılığa katkısı olmadıkları tespit edilmiştir.

Karo-Karo & Ginting (2020), insan sermayesi, toplam varlıklar ve toplam yükümlülüklerin şirketin net karı üzerindeki etkisini belirlemek amacıyla yaptıkları

çalışmada Endonezya Borsası LQ45 endeksinde listelenen 32 şirketin verilerinin analizini çoklu doğrusal regresyon analizi ile yapmışlardır. Elde edilen verilere göre insan sermayesi, toplam yükümlülükler ve toplam varlıkların şirketin net kârı üzerinde önemli bir etkiye sahip oldukları sonucuna varılmıştır.

Lumapow & Tumiwa (2020), şirket borç politikasının kârlılığı etkileyip etkilemediğini belirlemek amacıyla yaptıkları çalışmada amaçlı örnekleme kullanılarak 2012-2017 yılları arasında Endonezya Menkul Kıymetler Borsasında işlem gören 12 şirket, panel verileri ve çoklu regresyon analizine tabi tutulmuştur. Elde edilen sonuçlara göre borç politikasının şirketlerin kârlılığını negatif yönde etkilediği tespit edilmiştir.

NGO vd. (2020), borcun kârlılık üzerindeki etkisini belirlemeyi amaçladıkları çalışmada örneklem olarak seçilen Vietnam Borsasında işlem gören 118 şirketi korelasyon, regresyon ve genelleştirilmiş momentler yöntemi ile analiz etmişlerdir. Yapılan analizden elde edilen verilere göre borcun kârlılık üzerinde negatif bir etkiye sahip olduğu belirlenmiştir.

Aydoğmuş vd. (2022), ESG performanslarının işletmenin karlılığı ve değeri üzerindeki etkisini belirlemeyi amaçlamaktadır. Bu doğrultuda 2013'ten 2021'e kadar 1720 işletmenin verileri panel veri analizi ile analiz edilmiştir. ESG birleşik skorunun işletmenin karlılığı ile pozitif ve anlamlı bir ilişkiye sahip olduğu tespit edilmiştir.

Doğan vd. (2022), ESG performanslarının işletmenin kârlılığı üzerindeki etkisini belirlemeyi amaçlayan çalışmada, BRICS ülkelerinde (Brezilya, Rusya, Hindistan, Çin ve Güney Kore) 2013-2020 yıllarında bulunan 423 işletmenin verileri doğrusal regresyon modeli ile analiz edilmiştir. Analiz sonucuna göre ESG skorlarının işletme kârlılığı üzerinde pozitif ve anlamlı bir etkiye sahip olduğu belirlenmiştir.

Kalia & Aggarwal (2023), çevresel sosyal ve yönetişim skorlarının sağlık şirketlerin finansal performansı üzerindeki etkilerini belirlemeyi amaç edinen çalışmada 468 şirketin verileri korelasyon ve çok değişkenli regresyon ile analiz edilmiştir. Gelişmiş ekonomilerde söz konusu skorların şirket performansını olumlu yönde etkilediği sonucuna varılmıştır.

Erben-Yavuz (2023), tarafından yapılan ve amacı ESG skorlarının işletme kârlılığı üzerindeki etkisini belirlemek olan çalışmada Borsa İstanbul'da işlem gören ve 2013-2021 ESG skorları açıklanmış 15 işletmenin verilerinden yararlanılmıştır. İşletme verileri panel veri yöntemiyle analiz edilmiştir. Elde edilen analiz sonuçlarına göre işletmelerin ESG skorlarının kârlılık üzerinde anlamlı ve pozitif bir ilişki olduğu belirlenmiştir.

D'Amato vd. (2024), tarafından yapılan çalışmada ESG skorlarının işletmenin kârlılığı arasındaki ilişki yapay zekânın alt kümelerinden olan makine öğrenmesi ile karar ağaçları, rastgele orman ve gradient boosting gibi yöntemleri kullanmıştır. Elde edilen verilere göre ESG skoru arttıkça işletmenin kârlılığına daha fazla katkı sağlayacağı sonucuna ulaşılmıştır.

Meliala vd. (2024), tarafından yapılan çalışmada, emlak şirketleri için satış büyümesinin ve toplam varlıkların şirket kârları üzerindeki etkisinin belirlenmesi amaçlanmıştır. Bu doğrultuda 2021-2023 yılları arasında IDX'te doğrulanan 66 emlak şirketinin verileri çoklu doğrusal regresyon yaklaşımı ile analiz edilmiştir. Analiz sonuçları satış büyümesinin şirket kârları üzerinde önemli bir etkiye sahip olmadığını, toplam varlıkların şirket kârları üzerinde önemli bir etkiye sahip olduğunu göstermektedir.

Rizqo & Qadri (2024), çevresel, sosyal ve yönetişim skorları ile finansal kârlılık arasındaki ilişkiyi belirlemeyi amaçladıkları çalışmada Endonezya Borsasında listelenen 55 şirketin verileri panel veri regresyon metodolojisi ile analiz edildi. Buna göre çevresel, sosyal ve yönetişim değişkenlerinin kurumsal kârlılık üzerinde önemli bir pozitif etki yarattığı sonucuna varılmıştır.

ESG skorları ve finansal göstergelerin şirket kârı arasındaki ilişkiyi ele alan yukarıdaki çalışmalara bakıldığında genel olarak panel veri analizi, korelasyon analizi ve regresyon analizi kullanıldığı ve bu çalışmalarda birbirine benzer sonuçların ortaya konulduğu görülmektedir. Diğer çalışmalardan farklı olarak D'Amato vd. (2024), yapmış oldukları çalışmada yapay zekânın alt kümelerinden makine öğrenimi ile karar ağaçları, rastgele orman ve gradient boosting gibi yöntemleri işletmenin kârlılığını tahmin etmede kullanmışlardır. D'Amato vd. (2024), yapmış oldukları çalışmanın yapılan bu çalışmaya benzer yönlerinin olduğu ancak kullanılan yöntemlerin farklı olduğu söylenebilir. Çalışmada kullanılan yöntemin bu konuyu ele alan diğer çalışmalardan farklı olması bakımından yapılan çalışmanın literatüre katkı sağladığını söylemek mümkündür.

3. Yöntem

Çalışmanın bu kısmında veri seti, kullanılan araştırma modeli, modelin değerlendirme ölçütleri, veri analiz yöntemi ve bulgular detaylandırılmıştır. Çalışmada elde edilen verilere yer verilerek modelin doğruluğu ve performansı değerlendirilmiştir. Araştırmada, YSA ile olağanüstü kalemler öncesi net kâr tahmini yapmak amacıyla WEKA aracı kullanılmıştır. Belirlenen YSA modeli, veri setine uygulanarak tahminleme süreci gerçekleştirilmiş ve elde edilen sonuçlar gerçek değerlerle karşılaştırılmıştır. Çalışma kapsamında "Şirketlerin ESG skorları ve finansal göstergeleri, YSA ile olağanüstü kalemler öncesi net kâr tahmini yapmak için kullanılabilir mi?", "YSA modeli, olağanüstü kalemler öncesi net kâr tahmininde hangi öznitelik daha çok katkı sağlamaktadır?", "WEKA aracı ile oluşturulan YSA modeli, tahmin doğruluğu açısından nasıl bir performans göstermektedir?" ve "Elde edilen sonuçlar, muhasebede yapay zekâ kullanımına ilişkin ne gibi çıkarımlar sunmaktadır?" şeklindeki sorulara cevap aranmaktadır.

3.1. Veri Seti

2013-2022 yılları arasında Japonya, Birleşik Krallık, ABD, Avustralya, İrlanda, Malezya, Güney Afrika, İsviçre ve Hindistan ülkelerindeki endüstri sektöründe faaliyet gösteren 28 şirkete ait ESG skoru, çevresel destek skoru, sosyal destek skoru, yönetimsel

destek skoru, toplam varlıklar, toplam hasılat, toplam borç ve olağanüstü kalemler öncesi net kâr bilgilerinden yararlanılarak "ESG Skoru ve Muhasebe Veri Seti" olarak adlandırdığımız bir veri seti oluşturulmuştur. Datastream Veri Tabanında yer alan şirketlerin kârını etkileyen bir takım faktörler belirlenmiştir. Şirketlerin kârını etkileyen birçok unsur olduğu yapılan literatür çalışmaları ile de desteklenmektedir. ESG skorları, toplam varlıklar, toplam hasılat ve toplam borç bunların bir kısmıdır. Örneğin Rizqo ve Qadri (2024) ESG skorların, Karo-Karo & Ginting (2020) toplam varlıkların, Babalola (2013) toplam hasılatın ve Okuyan (2013) borçlanmanın şirket kârı ile arasındaki ilişkiyi inceleyen bilimsel çalışma yapmışlardır. Araştırmada kullanılan veriler, Datastream Veri Tabanından elde edilmiştir. Datastream Veri Tabanı, ülkelerin borsalarında işlem gören firmaların aynı tür verilerini işlemektedir. Dolayısıyla söz konusu şirketlerin muhasebe uygulamaları ve finansal tablo formatları uluslararası finansal raporlama standartlarına göre hazırlanmış standart verilerden oluşmaktadır. Çalışmada para cinsi olarak dolar (USD) kullanılmıştır. Söz konusu ülkeler ve bu ülkelerde bulunan endüstri şirketlerinin araştırma kapsamına dâhil edilmesinin nedeni, Datastream Veri Tabanından şirketlerin 2013 ile 2022 yılları arasındaki verilerine ulaşılabiliyor olmasıdır. Veri seti 7 tane bağımsız, 1 tane bağımlı öznitelikten oluşmaktadır. Olağanüstü kalemler öncesi net kârı veren öznitelik bağımlı özniteliktir.

Tablo: 1
Araştırmada Kullanılan Bağımsız ve Bağımlı Öznitelikler

	Bağımsız Öznitelik	Bağımlı Öznitelik
1	ESG	
2	Çevresel Destek Skoru	
3	Sosyal Destek Skoru	
4	Yönetimsel Destek Skoru	Olağanüstü Kalemler Öncesi Net Kâr
5	Toplam Varlıklar	
6	Toplam Hasılat	
7	Toplam Borç	

Yukarıdaki Tablo 1'de araştırmada oluşturulan veri setine ait 7 tane bağımsız ve 1 tane bağımlı öznitelik bilgilerine yer verilmiştir.

Aşağıda Tablo 2'de oluşturulan veri setine ait istatistiki bilgilere yer verilmiştir.

Tablo: 2
ESG Skoru ve Muhasebe Veri Seti İstatistikleri

| S. No	Öznitelik	Min	Max	Mean	StdDev
1	ESG Skoru	5.643	88.395	51.418	18.596
2	Çevresel Destek Skoru	0	97.265	51.084	27.213
3	Sosyal Destek Skoru	4.277	95.008	51.842	23.624
4	Yönetimsel Destek Skoru	4.888	95.069	50.805	20.872
5	Toplam Varlıklar	380590487.8	101549000000	10550991295.522	17222214718.22
6	Toplam Hasılat	265451261.7	104660000000	8233017896.758	13925970636.416
7	Toplam Borç	10575910.6	38111364047	3549493745.645	6573273767.22
8	Olağanüstü Kalemler Öncesi Net Kâr	875861.022	6742306428	427869777.056	719697276.774

Tablo 2'de veri setine ait özniteliklerin adı, en küçük değeri, en büyük değeri, ortalama ve standart sapma değerleri verilmiştir. Standart sapma, bir grubu oluşturan verilerin ortalamaya göre sağa ve sola ne kadar saptığını yaklaşık olarak ifade eder. Ortalamaya standart sapma verisi eklenip ve ortalamadan standart sapma verisi çıkarılarak

verilerin yaklaşık olarak hangi aralıkta yayıldığını görmek mümkündür (Özbek & Keskin, 2007: 65). Tablodaki faktörlere ilişkin standart sapma verileri ortalamaya göre yaklaşık ne kadar saptığını göstermek için verilmiştir. Örneğin ESG skorunun, ortalama - standart sapma ve ortalama + standart sapma (51.418 - 18.596 = 32.822 ve 51.418 + 18.596 = 70.014) formülünden yararlanılarak ortalamaya göre sağa ve sola yaklaşık olarak ne kadar saptığı görülebilir. Lucas (2022)'a göre ESG skorları 70 ve üzerinde ise mükemmel, 60-69 arasında iyi, 50-59 arasında orta, 50 veya daha düşük ise zayıf olarak kabul edilmektedir. Buna göre çalışmanın ortalama toplam ESG skoru ve ortalama diğer ESG skorlarının orta düzeyde olduğu söylenebilir.

3.2. Model

YSA modeli belirlenirken farklı ağ yapıları denenmiştir. Bu denemelerde 28 şirketin 2013 -2021 verileri farklı ağ yapıları ile eğitilmiş, 2022 yılının verileri tahmin edilmek üzere test veri seti olarak ağa sunulmuştur. Birçok denemeden sonra en iyi performansı gösteren ağ modeli Şekil 1'de gösterildiği gibi belirlenmiştir. YSA Modeli 3 katmandan oluşmaktadır; Yedi düğümden oluşan giriş katmanı, dört düğümden oluşan gizli katman, 1 düğümden oluşan çıkış katmanıdır. Öğrenme kuralı olarak delta kuralı ve aktivasyon fonksiyonu olarak sigmoid fonksiyonu seçilmiştir.

Şekil: 1
Yapay Sinir Ağ Modeli
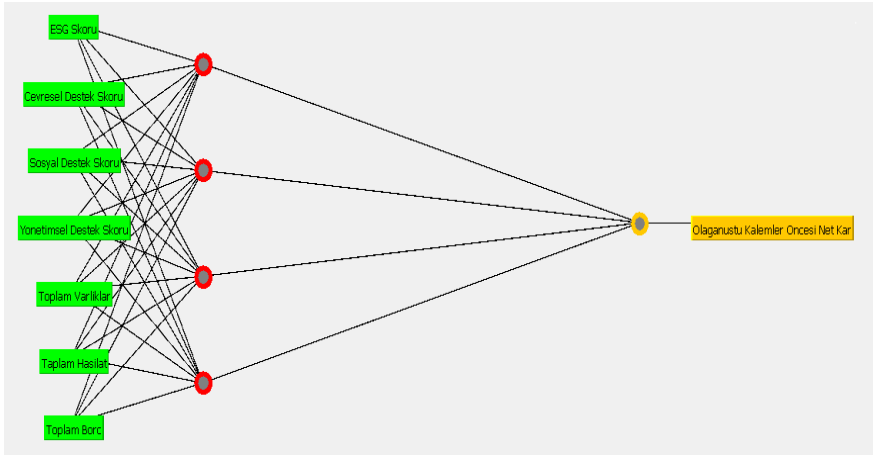
3.3. Değerlendirme Ölçütleri

Tahminleme yöntemlerinde %100 doğru bir tahmin söz konusu değildir. Her model belli bir hata oranı ile tahminleme gerçekleştirmektedir. Tahmin yöntemlerinin performanslarını değerlendirmek için birçok değerlendirme ölçütü mevcuttur. Burada önemli olan ölçütlerin, tahmin hatalarının ölçülmesi ile elde edilen tahmin doğruluğudur.

Bu çalışmada oluşturulan modelin performans ölçümü için korelasyon katsayısı; hata oranlarının ölçümü için MAE (mean absolute error - ortalama mutlak hata), RMSE (root mean squared error - kök ortalama kare hata), RAE (relative absolute error - bağıl mutlak hata) ve RRSE (root relative squared error - kök bağıl kare hata) temel alınarak değerlendirilmiştir.

Korelasyon katsayısı, iki değişken arasındaki ilişkinin yönünü ve gücünü belirlemektedir. Korelasyon katsayısının pozitif bir değer alması değişkenler arasında doğrusal bir ilişkinin olduğunu, negatif bir değer alması ise değişkenler arasında ters bir ilişkinin olduğunu göstermektedir (Ebren-Kara, 2022: 169).

Herhangi bir *t* anında tahmin hatası aşağıdaki gibidir (Marapelli, 2019: 1045-1046):

$$e_t = P_t - A_t \tag{1}$$

Burada P_t tahmini değer, A_t gerçek değer, n örnek sayısıdır.

$$MAE = \frac{1}{n}\sum_{t=1}^{n} |e_t| \tag{2}$$

$$RMSE = \sqrt{\frac{1}{n}\sum_{t=1}^{n} e_t{}^2} \tag{3}$$

$$RAE = \frac{\sum_{t=1}^{n} |e_t|}{\sum_{t=1}^{n} |A_a - A_t|} \tag{4}$$

Burada A_a gerçek değerlerin ortalaması, n örnek sayısıdır.

$$RRSE = \sqrt{\frac{\sum_{t=1}^{n} |e_t|^2}{\sum_{t=1}^{n} (A_a - A_i)^2}} \tag{5}$$

3.4. Veri Analiz Yöntemi

YSA Modeline sunulmak üzere 28 şirketin 280 veri kaydı bulunmaktadır. Veri seti, eğitim veri seti ve test veri seti olarak ikiye ayrılmıştır. Her şirketin 2022 yılı verileri test verisi olarak ayrılmıştır.

Şirketlerin 2013-2021 yılları arası verileri YSA'yı eğitmek için, 2022 yılı verileri YSA'yı test etmek için kullanılmıştır. YSA eğitildikten sonra şirketlerin 2022 yılı olağanüstü kalemler öncesi net kârı tahmin edilmeye çalışılmıştır. Gerçek değerler ile tahmin edilen değerler karşılaştırılarak YSA'nın performansı değerlendirilmiştir.

4. Bulgular

YSA'nın performansını ölçmek için YSA önce eğitim veri seti ile eğitilmiş, ardından test veri seti ile test edilmiştir. YSA'nın performansına yönelik ölçütlere Tablo 4'te yer verilmiştir.

4.1. Performans Değerleri

4.1.1. Yapay Sinir Ağının Eğitilmesi

Waikato environment for knowledge analysis (WEKA) aracı kullanılarak veri seti üzerinden testler yapılmıştır. YSA modeli önce eğitim veri seti ile eğitilmiştir. Tablo 3'te geliştirilen modelin öğrenme katsayısı, momentumu, devir sayısı ve gizli katman sayıları verilmiştir. Tablo 4'te modelin korelasyon katsayısı ve hata ölçüm değerleri verilmiştir.

Tablo: 3
Yapay Sinir Ağı

Öğrenme Oranı (Learning Rate)	Momentum Değeri (Momentum)	Devir Sayısı (Training Time)	Gizli Katman Sayısı (Hidden Layer)
0,005	0,9	500	1

Tablo: 4
Yapay Sinir Ağ Modelinin Değerlendirilmesi

Ağın Öğrenme Korelasyonu (CC)	MAE	RMSE	RAE%	RRSE%
0.9454	133447226.3911	213658769.4168	38.655	33.0711

CC: Correlation coefficient, MAE: Mean Absolute Error, RMSE: Root Mean Squared Error, RAE: Relative Absolute Error, RRSE: Root Relative Squared Error.

4.1.2. Yapay Sinir Ağının Test Edilmesi

YSA eğitildikten sonra RandomTree makine öğrenmesi algoritması ile test edilmiştir. Analiz sonuçları Tablo 5'te verilmiştir.

Tablo: 5
Yapay Sinir Ağı Test Sonuçlarının Değerlendirilmesi

Tahminde Gerçekleşen Korelasyon (CC)	MAE	RMSE	RAE%	RRSE%
0.9803	187232836.1621	454905353.5222	36.8731	36.3285

CC: Correlation coefficient, MAE: Mean Absolute Error, RMSE: Root Mean Squared Error, RAE: Relative Absolute Error, RRSE: Root Relative Squared Error.

4.1.3. Ağırlıklar (Weights)

Ağırlıklar, YSA nöronları arasındaki bağlantıları temsil eden katsayılardır. Bu katsayılar aynı zamanda giriş nöronlarının YSA üzerindeki etkisini belirlemektedir. Bir nörondan diğerine veri aktarılırken bu veriler ağırlıkları ile çarpılır ve iletilir. Her bir giriş nöronun kendine ait bir ağırlık değeri vardır (Elmas, 2016: 31). İlk ağırlık değerleri rastgele (random) verilir. Ağırlık değerleri, YSA'nın giriş nöronlarına ne kadar duyarlı olacağını ve hangi bilgiyi öğreneceğini belirlemektedir. Nöronun sahip olduğu ağırlık değerinin büyüklüğü önemi ile doğru orantılıdır (Aydemir, 2019: 35).

Ağın öğrenmesi, rastgele verilen ilk ağırlık değerleri ile başlatılır (He et al., 2015: 1028). Öğrenme süresince modelin performansını optimize etmek için bu ağırlık değerleri sürekli değiştirilir. O sırada modelin tahmin ettiği değerler ile gerçek değerler arasındaki fark (hata) hesaplanır. Bu fark ağın ağırlıklarını düzeltmek için kullanılır. Ağ gerçek

değerleri ya da gerçeğe en yakın değerleri tahmin ettiğinde öğrenme süreci tamamlanmış olur.

Tablo: 6
Yapay Sinir Ağ Modelinin Sahip Olduğu Ağırlıklar

Düğüm Girişler	Ağırlıklar
Eşik	1,392266878587042
Düğüm 1	-0,7473203169233885
Düğüm 2	-0,5544922820981443
Düğüm 3	-0,6176366310846405
Düğüm 4	-0,9826867436012036
Sigmoid Düğüm 1	
Girişler	**Ağırlıklar**
Eşik	0,19225017843700828
ESG Score	-0,16325319306336095
Çevresel Destek Skoru	-0,08639971141878618
Sosyal Destek Skoru	0,1812168165180118
Yönetimsel Destek Skoru	-0,09090026450788415
Toplam Varlıklar	-0,7718350212686313
Toplam Hasılat	-1,1665984447521782
Toplam Borç	-0,19964555123004016
Sigmoid Düğüm 2	
Girişler	**Ağırlıklar**
Eşik	-0,19504977469953583
ESG Score	-0,2004864673934827
Çevresel Destek Skoru	0,0524285258142071
Sosyal Destek Skoru	-0,00447421585638279
Yönetimsel Destek Skoru	0,20578976318272793
Toplam Varlıklar	-0,3047748756313089
Toplam Hasılat	-0,633164740618771
Toplam Borç	0,3750580850961123
Sigmoid Düğüm 3	
Girişler	**Ağırlıklar**
Eşik	-0,103525375978831962
ESG Score	-0,16539188028703075
Çevresel Destek Skoru	-0,04033513146564345
Sosyal Destek Skoru	0,03438569069118171
Yönetimsel Destek Skoru	0,17540179264053274
Toplam Varlıklar	-0,3264438895865131
Toplam Hasılat	-0,7712732367948276
Toplam Borç	0,39331327012172695
Sigmoid Düğüm 4	
Girişler	**Ağırlıklar**
Eşik	0,2572270639280115
ESG Score	-0,14549011880171184
Çevresel Destek Skoru	-0,06045187595828418
Sosyal Destek Skoru	0,2934372158450889
Yönetimsel Destek Skoru	-0,16378320791449655
Toplam Varlıklar	-1,0780362475204461
Toplam Hasılat	-1,3591383736039975
Toplam Borç	-0,4447227021107887

Ağırlığın eksili bir değere sahip olması etkisinin negatif olduğunu gösterirken, artılı bir değere sahip olması ise etkisinin pozitif olduğu anlamına gelmektedir. Ağırlık değerinin sıfır olması ise bir etkisinin olmadığı anlamını taşımaktadır (Öztemel, 2016: 49).

YSA modelinde bulunan ortalama ağırlık değerleri, her bir bağımsız özniteliğe ait 4 düğümde bulunan ağırlıkların toplamının 4'e bölünmesi ile bulunmuştur. Söz konusu bu ağırlıklar aşağıda Tablo 7'de verilmiştir.

Tablo: 7

Bağımsız Özniteliklere Ait Toplam ve Ortalama Ağırlık Değerleri

	Toplam Ağırlık	Ortalama Ağırlık Değeri
ESG Skoru	−0,6746216595455862	−0,16865541488639654
Çevresel Destek Skoru	−0,1347581930285067	−0.033689548257126675
Sosyal Destek Skoru	0,5135149389106645	0.12837873472766612
Yönetimsel Destek Skoru	0.12660808340088097	0.03165202085022024
Toplam Hasılat	-3,9301747957697743	-0.9825436989424436
Toplam Borç	0.12400310187701038	0.03100077546925259

Tablo 7'ye göre bağımlı öznitelik olan Olağanüstü Kalemler Öncesi Net Kârın tahmin edilmesinde en büyük katkıyı Sosyal Destek Skorunun sağladığı görülmektedir.

4.2. Yapay Sinir Ağının Test Sonuçları

YSA eğitim veri seti ile eğitildikten sonra test veri seti ile test edilme aşamasına geçilmiştir. Test veri setinde, 28 şirketin bağımsız öznitelikleri mevcut iken bağımlı özniteliği olan olağanüstü kalemler öncesi net kârı mevcut değildir. YSA'nın 28 şirketin 2022 yılının olağanüstü kalemler öncesi net kârının tahmin etmesi istenmiştir.

Tablo: 8

Yapay Sinir Ağının Tahmin Sonuçları ve Hata Oranları

Sayı	Gerçek	Tahmin	Hata
1	321617622,9	378753387,5	57135764,6
2	216718724,3	170051567,75	-46667156,55
3	676746671,1	243920505,9	-432826165,2
4	582377116,6	252348181,9	-330028934,7
5	187769192,8	390621000	202851807,2
6	623261548,6	93405600,72	-529855947,88
7	482179845,5	362212975	-119966870,5
8	532385336,2	431159420,3	-101225915,9
9	6742306428	4515725370	-2226581058
10	719521617,6	493351400,2	-226170217,4
11	466740000	753081689,5	286341689,5
12	539100000	547500000	8400000
13	410239808,8	403200870,8	-7038938
14	27298983,21	33768162,044	6469178,834
15	20211540,48	114003768,023	93792227,543
16	163173111,5	139477477,5	-23695634
17	24276950,04	33768162,044	9491212,004
18	807100373,2	858433372,967	51332999,767
19	35358315,49	86175127,947	50816812,457
20	1532000000	1513000000	-19000000
21	1142183148	1005760422	-136422726
22	46149599,4	34227206,24	-11922393,16
23	36036216,33	45945232,874	9909016,544
24	36047300,38	45945232,874	9897932,494
25	45574280,01	33768162,044	-11806117,966
26	302059256,1	182146548,675	-119912707,425
27	19465667,43	86175127,947	66709460,517
28	443342000	397091471,6	-46250528,4

Tablo 8'de YSA'nın, verilen test veri setinden elde ettiği tahmin değerleri verilmiştir. Bunun yanında örnek sayısı, olağanüstü kalemler öncesi net kârın gerçek değerleri ve hata oranları belirtilmiştir.

Şekil 2:
28 Şirketin 2022 Yılındaki Olağanüstü Kalemler Öncesi Net Kârlarının Tahmini ve Gerçek Değerleri
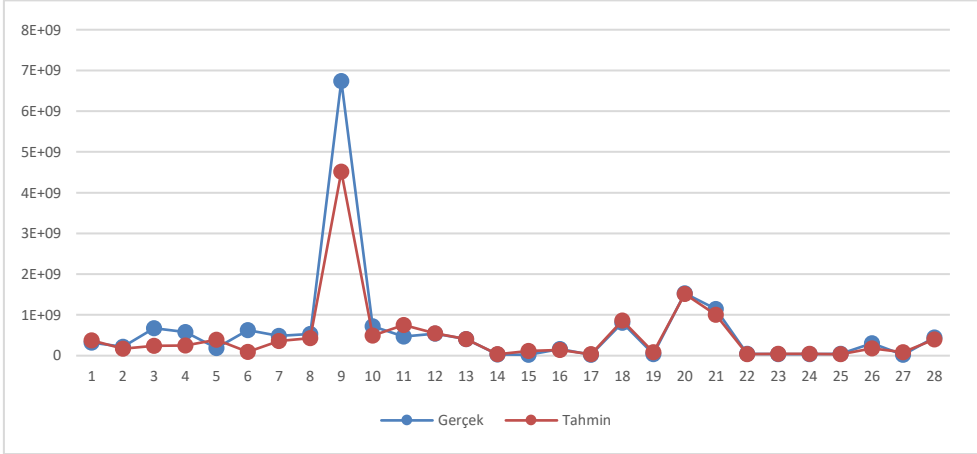
YSA modelinin gerçekleştirdiği tahmini değerler ile gerçek değerlerin ilişkisi yukarıdaki grafikte görselleştirilmiştir. Şekildeki "X" ekseni şirketleri "Y" ekseni ise şirketlere ait olağanüstü kalemler öncesi net kârı göstermektedir. Şirketler birbiriyle karşılaştırıldığında şirketlerin olağanüstü kalemler öncesi net kârının tahminlemesinde hata oranlarının değişiklik gösterdiği gözlenmiştir. Burada sunulan veriler olağanüstü kalemler öncesi net kârın tahminlemesinde hata oranlarını göstermektedir. Ayrıca 9 numaralı şirkette görünen sapmanın, bu şirketin diğer şirketlerden daha büyük skorlara sahip olmasından kaynaklandığı söylenebilir.

5. Sonuç

Şirketler gerçekleştirmiş oldukları faaliyetler sonucu kâr elde etmeyi amaçlamaktadır. Şirketler kâr elde edebilmek için faaliyetlerini sürdürmeye, faaliyetlerini sürdürebilmek için ise paydaşlara ihtiyaç duymaktadır. Burada şirketlerin sürdürülebilirliğine katkısı olan paydaşlardan yatırımcı paydaşı ön plana çıkmaktadır. Yatırımcılar da kâr elde etmek amacıyla şirketlere yatırım yapmaktadır. Amacı kâr elde etmek olan yatırımcı, yatırım yapacağı şirketin muhasebe verilerinden hareketle yatırım yapıp yapmayacağına karar vermektedir. Dolayısıyla önceden doğru bir şekilde tahmin edilmiş bir kâr hem yatırımcı hem de şirket için önem arz etmektedir. Bu doğrultuda yapılan çalışmada yapay zekâ kullanılarak şirketin elde edeceği olağanüstü kalemler öncesi net kârın önceden tahmin edilmesi amaçlanmıştır. Çalışmada veri setlerini kullanarak tahminleme yapabilen ve insan sinir sisteminin çalışma prensibine dayanılarak geliştirilmiş bir makine öğrenmesi olan yapay zekâ yöntemlerinden YSA yöntemi kullanılmıştır. Ayrıca çalışmada YSA modeli geliştirilirken WEKA veri madenciliği programı kullanılmıştır. YSA'nın

eğitilme performansı Tablo 4'te gösterilmiştir. Japonya, Birleşik Krallık, ABD, Avustralya, İrlanda, Malezya, Güney Afrika, İsviçre ve Hindistan ülkelerinde 2013-2022 yılları arasında endüstri sektöründe faaliyet gösteren 28 şirketin ESG skoru, çevresel destek skoru, sosyal destek skoru, yönetimsel destek skoru, toplam varlıklar, toplam hasılat, toplam borç şeklinde sıralanan kârı etkileyen faktörlerin verileri YSA'ya sunularak olağanüstü kalemler öncesi net kâr tahmin edilmiştir. Tahmin sonuçları Tablo 8 ve Şekil 2'de gösterilmiştir.

Çalışmanın amacı doğrultusunda olağanüstü kalemler öncesi net kârın yapay zekâ yöntemlerinden yapay sinir ağları kullanarak tahmin edilmiş ve gerçek değeri ile karşılaştırılmıştır. Tahmin sonuçları incelendiğinde gerçek değerler ile tahmin sonuçları arasında paralellik olduğu gözlemlenmiştir. Bu durum "WEKA aracı ile oluşturulan YSA modeli, tahmin doğruluğu açısından nasıl bir performans göstermektedir?" şeklindeki araştırma sorusuna cevap niteliği taşımaktadır. Kârı etkileyen faktörlerin olağanüstü kalemler öncesi net kâr üzerinde etkileri olduğu görülmüştür. Çalışmada oluşturulan YSA modeli incelendiğinde, bağımsız öznitelik olarak kullanılan kârı etkileyen faktörlerden Sosyal Destek Skoru faktörünün olağanüstü kalemler öncesi net kârın tahminlemesinde en fazla katkıyı sağladığı bilgisine ulaşılmıştır. Böylelikle "YSA modeli, olağanüstü kalemler öncesi net kâr tahmininde hangi değişken daha çok katkı sağlamaktadır?" şeklindeki araştırma sorusunun cevabına ulaşılmıştır. Şirketlerin gelecekte faaliyetlerini sürdürmeleri, uzun vadeli hedefleri ile uyumlu olarak sosyal sürdürülebilirliği entegre etmelerine bağlıdır. Bu durum şirketlerin sürdürülebilir ekonomik ilerlemesine katkı sağlayacaktır (Ajmal et al., 2018: 331). Bundan dolayı şirket yöneticilerinin sosyal sürdürülebilirliğin gerekliliklerini rekabet gereklilikleriyle uyumlu hale getirmeye dikkate etmeleri şirketin lehine olacaktır (Schönborn et al., 2019: 7). Dolayısıyla şirketler açısından sosyal destek skorunun önem arz ettiğini söylemek mümkündür. Ayrıca çalışmada şirketlerin yapay zekâ yöntemlerini kullanarak önceden belirlenen skorları temel alarak gelecek yıllardaki olağanüstü kalemler öncesi net kârlarını tahmin edebileceği ortaya konmuştur. Böylelikle "Şirketlerin ESG skorları ve finansal göstergeleri, YSA ile olağanüstü kalemler öncesi net kâr tahmini yapmak için kullanılabilir mi?" şeklindeki araştırma sorusu cevaplanmıştır. Şirketlerin kârını etkileyen 7 bağımsız öznitelik ve 1 bağımlı öznitelik verileri daha önce kullanılmayan yeni bir veri setinin yapay sinir ağlarında kullanılması ile şirketlerin gelecekteki olağanüstü kalemler öncesi net kârının tahmin edilmesi muhasebe alanında yapay zekâ yönteminin kullanılabilirliğini göstermiştir. Buradan gelecekte muhasebe alanında yapay zekâ yöntemleri kullanılarak çeşitli çalışmaların yapılabileceği çıkarılabilmektedir. Böylece "Elde edilen sonuçlar, muhasebede yapay zekâ kullanımına ilişkin ne gibi çıkarımlar sunmaktadır?" şeklindeki araştırma sorusu cevaplanmıştır. Aynı zamanda yapılan literatür taramasında D'Amato vd. (2024) tarafından yapılan çalışmada ESG skorları makine öğrenimi yoluyla kâr tahmininde kullandıkları görülmektedir. Çalışmada kullandıkları yöntem farklı olsa da ulaşılan sonuç bakımından çalışmamızı destekler niteliktedir. Muhasebe alanında yapay zekâ uygulamalarının kullanılması ile ilgili bilimsel çalışmalar son yıllarda yapılmaya başlanmıştır. Yapay zekâ yardımıyla kâr tahmininde bulunulması ile ilgili çalışmaların literatürde sınırlı sayıda olmasından dolayı literatürden sınırlı bir şekilde yararlanılması çalışmanın eksik tarafını göstermektedir. Ancak çalışmada belirtilen

faktörlerin YSA yöntemi ile daha önce kullanılmaması bakımından yapılan çalışmanın literatüre katkı sağladığı söylenebilir. Daha sonra yapılacak olan çalışmalarda farklı sektörde faaliyet gösteren şirketler birbirleriyle karşılaştırılarak mevcut verilerle gelecekte elde edilmesi planlanan olağanüstü kalemler öncesi net kârlar yapay zekâ yöntemleri kullanılarak tahmin edilebilir. Ayrıca muhasebe alanında, yapay zekâ uygulamaları ile muhasebe programlarının birlikte ele alındığı veya farklı yapay zekâ uygulamalarının bir arada kullanıldığı çalışmalar da yapılabilir.

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Optimal Nüfus ve Ekolojik Sürdürülebilirlik: Türkiye için Bir ARDL Yaklaşımı

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Optimal Population and Ecological Sustainability: An ARDL Approach for Türkiye

Abstract

As a demographic element, population constitutes one of the most important theoretical and political issues in economics. During the period following the Industrial Revolution, the world population grew faster than per capita income, rapidly depleting the global stock of natural capital. The severity of the destruction caused by human activities is reflected in the ecological footprint exceeding the biological capacity. The focus of the UN Sustainable Development Goals on human economic activity and reducing its environmental impact has brought attention back to the issue of population growth and its impact on the environment. This study employs the ARDL method to determine the optimal population level for Türkiye, taking into account both ecological and economic objectives. The findings indicate that Türkiye's population level is much higher than it should be in terms of increasing welfare and resource sustainability.

Keywords : Optimal Population, Ecological Footprint, Biocapacity.

JEL Classification Codes : J11, Q56, Q57.

Öz

Demografik bir unsur olan nüfus, iktisadın teorik ve politik anlamda önemli konularından birini oluşturmaktadır. Sanayi Devrimi'nden sonraki süreçte dünya nüfusunun, kişi başına gelirden daha hızlı artması küresel doğal sermaye stokunu hızla aşındırmıştır. Beşerî faaliyetlerin neden olduğu tahribatın şiddeti, ekolojik ayak izinin biyolojik kapasiteyi aşması ile de kendisini göstermektedir. Birleşmiş Milletler Sürdürülebilir Kalkınma Hedefleri'nin merkezinde insanın ekonomik faaliyetleri ve onun ekolojik ayak izini azaltma çabasının yer alması, dikkatleri yeniden nüfus düzeyine çekmiştir. Bu çalışmada ekolojik ve ekonomik hedefler bağlamında Türkiye için optimal nüfus düzeyinin ne olması gerektiği ARDL yöntemiyle araştırılmıştır. Bulgular refah düzeyinin artırılması ve kaynakların sürdürülebilirliği açısından Türkiye'nin nüfus düzeyinin olması gerekenin çok üzerinde olduğunu göstermektedir.

Anahtar Sözcükler : Optimal Nüfus, Ekolojik Ayak İzi, Biyolojik Kapasite.

