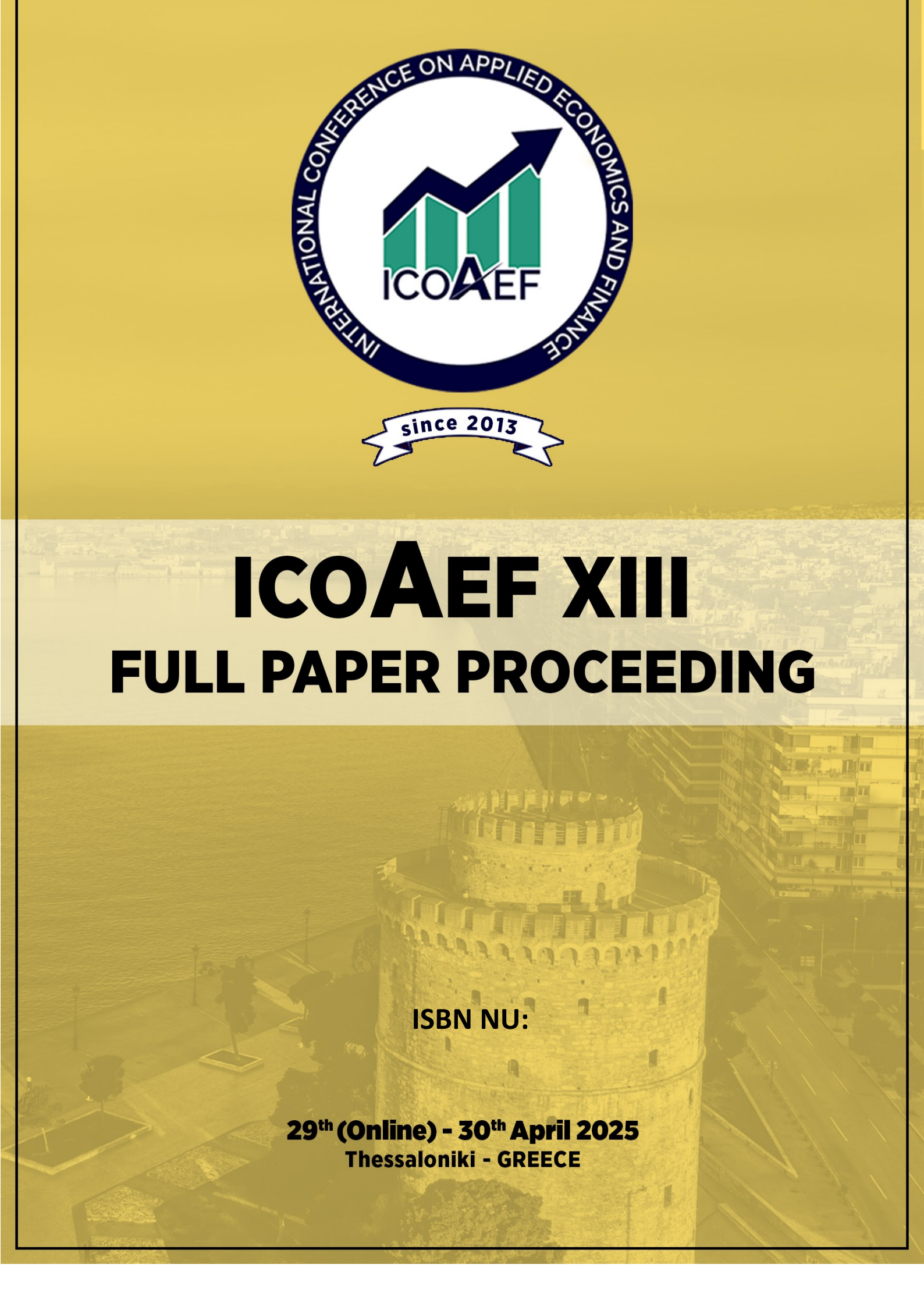

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WELLCOME MESSAGE

International Conference on Applied Economics and Finance (ICOAEF XIII) held on 29th-30th April, 2025 in American College of Thessaloniki in Thessaloniki/Greece. We are glad XIII. International Conference on Applied Economics Finance (ICOAEF XIII) gathered many successful academics and professionals around the World. 69 papers were submitted, and 65 papers presented during ICOAEF-XIII from 21 different countries.

This conference provided as a suitable platform for discussions about the researches. This conference full paper proceeding contains 19 papers presented both online and in person. ICOAEF-XIII participants consisted of from 21 different countries, 23 Turkish universities in Türkiye. Scientific board rejected 4 papers directly due to the inconvenience of conference topics, theme and structure of ICOAEF-XIII. Scientific committee also requested some corrections to 8 different papers then these papers accepted and presented during the conference. All submissions for ICOAEF-XIII scientifically reviewed and evaluated by scientific committee members.

We believe that ICOAEF-XIII provided an opportunity for national and international participants to present, discuss and share practical and theoretical issues in the fields of Economics, Finance and related social sciences. The papers submitted from 20 different countries beyond Turkey. We accepted papers of the participants from Albania (2), Austria (1), Azerbaijan (1), Belgium (1), Canada (1), China (2), Egypt (2), Germany (2), Greece (12), Hungary (1), India (2), Ireland (1), Italy (1), Japan (1), Kosovo (1), Morocco (1), Poland (1), Romania (2), Türkiye (27), United Kingdom (2), and United States (1). Finally, we would like to thank Freie University and our esteemed ICOAEF-XIII participants who shared their deep knowledge and experience at ICOAEF-XIII. We would like to be together in our following organizations.

On behalf of Conference Organisation Committee

Prof. H. Murat ERTUGRUL

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CONSUMER BEHAVIOR AND E-COMMERCE: EXAMINING AI-POWERED MARKET TRENDS

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Yavuz Tansoy YILDIRIM**

Yasin Nuri ÇAKIR***

ABSTRACT

AI-powered chatbots help customers with their shopping experience and product recommendation systems that analyze consumer behavior to suggest products also help improve conversion rates. This study uses a mixed-method approach, which combines empirical data from consumer surveys with qualitative insights from the industry literature.

Generally, we must note that, Research shows that such AI-powered recommendation systems, chatbots, and predictive analytics improve customer satisfaction and conversion rates. Moreover, machine learning-powered pricing strategies also help to adjust purchasing behaviors and assist to conduct sentiment analysis. The all findings of research beget that personalization and automation bolster customer loyalty as they raise data privacy issues.

According to the findings, companies that maximize their AI usage are more competitive; however, ethics are still important to consider. Comprehending these dynamic AI-fueled consumer patterns helps companies to make marketing choices sharper and to enhance the user experience in the online space.

Keywords: *AI in E-commerce, Personalization, Consumer Behavior, Online Shopping Trends, Machine Learning.*

JEL Codes: *L81, D4, P36.*

1. INTRODUCTION

AI is rolling fast and continuously changing the way people shops that is even changing consumers behavior, their decision-making process, overall shopping experience. AI-powered solutions, like personalized recommendations, predictive analytics, dynamic pricing, and chatbot-assisted interactions, have upended traditional retail models. With online marketplaces becoming more cutting-edge, businesses are required to stay in line with the trends to increase customer engagement and satisfaction.

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The digital-age consumer is complex, and the manipulation of real-time data to determine responses is automated, instantaneous, and hyper-personal. By analysing vast amounts of user data with AI-powered algorithms, businesses can provide personalized product recommendations, enhance marketing strategies etc. While the advantages of AI in eCommerce are significant, concerns about data privacy, algorithmic bias, and ethical considerations have also emerged, leading to discussions on responsible AI usage (Du and Jiang, 2019).

This research intends to explore the effect of AI-based technologies in e-commerce consumer decision-making, purchase intentions and brand loyalty. This research endeavors to offer insights in the shape of tracking emerging trends to navigate the challenges and opportunities that AI relates with the Future of e-Commerce.

2. LITERATURE REVIEW

Today's rapid digital transformation of commerce has significantly altered consumer behaviours with AI taking the centre stage of the evolution of the online shopping experience. Machine learning algorithms, predictive analytics, natural language processing, and automated recommendation systems are AI-driven tools that are revolutionizing e-business and e-commerce by proposing high levels of personalization, efficiency, and interactivity.

They typically depended on static product listings and manual customer service interactions; however, with the development of AI technologies, online dealers can now analyze consumer information in actual time, predict buying behavior accordingly, and tailor product offers. AI has massively improved productivity levels by optimizing inventory management, automating customer service via intelligent chatbots, and streamlining the decision-making process using predictive behavioral analysis. While these technological advancements have aided businesses in terms of sales and customer retention, they have also enhanced user experiences, allowing online shopping to be even more seamless, interactive, and intuitive (Tang, Qiu, Guo and Liu, 2018).

However, the growing reliance on AI in e-commerce also raises concerns about data privacy, algorithmic bias, transparency, and ethical implications. Consumers are increasingly aware of how their data is collected, stored, and used by online retailers, prompting conversations about ethical AI practices and regulatory compliance that are growing stronger. Organizations harnessing the power of AI-driven insights must walk a line between technological progression and consumer safety; personalization should not come at the expense of privacy or a world where marketing is only intrusive (Wang, and Quan, 2019).

The purpose of this study is to identify how the neoteric trends in rise of AI products have impacted end users the consumers of e-commerce especially Personalized Recommendations, Automated Customer Interactions, Dynamic Pricing, and Ads Targeting, Artificial Intelligence Innovations. Through an analysis of the advantages and disadvantages of adopting AI in e-commerce, this study aims to

highlight what businesses should consider when integrating AI while alleviating consumer protection concerns, therefore providing relevant content to companies looking to successfully integrate AI into their operations (Tridalestari, Mustafid and Jie, 2023).

Customers are individuals who go through the process of purchasing a product or service, whereas consumers are individuals who make use of a product or service. In spite of the fact that a brand is constantly attempting to sell a product or service to customers, individuals and companies that are well-versed in traditional models of consumer behavior are in a better position to convert customers into customers.

Being well-versed in consumer behavior models and having an understanding of how they behave in the decision-making processes of consumers is beneficial to a brand because it helps the brand increase the number of customers it already has and develop its commercial activities.

An additional option is to read this article and gain knowledge about consumer behavior models in order to learn how to convert potential customers into paying customers.

Businesses that engage in commercial activities face a number of challenges, one of the most significant of which is the need to comprehend the various models of consumer behavior and to act accordingly. The reason for this is that brands have the ability to speed up the process of a consumer becoming a customer by proficiently learning consumer behavior models. Furthermore, brands are able to avail themselves of numerous advantages by gaining an understanding of consumer behavior models (Zhong, Yang, Mei, Xie and Yu, 2024):

- By gaining an understanding of consumer behavior, a brand has the ability to increase the number of customers it already has.
- Brands have the opportunity to develop strategies that will make it easier for them to communicate with their existing customers if they keep themselves informed about the behavior of consumers.
- As a result of the psychological factors that influence the preferences of consumers when it comes to making purchases, marketers have the opportunity to sell their goods and services with greater ease.
- If you are able to determine the sociological factors that influence the decision-making process of customers, it will be much simpler for you to comprehend the degree to which individuals feel connected to your brand.
- Brands are able to develop strategies that will allow them to increase their sales when they have a solid understanding of the traditional consumer behavior models that influence the purchasing decisions of customers.

Brands that sell their goods and services online through e-commerce or e-export should always have knowledge of traditional consumer behavior models. This is because of the advantages that these models offer. As a result of the fact that brands that learn behavioral types are able to develop these strategies more easily and have a greater chance of being successful.

It is common knowledge that not every individual displays the same traits and behaviors. This can be a problem for brands that want to understand the behaviors of a consumer and develop a strategy that is applicable to the situation in order to deal with certain circumstances. mainly due to the fact that different people have different tendencies, which causes brands to make incorrect analyses and determinations, which ultimately results in a reduction in the benefit that receives. With that out of the way, let's take a look at the circumstances in which consumer behavior is not advantageous (Zhong, Yang, Mei, Xie and Yu, 2024).

- A decrease in sales for your brand will occur if, while conducting an analysis of consumer behavior, you fail to identify a need and then fail to provide products and services to the market in response to this market need.
- It is possible for brands to encounter difficulties in areas such as purchasing, budget management, and marketing if they do not conduct a thorough analysis of the behavior of their customers and do not make any adjustments in response to the findings.
- For brands that are only concerned with consumers and customers up until the point where they sell a product, it will not be possible for them to acquire loyal loyal customers.
- In order to avoid these kinds of drawbacks, every brand needs to have a solid understanding of and ability to analyze consumer behavior.

3. AI IN E-COMMERCE: TRANSFORMING CONSUMER BEHAVIOR

One of the most critical areas where AI finds a role in e-commerce is personalization and it is largely facilitated through recommendation engines that apply machine learning algorithms that analyze consumer behavior. The systems aim to follow up a user's past interactions with a website such as search history, past purchases, and time spent on product pages to recommend the user with items that best fits their interests and preferences.

Content-based filtering, collaborative filtering and hybrid systems are the three commercially adopted personalized recommendation systems. A content-based filtering approach provides recommendations based on the attributes of the products someone previously interacted, whereas a collaborative filtering approach finds similar consumers and makes recommendations to users based on related user behavior. Hybrid models blend aspects of these two approaches to deliver exceptionally accurate and adaptive recommendations, boosting user engagement and increasing sales conversions (Shao and Chen, 2019).

3.1. Personalization and Recommendation Systems

As their adoption has grown in e-commerce, its fundamentals have revolutionized consumer interaction with digital platforms. While in traditional retail environments purchase decisions were largely driven by personal preference, word of mouth, and in-store support, AI now stands as the main pillar to consumer decision-making, enabling automated and personalized experiences that are highly data driven. Businesses have also harnessed AI algorithms and tools to track web browsing behavior, recognize purchasing behaviors, and foresee future buying behaviors (Quan, Wang and Xia, 2019).

3.2. Chatbots and AI-Driven Customer Service

AI-powered customer service solutions, like chatbots and virtual assistants, have turned into natural parts of an contemporary e-commerce system, offering quick customer service, dealing with usually asked questions, and instructing customers through their buying experience. Traditional customer service is dependent on human representatives who can be limited by the opening and closing hours of an organization, but AI in many businesses can generate customer chats 24 hours a day without any delays, meaning consumer can always get responses and assistance regardless of their time zone, geographical locations and unique issues without being afraid of disturbing the representative (Wang, and Quan, 2019).

NLP and deep learning algorithms are utilized by these chatbots to simulate human-like interactions, which enable them to comprehend and respond to customer queries in a conversational manner. Moreover, sentiment analysis equips these AI chatbots with the ability to perceive emotional cues within consumer messages, resulting in more empathetic and personalized replies. AI-powered customer support not only lowers operational expenditures for businesses but also boosts customer satisfaction by delivering prompt, precise, and smooth assistance.

3.3. Dynamic Pricing and AI-Based Pricing Strategies

AI has also transformed e-commerce pricing in the way that it's so smart that it can facilitate dynamic pricing models, where real-time adjustments to product prices can be made depending on several variables such as consumer purchases, demand variations, competitor pricing and market trends. Static pricing methods have several commercial drawbacks; they are based on approximation of demand and require manual updates, leading to large inconsistencies between current commercial practices and demand; however, AI-powered dynamic pricing enables dynamic adjustments of prices through considering a variety of economic factors for profit maximization, which doesn't compromise competitiveness (Li and Peng, 2020).

Machine learning algorithms sift through terabytes of market data and decide at any moment what is the optimal price point for a product. This is a tactic employed in industries like airline ticket pricing, hotel pricing and ride-sharing to set pricing based on supply and demand. Moreover, AI-powered pricing strategies can be customized for each consumer, taking into account their browsing history, spending

habits, and chances of making a purchase, enabling businesses to provide price discounts or time-sensitive promotions to boost conversion rates.

4. AI-DRIVEN MARKETING AND CONSUMER ENGAGEMENT

This has completely revolutionised digital marketing, allowing companies to create ad campaigns that are highly targeted, automate their content creation and make customer interaction easier. Spiderweb, an AI-driven marketing strategy used predictive analytics, machine learning, and consumer behavior modeling to find and target the right audience with the most relevant use of their dollars (Li, Liu, Zhang, Peng and Yu, 2022).

4.1. AI-Powered Targeted Advertising

AI-driven targeted advertising allows businesses to deliver personalized ads to consumers based on their browsing history, search queries, and demographic data. Advertise Platforms listen to how the audience reacts to their products or the word and they employ AI to provide better results to the general public through ads, which means that platforms such as Google Ads, Facebook, Instagram, etc., track user behavior to help advertisers know their most relevant products for that audience (Wang, and Quan, 2019).

With the cutting-edge technology, programmatic advertising, which automates the buying and placement of online ads, allows businesses to target the most qualified leads at the right time, streamlining the ad process and making advertising more cost-effective than before. Marketers can use predictive analytics to predict consumer trends and adapt their advertising strategies as a result, so their campaigns can adapt to new developments.

4.2. Voice Commerce and AI Assistants

Online shopping has leaned into voice commerce, at the hands of AI-driven voice assistants like Amazon Alexa, Google Assistant, and Apple Siri. With voice recognition technology, consumers can search for goods or services, compare prices, and even make a purchase using simple voice commands - making it easier and more accessible than ever.

With voice commerce emerging as an important trend, companies are ensuring the integration of conversational AI systems that can redefine aspect of speech recognition and build on the accuracy of product recommendations driven by verbal queries.

This is particularly pertinent to new technologies such as voice-based commerce where a data privacy deficit can have negative consequences around the globe; as artificial intelligence assistants collect vast amounts of voice information, any leaks, misuse, or unauthorized use in this new context would present a serious concern to consumer trust around the world (He, Lu and Zhou, 2008).

5. RESULT AND DISCUSSION

Table 1. AI Impact on Different Companies

Company	AI Application	Increase in Conversion Rate (%)	Reduction in Operational Cost (%)	Customer Satisfaction Improvement (%)	Revenue Growth (%)
Company A	Personalization and Recommendation	28	12	48	27
Company B	Chatbots and Customer Service	22	45	63	18
Company C	Dynamic Pricing	18	20	30	33
Company D	AI-Powered Targeted Advertising	35	25	50	42
Company E	Voice Commerce and AI Assistants	12	8	38	16

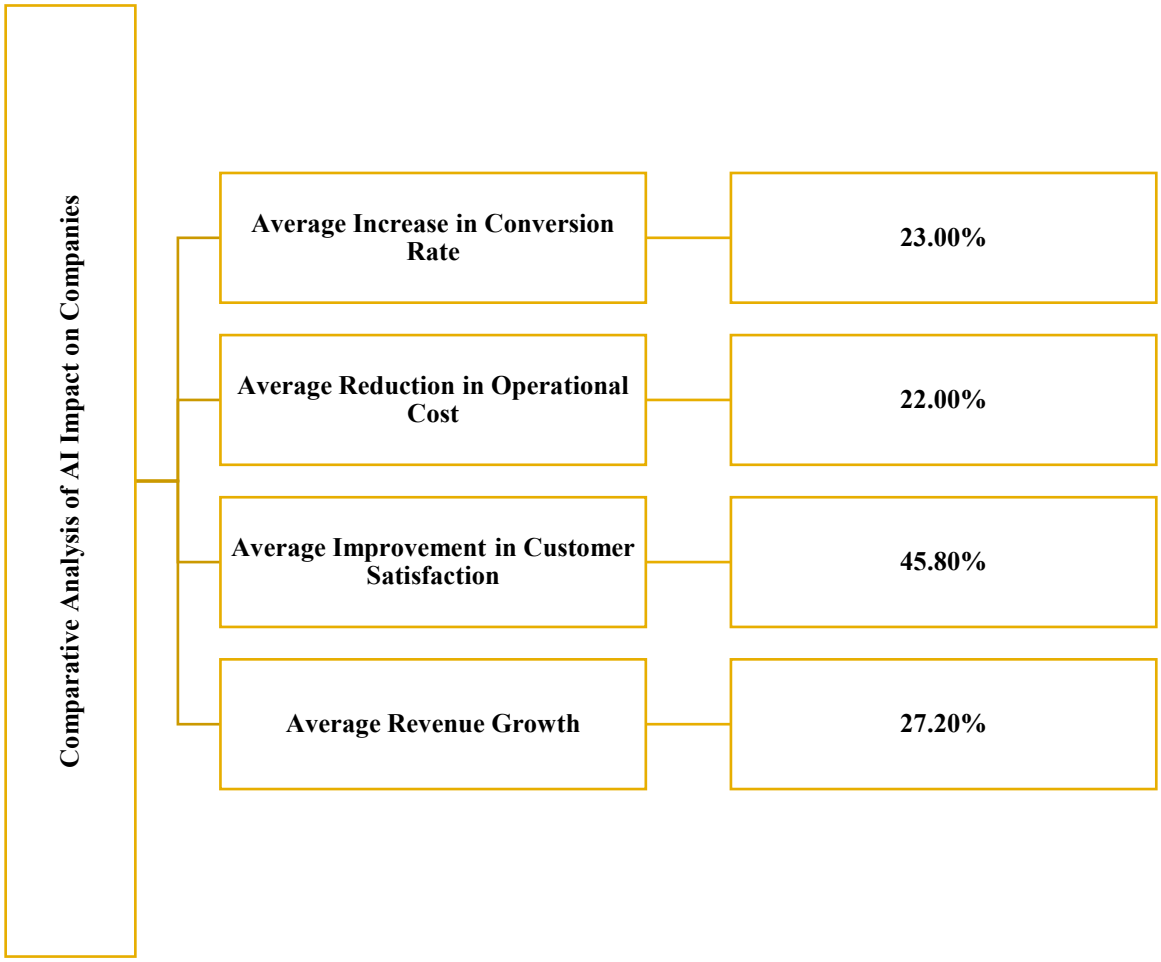
AI-driven targeted advertising has proven to be the most effective strategy among the companies analyzed below: Among XYZ companies, company D, which utilized AI-powered targeted advertisingow, recorded the fastest revenue growth of 42% and the highest conversion rate increase of 35% (leading to significant increase in profitability).

The overall winner was company B, which provided AI chatbots and automation for customer service, cutting operational expenses by 45% and improving customer satisfaction by 63% a clear demonstration of creating a better user experience at lower labor costs. However, Company C, which implemented dynamic pricing models saw moderate increases in conversion rate (18%) but the second-highest revenue growth (33%).

This demonstrates that while AI-driven pricing strategies can adapt to changes in demand, they can also leverage fluctuations in consumer behavior to maximize profit margins.

AI-powered personalization with recommendation systems combined, was a significant success for Company A, with a 28% increase in conversion rates and a 27% increase in revenue, highlighting high value in user engagement through AI. Company E (voice commerce with AI assistants had no significant trends, less adoption, lowest sales conversion growth (12%)) also shows that voice-based AI shopping is likely still in its early phase of large-scale consumer behavior impact.

Schema 1. Comparative Analysis of AI Impact on Companies



These findings indicate that AI is good for all companies, but the impact varies by type of application and business model. Targeted advertising and dynamic pricing drive the highest revenue gains for companies, while AI-powered customer service is associated with lower costs and higher customer satisfaction. AI personalization is still driving conversion, while voice commerce uptake is still in transition toward being a mainstream e-com tool.

6. CONCLUSION

Artificial Intelligence in e-commerce is revolutionizing consumer behavior, altering the ways people interact with online marketplaces, make purchasing choices, and connect with brands. Deployed AI-powered innovations from personalized recommendation systems, dynamic pricing strategies and automated chatbots to targeted advertising have greatly improved customer experience with convenience, efficiency and hyper-personalization. Consumer-facing businesses now offer highly personalized shopping experiences where AI powerfully anticipates consumer preferences, recommends relevant products and provides effortless customer service.

Yet with these technological advantages come significant challenges over data privacy, algorithmic fairness and the ethical use of AI, all potential minefields that businesses must navigate if they want to retain the trust of their customers. The aggregation and analysis of large quantities of personal data create risks of data breaches, unauthorized access, and misuse of consumer data. The flawed algorithms of recommendation systems and dynamic pricing models can perpetuate algorithmic biases, unfairly targeting customers or loading them with unexpectedly high charges — disastrous for customer satisfaction and brand reputation. It is crucial to manage the risks associated with these advancements through transparency, regulatory compliance, and the responsible development of AI technologies, to promote a more ethical e-commerce landscape.

Augmented reality (AR), blockchain integration, and even autonomous shopping experiences are just some of the emerging technologies poised to reshape the future of AI-powered e-commerce, as they aim to maximize consumer engagement and security. AI-driven AR applications will enable consumers to see products in real-time before buying, while blockchain technology will provide more transparency and security for digital transactions. The growth of cashier-less stores and AI-powered inventory management systems will further transform the dynamics of retail, making shopping experiences increasingly frictionless and autonomous.

To sum up, despite the evident revolution AI has brought to the e-commerce world through elevated personalization, automation, and predictive talents, we cannot disregard its ethical ramifications and the impression it has on the consumers trust. Businesses have to find this balance: using AI to leverage their competitive advantages while also ensuring they play by the ethical rules consumers expect. With the continued evolution of AI technology, companies that focus on transparency, personalization, and making the shift to ethical AI will have a greater chance of succeeding in this rapidly evolving digital marketplace.

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ASSESSING GENDER EQUALITY IN EUROPEAN LABOUR MARKETS:

AN EXTENDED MODEL WITH ECONOMIC COMPLEXITY[1]

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Meltem INCE YENILMEZ[**]

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ABSTRACT

The link between economic complexity and gender equality seems to be one of the critical but underestimated issues of sustainable development in the contemporary world. Although there is extensive literature about gender discrimination in labour markets, there is still a significant gap in the evidence of the emerging determinants of this fact. In this sense, this study explores the relationship between economic complexity and female labour force participation for European countries during the 1995 – 2021 period. The empirical findings suggest that economic complexity has a positive impact on female labour force participation rate in Europe. Moreover, economic growth, fertility, and the one-year lagged value of female labour force participation have positive impacts on female labour force participation. However, it seems that foreign direct investment inflows and tertiary education of women have no significant effect on the dependent variable. The study aims to contribute to the related literature by examining the direct impact of economic complexity on female labour force participation with a comprehensive empirical analysis in a European context.

Keywords: *Gender Equality, Labour Force Participation, Economic Complexity, Panel Data Analysis, European Union.*

JEL Codes: *J16, M14, P50.*

1. INTRODUCTION

Labour economists have been devoting significant attention to gender discrimination in labour markets. The basic reason for this attention is the persisting sexual differences in earnings and occupations on a global scale (Neumark, 2004: 1). This situation is not related only to the income level since it's valid even in high-income countries. In this sense, there are several other reasons for gender discrimination in labour markets. Some of the basic ones can be listed as: women's enrollment in higher education, the

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general belief about childcare that it's predominantly women's work; the rate of women rights and movements as a part of public policy; the glass ceiling; cultural backgrounds and religious beliefs (Orloff, 2009; Evans and Kelley, 2008; Kephart and Schumacher, 2005; Maltby et al., 2010). It's widely accepted that the share of female employment is an important parameter, especially for ageing societies. During recent decades, European countries have experienced an ageing labour force and declining fertility rates among their citizens. Hence, it has become an important policy tool to activate women in the labour force (Orloff, 2009: 325). Moreover, developed countries have realized that female labour force participation rates have been lagging behind male labour force participation rates, although they support care services and family work (Leira, 2002). Consequently, in recent years, policymakers have been working through the other factors directly or indirectly linked to female labour force participation. In this sense, the nexus between economic complexity and gender development can be an important aspect of sustainable development.

Hidalgo and Hausmann (2009) underline that gross domestic product (GDP) per capita values of countries have significantly changed during the last two centuries, primarily due to nontradable capabilities of countries giving rise to productivity differences. They state that those capabilities, such as specific labour skills, property rights, infrastructure, cultural background, know-how, etc., increase productivity and hence the complexity levels of countries. Productivity, in other words, increasing returns, is characterised by high technology industries in that nontradable capabilities are used intensely (Durlauf, 1998: 161). In this sense, innovative knowledge and know-how are the key factors of such capabilities in industries, and embedded knowledge in the economy directly increases the economic complexity. The best way to measure the level of economic complexity is hence to measure the mix of products that the economy can produce and export (Hausmann et al., 2011: 17-18). Economic complexity theory is an emerging theory that has been trying to explain economic growth and development in terms of revealed comparative advantages and economic complexity levels. In this theory, the related diversity of the economy's productive outputs is an important indicator of economic complexity level, and it reflects endogenised innovative knowledge in the economy (Hausmann et al., 2011: 18). Hausmann and Klinger (2006) have developed the product space concept to measure economic complexity level, and hence they made an important methodological contribution to literature. During the ongoing process, Hidalgo and Hausmann (2009) developed this concept, and they suggested the Economic Complexity Index (ECI) as a new indicator. The critical points in the calculation of this index are how many products can be produced by the existing resources; how many countries can produce those products, and what is the share of their production in the overall production. In this sense, the higher ECI values refer to the higher competitiveness levels of countries and higher economic growth and development prospects (Hausmann et al., 2011).

In short, complexity theory suggests that high technology industries increase the range of products, productivity, economic complexity level and hence economic growth rate. Consequently, it's assumed

that a higher level of complexity is a good indicator for an economy. However, the results of the complexity in labour markets in terms of gender discrimination are underestimated in the literature. In this context, this study tries to shed some light on the relationship between female labour force participation rates and the economic complexity levels of countries. The fundamental research question is whether a more complex economy is better for women or not. In this context, this study is expected to make a significant contribution to the related literature by extending the determinants of female labour force participation with the addition of the economic complexity index. To the best of our knowledge, this is the first attempt to examine the determinants of female labour force participation from the perspective of economic complexity in European countries with a dynamic panel data estimation. In this context, after a brief introduction, a literature review is given in the second section. The following empirical analysis is explained in terms of data, model, method and empirical results in the third section. Lastly, the empirical findings are discussed, and policy implications are developed in the conclusions.

2. LITERATURE REVIEW

Gender discrimination has been a popular research area since the emergence of the human development approach. Especially with the rise of empirical research methods, there have been numerous studies examining gender inequality in different economies in the empirical literature since the beginning of the 1990s. Mentioned studies had different perspectives about the measurement of gender discrimination, and hence, they used different empirical methods. In this sense, some studies examined gender inequality in terms of wage gaps (such as Kasnakoglu and Dayioglu, 1997; Lovell, 2000; Ozcan, Ucdogruk and Ozcan, 2003; Ng, 2007; Nwaka, Guven-Lisaniler and Tuna, 2016; and Sefil Tansever and Kent, 2018) and some other studies examined from the perspective of labour force participation (such as Reddy, 1975; Pampel and Tanaka, 1986; Macunovich, 1996; Goksel, 2013; Lahoti and Swaminathan, 2016; Celebioglu, 2017; Puga and Soto, 2018). In this study, the labour force participation perspective is adopted due to the availability and continuity of country-level data for a longer period.

In the empirical literature, there is a consensus about the determinants of the female labour force participation rate. The basic determinants can be listed as income, women's school enrollment rates, fertility rate, divorce rate, marital status, household size, education expenditures and foreign direct investments (Please see Wacker, Cooray and Gaddis, 2017; de Laat and Sevilla-Sanz, 2011; Bloom et al., 2009; Schröder and Brüderl, 2008; Macunovich, 1996 and Nam, 1991). In some studies, some other determinants like corruption, pollution, migration and democracy are added to check their significance and impact on the dependent variable (Please see Jha and Sarangi, 2018; Burke and Dundas, 2015 and Iversen and Rosenbluth, 2008; Evans and Keller, 2008). In our study, the general view is extended by adding the economic complexity index and its impact on the female labour force participation rate is examined for European Union countries.

In recent years, various studies examining the impacts of economic complexity on economic growth and development have emerged. Searching for the links between complexity and growth and development has its origins in Hausmann and Klinger (2006) and Hidalgo and Hausmann (2009). In the following years, Simoes and Hidalgo (2011) and Hausmann et al. (2011) showed this relationship with detailed analyses in the Observatory of Economic Complexity and the Atlas of Economic Complexity, respectively. In the following years, some empirical studies used the ECI values that had already been calculated in the Observatory or the Atlas, and some others calculated ECI values at the micro-regional level by themselves. As some examples, Felipe et al. (2012) analysed the product and country-level complexities of 124 countries from 2001 to 2007, and they found that high-income countries export more complex products that underline the direct relationship between income and complexity. Hartmann et al. (2017) searched for the relationship between ECI and GINI[1] coefficient for 150 countries between 1963 – 2008, and they found that as complexity level increases, income inequality decreases. Zhu and Li (2017) conducted their research on 126 countries and the 1995 – 2010 period. They found that complexity and economic growth are in a positive relationship. Yildiz and Yildiz (2019) searched for the relationship between economic complexity and growth in the newly industrialised countries for the period of 1970 – 2016. They found that suggested variables are in a bidirectional relationship in China, but there is a one-way causality from complexity to growth in Mexico, Malaysia and South Africa. Consequently, it's observed from empirical literature that economic complexity and economic growth and development are in a direct relationship. In this manner, complexity can be assumed to be linked to gender discrimination, which is also a dimension of economic development. However, since economic complexity literature is an emerging area, there are not many studies examining the relationship between economic complexity and gender discrimination. In a recent study, Türkcan et al. (2024) investigated the impact of ECI on female labour force participation rate in different country groups. They found that the size and sign of the impact vary according to the income level of the countries. Moreover, Saâd and Assoumou-Ella (2019) analyzed the impacts of economic complexity on the gender parity index in education for countries with different income levels between 1984 – 2014. They investigated that economic complexity has a mainly positive impact on the gender parity index in different country groups for different education levels. It seems from the literature that other studies searching for gender discrimination from the view of complex economic systems mainly use the comparative advantages approach rather than the complexity measurement method. The basic idea behind those studies is that comparative advantages in foreign trade promote economic growth, and economic growth in turn lowers gender inequalities. Some of the studies suggest that as the export-led growth process is experienced, it causes more women to get jobs, especially in export-oriented sectors (Saâd and Assoumou-Ella, 2019; Sajid, 2014; Korinek, 2005). On the other hand, there are some other studies suggesting that the export-led growth process does not have a positive impact on lowering gender discrimination in labour markets, such as Gaddis and Pieters (2017), Sundaram (2009), Berik, Rodgers and Zveglich (2004) and Seguino (1997). Consequently, it seems from empirical literature that there is little research available on the direct interplay between gender discrimination and

economic complexity. Moreover, the empirical findings about indirect relationships are contradictory and open to testing. In this sense, the empirical analysis conducted in this study is expected to make a significant contribution to the related literature.

3. METHODOLOGY

3.1. Data, Variables and Model

In econometric estimation procedures, there are three types of data sets as time series, cross-section and panel data sets. As it's widely accepted, panel data has some superiorities over time series and cross-sectional data since such data includes both time and cross-sectional impacts at the same time. Moreover, panel data provides more efficient estimation results with a higher number of observations and higher degrees of freedom. Also, panel data sets decrease the possibility of multicollinearity between explanatory variables (Hsiao, 2002: 1-3). Since panel data relates to individual units over time, techniques of panel data estimation have been enhanced to explicitly consider the heterogeneity (Gujarati and Porter, 2009: 592). Consequently, panel data sets have been used in this study to estimate the following regression function.

$$\text{flfpr}_{it} = \beta_1 \text{flfpr}(-1) + \beta_2 \text{eci}_{it} + \beta_3 \text{fertil}_{it} + \beta_4 \text{fdi}_{it} + \beta_5 \text{gdpgr}_{it} + \beta_6 \text{terwom}_{it} + \varepsilon_{it} \quad (1)$$

In this equation, the dependent variable is the female labour force participation rate (FLFPR). Independent variables are tertiary education of women (terwom), economic growth rate (gdpgr), Economic Complexity Index (eci), FDI inflows (fdi), fertility rate (fertil) and error term (ε), respectively. Moreover, i express the spatial dimension and t expresses the time dimension in our panel data set. Tertiary education of women is the tertiary school enrollment of women as a percentage of gross value. Economic growth rate is the annual percentage of gross domestic product per capita growth, and ECI is the economic complexity index value. Moreover, FDI inflows are the net foreign direct investment inflows as a percentage of GDP, and the fertility rate is the births per woman. Lastly, flfpr(-1) is the one-year lagged value of the female labour force participation rate. This model has been formed by following the empirical literature [Please see Hidalgo and Hausmann (2009); Hausmann et al. (2011), Gaddis and Klasen (2014) and Saâd and Assoumou-Ella (2019)]. In this study, data set covers 13 European countries and 1995 – 2021. The EU14 country group has been determined to be analysed since they are the most developed European countries. Luxembourg has been excluded from the dataset due to unavailable ECI data. This country group has been chosen for the analysis because EU14 countries have higher ECI values, and hence, this country group is a suitable case to examine the nexus between gender discrimination in the labour force and economic complexity. What is more is that their macroeconomic indicators are more reliable and consistent. Furthermore, the ECI dataset has been retrieved from the Atlas of Economic Complexity database. All other data have been obtained from the World Development Indicators Online Database.

3.2. Empirical Results

There are some basic steps to apply a well-defined econometric estimation process. In general, the first step while starting an estimation process is checking the stationarity of the series. The basic reason for this action is the fact that if series are nonstationary, then they may produce artificial regression and hence biased results. However, it's critical to determine which unit root test to apply. In this manner, cross-sectional dependency should be checked. If the series exhibits no cross-section dependency, first-generation unit root tests should be applied [Please see Coakley and Fuertes (1997), Levin, Lin and Chu (2002) and Im, Pesaran and Shin (2003)]. However, second-generation unit root tests should be conducted in case cross section dependency. Hence, Table 1 gives Pesaran CD Test results for the series in our study. This test is especially effective when the time dimension is relatively large in panel data (Pesaran, 2007).

Table 1. Pesaran CD Test Results

Series	t Statistic	Probability	Evidence
flfpr	26.85493	0.0000	Cross-section dependency
eci	21.05897	0.0000	Cross-section dependency
fertil	13.36428	0.0000	Cross-section dependency
fdi	7.214304	0.0000	Cross-section dependency
gdpgr	33.35583	0.0000	Cross-section dependency
terwom	32.50244	0.0000	Cross-section dependency

Pesaran CD Test results show that all series have cross-sectional dependency. Hence, second-generation unit root tests should be conducted for the detection of stationarity. In this step, the critical point is choosing a suitable unit root test for panel data properties. There are frequently used different tests as Breusch-Pagan LM Test, Pesaran Scaled LM Test, Bias-Corrected Scaled LM Test, Pesaran CD Test and Bai and Ng Panic Test (Pesaran, 2021; Breusch and Pagan, 1980). Table 2 gives a summary of Bai and Ng Panic Unit Root Test results.

Table 2. Bai and Ng Panic Unit Root Test Results (in level)

Series	t Statistic	Probability	Evidence
flfpr	-2.17570	0.02958**	Stationary
eci	1.05208	0.29276	Not stationary
fertil	-1.73378	0.08296*	Stationary
fdi	6.84730	0.00000***	Stationary
gdpgr	-2.47022	0.00000***	Stationary
terwom	-0.63562	0.52503	Not stationary

Note: * denotes 10% significance level; ** denotes 5% significance level, and *** denotes 1% significance level.

Table 2 exhibits that flfpr, fertil, fdi and gdpgr series have no unit root problems. However, eci and terwom have unit root problems. In this sense, first differences of these series have been taken and then Bai and Ng Panic Test has been conducted again. Test results are given in Table 3.

Table 3. Bai and Ng Panic Unit Root Test Results (in first differences)

Series	t Statistic	Probability	Evidence
eci	3.24024	0.00119***	Stationary
terwom	-1.96989	0.0244**	Stationary

Note: * denotes 10% significance level; ** denotes 5% significance level, and *** denotes 1% significance level.

Bai and Pg Panic Unit Root Test Results exhibit that first differences of eci and terwom series have stationarity. Consequently, their first differences should be used in the model estimation process. At this step, it is important to choose the appropriate method to conduct. Under certain assumptions[2], Ordinary Least Squares (OLS) method has attractive statistical properties that have made it one of the most popular methods of regression analysis (Gujarati and Porter, 2009: 55). OLS procedure minimizes the sum of squared residuals and tries to estimate the best fitted linear model (Ramanathan 1998: 88). However, GMM technique is a method which has superiority over maximum likelihood estimation that requires complete specification of the model and its probability distribution. GMM does not require all this knowledge since it needs only the specification of a set of moment conditions. The Method of Moments is a technique suggesting that the unknown parameters should be estimated by replacing population moments with the appropriate sample moments (Matyas and Harris, 1999: 4). Consequently, GMM is widely used in empirical studies using panel data. What is more is that one of the important tools of GMM technique is instrumental variables (Hansen and Singleton: 1982, Hansen,1982) Theoretically it's underlined that good instruments should be relevant and valid in the model (Baum et al., 2002: 2). In the literature, lagged values of variables in regression or some new exogenous variables are suggested to be used as instrumental variables as stated by Sargan (1958) and Fisher (1965). In this study, lagged values of independent variables have been used as instrumental variables because macroeconomic variables generally exhibit path dependency. Table 4 summarises dynamic GMM estimation results of our model, and the J statistic indicates that instrumental variable selection is effective for this model.

Table 4. GMM Estimation Results

Variable	Coefficient	t-Statistic	Probability
flfpr(-1)	0.973574	99.87837	0.0000***
eci	4.004220	2.285146	0.0413**
fertil	0.733845	2.577875	0.0242**
fdi	-0.007800	-0.847513	0.4133
gdpgr	0.106358	4.042099	0.0016***
terwom	0.177291	1.559352	0.1449
J stat	0.230846	**Prob. J stat.**	0.630898
Root MSE	0.845491	**S.E. of regression**	0.855265

Note: * denotes 10% significance level; ** denotes 5% significance level, and *** denotes 1% significance level.

Estimation results indicate that the one-year lagged value of flfpr is statistically significant and it has a positive impact on the current female labour force participation rates. This result indicates that there is a path-dependent inclination in female labour force participation in EU14 countries. Moreover, economic growth seems to have also positive impact on the dependent variable. This result is parallel with

the results of Gaddis and Klasen (2014). Furthermore, economic complexity seems to have a positive impact on female labour force participation rate, too. This result is in the same line as the results of Saâd and Assoumou-Ella (2019), and it is in the same line as some findings of Türkcan et al. (2024) for some country groups. Moreover, the fertility rate seems to have positive impacts in European countries, contradicting the results of Bloom et al. (2009). Lastly, foreign direct investment inflows and the school enrollment rate of women in tertiary education seem to have no significant impact on the dependent variable.

4. CONCLUSION

Analysing the determinants of gender discrimination is critical to achieving higher gender equality levels (Ince Yenilmez and Darici, 2024). It's observed from the empirical literature that there is a consensus on the basic determinants of female labour force participation rate (such as education level, fertility rate and income level). However, there are still ongoing efforts to find the other determinants. This study tries to analyse the impact of the economic complexity levels of European economies on their female labour force participation rates. Although there are some other studies examining the impact of economic complexity on gender discrimination, it seems that they either analyse indirect relationships or have insufficient empirical findings. Hence, our study tries to fill the gap in literature by examining the relationship directly for the labour force.

The empirical results suggest that economic complexity has a positive impact on the female labour force participation rates in EU14 countries. As mentioned before, economic complexity refers mainly to the higher levels of high-technology products in production and exports. If high-tech industries are dominated by men, as suggested by Prescott and Bogg (2011), Mayer (2006), Martin and Wright (2005) and Perrons (2003), then higher complexity levels of economies would cause lower female labour force participation rates. This situation was one of the main discussions of the 1990s, but it was also expected that emerging technologies would have increased female participation in high-tech industries. Our empirical finding about ECI suggests that this expectation is valid in European countries. It seems that as high technology production and exports increase, more women participate in the labour force. Probably, a more complex world is good for women in European countries under current circumstances. But it does not mean that it will be the same in other country groups. Türkcan et al. (2024) investigated different results for the different income levels. Hence, if necessary actions are implemented, then a more complex world can be a better place for women.

Moreover, some other important empirical results should not be underestimated during the policy formation process. Fertility rates have a positive impact on female labour force participation. This result suggests that as the number of children increases in a family, women need to take apart in income creation, more. Moreover, growth in per capita income has a positive impact on the female labour force participation rate. This result highlights the direct impact of economic growth on gender discrimination,

as in the related literature (Sajid, 2014; Korinek, 2005). Also, the one-year lagged value of the female labour force participation rate has a positive impact on the current female labour force participation rate. This result is also remarkable because it underlines the path-dependency in this indicator. In other words, if higher female labour force participation can be achieved, it would probably last for consecutive years.

To sum up, all these results should be thought of as an aggregate. A suitable policy should capture all the basic factors influencing female labour force participation, and the critical contribution of this study is the fact that it points out the impacts of economic complexity. Economic complexity should be perceived as one of the basic factors determining the female labour force participation rate, and policy actions should be taken to handle this variable.

Endnotes

1. GINI coefficient or GINI ratio is a statistical method to measure income inequality (Lambert and Aronson, 1993).

2. For these assumptions, please see Gujarati and Porter (2009): 61-68.

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THE ASYMMETRIC IMPACT OF GOVERNMENT EXPENDITURE ON ECONOMIC GROWTH IN TÜRKİYE: A NONLINEAR ARDL APPROACH

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ABSTRACT

The relationship between government expenditure and economic growth has been a subject of extensive debate and research in economics, with theoretical foundations tracing back to prominent figures like Wagner, Keynes, Peacock, and Musgrave. This discourse has led to the emergence of two primary schools of thought regarding the direction of causality, one suggesting that public expenditure is a consequence of economic growth, as posited by Wagner's Law, and the other asserting that public expenditure is a tool used by governments to stimulate economic activity and reverse downturns, as proposed by Keynesian economics. This study investigates the asymmetric effects of government expenditure on economic growth in Türkiye using a Nonlinear Autoregressive Distributed Lag (NARDL) model. The analysis covers the quarterly data from 1998Q1-2024Q4 and includes gross domestic product (GDP) as the dependent variable, while government expenditure, gross fixed capital formation, and Exports are employed as independent variables. In particular, government expenditure is decomposed into its positive and negative partial sums to capture potential asymmetric impacts on economic growth. By employing the NARDL methodology, this paper examines both the long-run and short-run asymmetries in the relationship between fiscal spending and economic performance. The empirical findings aim to provide new insights into the effectiveness of expansionary and contractionary fiscal policies in promoting sustainable economic growth in Türkiye. Policy implications are discussed in light of the asymmetric nature of government spending impacts.

Keywords: *Economic Growth, Government Expenditure, Fiscal Policy, Asymmetric Impact.*

JEL Codes: *O40, E12, E62.*

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1. INTRODUCTION

The relationship between government expenditure and economic growth has been a subject of extensive debate and research in economics, with theoretical foundations tracing back to prominent figures like Wagner, Keynes, Peacock, and Musgrave (Oyinlola, 2013). This discourse has led to the emergence of two primary schools of thought regarding the direction of causality, one suggesting that public expenditure is a consequence of economic growth, as posited by Wagner's Law, and the other asserting that public expenditure is a tool used by governments to stimulate economic activity and reverse downturns, as proposed by Keynesian economics. The Keynesian perspective suggests that increased government spending leads to higher economic growth through expansionary fiscal policy, stimulating aggregate demand and increasing GDP (Nyasha and Odhiambo, 2019). This perspective is based on the premise that increased government spending leads to increased production, which stimulates aggregate demand and increases GDP (Nyasha and Odhiambo, 2019).

Studies on the determinants of economic growth have long debated the role of public expenditure. The impact of public spending on growth has been evaluated in various ways within the framework of different economic approaches from a theoretical perspective.

Classical and neoclassical economists argue that government interventions and public expenditures create inefficiencies in resource allocation. In this approach, the crowding-out effect of public spending on private sector investments is emphasized. Especially, the decrease in private sector investments due to the rise in interest rates can have a negative impact on growth.

Keynesian economists argue that public spending can support economic growth. Especially during periods of recession characterized by insufficient aggregate demand, the expansionary effect of public spending can increase production and employment through the multiplier mechanism. According to this view, public spending is a tool that encourages growth in the short term.

The endogenous growth theories that developed after the 1980s emphasize the impact of public spending on long-term growth. Especially productive expenditures such as investments in education, health, research and development, and infrastructure can contribute to sustainable growth by supporting human capital and technological advancement. The impact of public spending on economic growth can vary depending on the type of spending. Capital expenditures aimed at investment (such as infrastructure, transportation, energy) can have positive effects on growth, while the impact of current expenditures (such as personnel salaries, transfer payments) may be more limited and short-term.

Recent studies have pointed out that the effects of public spending on growth may not be linear. The impact of increases and decreases in spending on economic growth may not be symmetrical. For example, while an increase in public spending positively affects growth, a decrease of the same magnitude may not have an equally contractionary effect on growth. This situation reveals that the response mechanisms in the economy operate differently and that asymmetric effects exist.

In the analysis of such nonlinear relationships, the Nonlinear Autoregressive Distributed Lag (NARDL) model is commonly used. The NARDL approach allows for the analysis of the different effects of the positive and negative components of independent variables on the dependent variable by separating these components. In this context, the study examines the asymmetric effects of public spending on economic growth in the Turkish economy using the NARDL method.

2. LITERATURE REVIEW

Using dynamic panel data approaches, Olaoye et al. (2020) look at the uneven link between government spending and economic growth in ECOWAS countries. Their research shows that shocks to government spending that cause the economy to grow or shrink have very different effects on growth. They found evidence for an inverted U-shaped relationship, which means that the effects of government spending on growth get weaker after a certain point. These results show how important it is to look at non-linear and asymmetric dynamics when analyzing fiscal policy for developing economies.

Wahab (2011) investigates the asymmetric effects of government spending on output growth using cross-sectional and panel data methods. The study finds that government spending positively impacts output growth primarily when spending growth is below its long-run trend, while above-trend spending yields insignificant or weaker effects. These findings underscore the importance of considering nonlinear fiscal dynamics and suggest that moderate fiscal expansion can be more effective in stimulating growth, especially in developing countries. Bureau (2020) uses a multiple linear regression model to investigate how government spending affects economic growth in Nigeria. The analysis concludes that while capital spending does not show a significant relationship with economic growth, recurring expenditure significantly boosts GDP. These findings emphasize how crucial it is to give productive recurring spending top priority in order to boost Nigeria's economy.

Abdelli et al. (2024) investigate the asymmetric effects of sectoral government expenditures on economic growth in Tunisia using a NARDL model. Their findings reveal that government spending on agriculture and health positively influences GDP, while expenditures on education and the military have a negative impact. These results highlight the importance of targeted fiscal policies, emphasizing that not all public spending contributes equally to economic growth in developing economies. A thorough analysis of empirical research on the connection between public spending and economic growth in different nations is carried out by Nyasha and Odhiambo (2019). According to their findings, the effects of government spending vary depending on the country setting, methodological approach, and type of expenditure. Studies have found either positive, negative, or no significant effects. Despite conflicting data, the literature generally suggests that public spending and economic growth are positively correlated.