1. Giriş

1960 yılında dünyanın Gayri Safi Yurt İçi Hasılası (GSYH) (2015 fiyatlarıyla) 10,9 trilyon dolar civarındayken dünya nüfusu yaklaşık 3 milyardı. Böylece ortalama bir insanın yıllık geliri 3.599 dolardı. Aynı yıl Türkiye'de 68,9 milyar dolarlık ulusal gelir 27,5 milyon kişi tarafından üretilmiş olup kişi başına düşen gelir 2.506 dolardı. O zamandan bu yana dünya tanınmayacak kadar zenginleşti. 2022 yılında dünya nüfusu 7,9 milyar kişiye çıkarken, küresel gelir 89,9 trilyon dolara ve kişi başına düşen gelir de 11.515 dolara yükseldi. Küresel olarak ölçülen ekonomik faaliyetler 60 yıl içinde 8 kattan fazla artarken kişi başına düşen gelir 2,6 kat artan nüfus nedeniyle sadece 3 katına çıktı. Türkiye'de ise 2022 yılına gelindiğinde 1960 yılına kıyasla nüfus 3 katına çıkarak 85 milyona yaklaştı, ulusal gelir 17 kat ve kişi başına düşen gelir de 5 kat arttı (WB, 2004). 1961 yılında Dünya'nın ekolojik ayak izi 0,74 iken 2022 yılında 1,71'e Türkiye'nin ekolojik ayak izi de aynı tarihler için 0,53'den 2,25'e yükseldi (Global Footprint Network, 2024). Bu veri Türkiye'de mevcut ekolojik taleplerimizi sürdürülebilir bir şekilde karşılamak için 2,25 Dünya'ya ihtiyacımız olduğuna işaret etmektedir.

Çevre ve yerbilimcilerin bir süredir üzerinde durduğu gibi bu ilerlemenin yaşamı tehdit eden bir bedeli vardır. İnsanlığın doğanın mal ve hizmetlerine olan talebinin sürdürülebilir seviyenin üzerine çıktığı günümüzde, insan faaliyetlerinin biyosferde yarattığı tahribatın şiddeti nedeniyle, ondan faydalandığımız birçok hayati düzenleme giderek daha fazla tehdit altına girmektedir. Belirli bir alandaki çeşitli ekosistemlerin üretiminin toplamı olan biyolojik kapasite, aynı zamanda mevcut talep eğilimlerine göre biyosferin yenilenme ve yaşam sağlama kapasitesini göstermektedir. Bu anlamda insan, ekonominin maddi metabolizmasını doğanın yenileyebileceği kaynaklarla karşılaştırmaktadır. Biyolojik kapasite ile ekolojik ayak izi arasındaki matematiksel farkın negatif olması ekolojik açık, pozitif olması ise ekolojik rezerv olarak tanımlanır (Schaefer et al., 2006: 6). Bu anlamda biyolojik kapasite ile biyosferin yenilenme kapasitesinin ne kadarının insan faaliyetleri tarafından kullanıldığını gösteren ekolojik ayak izi birbirini dengeleyen iki faktördür. Üretim sistemimiz için biyosferdeki doğal sermaye (sulak alanlar, ormanlık alanlar, mangrovlar, plantasyonlar ve tarım arazileri, turbalıklar ve fosil yakıtlar ile mineraller), üretilen sermaye (yollar, binalar, makineler, limanlar) ve insan sermayesinin (nüfus, sağlık ve eğitim) tamamlayıcı bir faktörüdür. Üretilen sermaye ve/veya beşeri sermayeye yapılan ilaveler nihai çıktıyı artıracak olsa da, kaynak tasarrufu sağlayan teknolojik ilerlemeler bu sürece eşlik etmediği sürece, yaratılan ilave atık kaçınılmaz olarak biyosferin sunduğu kaynaklara yönelik bir talep artışına neden olacaktır (Dasgupta et al., 2023: 669). Birleşmiş Milletler Çevre Programı tarafından desteklenen bir çalışmanın sonuçlarına göre 1992-2014 döneminde 140 ülkede kişi başına üretilen sermaye iki katına çıkmış ve kişi başına insan sermayesi yaklaşık %13 artmıştır. Ancak kişi başına doğal sermaye yaklaşık %40 azalmıştır (Managi & Kumar, 2018: 15). Nüfus büyüklüğü, yaşam standartları, kullanılan teknoloji ve kurumlar, insanlığın biyosferin mal ve hizmetlerine olan talebini şekillendirmektedir. Ehrlich ve Holdren (1971), bu talebi biyosfer üzerindeki etkimiz olarak tanımlamışlardır. Günümüzde ise bu etki ekolojik ayak izi olarak adlandırılmakta olup sadece doğadan

topladıklarımızı ve yararlandıklarımızı değil, aynı zamanda doğanın atıklarımızı karşılamak için sunduğu hizmetleri de dikkate almaktadır (Dasgupta et al., 2023: 662).

İnsanoğlunun eylemlerinin Dünya'nın işleyişine hâkim olduğu içinde bulunduğumuz Antroposen Çağı'nda aşırı nüfus artışı ve bu nüfusun beslenme mücadelesine paralel olarak artan kişi başına tüketim, genelde doğal sermayeye verilen zararın, özelde de iklim değişikliğinin ana nedeni olarak görülmektedir (Ehrlich et al., 1993: 20). Gıda üretiminin en önemli çevresel maliyeti, yeri doldurulamaz yaşamsal kaynakların kaybıdır; bu kayıp yoksulluğu da sürekli kılmaktadır. İnsan nüfusunun ulaştığı bu düzey ve yüksek nüfus artış hızı artık toplumsal yaşamın hemen hemen her yönünü etkilemekte olduğundan Birleşmiş Milletler Kalkınma Programı, ekonomik kalkınma, çevresel sürdürülebilirlik ve sosyal katılımın bir bileşimi olan Sürdürülebilir Kalkınmanın Hedeflerini (SKH) belirleyerek Dünya'nın her noktasındaki insanların karşı karşıya kaldığı ana sorunları ortadan kaldırmayı amaçlayan bir eylem planını ortaya koymuştur. Bu kapsamda sürdürülebilir üretim ve tüketim kalıpları sağlamak (SKH-12), iklim değişikliği ve etkileri ile mücadele için acil eylem planlarını uygulamaya koymak (SKH-13), okyanusları, denizleri ve deniz kaynaklarını korumak ve sürdürülebilir biçimde kullanmak (SKH-14) ve son olarak karasal ekosistemleri korumak, iyileştirmek ve sürdürülebilir kullanımını desteklemek (SKH-15) şeklindeki temel hedeflerin (UN, 2024) merkezinde insanın ekonomik faaliyetleri ve onun ekolojik ayak izini azaltma çabasının yer aldığı açıkça anlaşılmaktadır. SKH'lerin birbirleriyle olan bağlantıları ve entegre yapısı (Barbier & Burgess, 2019) dikkate alındığında tüm hedeflere ulaşmada nüfus kritik bir öneme sahiptir. Bu bağlamda geleceği şimdiki zaman için feda etmeyecek, sürdürülebilirliği sağlayacak optimal nüfusun ne olması gerektiği temel sorulardan birini oluşturmaktadır.

Bir ülke nüfusunun yerel olarak sürdürülebilir doğal üretim ve özümseme kapasitesini aşan kaynak tüketimi ve atık boşaltım seviyesi, ekolojik borç olarak adlandırılmaktadır (Oxford Climate Society). Türkiye, doğal kaynaklarını, bu kaynakların kendisini yenileyebilme hızından daha hızlı tükettiği için ekolojik anlamda borçlu ülkeler arasında yer almaktadır. Türkiye'nin, 1980'li yılların ortasından itibaren biyolojik kapasite açığı ile karşı karşıya kalmasının en önemli nedeni nüfus artışıdır (WWF-Türkiye, 2012). Bu çalışmada Pimentel vd. (1998) tarafından ileri sürülen modelden hareketle ve ARDL yöntemiyle Türkiye için hedef nüfus seviyesi ortaya konulmaya çalışılmıştır. Türkiye'nin kısa vadede ulaşmayı hedeflediği kişi başına gelir düzeyi ve ekolojik anlamda sürdürülebilirlik, bu nüfus düzeyini etkileyen temel kısıtlar olarak belirlenmiştir. İktisat literatüründe demografik unsurları ve özellikle nüfusu analize dâhil eden çok sayıda çalışma olmakla birlikte iklim krizinin etkilerinin yoğunlaştığı ve bu noktada nüfus kısıtlamasına yönelik politikaların önem kazandığı son dönemde Türkiye'yi odak alarak sürdürülebilir bir nüfus değeri bulmayı hedefleyen çalışma sayısı oldukça sınırlıdır. Bu çalışma ilgili boşluğu kapatmayı hedeflediği gibi hem müteakip çalışmalar ve hem de bu çalışmanın bulgularından esinlenebilecek demografik iktisat politikaları için bir referans olacaktır. Çalışmanın takip eden bölümünde nüfus kavramının iktisat teorisindeki yeri ve optimal nüfus düzeyine ilişkin yaklaşımlar ele alınmıştır. Bir sonraki bölüm literatür taramasını oluşturmakta iken

dördüncü bölüm ise ekonometrik analize ayrılmıştır. Son bölümde ise ekonometrik analiz bulgularından hareketle değerlendirme ve politika önerileri yer almaktadır.

2. Nüfusun Ekonomik Gelişmedeki Önemi ve Optimal Nüfus Düzeyi

Nüfus, ortalama refahın önemli bir belirleyeni olduğundan pek çok iktisatçının ilgisini çeken bir alan olmuştur. 18. yüzyılın sonunda Malthus, nüfusun kontrol edilmediğinde geometrik oranda artarken (her 25 yılda bir ikiye katlanırken) geçimin (gıda maddeleri üretiminin) sadece aritmetik bir oranda artacağını öngörmüştür. Toplumun bu ilerleyişi sefaletle sonuçlanacak yani nüfus artışının net etkisi olumsuz olacaktır. Besinleri insan yaşamı için gerekli kılan doğanın kanununa göre, eşit olmayan bu iki gücün etkileri eşit tutulmalıdır. Bu eşitlik, geçim zorluğu nedeniyle nüfus üzerinde güçlü ve sürekli işleyen bir kontrol ile mümkün olabilir (Malthus, 1998: 4-11). Malthus'un bu görüşleri temelde ekonomik olduğundan nüfus sorunu her zaman iktisatçıların ilgi alanını oluşturmuştur (Zimmermann, 1989: 1). Bununla birlikte 1798 tarihli The Essay on the Principle of Population başlıklı kitabındaki analizi, iktisat alanındaki takip eden yazılarına genişletildiğinde Malthus'un nüfusun ekonomik bir değişken olarak ekonomik büyüme analizine nasıl uyum sağladığı sorusuna da yanıt aradığını göstermektedir. Bu bağlamda hem Malthus'un hem de Marx'ın Klasik İktisat Okulu'nun ortodoks görüşünden farklı olarak dengeden ziyade büyümeyle ilgilendiği ifade edilebilir (Charbit, 2009: 1). Bir ülkenin nüfusunun optimal bir büyüklüğe, nüfus büyüklüğü ile ekonomik ve en büyük ekonomik faydayı sağlayan diğer kaynaklar arasındaki en uygun dengeye sahip olabileceği açıklaması, muhtemelen ilk kez 1819'da New Principles of Political Economy başlıklı çalışmasında Fransız iktisatçı Julien Sismondi tarafından dile getirilmiştir (Wickens, 1988: 163). Sismondi'ye göre zenginlik ile nüfus arasında belirli bir bölgedeki tüm insanlara en yüksek refahı garanti edecek bir dengeyi hedeflemek gereklidir (Girard, 2020: 23-41).

Her bireyin pozitif bir fayda düzeyine sahip olduğu durumda nüfus artışının toplam faydayı artıracağı ve bu nedenle nüfus artışının sorun yaratmanın ötesinde olumlu gelişmeler sağlayacağını iddia eden bir görüş de bulunmaktadır. Marx ve Keynes'e göre nüfus artışı GSYH'yi artırır, bu ilişkinin nedeni Marx'a göre endüstriyel yedek ordu ve göreli artık nüfus tartışmalarının sonucu olarak nüfus artışının ücretleri düşük, kârları yüksek tutarak sermaye birikiminin engellenmeden devam etmesine izin vermesidir. Keynes'te ise nüfusun piyasayı genişletmesi ve efektif talep üzerindeki etkisi GSYH'yi artıran unsurdur (Lianos et al., 2022: 610). II. Dünya Savaşı'nı takip eden dönemde bu bakış açısıyla hareket eden ekonomik birimlerin temel kaygılarından biri, GSYH ve kişi başına tüketimin artmasına yol açacak şekilde tüm ulusların ekonomik kalkınması olmuştur. Kapitalizmin altın çağı olarak adlandırılan 1950-1970 dönemindeki belirgin başarı, ekonomik büyüme hedeflerini desteklemiştir (Lianos, 2019: 56).

Aynı tarihlerde hızlı nüfus artışının yoksulluğun temel nedeni olduğunu vurgulayan bazı görüşler de ortaya atılmaya başlanmıştır. Nelson (1956), az gelişmiş ülkelerde nüfus artış hızının GSYH artış hızını aşması halinde ekonominin kişi başına düşen gelirin oldukça düşük seviyede olduğu bir denge gelir düzeyine hapsolabileceğini açıklamıştır. Yüksek

nüfus artışının neden olduğu bu tuzaktan kurtulmak için GSYH'yi daha hızlı artıracak daha verimli üretim yöntemleri ya da daha düşük bir nüfus artış oranı gerekmektedir. Aynı yıl Huxley (1956) gezegenin kaynakları üzerinde artan nüfus baskısının işaretlerine dikkat çekmiştir. Özellikle az gelişmiş ülkelerde nüfusun büyüklüğünün yaşam kalitesinden bağımsız olmadığına vurgu yaparak, doğum kontrolünün büyük ölçekte ve mümkün olan en kısa sürede hayata geçirilmesinin gerekliliğini ifade etmiştir (Huxley, 1956: 66). Bu öncü görüşleri takiben ekonomik büyümenin sonlu bir dünya ekosisteminin belirlediği sınırları aşamayacağı anlaşılmıştır. Nüfus artışının, sahip olunan tüketim kalıpları ve teknoloji seviyesi göz önünde bulundurulduğunda, ikame edilemez kaynakların sürekli tüketilmesine neden olarak; Dünya'nın sürdürülebilirlik kapasitesinin aşılmasına neden olduğu, pek çok araştırmacı tarafından vurgulanmaya başlanmıştır (Meadows et al., 1972; Daily et al., 1994: 469; Ehrlich & Ehrlich, 2009). Bazı araştırmacılar gelecek ile ilgili olarak oldukça karamsar olup nüfusun sancılı çöküşünden (Schade & Pimentel, 2010: 255) ve dünyanın birçok yerinde artan sosyal ve siyasi istikrarsızlıktan (Pimentel, 2012: 152) endişe etmektedirler. Nüfus büyüklüğüyle mücadele etmeye yönelik politikalar, sadece insanın çevreye olan etkilerini azaltmak için değil, aynı zamanda hem bugünkü hem de gelecekteki insan refahını artırmak için gereklidir (Samways, 2022: 16).

Bazı iktisatçılar ekonomilerin durağan denge durumuna doğru gösterdiği eğilimde nüfusun etkisine odaklanmışlardır. Adam Smith başta olmak üzere klasik iktisatçılara göre, kapitalist sistem başlangıçta ne kadar canlı olursa olsun, belli bir olgunluğa eriştikten sonra (tam zenginlik aşaması) sabit bir nüfus büyüklüğü ve sabit bir sermaye stoku ile artık daha ileri gitmenin mümkün olmadığı bir nihai duruma ulaşacaktır. Bu süreçte en önemli rolü nüfus artışı oynayacaktır. Böylesi bir ortamda nüfus, toprağın besleyebileceği veya mal üretim sürecinde çalıştırılabilecek bir düzeyde olacaktır. Böylece ücretler ancak nüfusun kendisini fiziksel olarak yeniden üretmesini mümkün kılacak surette minimum bir düzeyde oluşacaktır (Smith, 2009: 78). Smith'in bu görüşlerinden etkilenen klasik iktisatçılar ve en çok da John Stuart Mill (1857)'in katkılarıyla geliştirilen durağan durum, nüfusun ve sermaye stokunun artmadığı bir yapıyı açıklar. Durağan durumda doğum oranları ölüm oranlarına, üretim oranları da yıpranma oranlarına eşit olacak, böylece hem insan stoku (nüfus) hem de insan yapımı ürünler stoku (fiziksel sermaye) sabit kalacaktır. Durağan durumun ötesinde Mill'in nüfusa ilişkin olarak farklı görüşleri de vardır. O'na göre ekonomik büyüme daha büyük bir insan nüfusunu sürdürülebilir kılsa bile, bu doğal çevrenin yok edilmesi nedeniyle en iyi sonuç olmayacaktır. Mill, tüketim karşıtlığının öncülüğünü yaparak; insanlığın hem işbirliğinin hem de toplumsal ilişkinin tüm avantajlarından en üst düzeyde yararlanabilmesi için gerekli nüfus yoğunluğuna, en kalabalık ülkelerin hepsinde ulaşılmış olduğunu vurgular. Bu bağlamda insanların gelecek nesiller için zorunlu kalmadan önce daha büyük bir nüfus için değil daha iyi ya da daha mutlu bir nüfus için gerekli önlemleri almasını ümit ettiğini ifade eder (Mill, 2004: 191). Neoklasikler ise durağan durumu, ihtiyaçları sınırsız ve teknolojiyi de Dünya'yı etkin bir şekilde sonsuz kılacak kadar güçlü kabul ederek; sabit nüfus ve sermaye stoku ile değil, bunların orantılı büyümelerini ifade edecek şekilde yeniden tanımlamışlardır. Böylece sermaye stoku ve emek aynı oranda büyüdüğünden çalışan başına sermaye ve çalışan başına üretim sabit kalır. Ekolojik iktisadın

öncülerinden Herman Daly, durağan durumu sabit nüfus ve sabit sermaye stokuna sahip, ekosistemin yenilenme ve asimilasyon kapasiteleri kapsamında düşük bir üretim oranıyla sürdürülen bir ekonomi olarak tanımlar. Bu durum, düşük doğum oranlarının düşük ölüm oranlarına ve düşük üretim düzeyinin düşük amortisman oranlarına eşitlendiği bir denge üretim düzeyine karşılık gelir. Durağan duruma ulaşan ekonomilerde asgari ve azami gelirlere sınırlar koyarak; gelirin yeniden dağıtımı yoluyla yoksullukla mücadele edilebilir (Daly, 2008: 2-4). Burada tanımlanan durağan durumda niceliksel büyümenin yerini niteliksel gelişme veya iyileşme almaktadır (Daly & Farley, 2011: 492). Bir başka tanıma göre durağan durum ekonomisi, sonsuz ekonomik büyüme arayışına karşı olumlu bir alternatifi temsil etmektedir. Bu ekonomi, istikrarlı bir kaynak tüketimi seviyesini ve istikrarlı bir nüfusu korumayı amaçlayan bir ekonomidir. Bu, enerjinin ve kaynak kullanımının ekolojik sınırlar dahilindeki seviyelere indirildiği ve ekonomik çıktıyı maksimize etme hedefinin yerini yaşam kalitesini maksimize etme hedefinin aldığı bir ekonomidir. Bir ülkede yaşayan insan sayısı arttığında ya da bu insanların her birinin tüketim düzeyi arttığında ülkenin toplam kaynak kullanımı da artacaktır. Bu nedenle, durağan duruma ulaşmak için sadece kişi başına düşen kaynak kullanımının değil, nüfus düzeyinin de istikrara kavuşturulması gerekir (O'Neill et al., 2010: 11).

Doğum oranlarının ölüm oranlarına eşitlenmesi yoluyla nüfusun istikrara kavuşturulması gerektiğini söylemek yeterli değildir. Özellikle iktisatçılar nüfusun hangi büyüklükte istikrara kavuşacağının belirlenmesinin önemini ortaya koyarlar (Lianos, 2018: 87-88). Wicksell, optimal nüfus ile ilgili görüşleriyle bu iktisatçıların başında gelmektedir. Lundahl'ın aktardığı üzere Wicksell, güçlü bir nüfus artışının gıda talebini de artıracağını ileri sürmektedir. Tarımsal çıktı her zaman sermaye birikimi ve işgücünün büyümesiyle artırılabilir, ancak tarımdaki azalan getiriler nedeniyle çıktı, bu faktörlerden daha az artacaktır. Endüstriyel üretim de hem uzun dönemde tükenecek olan doğal kaynaklara hem de girdiler için tarıma bağlı olduğundan bu sektörde de azalan getiriler vardır. Zaman içinde teknolojik ilerlemenin azalan getirileri dengeleyeceği ve hatta aşacağı ve böylece gelirleri sürekli olarak artıracağı sıklıkla tartışılmaktadır. Ancak Wicksell'e göre bu durum marjinal verimlilik eğrisinin geçici olarak yukarı kaymasına yol açacak ve daha sonra azalan getiriler daha yüksek bir nüfus düzeyinde yeniden devreye girecektir. Nüfus artışı, ekonomide getirilerin azalması nedeniyle hem kişi başına düşen geliri hem de ücretleri düşürme eğilimindedir. Tüm bu ilişkilerin sonucu olarak Wicksell'e göre yoksulluk, nüfus artışından kaynaklandığından onunla mücadelede temel yol, ailelerin ve dolayısıyla toplam nüfusun büyüklüğünü sınırlamaktır. Bu bağlamda optimal nüfus, nüfusun ekonomik refahını en üst düzeye çıkaran nüfustur (Lundahl, 2015: 84).

Optimal nüfus kavramı daha sonra pek çok araştırmacının ilgisini çekmiştir. Dalton, Wicksell'e benzer şekilde optimal nüfusu kişi başına düşen geliri maksimum kılan nüfus olarak tanımlamıştır (Dalton, 1928: 32). Wolfe daha ayrıntılı bir tanım yaparak belirli doğal kaynaklar, ileri teknolojiler ve standart çalışma süresi ile tüketim mallarından kişi başına mümkün olan en büyük ürünü elde edebilecek nüfus düzeyini optimum olarak işaret eder (Wolfe, 1934: 585). Dasgupta'ya göre optimal nüfus, mevcut sermaye stokunun büyüklüğüne, optimal tasarruf oranı ise mevcut insan sayısına bağlıdır. Bu anlamda, eş

zamanlı bir tasarruf politikası olmaksızın bir nüfus politikası formüle edilemez (Dasgupta, 1969: 295).

Optimal nüfus kavramını sürdürülebilir kaynak kullanımı ve çevresel sürdürülebilirlik perspektifinden ele alan Pimentel vd. (1998)'e göre nüfusun büyüklüğü çevresel koşullarla tutarlı olmalıdır. Hedeflenen yaşam standardı ne kadar yüksekse, nüfus o kadar küçük olmalıdır. Teknolojik sermayenin gelecekte tüm ülkeler için bol miktarda mevcut olacağı varsayılsa bile doğal sermaye, nüfus artışını sınırlayan önemli bir faktördür. İnsan nüfusunun mevcut büyüklüğü gelecek nesillerin fırsatlarını tehlikeye atacak kadar fazladır. Kaynaklara yönelik beşeri sömürü, yenilenebilir ve yenilenemez kaynakların hızla yok olmasına neden olan döngüye çoktan girmiş olduğundan nüfus artışı bir an önce durdurulmalıdır (Pimentel et al., 1998: 142). Daly'nin görüşlerinden etkilenen Lianos, optimal nüfuslu durağan durum ekonomisini incelemiştir. Küresel kaynakların sınırlı olması ve bu nedenle doğal sermayenin korunması nedeniyle dünya ekonomisi bir bütçe kısıtı altındadır. Bu kısıt altında optimal büyüklüğün belirlenmesi, istenen kişi başına ürünün, yani istenen yaşam standardının tanımlanmasına bağlıdır. Böylece öncelikle kişi başına tüketimin istenen (veya optimal) seviyesinin ne olduğuna ve daha sonra maksimum dünya ürün miktarı göz önüne alınarak nüfusun büyüklüğüne karar verilmelidir (Lianos, 2013: 1544). Herkesin eğitime, sağlık hizmetlerine, sağlıklı yaşam koşullarına ve ekonomik fırsatlara erişimi olmalıdır; ancak bu temel hakların büyük nüfuslarda, özellikle de hızla büyüyen nüfuslarda güvence altına alınması zordur. Nüfus yoğunluğunun yüksek olduğu ve/veya kaynakların kıt olduğu durumlarda kişisel özgürlükler de kısıtlanma eğiliminde olacağından optimal nüfus, siyasal hakların korunmasında da önem kazanmaktadır. Bu bağlamda optimal nüfus, arzu edilen yaşam kalitesinin ve bu yaşam tarzına ulaşmanın gezegenin yaşam destek sistemleri üzerindeki kişi başına düşen etkisinin bir fonksiyonu olup zenginlik ve kaynakların adaletsiz dağılımı ve uzun vadeli oranlara ilişkin belirsizlik karşısında bile, herkese düzgün bir yaşamın asgari fiziksel bileşenlerini garanti etmelidir (Daily et al., 1994: 470-471).

3. Literatür

18. yüzyılın sonuna kadar uzanan teorik açıklamalar ile nüfus konusu ve bu doğrultuda optimal nüfusun ne olması gerektiğine ilişkin görüşler oldukça geniş bir çeşitliliğe sahiptir. Bununla birlikte iklim krizinin hem dünyanın hem de gelecek nesillerin devamlılığını tehdit eden yaygın bir endişe konusu haline gelmesine kadar gerçekleştirilen çalışmalar genellikle teorik ve kavramsal özellik göstermiştir. Malthus'un çalışmalarından etkilenen ve belirli bir ortamın fiziksel olarak destekleyebileceği azami nüfusu ifade eden taşıma kapasitesi (carrying capacity) yapılan çalışmaların odağında yer almıştır. Taşıma kapasitesini odağına alan çalışmaların bir kısmında kişi başına doğal kaynaklar azami nüfusun belirlenmesinde bir kriter olarak kullanılmaktadır.

Erken tarihli çalışmalardan Knibbs (1917), kişi başına mısır tüketimi ve kişi başına ekilebilir alan değerleri üzerinden Avustralya'nın en fazla 132 milyon nüfusa sahip olması gerektiği sonucuna ulaşmıştır. Penck (1925), optimal nüfusu belirlerken kişi başına gıda ihtiyacını esas alırken; Westing (1981), Penck (1925)'e ek olarak kişi başına su ihtiyaç

oranını da analize dahil etmiştir. Gıdanın yanı sıra, enerji, biyolojik olarak erişilebilir nitrojen, fosfor, tatlı su, ışık, toprak, alan, hastalıklar, atıkların bertaraf edilmesi, yakıt dışı mineraller, ormanlar, biyolojik çeşitlilik ve iklim değişikliği gibi unsurlar da optimal nüfusun belirlenmesinde kullanılmıştır (Cohen, 1995: 342). Ehrlich ve Ehrlich (1991), gelmiş ülkeler için kişi başına enerji kullanımının 7,5 kw'tan 3,5 kw'a düşürüldüğü ve gelişmekte olan ülkeler için bu değerin 1 kw'tan 3 kw'a çıkarıldığı "Holdren Senaryosu'nun" geçerli olması durumunda nüfusun (P) çevre üzerindeki etkisini (I), kişi başına gelir veya kişi başına tüketim dikkate alınarak hesaplanan refahın (A) ve teknolojinin (T) dâhil edildiği;

$$I = P \times A \times T \tag{1}$$

(1) numaralı denklem ile araştırmışlardır. Ülkeler, I'nın büyümesini ve yaşam destek sistemlerini zayıflatmasını (örneğin iklimi istikrarsızlaştırmasını veya biyolojik çeşitliliği tüketmesini) önlemek için P, A ve T değerlerini yönetmelidirler. Bu amaçla enerjinin verimli kullanılması ve negatif nüfus artış hızının önerildiği çalışmada yazarlar ABD'nin optimal nüfusunu 75 milyon olarak hesaplamışlardır. ABD için optimal nüfusu hesaplayan bir başka çalışma Pimentel vd. (1994)'e aittir. ABD, sürdürülebilir enerji, toprak, su ve biyolojik çeşitlilik kullanımı ve nispeten yüksek yaşam standardı ile yenilenebilir bir enerji ekonomisine geçerse optimal nüfusu yaklaşık 200 milyon olacaktır ki bu tahmin o dönem (1994) 258 milyonluk nüfusundan önemli ölçüde daha azdır. Çalışmada ayrıca yeterli gıdanın temin edilebilmesi için kişi başına 0,5 hektarlık arazinin gerekli olduğu tahminine dayanarak, yaklaşık 3 milyarlık küresel bir nüfusu sürdürmenin mümkün olacağı da hesaplanmıştır (Pimentel et al., 1994).

$$\text{Doğal Kaynak Kullanımı} \times \text{Teknoloji} = \text{Nüfus} \times \text{Kişi Başına Tüketim} \tag{2}$$

Daily vd. (1994) yukarıdaki (2) numaralı denklemin sol tarafını insanlığın enerji tüketim miktarını gösteren bir sabit olarak almışlardır. Dünyanın zenginleri ve fakirleri arasındaki enerji kullanımındaki büyük farklılıklara ve bunun sonucunda ortaya çıkan çevresel hasara dikkat çeken yazarlar, enerji kullanımının adil bir şekilde dağıtıldığını varsayarak, optimal insan sayısının 1,5 ila 2 milyar (1930'ların başındaki dünya nüfusu) civarında olduğunu tahmin etmişlerdir. Pimentel vd. (1998), nüfus-kaynak denklemi olarak adlandırdıkları (2) numaralı denklemi kullanarak optimal nüfus miktarını hesaplamaya çalışmışlardır. Yazarlar, bu denklemde yer alan teknolojinin, doğal kaynak sıkıntısını telafi etme kabiliyetinin sınırlı olduğunu vurgulamışlardır. Teknolojik sermaye ile doğal sermayenin birbirinin ikamesi değil tamamlayıcısı olduğunu vurgulayan yazarlara göre sınırlı doğal kaynakları ve kişi başına tüketimi yalnızca teknoloji ile büyük ölçüde artırmak mümkün değildir. Teknoloji, toprak ve su gibi doğal kaynakları mevcut olandan daha fazla erişilebilir hale getiremez; kaynak kullanımının verimliliğini yalnızca sınırlı ölçüde artırabilir. Bu düşünceyle çalışmada Kuzey Amerika'nın yanı sıra Latin Amerika'nın da optimal nüfusu 200 milyon kişi olarak hesaplanmıştır.

Wiley (2000), kişi başına su tüketimi, enerji kullanımı ve ekolojik olarak verimli arazi kriterleri üzerinden (1) numaralı denkleme benzer bir sürdürülebilirlik denklemi oluşturmuştur. Çevresel etkinin, I nüfusun, P tüketimin, C ve teknolojinin, T ile sembolize edildiği;

$$I = P \times C \times T \qquad\qquad (3)$$

(3) nolu denklik üzerinden elde edilen sonuçlar Dünya nüfusunun yarım ila bir milyar arasında olması gerektiğini ortaya koymaktadır. Lianos (2013) ile Lianos ve Pseiridis (2016)'da (2) nolu denklemdeki sol tarafı, ekolojik denge sağlandığında üretilebilecek gayri safi dünya hasılası olarak tanımlanmışlardır. Ekolojik denge, ekolojik ayak izi ile biyokapasitenin birbirine eşit olduğu bir seviyede sağlanmakta ve bu durumda dünya üretimi tam olarak mevcut kaynakların izin verdiği düzeyde ve doğal sermayeyi bozmadan sürdürülebilmektedir. Bu ilişkilerin bir sonucu olarak Lianos (2013)'e göre doğal sermayeyi tüketmeden 11.000 dolarlık bir kişi başı hasıla (o tarihte ortalama bir Avrupa vatandaşının refahıdır) için nüfusun 2,5 milyar kişiye düşürülmesi gerekir. Lianos ve Pseiridis (2016)'ya göre de kişi başına 11.000 doları mümkün kılacak duruma karşılık gelen optimal nüfus büyüklüğü ise yaklaşık 3,1 milyardır. Bu çalışmada yazarlar ayrıca Türkiye'nin de içinde yer aldığı 52 ülke için optimal nüfus büyüklüğünü hesaplamışlardır. Çalışmada Türkiye için optimal nüfusun 49 milyon olduğu tespit edilerek 2010 yılı itibariyle nüfusun 23,1 milyon azaltılması gerektiği vurgulanmıştır (Lianos & Pseiridis, 2016: 1689-1690). Dünya nüfusunun büyük oranda azalması ile daha küçük bir nüfusun üretim ve tüketim için doğal kaynak kullanımı azalacak ve aynı zamanda emek arzı azalarak ücretler artacaktır. Böylece hem ekolojik denge sağlanabilecek hem de gelir dağılımı büyük ölçüde iyileşecektir (Lianos, 2019: 55). Dasgupta vd. (2023), insanlığın biyosferi sürdürülebilir bir şekilde yaşatma ve ekonomik eşitliği sağlama yollarını bulması halinde, Dünya'nın 20.000 dolarlık (orta gelirli ülkelerin gelir düzeyini temsil etmesi nedeniyle) bir yaşam standardında destekleyebileceği insan nüfusunun yaklaşık 3,3 milyar olduğunu hesaplamıştır. Bu nüfus düzeyi mevcut nüfusun %42'sine denk gelmektedir. Kabaca üç milyarlık bir insan nüfusunun küresel olarak arzu edilir seviyeyi işaret ettiğini gösteren başka çalışmalar da mevcuttur (Tucker, 2019; Arrhenius & Duus-Otterström, 2024: 18).

Farklı tahmin yöntemleri kullanılarak yapılan bu çalışmaların elde ettikleri sonuçların büyük farklılık göstermemesi gezegenimizin aşırı nüfuslu olduğunun güçlü bir kanıtıdır. Şu anki nüfus büyüklüğünün (8,2 milyar), tahminlenen optimal büyüklükleri (gezegenimizin taşıma kapasitesini) açık ara aştığı nettir. Bu sonuçlar, nüfus dinamiklerinin insan kaynaklı çevre kirliliği ve sürdürülebilir gelişmeyle fazlasıyla ilişkili olduğunu göstermektedir. Ekosistemler ulusal sınırlara uymak zorunda olmadığı için birçok çevre ve gelişme sorunu doğal olarak küresel olup tüketim kalıplarıyla birlikte nüfus dinamiklerinin ve bunun mekânsal farklılıklarının politik gündemde ele alınması gerekir (Özgür, 2017: 1). Lianos (2013)'e göre optimal nüfusun üzerindeki nüfus seviyelerinde küresel olarak alınması gereken önlemler; teknolojiyi geliştirmek, nüfus büyüklüğünü azaltmak ve yaşam tarzımızı yeniden gözden geçirerek daha çevre dostu tüketim alışkanlıklarını benimsemek olacaktır. Lianos (2018), mevcut neslin gelecek nesillere zarar vermesini önlemek için hem

uygulanabilecek teşvik politikalarına ilişkin görüşlerini sunmuş hem de nüfus sorununu parasallaştırarak üreme hakları için bir pazar yaratmayı tavsiye etmiştir. Bu bağlamda ailelere bir buçuk çocuk hakkı verilerek, tek çocuk sahibi olmak isteyen ailelerin yarım çocuk hakkını satabilecekleri veya iki çocuğa sahip olmak istiyorlarsa da yarım çocuk hakkını satın alabilecekleri bir piyasa mekanizması önerilmiştir (Lianos, 2018: 83). Böylesi bir nüfus politikasının zorluklarının olacağı da açıktır. Bu süreçte nüfusun değişen yaş yapısı nedeniyle toplam efektif talebin azalması ve emeklilik fonlarının (kamu ve özel) yeterliliği en önemli sorunlar olarak ortaya çıkacaktır (Lianos, 2019: 75).

4. Veri Seti ve Ekonometrik Analiz

Çalışmada Pimentel vd. (1998) tarafından öne sürülen nüfus-kaynak eşitliğinden hareket edilmiştir. Bu eşitliğe göre;

Nüfus x Kişi Başına Tüketim = Doğal Kaynak Kullanımı x Teknoloji'dir.

Eşitliğin sağ tarafında yer alan doğal kaynak kullanımı ve doğal kaynaklardan daha verimli bir biçimde istifade etmeyi mümkün kılan teknoloji değişkenleri olarak daha güncel olan ve yeşil büyüme kavramı ile daha yakından bağlantılı olan ekolojik ayak izi ve biokapasite değişkenleri kullanılmıştır. Biyokapasite değişkeninin teknolojik gelişmeyi temsil eden bir gösterge olarak kullanılmasının arkasında çevre temelli teknolojik gelişmeler ile biyokapasite arasındaki yakın ve paralel ilişki yer almaktadır. Teknolojik gelişmeler, kaynak verimliliğini artırarak ve birim kaynak kullanımını optimize ederek biyokapasiteyi artırabilmektedir (Toprak, 2023: 603). Benzer biçimde biyokapasite değişkeni, ekosistem verimliliğinin de bir göstergesi olup teknolojik gelişmelerin neden olduğu artan kaynak talebinin karşılanabilme kapasitesini de göstermektedir (Mehmood et al., 2023: 603). Bu bağlamda biyokapasite değişkeni, ekolojik yenilenme kapasitesi, verimlilik ve kaynak kullanımındaki çevresel etkinlik göstergesi olarak teknolojik gelişmeyi temsil etmektedir. Nüfus düzeyinin belirlenmesinde etkili olan bir diğer faktör ise kişi başına milli gelir düzeyidir. Çalışmada kullanılan veriler Tablo 1'de sunulmuştur. Verilerin tümü için dönem aralığı 1961-2022'dir.