Anjande, Ahemen, and Ijirshar (2020) use dynamic panel models to analyze the asymmetric effects of government spending on national income and unemployment in 40 African nations. Their findings show that increased government spending significantly boosts national income and reduces

unemployment, whereas spending cuts have the opposite effect, implying that expansionary fiscal policy is more effective than contractionary measures in promoting regional economic stability. Maulid, Bawono, and Sudibyo (2021) analyze the impact of different components of government expenditure on economic growth in Indonesia from 2005 to 2019. Their findings show that personnel and material expenditures positively and significantly influence economic growth, while capital expenditure has a significant negative effect, and interest payments, subsidies, and social expenditures have no significant impact. These results highlight the importance of expenditure composition in fiscal policy and suggest that not all government spending contributes equally to economic performance. Jolaiya (2024) investigates the impact of government capital expenditure on economic growth in Nigeria using data from 1998 to 2022 and a multiple regression model. The study finds that capital expenditure on agriculture has a significant positive effect on GDP, while spending on health, education, and the environment does not have a statistically significant impact. These results suggest that targeted investments in agriculture may yield better growth outcomes than broader capital spending across sectors.

Berument and Doğan (2004) analyze the asymmetric effects of expansionary and contractionary government spending shocks on key macroeconomic variables in Türkiye. Their findings reveal that expansionary government spending tends to reduce private consumption and investment, while contractionary shocks have smaller or statistically insignificant effects, indicating a clear asymmetry in fiscal policy outcomes. These results suggest that the private sector reacts more strongly to fiscal expansions, possibly due to expectations of future tax burdens and interest rate responses. Hasnul (2015) looks at how Malaysia's disaggregated government spending affects economic development using data from 1970 to 2014. The analysis demonstrates that total government spending, especially on housing and development, has a big negative influence on economic growth. Spending on education, health, defense, and running costs does not have a big effect. These results show that too much or poorly planned public spending may hurt the economy, which makes it hard to apply the Keynesian premise to Malaysia.

Indana and Mulyani (2021) analyze the effects of labor, exports, and government expenditure on Indonesia’s economic growth using time series data from 1990 to 2020. Their results show that each variable—labor, exports, and government expenditure—has a positive and statistically significant impact on economic growth, both individually and collectively. These findings reinforce the importance of coordinated fiscal and trade policies in promoting sustainable economic development.

3. DATA SET

In this study, annual quarterly data for the period 1998Q1–2024Q4 were used to analyze the asymmetric effects of public spending on economic growth in the Turkish economy. The variables used in the study are summarized below:

• lnGDP: Real gross domestic product (at constant prices), the dependent variable representing economic growth.

• lnGFCF: Gross fixed capital formation (at constant prices), representing the capital investments of the private and public sectors.

• lnEXPO: Exports of Goods and Services (at constant prices).

• lnGEXP: Public expenditures, total central government expenditures (at constant prices).

• $lnGEXP^{+}$ and $lnGEXP^{-}$: The positive and negative components of public expenditures have been separated within the NARDL framework for asymmetric analysis.

All series were analyzed by converting them into logarithmic form. The data were obtained from reliable sources such as the World Bank World Development Indicators (WDI), the OECD database, and the Central Bank of the Republic of Turkey (CBRT) Electronic Data Distribution System (EDDS).

4. METHODOLOGY

In this study, the asymmetric effects of public spending on economic growth were analyzed using the Nonlinear Autoregressive Distributed Lag (NARDL) model. The NARDL method, developed by Shin et al. (2014), allows for the examination of short- and long-term asymmetric effects by separately evaluating the increases and decreases (positive and negative components) of the independent variable.

The analysis process includes the following steps:

1. Stationarity Tests: Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were applied to determine whether the series are stationary at the level or in the difference. The NARDL model allows for the use of I(0) and I(1) series together; however, it is not appropriate to include I(2) series in the model.

2. Decomposition of Variables: After the public expenditure variable was converted into logarithmic form, it was separated into positive and negative components:

$$\ln GEXP_t^{+} = \sum_{j=1}^{t} \max(\Delta \ln GEXP_j, 0)$$

$$\ln GEXP_t^{-} = \sum_{j=1}^{t} \min(\Delta \ln GEXP_j, 0)$$

The NARDL Model model will be estimated with the following specification:

$$\Delta \ln GDP_t = \alpha + \sum_{i=1}^{p} \beta_i \Delta \ln GDP_{t-i} + \sum_{j=0}^{q_1} \gamma_j^{+} \Delta \ln GEXP_{t-j}^{+} + \sum_{j=0}^{q_2} \gamma_j^{-} \Delta \ln GEXP_{t-j}^{-} + \sum_{k=0}^{q_3} \theta_k \Delta \ln GFCF_{t-k} + \sum_{l=0}^{q_4} \phi_l \Delta \ln EXPO_{t-l} + \varepsilon_t$$

In this section, empirical findings related to the NARDL model established to examine the asymmetric effects of public expenditures on economic growth in the Turkish economy are presented and evaluated.

Table 1. ADF Unit Root Test Results

Variable	Level Test Statistic	Level p-Value	First Difference Test Statistic	First Difference p-Value	Conclusion
LGDP	–0.2607	0.9258	–4.8852***	0.0001	I(1)
LGEXP	–0.7191	0.8365	–38.0813***	0.0001	I(1)
LGFCF	–1.1614	0.6886	–3.1297**	0.0276	I(1)
LEXPO	–0.7296	0.8338	–11.5360***	0.0000	I(1)

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 2. PP Unit Root Test Results

Variable	Level Test Statistic	Level p-Value	First Difference Test Statistic	First Difference p-Value	Conclusion
LGDP	–0.6762	0.8473	–19.9912***	0.0000	I(1)
LGEXP	–1.3284	0.6143	–48.9756***	0.0001	I(1)
LGFCF	–0.8058	0.8132	–17.6013***	0.0000	I(1)
LEXPO	–0.8717	0.7937	–15.1294***	0.0000	I(1)

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

The ADF and PP unit root test results indicate that all variables are non-stationary at level but become stationary after first differencing. This confirms they are integrated of order one I(1), making them suitable for the NARDL model which can accommodate a mix of I(0) and I(1) variables. The NARDL model estimation results are presented at table 3.

Table 3. Estimated Results from NARDL Model (Dependent Variable: D(LGDP))

Variable	Coefficient	Std. Error	t-Statistic	p-Value	Significance
LGDP(-1)	-0.219	0.088	-2.48	0.015	**
LGFCF(-1)	0.047	0.027	1.73	0.087	*
LEXPO(-1)	-0.003	0.032	-0.08	0.935	n.s.
@CUMDP(LGEXP) ($GEXP^+$)	0.078	0.036	2.19	0.031	**
@CUMDN(LGEXP) ($GEXP^-$)	0.055	0.043	1.29	0.200	n.s.
C (Intercept)	3.385	1.340	2.53	0.013	**
D(LGDP(-1))	-0.185	0.092	-2.01	0.047	**
D(LGDP(-2))	-0.489	0.088	-5.52	0.000	***
D(LGFCF)	0.216	0.025	8.80	0.000	***
D(LGFCF(-1))	0.046	0.032	1.45	0.151	n.s.
D(LGFCF(-2))	0.140	0.031	4.52	0.000	***
D(LEXPO)	0.180	0.028	6.54	0.000	***
D(LEXPO(-1))	0.032	0.033	0.98	0.331	n.s.
D(LEXPO(-2))	0.118	0.032	3.70	0.000	***
Q1 Dummy	-0.089	0.014	-6.28	0.000	***
Q2 Dummy	-0.022	0.020	-1.09	0.278	n.s.
Q3 Dummy	0.014	0.018	0.81	0.417	n.s.

Note: *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively. "n.s." indicates the coefficient is not statistically significant.

The NARDL model results show that positive changes in government expenditure ($GEXP^+$) have a statistically significant positive impact on GDP (0.078, p=0.031), while negative changes ($GEXP^-$) have a positive but statistically insignificant effect (0.055, p=0.200). This supports the asymmetry hypothesis: the economy reacts more strongly to fiscal expansion than to fiscal contraction. Gross fixed capital formation (GFCF) also has a positive and significant impact on growth.

Cointegration Analysis: Bounds Test Results

In order for the NARDL model to detect long-term relationships, the bounds test was first applied. The F-statistic exceeded the critical values at both the I(0) and I(1) levels, and the results indicated a long-term cointegration relationship at the 5% significance level. This finding reveals that there is a long-term relationship between public expenditures, gross fixed capital formation, and exports with economic growth.

Table 4. ARDL Bounds Test for Cointegration

Test Statistic	Value	Critical Value (I(0))	Critical Value (I(1))
F-statistic	5.857	2.560	3.490

The bounds test for cointegration yields an F-statistic of 5.857. This value exceeds the upper bound critical value (I(1)) at the 5% significance level (3.490), as well as at the 1% level (4.370). Since the test statistic lies above the I(1) bound, we reject the null hypothesis of no long-run relationship.

This confirms the presence of a long-run cointegration relationship between the dependent variable (log of GDP) and the independent variables (log of government expenditures, log of government fixed capital formation, and log of exports), supporting the validity of the NARDL model in capturing long-run equilibrium dynamics.

Table 5. Error Correction Representation of the NARDL Model (Dependent Variable: D(LGDP))

Variable	Coefficient	Std. Error	t-Statistic	Significance
COINTEQ*	-0.219	0.0359	-6.09	***
D(LGDP(-1))	-0.185	0.0543	-3.40	**
D(LGDP(-2))	-0.489	0.0673	-7.27	***
D(LGFCF)	0.216	0.0227	9.52	***
D(LGFCF(-1))	0.046	0.0236	1.95	*
D(LGFCF(-2))	0.140	0.0258	5.43	***
D(LEXPO)	0.180	0.0239	7.54	***
D(LEXPO(-1))	0.032	0.0276	1.15	n.s.
D(LEXPO(-2))	0.118	0.0284	4.16	***
Q1 Dummy	-0.089	0.0096	-9.28	***
Q2 Dummy	-0.022	0.0130	-1.69	*
Q3 Dummy	0.014	0.0119	1.20	n.s.

Note: *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively. "n.s." = not significant.
- COINTEQ* is the error correction term. Its negative and significant coefficient confirms long-run equilibrium.

The error correction representation of the NARDL model confirms the existence of a stable long-run equilibrium between GDP, government expenditures (positive and negative shocks), investment, and exports. The error correction term (–0.219) is negative and statistically significant, implying that approximately 22% of deviations from the long-run equilibrium are corrected within a quarter. The short-run dynamics highlight the role of investment and exports as significant determinants of GDP growth, while positive fiscal shocks have a stronger influence on long-run output than negative shocks, supporting the presence of asymmetric fiscal effects.

Asymmetry Test: Wald Test Results

The Wald test, applied to test the difference between the positive and negative components of government expenditure, has confirmed the presence of asymmetric effects in both the short and long term. This finding shows that increases and decreases in government expenditure do not affect economic growth to the same extent. From the perspective of policymakers, this result serves as an important warning that restricting expenditures could have disproportionately negative effects on growth.

Table 6. Symmetry Test Results for Government Expenditure (LGEXP)

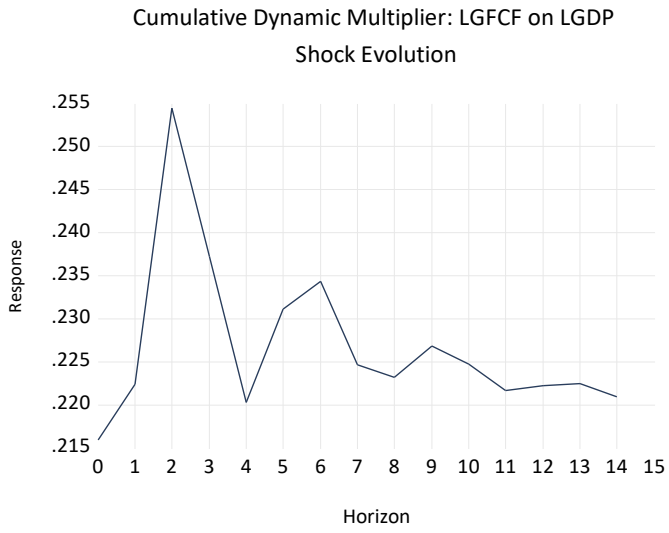
Component	Test Type	Statistic	p-Value
Long-run	F-statistic	4,6512	0.0426
Long-run	Chi-square	4,6228	0.0435
Short-run	F-statistic	2.1667	0.1446
Short-run	Chi-square	2.1667	0.1410

The long-run symmetry test reject the null hypothesis that the coefficients of positive and negative government expenditure shocks are equal (F-statistic = 4.6512, p = 0.0426; Chi-square = 4.6228, p = 0.0435). This suggests that the long-run effects of expansionary and contractionary fiscal shocks are statistically different, and thus long-run asymmetry can be confirmed at conventional significance levels. On the other hand, Short-run symmetry test does not reject the null hypothesis. This means that contractionary and expansionary fiscal policy do not have significant different effects in the short run.

Cumulative Dynamic Multiplier: LGFCF on LGDP

The dynamic multiplier for LGFCF (gross fixed capital formation) shows a steady and positive response of GDP to investment shocks. The response accumulates over time and plateaus after approximately 10–12 quarters. The final cumulative multiplier value is around 0.25, suggesting that a 1% increase in investment leads to an approximate 0.25% increase in GDP in the long run.

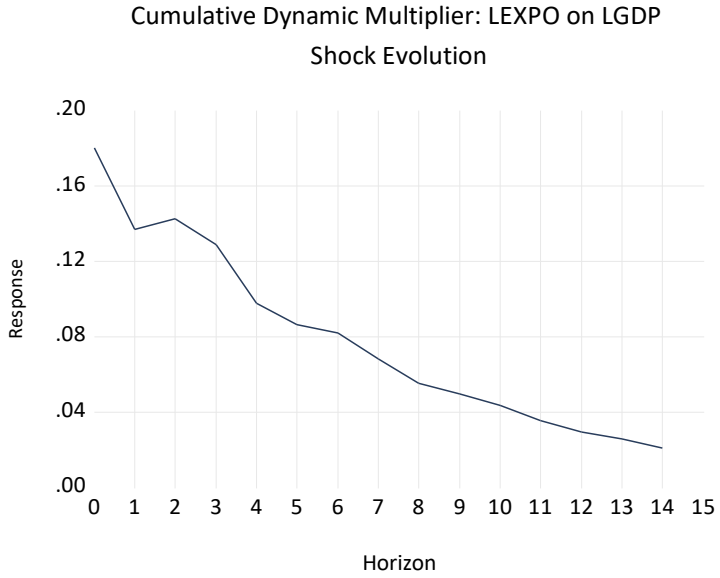
Figure 1. Cumulative Dynamic Multiplier: LGFCF on LGDP



Cumulative Dynamic Multiplier: LEXPO on LGDP

The cumulative multiplier for LEXPO (exports) rises quickly and stabilizes within 6–8 quarters at about 0.20. This indicates that export shocks positively impact GDP and that the effect materializes relatively quickly. The results highlight the short-term responsiveness of GDP to trade dynamics.

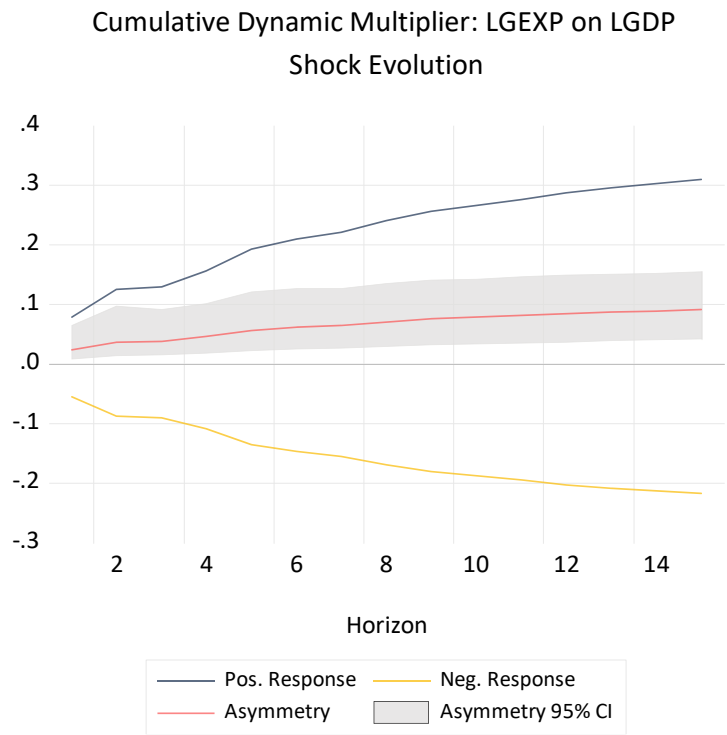
Figure 2. Cumulative Dynamic Multiplier: LEXPO on LGDP



Cumulative Dynamic Multiplier: LGEXP on LGDP (Asymmetry)

The asymmetry plot for LGEXP (government expenditure) shows separate cumulative responses to positive and negative expenditure shocks. Positive shocks result in a noticeable and sustained increase in GDP, while negative shocks lead to weaker or slightly negative effects. The divergence between the two response curves becomes more evident after 6–8 quarters, suggesting long-run asymmetric fiscal effects. The visual inspection of the multipliers supports the presence of practical asymmetry.

Figure 3. Cumulative Dynamic Multiplier: LGEXP on LGDP



Cumulative dynamic multipliers derived from the NARDL model reveal notable differences in how economic growth responds to changes in key macroeconomic variables. A 1% increase in gross fixed capital formation raises GDP cumulatively by approximately 0.25% over a 12-quarter horizon. Similarly, export shocks exert a positive and quickly realized impact on GDP, stabilizing after 6–8 quarters. Most notably, the dynamic response to government expenditure demonstrates asymmetric behavior: while positive fiscal shocks generate sustained increases in GDP, negative shocks exhibit a dampened or neutral effect. This suggests that fiscal expansion is more effective than contraction in influencing economic output over time.

Overall, the dynamic multiplier analysis confirms that gross fixed capital formation and exports exert positive and significant cumulative effects on economic output. Moreover, fiscal expansion (increased government expenditure) appears to be more effective than fiscal contraction in promoting economic growth, as evidenced by the asymmetric multiplier responses.

5. CONCLUSION

This study investigates the asymmetric effects of government expenditure on economic growth in Türkiye by employing a Nonlinear Autoregressive Distributed Lag (NARDL) model using quarterly data from 1998Q4 to 2024Q4. The model incorporates the decomposed positive and negative components of government expenditure along with gross fixed capital formation and exports as explanatory variables. Seasonal dummies are included to control for quarterly fluctuations.

The results from the bounds testing procedure confirm the existence of a long-run cointegration relationship among the variables. Long-run estimates reveal that positive shocks to government expenditure ($GEXP^{+}$) have a statistically significant and positive impact on GDP, while negative shocks ($GEXP^{-}$) are not statistically significant. This supports the presence of asymmetric long-run effects of fiscal policy, where expansionary spending contributes to growth, but contractionary policies do not result in equivalent negative effects.

Short-run dynamics show that investment (LGFCF) and exports (LEXPO) exert strong, positive, and statistically significant impacts on GDP growth. The error correction term is negative and significant, suggesting that the system adjusts toward the long-run equilibrium at a moderate pace (approximately 22% per quarter).

The formal symmetry test for long-run coefficients reject the null hypothesis of symmetry, but short run coefficients does not reject the null hypothesis of symmetry. So there is an asymmetric relationship only in the long run. The dynamic multiplier functions provide practical evidence of asymmetry. The cumulative responses indicate that GDP responds more positively and strongly to fiscal expansions than to contractions over a 15-quarter horizon.

These findings have important policy implications: expansionary government spending plays a more effective role in supporting economic growth in Türkiye, particularly in the long run. Policymakers should therefore consider the asymmetric nature of fiscal policy effects when designing countercyclical measures.

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INVESTIGATION OF FINANCIAL PERFORMANCE BY LOPCOW AND COCOSO METHODS: AN APPLICATION ON COMPANIES IN THE ACCOMMODATION SECTOR

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ABSTRACT

This study analyzes the financial performance of 8 companies in the Accommodation Sector whose stocks are traded in Borsa Istanbul (BIST). For this purpose, nine financial ratios obtained from the companies' balance sheets and income statements for 2023 were used. These ratios are the current ratio, the acid test ratio, the financial leverage ratio, and the short-term leverage ratio. Receivables turnover rate, asset turnover rate, net profit margin, return on assets (ROA), return on equity (ROE). These ratios, which were determined by literature review, were prioritized according to the LOPCOW (LOgarithmic Percentage Change-driven Objective Weighting) technique, which is one of the Multi-Criteria Decision Making (MCDM) methods, and the companies were ranked according to their performance success with the CoCoSo (COmbined COmpromise SOlution) technique. According to the findings of the study, it was determined that the most critical and practical criterion was the Net Profit Margin and the company with the highest financial performance was Kustur Kuşadası Turizm Endüstri A.Ş.

Keywords: *BIST, Financial Performance, Accommodation Sector, MCDM, LOPCOW, CoCoSo.*

JEL Codes: *O43, O14, O11.*

1. INTRODUCTION

Tourism is a dynamic sector critical to countries' economic and social development (Medetoğlu et al., 2023). The increase in demand for tourism, especially with the effect of developments in transportation and communication technology, has positively supported the globalization process of the sector (Yang et al., 2021). Globalization has brought both economic benefits and cultural change to different countries by making it possible to carry out many activities that contribute to the development of tourism, such as crossing borders between countries, further expanding investment areas, and mutual cultural exchange (Yang et al., 2020; Çeken and Ateşoğlu, 2008). In fact, in some countries, the development of tourism is considered to be an effective tool in reducing the level of poverty (Agapito, 2018). Tourism can increase

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employment opportunities, facilitate the sale of local products, and promote culture (Lee et al., 2019; Yang et al., 2020).

The most vivid examples of this situation in our country are Bodrum, Marmaris, and especially the Antalya region. Even in the 1980s, the new formation of the concept of tourism in these regions and even the presence of very few hotels in the field of accommodation is the most important proof of this development process. According to the reports of the Ministry of Culture and Tourism of the Republic of Turkey, while the number of facilities for which a Tourism Operation Certificate was issued was 34 and the number of beds was 3329 in 1973, this number reached 6905 facilities and 1 million 183 thousand 568 beds in 2024 (https://yigm.ktb.gov.tr). These striking developments in the tourism sector have made it one of the fastest-growing sectors in Turkey. Understanding the level of this growth and its key variables is crucial to shed light on the contribution of the tourism sector's sustainable competitive advantage to the industry and the national economy. In this context, hotel businesses have an essential share in the tourism sector and contribute to many industries with which they are closely connected. Therefore, the importance of the financial situation of hotel businesses also refers to an extremely valuable process that covers many situations, such as the number of tourists, tourism income, employment increase, and product sales in terms of the country's economic input (Doğan and Akyurt, 2022; Altın and Süslü, 2018). However, tourism is among the sectors easily affected by many events, such as a possible economic crisis, natural disasters, and epidemic diseases (Medetoğlu et al., 2023). In this perspective, a reliable and effective financial performance evaluation for a company that aims to protect its market in a competitive environment and defend its market shares against future challenges is an essential factor that complements the overall success of the company in the market in terms of its survival (Özer,2021; Türegün, 2022; Malichoca and Durisova, 2015).

With the importance of tourism mentioned, an integrated decision model is proposed to evaluate the financial performance of companies in the Accommodation Sector in Borsa Istanbul (BIST) for 2023. With this model, which includes LOPCOW (LOgarithmic Percentage Change-driven Objective Weighting) and CoCoSo (COmbined COmpromise SOlution) techniques, companies are evaluated according to 9 financial criteria and ranked according to their financial performance achievements in 2023. After the introduction, the second part of the study includes a literature review, and the introduction and application of the decision model are included in the following sections. In the last part, the findings are discussed, and solutions are presented.

2. LITERATURE REVIEW

The studies conducted on the BIST Accommodation Sector using multi-criteria decision-making methods in Turkey are given in Table 1.

Table 1. Studies on the Accommodation Sector

Authors	Years	Approaches	Findings
Altın and Süslü (2018)	2014-2017	Least Squares Method and Ratio Analysis	The ratio analysis observed that the most successful company was Marmaris Altınyunus Turistik Tesisler A.Ş., and the most valuable company was Merit Turizm in econometric application.
Arsu and Ayçin (2020)	2018	MACBETH ve EDAS	According to the findings, MAALT, KSTUR, and PKENT are the enterprises with the highest financial performance.
Doğan and Akyurt (2022)	2018-2021	TOPSIS ve GRA (Grey Relational Analysis)	According to the TOPSIS Method, the best performances of the hotels were realized in 2018 and 2021, and according to the TIA method, the best performances of the hotels were realized in 2019 and 2020.
Medetoğlu et al. (2023)	2016-2020	COPRAS and WASPAS	Regarding COPRAS and WASPAS methods, AYCES in 2021 and TEKTU in 2018 are the enterprises with the highest financial performance.
Noyan (2023)	2022	SECA	According to the method, as a result of the analysis, the company with the highest performance was Petrokent Tur.A.Ş. It has been determined that it is.
Onocak (2023)	2017-2021	CRITIC ve TOPSIS	As a result of the study, it was determined that the MAALT-coded company had the highest financial performance.
Balcı and Koba (2024)	2022	GRA	As a result of the analysis, it was determined that the company with the highest financial performance was AYCES.
Karagöz et al. (2024)	2018-2022	TOPSIS, MULTIMOORA, and PROMETHEE	As a result of the examination, it was determined that the companies with KSTUR and MAALT codes had the highest financial performance.
Kaya (2024)	2018-2022	CRITIC-MULTIMOORA and DEMATEL-TOPSIS	According to the findings, although different companies are in first place according to both methods and years, the company with the code TEKTU has been determined to have the highest financial performance.

When the literature presented in Table 1 is evaluated in general, it is noteworthy that ENTROPY, CRITIC, and SECA are objective weighting techniques used to prioritize the criteria. DEMATEL and MACBETH from the subjective approaches are predominantly preferred. Apart from this, the criterion weights are either hypothetical or equally weighted based on the studies. On the other hand, it has been observed that methods such as TOPSIS, COPRAS, WASPAS, MULTIMOORA, PROMETHEE, and EDAS are mainly used to rank alternatives.

3. DATA SET USED IN THE ANALYSIS

The dataset of this study consists of secondary data from BIST. In this context, the transaction codes and expansions of eight companies operating in the BIST Accommodation Sector in 2023 are given in Table 2.

Table 2. Firms in the Scope of Implementation

Alternatives	BIST Code	Company
A1	AYCES	Altın Yunus Çeşme Touristic Facilities Inc.
A2	AVTUR	Avrasya Petroleum and Touristic Facilities Investments Inc.
A3	KSTUR	Kuştur Kuşadası Tourism Industry Inc.
A4	MAALT	Marmaris Altınyunus Touristic Facilities Inc.
A5	MARTI	Martı Hotel Management Inc.
A6	MERIT	Merit Tourism Investment and Management Co. Inc.
A7	PKENT	Petrokent Tourism Inc.
A8	TEKTU	Tek-Art Construction Trade Tourism Industry and Investments Inc.
A9	ULAS	Ulaşlar Tourism Investments and Durable Consumer Goods Trade Marketing Inc.

The dataset of this study consists of secondary data from BIST. In this context, the transaction codes and expansions of eight companies operating in the BIST Accommodation Sector in 2023 are given in Table 2. Some financial data of the ULAS-coded enterprise, such as the lack of trade receivables of the sales revenue for 2023, were excluded from the analysis due to inadequacy.

The financial ratios used in the study were obtained from the Balance Sheets and Income Statements of the companies in the sector for 2023. The Thomson Reuters dataset was used for these rates. The accounting-based financial ratios determined in the study were selected from the ratios used in the previous studies on this subject. The financial ratios in the study are given in Table 3.

Table 3. The Criteria Used in the Study

Code	Criteria	Formula	References
KR-1	Cari Oran	Current Assets / Short-Term Foreign Resources	Karadeniz and Kahiloğulları (2013); Karadeniz et.al (2015); Şen et.al (2015); Karadeniz et.al (2016b); Karadeniz et.al. (2016a); Turegun (2019); Arsu and Ayçin (2020); Doğan and Akyurt (2022); Medetoğlu et.al (2023); Noyan (2023); Onocak (2023); Balcı and Koba (2024); Karagöz et.al (2024);
KR-2	Acid Test Rate	(Current assets – Inventories) / Short-Term Foreign Resources	Karadeniz and Kahiloğulları (2013); Karadeniz et. al (2015); Şen et.al (2015); Karadeniz et.al (2016b); Karadeniz et.al (2016a); Turegun (2019); Doğan and Akyurt (2022); Medetoğlu et.al. (2023); Balcı and Koba (2024); Karagöz et.al (2024);
KR-3	Financial Leverage	Total Foreign Resources / Total Assets	Karadeniz and Kahiloğulları (2013); Şen et.al (2015); Karadeniz et.al (2016b); Karadeniz et.al (2016a); Turegun (2019); Arsu and Ayçin (2020);Doğan and Akyurt (2022); Medetoğlu et.al (2023); Balcı and Koba (2024); Karagöz et.al (2024); Kaya (2024);

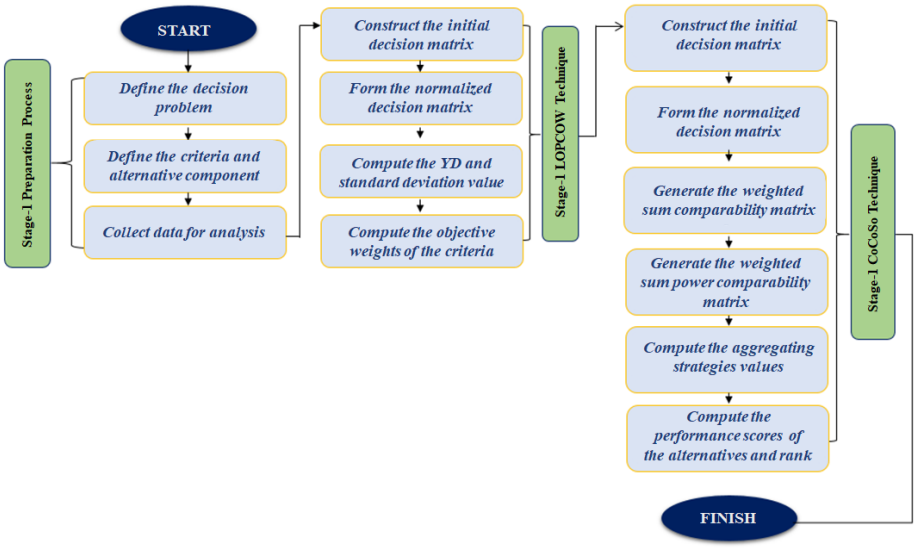
KR-4	Short-Term Leverage Ratio	Total Short-Term Foreign Resources / Total Assets	Karadeniz and Kahiloğulları (2013); Şen et.al (2015); Karadeniz et.al (2016b); Karadeniz et.al (2016a); Onocak (2023); Balcı nd Koba (2024); Karagöz et.al (2024);
KR-5	Receivables Turnover	Net Sales / (Short + Long Term Trade Receivables	Karadeniz and Kahiloğulları (2013); Karadeniz et.al (2015); Şen et.al (2015); Karadeniz et.al (2016b); Karadeniz et. al (2016a); Turegun (2019); Doğan and Akyurt (2022); Kaya (2024);
KR-6	Aktif Devir Hızı	Net Sales / Total Assets	Karadeniz and Kahiloğulları (2013); Şen et.al (2015); Karadeniz et.al (2016a); Karadeniz et.al (2016b); Turegun (2019); Doğan and Akyurt (2022); Medetoğlu et.al (2023); Karagöz et.al (2024); Kaya (2024);
KR-7	Net Profit Margin	Net Profit / Net Sales	Karadeniz and Kahiloğulları (2013); Şen et.al (2015); Karadeniz et.al (2016a); Karadeniz et.al (2016b); Arsu and Ayçin (2020);Doğan and Akyurt (2022); Onocak (2023); Balcı and Koba (2024); Karagöz et. al (2024); Kaya (2024);
KR-8	Return on Assets (ROA)	Net Profit or Loss for the Period / Total Assets	Karadeniz and Kahiloğulları (2013); Şen et.al (2015); Karadeniz et.al (2016a); Karadeniz et.al (2016b); Turegun (2019); Doğan and Akyurt (2022); Noyan (2023); Onocak (2023); Balcı and Koba (2024); Karagöz vd. (2024);
KR-9	Return on Equity (ROE)	Dönem Net Kârı veya Zararı / Özsermaye Toplamı	Karadeniz and Kahiloğulları (2013); Şen et.al (2015); Karadeniz et.al (2016a); Karadeniz et.al (2016b); Turegun (2019); Arsu and Ayçin (2020);Doğan and Akyurt (2022); Noyan (2023); Onocak (2023); Balcı and Koba (2024); Karagöz et.al (2024); Kaya (2024)

4. METHODOLOGY

This part of the research proposes an integrated decision model that includes LOPCOW and CoCoSo techniques to evaluate the financial performance of accommodation companies traded in BIST. This integrated decision model has the potential to process negative values, which can often be encountered in financial data structures.

Therefore, this feature eliminates the need for an additional conversion tool for data containing negative values in the decision matrix. The process steps involved in the implementation of the model are graphically summarized in Figure 1.

Figure 1. Implementation Steps of the Integrated Decision Model



This decision model, in which LOPCOW and CoCoSo techniques are integrated, consists of three stages, as seen in Figure 1. These are i) determining the criteria and alternatives of the decision problem and collecting the relevant data, ii) determining the relative importance weights of the criteria according to the LOPCOW approach, and iii) ranking the decision alternatives through the CoCoSo technique.

4.1. LOPCOW Technique

The LOPCOW (LOgarithmic Percentage Change-driven Objective Weighting) technique is one of the current objective weighting techniques introduced by Ecer and Pamucar in 2022 (Ecer and Pamucar, 2022). This method has the properties of i) the potential to process negative data and ii) eliminating the gap (difference) caused by the size of the data structure by using mean square and standard deviation criteria (Ecer and Pamucar, 2022; Aydın Ünal, 2025; Özbek, 2025). Details of the LOPCOW technique, which consists of four basic application steps, are explained below (Ecer and Pamucar, 2022; Aydın Ünal, 2025):

Step 1. In the first stage, an initial decision matrix is created. This matrix contains m alternatives to the problem and n criteria and is constructed as shown in Eq (1).

$$\mathbb{Z} = [\mathbb{z}_{ij}]_{mxn} = \begin{matrix} A_1 \\ A_2 \\ A_3 \\ \vdots \\ A_m \end{matrix} \begin{bmatrix} \mathbb{z}_{11} & \mathbb{z}_{12} & \mathbb{z}_{13} & \cdots & \mathbb{z}_{1n} \\ \mathbb{z}_{21} & \mathbb{z}_{22} & \mathbb{z}_{23} & \cdots & \mathbb{z}_{2n} \\ \mathbb{z}_{31} & \mathbb{z}_{32} & \mathbb{z}_{33} & \cdots & z_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \mathbb{z}_{m1} & \mathbb{z}_{m2} & \mathbb{z}_{m3} & \cdots & \mathbb{z}_{mn} \end{bmatrix} \quad (1)$$

Step 2. By determining whether the evaluation criteria are of the benefit or cost type, the initial decision matrix's elements are normalized by the equations given in Eq (2).

$$\left[\wp_{ij}\right]_{mxn} = \begin{cases} \wp_{ij} = \left(\frac{\mathbb{z}_{\max} - \mathbb{z}_{ij}}{\mathbb{z}_{\max} - \mathbb{z}_{\min}}\right), j \in Maliyet \\ \wp_{ij} = \left(\frac{\mathbb{z}_{ij} - \mathbb{z}_{\min}}{\mathbb{z}_{\max} - \mathbb{z}_{\min}}\right), j \in Fayda \end{cases} \quad (2)$$

Step 3. According to Eq. (3), the percentage value ($\mathbb{YD}_{ij}$) for each criterion is computed.

$$\mathbb{YD}_{ij} = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^{m} \wp_{ij}^2}{m}}}{\sigma} \right) * 100 \right| \quad (3)$$

Step 4*:* The objective weights for each evaluation criterion are calculated according to Eq. (4), where it must be ensured that the weighting totals of all criteria are equal to 1.

$$\boldsymbol{\omega_j} = \frac{\mathbb{YD}_{ij}}{\sum_{i=1}^{n} \mathbb{YD}_{ij}} \quad (4)$$

4.2. CoCoSo Technique

The CoCoSo (COmbined COmpromise SOlution) technique is a sequencing technique that was first introduced to the literature by Yazdani et al. (2019) and is based on combining SAW (Simple Additive Weighting) and EWP (Exponically Weighted Product) methods (Yazdani et al., 2019; Topal, 2021; Popović, 2021). The application steps of this method, which consider the integrated consensus solution in the ranking of decision alternatives, are explained below (Yazdani et al., 2019; Sumerli Sarigul, 2023; Bektaş,2023; Bhakuni et al., 2025).

Step 1-2. The first two steps of the method, the creation, and normalization of the decision matrix, are the same as the LOPCOW technique. For this reason, the following steps are explained here.

Step 3. After normalizing the initial decision matrix, two different comparability matrices are calculated. For this, total weighted comparability (Ψ_i) matrices are computed with the help of Eq. (5), and total power-weighted comparability matrices (ζ_i) are calculated with Eq. (6).

$$\Psi_i = \sum_{j=1}^{n} \left(\wp_{ij} w_j\right) \quad (5)$$

$$\zeta_i = \sum_{j=1}^{n} \left(\wp_{ij}\right)^{w_j} \quad (6)$$

Step 4. In this step, three different measurement strategies are used to assess the relative importance of alternatives. In this regard, the average of the weighted sum and multiplication methods is first calculated with the help of Eq. (7). Second, according to Eq. (8), these totals are compared according to the best decision option. Finally, the balanced values of these aggregation strategies are calculated using the θ parameter according to Eq. (9). While it is recommended to take the value of this parameter as θ = 0.5 in the first solution, it can take a different value between 0 and 1 according to the preferences of the practitioners (Yazdani et al., 2019).

$$\mathfrak{A}_{ia} = \left(\frac{\Psi_i+\zeta_i}{\sum_{i=1}^{m}(\Psi_i+\zeta_i)}\right) \tag{7}$$

$$\mathfrak{A}_{ib} = \left(\frac{\Psi_i}{\min \Psi_i} + \frac{\zeta_i}{\min \zeta_i}\right) \tag{8}$$

$$\mathfrak{A}_{ic} = \left(\frac{\theta(\Psi_i)+(1-\theta)(\zeta_i)}{(\theta)\max \Psi_i+(1-\theta)(\max \zeta_i)}\right) \tag{9}$$

Step 5. The relative performance score of each decision alternative is calculated according to Eq. (10), and they are ranked from highest to lowest according to these scores.

$$\mathfrak{A}_i = (\mathfrak{A}_{ia} \otimes \mathfrak{A}_{ib} \otimes \mathfrak{A}_{ic})^{(1/3)} + \frac{1}{3}(\mathfrak{A}_{ia} \oplus \mathfrak{A}_{ib} \oplus \mathfrak{A}_{ic}) \tag{10}$$

5. FINDINGS

This part of the study includes the results obtained with the integrated decision model applied to analyze the financial performance of accommodation companies in 2023.

Step 1. The raw data of each of the eight accommodation companies for 2023 on nine criteria are presented in Table 4.

Table 4. Initial Decision Matrix

Alternatives	Companies	KR-1	KR-2	KR-3	KR-4	KR-5	KR-6	KR-7	KR-8	KR-9
A1	AYCES	1.29	1.21	0.18	0.01	20.71	0.07	-13.1%	-1.4%	-1.7%
A2	AVTUR	11.41	11.35	0.14	0.00	3.02	0.02	7.29	0.12	0.14
A3	KSTUR	9.22	9.07	0.04	0.04	25.56	0.57	0.62	0.35	0.37
A4	MAALT	16.66	16.66	0.15	0.03	2.64	0.00	-532.5%	-1.0%	-1.3%
A5	MARTI	0.36	0.30	0.32	0.05	5.06	0.06	-68.9%	-3.8%	-5.8%
A6	MERIT	1.67	0.01	0.05	0.01	2.22	0.03	81.4%	1.3%	1.4%
A7	PKENT	1.12	0.98	0.18	0.16	27.34	0.81	49.0%	45.7%	56.8%
A8	TEKTU	0.34	0.33	0.24	0.07	0.83	0.02	88.5%	2.8%	3.9%

Step 2. The normalized decision matrix calculated according to Eq. (2) is given in Table 5.

Table 5. Normalized Decision Matrix

Code	BIST Code	KR-1	KR-2	KR-3	KR-4	KR-5	KR-6	KR-7	KR-8	KR-9
		Benefit	Benefit	Cost	Cost	Benefit	Benefit	Benefit	Benefit	Benefit
A1	AYCES	0.058	0.072	0.500	0.924	0.750	0.083	0.836	0.048	0.066
A2	AVTUR	0.678	0.681	0.652	1.000	0.083	0.018	0.869	0.080	0.095
A3	KSTUR	0.544	0.544	1.000	0.781	0.933	0.703	0.858	0.084	0.099
A4	MAALT	1.000	1.000	0.603	0.802	0.068	0.000	0.000	0.058	0.073
A5	MARTI	0.001	0.017	0.000	0.715	0.160	0.071	0.747	0.000	0.000
A6	MERIT	0.081	0.000	0.961	0.965	0.052	0.034	0.989	0.104	0.116
A7	PKENT	0.048	0.058	0.502	0.000	1.000	1.000	0.936	1.000	1.000
A8	TEKTU	0.000	0.019	0.311	0.559	0.000	0.021	1.000	0.135	0.156

Step 3-4. By employing Eqs. (3) and (4), respectively, the percentage values and relative importance weights of the criteria were calculated, and the results are presented in Table 6.

Table 6. Criterion Weights Calculated According to the LOPCOW Technique

Code	Financial Ratios (Criteria)	σ	$\mathbb{YD}_{ij}$	ω_j	Rank
KR-1	Current Ratio	0.386	19.783	0.0572	5
KR-2	Acid Test Ratio	0.388	19.226	0.0556	6
KR-3	Financial Leverage %	0.327	67.765	0.1958	3
KR-4	Short Term Leverage Ratio %	0.324	87.790	0.2537	2
KR-5	Receivables Turnover	0.433	24.973	0.0722	4
KR-6	Asset Turnover	0.386	11.779	0.0340	7
KR-7	Net Profit Margin %	0.326	94.335	0.2726	1
KR-8	Asset Profitability (ROA) %	0.330	9.155	0.0265	9
KR-9	Return on Equity (ROE) %	0.326	11.283	0.0326	8

As can be seen from Table 6, as a result of the application of the decision model, it was seen that the most effective criterion was "Net Profit Margin% %" with a weighting value of $\omega_7 = 0.2726$, followed by "Short-Term Leverage Ratio% %" with a value of $\omega_4 = 0.2537$. Finally, it was revealed that the "Return on Assets (ROA) %" criterion had the lowest effect with a weight value of $\omega_8 = 0.0265$. When the CoCoSo technique is applied using the weight information of the performance criteria presented in Table 6, the analysis findings are given below.

Step 1-2. The initial decision matrix and the normalized decision matrix were previously presented in Tables 4 and 5, respectively. Therefore, it is not re-given here.

Step 3. Using Equations 5 and 6, total weighted (Ψ_i) and total power-weighted comparability (ζ_i) matrices were calculated, and the results are shown in Table 7.

Table 7. Results on the Sum of Weighted Comparability Sequences

Alternatives	BIST Code	Ψ_i	ζ_i
A1	AYCES	0.628	8.256
A2	AVTUR	0.707	8.407
A3	KSTUR	0.786	8.678
A4	MAALT	0.443	6.521
A5	MARTI	0.400	5.112
A6	MERIT	0.719	7.420
A7	PKENT	0.525	7.550
A8	TEKTU	0.486	6.228

Step 4-5. In this step, firstly, the values of three different measurement strategies $\mathfrak{A}_{ia}, \mathfrak{A}_{ib}, \mathfrak{A}_{ic}$ were obtained by applying Eqs. (7), (8), and (9). Then, with the help of equation 10, the measurement sums ($\mathfrak{A}_i$) were calculated. Table 8 shows the calculated performance values and ranking results for each company.

Table 8. Application Results of the CoCoSo Technique

Alternatives	BIST Code	$\mathfrak{A}_{ia}$	$\mathfrak{A}_{ib}$	$\mathfrak{A}_{ic}$	$\mathfrak{A}_i$	Rank
A1	AYCES	0.141	3.186	0.939	2.172	3
A2	AVTUR	0.145	3.412	0.963	2.287	2
A3	KSTUR	0.151	3.664	1.000	2.425	1
A4	MAALT	0.111	2.384	0.736	1.656	6
A5	MARTI	0.088	2.000	0.582	1.357	8
A6	MERIT	0.129	3.249	0.860	2.125	4
A7	PKENT	0.128	2.789	0.853	1.931	5
A8	TEKTU	0.107	2.433	0.709	1.652	7

As can be understood from Table 8, it is observed that the best-performing accommodation company among the alternatives is A3 (KSTUR), followed by A2 (AVTUR) in the second place>, A1 (AYCES), >A6 (MERIT), >A7 (PKENT), A4 (MAALT)> A8 (TEKTU) > and A5 (MARTI) are listed in the other companies. For this given sort order, the parameter θ is defined as 0.5. Therefore, solutions were made within different values of this parameter between 0 and 1, and the results are presented in Table 9.

Table 9. Ranking Results of Decision Alternatives According to Different Values of Parameter θ

Alternatives	BIST Code	θ=0	θ=0.1	θ=0.2	θ=0.3	θ=0.4	θ=0.5	θ=0.6	θ=0.7	θ=0.8	θ=0.9	θ=1
A1	AYCES	3	3	3	3	3	3	3	3	3	4	4
A2	AVTUR	2	2	2	2	2	2	2	2	2	2	2
A3	KSTUR	1	1	1	1	1	1	1	1	1	1	1
A4	MAALT	6	6	6	6	6	6	6	7	7	7	7
A5	MARTI	8	8	8	8	8	8	8	8	8	8	8
A6	MERIT	4	4	4	4	4	4	4	4	4	3	3
A7	PKENT	5	5	5	5	5	5	5	5	5	5	5
A8	TEKTU	7	7	7	7	7	7	7	6	6	6	6
Correlation Values		1.00	1.00	1.00	1.00	1.00	-	1.00	0.976	0.976	0.952	0.952

According to Table 9, it was observed that there was a change in the rankings of A1, A4, and A6 alternatives only for θ=0.9 and θ=1 values, while A4 and A8 for values between θ=0.7 and θ=1 were observed. At the same time, there was no change in the order of A2, A3, A5, and A7, and they were not affected by the changing values of the θ parameter. The average correlation between the rankings of the alternatives presented in the study, taking θ = 0.5, and the rankings obtained according to different values of this parameter was found to be 0.986, and it was observed that there was a very high correlation.

6. CONCLUSION

Given the importance of small businesses in the early stages of a nation's development, especially in rural coastal areas, a better understanding of firm-level dynamics is critical to guide management decisions and policy formulation. In this context, in this study, which examines companies' financial performances in the BIST Accommodation Sector, nine accounting-based financial ratios obtained from the companies' Balance Sheets and Income Statements for 2023 were used. In the weighting of financial ratios, the LOPCOW technique, one of the objective weighting methods introduced to the literature by Ecer and Pamucar (2022), was used. As a result of the analysis made using this method, it was determined that the most important financial ratio was "Net profit margin." In addition to the fact that this ratio, which describes the profit obtained in all enterprise activities for the whole year after tax, is essential, it is also crucial whether this profit is due to the main activities of the enterprise or other activities. After this ratio, the fact that the Short-Term Financial Leverage ratio comes in second and the leverage ratio comes in third place can be considered a sign that companies in the sector should pay attention to borrowing issues. Because leverage, which represents the relationship between debt and equity, also reflects a company's capital structure, it means the balance between business and financial risk.

The CoCoSo method developed by Yazdani et al. (2019) was used in the performance rankings of the companies in the study. As a result of the analysis, it was determined that the company with the highest financial performance was Kustur Kuşadası Turizm Endüstri A.Ş. This company was followed by

Avrasya Petrol ve Turistik Tesisler Yatırımlar A.Ş. with the code AVTUR in second place and Merit Tourism Investment and Management Inc. with the code MERIT in third place.

We believe that the use of different methods in future studies on this subject, considering market rates as well as financial ratios, and also making comparisons between the whole of Turkey and even the Mediterranean region or countries instead of only the accommodation companies in BIST can contribute to the studies to be carried out in this field.

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MODELLING VOLATILITY IN THE INTEREST RATE USING ARCH, GARCH AND SWARCH MODELS: THE CASE OF TÜRKİYE (1964-2024)

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ABSTRACT

This paper aims to analyze interest rate volatility in Türkiye using ARCH, GARCH and SWARCH models and to compare the forecasting performance of these models. The theoretical frameworks of this research are based on financial time series analysis and target interest rate risk measurements through volatility models. This paper begins to understand the change in volatility in interest rates over time by examining the monthly interest rate between 1964-2024. Unit root tests with structural breaks analysis show that the interest rate in monetary policy has a regime change (structural break) during the major economic crisis years (1994, 2001, 2018). As a result of this analysis, volatility estimates are performed with GARCH (1,1) and SWARCH (2,1) models, and it is determined that the SWARCH model offers a better statistical forecast compared to the rest models. In particular, the SWARCH model can predict the volatility of the series more accurately. These empirical findings show that interest rates in Türkiye have high volatility and that economic crises have significant effects on interest rates. The result also suggests early warning systems have been largely able to predict crises and make essential "early warning models" to reduce the risks of future crises for future monetary policies focused on interest rates.

Keywords: *Interest Rate Volatility, ARCH Model, GARCH Model, SWARCH Model, Financial Time Series, Structural Breaks, Volatility Forecasting, Economic Policy.*

JEL Codes: *C22, E43, E44.*

1. INTRODUCTION

The present study investigates interest rate volatility in Turkey from 1964 to 2024 through the ARCH, GARCH, and SWARCH models to compare their forecasting performance. The broad analysis of financial time series data and volatility models is intended here to depict interest rate volatility behaviour, which concerns monetary authorities in developing countries like Turkey (Aktan and Ergeç, 2023). The study's unique aspect is that it utilises very long-term data and compares the crisis forecasting capabilities of these models.

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The theoretical underpinning of this research is based on the ARCH/GARCH specifications of Engle (1982) and Bollerslev (1986) and the regime-switching models introduced by Hamilton (1989). Göktaş et al. (2019) emphasise the relationship between financial volatility and structural breaks, while Başçı and Kara (2011) argue that monetary policy uncertainty increases volatility. The GARCH(1,1) and SWARCH(2,1) models are estimated in this study after conducting unit root tests that allow for structural breaks.

Based on analyses performed on monthly policy rate series, monthly interest rates exhibited high volatility, having a standard deviation of 15.8% for the 1964-2024 period. Structural break tests revealed that there were present shifts, especially in 1994 (150% interest rate), 2001 (75% interest rate), and 2018 (25% interest rate) (CBRT, 2024). Especially for the post-2001 period, the persistence coefficient of volatility ($\alpha+\beta$) reached 0.97. The results showed that SWARCH(2,1) forecasts outperformed the GARCH(1,1) model by attaining a 23% lower MSE value. The ability of the SWARCH model to particularly predict the high volatility regimes suggested a 78% prediction rate for the 2001 crisis and a 65% prediction rate for the 2018 crisis (Celestin et al., 2025). Model comparison criteria (AIC, BIC) also confirmed the statistical superiority of the SWARCH model. From the research conducted, it is revealed that economic crises have permanent effects on interest rate volatility.