Tablo: 1
Veri Seti

Değişken	Kısa adı	Kaynak
Nüfus (kişi)	POP	TÜİK (www.tuik.gov.tr) ve Statista (www.statista.com)
Kişi başına düşen GSYH (nominal $)	KBDG	Dünya Bankası (https://data.worldbank.org/)
Kişi başına düşen ekolojik ayak izi (gha)	ECO	Global Footprint Network (https://data.footprintnetwork.org/)
Kişi başına düşen biyokapasite (gha)	BIO	

Rees (1992) tarafından ortaya konulan bir terim olan ekolojik ayak izi, yenilenebilir kaynakların tüketiminin bir ölçüsüdür. Biyokapasite ise ekosistemlerin üretiminin toplu bir ölçüsü olup biyosferin yenilenme kapasitesini temsil etmektedir (Lianos & Pseiridis, 2016: 1682). Lianos ve Pseiridis (2016) baz alınarak bu iki değişkenin birbirine eşit olduğu nokta ekolojik anlamda sürdürülebilir nüfus düzeyi olarak kabul edilmiştir. Çalışmada kişi başına gelir hedefi olarak Türkiye Cumhuriyeti Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı

tarafından yayımlanan On İkinci Kalkınma Planı (2024-2028)'nda belirlenen 17.500 $'lık kişi başına milli gelir düzeyi hedefi esas alınmıştır. Aşağıda yer alan Grafik 1'de Türkiye'de kişi başına biyokapasite ve kişi başına biyolojik ayak izi değişkenlerinin seyri gösterilmektedir.

Grafik: 1
Türkiye'de Kişi Başına Biyokapasite ve Ekolojik Ayak İzi (1961-2021)
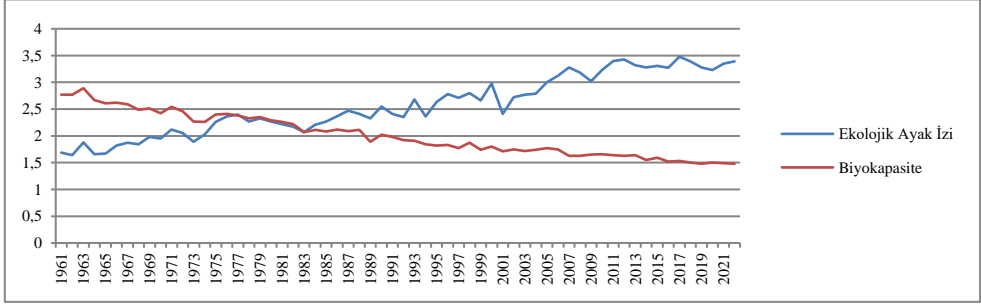
Kaynak: Global Footprint Network, data.footprintnetwork.org, 02.06.2024.

Grafik incelendiğinde her iki değişkenin de birbirinin tersi yönde bir eğilim gösterdiği görülebilmektedir. Değişkenler arasında 1970'lerin ikinci yarısında kısa süreli bir dengenin sağlanmasının ardından 1980'lerle birlikte iki değişken arasındaki fark giderek açılmıştır. Bu durum Çevresel Kuznets Eğrisi yaklaşımı ile tutarlıdır. Ekonomik kalkınmanın ilk aşamalarında gelir düzeyi arttıkça çevre kirliliği de artacaktır. Fakat bu kirlilik artışı geçici olup ekonomik gelişmişlikle birlikte bireyler daha temiz bir çevre talep ederken üretim sürecinde de kirlilik yaratan teknolojiler daha temiz teknolojiler ile ikame edilebilmektedir (Grossman & Krueger, 1995: 371). Çevre ve iktisadi büyüme arasındaki ilişki, gelişmiş ve gelişmekte olan ülkeler arasında farklılık göstermektedir. Gelişmiş ülkelerde katı çevre politikaları üretim maliyetlerini artırmakla birlikte kirlilik yaratan endüstrilerden temiz endüstrilere geçiş daha düşük maliyetle mümkün olabilmektedir. Gelişmekte olan ülkelerde ise çevre bilincinin gelişmemiş olmasının yanı sıra iktisadi öncelikler gelirlerin ve üretim hacminin artırılmasına dayandığından çevre kirliliğine ilişkin standartlar göz ardı edilebilmektedir (Temurshoev, 2006: 2; Ertürk, 2016: 3).

4.1. Durağanlık Analizi

İktisadi zaman serileri trend, konjonktürel ve arızi hareketler ile mevsimsel dalgalanmalar nedeniyle genellikle durağan olmayıp birim kök içermektedir. Birim kök içeren zaman serilerinin kullanılmasıyla gerçekleştirilen analizler sahte regresyon sorununa neden olabilmektedir (Johansen & Jesulius, 1990: 170; Granger & Newbold, 1974: 111-112). Çalışmada değişkenlere ilişkin durağanlık sınaması, ADF ve Phillips-Perron Birim Kök testleri ile gerçekleştirilmiştir.

Tablo: 2
Birim Kök Test Sonuçları

Değişken	Düzey/Fark	ADF Test İstatistiği		Phillips-Perron Test İstatistiği	
		Sabitli	Sabitli ve Trendli	Sabitli	Sabitli ve Trendli
POP	Düzey	1.4522 (0.999)	-2.54 (0.3086)	1.96997 (0.9998)	-2.54002 (0.3086)
	1. Fark	-10.172* (0.000)	-10.8928* (0.000)	-10.03068* (0.0000)	-11.08937* (0.0000)
KBDG	Düzey	-0.04131 (0.9506)	-1.77387 (0.7053)	-0.210781 (0.9308)	-1.977601 (0.6016)
	1. Fark	-6.88269* (0.0000)	-6.88647* (0.0000)	-6.957749* (0.0000)	-6.960977* (0.0000)
ECO	Düzey	-0.96832* (0.7591)	-5.151002* (0.0004)	-0.835572 (0.8016)	-5.247041* (0.0003)
	1. Fark	-12.0205* (0.0000)	-11.92436* (0.0000)	-17.17550* (0.0000)	-17.08281* (0.0000)
BIO	Düzey	-1.54031 (0.5065)	-3.88472** (0.0186)	-1.90963 (0.3259)	-3.67937** (0.0314)
	1. Fark	-11.3961 (0.0000)	-11.45572 (0.0000)	-17.13786 (0.000)	-34.17672 (0.0001)

%1, %5 ve %10 anlamlılık düzeylerinde sabitli yöntem için kritik değerler sırasıyla -3.544063, -2.91086 ve -2.593090 iken sabitli ve trendli yöntemde -4.115684, -3.485218 ve -3.170793'tür. * ve ** işaretleri sırasıyla %1 ve %5 düzeyinde anlamlılığı ifade etmektedir.

Birim kök test sonuçlarından görülebildiği üzere nüfus ve kişi başına gelir değişkenleri fark durağan iken ekolojik ayak izi ve biyokapasite değişkenleri sabitli ve trendli yöntemde düzeyde durağan çıkmaktadır. Bu durum serilerde yaşanan kısa vadeli şokların uzun vadede ortadan kalktığı ve serinin istikrar gösterdiği anlamına gelmektedir. Deterministik trendden kaynaklanabilecek etkinin arındırılması amacıyla her iki değişkene de KPSS birim kök testi uygulanmıştır (Kwiatkovski vd., 1992: 159). Elde edilen sonuçlara göre biyokapasite değişkeni hem sabitli hem de trend ve sabitli modelde fark durağan iken ekolojik ayak izi değişkeni ADF ve Phillips-Perron testlerinde olduğu gibi sabitli ve trendli modelde düzeyde durağan çıkmıştır[1]. Bu durumun tahmin sonuçlarında sapmaya neden vermemesi için modele bir trend değişkeni eklenmiştir.

4.2. ARDL Analizi

Zaman serisi analizlerinde kullanılan serilerin durağan hale getirilmesi için fark alma işlemi uygulanabilirse de bu işlemin neden olduğu bilgi kaybı, seriler arasındaki ilişkiyi bozabilmektedir. Bu durumda farklı seviyelerden durağan olan serilerin bileşimlerinin durağan olabileceğinden hareketle eşbütünleşme analizleri gerçekleştirilebilmektedir. Eşbütünleşme analizi serilerin durağan olmadıkları durumda bile seriler arasında uzun dönemli bir ilişkinin olabileceği ve bu ilişkinin durağan olabileceği varsayımına dayanmaktadır (Harris & Sollis, 2003: 22).

ARDL Sınır Testi Yaklaşımı, analize dahil edilen değişkenlerin farklı düzeylerde durağan olmalarına rağmen uygulanabilir olması, Engle-Granger yöntemine göre daha iyi istatistiki özelliklere sahip olması, nispeten küçük örneklemlere de uygulanabilir olması ve otoregresif gecikmesi dağıtılmış modellere dayandığından değişkenler arasındaki içsellik

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[1] *Ekolojik ayak izi değişkeni için KPSS testi trendli ve sabitli modelde test istatistiği 0.097952 iken kritik değerler %1, %5 ve %10 için sırasıyla 0.216, 0.146 ve 0.119'dur.*

sorununu dikkate almaması nedeniyle ön plana çıkmaktadır (Pesaran et al., 2001: 290; Narayan & Narayan, 2005: 429; Narayan & Smyth, 2005: 103).

Sınır Testi'nin gerçekleştirilmesinden önce ARDL modeli için gecikme uzunluklarının belirlenmesi gerekmektedir. Bu çalışmada gecikme uzunluklarının tespitinde Akaike (AIC) kriteri baz alınmıştır. Shibata (1981)'e göre sınırlı sayıda gözlemin yer aldığı örneklemlerde Akaike kriteri daha etkin tahminler gerçekleştirebilmektedir. Model seçimine ilişkin sonuç aşağıda yer alan Şekil 1'de gösterilmiştir.

Şekil: 1
Gecikme Uzunluğunun Tespiti

Akaike Information Criteria (top 20 models)
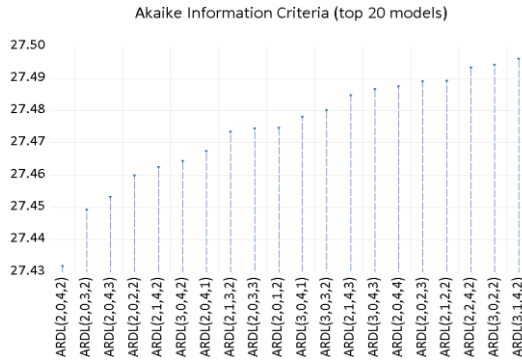
Şekil 1'de verilen bilgiler doğrultusunda tahmin edilecek model ARDL(2,0,4,2)'dir. ARDL yaklaşımının ilk aşaması Sınır Testi'dir. Sınır Testi ile modelde yer alan değişkenler arasında uzun dönemli bir ilişkinin tespit edilmesinin ardından takip eden aşamalarda uzun ve kısa dönem katsayılar elde edilir (Narayan & Smyth, 2006: 337). Sınır testinin tahmin edilmesiyle elde edilen F istatistik değeri, Pesaran vd. (2001) tarafından geliştirilen ve Narayan (2004) ve Narayan (2005) tarafından az sayıda gözlemin yer aldığı küçük örneklemler için yeniden formüle edilen iki asimptotik kritik değer kümesiyle karşılaştırılır. Kritik değerler, modelin deterministik bir trend içerip içermediğine bağlı olarak sırasıyla I(0) ve I(1) için alt ve üst sınırı oluşturmaktadır. F-istatistiği üst sınırın üzerinde veya üstündeyse, değişkenler arasında uzun dönemli düzey ilişkisinin var olduğu; alt sınırın altında veya alt sınırdan küçükse, değişkenler arasında uzun dönemli düzey ilişkisinin olmadığı söylenir. F-istatistiğinin alt ve üst sınırlar arasında kalması durumunda değişkenler arasında eşbütünleşme olup olmadığına karar verilemez (Pesaran et al., 2001; Narayan, 2004; Narayan, 2005). Modele ilişkin Sınır Testi sonuçları Tablo 3'te verilmiştir.

Tablo: 3
ARDL Sınır Testi Sonuçları

k	F	%1 Anlamlılık Düzeyinde Kritik Değerler		%5 Anlamlılık Düzeyinde Kritik Değerler		%10 Anlamlılık Düzeyinde Kritik Değerler	
		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
3	4,97	5,835	7,108	4,298	5,445	3,645	4,678

Tablo 3'te görüldüğü üzere hesaplanan F istatistiği %10 anlamlılık düzeyinde üst
sınır değerinden daha büyük olmakla birlikte %5 düzeyinde alt ve üst sınırların arasında
kalmaktadır. Bu durumda uzun dönemli eşbütünleşme ilişkisinin varlığı konusunda yorum
yapmak zorlaşsa da uzun dönemli ilişkinin varlığına işaret eden başka işaretler söz
konusudur. Bunlardan ilki kısa dönem hata düzeltme modelinde hata teriminin katsayısı (-
0.389045) hem negatif hem de anlamlıdır. Hata düzeltme modeli ve modele ilişkin tahmin
sonuçları aşağıdaki gibidir.

$$\Delta Pop = \alpha_0 + a_1 trend + \sum_{i=1}^{m} \alpha_{2i} \Delta Pop_{t-i} + \sum_{i=0}^{m} \alpha_{3i} \Delta Eco_{t-i} + \sum_{i=0}^{m} \alpha_{4i} \Delta Bio_{t-i} + \sum_{i=0}^{m} \alpha_{5i} \Delta[\frac{1}{KBDG}]_{t-i} + \alpha_6 ECM_{t-i} + u_t$$

Tablo: 4
Hata Düzeltme Modeli Tahmin Sonuçları

Değişkenler	Katsayılar	Standart Hata	t-statistics	Prob.
D(POP)				
ECM (-1)	-0.389045	0.084475	-4.605419	0.00000
D(POP(-1))	-0.345235	0.111091	-3.107665	0.0032
D(BIO)	-1253264	456995.9	-2.742396	0.0085
D(BIO(-1))	-1953288	627252.7	-3.114038	0.0031
D(BIO(-2))	-1362313	569258.4	-2.393136	0.0207
D(BIO(-3))	-758103.6	455848	-1.663062	0.1028
D(1/KBDG)	834403256	243577533	3.42561	0.0013
D(1/KBDG(-1))	-449156211	236867145	-1.89623	0.0640
c	5685723	976921	5.82004	0.0000
Trend	400259.7	86073.32	4.65021	0.0000

Tabloya göre ele alınan dönemde dengeden herhangi bir sapma oluşturacak şokun ilk
dönemde %64 gibi bir hızla dengeye yaklaştığı söylenebilir. Bu anlamda kısa dönemli
sapmalar uzun dönemde ortadan kalkmakta olup değişkenler arasında uzun dönemli bir
ilişkinin var olduğu ifade edilebilir. Uzun dönemli ilişkinin varlığını destekleyici bir başka
gösterge de robustness check olarak yapılan Phillips-Ouliaris testi olmuştur. Phillips ve
Ouliaris (1990) tarafından geliştirilen eşbütünleşme testi serilerin ardışık bağımlılık ve farklı
varyans içermeleri durumunda ve sınırlı örneklemlerde etkin sonuçlar vermektedir (Chau &
Zou, 2018: 4). Phillips-Ouliaris testine ilişkin sonuçlar aşağıdaki tabloda verilmektedir.

Tablo: 5
Phillips-Ouliaris Eşbütünleşme Testi Sonuçları

	Value		Prob	
Phillips-Ouliaris tau-statistic	-4.4467193		0.034570	
Phillips-Ouliaris z-statistic	-32.373487		0.016731	
	Coeff.	Std. Error	t-statistic	Prob
Resid(-1)	-0.48479	0.113802	-4.25994	0.0001

Tablo 5'ten görüldüğü üzere tau istatistiği %5'ten küçük olup. Değişkenler arasında
koentegre ilişkinin olmadığını ileri süren H_0 hipotezi reddedilmektedir. Buna göre
değişkenler arasında uzun dönemli bir ilişkinin olduğu ileri sürülebilecektir. Takip eden
aşamada ARDL yöntemi çerçevesinde uzun dönem katsayıları tahmin edilmiştir. Tahmin
edilecek denklem aşağıdaki gibidir:

$$Pop = \alpha_0 + \alpha_1 trend + \sum_{i=1}^{m} \alpha_{2i} Pop_{t-i} + \sum_{i=0}^{m} \alpha_{3i} Eco_{t-i} + \sum_{i=0}^{m} \alpha_{4i} Bio_{t-i} + \sum_{i=0}^{m} \alpha_{5i} [\frac{1}{KBDG}]_{t-i} + u_t$$

Modelin tahmin sonuçları ve elde edilen uzun dönem katsayıları ile tanısal test sonuçları Tablo 6'da görülmektedir.

Tablo: 6
ARDL (2,0,4,2) Regresyon Tahmin Sonuçları

Değişkenler	Katsayılar	Standart Hata	t-statistics	Prob.
POP				
POP(-1)	0.26572	0.15159	1.75279	0.08644
POP(-2)	0.34523	0.15042	2.29502	0.02644
ECO	560515.431	203688.416	2.75182	0.00851
BIO	-1253263.9	586627.439	-2.13638	0.03812
BIO(-1)	772585.092	416375.059	1.85550	0.07008
BIO(-2)	590975.924	514133.208	1.14946	0.25643
BIO(-3)	604208.891	389031.949	1.55310	0.12740
BIO(-4)	758103.616	482500.767	1.57119	0.12314
1/KBDG	834403256.72	285198160.74	2.92569	0.00536
1/KBDG(-1)	-1166289308.	363276736.02	-3.21047	0.00244
1/KBDG(-2)	449156211.4	235487842.9	1.90734	0.06287
Constant	5685723.302	2138727.125	2.65846	0.01083
Trend	400259.658	143273.024	2.79368	0.00762
Diagnostik Testler	**İstatistikler**			
Düzeltilmiş R²	0.99985			
F-İstatistiği	32306.72[0.0000]			
Durbin-Watson	1.90556			
Breusch-Godfrey LM	0.93306[0.40116]			
ARCH Heteroscedasticity	0.13194[0.71781]			
Jarque-Bera	1.20415[0.54767]			
Ramsey Reset	0.686431[0.4960]			

Modelin uzun dönem parametreleri incelendiğinde kişi başına ekolojik ayak izi ve kişi başına düşen gelir değişkenlerinin nüfus üzerindeki etkisinin pozitif yönlü ve istatistiki olarak da anlamlı olduğu görülmektedir. Bununla birlikte kişi başına biyokapasite değişkeninin nüfus üzerindeki etkisi aynı dönemde negatif olmakla birlikte ilgili değişkenin gecikmeli değerlerinin etkisi pozitiftir. Model bir bütün olarak anlamlıdır. Tanısal test sonuçlarının da gösterdiği üzere değişen varyans, spesifikasyon ve otokorelasyon sorunu olmamakla birlikte model normal dağılım göstermektedir.

Modelin katsayı tahminlerinin zaman içindeki kararlılığının yani sabit kalıp kalmadığının ve/veya yapısal kırılmaya maruz kalıp kalmadığının test edilmesiyle amacıyla CUSUM ve CUSUMQ istatistiklerinin sonuçlarına bakılmıştır. Kararlılık tanı testleri kapsamında CUSUM ve CUSUMQ grafikleri Şekil 2'de verilmiştir. Bu grafiklerde, alt ve üst sınırlar %5 güven aralığına göre çizilmiştir. Bu grafiklerde, katsayı tahminleri bu alt ve üst sınırlar arasında seyrettiğinden, incelenen dönem için katsayılarda yapısal bir kırılmanın oluşmadığı söylenebilir. CUSUM ve CUSUMQ test sonuçları aynı zamanda modelde yer alan değişkenler arasında uzun vadeli ilişkinin bulunduğu yönünde destekleyici bir önsel veri sağlamaktadır.

Şekil: 2
CUSUM ve CUSUMQ Test Sonuçları
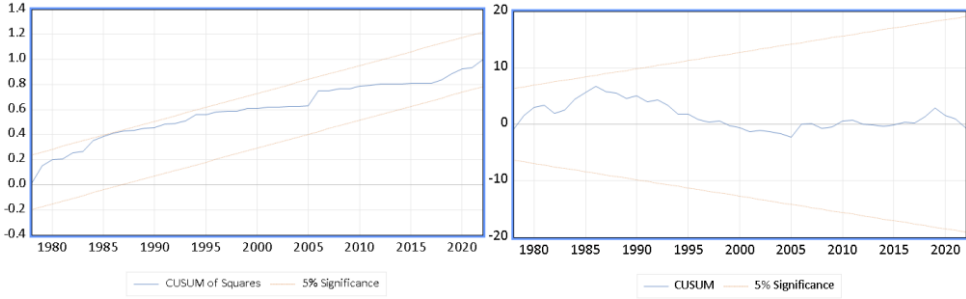
Takip eden aşamada bağımlı ve bağımsız değişkenler arasındaki uzun dönem esneklik katsayıları aşağıdaki yöntem yardımıyla elde edilir (Asteriou & Hall, 2021: 360).

$$Y_t^* = \alpha_0 + \alpha_1 Y_t^* + \gamma_0 X_t^* + \gamma_1 X_t^* + u_t \tag{1}$$

$$Y_t^*(1-\alpha_1) = \alpha_0 + (\gamma_0 + \gamma_1)X_t^* + u_t \tag{2}$$

$$Y_t^* = \frac{\alpha_0}{1-\alpha_1} + \frac{\gamma_0 - \gamma_1}{1-\alpha_1}X_t^* + u_t \tag{3}$$

$$Y_t^* = \beta_0 + \beta_1 X_t^* + u_t \tag{4}$$

$$\beta_1 = \left(\frac{\gamma_0 - \gamma_1}{1-\alpha_1}\right) \tag{5}$$

POP = 14.614.574,4 +
1.028.826,81Trend+1.440.748ECO+10.227.968,7BIO+5,14x10^9(1/KBDG)

Kişi başına ekolojik ayak izi ile kişi başına biyolojik kapasite arasındaki ilişki ekolojik açığın ölçümünü sağlamaktadır. Ekolojik ayak izinin biyolojik kapasiteden büyük olması durumunda Dünya ekolojik bir kıtlıkla karşı karşıya kalacak iken biyolojik kapasitenin büyük olması durumunda ise ekolojik rezerv birikimi sağlanacaktır. Küresel bağlamda bir ekolojik açığın varlığı, üretimin doğal sermayenin tüketilmesi yoluyla mümkün olduğu anlamına gelmektedir. İki terimin birbirine eşit olması ekolojik denge anlamında istenen durumu ifade etmektedir. Türkiye'de bu iki değişkenin eşit olduğu yıl 1983'dir. 1983 yılında kişi başına ekolojik ayak izi ve biyolojik kapasite değeri 2,07'dir. Öte yandan 2022 yılı itibariyle Türkiye'nin kişi başına biyolojik kapasite değeri 1,48 olarak gerçekleşmiştir. Daha önce bahsedildiği üzere 2024-2028 Kalkınma Planı'nda hedeflenen kişi başına milli gelir düzeyi de 17.500 $'dır. Trend değişkeninin katsayısı bağımlı değişken olan nüfusta yıllık olarak meydana gelen ortalama değişimi ifade etmektedir. Bu durum Türkiye'nin nüfusunun her yıl ortalama 1,028 milyon arttığı anlamına gelmektedir. Sabit terimin katsayısı olan 14,6 milyon ise trend, ekolojik ayak izi, biyolojik kapasite ve kişi başına gelir düzeyi değişkenlerinin nüfus düzeyi üzerindeki etkisi sıfır olduğunda beklenen nüfus düzeyini göstermektedir. Bu veriler yukarıdaki denkleme tatbik edildiğinde; bağımsız

değişkenler dışarıda bırakıldığında nüfusun beklenen düzeyi olan 14,6 milyon, nüfusun yıllık değişimini ifade eden 1,028 milyon, ekolojik ayak izi ile biyolojik kapasitenin birbirine eşit olduğu 2,07 değeri ve hedeflenen gelir düzeyini yansıtan 17.500 $ için optimal nüfus 40.091.506 olacaktır. Bununla birlikte 2,07 düzeyi şüphesiz biyolojik kapasite ile ekolojik ayak izinin eşit olduğu son değerdir. Biyolojik kapasitenin son değeri olan 1,48 için optimal nüfus düzeyi ise 33.206.963 olacaktır. Daha düşük bir biyolojik kapasite daha düşük bir nüfusu besleyebilecektir. Sonuç olarak Türkiye için optimal nüfus düzeyi 33.206.963 ile 40.091.506 arasında olmalıdır.

5. Sonuç

Sanayi öncesi toplumların refahını belirleyen ve sınırlandıran temel faktör nüfusun artış oranıdır. Tarihte Malthus Kapanı olarak adlandırılan ve nüfus ile refah arasındaki açmazı tanımlayan bu kavram, Sanayi Devrimi'nin hayat standartlarında sağladığı kalıcı ve sürekli yükselme ile aşılabilmiştir. Sürekli teknolojik gelişmenin klasik iktisadın Azalan Marjinal Verimler Yasası'nı geçersiz ve artan verimleri mümkün kılmasına rağmen gelinen noktada aşırı nüfus artışı ve hızla artan kişi başına tüketim, doğal sermayede yarattığı tahribat ile iklim değişikliğinin esas gerekçelerinden biri olarak görülmektedir. Bu durum, hızla artan ekolojik ayak izi ve doğal kaynak arzının temel bir göstergesi olan ve giderek azalan biyolojik kapasite olgusunda somut bir gerçeklik kazanmaktadır. İktisadın bağımsız bir bilim disiplini olmasını takiben Smith'ten Malthus'a, Sismondi'ye, Marx'a ve Keynes'e kadar çok geniş bir yelpazede ele alınan nüfus kavramı, iklim krizinin yoğunlaşması ile birlikte ekonomik performansa olan etkisinden ziyade, doğal sermayenin sınırlılığı ve beşeri faaliyetlerin bu sermayeyi tahrip edici etkiler doğurduğu kabulü altında, sürdürülebilirlik ilkesi çerçevesinde bir optimalite arayışı bağlamında ele alınmaya başlamıştır. Nitekim Birleşmiş Milletler Kalkınma Programı tarafından ortaya konulan SKH'lerin başarıyla gerçekleştirilebilmesinde nüfus yine merkezi bir konuma sahiptir.

Uzun yıllar boyunca ekonomik kalkınmanın temel amacı, doğal sermayeyi bir miktar aşağıya çekerek, üretilmiş sermaye ile insan sermayesini biriktirmek olmuştur. Ancak günümüzde insanlığın takip etmeyi seçtiği bu kalkınma süreci doğal sermayenin kritik seviyelere kadar azalmasına yol açtığından kalkınmanın talep ve sürdürülebilir arz arasındaki ekolojik uçurumu dikkate alan bir bakış açısıyla ele alınması zorunluluk haline gelmiştir. Bu çalışmada bu hassasiyetten yola çıkılarak Türkiye için ekolojik ayak izi ve biyolojik kapasite arasındaki dengeyi gözetmesi açısından sürdürülebilir ve refah göstergesi olarak belirlenen kişi başına gelir düzeyini yakalayabilecek optimal nüfus düzeyi araştırılmaktadır. Türkiye'nin ekolojik anlamda borçlu ülkeler arasında yer alıyor olması, literatürde yer alan çalışmaların daha ziyade teorik bir nitelik taşıyor olması ve Türkiye'yi odağına alan çalışmaların sayıca çok sınırlı olması bu çalışmanın temel motivasyonunu oluşturmuş ve bu çalışma ile literatürdeki ilgili boşluğun kapatılmasına katkıda bulunmak amaçlanmıştır.

Çalışmanın bulguları değerlendirildiğinde referans değerlerin ekonometrik analizler neticesinde elde edilen katsayılara uygulanması sonucunda Türkiye için ekolojik anlamda

sürdürülebilir ve 12. Kalkınma Planı'nda belirtilen kişi başına gelir düzeyini sağlayabilecek nüfus düzeyinin 33,2 milyon ile 40,1 milyon arasında olması gerektiği ortaya konulmaktadır. Şüphesiz belirli bir sapma ile değerlendirilmesi gereken bu tahminler Türkiye'nin mevcut nüfus düzeyi olan 85,3 milyonun oldukça altında yer almaktadır. Elde edilen bu optimal nüfus düzeyi fiili düzeyin oldukça altında kalmakla birlikte literatürdeki diğer çalışmalarla paralellik içerisindedir. Nitekim, güncel çalışmalardan Lianos ve Pseiridis (2015), Mısır için 2010 yılı optimal nüfusu 7,4 milyon kişi olarak bulurken aynı yıl için fiili nüfus 78,1 milyondur. Keza Birleşik Krallık için aynı çalışmada elde edilen optimal nüfus 12,1 milyon iken fiili nüfus düzeyi 62,8 milyondur. Benzer metodolojiyi kullanan çalışmalarda bu tür büyük çaplı sapmalar görülebilmektedir. Bu durum nüfus politikalarında köklü değişmelerden ziyade ekolojik ayak izini düşürmenin önemine vurgu yapmaktadır.

Süregelen ve çevresel hassasiyet anlamında zayıf olarak nitelendirilebilecek iktisadi politikaların gelecek nesillerin zararına sonuçlar yaratmaması adına Türkiye'nin hem demografi hem de kalkınma politikalarını gözden geçirerek revize etmesi ve çevre ile uyumlu bir kalkınma anlayışını benimsemesi gerekmektedir. Biyolojik kapasite ve ekolojik ayak izi arasındaki ciddi fark göz önüne alındığında üretim tekniklerinde sürdürülebilirliği esas alan köklü reformların yapılması gerekmektedir. Şüphesiz bu tür kapsayıcı reformların hayata geçirilmesi, ciddi bir kamu denetim ve planlamasını zorunlu kılmaktadır. Zira fiili nüfus düzeyini uzun vadede optimal düzeye doğru indirgeyecek politikalar, nüfusun kompozisyonunda radikal bir dönüşümü beraberinde getirecek; bu ise bağımlılık oranının artmasına ve sosyal güvenlik sisteminin bir noktada tıkanmasına ve daha birçok sosyal ve ekonomik probleme neden olabilecektir. Bununla birlikte çevreci teknolojik gelişmelerin üretim sistemlerine entegrasyonu ile ekolojik ayak izinin ve biyolojik kapasitenin artırılması ile optimal nüfus seviyesini yukarı çekmek, optimal düzey ile fiili düzey arasındaki farkı azaltarak içinden çıkılması güç sosyoekonomik problemlere yol açmadan optimal düzeye yakınsamak da mümkün olabilecektir. Nüfus dinamikleri, çevre ve sürdürülebilirlik arasındaki karmaşık etkileşimi anlamak için disiplinler arası çalışmalara daha fazla ihtiyaç vardır. Takip eden çalışmalarda kamunun söz konusu reformların hayata geçirilmesinde oynayacağı rol ve sorumluluklar ile birlikte uzun vadede fiili nüfus ile potansiyel nüfus düzeyi arasındaki farktan kaynaklanan refah kaybı ve bu kaybı tolere edebilecek politika önerileri farklı boyutlarıyla ele alınmalıdır.

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Enerji ve Kıymetli Metal Piyasaları Arasında Yayılım Etkisi: Wavelet Uyum Analizine Dayalı DCC-GARCH Yaklaşımı[1]

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Spillover Effects Between Energy and Precious Metals Markets: A DCC-GARCH Approach Based on Wavelet Coherence Analysis[2]

Abstract

In this study, using daily return data between October 1, 2012, and June 4, 2024, the volatility spillovers between energy commodity markets and precious metal markets are investigated using the Dynamic Conditional Correlation approach based on wavelet coherence Analysis, which allows for the analysis of relationships between markets in time-frequency space. According to the findings of the wavelet coherence analysis, a long-run, mostly positive interdependence effect was observed from Brent oil returns to gold, silver, and platinum returns, as well as a long-run interdependence effect from palladium returns to natural gas returns. In the dynamic conditional correlation analyses for the identified long-run investment cycles, conditional correlation and volatility persistence findings are obtained for each investment cycle. The findings are significant for investors with long-term investment horizons.

Keywords : Energy Commodities, Precious Metals, Wavelet Coherence Analysis, Dynamic Conditional Correlation.

JEL Classification Codes : G11, Q02, Q43.

Öz

Bu çalışmada 01.10.2012-04.06.2024 tarihleri arasındaki günlük getiri verileri kullanılarak enerji emtia piyasaları ile kıymetli metal piyasaları arasındaki volatilite yayılımı, zaman-frekans uzayında piyasalar arasındaki ilişkilerin incelenmesine olanak sağlayan Wavelet Uyum Analizi Dayalı Dinamik Koşullu Korelasyon yaklaşımı ile araştırılmıştır. Wavelet uyum analizi bulgularına göre, Brent petrol getirilerinden altın, gümüş ve platin getirilerine doğru uzun dönemli ve çoğunlukla pozitif; paladyum getirisinden doğal gaz getirilerine doğru ise uzun dönemli karşılıklı bağımlılık etkisi tespit edilmiştir. Belirlenen uzun dönemli yatırım döngüleri için uygulanan dinamik koşullu korelasyon analizlerinde ise, her bir yatırım döngüsü için koşullu korelasyon ve volatilite kalıcılığı bulgularına ulaşılmıştır. Elde edilen bulgular, özellikle uzun vadeli yatırım ufkuna sahip yatırımcılar için önem arz etmektedir.

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[1] *Bu çalışmanın önceki versiyonu 08-10 Temmuz 2024 tarihlerinde düzenlenen 3. Uluslararası Sigortacılık, Bankacılık ve Finans Sempozyumu'nda "Enerji ve Kıymetli Metal Piyasaları Arasında Yayılım Etkisi: Wavelet Uyum Analizine Dayalı Dinamik Koşullu Korelasyon Yaklaşımı" başlıklı özet bildiri olarak sunulmuştur.*

[2] *The former version of this paper was presented at the 3rd International Symposium on Insurance, Banking, and Finance held on July 08-10, 2024, as an short abstract entitled "Spillover Effects Between Energy and Precious Metals Markets: A Dynamic Conditional Correlation Approach Based on Wavelet Coherence Analysis".*

1. Giriş

Küresel piyasalar, geniş bir emtia yelpazesine ev sahipliği yaparken, reel sektör ve finansal piyasalar stratejik olarak önemli olan altın, gümüş, doğal gaz ve petrol gibi emtialara giderek daha fazla yönelmiştir. Bu metaller ile petrol ve doğal gazın endüstriyel uygulamalardaki yaygın kullanımı, son yıllarda emtia piyasalarını politika yapıcılar, yatırımcılar ve araştırmacılar arasında giderek artan bir ilgi odağı haline getirmiştir. Bu ilgi, emtia vadeli işlem piyasalarında ortaya çıkan yatırım fırsatlarının belirginleşmesine neden olmuştur (Rehman & Vo, 2021; Sertkaya, 2022). Buna bağlı olarak yatırımcılar, riskleri çeşitlendirme faydalarından ve optimal koruma stratejilerinden tam anlamıyla yararlanmak amacıyla alternatif yollar aramaya yönelmişlerdir. Bu arayış, emtiaların bir koruma aracı olarak ön plana çıkmasına neden olmuştur. Emtia piyasaları ve bu piyasalarda işlem gören ürünler, reel ekonominin önemli bileşenlerindendir. Emtiaların korunma amacıyla kullanılması, temel olarak anlaşılması nispeten kolay bir kavramdır. İlk olarak, emtiaların dalgalanma döngüsü, hisse senedi piyasalarından oldukça farklıdır (Roll, 2013). İkinci olarak, hisse senedi fiyatları ile yüksek korelasyon gösteren makroekonomik faktörler, emtia fiyatlarını aynı şekilde etkileyebilir ya da etkilemeyebilir (Gorton & Rouwenhorst, 2006). Ayrıca, emtiaların menkul kıymetleşmesi süreciyle birlikte, artık daha yüksek getiri sunan ve çeşitlendirme avantajı sağlayan çeşitli finansal enstrümanlar bulunmaktadır (Yoon et al., 2019). Emtiaların finansal piyasalarda işlem görmeye başlamasından bu yana, piyasalar arası volatilite yayılımlarını anlamaya yönelik önemli bir ihtiyaç ortaya çıkmıştır.

Emtia vadeli fiyatları, son on yılda yüksek volatilite sergilemiş ve dalgalanan eğilimler göstermiştir (Mandacı et al., 2020). Bu dönemde emtia piyasaları, siyasi belirsizlik, COVID19 salgını, ekonomik çalkantı ve savaşlar gibi küresel krizlerden etkilenmiş, bu da yatırımcılar ve politika yapıcıların hem makro hem de mikro düzeyde yayılımları incelemelerine neden olmuştur. Bu bağlamda, yatırımcılar ve portföy yöneticileri, yatırım risklerini azaltmak veya farklı yatırım araçlarının getirilerinden faydalanmak amacıyla portföylerinde birden fazla yatırım aracını tercih etmektedir (Yıldırım et al., 2020). Yatırımcılar, portföylerinde bulunduracakları araçları seçerken, bu araçların risk faktörlerine ve piyasa olaylarına nasıl tepki verdiğini bilmek istemektedirler. Portföylerdeki riski azaltmak için, farklı piyasa olaylarına farklı tepkiler veren yatırım araçları öncelikli olarak tercih edilmektedir. Portföy yönetiminde, yatırım araçlarının makroekonomik değişkenlere tepkisini anlamak, başarı düzeyini artırabilir. Çeşitlendirme ilkesine dayalı portföy yönetiminde dikkat edilmesi gereken önemli bir konu, herhangi bir piyasada yaşanan oynaklık hareketinin diğer piyasalara yayılıp yayılmadığıdır. Küresel finansal piyasalar arasındaki yüksek entegrasyon, sermaye akımlarının hızlanmasına olanak sağlarken, COVID19 salgını gibi küresel krizlerde finansal sorunların bulaşıcılığını artırmaktadır (Barro et al., 2020). Bu durum, portföy yönetimi stratejilerinde piyasa dinamiklerinin ve krizlerin olası etkilerinin dikkate alınmasını gerektirmektedir.