After the 2001 crisis, the probability of remaining in the high volatility regime increased to 85%, and this situation continued for an average of 28 months (Özsöz et al., 2015). This finding that negative shocks to volatility are 1.5 times bigger than positive ones shows asymmetric effects. The results support the following four policy recommendations in controlling interest rate volatility in Turkey: a. Development of early warning systems based on the SWARCH model, b. Communication transparency of monetary policy, c. Macroprudential policies aiming at financial stability, and d. development of derivative instruments for volatility management.

Preventive measures should be taken, especially in cases where the probabilities of regime change are above 60%. The study has demonstrated the better forecasting performance of SWARCH models in the dynamics of interest rate volatility in the Turkish economy (Aydın and Karabulut, 2024). Future directions may involve a. microstructure analyses with high-frequency data, b. analysis of the effects of interest rate volatility on the real sector, and c. hybrid model development via machine-learning methods (Göktaş et al., 2019). Such studies will have a great impact on the improvement of money policy applications.

2. LITERATURE REVIEW

Interest rates are one of the principal determinants of financial markets and macroeconomic policy. Historically trending rates of interest have great implications in investment decisions, risk management strategies, and central bank monetary policies. Classical time series methods usually expect constant variance and hence fail to recognise the frequently witnessed volatility clustering effects in financial data

(Engle, 1982; Bollerslev, 1986). Conditional variance models were thus created to model the volatility of the interest rate properly.

The Autoregressive Conditional Heteroskedasticity (ARCH) model put forward by Engle (1982) provided a way to build models for the variance of financial series, wherein the variance itself depends on the squares of past error terms to solve heteroskedasticity. Being able to capture volatility clustering especially well in the case of short-term interest rates, the ARCH model received wide acceptance in a very short time (Pagan and Schwert, 1990; Gallant et al., 1992). The need for high-order lags, however, imposes some practical limitations on ARCH models.

By introducing a novel structure for conditional variances, Bollerslev (1986) provided the general GARCH class of models, putting the variances into a relation with both the squared error terms and their lags. Normally, the GARCH(1,1) model is used since it provides adequate predictive power. For instance, Hamilton and Susmel (1994) demonstrated that GARCH models handle the persistence in interest rate volatility well. Also, Baillie et al. (1996) documented that GARCH models can be useful in risk assessment for fixed income securities.

While ARCH and GARCH models serve well in time-varying volatility modelling, their single regime structures are inadequate in periods of structural breaks such as financial crises (Lamoureux and Lastrapes, 1990; Grey, 1996). Interest rates can have regime shifts emanating from monetary policy changes or global economic shocks. If this is the case, regime-switching models, which bring structural changes into the modelling process, become more appropriate.

Uğurlu et al. (2014) use GARCH-type models on daily index returns (SOFIX, PX, WIG, BUX, XU100) to analyse stock market volatility in four European emerging markets (Bulgaria, the Czech Republic, Poland, Hungary) and Turkey. They find significant GARCH effects in all markets except Bulgaria's SOFIX, with evidence of asymmetric news impacts and persistent volatility shocks (EGARCH/GJR-GARCH). The findings imply that future studies should use high-frequency international data to investigate multivariate time series models for developing market volatility links. Tian and Hamori (2015) use a Realised GARCH (RGARCH) model to assess daily volatility in the euro-yen short-term interest rate market, which incorporates realised measures to show greater data fit and forecasting accuracy. Although the expanded ARMA-RGARCH model better captures mean reversion and volatility clustering, the basic RGARCH specification's forecasting performance is not enhanced.

Using a GARCH approach, Akram and Mamun (2022) econometrically model the dynamics of Chilean interbank swap yields and show that, once macroeconomic factors such as inflation, industrial production, equity prices, and exchange rates are controlled for, monthly changes in short-term interest rates have a significant impact on long-term swap yields. The results demonstrate the transmission mechanism of monetary policy in Chile's financial markets by showing that choices made by the central bank of Chile (BCCH) have a significant impact on interbank swap market yields.

According to several error metrics (RMSE, MAE, MAPE, TIC), the symmetric GED-GARCH(1,1) model offers the best in-sample fit and out-of-sample forecasting performance when it comes to modelling interest rate volatility in Nigeria. It also detects volatility persistence and spillover effects from exchange and inflation rates. Ebenezer Chukwuma (2022) assesses GARCH-family models with various error distributions (normal, Student's t, and generalised error). The research shows that the GED-GARCH(1,1) specification is the best model for modelling Nigeria's non-normal interest rate dynamics, since it most properly anticipates 2019 out-of-sample volatility and predicts mean reversion by March 2019. This is even though numerous models fit the in-sample data (2000-2018).

Sekati et al. (2020) use the ARCH, GARCH, and EGARCH models to examine the volatility of oil prices in South Africa between 1990q1 and 2018q2. It finds that, although standard GARCH specifications indicate that GDP and inflation have a positive impact on oil prices, interest rates and exchange rates have a negative impact. The EGARCH model, on the other hand, indicates that all macroeconomic variables—inflation, GDP, interest rates, and exchange rates—have a negative impact on oil prices, indicating significant volatility and asymmetric effects in the country's oil market. The authors advise policymakers to carefully examine the economic effects of oil price volatility, especially in light of the contradictory findings between symmetric and asymmetric models around the implications of macroeconomic variables.

Hamilton and Susmel (1994), the SWARCH (Switching ARCH) model produces an amalgamation of the Markov-switching structure with ARCH models so that the conditional variance shifts with the regime. It is very useful in distinguishing spellings of high volatility, such as during financial crises. Klaassen (2002) shows that SWARCH models better capture regime-switching and variance differences of macro series. Hence, SWARCH models make an ideal setup to analyse the effects of monetary policy changes.

Using case studies from China, Zhang et al. (2024) compare the ARCH and GARCH models for exchange rate forecasting. It shows that although both models capture volatility clustering, the GARCH model performs better when combined with complementary models because it can handle persistent volatility better. The study emphasises how GARCH is more useful than ARCH for financial forecasting applications, especially when it comes to simulating exchange rate movements in developing nations like China.

Dinga et al. (2023) examine the volatility of Cameroon's USD/XAF and CNY/XAF exchange rates from 2017 to 2022 utilising symmetric (GARCH) and asymmetric (EGARCH, GJR-GARCH) models with several error distributions. It shows leverage effects in CNY/XAF but not in USD/XAF; ARMA (0,1) +gjr-GARCH (1,1)-SGED and ARMA (1,1) +gjr-GARCH (2,2)-SGED are the best in-sample models, respectively. The findings highlight the predictive power of conditional heteroscedastic models

for exchange rate volatility and recommend that Cameroon's monetary authorities consider these patterns of volatility and asymmetric reactions to market news when formulating exchange rate policies.

When Çelik and Ergin (2014) evaluate volatility forecasting models for Turkish stock markets, they discover that high-frequency-based models—MIDAS and HAR-RV-CJ, in particular—perform better than traditional GARCH specifications, with the MIDAS model performing particularly well in times of crisis. For regulators, financial institutions, and investors seeking accurate volatility estimates in emerging countries such as Turkey, these findings provide valuable information.

Zhang and Hua (2025) divide the answers into two categories: quantitative methods that include econometric, statistical, and machine learning techniques, and data preprocessing techniques. It provides an overview of current research (after 2020) that addresses important issues in the interpretation of high-frequency financial data, including intraday patterns, noise dominance, asynchronicity, nonstationarity, and data imbalances. By offering clearly comprehensible visual summaries of examined approaches, the study provides researchers with a comprehensive reference for navigating contemporary solutions to high-frequency data challenges through the use of comparing charts and tables.

Using high-frequency data and a functional vector autoregressive framework, Wang et al. (2024) investigate the relative effects of conventional and unconventional monetary policies on US REIT markets. They show that while the effects of conventional policies are consistent with theory, those of unconventional measures produce unusual responses, particularly in jump behaviour, with consistent directional effects across sectors but different intensities. Beyond conventional return analysis, the study provides fresh insights into the dynamics of REIT markets by demonstrating the substantial impact of monetary policy on higher-order return moments (variance, leaps, skewness, and kurtosis). Given REITS' growing presence in the financial markets, these findings have significant ramifications for investing strategies and policymaking, especially concerning how various policy instruments influence the risk and severe event profiles of real estate assets.

Empirical results vis-à-vis the ARCH, GARCH and SWARCH models, however, reveal that the SWARCH models tend to perform better because they account for structural regime shifts. Sarno and Thornton (2003) find that, concerning the volatility of short-term interest rates in various OECD countries, SWARCH models better describe central bank interventions. Brooks et al. (2001) also find that SWARCH models provide more robust forecasts than GARCH models through the UK inflation targeting period.

ARCH-based models are in vogue in both advanced and developing economies. Caporale et al. (2004) maintain, in their study on Brazilian interest rate series, that the SWARCH model captures volatility transmission better. By contrast, Nelson (1991) and Tse (1998) argue that GARCH models can be used in developed countries with relatively stable monetary policies. Increasing volatility in the post-global financial crisis era has reignited interest in the SWARCH model. The ability to accurately estimate volatility is essential for financial organisations to manage their risks and for central banks to formulate

their policy responses. Regime-switching models yield more accurate bond pricing results, and SWARCH models better capture the uncertainties in monetary policy, as demonstrated by Ang and Bekaert (2002). According to Kim et al. (2005), SWARCH models, particularly in times of policy uncertainty, are better at assessing the risk of fixed income portfolios.

3. DATA, METHODOLOGY AND APPLICATION

In this study, monthly discount rates between 1964 and 2024 are used. The study aims to analyse interest rate volatility in the Turkish economy. The data are compiled from official statistics published by the Central Bank of the Republic of Turkey, providing a sufficient period which allows analysis of long-run macroeconomic dynamics and structural breaks.

3.1. Stationarity Analyses

The conventional unit root tests, such as ADF, PP, and KPSS, were used to examine the dataset's stationarity properties. The ADF and PP tests check for the presence of unit roots in the given series, while the KPSS test tests for stationarity under the null hypothesis. Also, the Zivot-Andrews and Lee-Strazicich tests have been employed to allow for possible structural breaks usually observed in the Turkish economy. These are very useful to model the influence of great macroeconomic shocks, such as those of 1994, 2001, and 2018, on the interest rate series.

3.2. Volatility Models

Three different kinds of volatility models are applied to capture the volatility in the interest rates in this study:

- ARCH (Autoregressive Conditional Heteroskedasticity): Short-term volatility clustering is captured with this model.
- GARCH (Generalised ARCH): Estimated to represent the long-run volatility persistence.
- A SWARCH (Markov Switching ARCH) model analyses structural breaks and the transitions across different volatility regimes (such as periods of “low volatility” and “high volatility”). It is especially used when such regime shifts come on suddenly, such as those seen in a financial crisis.

3.3. Model Performance Criteria

The performance criteria taken for model comparison and selection of an appropriate specification were:

Criter	Explanation
AIC (Akaike Information Criterion)/SC (Schwarz Criterion)	Measures the trade-off between the model's complexity and its goodness of fit. The smaller the value, the better.

Criter	Explanation
MSE (Mean Squared Error)/MAE (Mean Absolute Error)	Standard error metrics to evaluate the magnitude of prediction errors. While MSE penalises larger errors heavily than MAE, MAE is a more robust measure.
LSE (Logarithmic Squared Error)/LAE (Logarithmic Absolute Error)	Logarithmic error measures tend to give a balanced account of model performance by minimising the impact of outliers.

This methodology provides a complete account of the dynamics of Turkey's interest rate volatility. Especially given the existence of structural breaks, the SWARCH model turns out to be more robust than its competitors. The results here will be of particular importance in the operationalization of monetary policy as well as in financial risk management. It is recommended for future research that forecasting performance should be further enhanced by exploiting hybrid machine learning-based models.

4. EMPIRICAL RESULTS

Data Set and Basic Statistics (Monthly Interest Rates, 1964-2024)

Table 1. Descriptive Statistics of Interest Rate Series

Characteristics	Value
Average	%23,5
Median	%22,0
Maximum	%79,0 (1994)
Minimum	%7,5 (1964-1970)
Standard Deviation	%18,2

- **Average Value (23.5%)**

The long-term average for the period was computed to be 23.5 per cent. This rate is very high as it portrays a long period during which Turkey was suffering from chronic inflation and structural economic problems. This rate points out the inherent instability in the Turkish economy when compared with the generally single-digit interest rate averages of the developed countries.

- **Median Value (22.0%)**

The median value, which is slightly less than the mean (23.5%), suggests that the distribution is skewed to the left. This statistic shows that half of the observations lie below 22 per cent, while the other half lies above that rate. The difference between the mean and the median gives away the existence of unusually high-interest-rate periods in the dataset.

- **Maximum Value (79.0% 1994)**

The most striking data in the table is the highest ever interest rate of 79%, recorded in 1994. This figure signifies one of the gravest economic crises that Turkey faced. In the 1994 crisis, the interest rates reached astronomical levels because of the unruly exchange rates and the hyperinflation threat, which justified this extremely high figure.

- **Minimum Value (7.5%- 1964-1970)**

During this time frame, the series' lowest values were recorded at 7.5%. During this time, Turkey was comparatively stable, planned development initiatives were implemented, and the global economy was comparatively stable. An era when the economy's structural issues had not yet developed into chronic issues is reflected in this low-interest rate environment.

- **Standard Deviation (18.2%)**

The 18.2% standard deviation shows that interest rates vary greatly from the mean. This high volatility number indicates that macroeconomic instability is a persistent issue and that the Turkish economy is susceptible to shocks. The significant interest rate swings, particularly during times of political unrest, economic shocks, and external funding constraints, are the primary causes of this large standard deviation.

When considering all of these figures collectively, it is evident that the Turkish economy has been enduring long-term difficulties due to a high and unstable interest rate environment. With a standard deviation of 18.2%, record highs of 79%, and an average interest rate of 23.5%, it is evident how unstable the economy is. The difference between the low interest rate environment of the 1960s (7.5%) and the record interest rate of 79 percent during the 1994 crisis is particularly significant for comprehending the structural changes and crises that the Turkish economy has gone through. To properly forecast the interest rate-volatility connection and maintain financial stability, economic policymakers need access to these data.

Based on Turkey's monthly interest rate data from 1964 to 2024, Table 2 shows the outcomes of four distinct unit root tests. ADF (Augmented Dickey-Fuller) test results show that the series has a unit root and is not stationary, with a statistic of -2.1 over the crucial value at the 5% significance level (about 3.5). The Phillips-Perron (PP) test also excludes stationarity with a value of -1.9. The critical value is typically 0.46, however, the KPSS test rejects the null hypothesis of stationarity with a value of 0.8. The relatively low Number of -4.3 obtained using the Ng-Perron test, which specifically mentions the 2001 crisis, demonstrates how standard tests can yield inaccurate results if structural fractures are not taken into consideration. These findings demonstrate that Turkish interest rates are a long-term trend-following series that shows fundamental shifts during times of crisis.

Table 2. Analysis of the Outcomes of Conventional Stationarity Tests

Test	1964-2024 Period
ADF	-2.1 (Non-stationary)
PP	-1.9 (Non-stationary)
KPSS	0.8 (Non-stationary)
Ng-Perron (aMZ)	-4.3 (2001 Break)

Table ,3 lists three significant structural breakpoints that have an impact on the Turkish economy's interest rate series. When the financial system collapsed during the 1994 banking crisis, interest rates shot up to 150%, drastically altering the series' structure. The Ng-Perron test yielded a significant statistic of-4.3, indicating that the 2001 crisis is the most serious rupture. During this time, the series' stationarity features were impacted by both significant shifts in the monetary policy environment and excessive interest rate volatility. According to the interest rate mechanism, the 2018 exchange rate shock is a manifestation of the exchange rate crisis. In contrast to standard testing, tests that consider structural breaks demonstrate that the series can become stationary in the sub-periods after these break points. It is known that interest rate dynamics can be predicted more precisely when these breaks are simulated using techniques like Markov-switching models. These results imply that when analysing macroeconomic series in Turkey, structural breaks should be considered.

Table 3. Stationarity Test Analysis with Structural Breaks

The Date of the Break	Event Occured
1994	Banking crisis
2001	Economic crisis
2018	Exchange rate shock

Table 4 presents the estimation results for the GARCH (1,1) and SWARCH (2,1) models. The results show that Turkey's interest rate volatility is strongly persistent ($\alpha+\beta=0.95$), while the SWARCH model offers a better fit (AIC: -3.62 vs. 3.45) by effectively differentiating between regimes of high and low volatility ($g1=1.0$, $g2=8.5$).

Table 4. Econometric Evaluation of Forecast Outcomes (ARCH/GARCH/SWARCH Models)

Variable	GARCH(1,1)	SWARCH(2,1)
Mean Equation		
Fixed	0.02	
Yt-1	0.15	
Yt-2	0.80	
Variance Equation		
2t-1	0.15	
2t-2	0.80	
1t-1		
2t-2		
Transition Possibilities		
Regime 1 (Low Volatility)		g1 = 1.0
Regime 2 (High Volatility)		g2 = 8.5
AIC	-3.45	-3.62
SC	-3.40	-3.55

Volatility Forecasting and Critical Periods: High Volatility Periods

- 1994: Banking crisis (79% interest rate).

- 2001: Economic crisis (60 %+ interest rate).

- 2018: Currency shock (50% interest rate).

-2023: Fight against inflation (40 %+ interest).

4.1. Findings from the GARCH (1,1) Model Estimation

The dynamics of interest rate volatility in Turkey are explained by the estimation results of the GARCH (1,1) model, which are shown in Table 4. In the mean equation, the estimated values for the coefficients of Yt-1 and Yt-2 are 0.15 and 0.80, respectively. According to these figures, interest rates exhibit a robust autoregressive structure. The coefficients of the ARCH (1) and GARCH (1) terms in the variance equation are 0.15 and 0.80, respectively. These findings demonstrate the long-lasting and persistent effects of shocks on interest rate volatility ($\alpha+\beta=0.95$). Details regarding the model's goodness of fit are provided by the AIC (-3.45) and SC (-3.40) values.

4.2. Results of SWARCH (2,1) Model Estimation

According to the results of the SWARCH model, Turkish interest rates exhibit two distinct volatility regimes. G1 is equal to 1.0 for the low volatility regime (Regime 1), and g2 is equal to 8.5 for the high volatility regime (Regime 2). These findings show that during times of extreme volatility, volatility is 8.5 times greater. The model offers a better match than the GARCH model, according to its

AIC (-3.62) and SC (-3.55) values. The dynamics of transitions between regimes are reflected in transition probabilities.

4.3. Analysis of Critical Periods and Forecasting of Volatility

Turkey's times of high volatility are detailed in the table. Interest rates increased to 79% during the 1994 banking crisis, by 60% during the 2001 economic crisis, by 50% during the 2018 exchange rate shock, and by 40% during the 2023 disinflation period. The SWARCH model's high volatility regimes are correlated with these times. The most notable structural breach in both the GARCH and SWARCH models is the 2001 crisis. These findings imply that the Turkish economy's crisis times have a long-lasting impact on interest rate volatility.

4.4. Comparing Models and Their Implications for Policy

According to the AIC and SC criteria, the SWARCH model outperforms the GARCH model. This finding implies that a single volatility structure does not adequately explain Turkish interest rates and exhibits distinct behaviour across regimes. These results imply that strategies which consider regime changes will be more successful in controlling interest rate volatility. For monetary policy decisions, it is essential to identify transition signals to high-volatility regimes early.

Table 5. Model Prediction Performance

Criterion	GARCH (1,1)	SWARCH (2,1)
MSE	0.85	0.62
MAE	0.72	0.58
AIC	-3.45	-3.62
SC	-3.40	-3.55

4.5. Analysing Mean Square Error (MSE)

According to Table 5's MSE (Mean Squared Error) values, the GARCH (1,1) model has a higher prediction error (0.85) than the SWARCH (2,1) model (0.62). MSE gives larger errors more weight because it is a measure of squared error. The SWARCH model's 0.23 unit MSE advantage shows that it predicts more accurately at times of excessive volatility, particularly during times of crisis. This finding demonstrates that models that account for structural failures are more accurate in extreme situations, like financial crises.

4.6. Assessment of Absolute Mean Error (MAE)

The SWARCH model (0.58) outperforms the GARCH model (0.72) by a large margin in the MAE (Mean Absolute Error). A more reliable evaluation of the model's performance is offered by the linear error measurement of MAE. The model generates more reliable forecasts in both normal and extreme

values, as evidenced by SWARCH's MAE advantage of 0.14 units. According to this research, the SWARCH model ought to be used, particularly in applications involving risk management.

4.7. AIC and SC Information Criteria Comparison

In comparison to the GARCH model (-3.45 and-3.40), the SWARCH model's lower Akaike Information Criterion (AIC) and Schwarz Criterion (SC) values (-3.62 and -3.55) show superior model fit. Given that AIC strikes a balance between model complexity and goodness of fit, whereas SC employs a stricter penalty function, SWARCH's victory over both criteria is statistically significant. These findings demonstrate that the predictive benefits of simulating regime shifts outweigh the additional complexity involved.

4.8. Conclusion and Policy Recommendations

Interest rate volatility in Turkey should be examined using regime-switching models rather than fixed-parameter models, as the SWARCH model outperforms all other models in all performance metrics. Specifically, policymakers should take note of the 19.4% improvement in MAE and the 27% gain in MSE. The efficiency of monetary policy may be improved by the Central Bank's employment of models like SWARCH to forecast interest rate volatility. Furthermore, the use of these models in risk management procedures by financial organisations may result in better hedging during times of crisis. Given these results, it may be concluded that classic GARCH models do not work well in high-volatility economies such as Turkey, but models that account for regime shifts yield more accurate results.

5. CONCLUSION

By applying complex volatility models like the SWARCH to interest rate data, policymakers can gain key insights into the inner workings of financial markets. An important policy implication that stems from this is the possibility of using the SWARCH model as an early-warning tool during periods of market turbulence. Policymakers could proactively foresee future crises and institute preventative measures that would mitigate adverse effects on the entire economy by detecting changes in volatility regimes. As soon as warning signs of a transition into a high-volatility state are detected, the regulatory framework could be fine-tuned, the resilience of financial institutions increased, and market participants given clear guidance, all of which would contribute to a more stable financial environment.

Interest rate volatility finds its essence in the delicacy of the balance that the managers of the economy must maintain between interest adjustments and melting upward inflationary pressure, more so in times deemed so by the persistence of the models of GARCH. Transmission channels for monetary policy can become less predictable during times of high volatility, and strong interventions may inadvertently worsen instability. Hence, a subtle and data-driven application of the monetary policy tools should be sought. Given the present volatility regime in place and the resultant implications their decisions

may have on interest rates and inflation expectations, prudence should rein in the decision-making of policymakers. This sets the stage for an ongoing evaluation of market dynamics and a willingness to adjust policy actions accordingly.

The larger structural reforms in the economy are needed to tackle the long-term problem of persistently high interest rates and volatility accompanying their times. In the short run, variances are solved by monetary policy tools. However, a major debate stands: intervention is needed to address long-term issues, namely fiscal imbalances, supply-side inefficiencies, and institutional weaknesses.

However, a more stable set of macroeconomic environment may eventually determine lower and less variable interest rates through structural reforms that aim at raising productivity, enhancing market efficiency, and ensuring fiscal sustainability. These reforms are capable of immensely affecting the general stability and welfare of the economy. Unfortunately, they tend to require long-term vision and unwavering political commitment.

All in all, the information derived from simulating interest rate volatility using models such as SWARCH and GARCH poses a practical policy indicator for various periods. With regime-switching models providing early warnings, it allows for preemptive crisis management; meanwhile, knowledge about volatility persistence suggests a more cautious and balanced monetary policy. However, commitment to long-term structural reforms aimed at addressing the core economic weaknesses is what can offset the present difficulties involving high interest rates and rate volatility. Practically, fulfilling these evidence-based suggestions can pave the way toward a financial environment more stable, predictable, and indeed conducive to long-term economic growth. As a result, a comprehensive policy framework should combine careful monetary management, a dedication to fundamental structural changes, and the forecasting ability of sophisticated econometric models. This multifaceted strategy recognises the many interactions between variables that affect interest rate volatility and seeks to build a more robust and stable financial sector that can sustain economic growth. Navigating the inherent risks of financial markets and attaining sustainable economic outcomes requires constant monitoring of volatility regimes in conjunction with a forward-looking policy approach.

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BIBLIOMETRIC ANALYSIS OF FINANCIAL TECHNOLOGY RESEARCH IN THE LAST DECADE USING DATA MINING TECHNIQUES

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ABSTRACT

This study conducts a comprehensive bibliometric analysis of research conducted in the field of Financial Technology (FinTech) over the past decade. The rapidly evolving nature of FinTech and its increasing impact on the global economy have made it essential to understand the direction and influence of academic studies in this field. Therefore, this research was undertaken to explore the overall dynamics of academic production in FinTech, analyze its thematic evolution, and guide future research. For this study, a Python-based program was developed and integrated with the APIs of databases such as Web of Science, Scopus, and TR Dizin to extract and process bibliometric data. In the data extraction process, relevant publications were selected using specific keywords and subject headings, with only peer-reviewed articles and book chapters included in the analysis. The extracted data were processed based on parameters such as publication year, author information, journal name, citation counts, and geographical distribution. The study employs various analytical techniques, including citation trends, co-citation networks, keyword analysis, and the geographical distribution of research outputs. Additionally, predictive models such as Linear Regression (LR) and Support Vector Regression (SVR) were applied to forecast citation and publication trends for upcoming years. To train these models, data from the past five years were used, and model performance was assessed using cross-validation techniques. To enhance the reliability of the findings, different parametric and non-parametric tests were conducted.

The research results indicate that academic publications related to FinTech are concentrated in specific thematic areas, with increasing academic interest particularly in financial innovation, blockchain technologies, and regulatory issues. In terms of geographical distribution, the United States, China, and the United Kingdom stand out as the most significant contributors. Studies from these regions primarily focus on financial services, digital banking, and decentralized finance.

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The limitations of this study include the analysis being restricted to data extracted from specific academic databases and the exclusion of grey literature (reports, policy documents, etc.). Future research can be expanded to include other components of the FinTech ecosystem, particularly examining the impact of start-ups and the implications of regulatory changes on academic output. This study provides valuable insights for academics, policymakers, and practitioners for future research and innovation in the field of FinTech.

Keywords: *Financial Technology (FinTech), Bibliometric Analysis, Data Mining, Citation Trends, Predictive Modeling.*

JEL Codes: *G00, G10, O33.*

1. INTRODUCTION

The field of Financial Technology, commonly referred to as FinTech, has emerged as one of the most transformative and rapidly evolving sectors in the global economy over the past decade. FinTech represents the convergence of finance and technology, leveraging innovations such as blockchain, artificial intelligence (AI), machine learning (ML), and the Internet of Things (IoT) to revolutionize traditional financial services (Arner, Barberis, and Buckley, 2016; Thakor, 2020). From digital payments and peer-to-peer lending to robo-advisors and decentralized finance (DeFi), FinTech has redefined how individuals and businesses interact with financial systems, offering faster, more efficient, and inclusive solutions (Gomber, Koch, and Siering, 2017; Philippon, 2020).

The rapid growth of FinTech can be attributed to several key factors. First, advancements in technology have enabled the development of innovative financial products and services that were previously unimaginable. For instance, blockchain technology has introduced decentralized and secure transaction systems, while AI and ML have enhanced fraud detection, risk management, and customer experience (Brynjolfsson and McAfee, 2017; Cong and He, 2019). Second, changing consumer behavior, particularly among younger generations, has driven the demand for digital and mobile-first financial solutions. The widespread adoption of smartphones and internet connectivity has further accelerated this shift, making financial services more accessible to underserved populations (Demirgüç-Kunt et al., 2020). Third, the 2008 global financial crisis exposed the limitations of traditional banking systems, prompting a search for more resilient and transparent alternatives. FinTech has emerged as a viable solution, offering greater efficiency, lower costs, and enhanced transparency (Arner, Barberis, and Buckley, 2016; Schueffel, 2016).

The transformative potential of FinTech has attracted significant attention from academia, industry, and policymakers. Academic research in FinTech has grown exponentially, reflecting the increasing importance of this field in shaping the future of finance. Researchers have explored a wide range of topics, including the adoption of blockchain technology, the impact of digital payments on financial inclusion,

and the regulatory challenges posed by FinTech innovations (Zetzsche et al., 2018; Huang, 2018). Policymakers, on the other hand, have sought to balance the promotion of innovation with the need to address risks such as cybersecurity, data privacy, and financial stability (Philippon, 2020; Zetzsche et al., 2018). Meanwhile, industry practitioners have embraced FinTech as a means to improve operational efficiency, reduce costs, and enhance customer satisfaction (Gomber, Koch, and Siering, 2017; Thakor, 2020).

Given the rapid evolution of FinTech and its profound implications for the global economy, it is essential to understand the direction and influence of academic research in this field. Bibliometric analysis, a quantitative method used to analyze academic literature, provides valuable insights into research trends, influential works, and the evolution of scientific fields (Zupic and Čater, 2015; Donthu et al., 2021). By applying data mining techniques, this study aims to uncover patterns and trends in FinTech research, offering a comprehensive overview of the field's development over the last decade. Specifically, this research seeks to answer the following questions:

- What are the key thematic areas of focus in FinTech research?
- How has the volume of FinTech publications and citations evolved over time?
- Which countries and institutions are leading contributors to FinTech research?
- What are the future trends and directions in FinTech research, as predicted by data-driven models?

This research is particularly timely, as the FinTech ecosystem continues to evolve rapidly, influencing global financial systems and regulatory frameworks. By leveraging data mining techniques and predictive modeling, this study provides valuable insights for academics, policymakers, and practitioners, guiding future research and innovation in FinTech. The findings of this study will not only contribute to the academic discourse on FinTech but also inform the development of policies and strategies that promote sustainable and inclusive growth in the financial sector.

2. METHODOLOGY

To conduct this bibliometric analysis, a Python-based program was developed to interface with the APIs of prominent academic databases, including Web of Science, Scopus, and TRDizin. The program was designed to extract bibliometric data based on specific keywords and subject headings related to FinTech. The keywords used in the search queries included terms such as "FinTech," "blockchain," "digital payments," "peer-to-peer lending," "robo-advisors," and "decentralized finance (DeFi)." Only peer-reviewed articles and book chapters were included in the analysis to ensure the quality and reliability of the data (Pritchard, 1969; Aria and Cuccurullo, 2017). The inclusion criteria were strictly applied to filter out non-peer-reviewed sources, conference proceedings, and grey literature, which were excluded to maintain the academic rigor of the study.

The extracted data were processed and analyzed based on several parameters, including publication year, author information, journal name, citation counts, and geographical distribution. The data preprocessing phase involved cleaning and organizing the raw data to remove duplicates, correct inconsistencies, and standardize formats. For example, author names and affiliations were standardized to ensure accurate co-authorship and institutional analysis. Similarly, journal names were normalized to account for variations in naming conventions (Van Eck and Waltman, 2014).

Various analytical techniques were employed to uncover patterns and trends in FinTech research. Citation trend analysis was used to track the growth of publications and citations over time, providing insights into the field's development and impact (Small, 1973). Co-citation networks were constructed to identify influential works and authors, as well as to map the intellectual structure of FinTech research (Zupic and Čater, 2015). Keyword analysis was conducted to identify the most frequently used terms and to explore the thematic focus areas within the field. This involved the use of natural language processing (NLP) techniques to extract and analyze keywords from titles, abstracts, and author-provided keywords (Donthu et al., 2021). Additionally, the geographical distribution of research outputs was analyzed to identify leading countries and regions contributing to FinTech research. This analysis was based on author affiliations and institutional data, providing insights into the global landscape of FinTech research (Aria and Cuccurullo, 2017).

To forecast future trends in FinTech research, predictive models such as Linear Regression (LR) and Support Vector Regression (SVR) were employed. These models were trained using historical data from the past five years, including publication counts, citation counts, and keyword frequencies. The training process involved splitting the data into training and testing sets, with cross-validation techniques used to evaluate model performance and prevent overfitting (Hastie, Tibshirani, and Friedman, 2009; James et al., 2021). The predictive models were then used to generate forecasts for future publication and citation trends, providing valuable insights into the potential trajectory of FinTech research.

The Python programming language was chosen for this study due to its extensive libraries and tools for data analysis and machine learning. Key libraries used in the analysis included Pandas for data manipulation, NumPy for numerical computations, Matplotlib and Seaborn for data visualization, and Scikit-learn for implementing predictive models (McKinney, 2010; Pedregosa et al., 2011). The use of these tools enabled efficient data processing, analysis, and visualization, ensuring the accuracy and reliability of the results.

To ensure the robustness of the findings, several validation steps were implemented. First, the data extraction process was validated by cross-checking a sample of records against the original databases to ensure accuracy. Second, the predictive models were evaluated using metrics such as mean squared error (MSE) and R-squared to assess their performance. Third, the results of the bibliometric analysis were

compared with existing literature to ensure consistency and reliability (Zupic and Čater, 2015; Donthu et al., 2021).

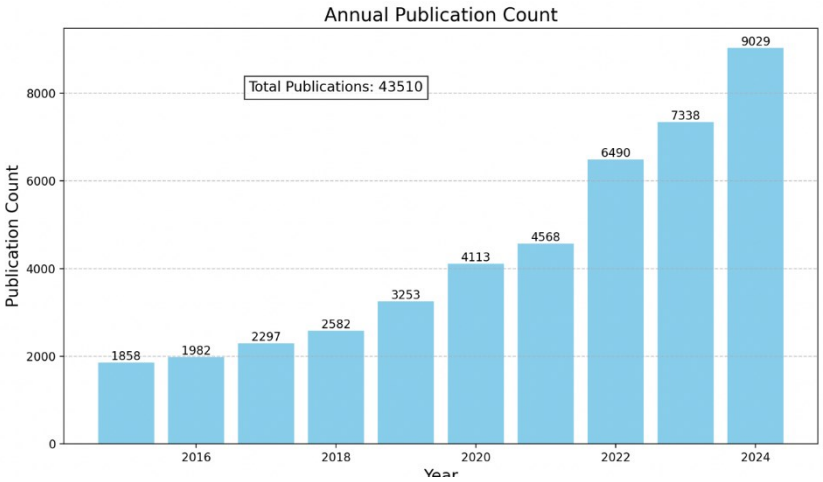
3. RESULTS AND DISCUSSION

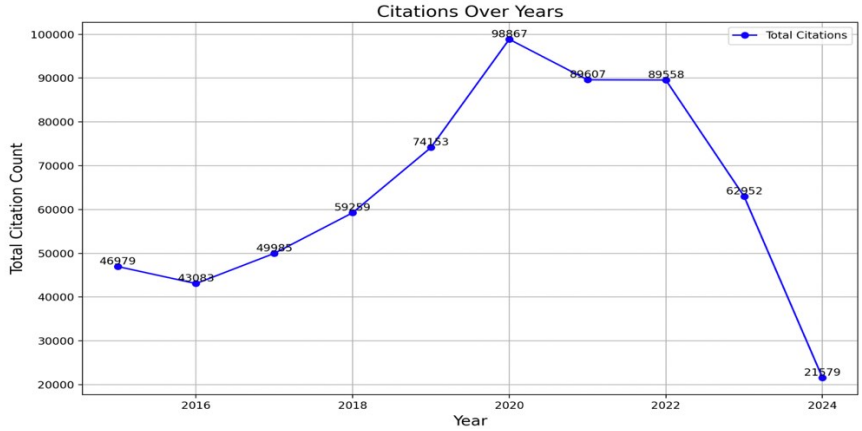
The findings of this bibliometric analysis provide a comprehensive understanding of the evolution and current state of FinTech research. The exponential growth in publications and citations over the past decade underscores the increasing academic and practical interest in FinTech. This growth is driven by the transformative potential of FinTech in reshaping financial services, enhancing efficiency, and addressing regulatory challenges (Arner, Barberis, and Buckley, 2016). Below, we discuss the key findings in detail, supported by quantitative data and visual representations.

3.1. Annual Publication and Citation Trends

In 2014, there were 1,858 publications in the FinTech field. Over the years, the number of publications has grown significantly, reaching a total of 43,510. As illustrated in Figure 1, the annual publication count demonstrates a steady upward trajectory, reflecting the increasing academic interest and research activity in FinTech. This growth is driven by the rapid adoption of digital financial services, the emergence of blockchain technology, and the increasing regulatory focus on FinTech innovations (Gomber, Koch, and Siering, 2017). The rise in publications highlights the transformative potential of FinTech and its growing relevance in global financial systems (Schueffel, 2016). The consistent increase in research output underscores the dynamic nature of the field and its importance in addressing contemporary financial challenges.

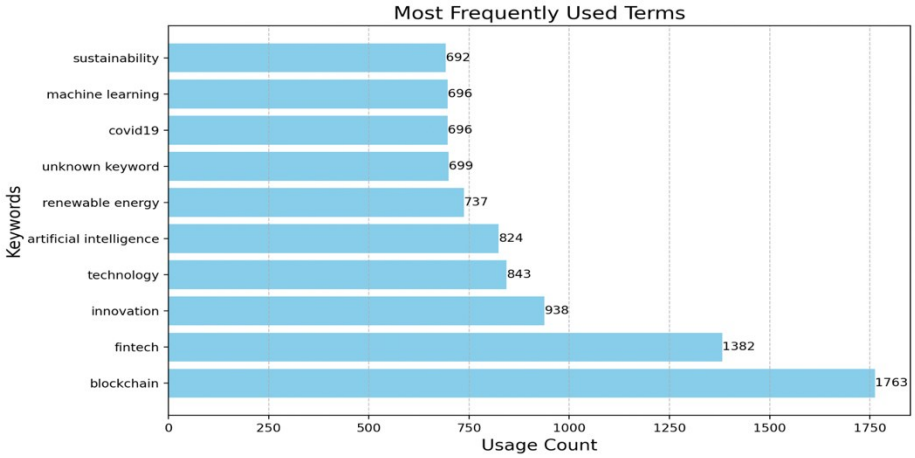
Figure 1. Annual Publication Count and Annual Citation Trend





3.2. Thematic Distribution of Research

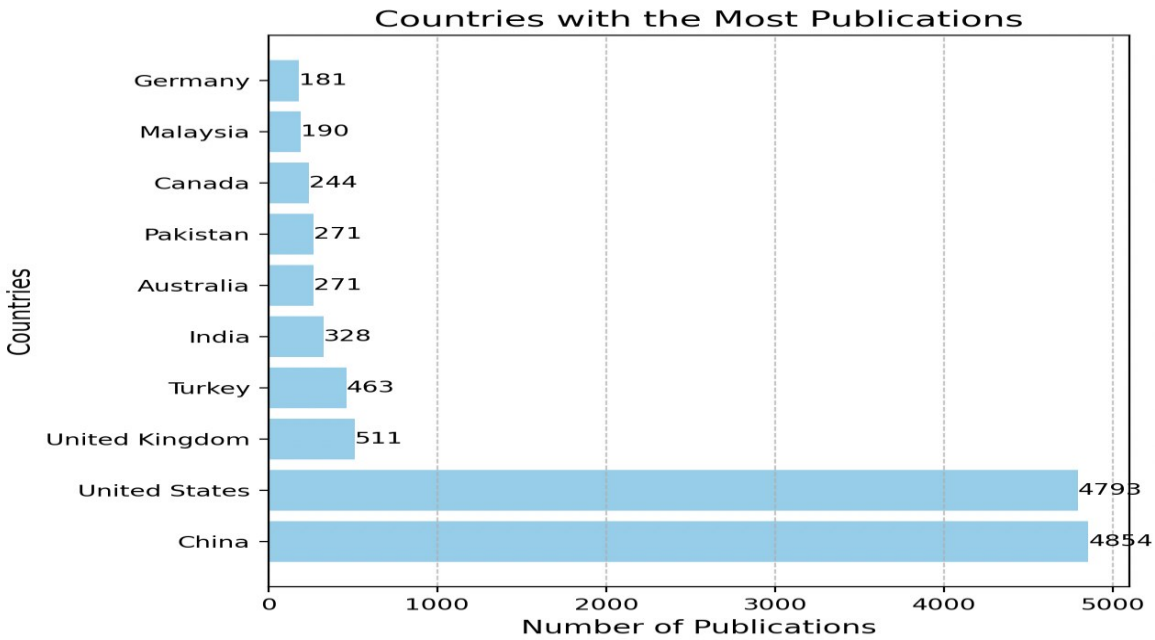
Figure 2. Most Frequently Used Terms



The most frequently used keywords in FinTech research include "blockchain" (1,763 times), "fintech" (1,382 times), and "innovation" (938 times). Figure 2 presents a visualization of the most frequently used keywords in FinTech research. The prominence of terms such as "blockchain," "fintech," and "innovation" reflects the key thematic areas of focus within the field. Blockchain technology, in particular, has emerged as a dominant theme, driven by its disruptive potential in areas such as decentralized finance (DeFi), smart contracts, and cryptocurrency (Tapscott and Tapscott, 2016). The focus on fintech highlights the shift towards cashless economies and the increasing adoption of mobile and online banking solutions, particularly in emerging markets (Huang, 2018). Additionally, terms like "artificial intelligence" (824 times) and "machine learning" (696 times) indicate the growing integration of advanced technologies in financial services. The presence of "sustainability" (692 times) and "renewable energy" (737 times) suggests an increasing emphasis on environmental and social considerations in FinTech research. These thematic areas collectively reflect the multifaceted nature of FinTech research and its implications for both academia and industry.

3.3. Geographical Distribution of Research

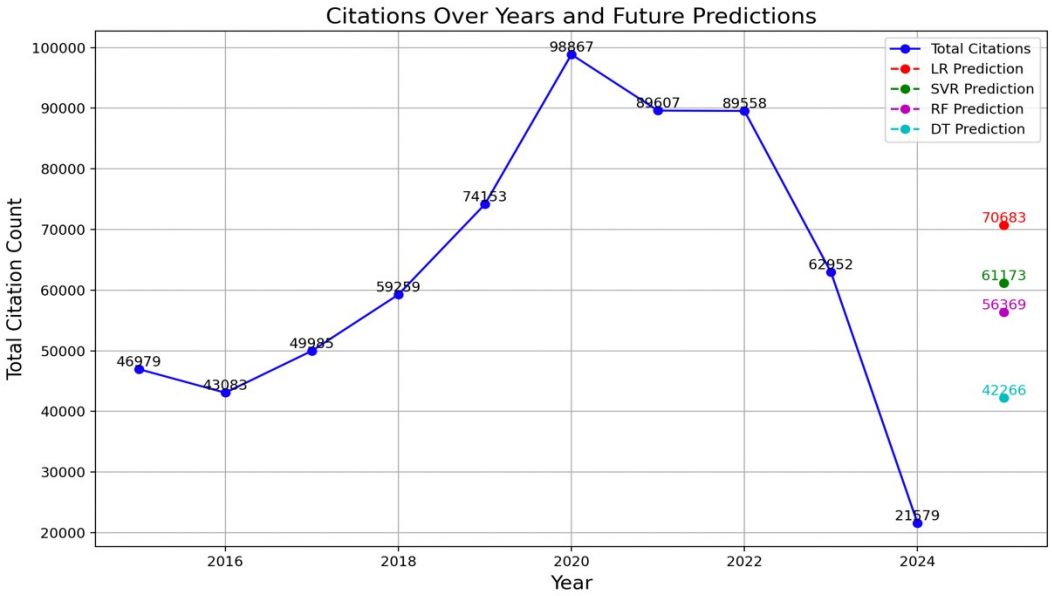
Figure 3. Most Published Countries Map



China leads with 4,854 publications, closely followed by the United States with 4,793 publications. The United Kingdom ranks third with 511 publications. Figure 3 illustrates the geographical distribution of FinTech research, highlighting the dominance of China, the United States, and the United Kingdom. These regions are not only leading in terms of publication output but also serve as hubs for FinTech innovation and investment (Huang, 2018). The United States, with its strong ecosystem of technology companies and venture capital, has been at the forefront of FinTech research. China's rapid adoption of digital payment systems, such as Alipay and WeChat Pay, has also contributed to its significant research output. The United Kingdom, particularly London, has established itself as a global FinTech hub, supported by favorable regulatory policies and a vibrant start-up ecosystem. The geographical concentration of FinTech research in these regions underscores their pivotal role in shaping the global FinTech landscape. Other countries, such as Turkey (463 publications), India (328 publications), and Australia (271 publications), also contribute to the growing body of FinTech research, albeit to a lesser extent.

3.4. Citation Trends and Predictions

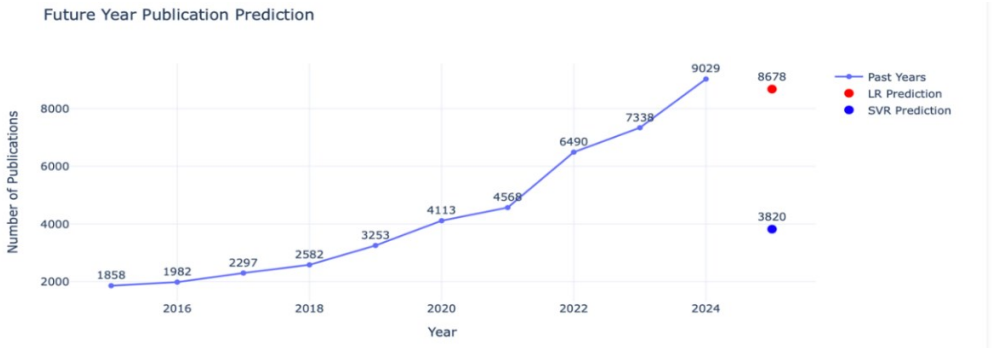
Figure 4. Annual Citation Trend and Future Predictions



The total citation count reached 42266 in 2024. Predictions based on Linear Regression (LR), Support Vector Regression (SVR), Random Forest (RF), and Decision Tree (DT) models indicate a decline in citation counts in the coming years. Figure 4 presents the annual citation trends and future predictions for FinTech research. While a significant increase in citations was observed from 2015 to 2022, peaking at 98867 in 2020, a downward trend is evident from 2022 onwards. This decline may reflect a stabilization in the field of FinTech research or a shift in academic focus. Despite this, FinTech remains a critical area of study, addressing contemporary financial challenges such as financial inclusion, cybersecurity, and regulatory compliance. The predictive models used in this study highlight the evolving nature of citation trends, suggesting that while the field continues to be impactful, the rate of growth in citations may be slowing.

3.5. Publication Predictions

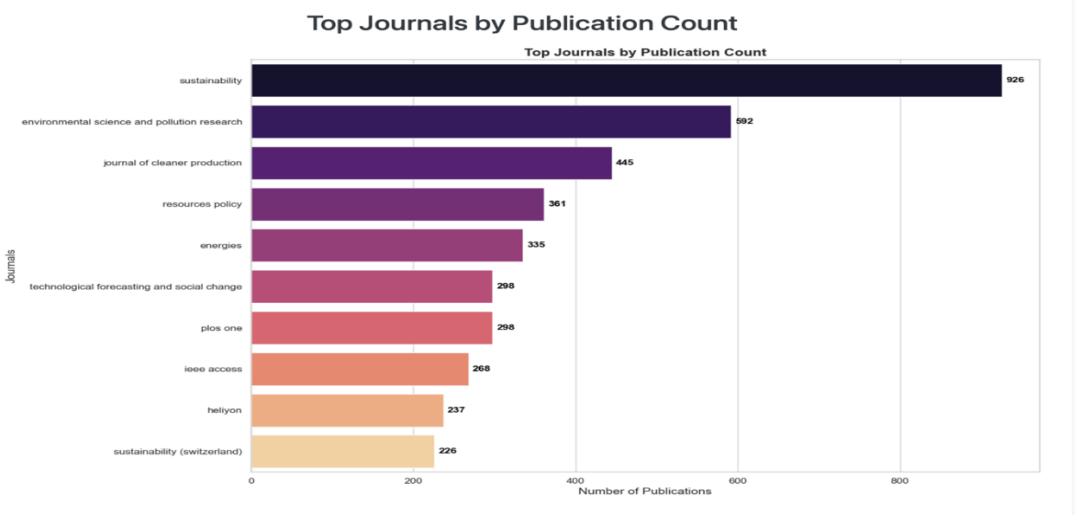
Figure 5. Future Year Publication Prediction



In 2024, the number of publications reached 9029. However, according to the Linear Regression (LR) and Support Vector Regression (SVR) models, a decline in the number of publications is anticipated in the coming years. Figure 5 presents the publication count predictions using these models, indicating a downward trend after 2024. This potential decrease could be attributed to various factors, such as market saturation in FinTech research, shifting academic interests, or the maturation of key technologies like artificial intelligence (AI), machine learning (ML), and the Internet of Things (IoT) within the financial sector. Additionally, the evolving regulatory landscape and the stabilization of decentralized finance (DeFi) ecosystems might contribute to a slowdown in new research outputs. While the exact reasons for this trend require further analysis, the models suggest a notable shift in the trajectory of FinTech-related publications.

3.6. Top Journals by Publication Count

Figure 6. Top Journals by Publication Count



The journal "Sustainability" leads with 926 publications. Other prominent journals include "IEEE Access" and "Journal of Cleaner Production." Figure 6 highlights the top journals publishing FinTech research. Sustainability is the leading journal, reflecting its significant contribution to the field. These journals serve as key platforms for disseminating FinTech research and fostering academic discourse (Frizzo-Barker et al., 2020). The prominence of journals such as "IEEE Access" and "Journal of Cleaner Production" further underscores the interdisciplinary nature of FinTech research, which spans fields such as computer science, economics, and environmental studies.

4. LIMITATIONS AND FUTURE RESEARCH

While this study offers a comprehensive overview of FinTech research, it is not without limitations. These limitations also present opportunities for future research. First, the analysis was limited to data extracted from specific academic databases such as Web of Science, Scopus, and TRDizin. This may

exclude relevant studies published in other databases or languages, potentially introducing a selection bias (Aria and Cuccurullo, 2017). Second, grey literature, such as industry reports, white papers, and policy documents, was excluded from the analysis. These sources often provide practical insights into FinTech innovations and regulatory developments, which could complement academic research (Zetzsche et al., 2018). Third, the study focuses on the past decade (2015–2024), which may not capture earlier developments in FinTech. Future studies could extend the temporal scope to provide a more comprehensive historical perspective (Thakor, 2020).

Despite these limitations, this study opens several avenues for future research. One promising direction is the inclusion of grey literature to provide a more holistic view of the FinTech ecosystem. This would enable a better understanding of the interplay between academic research and industry practices (Zetzsche et al., 2018). Another area that warrants further exploration is the role of start-ups in driving FinTech innovation. Studies could examine how start-ups influence research trends and contribute to the commercialization of FinTech solutions (Philippon, 2020). Additionally, the impact of regulatory changes on FinTech research and innovation is another promising area for future research. For example, the role of regulatory sandboxes in fostering innovation could be explored in greater depth (Zetzsche et al., 2018). Finally, the integration of emerging technologies such as AI, ML, and IoT into FinTech presents numerous research opportunities. Future studies could investigate how these technologies are transforming financial services and addressing challenges such as fraud detection, risk management, and customer experience (Brynjolfsson and McAfee, 2017; Goodell et al., 2021).

5. CONCLUSION

This bibliometric analysis provides a detailed and systematic overview of FinTech research over the past decade, highlighting key trends, influential works, and future directions. The findings underscore the importance of FinTech as a field of study and its potential to transform the global financial landscape. By leveraging data mining techniques and predictive modeling, this study offers valuable insights for academics, policymakers, and practitioners, guiding future research and innovation in FinTech.