Volatilitenin yayılması ve finansal piyasalar arasındaki etkileşim, yatırımcıların ve portföy yöneticilerinin yatırım stratejilerini ve finansal karar alma süreçlerini büyük ölçüde etkileyebilir. Yatırımcılar, finansal varlıkların getirilerini tahmin ederken oynaklığı ve bu oynaklığın uluslararası piyasalara olan etkisini dikkate almaktadırlar (Değirmenci & Abdioğlu, 2017). Bu nedenle hem oynaklığın hem de piyasalar arasındaki oynaklık yayılımının belirlenmesi, finansal varlık getirilerinin tahmin edilmesi açısından kritik bir öneme sahiptir. Portföy yöneticilerinin, siyasi belirsizlikler, COVID19 salgını ve ekonomik çalkantılar sırasında, bir piyasadaki şokların diğer piyasalardaki oynaklığı etkileyip etkilemediğini dikkatlice incelemesi gerekmektedir. Ancak, olağanüstü piyasa koşulları düşük korelasyonlu varlıkları çeşitlendirme amacıyla portföylerine dahil eden yatırımcılar, kriz dönemlerinde bu varlıklar arasındaki korelasyonun arttığını ve bu nedenle yeterli çeşitlendirme faydasının sağlanamadığını gözlemlemektedir (AlKulaib & Almudhaf, 2012; Diebold & Yılmaz, 2012; Barro et al., 2020). Kriz dönemlerinde finansal piyasalardaki oynaklık ve belirsizliklerin artması, risk iştahı azalan yatırımcıların ve portföy yöneticilerinin riskli varlıkları ellerinden çıkarmasına neden olmakta ve bu da varlıklar arasındaki korelasyonun artmasına yol açabilmektedir (Baur & McDermott, 2010; Deniz et al., 2018). Piyasalarda risk veya belirsizlik arttığında, portföy getirilerini korumak ve risk parametrelerini optimize etmek amacıyla yatırım portföyleri riskli varlıklardan güvenli limanlara kayabilmektedir.

Bu bağlamda, yatırımcıların portföy yönetiminde karar vermeleri gereken en önemli konulardan biri, portföye dahil edilecek yatırım araçlarının seçimidir. Hisse senetleri, tahviller ve değerli metaller bu araçlar arasında öne çıkmaktadır. Ayrıca, enerji ürünleri hem hane halkı hem de şirketlerin ana harcama kalemleri arasında bulunduğundan, petrol ve doğal gaz da yatırımcılar için önemli bir varlık olarak kabul edilmektedir. Enerji emtiaları ve değerli metaller, küresel piyasalarda üretim, tüketim ve dış ticarete konu olan en stratejik emtialar arasında yer almakta olup, bu nedenle finansal piyasalardaki risklere karşı portföyleri çeşitlendirme ve koruma amacıyla yatırımcılar tarafından dikkatle takip edilmektedir (Alkhazali & Zoubi, 2020; Trabelsi et al., 2021). Pandemi gibi finansal piyasalarda aşırı dalgalanmaların yaşandığı olağanüstü dönemlerde, hisse senetleri ve tahviller gibi diğer alternatif finansal varlıklarla negatif korelasyona sahip olmaları nedeniyle kıymetli metaller güvenli liman olarak görülmekte ve bu dönemde riskten korunma ve portföy çeşitlendirmesi amacıyla yaygın olarak tercih edilmektedir. Bu tercihin ardındaki sebep, kıymetli metallerin alternatif varlıklara göre daha istikrarlı fiyat hareketlerine sahip olmasıdır. Kıymetli metaller, hisse senetlerinden farklı olarak, fiyat oluşumunda üretimde girdi olarak da kullanılmaktadır. Petrol ve doğal gaz, ticareti yapılan en büyük emtialardan biri olarak hem ithalatçı hem de ihracatçı ülkeler için önemli bir üretim girdisi ve doğal kaynak niteliğindedir. Bu nedenle, petrol fiyatlarındaki artış ve dalgalanmalar ciddi üretim kayıplarına yol açabilmektedir. Uluslararası şoklardan en çok etkilenen varlıklardan biri olan petrol, fiyat oynaklıklarıyla bireysel ve küresel ekonomik gerilemelere neden olabilmektedir (Yıldırım et al., 2018; Erdoğan et al., 2020). Petrol, stratejik bir emtia olarak ekonomik faaliyetlerle karşılıklı etkileşim içinde olduğundan,

yatırımcılar tarafından yatırım varlığı olarak değerlendirilmektedir. Bu nedenle, ekonomik birimler yatırım kararlarını verirken petrol fiyatlarını da göz önünde bulundurmaktadır.

Finansal piyasalara yatırım yapmanın temelinde getiri beklentisi yatmaktadır. Beklenen getiri ise yatırımcının risk tercihlerine göre değişiklik göstermektedir (Yıldırım, 2021). Ancak, yapılan çalışmalar olumsuz şokların yol açtığı endişenin yatırımcıların risk alma isteğini değiştirdiğini göstermektedir (Guiso et al., 2018; Barro et al., 2020). Yatırımcıların risk iştahlarının finansal piyasalar üzerindeki etkileri de literatürde sıkça ele alınan bir konudur. Mevcut literatür, küresel varlık getirilerinin önemli bir kısmının küresel riskten kaçınma ile açıklanabileceğini ortaya koymaktadır (Demirer et al., 2018; Xu, 2019). Genel olarak, finansal veriler ile stratejik emtialar arasındaki ilişkiyi açıklamaya yönelik çeşitli yaklaşımlar bulunmaktadır.

Bu çalışma, enerji ve kıymetli metaller gibi stratejik emtialar arasındaki farklı yatırım döngülerine göre volatilite yayılımını, 12 Ekim 2012 ile 4 Haziran 2024 tarihleri arasındaki dönemi kapsayacak şekilde wavelet uyum analizine dayalı dinamik koşullu korelasyon (DCC-GARCH) analiz yaklaşımı ile incelemeyi amaçlamaktadır. Bu bağlamda, stratejik emtia piyasaları arasındaki volatilite yayılımının incelenmesi, yatırımcılara karar alma süreçlerinde yol gösterici olacaktır. Öte yandan, politika yapıcılara da politika oluşturma noktasında faydalı bilgiler sağlayacaktır. Bu amaçla, bu çalışmanın mevcut literatüre üç açıdan katkısı olacağı düşünülmektedir. Birincisi, emtialar arasındaki volatilite yayılımının doğru bir şekilde belirlenmesi, yatırımcıların tercihlerine katkı sağlayacaktır. İkincisi, olağanüstü piyasa koşullarında emtia piyasalardaki karşılıklı etkileşimin ortaya konulmasına olanak tanınacaktır. Üçüncüsü ise, son dönemde sürdürülebilirlik kavramı çerçevesinde önemi artan enerji ve kıymetli metal piyasaları arasındaki volatilite etkileşimi aydınlatılacaktır.

Çalışma şu şekilde planlanmıştır: İlk olarak, mevcut literatür incelenmekte ve bu alandaki boşluklar tespit edilerek çalışmanın belirli amaçları vurgulanmaktadır. İkinci olarak, kullanılan analiz yöntemleri detaylı bir şekilde ele alınmaktadır. Üçüncü olarak ise, çalışmada kullanılan veri seti tanıtılmaktadır. Ardından, analiz sonuçları sunulmakta ve son olarak, çalışmanın genel sonuçlarına yer verilmektedir.

2. Literatür

Volatilite yayılımı literatürü, finans piyasalarındaki yayılım etkilerini anlamada önemli bir katkı sağlamış olsa da mevcut çalışmaların çoğunun özellikle zaman ve frekans boyutlarını eşzamanlı olarak ele almakta yetersiz kaldığı gözlemlenmektedir. Özellikle enerji emtia piyasaları ile kıymetli metal piyasaları arasındaki volatilite yayılımını inceleyen araştırmalar, genellikle statik modelleme yöntemlerine dayanmakta ve zaman içinde değişen dinamikleri yeterince yakalayamamaktadır. Bu tür yaklaşımlar, piyasa ilişkilerinin karmaşık yapısını ve asimetrik şoklara verdikleri tepkileri analiz etmede sınırlı kalmaktadır. Mevcut literatürde bu eksiklikleri gidermek amacıyla, zaman-frekans uzayında piyasa ilişkilerini analiz eden Wavelet Uyum Analizi Dayalı Dinamik Koşullu Korelasyon (DCC-GARCH)

yaklaşımı kullanılmamıştır. Bu yöntem, piyasalar arasındaki ilişkiyi hem zaman hem de frekans bazında inceleyerek, kısa vadeli ve uzun vadeli yayılım etkilerini ayrı ayrı değerlendirme olanağı sunmaktadır. Oysaki birçok araştırma, volatilite yayılımını farklı yöntemler üzerinden değerlendirerek, piyasa şoklarının farklı yatırım ufuklarında nasıl evrildiğini gözden kaçırmaktadır. Bu bağlamda, bu çalışmanın enerji ve kıymetli metal piyasaları arasındaki volatilite yayılımını daha kapsamlı bir perspektiften ele alarak, literatürdeki mevcut boşlukları doldurması hedeflenmektedir. Araştırma çerçevesinde, özellikle emtia piyasalarını inceleyen güncel araştırmalar incelenmiş ve detaylı şekilde Tablo 1'de özetlenmiştir.

Tablo: 1
Güncel Literatür Araştırması

Yazar(lar)	Dönem	Değişkenler	Yöntem	Sonuç
Kırkkulak & Lkhamazhapov (2017)	21.04.2000 21.11.2014	Altın Gümüş Platin Paladyum	DCC-MGARCH	Değerli metallerin koşullu volatilitesinde uzun hafıza özelliği bulunmakta ve yüksek korelasyon göstermektedir. Gümüş, diğer metallerle düşük korelasyona sahip olduğu için iyi bir çeşitlendirici yatırım olarak öne çıktığı sonucuna varılmıştır.
Kamışlı et al. (2017)	16.09.2008 12.08.2017	Altın Gümüş Petrol	Hatemi-J Nedensellik	Araştırmanın bulguları, altın, gümüş ve petrol emtialar arasında kısa, orta ve uzun vadelerde asimetrik nedensellik ilişkilerinin varlığını ortaya koymuştur.
Moralı & Uyar (2018)	Günlük Haftalık Aylık Çeyreklik (2018)	Altın Gümüş Platin Paladyum	Hurst Üsteli	Emtiaların fraktal bir yapıya sahip olabileceğini ve yatırımcıların elde tutma süreleri arttıkça, varlık getirilerinin önceki fiyat hareketlerine daha fazla bağımlı hale geldiği gözlemlenmiştir. Buna bağlı olarak emtiaların geçmişteki pozitif veya negatif eğilimlere dayalı olarak daha öngörülebilir olabileceği sonucuna varılmıştır.
Arif et al. (2019)	Ocak 2000 Aralık 2016	Gümüş Platin Paladyum Brent Petrol	Quantile-On-Quantile Regresyon (QQR) ve ARDL Testi	Küresel petrol fiyatlarının platin ve paladyum getirilerini artırdığını, ancak gümüş getirileri üzerinde anlamlı bir etkisinin olmadığını tespit edilmiştir. Paladyum ve platin, yatırımcılar için güvenli liman işlevi görürken, petrol fiyatlarındaki değişim gümüş getirilerini etkilemediği gözlemlenmiştir.
Salisu et al. (2020)	2004 2019	Altın Gümüş Platin Paladyum Brent Petrol VIX EPU WTI	ARDL Testi	G-trendler serisi, değerli metallerin getirilerini olumlu ve önemli ölçüde etkilemekte ve tahmin modeline dahil edildiğinde rassal yürüyüş modelinden daha iyi performans gösterdiği sonucuna varılmıştır. Ayrıca negatif ve pozitif G-trendlerinden elde edilen ek bilgiler, tek öngörücüye dayalı modelin tahmin performansını önemli ölçüde artırdığı tespit edilmiştir.
Shafiullah et al. (2021)	Ocak 1990 Eylül 2019	Ham Petrol Altın Gümüş Altın Gümüş Platin Paladyum Çelik Titanyum	Quantile Regresyon Granger Nedensellik ARDL Testi	Petrol ve metal fiyatlarının durağanlığı ve eşbütünleşme modelleri kantiller arasında farklılık göstermektedir. Petrol fiyatlarından metal fiyatlarına doğru nedensellik kantillere göre değişirken, metal fiyatlarındaki hareketlerin petrol fiyatları üzerinde belirgin bir etkisi bulunmadığı sonucuna ulaşılmıştır.
Rehman & Vo (2021)	31.07.2000 31.07.2020	WTI Brent Petrol Doğal Gaz Gaz Yağı Benzin Dizel Altın Gümüş Bakır Alüminyum Çinko Nikel	Kantil Cross Spektral Yaklaşımı ve	Analiz sonuçlarına göre, kısa ve orta vadeli yatırım dönemlerinde üç emtia sınıfı arasında bir ilişki olduğu belirtilmiş ve uzun vadede, düşüş ve normal piyasa koşullarında bu ilişkinin arttığına dair kanıtlar elde edilmiştir.

Temel & Güneş (2022)	03.01.2000 18.02.2022	Brent Petrol Doğal Gaz Buğday Mısır Altın Gümüş Platin Paladyum	EGARCH	Araştırma sonuçlarına göre, pazartesi günü petrol, perşembe günü altın ve doğalgaz negatif etki gösterirken, cuma günü altın ve paladyumda pozitif etki gözlenmiştir. Gümüş, platin, buğday ve mısır emtialarının getirilerinde ise anlamlı bir etki bulunamamıştır.
Kumar et al. (2022)	Ocak 1997 Aralık 2019	Doğal Gaz Ham Petrol Döviz Kuru Altın Borsa	GARCH GJR-GARCH EGARCH	Analiz sonuçlarına göre, enerji emtialarının volatilitesinin borsa oynaklığı üzerinde etkisinin olmadığı, ancak döviz kuru volatilitesinin borsa oynaklığı üzerinde etkili olduğu gözlemlenmiştir. Ayrıca döviz kurunun, altın volatilitesini etkilediği, diğer değişkenlerin ise altın volatilitesini etkilemediği tespit edilmiştir. Son olarak, doğal gaz volatilitesinin borsa ve altın fiyat volatilitesi üzerinde etkili olduğu, ancak petrol ve döviz kuru oynaklığından etkilenmediği sonucuna varılmıştır.
Yaya et al. (2022)	01.03.2014 31.10.2021	WTI Altın Gümüş Altın Gümüş Platin Paladyum	GARCH MIDAS- X DCC-GARCH	Değerli metallerin, petrol talep ve arz şoklarına karşı korunma potansiyeli olduğu ve bu şoklarla ilişkilerinde heterojenlik gözlemlendiği ve ayrıca DCC-MIDAS sonuçlarına göre, platin hariç diğer değerli metaller ile petrol fiyatları arasında önemli dinamik korelasyonlar bulunduğuna dair kanıtlar sunulmuştur.
Santana et al. (2023)	02.01.2018 23.05.2022	Brent Petrol WTI Altın Gümüş	Detrended Dalgalanma Analizi (DFA) Detrended Çapraz Korelasyon Analizi (DCCA)	COVİD19 krizi öncesinde ve sırasında, WTI ve Brent ham petrol endeksleri arasındaki yüksek karşılıklı bağımlılığın COVİD19'un bulaşma etkisi üzerinde etkili olmadığı gözlemlenmiş ve ayrıca, COVİD19'un ham petrol ve değerli metal sektörleri üzerindeki pozitif bulaşma etkisiyle karşılıklı bağımlılıkta artış tespit edilmiştir.
Akbulaev (2023)	Mart 2016 Mart 2020	Brent Petrol WTI Doğal Gaz Altın Gümüş	ARDL Testi	SARS-COV2 salgını sırasında ve öncesinde WTI, Brent ve doğal gaz fiyatlarının gümüş ve altın fiyatları üzerinde büyük bir etkisi olduğunu gözlemlenmiştir.
Rajwani vd. (2023)	18.03.2010 15.01.2021	Ham Petrol Doğal Gaz Altın Gümüş Bakır Çinko	Granger Nedensellik DCC GARCH Frekans Bağlantılık	Enerjiden (ham petrol) metale (bakır) kısa dönemli dinamik yayılmalar ve tüm seriler arasında uzun dönemde önemli bağlantılar gözlemlenmiştir; Baruník & Křehlík (2018) testi, kısa ve uzun dönemden daha yüksek toplam bağlantılık göstermiştir. Ayrıca, ağ analizine göre, altın ve gümüş arasında pozitif korelasyon bulunurken, diğer metaller ve ham petrol arasında negatif korelasyon vardır; en pahalı hedge oranı Ham Petrol/Çinko, en ucuzu ise Ham Petrol/Altın çiftlerinde olduğu tespit edilmiştir.

3. Yöntem

Araştırmanın amacına uygun olarak bu çalışmada üç aşamadan oluşan bir yöntem sıralaması uygulanması tercih edilmiştir. İlk aşamada, grafiksel analizlere, tanımlayıcı istatistiklere ve korelasyon ilişkilerine yer verilmiştir İkinci aşamada, değişkenler arasındaki etkileşimin zaman ve frekans uzayında nasıl değiştiği Wavelet Uyum (Wavelet Coherence-WTC) Analizleri ile incelenmektedir. Araştırmanın üçüncü aşamasında ise, maksimum örtüşmeli kesikli wavelet dönüşümü (*maximal overlap discrete wavelet transform-*MODWT) yöntemi ile değişkenlere filtreleme işlemi gerçekleştirilmekte ve dinamik koşullu korelasyon (DCC-GARCH) yaklaşımı ile bu emtia piyasaları arasındaki kısa, orta ve uzun dönem koşullu korelasyon ve volatilite yayılımının kalıcı olup olmadığı incelenmektedir. Analizlerde kullanılan yöntemler, bu bölüm altında sırasıyla açıklanmaktadır.

3.1. Wavelet Çoklu Ölçeklendirme Analizi

Wavelet dayalı çoklu ölçeklendirme analizi, zaman frekans uzayındaki zaman serilerini analiz etmek için var olan ekonometrik yöntemlere göre ileri bir yeteneğe sahiptir (Lehkonen & Heimonen, 2014; Reboredo & Rivera-Castro, 2013; Bouri et al., 2017). Bir

zaman serisine uygulanan Wavelet dönüşümü, zaman serisinin zaman-frekans alanına yerleştirilmesini sağlar. Wavelet dönüşümleri ayrıca bir zaman serisi farklı ölçek (filtreleme) bileşenlere ayırma yeteneğine sahiptir. Bir serinin Wavelet dönüşüm analizi ile ayrıştırılması, farklı zaman ölçeklerinde bir serinin daha ince ayrıntıları yakalayabilir (Lehkonen & Heimonen, 2014). Dahası Wavelet tabanlı analiz, durağan olmayan zaman serilerini de analiz etme olanağı sağlar (Aydoğdu, 2024: 216).

Ramsey (2002)'e göre $f(t)\epsilon\ L^2(R)$ zamanının herhangi bir fonksiyonu baba (father) (Ø) ve anne(mother) (ψ) waveletleri tarafından bir dizi izdüşüm olarak temsil edilebilir. Baba wavelet orijinal serinin düşük frekanslı bileşenlerini içerir ve serinin trendini gösterir; anne wavelet ise serinin yüksek frekanslı bileşenlerini içerir ve trendden sapmaları gösterir, başka bir deyişle, veridaki detayları yansıtır (Crowley, 2007). Ölçekleme katsayıları (*scaling coefficients*) baba Wavelet fonksiyonu tarafından üretilirken, ayrıştırma katsayıları (*differentiation coefficients*) anne wavelet fonksiyonu tarafından üretilmektedir.

Baba Wavelet fonksiyonu matematiksel olarak aşağıdaki gibi ifade edilir:

$$\emptyset_{j,k} = 2^{-j/2}\emptyset\left(\frac{t-2^j k}{2^j}\right) ile \int \emptyset(t)dt = 1 \tag{1}$$

Anne Wavelet fonksiyonu ise aşağıdaki gibi tanımlanır:

$$\psi_{j,k} = 2^{-j/2}\psi\left(\frac{t-2^j k}{2^j}\right) ile \int \psi(t)dt = 0 \tag{2}$$

Burada j ve k ilgili ölçek ve öteleme parametrelerini gösterir. $\emptyset_{j,k}$ ve $\psi_{j,k}$ fonksiyonlarının ölçeği veya genişliği 2^j ile ölçülür.

Baba Wavelet fonksiyonundan elde edilen düzgün katsayıları (*smooth coefficients*) aşağıdaki gibidir:

$$S_{j,k} = \int f(t)\psi_{j,k} \tag{3}$$

Anne Wavelet fonksiyonu detay katsayıları (*detail coefficients*) şu şekilde ifade edilir:

$$d_{j,k} = \int f(t)\psi_{j,k} . j = 1, \ldots \ldots . J \tag{4}$$

Böylece, bir $f(t)\epsilon\ L^2(R)$ fonksiyonunun Wavelet temsili, Wavelet fonksiyonunun doğrusal kombinasyonu olarak aşağıdaki gibi tanımlanır:

$$f(x) = \sum_k s_{j,k}\emptyset_{j,k}(t) + \sum_k d_{j,k}\psi_{j,k}(t) + \sum_k d_{j-1,k}\psi_{j-1,k}(t) + \cdots + \sum_k d_{1,k}\psi_{1,k}(t) \tag{5}$$

Denklem (5) şu şekilde basitleştirilebilir:

$$f(t) = S_J + D_J + D_{J-1} + \cdots D_J + \cdots D_1 \tag{6}$$

Aşağıdaki projeksiyonlar Wavelet katsayısı ile tahmin edilir:

$$S_{j,k} = \approx \int f(t)\emptyset_{j,k}(t)dt \tag{7}$$

$$d_{j,k} = \approx \int f(t)\psi_{j,k}(t)dt. \; j = 1, \dots J \tag{8}$$

Burada $\emptyset_{j,k}$ ve $\psi_{j,k}$ temel fonksiyonlarının ortogonal (orthogonal) olduğu varsayılır.

Denklem (6)'daki, $\{S_j, D_{j-1}, \dots D_j, \dots D_1\}$ f(t)'nin çok ölçek ayrıştırmasını ifade eder. D_j, γ_j serisindeki değişikliklere karşılık gelen j. Seviye Wavelet detayını gösterir. Her bir detay ölçeğindeki varyasyonların toplamı, daha yüksek j seviyeleri ile daha yumuşak hale gelen S_j ile gösterilir (Gençay & Selçuk, 2002).

Ölçek ve Wavelet katsayılarını hesaplamak için *Maksimum Örtüşmeli Kesikli Wavelet Dönüşümü* (MODWT) uygulanmıştır. Söz konusu zaman serisi verilerinin ayrıştırılması, Daubechies[3] 8 (sekiz) uzunluklu en az asimetrik filtre LA(8)[4] kullanılarak yapılmıştır. LA(8) filtrelerinin Haar dalgacık filtrelerine göre en az birkaç avantajı vardır. Birincisi, LA(8) filtreleri daha pürüzsüzdür (Gençay & Selçuk, 2002; Aydoğdu, 2024: 19) ve ikincisi, LA(8) filtreleri ölçekler arasında ilişkisiz katsayılar üretir (Cornish et al., 2006).

Bu çalışmada, değişkenlere ait zaman serilerini D_1'den D_3'e kadar ayrıştırmak için Bouri vd. (2017)'ni çalışması takip edilmiştir. İncelenen verilerin 2^j ile $2^j + 1$ ölçekleri için sağlanmıştır. 2-4, 4-8, 8-16, 16-32, 32-64, 64-128, 128-256 ve 256-512 günlük döngü süreleri (bkz. Tablo 2) sırasıyla D_1, D_2, D_3, D_4, D_5, D_6, D_7, D_8 ve D_9 wavelet ölçeklerine karşılık gelmektedir. Yumuşak bileşen S_8 uzun vadedeki hareketleri temsil etmektedir.

Tablo: 2
Farklı Zaman Ölçekleri

Ölçekler (2^j)	Günlük Frekans	Döngü Süresi	
D_1	2^1	2-4	1 haftaya kadar
D_2	2^2	4-8	2 haftaya kadar
D_3	2^3	8-16	3 haftaya kadar
D_4	2^4	16-32	1 aya kadar
D_5	2^5	32-64	İki aya kadar
D_6	2^6	64-128	4 aya kadar
D_7	2^7	128-256	1 yıla kadar
D_8	2^8	256-512	2 yıla kadar
D_9	2^9	512-1024	3 yıla kadar

Kaynak: (Uyar & Kangallı-Uyar, 2021: 319).

3.2. Wavelet Uyum Analizi

İki zaman serisi arasındaki ortak hareketler ve nedensellik bağlantıları farklı frekanslara göre zaman içerisinde nasıl değiştiğini araştırmak için Wavelet Uyum Analizi (*Wavelet Coherence - WTC*) uygulanır. WTC analizini açıklamadan önce Torrence ve

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[3] *Daubechies; Otogonal wavelet ailesinde yer almaktadır.*

[4] *Bundan sonra Daubechies: LA(8) olarak ifade edilecektir.*

Compo (1998)'nın çalışmasında belirtildiği gibi *Wavelet Güç Spektrumu (Wavelet Power Spectrum - WPS)* ve Çapraz Wavelet Dönüşüm (*Cross-Wavelet Transform* - XWT) ölçüleri tanımlanması gerekmektedir. Bu bağlamda, WPS farklı frekanslar için bir zaman serisinin varyansının zaman göre nasıl evrildiğini göstermektedir ve aynı zamanda farklı zaman ölçeklerindeki varyansların büyüklüğü, gücün büyüklüğü olarak tanımlanmaktadır. XWT ölçüsü, her bir zaman ölçeğine ait iki zaman serisi arasındaki lokal (yerel) kovaryansın hesaplanmasına olanak sağlayan bir ölçü olarak nitelendirilir. Bu ölçü zaman ve frekans uzayında zaman serilerinin ortak varyanslarının yüksek olduğu alanları belirlemek için kullanılır. Son olarak WTC analiziyle zaman ve frekans uzayında iki zaman serisinin ortak hareket ettiği veya nedensellik bağlantısı içinde olduğu bütün bölgeleri belirlemek mümkündür. Bu bağlamda zaman ve frekans uzayında iki zaman serisi arasındaki lokal korelasyon katsayısı hesaplanmasına olanak tanır (Kangallı-Uyar, 2021: 126-127).

Torrence ve Compo (1998)'nın çalışmasında $p(t)$ ve $q(t)$ gibi iki farklı zaman serisi için XWT ölçüsünü Denklem (9)'deki gibi tanımlanır:

$$W_{p,q}(\tau,s) = W_p(\tau,s)W_q^*(\tau,s) \tag{9}$$

Burada $W_p(\tau,s)$ ve $W_q(\tau,s)$ sırasıyla $p(t)$ ve $q(t)$'nin Sürekli Wavelet Dönüşümlerini (*Continuous Wavelet Transforms* - CWT) ifade eder. τ konum, s ölçek parametresini, * işareti ise karmaşık sayının eşliğini gösterir. $p(x)$ ve $q(x)$ iki zaman serisi arasındaki Wavelet uyum ölçüsü Denklem (10)'de olduğu gibi tanımlanır:

$$R^2(\tau,s) = \frac{\left|S\left(t^{-1}W_{p,q}(\tau,s)\right)\right|^2}{S\left(t^{-1}\left|W_p(\tau,s)\right|^2\right)S\left(t^{-1}\left|W_q(\tau,s)\right|^2\right)} \tag{10}$$

Burada $R^2(\tau,s)$ her zaman ve frekansta $p(t)$ ve $q(t)$ arasındaki korelasyonu ölçer. S zaman ve ölçeklerdeki yumuşatma (düzgünleştirme) parametresini gösterir. Wavelet uyum analizi değeri[5] 0 (sıfır) ile 1 (bir) arasında değişir ($0 \leq R^2(\tau,s) \leq 1$). $R^2(\tau,s)$'un sıfıra yakın değerler alması $p(t)$ ve $q(t)$ gibi iki zaman serisi arasındaki lokal korelasyonun zayıf olduğunu yani etkileşimin veya nedensellik bağlantılarının olmadığını gösterirken, bire yakın değerler alması durumunda ise güçlü olduğunu yani birlikte hareketin olduğu ve nedensellik bağlantılarının güçlü olduğunu göstermektedir (Rua & Nunes, 2009: 634). WTC'nin iki zaman serisi arasındaki etkileşiminin pozitif mi yoksa negatif yönden mi olduğunu göstermemesi gibi bir sınırlaması bulunur ve bu sınırlama "lead-lag" ilişkilerinin hesaplanmasıyla çözülür. Denklem (11), Torrence ve Webster (1999)'a göre iki zaman serisi arasındaki faz farklı bağlantısını tahmin etmek için kullanılır.

$$\emptyset_{p,q}(\tau,s) = \tan^{-1}\left(\frac{\Im\{S(t^{-1}W_{p,q}(\tau,s))\}}{\Re\{t^{-1}W_{p,q}(\tau,s)\}}\right) \tag{11}$$

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[5] *Bu değerin dağılımı hala bilinmediği için istatistiksel anlamlılık düzeyinin incelenmesinde Monte-Carlo simülasyon analiz yöntemleri kullanılmaktadır (Kangallı-Uyar, 2021: 127).*

Burada $\mathfrak{J}$ ve $\mathfrak{R}$ sırasıyla düzgünleştirme güç spektrumunun gerçek ve sanal kısımlarını ifade etmektedir.

3.3. DCC-GARCH Yaklaşımı

Bollerslev (1990) tarafından önerilen Sabit Koşullu Korelasyon GARCH *(Constant Conditional Correlation GARCH-CCC)* kullanılarak Engle ve Sheppard (2001), Tse ve Tsui (2002) ve Engle (2002) tarafından geliştirilen Dinamik Koşullu Korelasyon *(Dynamic Conditional Correlation-DCC)* GARCH yaklaşımı, Finansal varlık getirileri arasındaki zamana bağlı olarak değişen korelasyonları incelemek amacı ile geliştirilmiştir. Bu yaklaşım geçmiş korelasyonların ve tarihsel koşullu oynaklıkların bir fonksiyonu olduğu için farklı zaman serileri arasındaki dinamik koşullu korelasyonu analiz etmek için kullanılır. Ayrıca DCC tahmincilerinin esnekliği tek değişkenli GARCH modelleriyle karşılaştırılabilir ve GARCH modellilerine kıyasla daha az karmaşıklık düzeyine sahiptir. DCC GARCH yaklaşımı, koşullu kovaryans matrisinin zaman içinde değişen iki kısma ayrıştırılmasına dayanır: Birincisi, koşullu standart matrisi, ikincisi ise korelasyon matrisleridir. Ayrıştırmanın temel esası, tek değişkenli ve çok değişkenli dinamikleri ayırarak tahmin sürecinde kolaylık sağlamaktır. Bu yaklaşımın nasıl geliştirildiğini ve hangi varsayımlara dayandığını daha detaylı incelemek için k tane finansal varlığın logaritmik getirilerini içeren vektör r_t ile gösterilsin. Finansal varlık getirileri ortalama getiriler arasında otokorelasyonun olmadığı ve ikinci dereceden momentlerin zamana bağlı olarak değiştiği varsayımları altında aşağıdaki dağılıma sahiptir. DCC GARCH sürecinin detayları Denklem (12)'de gösterildiği gibidir:

$$r_t \mid I_{t-1} \sim D(\mu, H_t) \tag{12}$$

Burada, r_t, $k \times 1$ boyutundaki getiri vektörüdür; I_{t-1}, $t-1$ zamanındaki bilgi setini; μ, genellikle sıfıra çok yakın veya sıfıra eşit olan koşulsuz ortalamayı; H_t, $k \times k$ boyutundaki k-getiri serisinin dinamik koşullu kovaryans matrisini ve $D(u, H_t)$, ortalama vektörü ve dinamik koşullu kovaryans matrisine bağlı olan çok değişkenli yoğunluk fonksiyonunu göstermektedir. Engle (2002), kovaryans matrisini dinamik koşullu standart sapmaların ve dinamik koşullu korelasyonların çarpımı olarak ayrıştırmıştır (Denklem 13):

$$H_t = D_t R_t D_t \tag{13}$$

Burada D_t, $k \times k$ boyutunda ve elemanlarının tek değişkenli GARCH modellerinden elde edilen ve zamana göre değişen standart sapmalardan oluştuğu bir köşegen matristir. D_t matrisinde köşegenin i'inci elemanı $\sqrt{h_{it}}$ hit şeklinde gösterilebilir (Denklem 14):

$$D_t = \begin{bmatrix} \sqrt{h_{1t}} & 0 & \cdots & 0 \\ 0 & \sqrt{h_{2t}} & \ddots & \vdots \\ 0 & \cdots & \cdots & \sqrt{h_{kt}} \end{bmatrix} \tag{14}$$

R_t, kxk boyutunda standardize edilmiş artıkların $\eta_t = D_t^{-1} * r_t$, $R_t \sim N(0, R_t)$, zamana bağlı olarak değişen korelasyon matrisidir (Denklem 15):

$$R_t = \begin{bmatrix} 1 & \rho_{12,t} & \cdots & \cdots & \rho_{1k,t} \\ \rho_{12,t} & 1 & \vdots & \ddots & \vdots \\ \rho_{1k,t} & \cdots & \rho_{k-1,k,t} & \cdots & 1 \end{bmatrix} \tag{15}$$

H_t, kovaryans matrisi olması nedeniyle pozitif tanımlı bir matris olmalıdır. D_t, pozitif köşegen elemanları nedeniyle pozitif tanımlı bir matris olduğundan, R_t'nin de pozitif tanımlı bir matris olması gerekir. Son olarak, R_t'deki elemanların koşullu korelasyon katsayılarını kapsaması nedeniyle 1'e eşit veya daha küçük olması gerekir.

Denklem (12)-(13)'deki gösterimlerden yararlanarak r_t vektörünün her bir elemanının, başka bir deyişle her bir finansal varlığın getirisinin marjinal yoğunluk fonksiyonu "zamana bağlı olarak değişen koşullu varyansa bağlıdır" çıkarımı yapılabilir ve volatilitenin temsilcisi olan zamana bağlı olarak değişen koşullu varyans, tek değişkenli GARCH süreci şeklinde modellenebilir. Buna göre, D_t matrisi Denklem (13)'de tanımlanan tek değişkenli GARCH (p, q) modelinden yararlanılarak oluşturulabilir (Denklem 16):

$$h_{it} = \theta_i + \sum_{p=1}^{p_i} \alpha_{ip} \varepsilon_{it-p}^2 + \sum_{q=1}^{Q_i} \beta_{iq} h_{it-q} \quad i = 1,2,\ldots,k \tag{16}$$

Burada, θ_i sabit terimdir. GARCH (p, q) modelinde parametrelerin negatif olmama ve varyansta durağanlık (Denklem 17):

$$\sum_{p=1}^{p_i} \alpha_{ip} \varepsilon_{it-p}^2 + \sum_{q=1}^{Q_i} \beta_{iq} h_{it-q} < 1 \tag{17}$$

(17) denklemdeki kısıtlarının sağladığı varsayılmaktadır. Bu kısıtların sağlanması, tüm zaman noktaları için H_t matrisinin pozitif tanımlı bir matris olmasını sağlar. Her bir finansal varlığın getirisi koşullu standart sapmasına, $\sqrt{h_{it}}$, bölünerek standardize edilmiş getiri vektörü elde edilir (Denklem 18):

$$\eta_t = D_t^{-1} * r_t, \eta_t \sim N(0, R_t) \tag{18}$$

Bu vektör Engle (2002)'in getiri serisi için tanımlandığı dinamik koşullu korelasyon yapısının tanımlanmasında kullanılabilir (Denklem 19):

$$Q_t = (1 - \sum_{m=1}^{M} \alpha_m - \sum_{n=1}^{N} \beta_n) * \bar{Q} + \sum_{m=1}^{M} \alpha_m (\eta_{t-m} \acute{\eta}_{t-m}) + \sum_{n=1}^{N} \beta_n Q_{t-n} \tag{19}$$

Burada α_m ve β_n negatif olmayan birimlerdir. Kararlılık koşulu gereği $\alpha_m + \beta_n < 1$ olduğu varsayılır. Bu varsayımların sağlanması H_t matrisinin pozitif tanımlı matris olması açısından önemlidir. $\alpha_m = \beta_n = 0$ kısıtının gerçekleşmesi durumunda $Q_t = \bar{Q}$ olacağından ilişkilerin incelenmesinde zamana göre değişmeyen koşullu korelasyon modelinin kullanımının yeterli olacağı söylenebilir (Lebo & Box-Steffensmeier, 2008: 694). $\bar{Q}$, ilk

aşamadaki tahminden elde edilen standardize edilmiş artıkların koşulsuz kovaryans matrisidir (Denklem 20):

$$\bar{Q} = Cov[\eta_t \acute{\eta}_t] = E[\eta_t \acute{\eta}_t] \text{ ve } \bar{Q} = \frac{1}{T}\sum_{t=1}^{T} \eta_t \acute{\eta}_t \tag{20}$$

Denklem (20) ile tahmin edilebilir. Son olarak, eşitlik (17)'de tanımlanan model DCC (m, n) olarak gösterilebilir. Ancak, Q_t, dinamik koşullu korelasyon matrisi tanımına uymadığından Engle (2002) aşağıdaki standardizasyonu önermiştir (Denklem 21):

$$R_t = Q_t^{*-1} * Q_t * Q_t^{*-1} \tag{21}$$

Burada Q_t^*, Q_t matrisinin köşegen elemanlarının kareköklerini kapsayan bir köşegen matristir (Denklem 22):

$$Q_t^* = \begin{bmatrix} \sqrt{q_{11,t}} & 0 & \cdots & 0 \\ 0 & \sqrt{q_{22,t}} & \ddots & \vdots \\ 0 & \cdots & \cdots & \sqrt{q_{nn,t}} \end{bmatrix} \tag{22}$$

Q_t^*, Q_t matrisinin elemanlarını $|\rho_{ijt}| = \left|\frac{q_{ijt}}{\sqrt{q_{iit}q_{jjt}}}\right| \le 1$ olacak şekilde yeniden ölçeklendirir. Q_t, pozitif tanımlı bir matris olmalıdır. R_t matrisinin elemanları ise $\rho_{ijt} = \frac{q_{ijt}}{\sqrt{q_{iit}q_{jjt}}}$ formundadır. R_t matrisinin pozitif tanımlı bir matris olması, Q_t matrisinin pozitif tanımlı bir matris olmasına bağlıdır. Engle (2002) Denklem (15)'de tanımlanan DCC modelinin maksimum olabilirlik yöntemi ile tahmini için logaritmik olabilirlik fonksiyonunu aşağıdaki gibi tanımlamıştır (Denklem 23):

$$L = \frac{1}{2}\sum_{t=1}^{T} k * \log(2\pi) + \log(|H_t|) + r_t'H_t^{-1}r_t \tag{23}$$

Denklem 14'de H_t'nin eşit olduğu ifade Denklem (19)'da yerine konulursa ve $\eta_t = D_t^{-1} * r_t$ eşitliğinden yararlanılarak eşitlik (15)'deki logaritmik olabilirlik fonksiyonu Denklem 24'de gösterildiği şekilde elde edilir:

$$L = \frac{1}{2}\sum_{t=1}^{T} k * \log(2\pi) + 2 * \log(|D_t|) + n_t'R_t^{-1}n_t \tag{24}$$

Logaritmik olabilirlik fonksiyonunun Denklem (24)'deki tanımı DCC modelinin tahminini kolaylaştırır, çünkü fonksiyonun volatilite bileşeni ve korelasyon bileşeni olmak üzere iki bileşeni vardır ve tahmin süreci ikiye ayrılarak tahmin gerçekleştirilebilir. İlk bileşen volatilite bileşeni olup sadece D_t, cinsinden terimleri içerir ve ikinci bileşen korelasyon bileşeni olup sadece R_t, cinsinden terimleri içerir. DCC modelinin iki aşamada tahmin edilmesinin nedeni bu yapı ile açıklanabilir. İlk aşamada sadece volatilite bileşeninin olduğu kısım, ikinci aşamada ise D_t'ye koşullu olarak korelasyon bileşeni maksimize edilir ve böylece DCC modelinin parametrelerinin, α_m ve β_n, tahminleri elde edilir. α_m ve β_n

parametreleri iki seri arasındaki korelasyonun belirleyicisidir. α_m parametresi volatilitenin kısa dönem etkilerini, β_n parametresi uzun dönem kalıcı etkilerini gösterir.