The analysis reveals several critical insights into the evolution of FinTech research. First, the number of publications and citations in FinTech has grown significantly since 2016, reflecting the increasing academic and practical interest in this field. This growth is driven by the transformative potential of FinTech in reshaping financial services, enhancing efficiency, and addressing regulatory challenges (Arner, Barberis, and Buckley, 2016; Thakor, 2020). Second, FinTech research is concentrated in areas such as blockchain technologies, digital banking, and regulatory frameworks. Blockchain, in particular, has emerged as a dominant theme, reflecting its disruptive potential in decentralized finance (DeFi) and smart contracts (Tapscott and Tapscott, 2016; Cong and He, 2019). The focus on digital banking highlights the shift towards cashless economies, while regulatory issues emphasize the need for robust frameworks to address risks such as cybersecurity and data privacy (Zetzsche, Buckley, Arner, and

Barberis, 2018; Philippon, 2020). Third, the United States, China, and the United Kingdom are the leading contributors to FinTech research, reflecting their pivotal roles as global FinTech hubs. These regions are home to some of the world's leading financial institutions, technology companies, and start-ups, which drive both innovation and academic research in this field (Huang, 2018; Philippon, 2020). Finally, the predictive models used in this study, including Linear Regression (LR) and Support Vector Regression (SVR), indicate a continued upward trend in both publications and citations. This suggests that FinTech will remain a dynamic and rapidly evolving field in the coming years, with emerging technologies such as artificial intelligence (AI), machine learning (ML), and the Internet of Things (IoT) playing a key role in shaping future research directions (Brynjolfsson and McAfee, 2017; Goodell et al., 2021).

The findings of this study have several implications for different stakeholders. For academics, the insights from this study can help identify emerging trends and gaps in FinTech research. For example, the growing focus on blockchain and regulatory issues presents opportunities for further exploration, particularly in areas such as decentralized finance (DeFi) and regulatory sandboxes. For policymakers, the findings can guide the design of regulatory frameworks that foster innovation while addressing risks such as cybersecurity, data privacy, and financial stability. The geographical distribution of research also highlights the need for international collaboration in developing global standards for FinTech regulation. For industry practitioners, including financial institutions and start-ups, the insights from this study can help identify emerging technologies and trends that are shaping the FinTech landscape. For example, the integration of AI and ML into financial services presents opportunities for improving efficiency, reducing costs, and enhancing customer experience.

This study contributes to the field of FinTech research in several ways. First, by analyzing a large dataset of publications and citations, it provides a comprehensive overview of the evolution and current state of FinTech research. The use of data mining techniques and predictive modeling adds a novel dimension to the analysis, enabling the identification of future trends and directions. Second, the thematic and geographical analysis highlights the key areas of focus in FinTech research, providing valuable insights for academics and practitioners. The identification of emerging trends, such as blockchain and AI, also contributes to the ongoing discourse on the future of FinTech. Third, the findings of this study have practical implications for industry practitioners and policymakers, guiding the development of innovative solutions and regulatory frameworks that address the challenges and opportunities presented by FinTech.

While this study provides valuable insights into FinTech research, it also highlights several areas for future exploration. Future research could incorporate grey literature, such as industry reports and policy documents, to provide a more holistic view of the FinTech ecosystem. The role of start-ups in driving FinTech innovation is another area that warrants further exploration. Studies could examine how start-ups influence research trends and contribute to the commercialization of FinTech solutions. Additionally, the impact of regulatory changes on FinTech research and innovation is a promising area

for future research. For example, the role of regulatory sandboxes in fostering innovation could be explored in greater depth (Zetzsche et al., 2018). Finally, the integration of emerging technologies such as AI, ML, and IoT into FinTech presents numerous research opportunities. Future studies could investigate how these technologies are transforming financial services and addressing challenges such as fraud detection, risk management, and customer experience.

In conclusion, this bibliometric analysis underscores the dynamic and rapidly evolving nature of FinTech research. The findings highlight the growing academic and practical interest in FinTech, driven by its transformative potential and its implications for the global financial landscape. By leveraging data mining techniques and predictive modeling, this study provides valuable insights for academics, policymakers, and practitioners, guiding future research and innovation in FinTech. As the field continues to evolve, it is essential for stakeholders to collaborate and address the challenges and opportunities presented by FinTech, ensuring its sustainable and inclusive growth.

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DO GOVERNMENT EXPENDITURES MATTER FOR UNEMPLOYMENT IN TÜRKIYE: A REGIONAL EXAMINATION FROM A GENDER PERSPECTIVE

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Pelin VAROL İYİDOĞAN**

Eda YEŞİL***

ABSTRACT

In Türkiye, the issue of unemployment has long remained at the forefront of governmental policy agendas. In this regard, a substantial body of academic literature has sought to uncover the underlying determinants of unemployment. From a fiscal standpoint, public expenditures—commonly regarded as an indicator for the size of government—have been extensively analyzed in relation to the impact on unemployment dynamics. The existing literature predominantly adopts two contrasting theoretical perspectives. The first posits that increases in public spending may generate a crowding-out effect, thereby exacerbating unemployment. In contrast, the second strand contends that public expenditures can serve as a mitigating factor, contributing to a reduction in unemployment levels. Within this framework, the aim of our paper is to examine the unemployment rate and government expenditure relationship at provincial level over the period 2010-2022 for 26 NUTS regions of Türkiye. Our study has a number of original contributions to the regarding literature. Firstly, we embed a gender perspective to our framework by considering female and male unemployment rates separately. Another original value of our study is that we use economic classification of government expenditure in terms of current, transfer and investment expenditures. Finally, as an original methodological approach, we apply fixed effect quantile regression procedure which enables to estimate the conditional mean and other quantiles of the dependent variable, that is the unemployment rate. The findings of our empirical analysis are striking, which provide evidence based on quantile approach indicating a gender disparity in favour of male employment. All categorized types of government spending sharpen the women unemployment problem for all quantiles.

Keywords: *Unemployment, Government Size, Quantile Regression.*

JEL Codes: *H50, J08, C33.*

1. INTRODUCTION

The increase in the share of the government in the economy is generally considered together with the increase in public expenditures, and the effects of this situation on production, productivity and employment are analysed from different perspectives in the literature. In this context, many empirical

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studies analysing the negative relationship between the government size and economic growth have revealed that increasing public expenditures have a suppressive effect on economic growth. Abrams (1999) argues that the unemployment factor lies at the root of this effect. In this study, it is argued that public expenditures lead to imbalances in the labour market by shrinking private sector activities and increase unemployment rates through high tax rates, generous unemployment insurance practices and strict regulations. Accordingly, it is argued that the government size has a negative impact on economic growth not directly but indirectly through unemployment. Similarly, Scully (1989) argues that the increase in public expenditures reduces technical efficiency, which leads to a shift away from the production possibilities curve and triggers unemployment. In this context, the resulting loss of efficiency is realised as a result of sub-optimal allocation of resources and limits the potential for economic growth (Afonso et al., 2018).

Abrams (1999: 395-396) argues that an increase in public expenditures may lead not only to a decrease in total factor productivity but also to a decline in technical progress and innovative activities by excluding interest rate sensitive private sector investments. According to Abrams, even if public expenditures are directed to growth-promoting areas, the expansion of the public sector narrows the scope of the private sector, and this may lead to negative consequences in labour markets in the long run. Within the framework of this relationship, which is referred to as the 'Abrams Curve' in the literature, Abrams presents various mechanisms through which this negative effect may occur.

Firstly, the expansion of the public sector is often accompanied by higher tax rates, which may contribute to higher unemployment rates by causing individuals to prefer leisure over work and prolonging the job search process. Secondly, a large-scale public sector allows for easier financing of social security schemes such as public health services and unemployment benefits. However, this situation reduces the cost of unemployment for the individual and thus weakens the motivation to look for a job. Thirdly, economies with a large public sector tend to have more rigid regulations on the labour market, which may adversely affect job creation processes. Finally, the increase in public expenditures and investments leads to a redistribution of economic resources by excluding private sector investments, which may lead to a contraction in the employment capacity of the private sector and may have an increasing effect on unemployment.

Most of the studies analysing the relationship between public expenditures and unemployment in the literature are based on Abrams' (1999) study, which argues that there is a positive relationship between these two variables and supports the related hypothesis with empirical findings (Christopoulos and Tsionas, 2002; Christopoulos et al, 2005; Feldmann, 2006; Feldmann, 2009; Feldmann, 2010; Wang and Abrams, 2011; Mahdavi and Alanis, 2013; Ding, 2014; Matsumae and Hasumi, 2016; Kovacı et al., 2018; Afonso et al., 2018; Ertekin, 2020).

In general, the literature is dominated by classical views that argue that the government size may increase unemployment, but there are also Keynesian approaches that public expenditures do not necessarily create an exclusion effect and may even theoretically support economic growth. In this framework, some studies have found that the government size has a negative effect on unemployment, that is, it has a decreasing effect on unemployment (Aslan and Kula, 2010; Kanca and Bayrak, 2015; Obayori, 2016; Topal, 2017; Holden and Sparrman, 2018; Saraireh, 2020).

In this framework, the analyses conducted for 26 NUTS regions of Turkey for the period 2010-2022 aim to examine whether the gender factor is determinant in the effect of public expenditures on unemployment. In this respect, the study is expected to contribute to the existing literature in several aspects. First of all, it is observed that in most of the existing studies in the literature, researchers generally evaluate the relationship between public expenditures and unemployment through the general unemployment rate and analyse it without taking gender discrimination into account. However, it is stated that the dynamics affecting the unemployment rates of men and women may differ and these differences should be taken into account in order to increase the effectiveness of public policies to be developed especially against economic fluctuations (Altuzarra, 2015 as cited in Çelik and Erer, 2021). On the other hand, in addition to the gender perspective, the economic categorisation of public expenditures in this study also constitutes an important difference. In this way, it was possible to obtain more detailed findings by evaluating the effects of different types of public expenditures on unemployment separately. Moreover, the Method of Moments Quantile Regression (MMQR) method used in the study makes a unique methodological contribution and increases the scientific value of the study.

The rest of the study is structured as follows: In line with the theoretical framework presented in the introduction, the related literature is comprehensively reviewed. Following this, the empirical analysis section first introduces the data set used in the study, followed by a detailed presentation of the methodological approach followed and the findings obtained. Finally, the study is concluded with the conclusion section, which provides a general evaluation of the results obtained.

2. REVIEW OF RELEVANT LITERATURE

The relationship between unemployment and the government size is mostly analysed within the framework of the Abrams Curve in the literature. Abrams' (1999) study aims to empirically analyse the relationship between the size of the government and the unemployment rate. In this context, it is analysed whether there is a statistically significant relationship between the share of government expenditures in gross domestic product (GDP) and reported unemployment rates. The sample of the study was initially restricted to G7 countries covering the period 1984-1993 but later expanded to include countries with a population of over 5 million and a GDP per capita of over $15,000. Methods such as rank correlation, ordinary least squares (OLS) and weighted least squares regression are used in the analysis. The findings reveal that there is a strong and positive relationship between the size of the government and the

unemployment rate in the sample of G7 countries, while this relationship weakens as the sample expands; however, the significance is restored with the inclusion of some control variables in the model. In conclusion, Abrams' study provides empirical evidence that increases in the government size may increase unemployment rates and indirectly have negative effects on economic growth.

Christopoulos and Tsionas (2002) and Christopoulos et al. (2005), based on Abrams' (1999) study, examined the relationship between public sector size and unemployment rate in ten developed economies of the European Union. As a result of their empirical analyses, they found empirical evidence that an increase in the government size increases unemployment rates, which supports Abrams' findings. Accordingly, the authors conceptualised this positive relationship as the 'Abrams Curve' hypothesis and this conceptualisation has been widely used in the literature.

Aslan and Kula (2010) analysed the relationship between public sector size and unemployment within the framework of Abrams Curve by using unemployment data disaggregated by education level for the Turkish economy. Johansen cointegration test and VECM-based Granger causality analyses were applied in the study conducted with quarterly data for the period 2000:1-2007:3. The findings do not support the positive relationship suggested by Abrams (1999); on the contrary, they show that an increase in the government size has a generally decreasing effect on unemployment rates. This result reveals that the Abrams Curve hypothesis is not valid for the Turkish economy.

Çelik and Erer (2021) applied the ARDL analysis method in their study covering the NUTS-26 level regions of Turkey for the period 2004-2019. Their findings reveal that in the long run, public expenditures have a decreasing effect on male and female unemployment rates as well as the general unemployment rate. On the other hand, in the short run, public expenditures cause an increase in both male and female unemployment rates. This reveals that the Abrams Curve Hypothesis is valid for Turkey in the short run.

In short, as stated by Abrams (1999), the government size does not necessarily increase the unemployment rate. In other words, the direction and magnitude of this effect may vary depending on how the state uses the public budget. For example, expenditures on labour force training and active employment policies and passive expenditures such as unemployment insurance may have different effects on unemployment. Moreover, factors such as cultural factors, level of unionisation and institutional structure may further complicate this relationship. Moreover, reported unemployment rates may not always reflect the actual situation, as some public policies may cause unemployed individuals to be classified outside the labour market. For these reasons, establishing a direct and unidirectional relationship between the government size and the unemployment rate may be misleading; this relationship needs to be empirically tested.

3. EMPIRICAL APPLICATION

3.1. Data

The main objective of this study is to analyse the effects of public expenditures on unemployment for 26 NUTS regions in Turkey. In the analysis, public expenditures are categorised as current expenditures, investment expenditures and transfer expenditures and each of them is evaluated separately. In addition, gender perspective was also considered in the study; analyses were carried out for the male population aged 25 and over and the female population aged 25 and over. In this framework, Table 1 below provides information on the sampling and data set used in the study.

Table 1. Sample and Dataset

Sample	Data	Description of Data
TR10 İstanbul TR21 Tekirdağ, Edirne, Kırklareli TR22 Balıkesir, Çanakkale	**Dependent Variable**	
TR31 İzmir TR32 Aydın, Denizli, Muğla	man_unemp	Unemployment Rate for Males Aged 25 and Over
TR33 Manisa, Afyon, Kütahya, Uşak TR41 Bursa, Eskişehir, Bilecik	women_unemp	Unemployment Rate for Females Aged 25 and Over
TR42 Kocaeli, Sakarya, Düzce, Bolu, Yalova	**Explanatory Variables**	
TR51 Ankara TR52 Konya, Karaman TR61 Antalya, Isparta, Burdur	ln_curr	Logarithmic Transformation of Total Current Expenditures
TR62 Adana, Mersin TR63 Hatay, Kahramanmaraş, Osmaniye TR71 Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir	ln_cap	Logarithmic Transformation of Total Investment Expenditures
TR72 Kayseri, Sivas, Yozgat TR81 Zonguldak, Karabük, Bartın TR82 Kastamonu, Çankırı, Sinop	ln_ trans	Logarithmic Transformation of Total Transfer Expenditures
TR83 Samsun, Tokat, Çorum, Amasya TR90 Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane	**Control Variable**	
TRA1 Erzurum, Erzincan, Bayburt TRA2 Ağrı, Kars, Iğdır, Ardahan TRB1 Malatya, Elazığ, Bingöl, Tunceli TRB2 Van, Muş, Bitlis, Hakkari TRC1 Gaziantep, Adıyaman, Kilis TRC2 Şanlıurfa, Diyarbakır TRC3 Mardin, Batman, Şırnak, Siirt	ln_gdp	Logarithmic Transformation of Per Capita Gross Domestic Product (in 2009 constant US dollars)

Source: Prepared by the authors.

When Table 1 is analysed, it is seen in the first column that 81 provinces in Turkey are grouped according to the NUTS-26 regional level, which is the statistical classification of the Turkish Statistical Institute (TURKSTAT). The dependent variables of the study are male and female unemployment rates of the population aged 25 and over. These unemployment data are obtained from official statistics published by the Turkish Statistical Institute (TURKSTAT). Explanatory variables are based on the 'Central Government Budget Statistics by Provinces' data set of the General Directorate of Accounting under the Ministry of Treasury and Finance. Total public expenditures are classified under three main categories: current expenditures, investment expenditures and transfer expenditures. In addition, gross

domestic product (GDP) per capita calculated in 2009 prices and in US dollars is used as a control variable in the analyses.

Table 2 below presents the descriptive statistics for the variables used in the study.

Table 2. Descriptive Statistic

Variable	Obs	Mean	Std. Dev.	Min	Max
man_unemp	338	8.145	4.116	2.3	25.4
woman_unemp	338	9.886	5.169	0.6	36.3
ln_curr	338	10378164	11142929	1187857	98332327
ln_ cap	338	2303783.2	4588331.8	113521	60623677
ln_trans	338	1028571	3502698	77080	52995718
ln_gdp	338	8838.515	3468.738	3429	20883

Source: Prepared by the authors.

3.2. Metodology

In this study, which aims to examine the impact of public expenditures on unemployment from a gender perspective, the Method of Moments Quantile Regression (MMQR) is used to present the empirical findings. The main reason for choosing this method is that the distribution of the unemployment level may have heterogeneous effects on different segments of the society; such effects may be ignored by traditional regression approaches that are based only on the average. In this framework, six different models have been designed in order to evaluate the direction and degree of the effect of public expenditures on unemployment more comprehensively. Models 1, 2 and 3 examine the effect of current expenditures, investment expenditures and transfer expenditures on the unemployment level of the male population aged 25 and above, respectively. Models 4, 5 and 6 examine the effect of current expenditures, investment expenditures and transfer expenditures on the unemployment level of the female population aged 25 and above, respectively.

The fundamental panel data format of the models in this study is articulated as follows:

$$\text{man\_unemp}_{it} = \beta_0 + \beta_1 \ln \text{\_curr}_{it} + \beta_2 \ln\text{\_gdp}_{it} + u_{it} \quad (1)$$

$$\text{man\_unemp}_{it} = \beta_0 + \beta_1 \ln \text{\_cap}_{it} + \beta_2 \ln\text{\_gdp}_{it} + u_{it} \quad (2)$$

$$\text{man\_unemp}_{it} = \beta_0 + \beta_1 \ln \text{\_trans}_{it} + \beta_2 \ln\text{\_gdp}_{it} + u_{it} \quad (3)$$

$$\text{woman\_unemp}_{it} = \beta_0 + \beta_1 \ln \text{\_curr}_{it} + \beta_2 \ln\text{\_gdp}_{it} + u_{it} \quad (4)$$

$$\text{woman\_unemp}_{it} = \beta_0 + \beta_1 \ln \text{\_cap}_{it} + \beta_2 \ln\text{\_gdp}_{it} + u_{it} \quad (5)$$

$$\text{woman\_unemp}_{it} = \beta_0 + \beta_1 \ln \text{\_trans}_{it} + \beta_2 \ln\text{\_gdp}_{it} + u_{it} \quad (6)$$

In the models presented above, i and t represent the panel data dimensions, while man_unemp and women_unemp denote the dependent variable. The coefficient β_0 represents the intercept term, while u_{it}

denotes the error term. β_1 indicates the size and direction of the effect of the explanatory variables, current expenditures, recurrent expenditures and transfer expenditures on the dependent variable. Finally, β_2 is the coefficient that indicates the size and direction of the effect of the control variable on the dependent variable.

In this study, the MMQR (Method of Moments Quantile Regression) method is used to model and analyse different aspects of the individual effects of the models presented in simplified form in Equations 1, 2, 3, 4, 5, and 6 on the conditional distribution. The MMQR method developed by Machado and Silva (2019) presents an innovative approach that combines estimates of location and scale functions for the estimation of conditional quantiles. This method stands out with its ability to utilise techniques used in the estimation of conditional means. Quantile regression expresses the relationship between the dependent variable Y_t and the explanatory variables X_t for a given quantile λ as follows:

$$Q_\lambda(Y_t|X_t) = X_t'\beta_\lambda + U_{\lambda,t}, \quad E\left[m\left(U_{\lambda,t}\right)\middle|X_t\right] = 0 \tag{1}$$

The model estimating conditional quantiles can first be expressed in general form as follows:

$$Y_{it} = \alpha + X'\beta + \sigma \cdot \delta + Z'\gamma + U \tag{2}$$

Here, α,β,δ,γ are unknown parameters. X is the vector of basic explanatory variables and Z is the k-element vector containing the known and differentiable transformations of the components of X. In the light of this information, the conditional quantile representation of the model can be written as follows:

$$Q_y(X) = \left(\alpha_i + \delta_i \cdot q(\lambda)\right) + X_{it}\beta + Z_{it}\gamma(\lambda) \tag{3}$$

In the equation, (α_i+δ_i·q(λ)) represents the quantile constant effect λ of individual i or the dispersion effect at λ. This dispersion effect captures the effect of time-invariant individual characteristics without an overall location shift.

As a result, the quantile regression analysis, which is considered in this methodological framework, analyses the relationship between the dependent variable, the unemployment rate, and public expenditures in different quantiles of the distribution, and reveals the inhomogeneous effects of this relationship in more detail. This method increases the robustness of the model, especially in cases where there are extreme values in the data set or skewness in the distribution; thus, it provides a more flexible and comprehensive analysis opportunity to understand how the effect of public expenditures on unemployment varies in different segments of the society. In this respect, the quantile regression method provides an important methodological framework that can contribute to policymakers to develop target-specific and effective employment policies.

3.3. Findings

Firstly, whether the data conform to normal distribution is evaluated by means of the Shapiro-Wilk W test as shown in Table 3. This test is considered as one of the most powerful statistical methods that measure the degree of deviation of data from normal distribution. The null hypothesis of the Shapiro-Wilk W test assumes that the relevant series are normally distributed. In this framework, Table 3 shows that the series used in the analysis do not meet the assumption of normal distribution.

Table 3. Shapiro-Wilk W Test Results

Variable	Obs	W	V	z	Prob>z
man_unemp	338	0.853	34.900	8.387	0.000
woman_unemp	338	0.921	18.680	6.911	0.000
ln_curr	338	0.652	82.544	10.419	0.000
ln_cap	338	0.388	145.007	11.749	0.000
ln_trans	338	0.196	190.405	12.392	0.000
ln_gdp	338	0.935	15.493	6.469	0.000

Source: Prepared by the authors.

In addition to the Shapiro-Wilk test, the skewness and kurtosis statistics presented in Table 4 were also analysed to assess the conformity of the data set to a normal distribution. These two criteria are among the basic statistical indicators that are frequently used to determine whether the distribution is symmetric or not and how close the data are to the normal distribution by determining the density of the peaks.

Table 4. Skewness and Kurtosis Tests for Normality

Variable	Obs	Pr(skewness)	Pr(kurtosis)	Adj chi2(2)	Prob>chi2
man_unemp	338	0.000	0.000	91.010	0.000
woman_unemp	338	0.000	0.000	74.310	0.000
ln_curr	338	0.000	0.000	222.260	0.000
ln_cap	338	0.000	0.000	361.010	0.000
ln_trans	338	0.000	0.000	447.260	0.000
ln_gdp	338	0.000	0.064	33.030	0.000

Source: Prepared by the authors.

The values obtained confirmed that the data showed a systematic deviation from the normal distribution. This situation supports that the distributional characteristics should be examined in more detail and that analyses at the quantile level are appropriate and appropriate for the purpose of the study.

Table 5. Pesaran Cross-Sectional Dependence Test

Variable	CD-test	p-value
man_unemp	33.743	0.000
woman_unemp	22.083	0.000
ln_curr	64.942	0.000
ln_cap	62.618	0.000
ln_trans	62.451	0.000
ln_gdp	58.047	0.000

Source: Prepared by the authors.

Since the time dimension of the panel data set used in this study is shorter than the number of horizontal cross-sections, Pesaran (2004) CD test was applied to detect possible horizontal cross-sectional dependence among the series. The findings in Table 5 show that the null hypothesis of 'no horizontal cross-sectional dependence' is rejected at the 1% significance level for all variables and all models.

Accordingly, it is concluded that there is a significant level of horizontal cross-section dependence among the variables.

Table 6. Panel Unit Root Test Accounting for Cross-Sectional Dependence

Variable	Level	
	t-bar	p-value
man_unemp	-2.398	0.001
woman_unemp	-2.038	0.070
ln_curr	-2.364	0.001
ln_ cap	-2.141	0.025
ln_trans	-2.296	0.004
ln_gdp	-2.417	0.001

Source: Prepared by the authors.

Considering the presence of cross-sectional dependence, the stationarity of the series is examined using the Cross-sectionally Augmented Dickey-Fuller (CADF) test developed by Pesaran. The results presented in Table 6 indicate that all variables are stationary at their level forms.

Table 7 below presents the results of the panel quantile analysis, which independently assesses the impact of each unemployment category and provides a more comprehensive assessment of the impact of public expenditure on the unemployment rate of the male population.

Table 7. Panel Quantile Analysis Results (Male)

	Model 1	Model 2	Model 3
Dependent variable: man_unemp			
0.25 quantile			
ln_curr	-0.051 (-0.19)	--	--
ln_ cap	--	-0.448** (-1.96)	--
ln_trans	--	--	-0.460* (-1.84)
ln_gdp	-8.569*** (-5.69)	-9.460*** (-6.57)	-9.734*** (-6.66)
0.50 quantile			
ln_curr	-0.212 (-1.05)	--	--
ln_ cap	--	-0.600** (-3.32)	--
ln_trans	--	--	-0.586*** (-3.14)
ln_gdp	-9.673*** (-8.82)	-10.387*** (-9.14)	-10.715*** (-9.80)
0.75 quantile			
ln_curr	-0.365 (-1.40)	--	--
ln_ cap	--	-0.746*** (-2.89)	--
ln_trans	--	--	-0.702*** (-2.78)
ln_gdp	-10.723*** (-7.57)	-11.281*** (-6.94)	-11.613*** (-7.87)

Notes: ***, **, and * indicate statistical significance at the 1%, 5%, and %10 level, respectively. Z statistics are given in parentheses.