4. Veri Seti ve Ekonometrik Analiz

Bu çalışmada, 01.10.2012-04.06.2024 tarihleri arasındaki dönemi kapsayan günlük veriler kullanılarak enerji emtia (Brent petrol, doğal gaz) piyasaları ile kıymetli metal (altın, gümüş, platin ve paladyum) piyasaları arasındaki volatilite yayılımı, zaman-frekans uzayında piyasalar arasındaki ilişkilerin incelenmesine olanak sağlayan Wavelet Uyum Analizi Dayalı Dinamik Koşullu Korelasyon (DCC-GARCH) yaklaşımı ile araştırılmıştır. Çalışma dönemi, analizde kullanılan emtia değişkenleri için mümkün olan en uzun günlük gözlem sayısına ulaşılacak şekilde kurgulanmıştır. Tüm değişkenler dolar bazlı olup, emtia ve kıymetli metal değişkenlerine ait fiyat serileri investing.com veri tabanı kullanılarak elde edilmiştir. Değişkenler arasındaki tarih uyumsuzluğu gidermek amacıyla senkronizasyon işlemi gerçekleştirilmiştir. Oluşturulan modellerde enerji fiyatları bağımlı değişken, metaller ise bağımsız değişken olarak kullanılmaktadır. Değişkenlere getiriler Denklem (25) yardımıyla hesaplanmıştır.

$$r_{i,t} = \log\left(\frac{P_{i,t}}{P_{i,t-1}}\right) \tag{25}$$

Denklem (25)'deki; $r_{i,t}$, t zamanında i'nci değişkenin getiri serisini; $P_{i,t}$ ve $P_{i,t-1}$ sırasıyla t ve t-1 zamanında değişkenlerin kapanış fiyatlarını belirmektedir. Değişkenlere ait özet bilgiler Tablo 3'te yer verilmiştir.

Tablo: 3
Değişkenlere ait Özet Bilgiler

| Değişkenler	Veri Türü	Tarih Aralığı	Veri Tabanı
Brent Petrol			
Doğal Gaz			
Altın Ons	Günlük	01.10.2012-04.06.2024	investing.com
Gümüş Ons			
Platin			
Paladyum			

5. Bulgular

5.1. Tanımlayıcı Analizler

Günlük veri setinin kullanıldığı bu çalışmada enerji ve kıymetli metal serilerine ait fiyat ve getiri grafikleri Şekil 1'de, tanımlayıcı istatistikler Tablo 4'te ve korelasyon matrisi ise yer verilmiştir.

Şekil 1 incelendiğinde, incelenen veri aralığında hem enerji (Brent petrol, doğal gaz) piyasaları hem de kıymetli metal (altın, gümüş, platin ve paladyum) piyasalarındaki fiyatların, çeşitli küresel olaylardan önemli ölçüde etkilendiği görülmektedir. Buna bağlı olarak Brent petrol fiyatların, incelenen veri aralığında dalgalı bir seyir izlemiştir. 2014 yılında petrol arzındaki artış ve OPEC'in üretim politikasındaki değişiklikler nedeniyle

fiyatlarda belirgin bir düşüş yaşanmıştır. 2020 yılında COVID19 pandemisi küresel ekonomiyi durma noktasına getirmiş ve petrol fiyatlarının keskin bir şekilde düşüşüne neden olmuştur. 2021 yılından itibaren ekonomik toparlanma ile fiyatlar yeniden yükselmeye başlamış, 24 Şubat 2022 yılında başlayan Rusya-Ukrayna savaşı ise enerji piyasalarında belirsizliği artırarak fiyatları daha da yükseltmiştir. Doğal gaz fiyatları da bu dönemde önemli dalgalanmalar göstermiştir. 2014'te Ukrayna krizinin patlak vermesi ve Rusya'nın doğalgaz arzını stratejik bir silah olarak kullanması, fiyatların volatilitesini artırmıştır. COVID19 pandemisi sırasında fiyatlarda düşüş görülmüş, ancak 2021 yılında küresel talebin artması ve arz kısıtlamaları nedeniyle fiyatlar keskin bir şekilde yükselmiştir. Rusya-Ukrayna savaşı, doğal gaz arzındaki belirsizlikler nedeniyle fiyatların daha da yükselmesine neden olmuştur.

Şekil: 1
Fiyat ve Getiri Serilerine İlişkin Grafikler

Değişkenlere İlişkin Fiyat Serileri *Değişkenlere İlişkin Getiri Serileri*
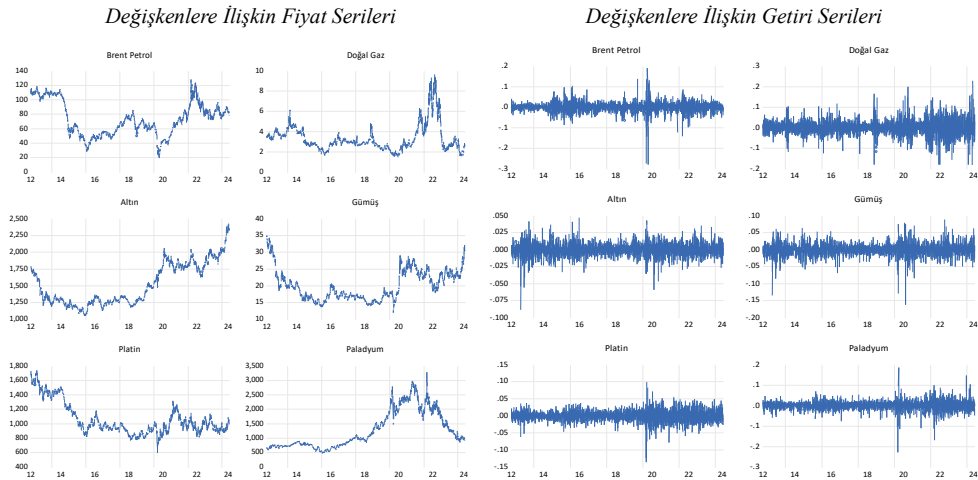
Altın, genellikle güvenli liman olarak görülen bir yatırım aracıdır ve fiyat hareketleri bu niteliği yansıtmaktadır. 2008 finansal krizinin ardından başlayan yükseliş trendi, 2012 yılında en yüksek değerine ulaşmış ve ardından düzeltme hareketini gerçekleştirmiştir. 2020 yılında COVID19 pandemisi sırasında, yatırımcıların güvenli liman arayışları altın fiyatlarının yeniden yükselmesine neden olmuştur. Rusya-Ukrayna savaşı da jeopolitik belirsizlikleri artırarak altın fiyatlarını desteklemiştir. Gümüş fiyatları, altın ile benzer bir eğilim izlemekle birlikte, endüstriyel kullanım alanları nedeniyle daha fazla volatilite göstermiştir. 2020 yılında COVID19 pandemisinin endüstriyel talebi azaltması fiyatları düşürmüş, ancak toparlanma sürecinde fiyatlar yeniden artmıştır. Jeopolitik risklerin arttığı dönemlerde güvenli liman olarak talep gören gümüş fiyatlarında artış gözlemlenmiştir. Platin fiyatları, otomotiv ve endüstriyel kullanım alanlarındaki talep dalgalanmaları nedeniyle belirgin bir volatilite sergilemiştir. 2012-2020 yılları arasında fiyatlarda düşüş yaşanırken, COVID19 pandemisi döneminde arz zincirlerindeki bozulmalar ve talepteki

düşüş fiyatları baskılamıştır. Küresel ekonomik toparlanma ile fiyatlarda bir miktar iyileşme gözlenmiştir. Paladyum fiyatları, özellikle otomotiv sektöründeki emisyon standartlarının sıkılaştırılması nedeniyle güçlü bir talep görmüştür. 2019 ve 2020 yıllarında paladyum fiyatlarında önemli bir artış yaşanmış, ancak COVID19 pandemisinin etkisiyle bu yükseliş trendi kısa süreli bir duraklama göstermiştir. 2022'de Rusya-Ukrayna savaşı, Rusya'nın önemli bir paladyum üreticisi olması nedeniyle arz endişelerini artırmış ve fiyatların yükselmesine yol açmıştır.

İncelenen veri aralığında hem enerji (Brent petrol, doğal gaz) piyasaları hem de kıymetli metal (altın, gümüş, platin ve paladyum) piyasalarına ait getiri serileri değerlendirildiğinde ise enerji emtia piyasalarına ait fiyatları etkileyen küresel olaylara bağlı olarak 2016 yılındaki Ukrayna krizi ve Rusya'nın doğalgaz politikaları volatiliteyi artırmıştır. 2020 yılında COVID19 pandemisi nedeniyle enerji talebindeki düşüş hem petrol hem de doğal gaz fiyatlarındaki dalgalanmayı artırmıştır. 2021 yılında, küresel talebin artması ve arz kısıtlamaları nedeniyle volatilite devam etmiştir. Altın, gümüş, platin ve paladyum emtia piyasalarının getirilerinde incelenen veri aralığında gözlemlenen volatilite kümelenmeleri ve bu dalgalanmaların altında yatan nedenler ortaya konmaktadır. Altın getirilerinde özellikle 2020 yılında COVID19 pandemisinin neden olduğu belirsizlik ve yatırımcıların güvenli liman arayışları, volatiliteyi artırmıştır. Gümüş getirilerinde ise endüstriyel kullanım alanlarının etkisiyle volatilite dalgalanmaları gözlemlenmektedir. 2020 yılında pandeminin endüstriyel talebi azaltması ve ardından toparlanma sürecinde gümüş fiyatlarında volatilite artmıştır. Platin getiri serilerinde özellikle 2016 ve 2020 yıllarında belirgin volatilite kümelenmeleri görülmektedir. Paladyum getiri serilerinde ise özellikle 2019 ve 2020 yıllarında belirgin volatilite kümelenmeleri gözlemlenmiştir. 2019'da emisyon standartlarının sıkılaştırılması nedeniyle talep artışı fiyat dalgalanmalarına yol açmış ve 2020 yılında pandeminin etkisiyle arz endişeleri ve talep dalgalanmaları volatiliteyi artırmıştır. 2022 yılında ise Rusya-Ukrayna savaşı, Rusya'nın önemli bir paladyum üreticisi olması nedeniyle arz endişelerini artırmış ve volatiliteyi yükseltmiştir.

Özetle, enerji ve kıymetli metal emtia piyasalarına ait fiyat ve getiri serilerinin, küresel finansal krizler, siyasi krizler, COVID19 pandemisi ve Rusya-Ukrayna savaşı gibi önemli olaylardan büyük ölçüde etkilendiği görülmektedir. Bu emtia piyasalarının getirilerinde kısa, orta ve uzun dönem koşullu korelasyon ve volatilite yayılımı ve kalıcılığı anlaşılması, yatırımcılar ve politika yapıcılar için kritik öneme sahiptir. Enerji ve kıymetli metal piyasalarındaki dinamikler, küresel ekonominin genel yapısı ve jeopolitik gelişmelerin piyasalara olan etkilerini yansıtmakta ve gelecekteki olası risklere karşı stratejik planlama yapılmasına olanak sağlamaktadır.

Tablo 4'teki bulgular incelendiğinde, Brent petrol, doğal gaz, gümüş ve platin emtia piyasaları negatif ortalamaya sahip iken, altın ve paladyum emtia piyasaları ise pozitif ortalamaya sahip olduğu görülmektedir. Volatilite açısından değerlendirildiğinde, doğal gaz, Brent petrol ve paladyum incelenen veri aralığında en yüksek standart sapmaya sahip emtia piyasaları olduğu göstermektedir. Doğal gaz emtia piyasası hariç diğer enerji ve kıymetli metal emtia piyasaları negatif çarpıklık değerler aldığı ve dolayısıyla sola çarpık ve

leptokörtik (sivri) dağılıma sahip olduğu görülmektedir. Emtia piyasalarına ait tüm getiri serilerinin basıklık değerleri incelendiğinde ise normal dağılım değerinden oldukça büyük ve kalın kuyruklu yapıya sahip olduğu görülmektedir. Jarque-Bera normallik test istatistiklerine göre hem enerji hem de kıymetli metal piyasalarına ait getiri serilerinin hiçbiri normal dağılım göstermemektedir. Bu sonuç enerji ve kıymetli metal emtia piyasaları arasındaki volatilite yayılımını incelemek için herhangi bir dağılımsal varsayımda bulunmayan Wavelet uyum analizine dayalı Dinamik Koşullu Korelasyon (DCC-GARCH) yaklaşımının kullanılması açısından önemli bir neden sunmaktadır.

Tablo: 4
Değişkenlere ait Tanımlayıcı İstatistikler

	Brent Petrol	Doğal gaz	Altın	Gümüş	Platin	Paladyum
Ortalama	-0.000123	-7.72E-05	9.29E-05	-4.15E-05	-0.000175	0.000123
Medyan	0.000847	0.000000	0.000253	1.59E-05	0.000000	0.001022
Maksimum	0.190774	0.229320	0.046928	0.088348	0.099314	0.186270
Minimum	-0.279761	-0.182223	-0.088756	-0.162015	-0.136136	-0.229171
S.Sapma	0.023693	0.035352	0.009180	0.016789	0.015520	0.021532
Çarpıklık	-0.958013	0.017083	-0.547024	-0.549340	-0.286519	-0.391153
Basıklık	20.31741	6.721186	8.948138	10.99300	8.401672	13.14850
Jarque-Bera	38147.86***	1740.281***	4596.546***	8180.296***	3707.975***	13019.57***
P. Değeri	[0.000000]	[0.000000]	[0.000000]	[0.000000]	[0.000000]	[0.000000]
Gözlem Sayısı	3016	3016	3016	3016	3016	3016

Not: ***, %1 güven aralığında istatistiksel anlamlılık düzeyini ifade etmektedir.

Şekil: 2
**Korelasyon Matrisi**
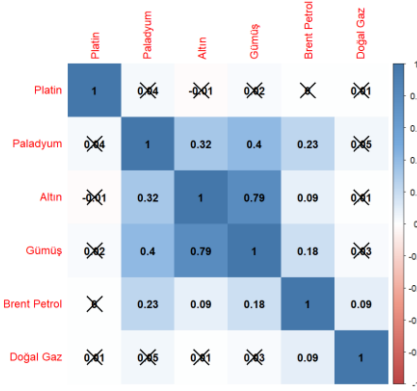
Şekil 2'de yer alan Pearson korelasyon matrisi incelendiğinde, korelasyon katsayıları arttıkça renk skalası kırmızıdan maviye doğru değişmekte ve üzerinde çarpı işareti yer alan katsayılar %1 anlamlılık düzeyine göre anlamlı olmayan katsayıları göstermektedir. Buna göre Brent petrol ile paladyum, altın, gümüş ve doğal gaz getirileri arasında 0.09 ile 0.23 aralığında %1 anlamlılık düzeyinde anlamlı, ancak göreceli olarak zayıf pozitif korelasyona sahip olduğunu göstermektedir. Doğal gaz ile paladyum, altın, gümüş, platin getirileri arasında anlamlı bir korelasyon ilişkisini göstermezken, diğer yandan Brent petrol getirileri ile %1 anlamlılık düzeyinde anlamlı ancak göreceli olarak zayıf pozitif bir ilişkiye sahiptir.
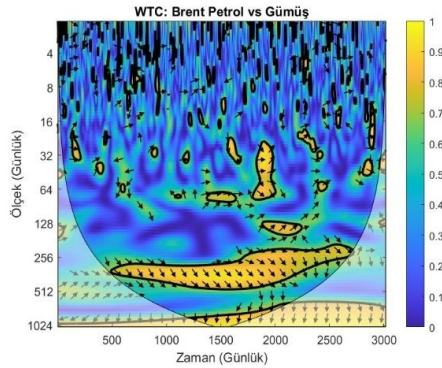
5.2. Wavelet Uyum Analizi Bulguları

Araştırmanın bu bölümünde, Wavelet uyum analizi yöntemi ile enerji emtiaları ile kıymetli metal emtia piyasaları arasındaki volatilite etkileşimi ve nedensel bağlantılar araştırılmıştır. MODWT filtreleme yöntemi ile hem enerji hem de kıymetli metal emtialarının getiri serilerine filtreleme işlemi gerçekleştirilecektir. Son olarak, DCC-GARCH yaklaşımı ile enerji ve kıymetli metal piyasaları arasındaki kısa, orta ve uzun dönem koşullu korelasyonun ve volatilite yayılımının kalıcı olup olmadığı incelenecektir.

Şekil: 3
Enerji ve Metal Emtialara ait Wavelet Uyum Analizi Grafikler
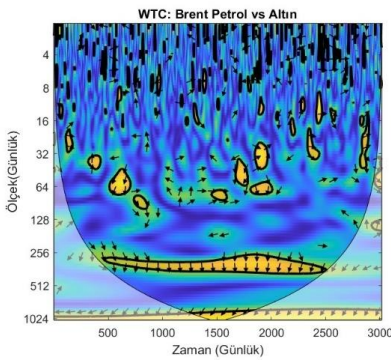
Wavelet Coherence: Brent Petrol-Altın

Wavelet Coherence: Brent Petrol-Gümüş
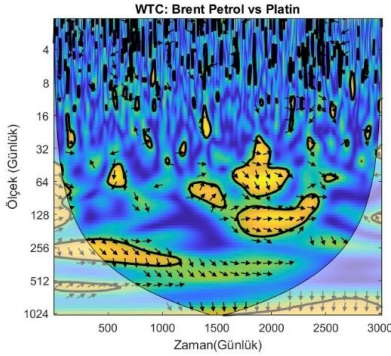
Wavelet Coherence: Brent Petrol-Platin
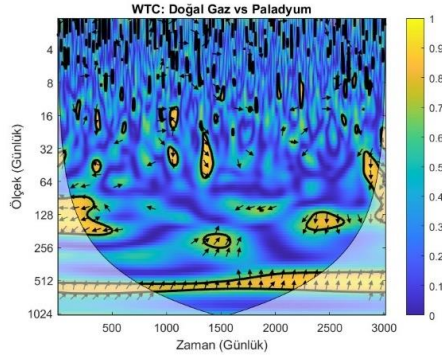
Wavelet Coherence: Doğal Gaz-Paladyum

Şekil 3'te enerji ve kıymetli emtia piyasalarına ait getiri serisi çiftleri için Wavelet uyum analizi (WTC) grafiklerine yer verilmiştir. WTC grafiklerinde yer alan oklar, faz farklılığı analizinin çıktılarını göstermektedir. Bu okların yönü zaman serileri arasındaki ilişkilerin yönü hakkında bilgiler sunmaktadır. Sağ tarafı gösteren oklar emtiaların getiri serileri arasındaki ilişkinin pozitif yönlü olduğunu, sol tarafı gösteren oklar ise ilişkinin

yönünün negatif olduğunu belirtir. Ayrıca okların yönü emtia getiri serileri arasındaki nedensellik ilişkilerini de inceleyememize imkân tanır. Diğer bir ifadeyle, iki emtia piyasası arasındaki birlikte hareketlerinin gücünü gösterir ve mavi (zayıf birlikte hareketler) ile sarı (güçlü birlikte hareketler) arasında değişir (Vacha & Baruník, 2012; Yang et al., 2016; Marín-Rodríguez et al., 2023;). Bu doğrultuda yukarıyı gösteren oklar emtia getiri serilerinden ilkinin ikinciyi etkilediğini, aşağıyı gösteren oklar ise ikinci emtia piyasa getiri serisinin ilk piyasanın getiri serisini etkilediğini gösterir (Goodell & Goutte, 2021; Haq & Bouri, 2022; Jana et al., 2023). Şekil 3'teki WTC grafiklerinin, yatay ekseninde incelenen dönem, dikey ekseninde frekanslar veya zaman ölçekleri yer alırken; renk lejantında ise 0 ile 1 arasında değerler almış, karesi alınmış Wavelet uyum katsayısına ait değerler yer almaktadır. Sıfıra yakın değerler iki emtia getiri serisi arasındaki lokal korelasyonun zayıf olduğunu, 1'e yakın değer alması durumunda ise güçlü olduğunu ifade etmektedir (Kangallı-Uyar, 2021: 136-139). İnce gri "U" şekilli çizgi, kenar etkilerimi gösteren (cone of influence-COI)'koniyi ifade eder (Dewandaru et al., 2017). COI çizgisinin ötesindeki gri gölgeli alan, önemsiz varyansı ifade etmektedir ve yorumlamalarda kullanılamamaktadır.

5.3. Wavelet Uyum Analizine Dayalı DCC-GARCH Bulguları

Wavelet uyum analizi (WTC) sonuçlarına dayanarak, emtia (Brent petrol ve doğal gaz) ve kıymetli metal (altın, gümüş, platin ve paladyum) piyasa getirileri arasında uzun vadeli bağımlılığın varlığı tespit edilmiştir. Bu bağımlılığı daha detaylı bir şekilde incelemek amacıyla, DCC-GARCH modelleri ölçek 8 ve 9 seviyelerinde uygulanmıştır. Emtia (Brent petrol ve doğal gaz[6]) ve kıymetli metal (altın, gümüş, platin ve paladyum) emtia piyasalarına ait getiri serileri için WTC grafikleri incelendiğinde, Brent petrol ile altın getiri serileri arasında bir yıllık zaman ölçeğinde veya 256-512 günlük frekansta anlamlı ve güçlü ilişki sebebiyle Brent petrol getiri serilerinden altın getiri serilerine doğru uzun dönemli ve pozitif bir etkileşim olduğu gözlenmiştir. Brent petrol ile gümüş getirileri arasında bir ve iki yıllık zaman ölçeklerinde ya da 256-512 günlük ve 512-1024 günlük frekansta anlamlı ve güçlü ilişkisi nedeniyle Brent petrol getiri serilerinden gümüş getiri serilerine doğru uzun dönemli ve pozitif bir etkileşim olduğu ifade edilebilmektedir. Brent petrol ile platin getiri serileri arasında COVID19 pandemi öncesinde bir yıllık zaman ölçeklerinde veya 256-512 günlük frekansta anlamlı ve güçlü bir ilişki olduğu ifade edilebilir. COVID19 pandemi sonrasında ise dört aylık zaman ölçeklerinde veya 128-256 günlük frekansta anlamlı ve uzun dönemde güçlü bir ilişki olduğu ve ilişkinin yönü pozitif olduğu gözlenmektedir. Doğal gaz ile paladyum getiri serileri arasında bir buçuk veya iki yıllık zaman ölçeklerinde ya da 512-1024 günlük yatırım döngülerinde anlamlı ve güçlü ilişki sebebiyle uzun dönemde karşılıklı etkileşim olduğu söylenebilir. Paladyum ile doğal gaz getirileri arasındaki uzun dönemli bağımlılığın çoğunlukla endüstriyel üretim, arz ve talep kaynaklı olduğu düşünülmektedir.

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[6] *Doğal gaz ile kıymetli metal (altın, gümüş ve platin) piyasaları arasındaki ilişki ve etkileşim incelenmiş, ancak elde edilen sonuçlar anlamsız olduğu için EK 1'de sunulmuştur.*

Tablo: 5
256-512 Günlük Yatırım Döngülerinde Brent Petrol ile Altın Getirilerine ait DCC-GARCH Modeli Sonuçları

	Katsayılar	Standart Hatalar	t-İstatistikleri	Olasılık Değerleri
Sabit$_1$	4.0706e-10	1.8355e-10	2.21769**	0.0265
Sabit$_2$	3.4920e-08	2.7130e-08	1.28713	0.1980
α_1	0.1706	8.9611e-03	19.03709***	0.0000
α_2	0.1383	8.3487e-03	16.56350***	0.0000
β_1	0.4672	0.0202	23.15456***	0.0000
β_2	0.4476	0.0198	22.63116***	0.0000
DCC$_\alpha$	0.2040	0.0142	14.41240***	0.0000
DCC$_\beta$	0.7925	0.0143	55.23456***	0.0000

*Not: ***, ** ve * sırasıyla %1, %5 ve %10 güven aralığında istatistiksel anlamlılığı ifade etmektedir.*

Enerji ve kıymetli metal piyasalarına ait getirilerini belirlemede zamanla değişen korelasyonlar ve volatilite önemli rol oynamaktadır. WTC analizleri sonucunda elde edilen bulgulara göre emtialar arasındaki zamanla değişen korelasyonlarını belirlemek için Wavelet dayalı DCC-GARCH yaklaşımı kullanılmıştır. Tablo 5'te Brent petrol ile altın getiri serileri için 256-512 günlük yatırım döngülerine ilişkin sonuçlara yer verilmiştir. Tablo 5'te yer alan bulgulara göre, Brent petrol ile altın getirilerinin α ve β tahminlerinin toplamının 1'den küçük hesaplanması, DCC-GARCH modelinin uygulanabilirliğini desteklemektedir. Ayrıca DCC-GARCH sonucuna dayanarak 256-512 günlük yatırım döngülerinde Brent petrol ve altın getirileri için α tahminlerin %1 anlamlılık düzeyinde anlamlı olduğu, bu altın getiri volatilitesi üzerinde Brent petrol getirilerinin kısa vadeli etkisini gösterdiğini söylenebilir. Diğer bir ifadeyle Brent petrol getirilerinden altın getirilere doğru kısa vadeli volatilite yayılımı olduğunu görülmektedir. Bunun yanı sıra β tahminin %1 anlamlılık düzeyinde anlamlı olduğu, Brent petrol getiri volatilitesinin altın getiri volatilitesi üzerinde uzun vadeli önemli etkileri olduğunu göstermektedir. Yani Brent petrol getirilerinden altın getirilere doğru uzun vadeli volatilite yayılım etkisi olduğunu bulunmaktadır. Ancak $\alpha + \beta < 1$ tahminin 1'e oldukça yakın olması, 256-512 yatırım döngülerinde dinamik korelasyonların sabit bir seviye etrafında dalgalandığını ve ortalamaya dönme eğilimindeki bir sürece sahip olduğunu ortaya koymaktadır. Aynı zamanda bu günlük yatırım döngülerinde Brent petrol ile altın getirileri için koşullu volatilitenin kalıcı olma ihtimalinin daha yüksek olduğu ifade edilebilir. Bu bulgu, piyasaların getirilerini yavaşça dengede tuttuğu ve şokların yavaşça azaldığını göstermektedir. Dolayısıyla, volatilite ve korelasyon katsayı tahminleri, bu piyasalardaki yatırımcıların şoklar sonucunda ani bir kayıpla karşılaşma olasılığının daha düşük olduğu sonucunu ortaya koymaktadır.

Tablo 6'da, Brent petrol ile gümüş getiri serilerine ait 256-512 günlük yatırım döngülerini inceleyen wavelet uyum analizine dayalı DCC-GARCH yaklaşımına ilişkin sonuçlara yer verilmiştir. Tablo 6'da yer alan bulgular incelendiğinde, her iki yatırım döngüsünde de Brent petrol ile gümüş getirilerinin α ve β katsayı tahminlerinin toplamı 1'den daha az olduğunu görülmektedir. Ayrıca DCC-GARCH sonucuna dayanarak 256-512 günlük yatırım döngülerinde Brent petrol ve gümüş getirileri için α tahminlerin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olduğu, bu sonuç gümüş getiri volatilitesi üzerinde Brent petrol getirilerinin uzun vadeli etkisini gösterdiği ifade edilebilmektedir.

Başka bir ifadeyle Brent petrol getirilerinden gümüş getirilere doğru uzun vadeli volatilite yayılım etkisi olduğu gözlenmektedir. Öte yanda β katsayı tahmininin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olduğu, Brent petrol getiri volatilitesinin gümüş getiri volatilitesi üzerinde uzun dönemli önemli etkileri olduğunu göstermektedir. Diğer bir ifadeyle elde edilen bulgular, Brent petrol getirilerinden gümüş getirilere doğru uzun dönemli volatilite yayılım olduğunu göstermektedir. Ancak $\alpha + \beta < 1$ katsayı tahmininin 1'e oldukça yakın olması, 256-512 günlük yatırım döngülerinde Brent petrol ile gümüş getirileri için koşullu volatilitenin kalıcı olma olasılığının daha yüksek olduğu göstermektedir. Bu durum, piyasaların getirilerini yavaşça dengede tuttuğu ve şokların yavaş yavaş elimine olduğunu ifade etmektedir. Dolayısıyla, tahmin edilen volatilite ve korelasyon katsayıları, bu piyasalardaki yatırımcıların şoklar sonucunda ani bir kayıpla karşılaşma ihtimalinin daha düşük olduğu göstermektedir.

Tablo: 6
256-512 Günlük Yatırım Döngülerinde Brent Petrol ile Gümüş Getirilerine ait DCC-GARCH Modeli Sonuçları

	Katsayılar	Standart Hatalar	t-İstatistikleri	Olasılık Değerleri
Sabit$_1$	4.3399e-10	1.0453e-10	4.15165***	0.0000
Sabit$_2$	6.3432e-09	1.2021e-09	5.27694***	0.0000
α_1	0.1918	0.0103	18.61635***	0.0000
α_2	0.1784	7.7678e-03	22.96931***	0.0000
β_1	0.3874	0.0161	24.04653***	0.0000
β_2	0.3861	0.0228	16.96783***	0.0000
DCC$_\alpha$	0.4555	0.0292	15.57993***	0.0000
DCC$_\beta$	0.5422	0.0291	18.65540***	0.0000

Not: ***, ** ve * sırasıyla %1, %5 ve %10 güven aralığında istatistiksel anlamlılığı ifade etmektedir.

Tablo 7'de Brent petrol ile gümüş getiri serilerine ait 512-1024 günlük yatırım döngülerini inceleyen wavelet uyum analizine dayalı DCC-GARCH yaklaşımının sonuçlarına yer verilmiştir.

Tablo: 7
512-1024 Günlük Yatırım Döngülerinde Brent Petrol ile Gümüş Getirilerine ait DCC-GARCH Modeli Sonuçları

	Katsayılar	Standart Hatalar	t-İstatistikleri	Olasılık Değerleri
Sabit$_1$	1.0182e-10	5.3499e-11	1.90328*	0.0570
Sabit$_2$	9.9304e-09	1.61151e-09	6.14848***	0.0000
α_1	0.1362	5.7688e-03	23.60840***	0.0000
α_2	0.1194	4.6723e-03	25.55787***	0.0000
β_1	0.4261	0.0198	21.52783***	0.0000
β_2	0.4091	0.0198	20.63652***	0.0000
DCC$_\alpha$	0.2560	0.0154	16.58155***	0.0000
DCC$_\beta$	0.7420	0.0155	47.81426***	0.0000

Not: ***, ** ve * sırasıyla %1, %5 ve %10 güven aralığında istatistiksel anlamlılığı ifade etmektedir.

Tablo 7'de Brent petrol ile gümüş getiri serileri için 512-1024 günlük yatırım döngülerine ilişkin sonuçlara yer verilmiştir. Tablo 7'de yer alan bulgular incelendiğinde, her iki yatırım döngüsünde de Brent petrol ile gümüş getirilerinin α ve β katsayı tahminlerinin toplamı 1'den daha az olduğunu görülmektedir. Ayrıca, DCC-GARCH sonucuna dayanarak 512-1024 günlük yatırım döngülerinde Brent petrol ve gümüş getirileri

için α tahminlerinin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olduğu; bu sonucun, gümüş getiri volatilitesi üzerinde Brent petrol getirilerinin uzun vadeli etkisini gösterdiği ifade edilebilmektedir. Başka bir ifadeyle Brent petrol getirilerinden gümüş getirilere doğru uzun vadeli volatilite yayılım etkisi olduğu gözlenmektedir. Öte yanda β katsayı tahminin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olduğu, Brent petrol getiri volatilitesinin gümüş getiri volatilitesi üzerinde uzun dönemli önemli etkileri olduğunu göstermektedir. Diğer bir ifadeyle elde edilen bulgular, Brent petrol getirilerinden gümüş getirilere doğru uzun dönemli volatilite yayılım olduğunu göstermektedir. Ancak $\alpha + \beta < 1$ katsayı tahminin 1'e oldukça yakın olması, 512-1024 günlük yatırım döngülerinde Brent petrol ile gümüş getirileri için koşullu volatilitenin kalıcı olma olasılığının daha yüksek olduğu göstermektedir. Bu durum, piyasaların getirilerini yavaşça dengede tuttuğu ve şokların yavaş yavaş elimine olduğunu ifade etmektedir. Dolayısıyla, tahmin edilen volatilite ve korelasyon katsayıları, bu piyasalardaki yatırımcıların şoklar sonucunda ani bir kayıpla karşılaşma ihtimalinin daha düşük olduğu göstermektedir. WTC analizinden elde edilen bulgulara göre, Brent petrol ve platin arasındaki dinamik koşullu korelasyon analizi, COVID19 pandemi öncesi ve sonrası olarak iki ayrı dönem şeklinde incelenmiştir. Bu bağlamda, wavelet uyum analizinin sağladığı frekans ve zaman çözünürlüğü, farklı dönemlerdeki ilişki yapısını ayrıntılı bir şekilde değerlendirmeye olanak tanımıştır. Özellikle, COVID19 pandemisinin piyasalarda yarattığı belirsizlik ve şoklar göz önünde bulundurularak, analiz edilen dönemler arasındaki korelasyon farklılıkları incelenmiştir. Tablo 8 ve Tablo 9'da Brent petrol ile platin getiri serileri için COVID19 pandemi öncesi 256-512 ve pandemi sonrası 128-256 günlük yatırım döngülerine ilişkin wavelet uyum analizine dayalı DCC-GARCH yaklaşımına ilişkin sonuçlara yer verilmiştir.

Tablo: 8
Pandemi Öncesi 256-512 Günlük Yatırım Döngülerinde Brent Petrol ile Platin Getirilerine ait DCC-GARCH Modeli Sonuçları

	Katsayılar	Standart Hatalar	t-İstatistikleri	Olasılık Değerleri
Sabit$_1$	2.4398e-10	6.2819e-11	3.88391***	0.0001
Sabit$_2$	1.6915e-06	7.9705e-11	2.12217**	0.0338
α_1	0.1724	9.9654e-03	17.30424***	0.0000
α_2	0.1527	7.4293e-03	20.55032***	0.0000
β_1	0.4228	0.0233	18.14366***	0.0000
β_2	0.4736	0.0229	20.71217***	0.0000
DCC$_\alpha$	0.2674	3.0045e-03	89.00.887***	0.0000
DCC$_\beta$	0.7325	2.9499e-03	248.30964***	0.0000

*Not: ***, ** ve * sırasıyla %1, %5 ve %10 güven aralığında istatistiksel anlamlılığı ifade etmektedir.*

Tablo 8'de Brent petrol ile platin getiri serileri için COVID19 pandemi öncesi 256-512 günlük yatırım döngülerine ilişkin DCC-GARCH yaklaşımına ilişkin sonuçlara yer verilmiştir. Tablo 8'de yer alan bulgulara göre, pandemi öncesi Brent petrol ile platin getirilerinin α ve β katsayı tahminlerinin toplamı 1'den daha küçük olduğunu görülmektedir. Ayrıca, DCC-GARCH sonucuna dayanarak pandemi öncesi 256-512 günlük yatırım döngülerinde Brent petrol ve platin getirileri için α tahminlerinin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olduğu; bu sonucun, platin getiri volatilitesi üzerinde Brent petrol getirilerinin uzun vadede etkili olduğu söylenebilmektedir. Başka bir deyişle, pandemi öncesi ve sonrası dönemde Brent petrol getirilerinden platin getirilerine doğru uzun vadeli

bir volatilite yayılım etkisinin mevcut olduğunu ortaya koymaktadır. Bunun yanı sıra β katsayı tahminin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olması, Brent petrol getiri volatilitesinin platin getiri volatilitesi üzerinde pandemi öncesi uzun dönemde önemli etkileri olduğunu göstermektedir. Diğer bir ifadeyle, Brent petrol getirilerinden platin getirilerine doğru uzun vadeli volatilite yayılımı olduğu görülmektedir. Ancak $\alpha + \beta < 1$ katsayı tahminin 1'e oldukça yakın olması, pandemi öncesi 256-512 günlük yatırım döngülerinde Brent petrol ile platin getirileri için koşullu volatilitenin kalıcı olma olasılığının daha yüksek olduğu göstermektedir. Bu durum, piyasaların getirilerini orta ve uzun vadede yavaşça dengede tuttuğu ve şokların yavaş yavaş elimine olduğunu ifade etmektedir. Dolayısıyla, volatilite ve korelasyon katsayı tahminleri, uzun vadede bu piyasalardaki yatırımcıların şoklar sonucunda ani bir kayıpla karşılaşma ihtimalinin daha düşük olduğu göstermektedir.

Tablo: 9
Pandemi Sonrası 128-256 Günlük Yatırım Döngülerinde Brent Petrol ile Platin Getirilerine ait DCC-GARCH Modeli Sonuçları

	Katsayılar	Standart Hatalar	t-İstatistikleri	Olasılık Değerleri
Sabit$_1$	2.2832e-08	4.5069e-09	5.06594***	0.0000
Sabit$_2$	2.8328e-09	9.8508e-10	2.87567***	0.0040
α_1	0.5021	0.0106	47.25581***	0.0000
α_2	0.4917	0.0112	43.86607***	0.0000
β_1	-0.4877	9.8103e-03	-49.70976***	0.0000
β_2	-0.4582	0.0200	-22.92426***	0.0000
DCC$_\alpha$	0.9552	5.2993e-03	180.24466***	0.0000
DCC$_\beta$	0.0438	5.3293e-03	8.22275***	0.0000

Not: ***, ** ve * sırasıyla %1, %5 ve %10 güven aralığında istatistiksel anlamlılığı ifade etmektedir.

Tablo 9'da yer alan bulgulara göre, pandemi sonrası Brent petrol ile platin getirilerinin α ve β katsayı tahminlerinin toplamı 1'den daha küçük olduğunu görülmektedir. Ayrıca DCC-GARCH sonucuna dayanarak pandemi sonrası 128-256 günlük yatırım döngülerinde Brent petrol ve platin getirileri için α tahminlerin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olduğu, bu sonuç platin getiri volatilitesi üzerinde Brent petrol getirilerinin orta ve uzun vadede etkisinin olduğu söylenebilmektedir. Diğer bir ifadeyle, Brent petrol getirilerinden platin getirilere doğru pandemi sonrası orta ve uzun vade de volatilite yayılım etkisi olduğunu göstermektedir. Bunun yanı sıra β katsayı tahminin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olması, Brent petrol getiri volatilitesinin platin getiri volatilitesi üzerinde pandemi sonrasında uzun dönemde önemli etkileri olduğunu göstermektedir. Diğer bir ifadeyle, Brent petrol getirilerinden platin getirilerine doğru uzun vadeli volatilite yayılımı olduğu görülmektedir. Ancak $\alpha + \beta < 1$ katsayı tahminin 1'e oldukça yakın olması, pandemi öncesi 128-256 günlük yatırım döngülerinde Brent petrol ile platin getirileri için koşullu volatilitenin kalıcı olma olasılığının daha yüksek olduğu göstermektedir. Bu durum, piyasaların getirilerini orta ve uzun vade de yavaşça dengede tuttuğu ve şokların yavaş yavaş elimine olduğunu ifade etmektedir. Dolayısıyla, volatilite ve korelasyon katsayı tahminleri, uzun vade de bu piyasalardaki yatırımcıların şoklar sonucunda ani bir kayıpla karşılaşma ihtimalinin daha düşük olduğu göstermektedir. Tablo 10'da doğal gaz ve paladyum getiri serilerine ait 512-1024 günlük yatırım döngülerini

inceleyen wavelet uyum analizine dayalı DCC-GARCH yaklaşımının sonuçları sunulmuştur.

Tablo: 10
512-1024 Günlük Yatırım Döngülerinde Doğal Gaz ile Paladyum Getirilerine ait DCC-GARCH Modeli Sonuçları

	Katsayılar	Standart Hatalar	t-İstatistikleri	Olasılık Değerleri
Sabit$_1$	3.07973e-10	8.38633e-11	3.67232***	0.0002
Sabit$_2$	9.06864e-09	1.72824e-09	5.24734***	0.0000
α_1	0.12225	0.00483	25.29533***	0.0000
α_2	0.10960	0.00423	25.93016***	0.0000
β_1	0.38561	0.01672	23.06074***	0.0000
β_2	0.40793	0.01821	22.40127***	0.0000
DCC$_\alpha$	0.21476	0.01292	16.62616***	0.0000
DCC$_\beta$	0.78472	0.01299	60.41290***	0.0000

*Not: ***, ** ve * sırasıyla %1, %5 ve %10 güven aralığında istatistiksel anlamlılığı ifade etmektedir.*

Tablo 10'da yer alan bulgular incelendiğinde, doğal gaz ile paladyum getirilerinin α ve β tahminlerinin toplamı 1'den küçük olduğunu ortaya koymaktadır. DCC-GARCH sonucuna dayanarak aynı zamanda 512-1024 günlük yatırım döngülerinde doğal gaz ve paladyum getirileri için α tahminlerin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olması, bu paladyum getiri volatilitesi üzerinde doğal gaz getirilerinin kısa vadeli etkisini göstermektedir. Diğer bir deyişle, doğal gaz getirilerinden paladyum getirilerine doğru kısa vadeli volatilite yayılımı olduğunu göstermektedir. Bunun yanı sıra β tahminin %1 anlamlılık düzeyinde anlamlı olması, doğal gaz getiri volatilitesinin paladyum getiri volatilitesi üzerinde uzun vadeli önemli etkileri olduğunu göstermektedir. Diğer bir ifadeyle, doğal gaz getirilerinden paladyum getirilerine doğru uzun vadeli volatilite yayılım etkisi olduğu bulunmaktadır. Ancak $\alpha + \beta < 1$ katsayı tahminlerinin 1'e oldukça yakın olması, 512-1024 yatırım döngülerinde dinamik korelasyonların sabit bir seviye etrafında dalgalandığını ve ortalamaya dönme eğilimindeki bir sürece sahip olduğunu ortaya koymaktadır. Aynı zamanda, günlük yatırım döngülerinde doğal gaz ile paladyum getirileri için koşullu volatilitenin kalıcı olma ihtimalinin daha yüksek olduğu da söylenebilmektedir. Bu durum, piyasaların getirilerini yavaşça dengede tuttuğu ve şokların yavaşça azaldığını göstermektedir. Dolayısıyla, volatilite ve korelasyon katsayılarının sonuçları, bu piyasalardaki yatırımcıların volatilite şokları sonucunda ani bir kayıpla karşılaşma ihtimalinin daha düşük olduğu ifade edilebilir.

6. Sonuç

Dünya ekonomisindeki artan belirsizlikler ve fiyat dalgalanmaları, yatırımcılar için risk yönetimi ve portföy çeşitlendirmesini kaçınılmaz hale getirmektedir. Risk yönetiminde, değerli metaller gibi türev ürünlerin etkileşimleri, yatırım stratejilerinin belirlenmesinde önemli bir rol oynamaktadır. Literatürde, yatırım getirisini optimize etmek amacıyla portföye dahil edilen düşük korelasyonlu varlıkların, kriz dönemlerinde korelasyonlarının artabileceği sıkça tartışılmaktadır. Bu nedenle, çalışmada enerji emtia ve kıymetli metal piyasalarına ait fiyat getirileri arasındaki volatilite yayılımı wavelet uyum analizine dayalı dinamik koşullu korelasyon yaklaşımı ile incelenmektedir.

Kıymetli metaller, emtia olarak kabul edilmekte olup bu varlıkların spot ticareti, vadeli işlemleri ve yatırım fonları kapsamında alım satımı gerçekleştirilmektedir. Yatırımcılar, hedgerlar, arbitrajcılar, spekülatörler, analistler ve ekonomistler bu işlemleri yapabilmektedir. Altın, gümüş, platin ve paladyum gibi yüksek likiditeye sahip değerli metaller, yatırımcılar ve hedgerlar için çoğunlukla enflasyon ve döviz kuru riskinden korunma sağlayabilmektedir. Ayrıca, bu metaller spekülatörler ve arbitrajcılar tarafından kısa vadeli işlemler için de kullanılmaktadır. Bu bağlamda, kıymetli metallerin fiyat oluşumunu etkileyebilecek her bilgi, yatırımcılar ve diğer ilgili taraflar için büyük önem taşımaktadır Dolayısıyla, araştırmanın önemli katkılarından biri, farklı yatırım döngülerine göre zamanla değişen koşullu korelasyon yaklaşımını kullanarak hem COVID19 pandemisi hem de Rusya-Ukrayna savaşının etkilerini dikkate alarak, enerji emtiaları ile kıymetli metal piyasalarındaki fiyat ve getiri dinamiklerini anlamaya ve bu bilgileri yatırım kararlarında kullanmaya katkı sağlamasıdır.

Wavelet uyum analizi bulgularına göre, Brent petrol getirilerinden altın, gümüş ve platin getirilerine doğru uzun dönemli ve genellikle pozitif bir karşılıklı etkileşim etkisi tespit edilmiştir. Paladyum getirilerinden doğal gaz getirilerine doğru ise yine uzun dönemli bir karşılıklı etkileşim görülmüştür. Belirlenen bu uzun dönemli yatırım döngüleri için uygulanan dinamik koşullu korelasyon analizleri, her bir yatırım döngüsü için koşullu korelasyon ve volatilite kalıcılığına dair bulgular ortaya koymuştur. İki aşamalı analizlerin sonucu değerlendirildiğinde, Brent petrol ile altın, gümüş ve platin getirileri arasında çoğunlukla finansal piyasa kaynaklı uzun dönemli bağımlılığın yanı sıra korelasyon ve volatilite yayılımı olduğu düşüncesi güçlenmektedir. Paladyum ile doğal gaz getirileri arasındaki uzun dönemli bağımlılık, korelasyon ve volatilite yayılımının ise çoğunlukla endüstriyel üretim, arz ve talep kaynaklı olduğu düşüncesini pekiştirmektedir. Ayrıca, paladyumun yatırım aracı olarak değil, daha çok üretim aracı olarak ekonomik konjonktürde yer aldığı ve petrol ile birlikte ekonomik durumu takip ettiği görülmüştür.

COVID19 pandemisi ve Rusya-Ukrayna savaşı nedeniyle küresel ekonomideki belirsizlikler artmış, küresel üretim ve talepte azalma meydana gelmiştir. Makroekonomik riskin artması, yatırımcıları hedge etme yöntemlerini düşünmeye yönlendirmiştir. Bu bağlamda, kriz dönemlerinde menkul kıymetleştirilmiş emtialar, alternatif bir yatırım aracı olarak daha fazla ilgi çekmişlerdir. COVID19 ve Rusya-Ukrayna savaşının petrol ve değerli metaller arasındaki pozitif ilişkiyi güçlendirdiği ve bağımlılığı artırdığı saptanmıştır. Ayrıca, COVID19 pandemisinin petrol kaynaklı volatilite aktarımını değerli metallere doğru güçlendirdiği gözlemlenmiştir. Özellikle altın ve gümüşün, kriz dönemlerinde güvenli bir yatırım aracı özelliği gösterdiği tespit edilmiştir. Öte yandan, platin fiyat getirilerinin petrol fiyat getirileri ile doğrusal ve pozitif bir ilişki içerisinde olduğu tespit edilmiştir. Ewing ve Malik (2013), Mensi vd. (2015), Yaya vd. (2016), Rehman vd. (2018), Zhang vd. (2018), Chen ve Qu (2019) ve Yıldırım vd. (2020) çalışmalarında, benzer şekilde petrol ve değerli metaller arasındaki volatilite yayılımına dair kanıtlar elde etmişlerdir.

Elde edilen bu bulgular, özellikle uzun vadeli yatırım ufkuna sahip yatırımcılar için önem arz etmektedir. Portföylerine enerji ve kıymetli metal varlıklarını dahil etmek isteyen

yatırımcıların, uzun vadeli yatırım ufkunda bu varlıklar arasındaki etkileşim ve yayılım etkilerini dikkate almaları faydalı olacaktır. Bu bağlamda, emtialara dayalı portföy oluşturan yatırımcıların, öncelikle emtia piyasasında yaşanan gelişmeleri yakından takip etmeleri gerekmektedir. Ayrıca, yatırımcıların portföy oluşturma, risk yönetimi ve alım satım işlemlerinde yatırım ufuklarına (kısa, orta ve uzun dönem) bağlı olarak karar almaları uygun olacaktır. Bu araştırmanın, bu yönüyle yatırımcılara ve diğer ilgili taraflara katkı sağlayabileceği düşünülmektedir.

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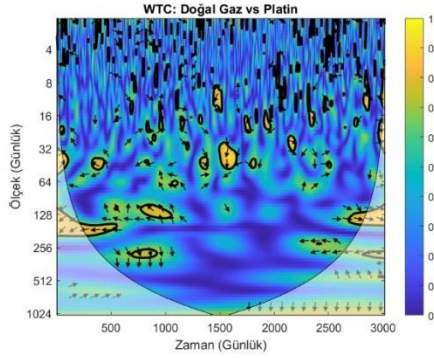
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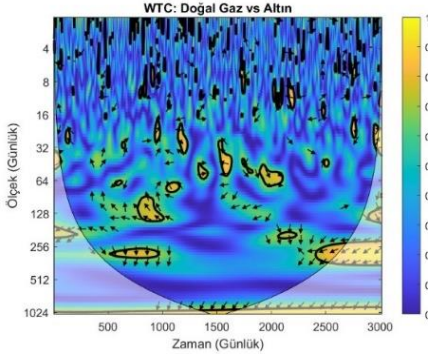
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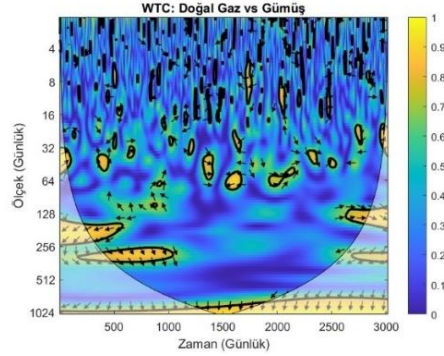
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Wavelet Coherence: Doğal Gaz-Platin

Büyük Verinin Bankacılık Sektöründe Pazarlama Öngörülerinde Kullanımına İlişkin Nitel Bir Araştırma[1]

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A Qualitative Study on the Use of Big Data in Marketing Insights in the Banking Sector[2]

Abstract

This study aims to determine how data obtained from different sources in the banking sector is used for marketing insights targeting customers. The research scope encompasses 38 banks listed on the Banking Regulation and Supervision Agency (BRSA) website, comprising 32 deposit banks and six participation banks. The data was collected through interviews with 20 participants from 13 banks. Descriptive and content analysis methods were used in the analysis process. The study's findings indicate that banks utilise big data for risk management, fraud detection, and customer relationship management. Additionally, banks effectively use all data obtained from internal and external processes to inform marketing insights, encompassing product, price, distribution, promotion, people, physical evidence, and process components.

Keywords   :   Data, Big Data, Banking Sector, Service Marketing, Case Study.

JEL Classification Codes :   G21, M31.

Öz

Çalışmanın amacı, bankacılık sektöründe farklı kaynaklardan elde edilen verilerin, müşterilere yönelik pazarlama öngörülerinde nasıl kullanıldığını belirlemeye çalışmaktır. Araştırma kapsamını, Bankacılık Düzenleme ve Denetleme Kurumu (BDDK)'nın internet sitesinde bulunan 32 mevduat, 6 katılım olmak üzere toplam 38 banka oluşturmaktadır. Veriler, 13 farklı bankadan 20 katılımcıyla gerçekleştirilen görüşmeler aracılığıyla elde edilmiştir. Analiz sürecinde betimsel ve içerik analizi birlikte kullanılmıştır. Çalışmanın sonuçlarında, bankaların büyük veriden risk yönetimi, dolandırıcılık tespiti, müşteri ilişkileri yönetimi gibi konularda faydalandıkları ve bankaların, dâhili ve harici süreçlerden elde ettikleri tüm verileri; ürün, fiyat, dağıtım, tutundurma, insan, fiziksel kanıt ve süreç bileşenlerini pazarlama öngörülerinde etkin bir şekilde kullandıkları tespit edilmiştir.

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1. Giriş

Günümüz teknoloji çağında, bilgisayarlarla birlikte cep telefonlarında bulunan Küresel Konumlama Sistemi (Global Positioning System (GPS), Mobil Elektronik Sistem Entegrasyonu (MOBESE) kameraları ve internet bağlantısı olan diğer cihazlar, giderek daha akıllı hale gelmektedir. Bu cihazlar internete bağlanarak aralarında ağlar oluşturmakta ve özellikle internet uygulamalarıyla sosyal medya platformları, bireylerin günlük yaşamlarının önemli bir kısmını çevrimiçi veya dijital ortamlarda geçirmelerine teşvik etmektedir (Özcan, 2021: 14-15). Bu durum büyük veri (BV) kavramının ortaya çıkmasını sağlamaktadır (Bumblauskas et al., 2017: 4). BV, çeşitli kaynaklardan elde edilen yapılandırılmış ve yapılandırılmamış verilerin, veri bilimcileri veya analistleri tarafından karmaşık sistemlerde analiz edilerek, kullanıcı ihtiyaçları ve gereksinimlerine uygun olarak önce veri tabanına daha sonra bilgiye dönüştürülmesidir (Baran, 2017: 3). Veri tabanı (database), herhangi bir konuda birbirleri ile ilişkili verilerin sistematik olarak oluşturduğu yapılardır (Başar & Aslay, 2010: 333).

Çalışmanın kapsadığı bankacılık sektöründe; şubeler, ATM'ler, çağrı merkezleri, teknolojinin gelişmesiyle birlikte ortaya çıkan akıllı telefonlar, tabletler, bilgisayarlar, internet ve mobil bankacılık işlemleri gibi çok çeşitli kanallardan, çok hızlı ve çok büyük boyutlarda veriler elde edilmektedir. Ayrıca bankalar müşterilerine ait daha çok veri elde edebilmek için konum, operatör, sosyal medya platformları gibi dış kaynaklı verileri de kullanabilmektedir.

Bankaların dijital bir şekilde gelişen iş ortamlarında faaliyet gösterebilmeleri için BV'yi benimsemesi ve mevcut iş süreçlerine dahil etmesi bir zorunluluk olarak görülmektedir (Fedak, 2018). BV'yi benimseyip stratejilerinin bir parçası olarak gören bankalar, rekabet üstünlüğü kazanmada, düzenlemelere daha iyi uyum sağlamada, dolandırıcılığı önceden tespit edip önlemede, müşteri davranışlarını belirlemede ve satışlarını artırmada daha avantajlı hale gelebilmektedir (Shukla, 2018). Müşterilerinin her türlü hareketini izleyen, kaydeden, tahlil eden ve anlamaya çalışarak bir değer oluşturabilen ve böylece ticari menfaat elde edebilen işletmeler rekabet üstünlüğü sağlayabilmektedir. Bankaların ellerinde bulundurdukları veriyi işleyerek bir değer üretme noktasında başarılı olma şansları fazladır.

Web of Science ve SCOPUS veri tabanlarında gerçekleştirilen mevcut literatür taraması sonucunda, bankacılık ve finans sektöründe BV'nin incelendiği çeşitli akademik çalışmalara rastlanmıştır. Ancak, bankacılık sektöründe BV'nin özellikle pazarlama öngörülerinde nasıl kullanıldığına dair kapsamlı bir çalışmanın bulunmadığı tespit edilmiştir. Bu durum, BV'nin bankacılık sektöründeki pazarlama stratejilerine etkisini inceleyen akademik çalışmaların sınırlı olduğunu ve bu alanda araştırma boşluğunun

bulunduğunu göstermektedir. Bu kapsamda çalışmanın amacı, bankacılık sektöründe çeşitli kaynaklardan elde edilen yapılandırılmış ve yapılandırılmamış verilerin, müşterilere yönelik pazarlama uygulamalarında nasıl kullanıldığını belirlemeye çalışmaktır. Bu amaca bağlı olarak çalışmanın önemi, bankaların elde ettikleri bu verileri kullanarak hem kendileri hem de müşterileri için nasıl katma değer oluşturabilecekleri konusunda farkındalık oluşturma aşamasında ortaya çıkmaktadır.

Bu çalışmada, bankacılık sektöründe BV'nin banka ve müşteriler açısından nasıl bir değere dönüştürüldüğünü anlamak amacıyla nitel araştırma yöntemlerinden faydalanılmıştır. Nitel araştırma yöntemleri, literatürde mevcut bilgileri kullanmak yerine araştırmacının konuyu keşfetmesini sağlamaktadır (Creswell, 2015: 47-48). Araştırmada, veri toplama aracı olarak bireylerin algı ve anlayışlarını derinlemesine incelemeye olanak tanıyan görüşme tekniği tercih edilmiştir.

Görüşmeler sonucunda katılımcılardan elde edilen verilerin analizinde betimsel ve içerik analizi yöntemleri bir arada kullanılmıştır. Betimsel analiz, araştırma kapsamında önceden belirlenmiş kavramsal çerçeveye dayalı yüzeysel bir inceleme sağlarken, içerik analizi daha derin bir yaklaşımla henüz tanımlanmamış kavramsal boyutların keşfedilmesine de imkân tanımaktadır (Yıldırım & Şimşek, 2016: 223). Her iki yöntemin kullanılmasının nedeni betimsel analizin daha yüzeysel olup kavramsal çerçevenin belli olduğu araştırmalarda kullanılması, içerik analizinin ise daha derinlemesine olup önceden belli olmayan kavramsal çerçeve boyutlarının belirlemesinde kullanılmasıdır.

Çalışmanın amacı ve önemine de paralel olarak, bankaların elde ettikleri verileri işleyerek yeni bir ürün oluşturma veya mevcut bir ürünle ilgili karar verme süreçlerinde BV'den faydalanabilecekleri düşünülmektedir. Bu verilerin, ürünlerin hangi fiyattan ve kimlere sunulması gerektiği ve ATM ile şube yerleri için en uygun konumun belirlenmesi gibi konularda bankalara rehberlik edeceği düşünülmektedir. Ayrıca, bankaların müşteri memnuniyetini sağlamak için gerekli adımları belirlemede, banka çalışanlarının müşterilere en uygun şekilde davranmalarını sağlamada, müşterilerin işlemlerini rahat ve kolay bir şekilde gerçekleştirmeleri için hem fiziksel koşulların hem de işlem süreçlerinin geliştirilmesinde BV kullanımının yol gösterici olacağı öngörülmektedir.

2. Kavramsal Çerçeve

2.1. Büyük Veri Kavramı ve Bileşenleri

Teknoloji kullanımının artmasıyla birlikte, işletme, sağlık, politika, finans, tarım, güvenlik ve daha birçok alanda, elde edilen verilerin boyutu giderek artmakta ve bu veriler BV olarak adlandırılmaktadır (Anshari et al., 2018: 2). BV, Manyika vd. (2011: 1); Ohlhorst (2013: 1); Anshari vd. (2018: 95) ve Narayanan (2014: 2) tarafından *"Geleneksel(klasik) yöntemlerin (bilgisayar, yerel disk ve harici disk) veri toplama, saklama, yönetme ve analiz etme konularında yetersiz kaldığı, büyük boyuttaki veri kümeleri olarak tanımlanmaktadır. Verilerin toplanması, saklanması, yönetilmesi ve analiz edilmesi konularında, geleneksel yöntemlerin (bilgisayar, yerel disk ve harici disk) yetersiz kalmasına neden olan boyuttaki*

veri kümeleri" olarak tanımlamaktadır. Davenport (2014: 10) ise BV'yi "*Metin, video ve ses gibi yapılandırılmamış formatta bulunan ve sürekli akan 100 terabayttan 1 petabayta kadar olan büyük hacimli verilerin yönetilmesi ve analiz edilmesini mümkün kılan teknolojiler*" olarak ifade etmektedir.

Günümüzde, verilerin hızlı bir şekilde toplanması ve işlenmesi, işletmelerin stratejik kararlar alırken daha doğru ve verimli analizler yapabilmesine olanak tanımaktadır. Bu noktada, BV teknolojisi, işletmelerin karar alma süreçlerini hızlandırmak ve stratejik planlamaları daha etkin bir şekilde gerçekleştirmek için kritik bir rol oynamaktadır. BV teknolojileri, yalnızca yapılandırılmış verilerle değil, aynı zamanda yapılandırılmamış verilerle de ilgilenmektedir. Veri ambarı (Data Warehouse), BV kavramının bir parçası olarak, işletmelerin karar verme süreçlerini hızlandırmayı hedeflemektedir. Veri ambarı, farklı kaynaklardan toplanan verilerin bir araya getirildiği, organize edildiği ve analiz için uygun hale getirildiği merkezi bir veri deposu olarak tanımlanmaktadır. Bu yapı, işletmelere veriye dayalı kararlar alma ve stratejik planlamalar yapma konusunda önemli avantajlar sunmaktadır (Tonkunaite et al., 2006: 106). Ancak, veri ambarı, esas olarak yapılandırılmış verilerle ilgilenirken, BV analitiği yapılandırılmış verilerle birlikte video, ses, metin gibi yapılandırılmamış verileri de işleyerek anlamlı bilgilere ulaşmayı amaçlamaktadır. BV, işletmelerin daha hızlı ve doğru kararlar alabilmelerini sağlarken, veri ambarları da bu verilerin merkezi bir depoda toplanmasını ve düzenli bir şekilde analiz edilmesini mümkün kılmaktadır (Aktan, 2018: 3).

Şekil: 1
Büyük Veri Bileşenleri
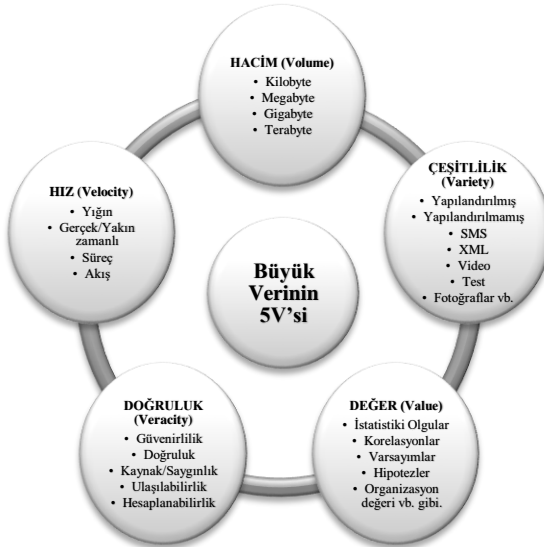
Kaynak: Wagar, 2017: 3.

Şekil 1'de görüldüğü üzere BV; hacim (Volume), hız (Velocity), çeşitlilik (Variety), değer (Value) ve doğruluk (Veracity) olmak üzere, 5 bileşenden (5V) oluşmaktadır (Baran, 2017: 15).

Hacim; işletmeler tarafından depolanan yapılandırılmış veya yapılandırılmamış şekillerde, bazen terabayt bazen de petabayt olarak verilerin büyüklüğünü ifade etmek için kullanılan bir kavramken (Arnaboldi et al., 2017: 3-4), *hız;* sürekli hareket halinde olan verilerin üretildiği hızı ifade etmektedir. *Çeşitlilik;* verilerin elde edilme türlerinde ve kaynaklarında farklı yapıların olduğu (Hoy & Brigham, 2014: 3), *değer* ise elde edilen büyük boyutlardaki verilerin, işlenerek nasıl ekonomik fayda sağlandığı konusuyla ilgilenmektedir. Son olarak *doğruluk*, belirli veri türleriyle olan ilişkilerin güvenirlik düzeyini belirleyerek, bu verilerin temin edildiği kaynakların ne kadar güvenilir olduğu konusu üzerinde durmaktadır (Gandomi & Haider, 2015: 139).

2.2. Bankacılık Sektöründe Büyük Veri Kaynakları

Akıllı telefonlar, bilgisayarlar, tabletler, sensörler, tıbbi cihazlar, web akışları ve sosyal medya etkileşimleri gibi teknolojilerden elde edilen veriler, eczacılık, meteoroloji ve simülasyon gibi alanlarda çözümler sunarak, bilimsel araştırmalardan ortaya çıkan kaynaklarla birlikte BV kapsamında değerlendirilmektedir (Aktan, 2018: 6).

BV kaynaklarının en önemlisi internet olup, üretilen verilerin büyük bir kısmı internet aracılığıyla ortaya çıkmaktadır. İnternet kaynaklı verilere örnek olarak; mesajlar, e-postalar, paylaşılan fotoğraflar, beğeniler, yorumlar, arama motoru sorguları, çevrimiçi oyunlar, web akışları, çevrimiçi alışverişler, hastane randevuları, internet ve mobil bankacılık işlemleri ile uçak rezervasyonları gibi birçok kanaldan elde edilen veriler gösterilebilir (Snijders et al., 2012: 3).

Bankacılık sektöründe, müşterilerin gerçekleştirdiği işlemler sonucunda farklı kaynaklardan hızlı bir şekilde büyük miktarda yapılandırılmış ve yapılandırılmamış veri üretilmektedir (Shukla, 2018). Bu veriler, bankalar tarafından yasal gereklilikler, güvenlik öncelikleri ve analiz ihtiyaçları doğrultusunda kaydedilerek BV sistemine katkı sağlamaktadır. Bankaların topladığı verilerin önemli bir kısmı, müşterilere ait bilgileri ve onların gerçekleştirdiği işlemlere dair detayları içermektedir. Örneğin, bir işlemin hangi müşteri tarafından, hangi kanal aracılığıyla, hangi tarihte ve saatte gerçekleştirildiği; kullanılan sunucunun donanım ve yazılım bilgileri; işlemin başarı durumu ya da oluşan hatalar gibi bilgiler sistemde kayıt altına alınmaktadır (Kuş-Khalilov & Gündebahar, 2014: 2).

Ayrıca, çağrı merkezlerinde müşterilerle yapılan görüşmeler, ATM üzerinden gerçekleştirilen işlemler ve kurum içindeki alanların kameralarla izlenmesi gibi kaynaklardan da veri toplanmaktadır. Bununla birlikte, görüntülü işlemler sunan alternatif dağıtım kanallarında kayıt altına alınan görüntüler de bu veri havuzuna dahil edilmektedir. Ek olarak, çalışanların giriş-çıkış saatlerini gösteren loglar, dosya sistemi ve internet erişim

kayıtları, gönderilen e-postalar, donanım ve sistem logları, mobil uygulamalar üzerinden toplanan veriler ve sosyal medya platformlarındaki etkileşimler de bankacılık sektöründe BV kapsamına girmektedir (Shukla, 2018). Şekil 2'de bankaların dahili ve harici süreçlerde elde ettikleri veri kaynaklarına yer verilmektedir.

Şekil: 2
Bankacılık Sektöründe Büyük Veri Kaynakları
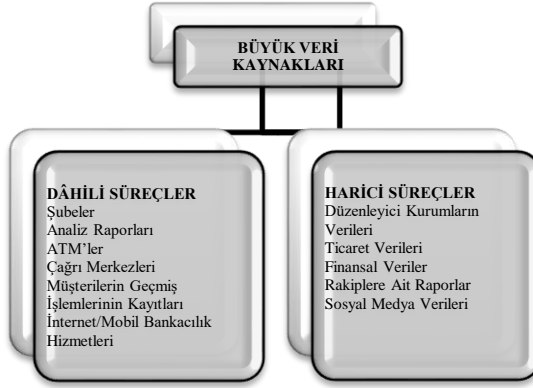
Kaynak: Dvorski Lackovic et al., 2016: 51.

Bankacılık sektöründe BV, dâhili ve harici süreçlerden elde edilen geniş bir veri yelpazesini içermektedir. Dâhili veriler, şube işlemleri, analiz raporları, ATM kayıtları, çağrı merkezi verileri ve müşteri işlem geçmişi gibi bankanın kendi operasyonlarından elde edilen bilgileri kapsamaktadır. Ayrıca, internet ve mobil bankacılık platformlarından sağlanan kullanıcı verileri de BV'nin önemli bileşenleri olarak görülmektedir (Vural vd., 2019: 76).

Harici veriler ise; düzenleyici kurumlar, ticaret ve finansal veriler, rakip analiz raporları ve sosyal medya etkileşimlerinden elde edilmektedir. Bu veriler, bankaların daha bilinçli kararlar almasını sağlayarak hizmetlerini geliştirmelerine katkıda bulunmaktadır. BV'nin etkin analizi, sektörde rekabet avantajı sağlamak ve müşteri deneyimini iyileştirmek açısından kritik bir rol oynamaktadır.

2.3. Bankacılık Sektöründe Pazarlama Karması Bileşenleri

Genel olarak, işletmeler hedeflerine ulaşabilmek için bünyelerinde kontrol edebildikleri faktörlerden oluşan çeşitli kaynaklar kullanmaya ihtiyaç duymaktadır. Pazarlama biliminde, işletmelerin kullandıkları bu faktörlere pazarlama karması adı verilmektedir (Ocak, 2011: 20). Kotler (2000: 9) pazarlama karmasını, "*İşletmelerin hedef pazara yönelik amaçlarını gerçekleştirmek için kullandıkları pazarlama araçları*" olarak tanımlamaktadır.

Geleneksel pazarlama karması bileşenleri; ürün (Product), fiyat (Price), tutundurma (Promotion) ve dağıtımdan (Place) (4P) oluşmaktadır. Geleneksel pazarlama karmasının sadece ürünlere yönelik geliştirilmesi nedeniyle, hizmet pazarlaması kapsamında yapılan araştırmalarda yetersiz kaldığı yönündeki eleştiriler (Goi, 2009: 3-4) sonucunda 4P'ye insan (People), fiziksel kanıtlar (Physical evidence) ve süreç (Process) olmak üzere 3 bileşen daha eklenmiş ve yeni karmaya Genişletilmiş Pazarlama Karması, kısaca 7P denilmiştir (Turna, 2015: 53).

İşletmeler gerçekleştirmek istedikleri pazarlama faaliyetlerine, *"ürün"* bileşeni ile başlamakta ve diğer pazarlama karması bileşenleri hakkında neler yapabileceklerini belirlenen ürüne göre planlamaktadır (Sezgin & Şendoğdu, 2008: 90). Bankacılık sektöründe ürün; borç verme, yatırma ve aktarma gibi farklı tür ve nitelikteki nakit ile ilgili bankacılık hizmetleri olarak ifade edilmektedir (Tidke, 2017: 130).

Fiyat; kârlılığı belirleyen bir bileşen olduğu için (Kozak vd., 2011: 85), işletmeler tarafından pazarlama karmasının en önemli bileşeni olarak görülmektedir (Cetina & Mihail, 2007: 27). Bankacılık sektöründe fiyat, *"Müşterilere sunulan hizmetlerin karşılığında alınan faiz, komisyon, işlem masrafları ve diğer hizmetlere karşı alınan bedeller"* olarak tanımlanmaktadır (Yapraklı & Erdal, 2015: 484).

Tutundurma; müşterilere ve piyasaya bilgi verilmesi, müşterilerin ikna edilmesi ve sunulan mal ve hizmetlerin tercih edilmesi için bankalar tarafından gerçekleştirilen faaliyetlerin tümü olarak ifade edilmektedir (Gümüş, 2014: 228).

Dağıtım; işletmelerin hizmetlerini müşterilere sunabilmeleri için fiziksel çevrelerin varlığı, olarak değerlendirilmektedir. Bankaların müşterilerine hizmet sunduğu dağıtım kanalları; şubeler, telefon bankacılığı, internet bankacılığı, otomatik vezne makineleri (Automated Teller Machine (ATM)) olarak sıralanmaktadır.

Hizmet işletmelerinde müşterilere sunulan hizmeti, insan bileşeninden ayırmak mümkün olmamaktadır. İşletmelerin diğer işletmelere karşı rekabet avantajı kazanması ve farklılaşması, çalışanların müşteriye hizmeti sunma biçimine bağlı olmakta, hizmetin kalitesi çalışanların performansına göre değerlendirilmektedir (Hossain et al., 2020: 365-366).

Fiziksel Çevre; hizmetlerin ulaştırıldığı, işletme çalışanları ile tüketicilerin karşılıklı iletişimde bulunduğu ve sunulan hizmetlerin performansını kolaylaştıran, dokunulabilir / hissedilebilir / görülebilir özelliklere sahip ortamlar olarak değerlendirilmektedir (Öztürk, 1998: 22).

Süreç; hizmetlerin mimari yapısı olarak görülmekte (Yapraklı & Erdal, 2015: 486) ve hizmetlerin müşteriye ulaştırılmasındaki tüm işlemleri, görevleri, programları, mekanizmaları, aktiviteleri ve yöntemleri kapsamaktadır (Aligil, 2010: 34-35). İşletmelerde müşterilerin geçtiği süreçler, pazarda güçlü bir konum elde etmek ve müşterilere kaliteli hizmet sağlamak üzere hızlı, güvenilir ve kolay olmalıdır (Duraichamy & Prasad, 2016: 85).

2.4. Literatürde Bankacılık Sektöründe Büyük Veri'nin Kullanımı ile ilgili Yapılan Çalışmalar

Literatür taraması sonucunda bankacılık ve finans sektöründe BV'nin araştırıldığı çalışmalar bulunmakla birlikte bankacılık sektöründe BV'nin pazarlama öngörülerinde kullanılması ile ilgili Türkçe literatürde araştırmacının olanakları dâhilinde ulaştığı veri tabanlarında herhangi bir çalışmaya rastlanılmamıştır. İlerleyen kısımlarda literatür taraması sonucunda bankacılık ve finans sektöründe BV'nin araştırıldığı çalışmalara ve çalışmaların sonuçlarına değinilmektedir.

Bankacılık ve finans sektöründe BV'nin nasıl ve hangi konularda kullanıldığını ortaya çıkarmak amacıyla Schroeck vd. (2011) tarafından yapılan çalışmada, veriler IBM (International Business Machines) İş Değerleri Enstitüsü ve Oxford Üniversitesi Said İş Okulu'nun işbirliği ile 95 ülkede, 1144 iş ve BT (Bilgi Teknolojileri) uzmanına uygulanan anketler aracılığıyla elde edilmiştir. Çalışmanın sonuçlarına göre, katılımcıların %71'i rekabet üstünlüğü sağlamak için BV'den faydalanmanın önemli olduğunu düşünmektedir. Rekabet üstünlüğü sağlamak için işletmelerin BV'yi benimsemesi gerektiği sonucuna ulaşılan bir diğer çalışma ise Kaya ve Akbulut (2018)'a aittir. Bu çalışmada, muhasebe ve finansal raporlama alanında BV analizlerinin etkisini araştırmak amacıyla farklı endüstrilerdeki muhasebe uzmanlarıyla derinlemesine görüşmeler gerçekleştirilmiştir.

Orka (2017) yüksek lisans tez çalışmasında, bulut bilişim ve BV teknolojilerinin kamu ve özel sektördeki kullanım alanlarını ve bu teknolojilerin müşteri ilişkileri yönetimi ve pazarlama stratejilerinin belirlenmesindeki etkilerini ortaya çıkarmayı amaçlamaktadır. Nitel veri toplama yöntemlerinden görüşme tekniği kullanılarak elde edilen çalışmanın sonuçlarında, işletmelerin mevcut durumlarını, pazarlama stratejilerini ve ileriye dönük planlarını yaparken BV'den faydalandıkları ortaya çıkarılmıştır. Benzer sonuçları içeren bir diğer çalışma ise; Delgosha vd. (2021) tarafından yapılmıştır. Bankalarda BV analitiğinin uygulanmasındaki itici güçleri ve karşılaşılan temel zorlukları anlamak ve öncelendirmek amacıyla yapılan bu çalışmanın sonuçlarında BV'yi uygulamak için itici gücün, bankaların karar verme süreçlerinde ve yeni ürün geliştirme aşamalarında ortaya çıktığı belirlenmiştir.

Kara (2018) tarafından bankaların BT bölümlerinde görev alan yönetici ve çalışanların, BV algılarını ve BV'nin stratejik yönetim süreçlerine olan katkısını anlamak amacıyla yapılan yüksek lisans tez çalışmasında, veriler nitel araştırma yöntemlerinden görüşme tekniği kullanılarak elde edilmiştir. Çalışmanın sonuçlarında; bankacılık sektöründe BV'nin henüz uzun vadeli hedefler için kullanılmadığı sonucuna ulaşılmıştır. Al-Dmour vd. (2021) tarafından Ürdün'de faaliyet gösteren ticari bankaların BV analitiği uygulamalarında ve banka performansını incelenmesi amacıyla yapılan çalışmada ise bankaların BV uygulamalarının orta düzeyde (%60) etkileyen faktörlerin olduğu sonucuna ulaşılmıştır.

Bankalarda işlem çeşitliliği ve karşı karşıya kalınan durumlar çok çeşitli olduğu için BV'nin kullanım konuları da çeşitlilik göstermektedir. Bu durumu en iyi özetleyen çalışma

Kuş Khalilov ve Gündebahar (2014) tarafından yapılan yapılmıştır. Bir literatür taraması olarak yürütülen çalışmada, bankacılık sektöründe BV uygulamalarının açıklamaları incelenmiştir. Bu çalışmanın sonuçlarına göre, pazarlama alanında sosyal medya verilerinin kullanımı, müşteri memnuniyetinin sağlanması, çağrı merkezi görüşme kayıtlarının analizi, dolandırıcılık tespiti, pazarlama tahminleri, operasyonel verimliliğin artırılması, verilerin saklanılması ve güvenliğin sağlanması gibi konularda BV'den faydalanılabileceği ortaya çıkarılmıştır. Çalışmanın sonuçlarında yer alan müşteri memnuniyetinin ve güvenliğin sağlanması için BV'den faydalanılabileceği konusu Srivastava ve Gopalkrishnan (2015) tarafından 2008 krizinden sonra Hint bankalarının yaşadıkları sorunlarda BV'den nasıl faydalandıklarının belirlenmesi amacıyla yapılan çalışmanın sonuçlarında da elde edilmiştir. Çalışmada Orta Doğu'daki bir bankanın, 2011 yılından itibaren müşterilerinden gelen yaklaşık 20.000 kayıtlı geri bildirim verisi kullanılmıştır. Bu çalışmanın sonuçlarına göre, bankacılık sektöründe BV, hem iç hem dış müşterilere daha iyi hizmet sunmak ve güvenlik sistemlerini geliştirmek gibi çeşitli alanlarda kullanıldığı ortaya çıkarılmıştır. BV'nin bankalarda güvenlik konusunda kullanıldığı literatürdeki bazı çalışmalarda görülmektedir. Hasan vd. (2021) tarafından bir literatür taramasına yönelik yapılan araştırmada, güvenlik konusunda BV'den faydalanılmasının banka faaliyetlerini olumlu yönde etkilediği belirtilmiştir. Bu çalışmada, BV'nin bankacılık operasyonları üzerindeki etkileri Web of Science ve SCOPUS veri tabanlarında yer alan mevcut literatür araştırmalarının analizi yapılarak incelenmiştir.

3. Yöntem

Bankacılık sektöründe hızlı bir şekilde, çeşitli kaynaklardan elde edilen verilerin müşteri ve bankalar için nasıl bir değere dönüştürüldüğünün belirlenmek istenmesi, bu çalışmada nitel araştırma yöntemlerinden faydalanılmasının temel nedenini oluşturmaktadır. Nitel araştırma yöntemleri, yapısı gereği yeniliklere, değişime, sosyal olgu ve olayların derinlemesine araştırılmasına ve ihtiyaç sahiplerine gerekli olan derin bilgiyi sunmayı amaçlamaktadır (Güçlü, 2021: 41-42). Ayrıca, teknoloji kullanımının giderek artmasıyla birlikte elde edilen çok büyük boyutlarda verilerin oluşması BV farkındalığını artırmakta (Anshari et al., 2018: 2) ve ülkemizde bu konu birçok araştırmacı ve işletme açısından önem kazanmaktadır (Koltan-Yılmaz, 2021: 44). Bu kapsamda konunun güncelliği ve yapılan literatür taraması sonucunda BV'nin bankacılıktaki pazarlama öngörülerinde (uygulamalarında) nasıl kullanıldığının araştırıldığı bir çalışmaya taranılan veri tabanları kapsamında rastlanılmaması, çalışmada nitel araştırma yöntemlerinden faydalanılmasının diğer nedenleri arasında yer almaktadır. Ayrıca, araştırmada karmaşık konuların keşfedilmesi ve belirli olgular veya durumlar hakkında iç görüler oluşturulması hedeflendiği için, araştırma deseninin durum çalışması üzerine kurgulanması uygun görülmüştür.

3.1. Araştırmanın Evren ve Örneklemi

Çalışmanın kapsamını, Türkiye'deki kuruluşların faaliyetlerini güvenli ve sağlam bir şekilde gerçekleştirmelerini, kredi sisteminin etkin bir şekilde işlemesini, tasarruf sahiplerinin hak ve menfaatlerinin korunmasını sağlamak amacıyla kurulmuş olan

Bankacılık Düzenleme ve Denetleme Kurumu'nun (BDDK) internet sitesinde yer alan bankalar oluşturmaktadır. BDDK'nın internet sitesinde, mevduat, kalkınma ve yatırım, katılım bankaları ve Tasarruf Mevduatı Sigorta Fonu (TMSF) bünyesindeki bankalar olmak üzere dört banka grubu bulunmaktadır (BDDK, 2021). Çalışmada, bireysel müşteri verilerinin pazarlama uygulamalarında nasıl kullanıldığının belirlenmek istenmesi amacıyla, bu dört banka grubundan sadece mevduat ve katılım bankaları dikkate alınarak çalışma yürütülmüştür.

Bu çalışmada, nitel verilerin elde edildiği bir çok araştırmada da tercih edilen amaçlı örnekleme tekniğine başvurulmuştur. Bu teknikte katılımcılar, araştırma sorusuyla ilgili önceden belirlenmiş kriterlere göre gruplandırılmakta ve örneklem büyüklüğü, veri toplama sırasında, araştırma sorularına ek olarak yeni iç görüler sağlanamadığı noktada sonlandırılmaktadır (Mack et al., 2005: 6). Çalışmanın amacına ulaşmayı sağlayacak örneklem, bankacılık sektöründe mevduat ve katılım bankalarında çalışmakta olan ve BV süreçleri konusunda sorumlu ve/veya bilgi sahibi olan kişilerden oluşmaktadır.

Görüşmeler sırasında, örneklem sayısını belirlemek için katılımcılara bulundukları bankada BV konusuyla ilgili çalışan kişi sayısı sorulmuştur. Ancak bankaların bilgi gizliliği politikaları nedeniyle, bu konuda bilgi alınamamıştır. Sonuç olarak, çalışmanın amacına uygun kişilerle görüşüldüğü düşünülerek, toplamda yirmi (20) kişiyle çalışma yürütülmüştür.

3.2. Araştırmanın Veri Toplama Araçları

Bu çalışmada, nitel araştırma yöntemlerinden en yaygın kullanılan derinlemesine görüşme tekniğinden faydalanılmıştır. Derinlemesine görüşme tekniğinin tercih edilme nedeni, bankacılık sektöründe BV'nin pazarlama uygulamalarında nasıl kullanıldığıyla ilgili detaylı veri toplanması için en uygun yöntemin görüşme olduğunun düşünülmesidir. Bu çerçevede, bankalarda çalışan, konu hakkında bilgi sahibi olan, bu süreçleri yöneten kişilerle gerçekleştirilen derinlemesine görüşmelerde, BV konusuna ilişkin algıları, anlama seviyeleri, bankalarında yapılan ve yapılması düşünülen uygulamalar hakkındaki düşünceleri ele alınmıştır.

Çalışma kapsamında ilk görüşme 7 Haziran 2021, son görüşme ise 25 Ocak 2022 tarihinde gerçekleştirilmiştir. Derinlemesine gerçekleştirilen yarı yapılandırılmış görüşmeler genellikle araştırmacı ile katılımcı arasında diyalog şeklinde gelişmekte ve görüşme süresi otuz dakikadan birkaç saate kadar sürebilmektedir (DiCicco-Bloom & Crabtree, 2006: 315). Bu çalışmada görüşmeler ortalama 51-52 dakika olarak gerçekleştirilmiştir. Görüşmelerde katılımcıların uzmanlığı, elde edilen verilerin kalitesine katkısı bulunmaktadır. Bu nedenle görüşülen kişilerin, araştırılan konunun uzmanı ya da o konuda karar verici nitelikte olmaları beklenmektedir (Baş & Akturan, 2008: 112). Bu araştırmada teknolojinin neden olduğu BV ile ilgili en doğru ve en kaliteli bilginin bankaların Bilişim Teknolojileri (BT) bölümünde, veri konusu ile ilgili çalışanlardan elde edileceği düşünülmüştür. Bu kapsamda, 4 Veri Bilimcisi, Veri Mühendisi, BV Yazılım

Uzmanı, Pazarlama Analisti, BT Müfettişi, Pazarlama Analitiği Müdürü, Veri ve İleri Analitik'ten Sorumlu Genel Müdür Yardımcısı, Müşteri Deneyimi ve Yönetimi Başkanlığı Uygulama Geliştirme Direktörü, Veri Ambarı ve İş Zekâsı Uygulamaları Müdürü, Veri Yönetimi Bölümü Birim Müdürü, Veri Yönetimi Bölümü Müdür Yardımcısı, BT Kıdemli Uzman, BT Veri Yönetimi Bölüm Lideri, Perakende Bankacılık Analitik ve Kampanya Yönetimi, Veri Bilim Müdürü, Veri Analitiği, Müşteri Değer Yönetimi ve Politika Genel Müdür Yardımcısı, Yapay Zekâ ve Veri Bilimi Direktörü ile görüşülmüş olup, katılımcıların bankalardaki unvanları gereği araştırılan konunun uzmanı olarak değerlendirilmiştir.

3.3. Araştırma Verilerinin Analizi

Araştırma kapsamında elde edilen veriler, nitel analiz yöntemlerinden betimsel ve içerik analizi birlikte kullanılarak incelenmiştir. Her iki yöntemin tercih edilme nedeni, betimsel analiz yönteminin, kavramsal çerçevenin önceden belirlendiği araştırmalarda verileri temalar doğrultusunda özetleyerek yüzeysel bir inceleme sunması; içerik analizinin ise daha derinlemesine bir inceleme yaparak önceden belirlenmemiş kavramsal çerçeve boyutlarını keşfetmeye olanak tanımasıdır. Betimsel analiz kapsamında, katılımcılardan elde edilen veriler önceden belirlenen temalara göre özetlenerek yorumlanmaktadır (Yıldırım & Şimşek, 2016: 223-240). İçerik analizinde ise araştırmacı, veriler arasındaki kavramsal ilişkileri ortaya koyarak daha derinlemesine bir anlamlandırma yapmayı amaçlamaktadır (Sığrı, 2018: 276).

Betimsel ve içerik analizi yöntemlerinin birlikte kullanıldığı bu çalışmada analize ilk olarak kodlama işlemi ile başlanmıştır. Ses kaydının yazılı ortama aktarılması sonucu elde edilen 155 sayfalık metin elde edilmiştir. Bu şekilde özet bir kod tablosu oluşturulmuş ve bu kodlar öncelikle betimsel analiz yöntemiyle çalışma konusuyla ilgili önceden belirlenmiş kavramsal çerçeve kapsamında kategori ve temalara göre sınıflandırılmıştır. Önceden belirlenen kategori ve temalar dışında kalan kodlar için ise gerekli incelemeler yapılmış ve anlam bütünlüğü bozulmayacak şekilde birbiriyle ilişkili olan kodlar bir araya getirilmeye çalışılmıştır. Bu şekilde betimsel analiz ile farkedilmeyen veya gözden kaçan kategori ve temalara yer verilmiştir. Analizin son aşamasında, tüm kodlar kategoriler altında, kategoriler de temalar altında birbirleriyle ilişkili olacak şekilde birleştirilmiştir. Betimsel ve içerik analizi sonucunda elde edilen 168 kodun 22 kategori altında toplandığı ve bu kategorilerin 6 temel temayı oluşturduğu belirlenmiştir.

4. Bulgular

Bankacılık sektöründe müşteriler tarafından gerçekleştirilen işlemler sonucunda elde edilen verilerin pazarlama öngörülerinde nasıl kullanıldığını belirlemek amacıyla gerçekleştirilen bu çalışmada, elde edilen tema ve kategoriler Şekil 3'te sunulmaktadır.

Şekil 3:
Görüşme Analizinde Elde Edilen Tema ve Kategoriler

Veri Tanımı	Büyük Veri Kullanımı	Büyük Veri Kaynakları	Karşılaşılan Zorluklar	Kullanılan Alanlar	7P Kapsamında Büyük Verinin Kullanımı
• Geleneksel yöntem • Büyük veri	• Kullanım düzeyleri • Kullanan birimler	• Dâhili süreçler • Harici süreçler	• Veri yönetimi • Yasal zorunluluklar • İnsan kaynağı • Diğer karşılaşılan zorluklar	• Müşteri ilişkileri yönetimi • Dolandırıcılık tespiti • Risk yönetimi • Veri yönetimi • Diğer bankacılık işlemleri	• Ürün • Fiyat • Dağıtım • Tutundurma • İnsanlar • Fiziksel kanıtlar • Süreç

4.1. Veri Tanımı

Yapılan analizler sonucunda oluşturulan veri tanımı teması altında geleneksel yöntem ve BV olmak üzere iki kategori elde edilmiştir.

4.1.1. Geleneksel Yöntem

Araştırma kapsamında gerçekleştirilen görüşmeler neticesinde katılımcılar geleneksel yöntemi; geleneksel yöntemlerle işlenen veri, bilgisayar yerel disk ve harici diskler ve veri ambarında depolanan veri olarak tanımlamaktadır.

Katılımcı K, BV'yi tanımlarken veri ambarı kavramına vurgu yapmıştır.

"*Veri ambarı çok büyük bir yapıdır. Veri ambarı çok klasik bir sistemdir. Bankacılık temel sistemlerinden mevduat, kredi, kredi kartı gibi temel yapılardan gelen veriler bizim bankada veri ambarına aktarılmaktadır*" şeklindedir.

Katılımcı L BV'nin tanımına değinirken BV'nin geleneksel yöntem (klasik yöntem) ile aralarındaki ilişkiye yer vermiş ve şu açıklamalarda bulunmuştur. "*Büyük veri tanımı ortaya çıktığı zamandan bu yana sistemler önceden şöyleydi. Bir büyük veri var bir de klasik veri var. Yapısal veri var bir de yapısal olmayan büyük veri var gibiydi. Ama şimdi ikisi de birbirinin avantajını kullanmaya başladılar ve birbiriyle çok içli dışlılar aslında. Yani sistemler birbirlerinden çok izole değiller aslında birbirleri ile daha çok entegre olmaya başladılar*".

4.1.2. Büyük Veri

Katılımcılar BV'yi büyük hacimli, teknoloji gerektiren, geleneksel yöntemlerin yetersiz kalmasına neden olan, depolanabilen, hızlı bir şekilde büyüyen, sürekli gelişen, farklı şekillerde tanımlanan, yapılandırılmış ve yapılandırılmamış verileri kapsayan, tanımının yapılması zor olan, çeşitli kaynaklardan gelen ve değer üretilen veri olarak tanımlamaktadır.

Katılımcı J, BV tanımı konusunda yapılan birbirinden farklı tanımların olması, gelişmiş teknoloji gerektirmesi, geleneksel yöntemlerle işlenemeyen, bünyesinde hem yapılandırılmış hem de yapılandırılmamış verileri bulundurması ve işlenerek değer üretilmesi gibi ifadelere BV tanımı kapsamında yer vermektedir.

Katılımcı M, yaptığı tanımda BV'nin hacmine "*Büyük veri kelimesi itibari ile hacimsel büyüklük ön plana çıkıyor*" şeklinde vurgu yapmaktadır.

Katılımcı C, BV konusunda standart bir tanımın yapılmasının zor olduğuna vurgu yaparak, "*Formal bir tanım yapmak biraz zor. Kurumdan kuruma dahi değişiyor. Bankamızda, klasik sistemlerle çözülemeyen problemleri çözüldüğü alan olarak görüyoruz. İşte nedir bu klasik data baselerdir. Nedir bu klasik tek serverlı sistemde çözülemeyen problemlerdir. Ya da tek uygulamayla çözemediğimiz problemleri dağıtık platformlarda çözebildiğimiz yer olarak görüyoruz büyük veriyi. Formal bir tanım yapmak o kadar kolay değil*" ifadelerine yer vermektedir.

Sonuç olarak BV her sektör, işletme, kurum için farklı şekillerde tanımlanmakta ve BV olarak değerlendirilen verilerin büyüklüğü farklı algılanmaktadır. Daha açık bir ifade ile bir işletme için küçük olan veri başka bir işletme için büyük olabilmektedir. Bu kapsamda çalışma kapsamındaki bankalar verileri depolamak, yönetmek ve işlemek için öncelikle geleneksel yöntemlere başvurmakta, geleneksel yöntemlerin yetersiz kaldığı durumlarda BV'den faydalanmaktadır. BV ile yapılandırılmamış formatta olan veriler yapılandırılmış hale getirilerek, eldeki verilerden anlam çıkarılmakta ve böylece işletmeler hem kendileri hem de kamuoyu için katkı sağlayabilmektedir.

4.2. Büyük Veri Kullanımı

BV kullanımı teması altında kullanım düzeyleri ve kullanan birimler olmak üzere iki kategori elde edilmiştir.

4.2.1. Kullanım Düzeyleri

Bankalarda BV kullanım düzeyleri konusunda yoğun, olgunluk düzeyinde, başlangıç düzeyinde, pilot uygulama aşamasında veya BV'nin kullanılmadığı gibi sonuçlara ulaşılmıştır.

Bankalarında BV'yi yoğun bir şekilde kullandıklarını belirten Katılımcı L, "*Bizdeki büyük verinin gelişimi şöyleydi. Önce bir aşınalık kazanmak istedik. Bu durum 2010'lı yıllara dayanıyor. Ama hızlanması 2015, 2016. Bu zamanlarda hızlanma yaşandı diyebilirim. Ve şimdi de tamamen bizim yoğun kullanım alanlarımız haline gelmeye başladı*" ifadeleri ile konu hakkındaki görüşünü belirtmektedir.

Katılımcı İ, "*Büyük veriden yoğun bir şekilde faydalanıyoruz, iç görüler oluşturuyoruz. Büyük veriyi anlamlandırıyoruz, yani biz bir iç görü oluşturabilmek için*

müşterinin çok çok farklı yerlerde farklı kanallardaki izlerini birleştirebiliyoruz" ifadeleri ile bankalarında BV'den yoğun bir şekilde faydalandıklarını belirtmektedir.

Diğer bir görüş olarak Katılımcı J ise; "*Büyük verinin biraz daha kırılgan bir yapısı var. Şu an için böyle. Olgunluk seviyesinde diyebilirim*" ifadeleri ile bankalarında BV kullanım aşamasının olgunluk düzeyinde olduğunu vurgulamaktadır.

4.2.2. Kullanan Birimler

Bankalarda pazarlama, bireysel müşteri ilişkileri, operasyon, bilişim teknolojileri, risk yönetimi gibi birden fazla birim bulunmaktadır. Bu birimler kendi içlerinde BV'den faydalanmaktadır. Örneğin, bankanın operasyon birimi BV'den faydalanırken, pazarlama birimi de kendi içinde BV'den yararlanmaktadır. Bu kapsamda görüşülen bireyler BV'yi kullanan birimler olarak, tüm birimlerin, operasyonun, bankaların tüm alt yapısının ve yapay zekâ alt yapısının dâhil olduğu farklı birimler tarafından kullanıldığını belirtmektedir.

Bankaların tüm alt yapısında BV'nin kullanıldığına vurgu yapan Katılımcı M, "*Yani açık söyleyeyim kullanmadığımız alan yok. En çok diye bir şey de yok. Herkes kendine göre full performans bunu kullanmaya çalışıyor. Hizmet birimi olarak yani müşteri birimi de bunu kullanıyor, pazarlama birimi de kullanıyor, ticari birimler de bunu kullanıyor, bankada ne kadar birim varsa, risk yönetimi özellikle çok aktif kullanıyor, yani biz müşteriye hitap eden kısımda gayet iyi kullanıyoruz diye düşünüyorum*" ifadelerine yer vermektedir.

Bu bulgular, bankalarda tüm birimler tarafından ihtiyaç halinde BV'den faydalanıldığını ortaya koymaktadır.

4.3. Büyük Veri Kaynakları

BV kaynakları teması altında dâhili süreçler ve harici olmak üzere iki kategori elde edilmiştir.

4.3.1. Dâhili Süreçler

Bankaların iç süreçlerinde elde ettikleri veriler, dahili süreçler olarak tanımlanmaktadır. Bu veriler, geçmiş işlem kayıtları, web ve mobil bankacılık hizmetleri, mobil bankacılık faaliyetleri, kişisel bilgiler, ATM ve şube işlemleri, çağrı merkezleri görüşme kayıtları, şikayetler, ses ve e-posta kayıtları, talimatlar, görsel veriler ve arşivler gibi çeşitli kaynaklardan elde edilmektedir. Müşteriler bankalara dokundukları her an arkalarında bir veri bırakmakta ve bu verileri bankalar BV kapsamında değerlendirerek işleyebilmektedir.

Konuyu Katılımcı Ö, "*Veri birçok kanaldan oluşuyor. Örneğin mobil bankacılık kullanılıyorsa mobil bankacılık veriyi oluşturuyor, ATM kullanılıyorsa ATM veri oluşturuyor, şubeye geldiğinde şubede veri oluşturuyor, yine müşteri hiçbir şey yapmasa bile kendi kendine de veri oluşur. Örneğin son ödeme tarihi geçmiştir, müşteri gecikmeye*

düşer, hiçbir şey yapmamıştır ama bir veri oluşur orada. Daha sonra bu veriler bankanın database havuzunda beslenir. İşlenerek beslenir. Ayrıca şu da kullanılıyor. Müşteriler EFT yapmak için özellikle şirketler bize faks çekiyorlar veya e-mail atıyorlar. O attıkları faksları, e-mailleri işliyoruz. Mesela diyoruz ki bu gelen e-mail bir EFT talimatıdır müşteri şu şirkete şu kadar para göndermek istiyor diye onu işliyoruz" şeklindeki ifadeleri ile açıklamaktadır.

Katılımcı G ise "*Müşterinin izin verdiği bütün datayı işleyebiliyoruz. Bunlar bizim ulaştığımız bütün kanallarda olabilir çağrı merkezi, şube, telefon, internet, ATM, mobil ve benzeri gibi*" ifadeleri ile müşterilerinin izni dâhilinde olan her türlü veriyi kullandıklarını belirtmektedir.

Bankaların müşteriler tarafından şubede veya internet ortamında gerçekleştirilen tüm bankacılık işlemlerine ait verileri depoladığı ve bu verileri ihtiyaçlarına göre süreçlerinde kullandıkları tespit edilmektedir.

4.3.2. Harici Süreçler

Bankaların dış kaynaklardan da elde edebildikleri veriler bulunmaktadır. Bu veriler, müşteri konum verileri, telefon operatör verileri, Kredi Kayıt Bürosu (KKB) verileri, Kişisel Verilerin Korunması Kanunu (KVKK) kapsamında elde edilen veriler, sosyal medya verileri, diğer bankaların verileri, metinler, anlık veri akışıyla elde edilen veriler, finansal veriler ve Türkiye İstatistik Kurumu (TUİK) verileridir.

Katılımcı T, "*Bir de regüle edilmiş dış kaynaklı kurumlar var, yani banka dışı kurumlar var. Risk merkezi, kredi kayıt bürosu, işte Telekom şirketleri vs. gibi düşünebilirsiniz. KVKK kapsamında, onlardan temin edilen birtakım veriler var diyebiliriz*" ifadelerinde dış kaynak verilerinin neler olduğuna vurgu yapmaktadır.

Katılımcı I, harici kaynak verilerini, "*Bazen merkezi kurulların, resmi kurulların sağladığı servisler, ses kayıt bürosu buna örnek verilebilir. Türkiye Cumhuriyeti Kimlik Numarası (TCKN), Kimlik Paylaşım Sistemi (KPS), Acele Posta Servisi (APS) sorgularının yapıldığı yerler olabilir. Buralardan tüm verileri alabiliyoruz*" ifadeleri ile belirtmektedir.

Katılımcı R ise, "*Diğer bankalardaki verileri kullanabilme, orada yaptıkları kredi, kredi kartı kullanımları vs. takip edebilmek içinde KKB verilerini kullanıyoruz. Onun haricinde fatura ödemeleri, hangi faturayı hangi boyutta kullanıyor vs. gibi su, elektrik, telefon, bunlarla ilgili Turkcell, Vodafone ile çalışmalarımız var. Onun haricinde facebook, twitter gibi uygulamalarda bıraktıkları izleri takip edebilme şansına da sahibiz*" açıklamaları ile harici süreçler kapsamında elde edilen verilerine değinmektedir.

KVKK kapsamında, operatör verileri, Küresel Konumlama Sistemi (Global Positioning System (GPS)) verileri, diğer banka verileri, sosyal medya verileri, internet erişim verileri vb. gibi müşterilerine ait erişebildikleri tüm kanallardan veri temin etmeye çalışarak, bu verileri bankacılık süreçlerine dahil etmektedir.

4.4. Karşılaşılan Zorluklar

Karşılaşılan zorluklar teması altında, veri yönetimi, yasal zorunluluklar, insan kaynağı ve diğer karşılaşılan zorluklar olmak üzere dört farklı kategori oluşturulmaktadır.

4.4.1. Veri Yönetimi

Bankalar; dâhili ve harici süreçlerde müşteriler hakkında elde ettikleri verileri yönetme konusunda birçok zorlukla karşılaşmaktadır. Bu zorluklar verilerin doğruluğu, yönetilmesi, filtrelenmesi, birleştirilmesi, kalitesi, analizi, depolanması, çok büyük hacimli olması, işlenmesi ve verilerden değer üretilmesi aşamasında veri kaybının yaşanması gibi durumlar sonucunda oluşmaktadır.

Katılımcı A, "*Verinin kirliliği. Verinin kirliliği derken şunu kastediyorum. Örneğin, benim resmiyette ikametgâhım Ankara'da. Ama ben İstanbul'da yaşıyorum. Bankanın veri kaynaklarında da benim ikametgâhım Ankara olarak geçiyor. Dolayısıyla bu veri beyana dayalı yanlış bir veri. Bu tarzda hatalı veri çok fazla oluyor. En büyük sıkıntımız bu*" ifadelerinde karşılaştıkları zorluklara değinmektedir.

Katılımcı Ç ise, "*Verinin dağınık yapıda olması, belli bir yapısının olmaması. Bu iş tabi biraz ihtiyaç doğrultusunda güncellemelerle gittiği için başta yapılmış bir tablo işinizi görmeyince ek bir tablo ona ilave yapılıyor. O da işimizi görmeyince yeni bir tablo oluşturuluyor. Dolayısıyla o verileri birleştirip işleme süreci başlı başına bir süreç haline geliyor. Çünkü her ihtiyacımız olan veri farklı tablolarda kaydedilmiş oluyor. Düzgün bir yapısı olmadığı için en zorlandığımız taraf bu. Yani verinin düzenlenerek amacına uygun hale getirilmesi diyebilirim*" açıklamaları ile karşılaştıkları zorlukları ifade etmektedir.

Veri yönetimiyle ilgili karşılaşılan zorluklar genel olarak, müşteri tarafından beyan edilen bilgilerin yanlış olması, yetersiz kalitede verilerin bulunması, verilerin standart bir yapıya sahip olmaması, farklı formatlardaki verilerin işlenebilir hale getirilmesi gerekliliği, verilerin büyük boyutlara ulaşması gibi durumlar olarak görülmektedir.

4.4.2. Yasal Zorunluluklar

Bankaların yasal zorunluluklar sonucunda karşılaştıkları zorluklar, KVKK, banka müşterisi olmayan kişilerin verilerinin kullanılmaması ve yasal düzenlemeler olarak ortaya çıkmaktadır.

Katılımcı İ, "*KVKK ile birlikte bazı zorluklar ve engeller yaşanmaktadır. Bu yaşanılan ve karşı karşıya kalınan aşikar bir durumdur.*" ve Katılımcı Ö "*Kişisel verilerin korunması hakkında bir kanun var. O kanun çok açıkça kendi müşteriniz olmayan kişilerin datasına ulaşsanız bile kullanamazsınız diyor. Bir insanın datasını kullanabilmeniz için o kişinin imzası gerekir diyor. O yüzden banka müşterisi olmayan kişilerin datasını kullanamıyoruz maalesef*" ifadeleri ile KVKK'nın karşılaşılan bir zorluk olarak görüldüğünü ifade etmektedir.

4.4.3. İnsan Kaynağı

BV kullanımı konusunda bankaların karşılaştıkları diğer bir zorluk ise BV teknolojisini kullanabilen nitelikli insan kaynağının yetersiz olması sonucunda ortaya çıkmaktadır.

Bu konuda Katılımcı D, "*Bir sıkıntımız var. Yetkin insan, yetiştirilmiş insan, yetiştirilecek insan sorunu. Hem kendi bankamızda hem yurtdışı bankalarında, diğer bankalardaki insan kaynağına baktığım, konuştuğum zaman, artık yurtdışında da nitelikli insan bulamıyorlar*" ifadeleri ile düşüncelerini dile getirmektedir.

Nitelikli insan kaynağı konusunda zorluk yaşanacağını düşünen Katılımcı H "*En büyük problem aslında insan kalitesinde olacak gibi. Büyük problemin veri bilimi ile uğraşan analitik insanların olamaması gibi görüyorum*" ifadelerine yer vermektedir.

Son olarak Katılımcı M, "*Hem iş gücü zorluğu var hem de teknolojiyi kullanan insanın uzman olma durumuyla ilgili bir sıkıntı var. Yani orada bir sürü kaynaktan alırken o bir sürü kaynağın uzmanı olmanız ya da uzman insanlarla bir arada çalışıyor olmanız gerekir*" konu ile ilgili düşüncelerini ifade etmektedir.

Müşteriler ile ilgili verileri işleyerek ondan değer üretebilen, verinin dilinden anlayan, BV teknolojilerini kullanabilen nitelikli insan kaynağının olmaması bankalarda karşılaşılan zorluklar olarak değerlendirilmektedir.

4.4.4. Diğer Karşılaşılan Zorluklar

Bankalarda BV kullanımı konusunda karşılaşılan diğer bir zorluk ise bu teknolojinin maliyetli olması ve kullanımı için gereken uygun alt yapının olmaması durumlarında ortaya çıkmaktadır.

Katılımcı N, "*Büyük veriyi işlemenin biraz maliyeti var. İşleme maliyeti var. Bu da biraz zaman gerektiriyor. Bir ihtiyacı karşılama sırasında aslında tüm verinin o anda işlenmesi bazen ek maliyet oluşturabiliyor*" ifadelerinde konu ile ilgili düşüncelerine yer vermektedir.

4.5. Kullanılan Alanlar

Kullanılan alanlar teması altında müşteri ilişkileri yönetimi, dolandırıcılık tespiti, risk yönetimi, veri yönetimi ve diğer bankacılık işlemleri olmak üzere beş kategori elde edilmektedir.

4.5.1. Müşteri İlişkileri Yönetimi

Müşteri ilişkileri yönetimi kategorisinde; müşteri profillerini oluşturmak, müşterilerin ihtiyaçlarını saptamak, müşteri davranışlarını analiz etmek ve izlemek, müşteriyle ilgili sorunları tespit etmek ve çözmek, müşteri memnuniyetini sağlamak,

müşterilerle sağlam ilişkiler geliştirmek, müşteri tatminini değerlendirmek, müşterilerin harcama davranışlarını anlamak, müşteri şikâyetlerini etkin bir şekilde yönetmek, yeni müşteriler edinmek, satış hedeflerini ve hedef kitleyi belirlemek ve tamamlanmamış işlemleri izlemek gibi çeşitli başlıklar değerlendirilmektedir.

Katılımcı I, "*Her alanda kullanılıyor. Pazarlama, satış yani müşteriye düzgün hizmet modeli kurmak için segmentasyonlarda, ürün alma eğilimlerinin çıkartılması, müşterinin terk etme eğilimlerinin belirlenmesi, finansal sağlık, müşterinin çağrı merkezini aradığı zaman niye aradığını tahminleme, bireysel kredi, ticari kredi başvuru süreçlerinde kredi sağlığının ölçümlenmesi gibi kullanım alanları var*" ifadeleri ile BV'den faydalandıkları alanlara dikkat çekmektedir.

Katılımcı İ, konu ile ilgili şu açıklamalarda bulunmaktadır. "*Müşteri şikâyetlerini analiz edip, müşteriler genelde hangi konularda şikâyette bulunuyor. Bunun analizi yapılıyor. Burada kullanıyoruz. Bir müşterinin bir ürünü alma veya almama eğilimiyle ilgili kullanıyoruz. Bu müşteri bu ürünü ister mi yani veya bu ürünü istemez mi? İşte %60 olasılıkla ister gibi modellerde kullanıyoruz. Müşteri segmentasyonunda kullanıyoruz. Çapraz ürün satışında kullanılıyor*".

Katılımcı Ö ise, "*Bizim kampanya yönetim sistemi dediğimiz bir sistemimiz var. Müşterilere pazarlama teknikleri bu sistem üzerinden çıkıyor. Müşteri ATM'ye geldiğinde ona çıkacak reklamlar, mobil şubeye girdiğinde ona çıkacak kampanya teklifleri. Burada hangi müşteriye hangi teklifi sunacağımızın tamamı bankada modelleme ile yapılıyor. Örneğin, hiç taksit kullanmayan veya taksit kullanmayacağını düşündüğümüz bir müşteriye kredi kartına taksit yapmak ister misin gibi bir konuda iletişim kurmuyoruz. Müşterilerin ürün eğilimlerini belirlemek için modeller oluşturmada kullanıyoruz*" açıklamalarıyla müşteri ilişkileri yönetiminde BV'den faydalandıkları konulara değinmektedir.

Bankalar müşteriye ulaşma veya hizmetlerini potansiyel satışa dönüştürme fırsatı buldukları her durum için elde ettikleri her türlü veriden faydalanmayı tercih etmektedir. Bu noktada, müşteri profilinin detaylı bir şekilde tanımlanması ve uygun ürünün, uygun zamanda, en uygun müşteriye sunulması, BV kullanımının sağlayabileceği faydalar arasında görülmektedir.

4.5.2. Dolandırıcılık Tespiti

Banka müşterilerinin karşılaştıkları en temel sorunlardan biri dolandırıcılık riskidir. Bankacılık sektöründe, müşterilerin olası zararlardan korunması veya dolandırıcılık olaylarının erken aşamada tespit edilmesi amacıyla BV teknolojileri etkin bir şekilde kullanılmaktadır. Bu kapsamda gerçekleştirilen görüşmeler neticesinde, dolandırıcılık faaliyetlerini saptamak, işlemi gerçekleştiren müşterilerin kimlik doğrulamasını yapmak, gerçekleştirilen işlemleri denetlemek gibi konularda BV'den faydalanıldığı ortaya çıkarılmaktadır.

Konu ile ilgili görüşlerini Katılımcı A şu şekilde aktarmaktadır. "*Mesela birisi bir hesap açtı ve yüklü miktarda kredi çekti ve alıp o krediyi kaçacak. Bu tarz olayların yakalanmasında kullanılıyor*".

Katılımcı I, "*Bir müşteri bir işlem yaptığı zaman gerçekten işlemi yapan o müşteri mi, bir sahtecilik var mı, lokasyon müşterinin yaşam alanı ile uyumlu mu, genel yaptığı hareketlerden çok farklı bağımsız başka bir şekle mi gidiyor? Bu tip müşteriler sahtecilik işlemlerinin tespit alanları*" ifadeleri ile dolandırıcılık işlemlerinde BV'den nasıl faydalandıklarını belirtmektedir.

Son olarak, Katılımcı L dolandırıcılık tespitinde BV'den faydalanma konusundaki işlem süreçlerinden şu şekilde bahsetmektedir. "*Dolandırıcılık tespitinde anlık veriyi işliyoruz. Bir ortamımız var. Bütün ATM'lerden gelen verileri alabiliyoruz. Anlık olarak yani 10 dakikalık pencerelerde izliyoruz. Ve orada çok rahat çıkabiliyor. Sizin kredi kartınız ya da bankamatik kartınız çalındı diyelim ve birisi bununla Türkiye'nin her tarafında para çekmeye başladı. Bunu anında tespit edebiliyoruz*".

Bankacılık sektörü, dolandırıcılık faaliyetlerinin yaygın olarak gerçekleştiği bir alan olarak bilinmektedir. Bu durum karşısında, bankaların müşteri bilgilerini ve varlıklarını koruması, her türlü dolandırıcılık girişimine karşı önlem alması büyük önem taşımaktadır. Bankalar, müşterilerine ait verileri etkin bir şekilde işleyerek, BV analizlerinden yararlanarak bu tür tehlikelere karşı daha etkili bir koruma sağlayabilmektedir.

4.5.3. Risk Yönetimi

Bankacılık sektörü, çeşitli risklerle mücadele etmektedir. Bu kapsamda bankalarda, karşılaşılan riskleri tanımlayıp bunlara karşı önlemler alabilmek için ayrı bir birim bulunmaktadır. Yapılan görüşmeler neticesinde bu birimlerin; risk modelleri oluşturma, müşterilerin risk profilini analiz etme, bilgi sızıntısını önleme, kredi kartı ödeme risklerini ve kredi risklerini belirleme gibi alanlarda BV'yi kullanarak risk yönetimi stratejilerini belirledikleri ortaya çıkmaktadır.

Katılımcı A konu ile ilgili "*Büyük veri risk tarafında kullanılıyor, kredi risk modellemeler de kullanılıyor*" ifadeleri ile BV'yi kredi riski tarafında kullandıklarını belirtmektedir.

Katılımcı D, "*Risk yönetiminde kullanılan uygulamalar oluyor. Geriye dönük 10 yıl bir projeksiyon yapılıyor. Hangi birim ne kadar seviyede bulgulandığı, işte hangi konularda kritiklik seviyesinde olduğu belirleniyor*" ifadeleri ile BV'den risk yönetimi konusunda nasıl faydalandıklarını açıklamaktadır.

Risk yönetimi, bankacılık sektöründe kritik bir öneme sahiptir. Bankaların karlılık düzeyi, risklerin doğru bir şekilde analiz edilip yönetilmesiyle yakından ilişkilidir. Bankalar, müşterileri ile ilgili elde ettikleri verilerle risk yönetiminde daha kesin kararlar alabilmekte ve risklerini daha etkili bir şekilde değerlendirebilmektedir.

4.5.4. Veri Yönetimi

Veri yönetimi teması altında veriden değer üretmek, veriden model oluşturmak, verileri hızlı bir şekilde işlemek, verileri analiz etmek, analitik yöntemler geliştirmek, verileri işlemek, yapılandırılmamış verileri yapılandırılmış hale getirmek, çeşitli kaynaklardan farklı özelliklere sahip olan verileri kullanmak gibi kategorilere yer verilmektedir.

Katılımcı C veri yönetimi konusunda BV'den faydalandıklarını şu ifadeleri ile belirtmektedir: "*Analitik anlamda çok fazla kullanıyoruz. Yani yapay zeka alt yapı çalışmalarımız için zaten kullanıyoruz. Data büyüklüklerinden kaynaklı diğer sistemlerle işleyemediğimiz datalar burada işlenmekte. Yani biz dataları işlemede kullanıyoruz*".

Katılımcı Ö ise, "*Makine öğrenmesi modelleri oluşturmak için kullanılıyor. Örneğin krediler. Bir müşteri krediye başvurduğunda bunu ödeyebilir mi veya karta başvurduğunda ödeyebilir mi batma ihtimali kaçtır bu tür modeller için kullanıyoruz*" açıklamaları ile BV'den veri yönetimi konusunda nasıl faydalandıklarını belirtmektedir.

4.5.5. Diğer Bankacılık İşlemleri

BV'nin banka raporlamalarında kullanılması, karar verme süreçlerinde faydalanılması, performans yönetiminde kullanılması, görüntülü bankacılıkta kullanılması, modellerin ölçümlenmesi, maliyet analizlerini yapılması gibi diğer bankacılık işlemlerinde kullanılmaktadır.

Konu ile ilgili düşüncelerini Katılımcı Ö, "*Bir kere raporlar için ne kadar kredi kullanıldı, ne kadar kart işlemi gerçekleşti gibi durumlar için kullanılıyor*" ve Katılımcı T, "*Bir defa rutin raporlama dediğimiz hani mevcutta ne oluyor, rakamlar nasıl değişiyor, nasıl gelişiyor, raporlama esnasında kullanılıyor*" ifadelerinde yer vermektedir.

4.6. 7P Kapsamında Büyük Verinin Kullanımı

7P Kapsamında BV'nin Kullanımı teması altında ürün, fiyat, dağıtım, tutundurma, insanlar, fiziksel kanıtlar ve süreç olmak üzere yedi farklı kategori elde edilmektedir.

4.6.1. Ürün

Ürün kategorisi ile ilgili olarak; yeni ürün belirlemek, müşterilere kişiselleştirilmiş ve doğru ürünü teklif etmek, çapraz ürün satışı yapmak, doğru zamanda doğru ürünü teklif etmek, müşterilerin ekran hareketlerini izleyerek satılmak istenilen ürünü o alana koymak, müşterilerin ayak izini takip ederek ürün sunmak, ürün tekliflerinin sonuçlarını takip etmek ve ürün satışlarını tahmin etmek gibi ifadelere ulaşılmaktadır.

Katılımcı Ç, "*Büyük veriyi, eğilimi olan müşterileri çıkarıp onlar üzerinden bir pazarlama kampanyası yürütülmesinde kullanıyoruz. Onun dışında ürün birliktelikleri*

aracıyla mesela şunu kullanan bunu kullanıyor mu gibi sepet analizleri yapıyoruz" şeklindeki ifadeleri ile BV'den bankalarında ürün kapsamında faydalandıkları konulara değinmektedir.

Katılımcı F, ürün kapsamında BV'den faydalandıkları konuları şu şekilde açıklamaktadır: "*Bence burada öncelikle profil belirlemede kullanıyoruz. Çünkü doğru müşteriye doğru ürünü sunmak çok önemli. Müşteriye bir sürü bildirim geliyor ve bunların içinden nokta atışı yapmanız gerekiyor. O nokta atışını yapabilmeniz için de doğru ürünü hatta doğru zamanda sunmanız gerekiyor. Mesela bir müşteri diyelim ki sosyal medyada akşam yediden sonra vakit geçiriyor, siz bunu tespit edebilirseniz o bildirimi yedi gibi oradan o müşteriye sunarsanız o onu görecektir. Ama mesela kişi gündüz yoğun bir şekilde çalışıyor. Sosyal medyada vakit geçiremiyor istediğiniz kadar sosyal medyada reklam verin o ona gitmez yani bence bu konuda büyük veri çok önemli*". Katılımcı H ise, bankalarında ürün kapsamında BV'den en çok kişiselleştirilmiş ürün tekliflerinde faydalandıklarını belirtmektedir.

Pazarlama karmasının yer alan ürün bileşeni, aslında diğer bileşenlerin var olmasını sağlayan temel unsurdur. Dolayısıyla, ürünle ilgili alınan kararların son derece doğru olması önem arz etmektedir. Bankalar, hangi ürünün, hangi müşteri profiline, hangi pazarda uygun olduğunu belirlemek veya yeni bir ürün geliştirmek için BV'den faydalanmaktadır. Müşterilere sundukları ürünler aracılığıyla bankalar gelir elde ettikleri için doğru müşteriye, doğru ürünün, doğru zamanda sunmaları son derece kritik bir öneme sahiptir. Bu kapsamda BV'yi etkili bir şekilde işleyen ve yöneten bankalar, ürün geliştirme konusunda başarılı olurken aynı zamanda rakiplerine karşı üstünlükte sağlamaktadır.

4.6.2. Fiyat

Fiyat kategorisi ile ilgili olarak; fiyatlandırma politikalarını doğru şekilde belirleme, belirlenen profillere uygun faiz, komisyon vergiler alma, mevduatları fiyatlandırma, müşterilerin fiyat hassasiyetlerini belirleme, kredi fiyatlandırmasını ve riske dayalı fiyatlandırma yapma, kredi kartı limit artışlarına karar verme ve müşterilerin geri ödemelerini tahmin etme gibi konularda BV'den faydalanılmaktadır.

Katılımcı H fiyat ile ilgili olarak; "*Fiyatla ilgili yapılan modeller sayesinde hem bankanın kârını maksimize ederim hem de müşteriye gereksiz faiz vermiş olmam. Bu projelerde hem pazarlama ekibi hem de vadeli mevduat ekibiyle çalışıyoruz. Bizim bir tabela faizimiz var. Yani herhangi bir yeni parayı bankaya getirmenin kazandırdığı faiz. Birde müşterilere belirlediğimiz hassasiyet skoruna göre verilen faiz oranı var. Yani müşterinin başka bir bankaya parasını götürmeyecek şekilde ancak bankadaki maliyeti minimaliz edecek şekilde bir model çalışıyoruz*" açıklamalara yer vermektedir.

Katılımcı P ise fiyat ile ilgili şu açıklamalarda bulunmaktadır: "*En temelde büyük verinin içerisindeki datalar kullanılarak, müşterinin fiyat hassasiyetleri takip ediliyor. Müşteri bunu bu fiyatla şu vadede ödeyebilir mi mesela bu ilk soru. Bunu biliyor olmanız*

*lazım. Dolayısıyla elinizdeki veriyi kullanarak, müşteri bu ürüne bu fiyata ne kadar hassas,
bu fiyattan alır mı? Müşterinin fiyat hassasiyetini ve oluşan riski belirlemek açısından büyük
veriyi kullanıyoruz*".

Bankalar müşterilerine sundukları ürünlerin fiyatlandırmasında BV'den faydalanarak
doğru müşteriye doğru fiyatı sunabilme yeteneklerini artırabilmektedir.

4.6.3. Dağıtım

Dağıtım kategorisi ile ilgili olarak çeşitli alanlarda verilere dayalı kararlar
alınmaktadır. Bu kararlar arasında, ATM'lerin konumlandırılması, ATM sorunlarının
belirlenmesi, şube müşteri yoğunluğunun değerlendirilmesi, yaşam ve iş alanlarına yakın
bölgelerdeki yer seçimleri, ATM kullanım yoğunluğunun analizi, ATM para yükleme
miktarlarının belirlenmesi, şube müşteri trafiğinin azaltılması, ATM maliyetlerinin
hesaplanması, şube kapatma kararları ve ATM'lerdeki para tanıma ve görüntü
algoritmalarının geliştirilmesi gibi konular bulunmaktadır.

Katılımcı H, dağıtım kanalları konusunda bankaların BV'den nasıl faydalandıklarını
şu şekilde açıklamaktadır: "*ATM ve şubeyle ilgili hatta dış veriler de alıp biraz daha o kararı
daha akıllı hale getirmeye çalışıyoruz. Altıgen bölmelere ayrılmış yerlerdeki, işte belli metre
kare alanda nüfusları, bankacılık nüfusları, o ilgili bölgedeki müşterilerin gelirleri gibi bu
tarz coğrafi veriler sağlayan firmalar var. Bu arada o altıgen şekillerde aklınıza gelebilecek
diğer şeyler de var. İşletme sayıları, ticari işletme sayıları, işte konuk sayısı, nüfus yaşı gibi
tarz veriler de var. Bunları da aslında kullanarak ve o ATM'lerin sonuçta kullanılması ve
yoğunluğuyla da ilgili olarak bizim müşterilerin nerede dağıldığı ile ilgili olarak bunların
hepsini bir araya getirip yeni ATM açılmasına karar veriyoruz*".

Katılımcı Ö dağıtım konusunda, "*Yeni açacağımız ATM'leri nereye koymamız
gerektiği konusuna çalışırken verilerden faydalanıyoruz. O da müşterilerimizin ve
alışverişte şu tür veriler oluyor. Genelde müşterimizin alışverişlerini nerede yaptıklarını
görüyoruz kredi kartıyla hangi dükkânda harcama yaptıklarını biliyoruz. Müşteriler hangi
saatlerde nerelerde yoğun geziyorsa onları tespit edip haritalar üzerinde yer çıkartıp,
ATM'leri genelde oralara koymaya çalışıyoruz*" ifadelerine yer vermektedir.

Bir işletmenin konumu, ne sunduğu kadar önemlidir. Bu yüzden bankalar, müşterileri
için en uygun ATM ve şube konumlarını belirlemek için BV'yi kullanmaktadır.

4.6.4. Tutundurma

Tutundurma kategorisi ile ilgili olarak; müşterilerin bankadan ayrılma olasılıklarının
belirlenmesi, müşteri tutundurma analizlerinin yapılması, pasif müşterilerin aktifleştirilmesi,
özel müşterilerin tanımlanması, müşterilerin bankayı çevrelerine tavsiye etme oranlarının
belirlenmesi, müşteri şikâyetlerinin ve önerilerinin analiz edilerek müşteri memnuniyetinin
sağlanması, çağrı merkezine gelen müşterilerin doğru şekilde yönlendirilmesi, müşterilere

bilgi verilmesi, müşterilerin yapacakları işlemlerin tahmin edilmesi ve özel müşterilerin şubelerde bekleme sürelerinin azaltılması gibi konularda BV'den faydalanılmaktadır.

Katılımcı C tutundurma bileşeni ile ilgili olarak; "*Biz müşteri bize daha gelmeden biz ona gitme çabasındayız aslında. Yani bugüne kadar yaptığımız oydu. Biz daha çok müşteri bizi aramadan biz müşteriyi arayalım, yani problemi müşteriden bir adım önce tahmin edip, büyük veriyi kullanıp, müşteri bize gelmeden, biz müşteriye gitme çabasındayız*" ifadelerine yer vermektedir.

Katılımcı G, "*Müşteriyi elde tutma kısmı çok önemli. Onu hala bütün bankalar da yapar yani o modeli, elde tutma modelleri. Müşteri bankayı daha az kullanmaya başlıyor. Ya da sana borçlu olmuyor. Banka aslında müşterinin borçlu olmasını ister. Yani ilişkisi olsun ister. Az da olsa bir borç aslında bir iletişimdir. Yani şöyle düşün senin bankaya hiç borcun kalmamış orada düşük miktarda bir para tutuyorsun login olmamaya başlıyorsun. Bu tip göstergeler var. Sonra müşteri bankayı bırakmaması için pazarlama birimi devreye giriyor. Yani pazarlama birimi isterse indirim yapar isterse bonus verir kartına. Ona göre bir şey yapar*" konu ile ilgili açıklamalarda bulunmaktadır.

BV'den çapraz satış konusunda faydalandıklarını ifade eden Katılımcı L, "*Çapraz satış konusunda. Bunu alan neyi almış. Bunlar analiz ediliyor. Bankada da ürünlere böyle bakılıyor. İşte sigortanız var mı? Ek hesabınız var mı? Bir de harcamalarınıza bakıyor. Mesela müşteri potansiyel bir adaydır ve artık pazarlama teknikleri tamamen kişiselleştirilmiş olarak gönderilmeye çalışılıyor*" şeklinde açıklamalarda bulunmaktadır.

Bankaların müşterilerine vazgeçemeyecekleri bir ürünü sunabilmeleri büyük önem taşımaktadır. Bu kapsamda bankalar elde ettikleri BV'yi çok iyi analiz ederek, müşterilerine vazgeçilmez ürünleri sunma imkânına sahip olmakta ve müşteri memnuniyetini sağlamak için doğru tutundurma stratejileri belirleyebilmektedir.

4.6.5. İnsan

İnsan kategorisi ile ilgili olarak çeşitli konularda verilere dayalı kararlar alınmaktadır. Bu kararlar arasında, personelin müşterilere daha iyi hizmet sunmasını sağlama, personelin iş yükünü azaltma, personel memnuniyet anketleri düzenleme, personeli müşteri talepleri konusunda eğitme ve hizmetleri daha verimli hale getirme, sorun yaşayan personeli belirleyerek gerekli önlemleri alma ve uygun hizmet modelini belirleme gibi konular yer almaktadır.

Katılımcı A insan ile ilgili olarak BV'den şu şekilde faydalandıklarını söylemektedir. "*Yani şöyle bu zaten hali hazırda yapılıyor. Hem çağrı merkezini aradığında mesela o çağrı merkezinde konuştuğu insanı puanlayabiliyorsun. Burada bir veri topluyorsun. Ve aslında buna bakılarak işte belli bir çalışanı puanlamasına bakılarak, ortalamada insanlar bu kişiden memnun mu değil mi buna bakıyoruz*".

Katılımcı J müşteri memnuniyetini takip etme konusunda BV'den faydalandıklarını "*Aslında müşterinin memnuniyetini takip ediyoruz. Mesela anketlerimiz var. Anketlerde bize düşük puan vermiş müşteri. Bunun sebebi ne. O anketi okuyarak, sorunun asıl sebebi ne, kök sebebi ne, diye bakabiliyoruz. Müşteri ne yapmış. Ayak izine bakıyoruz. Mesela müşteri önce ne bileyim mobili yüklemiş, sonra bizi aramış, ulaşamamış. Ulaşmış şu kişiyle görüşmüş kapatmış. Ulaşmış bilmem kimle görüşmüş kapatmış. Üç defa aramış mesela. Sonra bizim şikâyet tarafına mesaj atmış. Hani bu izi takip ediyoruz mesela. Buna göre şu da oluyor. Memnuniyetsizlik acaba bir noktada mı birleşiyor. Şu kişiyi arayan gidiyor. Çok nadirde olsa bu olabiliyor. Bunlarında çalışması yapılıp şu istasyondan kaynaklanıyor. Şu istasyonda derinleşelim deniliyor ve ona göre çözümler sunuluyor*" ifadeleri ile belirtmektedir.

Bankalar elde ettikleri her türlü veriyi kullanarak müşterilerinin karşılaştıkları problemlerde yardımcı olmaya çalışmaktadır. Bu durum hem müşterilere hem de bankalara zaman tasarrufu sağlayarak, müşteri memnuniyetinin oluşmasını sağlamaktadır.

4.6.6. Fiziksel Kanıtlar

Fiziksel kanıtlar kategorisi ile ilgili olarak; müşterilere şube içi deneyim çalışması yapmak, şube içi tasarımlar yapmak, müşterilerin şubede beklediği alanlara gerekli reklamları koymak, insansız şubeler oluşturmaya çalışmak, müşteriler için gereken rahat ortamı sunmak ve numeratörün yerine karar vermek gibi konularda faydalanıldığı belirlenmektedir.

Katılımcı Ö'nün fiziksel kanıtlar kapsamında BV'den faydalandıklarını belirten ifadeleri şu şekildedir: "*Net tavsiye skoru diye bir kavram var. Bunu modelleme ve makine öğrenmesi ile değil de daha çok anketle yapıyoruz. Örneğin, Beşiktaş şubeden işlem yapmış, 50.000 müşteri var diyelim. Bunların içinden rastgele 100 tanesini seçip arayıp şubede yaptığınız işlemden memnun kaldınız mı diye soruyoruz. Sonra şubeleri sıralıyoruz. 500 şube var diyelim ki en düşük skor alan şubelere sizin memnuniyet oranınız düşük, biraz daha dikkatli olur musunuz diye söylüyoruz. Orada da yine ajans aracılığıyla anket gibi küçük müşteri gruplarına toplayarak tasarım soruluyor şöyle yapsak daha mı memnun olursunuz? gibi anketler yapılıyor*".

Katılımcı J ise konu ile ilgili olarak "*Şube yenileme çalışmalarımızda kullanıyoruz. Burada şu dizaynı uygulasak ne olur gibi çalışmalar yapıyoruz. Şubelerimizde karşılama masası var. Birçok şey orada halledilir. Eğer uygunsa bir yere yönlendiriliyor. Uygunsa satış temsilcisine yönlendiriyor gibi bir sistem kuruldu ve onun her adımı datayla dizayn edilerek çalışıldı*" açıklamalarda bulunmaktadır.

Banka müşterileri, şubeleri ziyaret ettiklerinde genellikle uzun bekleme süreleriyle karşı karşıya kalabilmektedir. Bu süreçte bankaların müşteri memnuniyetini artırabilmeleri için müşterilerine konforlu ve rahat bir ortam sağlamaları gerekmektedir. Müşterilerin banka deneyimlerinden olumlu izlenimlerle ayrılmalarını sağlamak adına hem şube içinde hem de

dışında hangi iyileştirmelerin yapılacağına dair kararlar, BV'nin analiziyle desteklenmektedir. Bu analizler sayesinde, müşterilerin işlemlerini mümkün olan en rahat şartlarda tamamlayabilmeleri için gerekli düzenlemelerin yapılması hedeflenmektedir.

4.6.7. Süreç

Süreç kategorisi ile ilgili olarak; işlem sürelerinin kısaltılması, süreçlerin kolay ve hızlı bir şekilde gerçekleştirilmesinin sağlanması, bekleme sürelerinin azaltılması, işlemlerin dijitalleştirilmesi, süreçlerde yaşanan aksaklıkların belirlenerek çözüm yollarının bulunması, kâğıt kullanımının azaltılması, süreç analizlerinin yapılması, personel gereksinimi olmadan işlemlerin gerçekleştirilebilecek ortamların geliştirilmesi, süreçlerle ilgili olası sorunların önceden tahmin edilmesi ve iş süreçlerini etkileyen çözümlerin geliştirilmesi gibi konularda BV'den faydalanıldığı ortaya çıkmaktadır.

Katılımcı H bankalarında bekleme sürelerinin düzenlenmesi ile ilgili olarak BV'den nasıl faydalandıklarını şu şekilde aktarmaktadır: "*Şubede numaraların yanma algoritması var. Orası ile ilgili hani küçük dokunuşlarımız oluyor. Yani işte bizim çok kar ettiğimiz çok önemli gördüğümüz bir müşteri daha önce sıralamada gelebiliyor. Şöyle şeylerle karşılaşabiliyoruz tabii ki. Ben 25 dakikadır bekliyorum biri geldi 3 dakikada onun numarası yandı gibi. Ama hani bu işin doğasında da var. Bir de bir taraftan da o algoritmayı müşteriler için bekleme süresinin maksimum 25 dakika olacak şekilde yapıyoruz ki 26. dakikada hani kim gelse 26. dakikada o çok bekleyen müşteriyi çağırıyoruz gibi bir durum oluyor aslında. O yüzden hem çok şikâyet olmasın hem de aslında benim karlı müşterime öncelik verebileyim konusu. Müşterilerin şubelerin şikâyet azaltması hem de daha pürüzsüz hizmet alması için büyük veri ve algoritmalardan yararlanıyoruz*".

Katılımcı J ise kâğıt kullanımının azaltılması konusunda BV'den faydalandıklarını "*Şubeye kaç kişi koysak hangi saatlerde kaç kişi olsa orada hızlı erimeyi sağlarız. Müşterilerde bekleme oranını düşürürüz gibi şeyler data üzerinden yürütülüyor. Mesela kâğıtsız şube gibi bir çalışmamız var. Örneğin 20 sayfalık bir doküman var. 20 sayfaya da imza atıyorsa bu 12 ye düşemez mi? Yani hem bizi koruyacak yani anlaşmayı koruyacak kadar sağlıklı hem de hızlandıracak kadar iyi bir yöntem. Ya da imzası varsa mobile göndersin karşı taraf bir telefondan tıklasın ve bitsin. Hani imza sürecini hızlandıralım gibi şeyler var*" ifadeleri ile belirtmektedir.

Bankacılık işlemleri uzun süreleri kapsayan işlemler olup, müşteri memnuniyetinin oluşmasında çok kritik bir öneme sahiptir. Çünkü çoğu insan beklemeyi sevmemekte işlemlerinin hızlı bir şekilde tamamlanmasını istemektedir. Bankalar, işlemlerin uzunluğu ve müşteri yoğunluğu gibi faktörler nedeniyle bu konuda sürekli olarak çalışmalar yapmaktadır. Elde ettikleri BV'yi kullanarak, müşterilerin bekleme sürelerini mümkün olduğunca kısaltmaya çalışmaktadır. BV sayesinde, bankalar müşteri bekleme sürelerini azaltma, işlemleri daha az evrakla gerçekleştirme, işlemlerini dijital platformlara taşıma, işlem süreçlerini pürüzsüz ve kolay hale getirme gibi konularda faydalanmakta ve böylece müşteri memnuniyetini artırmaktadır.

5. Sonuç ve Öneriler

5.1. Sonuçlar

Büyük veri tanımı, uygulama söz konusu olduğunda ülkeden ülkeye, sektörden sektöre ve hatta işletmeden işletmeye farklılık göstermektedir. Bu tanım çalışma kapsamında katılımcılar tarafından da farklı şekillerde ifade edilmektedir. Ancak genel olarak bakıldığında BV, geleneksel yöntemlerin yetersiz kaldığı durumlarda ortaya çıkan çeşitli kanallardan, yüksek hızda ve büyük boyutlarda elde edilen veriler olarak kabul edilmektedir.

Bankacılık sektöründe BV kaynakları, dâhili ve harici süreçler olmak üzere ikiye ayrılmaktadır. Dâhili süreçler; ATM'ler, şubeler, çağrı merkezleri, internet bankacılığı gibi bankaların kendi içinden elde ettiği verilere işaret ederken, harici süreçler; müşteri konum bilgisi verileri, sosyal medya ve Kredi Kayıt Bürosu verileri gibi dış kaynaklardan sağlanan verilerdir. Bankalar, KVKK kapsamında erişebildikleri tüm verileri BV olarak değerlendirmekte ve operasyon, pazarlama, satış, müşteri ilişkileri yönetimi, risk yönetimi, finans, bireysel ve KOBİ bankacılığı gibi birçok birimin iş süreçlerinde kullanmaktadır.

Bankalar, BV kullanımında özellikle veri yönetimi ve verilerden değer üretme süreçlerinde çeşitli zorluklarla karşılaşmaktadır. Müşterilerden alınan beyana dayalı bilgilerin hatalı veya yanlış olması, verilerden değer üretme aşamasında önemli engeller oluşturmaktadır. Bununla birlikte, BV kullanımında karşılaşılan bir diğer temel sorun, verilerin analizi için gerekli olan nitelikli insan kaynağının eksikliğidir. Bu durum, Yılmaztürk ve Akdoğan'ın (2023) çalışmasında da vurgulanmış ve BV teknolojilerinin etkin bir şekilde kullanılabilmesi için iki temel ihtiyacın altı çizilmiştir. İlki, gerekli altyapının kurulması; ikincisi ise bu altyapıyı kullanabilecek nitelikli işgücünün tedarik edilmesidir. Araştırmada, söz konusu eksikliklerin BV süreçlerinde önemli bir kısıt oluşturduğu belirtilmiştir.

Bankacılık sektöründe BV müşteri ilişkileri yönetimi, dolandırıcılık tespiti, risk yönetimi ve veri yönetimi konularında kullanılmaktadır. Benzer şekilde Kuş Khalilov ve Gündebahar (2014)'da yaptıkları çalışmada bankaların BV'yi müşteri memnuniyeti, çağrı merkezi kayıtlarının analizi, dolandırıcılık analizi, pazarlama öngörülerinde, Delgosha vd. (2021) tarafından yapılan çalışmada ise, dolandırıcılık işlemlerinin tespitinde ve kredi riski analizinde BV'den faydalandıkları ortaya çıkarılmaktadır.

Müşteri İlişkileri Yönetimi konusunda, bankalarda müşterilerin gerçekleştirdiği her türlü işlem izlenerek, davranış ve harcama alışkanlıkları belirlenmekte ve bu verilere dayanarak müşteri profilleri oluşturulmaktadır. Müşteri profillerinin oluşturulması ile birlikte bankalar müşteri ihtiyaçlarına yönelik doğru ürünün, doğru müşteriye sunulmasını, müşterilerin alışveriş eğilimlerinin belirlenmesini, çapraz satış ve kişiselleştirilmiş ürünlerin sunulmasını doğru bir şekilde sağlamaktadır.

Bankalar, müşteri ilişkileri yönetimi konusunda müşterilerinin yaşadıkları sorunları BV sayesinde tespit edebilmektedir. Bir müşterinin yaptığı bir işlemi yarıda bırakması

durumunda banka çalışanları tarafından hızlıca müdahale edilerek sorunun çözüme kavuşturulması için BV'den faydalanılmaktadır. Ayrıca, bankalar müşteri şikâyetlerini analiz ederek ortaya çıkan sorunları çözmekte ve müşteri memnuniyetini artırmaktadır. Müşteri memnuniyeti veya memnuniyetsizliği, müşterilerin çağrı merkezini aradıklarında bekleme sürelerinin uzun olması durumunda da ortaya çıkmaktadır. Ancak bu durum BV ile müşterilerin çağrı merkezini neden aradıkları tahmin edilerek, ilgili kişilere yönlendirilmesi sonucu çözüme kavuşmaktadır. Bu şekilde müşteriye özelleştirilmiş hizmet sunulması, bankalara olan müşteri memnuniyetini artırmakta ve müşteri sadakatini güçlendirmektedir.

BV, ürün konusunda müşteri izlerinin takip edilerek, müşteri ihtiyaçlarına uygun kampanya ve yeni ürünlerin oluşturulmasında, alışveriş alışkanlıklarının tahminlenmesinde kullanılmaktadır. Ayrıca bankalar, her müşterinin özel ihtiyaçlarını belirleyerek kişiselleştirilmiş ürünler sunma konusunda BV'den faydalanmaktadır. Bu yaklaşım, bankaların müşteri memnuniyetini artırmasına ve daha etkili hizmetler sunmasına olanak tanımaktadır. Arslan ve Elitaş (2024) tarafından yapılan çalışmada da benzer bir sonuç ortaya çıkmıştır. Çalışmada, BV ve Öngörüsel Analitik yöntemlerinin birleşimiyle, müşterilere uygun kişiselleştirilmiş finansal ürünlerin, sanal veya fiziksel satış kanallarından, zaman ve mekândan bağımsız bir şekilde sunulabilmesi için planlanmış bir yapı oluşturulmasının vazgeçilmez olduğu vurgulanmıştır. Bu bulgular, BV ve analitik yöntemlerinin bankaların müşteri odaklı stratejilerini geliştirmede önemli bir araç haline geldiğini ve kişiselleştirilmiş hizmetlerin daha verimli bir şekilde sunulmasında kilit rol oynadığını göstermektedir.

Fiyat konusunda BV sayesinde, bankalarda müşterilerin profillerine göre ödeme güçleri, hangi ürünü hangi fiyatla kabul edebileceklerini belirlenerek müşterilerin fiyat hassasiyetleri ortaya çıkarılmaktadır. BV kullanılarak fiyat belirlenirken, bankalar hem kârlarını maksimize etmeye çalışmakta hem de müşterilerine gereksiz faiz yüklememektedir.

Bankalar, dağıtım konusunda BV'den şube ve ATM yerleşimlerinde faydalanmaktadır. Şube ve ATM'lerin müşterilerin kolaylıkla erişebileceği yerlerde bulunması büyük önem taşımaktadır. Bahsedilen dağıtım kanallarının nerede ve nasıl kurulacağına dair en optimize kararların alınması ve bu kararların daha akıllı hale getirilmesi için bankalar BV'den faydalanmaktadır. Bu kararlar alınırken, müşteri konum bilgisi verileri, trafik bilgileri, operatör verileri ve mobil uygulamalardan alınan sinyaller gibi bilgilerden faydalanılmaktadır.

Bankalar, tutundurma konusunda BV'yle müşterilerin ihtiyaçlarını önceden tahmin etmekte ve müşterilerin aldıkları hataları tespit ederek hızlıca yardımcı olmayı amaçlamaktadır. Bu sayede müşterilere önem verildiği hissettirilerek müşteri memnuniyetini sağlanılmaktadır. Ayrıca, BV kullanımıyla bankalar müşteri sadakatini artırmayı hedefleyen modeller geliştirmektedir. Bu modeller sayesinde, bankalar müşterilerin hareketlerini izleyerek bankadan ayrılma eğiliminde olanları belirleyebilmekte ve bu müşterileri yeniden kazanmak için pazarlama faaliyetlerinde bulunmaktadır.

Bankalar, insan kaynakları yönetiminde BV'yi kullanarak çalışanları değerlendirmekte ve onların performanslarını izleyebilmektedir. Bankaların sistemlerinde, müşterilerin hangi işlemleri, hangi personel tarafından gerçekleştirildiği kaydedilmektedir. Böylece müşteriler işlemlerini tamamladıktan sonra bankalar, işlemi gerçekleştiren personeli değerlendirmek için müşterilerini arayarak, yapılan işlemi puanlandırmasını istemektedir. Buradan alınan sonuçlara göre bankalar kişilerle ilgili gerekli aksiyonları alabilmektedir.

Bankalar, fiziksel kanıtların yönetiminde BV'yi kullanarak, müşterilerle şube içi deneyim çalışmaları yapmakta ve buradan elde ettikleri verileri analiz ederek şube içi tasarımlar hakkında kararlar alabilmektedir. Bu kapsamda, ilgili verileri toplamak için küçük müşteri gruplarına anketler yapılmaktadır. Elde edilen verilere dayanarak, numaratörlerin yerleşimi, hangi portföyden ne kadar bulunması gerektiği, gişe sayısı, müşterinin bekleme süresinde görmesi gereken reklamların yerleşimi, müşterilerin rahat etmeleri için bekleme alanlarının düzenlenmesi, şubeye ulaşım ve park sorunlarının çözülmesi gibi konularda kararlar verilebilmektedir.

Bankalar, süreçlerin yönetiminde BV'den faydalanarak, müşterilerin bankacılık işlemlerini kolay, sorunsuz ve hızlı bir şekilde gerçekleştirmelerini sağlamaktadır. Bankalar, elde ettikleri veriler üzerinden süreç analizleri yaparak kararlar almaktadır. Bu kararlar doğrultusunda, bankalar müşterilerin dijitalleşen işlemlerini desteklemekte ve evrak veya kâğıt kullanımını azaltarak müşteri memnuniyetini artırmakta ve personelin işlerini daha verimli bir şekilde yürütmesine olanak tanımaktadır.

Sonuç olarak, BV kullanımı, bankalara doğru müşteriye doğru ürünü, doğru fiyatla, doğru dağıtım kanalıyla, doğru kampanyayla, doğru kişilerle, doğru fiziksel imkânlarla ve doğru süreçlerle sunma yeteneği kazandırarak piyasada rekabet üstünlüğü elde etmelerine katkı sağlamaktadır. Bu sonuç, Bil ve Kaya (2022) tarafından yapılan çalışmada da desteklenmektedir. Çalışmada, BV kullanımını süreçlerine entegre eden işletmelerin daha rekabetçi ve başarılı olabileceği vurgulanmıştır. Benzer şekilde, Kaya ve Akbulut (2018) tarafından yapılan araştırmada, işletmelerin rekabet üstünlüğü sağlamak için BV'yi benimseme eğiliminde oldukları ortaya konmuştur. Ayrıca, Schroeck vd. (2011) tarafından yapılan bir başka çalışmada da, işletmelerin rekabet avantajı elde edebilmek için BV'den faydalanmaları gerektiği sonucuna ulaşılmıştır. Bu çalışmalar, BV'nin etkin bir şekilde kullanılması durumunda işletmelerin rekabet üstünlüğü kazanabileceğini ve başarının artırılabileceğini göstermektedir.

5.2. Öneriler

Bankalar, geniş bir müşteri tabanına sahip olup günlük binlerce işlem gerçekleştirmektedir. Bankaların sistemleri ve veri tabanları, müşterileriyle ilgili büyük miktarda veriyi içermektedir. Bu verileri bankalar, mevcut durumdan daha fazla değer oluşturmak için daha etkin bir şekilde kullanabilir. BV'yi kullanmayan veya yeterince kullanmayan bankalar, ilerleyen süreçlerde ya bu eksikliklerinin farkına varacaklar ya da

rekabet karşısında güçsüz kalarak yok olma tehlikesiyle karşı karşıya kalacaklardır. Bu nedenle, bankaların ve diğer işletmelerin veri kullanımını artırmak ve kendilerini geliştirmek için şimdiden neler yapabilecekleri konusunda çalışmalar yapmaları önerilmektedir.

Yapılan araştırmalar, BV'nin bankacılık sektöründe risk yönetimi, dolandırıcılık tespiti ve müşteri ilişkileri yönetimi gibi alanlarda kullanıldığını ortaya koymaktadır. Bununla birlikte, araştırmacılar daha fazla çalışma yaparak bu konularda BV'nin kullanımını daha da geliştirebilir. BV kullanımının yaygınlaştırılması için sektördeki profesyonellerin ve yöneticilerin BV'ye yönelik eğitim ve farkındalık düzeylerinin incelenmesi önemlidir. Bu şekilde, sektördeki kişilerin bu teknolojiyi daha etkin bir şekilde kullanmaları teşvik edilebilir.

Veri, günümüzde tüm işletmeler için önemli bir kaynak haline gelmiştir. Veriden değer üretme ve katma değer oluşturma konusunda yapılan çalışmaların, tüm sektörlerde uygulanması gerektiği düşünülmektedir. Analiz kısmında, veriler manuel olarak analiz edilmiştir. Bu verilerin analiz edilmesi için geliştirilmiş paket programlar kullanılarak yeni araştırmalar yapılabilir. BV'nin pazarlama öngörülerinde kullanımını belirlemek amacıyla yapılan bu çalışma, işletmelerin muhasebe, finans, insan kaynakları, AR-GE gibi diğer departmanlarında da uygulanabilir. Bu sayede, BV ile işletmelerde neler yapılabileceği keşfedilebilir.

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Books: Kenen, P.B. (1989), *The International Economy*, Englewood Cliffs, N.J.: Prentice-Hall, Inc.

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<u>Dergiler:</u> Langeheine, B. & U. Weinstock (1985), "Graduate Integration", *Journal of Common Market Studies*, 23(3), 185-197.

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8. Kaynaklar'da web sitelerine yapılan atıflar muhakkak, gün, ay, yıl olarak alındığı tarih itibariyle ve tam adresleriyle birlikte belirtilmelidir.

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