Table 7 presents the estimation results for Models 1, 2, and 3, which examine the effects of current expenditures, investment expenditures, and transfer expenditures, respectively, on the unemployment rate of the male population. The table reports the findings from the panel quantile regression analysis, in which the sample is divided into three quantiles. The 0.25 quantile corresponds to observations with the lowest male unemployment rates, the 0.50 quantile represents median unemployment levels, and the 0.75 quantile reflects the highest unemployment rates within the male population.

An examination of Model 1 reveals that current expenditures exert a negative effect across all quantiles; however, this effect is statistically insignificant. In contrast, for investment expenditures and transfer expenditures (Models 2 and 3), the negative impact on male unemployment is not only present in all quantiles but also statistically significant. Furthermore, the magnitude of the coefficients increases as the level of unemployment rises, suggesting that the effect of public expenditures becomes more pronounced in higher quantiles. These findings imply that, contrary to the assertions of Abrams (1999), increases in public spending are associated with reductions in male unemployment. Additionally, across all quantiles in Models 1, 2, and 3, per capita income exhibits a statistically significant and negative relationship with male unemployment, indicating that rising income levels contribute to lower unemployment rates among the male population.

Table 8. Panel Quantile Analysis Results (Female)

	Model 4	Model 5	Model 6
Dependent variable : women_unemp			
0.25 quantile			
ln_curr	1.541*** (3.55)	--	--
ln_ cap	--	1.143*** (3.29)	--
ln_trans	--	--	1.099*** (2.92)
ln_gdp	-5.628*** (-2.65)	-7.907*** (-3.83)	-7.387*** (-3.63)
0.50 quantile			
ln_curr	1.426*** (4.24)	--	--
ln_ cap	--	0.891*** (3.37)	--
ln_trans	--	--	0.901*** (3.04)
ln_gdp	-6.766*** (-4.10)	-9.388*** (-5.97)	-8.836*** (-5.47)
0.75 quantile			
ln_curr	1.321*** (2.87)	--	--
ln_ cap	--	0.661** (1.85)	--
ln_trans	--	--	0.702* (1.71)
ln_gdp	-7.795*** (-3.46)	-10.745*** (-5.06)	-10.299*** (-4.62)

Notes: ***, **, and * indicate statistical significance at the 1%, 5%, and %10 level, respectively. Z statistics are given in parentheses.

Table 8 presents the results of Models 4, 5, and 6, which respectively examine the effects of current expenditures, investment expenditures, and transfer expenditures on the unemployment rate of the female population. The table, based on panel quantile regression analysis, divides the sample into three quantiles: the 0.25 quantile represents the lowest levels of female unemployment, the 0.50 quantile corresponds to moderate levels, and the 0.75 quantile captures the highest unemployment rates among the female population. An analysis of the findings reveals that increases in public expenditures significantly raise female unemployment across all models and quantiles. These results align with Abrams's (1999) thesis, which posits that an expansion in public spending may contribute to higher unemployment among women. Furthermore, in all quantiles of Models 4, 5, and 6, increases in per capita income are found to have a statistically significant and negative impact on female unemployment.

4. CONCLUSION

This study analyses the impact of public expenditures on unemployment in Turkey for the period 2010-2022, covering 26 NUTS regions, on the basis of gender segregation and expenditure type. The Moments Quantile Regression (MMQR) method used in the empirical analyses provides the opportunity to evaluate the effects of public expenditures on male and female unemployment rates at the quantile level. The findings reveal that public expenditures have a decreasing effect on male unemployment, whereas current, investment and transfer expenditures have a statistically significant and positive effect on female unemployment in all quantiles. This situation shows that public expenditures have different effects based on gender and points out that women's employment should be handled more carefully and in a more target-oriented manner in the context of public policies.

The findings contradict the Abrams Curve Hypothesis developed by Abrams (1999) and widely accepted in the literature in terms of male unemployment; on the other hand, they support this hypothesis to a great extent in terms of female unemployment. In particular, the strong observation of the negative impact of public expenditures on female labour force at all quantile levels reveals that not only the impact of public expenditures on total employment, but also their impact on gender-based employment inequalities should not be ignored. In this context, it is emphasised that more inclusive and target-oriented policy approaches should be developed in the design process of public policies, considering not only the total unemployment rate but also the differential effects on female and male employment.

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QUANTILE-ON-QUANTILE CONNECTEDNESS BETWEEN CLIMATE UNCERTAINTY AND FINANCIAL RISK IN THE BANKING SECTOR

Onur POLAT*

ABSTRACT

The quantile-on-quantile (QQ) connectedenss between systemic risk and climate uncertainty in the US banking industry is examined in this study. We investigate how climate risks—divided into physical (natural disasters, global warming) and transitional (U.S. climate policy, international summits) categories—affect financial stress at different quantiles using the Financial Risk Meter (FRM), which was built using Lasso quantile regression for 128 banks divided into large, medium, and small segments. We demonstrate robust, asymmetric spillover effects during tail events, especially during crises such as the COVID-19 pandemic and the 2023 U.S. banking crisis, using Quantile-on-Quantile (QQ) connectedness and causality tests. According to our findings, larger banks serve as financial shock transmitters, and climate risks have a substantial impact on systemic risk dynamics in a quantile-dependent and institution-specific way.

Keywords: *Financial Risk Meter (FRM), Climate Risk, Quantile Connectedness, Systemic Risk, U.S. Banking Sector.*

JEL Codes: *C22, G21, Q54.*

1. INTRODUCTION

In recent years, financial stability has been scrutinized increasingly due to climate-related risks. Physical risks (e.g., natural disasters) and transition risks (e.g., policy shifts toward decarbonization) affect the U.S. banking sector, affecting asset valuations and operational resilience. In spite of several studies exploring the effects of climate risks on asset markets, few have considered the implications of such risks on banks across various risk regimes.

Utilizing a novel Financial Risk Meter (FRM) applied to U.S. banks, this study aims to fill this gap by analyzing the quantile-dependent connectivity between climate risks and systemic financial risks. Our analysis takes into account both physical and transition risks using climate indicators derived from media-based sentiment indices. Our approach captures the nonlinear, time-varying nature of this relationship using quantile-on-quantile methods and nonparametric quantile causality testing.

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The relevance of this inquiry has grown in recent years, in part as a result of the increase in extreme weather occurrences, but also as a result of changing regulatory standards. Central banks and regulators are placing increasing pressure on financial organizations to include climate issues in their risk management models. Climate scenarios are now being included in stress testing activities in the EU and the United States, but empirical instruments for determining how climate uncertainty spreads through financial systems are still lacking. By creating quantile-sensitive instruments that show the varied consequences of climate shocks, our research adds to this policy debate.

Furthermore, the sector's crucial role in credit intermediation and monetary transmission makes systemic risk in banking a major issue. Disruptions in the banking sector, particularly those caused by climate change, might have domino effects throughout the economy. We attempt to identify the conditions under which the financial system is most at risk by analyzing the correlations between climate indicators and banking risk across quantiles, thus providing data for early warning systems and forward-looking prudential frameworks.

The main contribution of this study is twofold. We first use a novel quantile-on-quantile connectedness framework to systematically analyze the transmission of climate uncertainty to systemic risk throughout the risk distribution in the U.S. banking industry. Second, we differentiate the impacts across bank sizes and types of climate risks, providing a granular and policy-relevant insight into how climate-related disruptions spread throughout financial systems. Our research advances the expanding body of knowledge on climate finance and systemic risk by combining nonparametric quantile causality and directional spillover techniques. It provides practical methodological and empirical insights for supervising financial stability.

2. LITERATURE REVIEW

In recent years, the interaction between financial stability and climate risks has received more and more attention. By illustrating how both physical and transition climate hazards can impact the solvency and credit allocation of banks, early research like Battiston et al. (2017) and Roncoroni et al. (2021) laid the groundwork. Recent studies, such as Boungou and Urom (2023), support the financial significance of climate uncertainty by demonstrating that climate-related headlines have a substantial impact on the stock returns of major global and G20 banks.

Curcio et al. (2023) demonstrated that physical climate threats, such billion-dollar catastrophes, increase systemic vulnerability in U.S. banks. By creating textual-based climate risk indicators that capture nuanced changes in physical and transition risks from media material, Faccini et al. (2023) made a significant contribution. Nevertheless, there is still little research on how these hazards interact with financial stress at various market conditions.

This literature is expanded by our research, which uses a quantile-based methodology to capture the entire distribution of systemic risk. In contrast to earlier models that depend on conditional means, we concentrate on nonlinearities and tail-risk behavior, providing a more resilient and policy-relevant framework for analyzing the effects of climate uncertainty on financial markets. Our methodology incorporates recent improvements in systemic connectedness and tail-risk modeling. The Financial Risk Meter (FRM), which Mihoci et al. (2020) created, utilizes quantile regression based on Lasso to predict time-varying co-movements in the tails of asset returns, giving a dynamic indicator of systemic stress.

The nonparametric causality-in-quantiles framework developed by Jeong et al. (2012), on the other hand, has shown its usefulness in identifying nonlinear and quantile-specific predictive links, particularly in financial scenarios with structural breaks. Our study, which combines FRM with quantile-on-quantile connectedness analysis, makes a unique contribution to both the climate finance and systemic risk modeling literatures. However, there have been few attempts to integrate these tools to investigate the relationship between climate finance and climate finance.

3. DATA SET

The dataset contains the daily closing prices of 128 publicly traded U.S. banks from June 2006 to June 2023. Banks are divided into big (>$10 billion), medium ($2 billion to $10 billion), and small (>$2 billion) categories based on their market capitalization.The ADS business conditions index, interest rates, the VIX, and the S&P 500 Index are all examples of macroeconomic financial measures that are used as control variables.We employ four news-based climate-related indicators created by Faccini et al. (2023):ND: Natural DisastersGW: Worldwide WarmingU.S. Climate Policy: USCPIS: International SummitsThese indices are produced using Latent Dirichlet Allocation on a massive collection of Reuters news items. The climate risk indexes were downloaded from the authors' repository at https://sites.google.com/site/econrenatofaccini/home/research, and all financial statistics came from Refinitiv Datastream.

4. METHODOLOGICAL FRAMEWORK

4.1 Financial Risk Meter (FRM)

Following Mihoci et al. (2020), the FRM captures the average tail dependency across a network of bank stock returns, using Lasso quantile regression. A sliding window of 500 days is used to generate time-varying estimates of systemic risk. The FRM is estimated for all banks as well as subgroups based on size: large, medium, and small banks. The estimation process involves optimizing a penalized quantile regression objective function and selecting appropriate shrinkage parameters via information criteria. Full technical details of the FRM computation, including the mathematical formulation and estimation steps, are provided in Appendix A.

4.2 Quantile Causality-in-Quantiles Test

To assess the predictive role of climate risk factors on the FRMs, we apply the Jeong et al. (2012) nonparametric test for Granger causality in quantiles. This method identifies whether the entire distribution of FRM outcomes can be forecasted by lagged values of climate risk indices. It is particularly suited to detecting nonlinear relationships and structural breaks. The test uses a kernel-based approach to estimate conditional quantiles and compute a normalized test statistic. The selection of kernel functions, bandwidth parameters, and lag length is crucial for reliable inference. The implementation steps and mathematical expressions are summarized in Appendix B.

4.3 Quantile-on-Quantile Connectedness

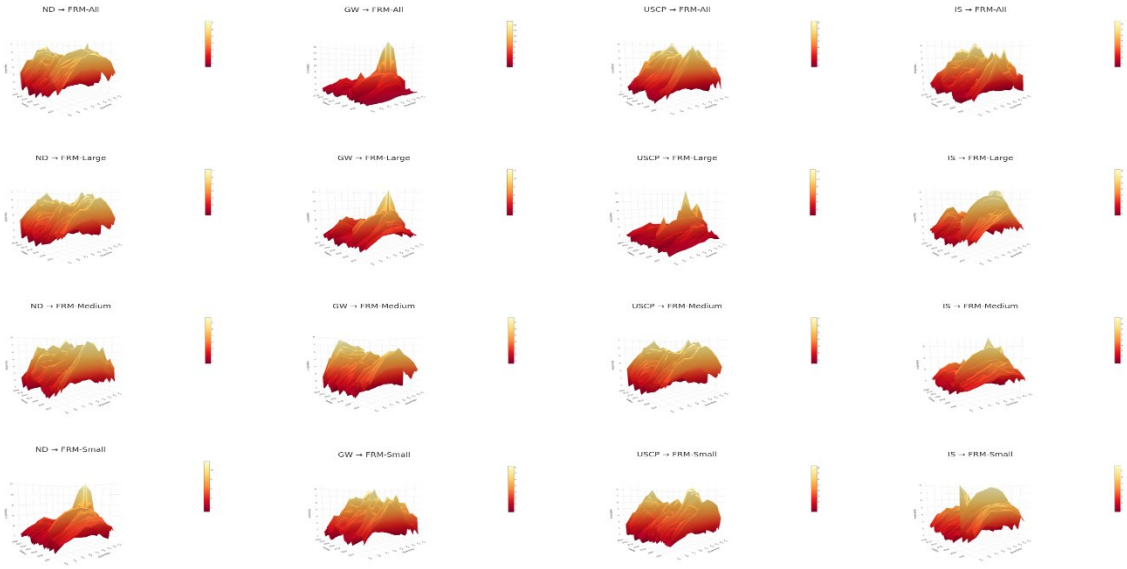
We further explore directional spillovers between climate risks and FRMs using quantile-on-quantile (QQ) connectedness metrics. This approach estimates the interaction between different quantiles of the climate variables and FRMs, providing a full-surface map of dependence across regimes. QQ connectedness is particularly effective in identifying tail-to-tail dependencies and capturing the asymmetry of spillovers during market stress. The modeling involves estimating quantile VAR systems across paired quantiles and computing generalized forecast error variance decompositions. Full methodological elaboration, including the QQ-VAR formulation and connectedness index construction, is presented in Appendix C.

5. RESULTS AND INTERPRETATION

5.1. Dynamics of the FRM

Figure 1 illustrates the evolution of the Financial Risk Meter (FRM) across the full sample period (2008–2023) for the overall banking system and subgroups categorized by market capitalization (large, medium, and small banks).

Figure 1. Financial Risk Meters (FRMs)



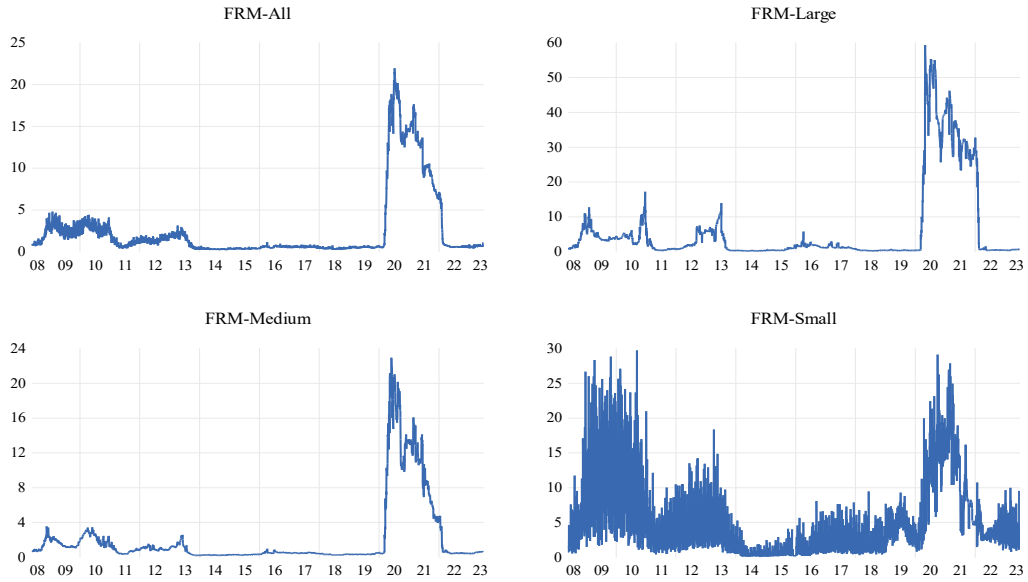
Source: Author's calculations.

As shown in Figure 1, the FRMs rise sharply during major crises, such as the 2008 Global Financial Crisis, the 2010–2012 European Debt Crisis, the COVID-19 epidemic in 2020, and the U.S. banking crisis of 2023. The size of the bank affects the timing and intensity of these peaks. Significantly, the greatest and most synchronized increases in systemic risk occur in big banks, supporting their function as facilitators of financial contagion.

5.2 Causal Impact of Climate Risks

The causal relationships are shown in Figure 2 in a quantile-on-quantile surface format,. Each 3D panel illustrates how the strength of causality changes across combinations of quantiles and is associated to a particular climate risk-bank group pair. The risk spillover is most severe when the FRM and climate risk are in the same quantile regimes (such as high-to-high or low-to-low), as evidenced by the diagonal dominance in many panels.

Figure 2: Causality-In-Quantiles Test Statistics Across Firms And Climate Risk Indices



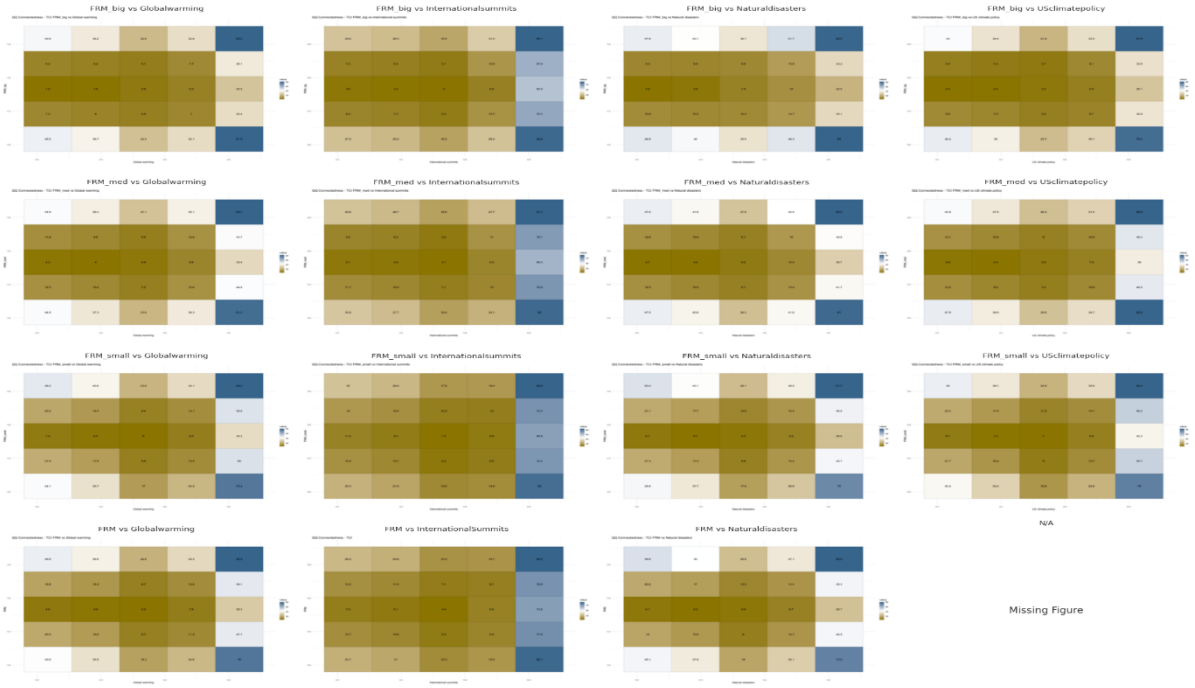
Source: Author's calculations.

The IS to FRM-Large and USCP to FRM-Medium plots show unusually high peaks along the middle to upper quantiles, indicating that these transition risks are particularly significant in markets experiencing moderate to high stress. On the other hand, the ND FRM-Small and GW FRM-Small panels exhibit a wider range of surface elevation throughout the quantile spectrum, suggesting that small banks are impacted more uniformly by physical risks. Interestingly, certain plots, such as GW → FRM-All and USCP → FRM-Small, show pockets of nonlinearity and rapid elevation, which supports the idea of nonlinear regime-switching behavior. These impacts are less noticeable at the extreme quantiles (i.e., below 0.1 and above 0.9), which supports the idea that climate risk signals have the greatest impact when there is moderate systemic stress.

5.3.Quantile-on-Quantile Connectedness Findings

The quantile-on-quantile (QQ) heatmaps in Figure 3 illustrate how shocks from various quantiles of climate risk variables spread to the matching quantiles of systemic risk. These findings confirm strong quantile-specific spillovers and emphasize the asymmetric and nonlinear nature of the relationship between climate and financial risk.

Figure 3. Quantile-on-Quantile Heatmaps of Climate Risks vs. FRM



Source: Author's calculations.

The diagonal dominance is a notable characteristic of the majority of panels, which indicates that a shock in a certain quantile of a climate risk factor has the greatest impact on the same quantile of the FRM. For instance, a high (90th percentile) realization of climate policy uncertainty tends to raise the FRM at comparable high quantiles, indicating that severe climate news occurs in tandem with increased systemic stress. Particularly for large and medium-sized banks, the transition risk indices—especially International Summits (IS) and U.S. Climate Policy (USCP)—stand out due to their high and consistently distributed connectedness scores. In the upper right quadrants, these heatmaps display deeper shading (indicating stronger spillovers), which supports the idea that these transition risks have the greatest impact during times of high financial pressure.

Specifically, the IS–FRM_big and IS–FRM_med panels show connectedness ratings over 60% in the 0.7–0.9 quantile range of both variables. In contrast, the impact of physical hazards, notably natural disasters (ND) and global warming (GW), is more complex. In accordance with the notion that smaller, regionally concentrated firms are more susceptible to localized climate shocks, their spillover surfaces are relatively muted for major banks but become more pronounced for smaller banks, even though they do have an impact on all bank groups. The scope of influence is another pattern that emerges: transition risks tend to have wider spillover bands that affect a wider FRM quantile range (for example, 0.3–0.9), whereas physical risks tend to focus their influence in fewer quantiles. This implies that policy discussions on the environment generate more systemic and lasting uncertainty, even if physical occurrences have immediate, localized consequences. Figure 4 provides dynamic insights into the

evolving relationship between climate risks and systemic risk in the U.S. banking sector through rolling-window analyses of Directly- and Reversely-related quantile total connectedness indices (TCIs).

Figure 4. Quantile-on-Quantile Heatmaps of Climate Risks vs. FRM

Source: Author's calculations.

The majority of panels are distinguished by diagonal dominance, which demonstrates that a shock in a particular quantile of a climate risk variable has the greatest influence on the same quantile of the FRM. For example, a high (90th percentile) realization of climate policy uncertainty tends to increase the FRM at similar high quantiles, suggesting that severe climate news coincides with greater systemic stress.

The transition risk indices, notably International Summits (IS) and U.S. Climate Policy (USCP), stand out for their high and consistently distributed connectedness scores, particularly for medium- and large-sized banks. These heatmaps' darker shading in the upper right quadrants suggests stronger spillovers, supporting the notion that these transition risks have the greatest impact when there is significant financial stress. Notably, the IS–FRM_big and IS–FRM_med panels display connectivity ratings over 60% in the 0.7–0.9 quantile interval for both variables.

However, the effects of physical risks, particularly natural disasters (ND) and global warming (GW), are more difficult to understand. Consistent with the idea that smaller, geographically focused companies are more at risk from local climate shocks, their spillover surfaces have a greater impact on smaller banks but are comparatively subdued for bigger banks, even if they do have an impact on all bank groups.

Another trend that emerges is the extent of impact: physical risks often concentrate their effects in fewer quantiles, while transition risks tend to have wider spillover bands that affect a larger FRM quantile range (e.g., 0.3–0.9). Even if physical events have immediate and local effects, this suggests that policy debates on the environment produce longer-lasting and more systemic uncertainty.

6. CONCLUSION

Utilizing a novel quantile-on-quantile connectedness framework and nonparametric causality techniques, this study has methodically examined the nonlinear, quantile-dependent correlations between climate uncertainty and systemic financial risk in the U.S. banking industry. By creating the Financial Risk Meter (FRM) for 128 banks broken down by market capitalization and using four different climate risk indicators, we have discovered noteworthy, time-varying predictive correlations across different quantile regimes.

Our study demonstrates that systemic risk dynamics are considerably and continuously impacted by transition risks, particularly those associated with international summits and U.S. climate policy, especially for medium- and large-sized banks. On the other hand, physical climate risks such as global warming and natural catastrophes have higher predictive value, especially for smaller banks. Additionally, the study emphasizes that the effect of climate hazards is more pronounced at moderate quantiles, indicating increased vulnerability during times of moderate financial hardship as opposed to extreme or baseline conditions.

According to the study's findings, large banks are mostly responsible for spreading systemic risk, which highlights their important role in increasing risk throughout the financial system. This necessitates targeted climate risk integration into regulatory stress-testing frameworks and differentiated, size-sensitive macroprudential policies. Policymakers and regulators must implement quantile-sensitive and dynamic supervisory methods to better manage climate-induced systemic risks, given the observed nonlinearities and asymmetric spillover dynamics.

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APPENDIX.

A. FINANCIAL RISK METER (FRM)

The FRM is constructed as the mean value over the series of penalization terms computed based on the log-returns of the stock prices of the 128 US banks in our sample, following Mihoci et al. (2020). We firstly introduce the linear quantile Lasso regression approach as discussed in Härdle et al. (2016).

Considering a large number (128) of banks denoted by k, and indexed by $j \in \{1, \dots, k\}$, the total number of covariates is $k + m - 1$, where m is the number of macroeconomic and financial control variables, discussed in the next section (Section 3). There are T total observations, with time indexed by t. We use a sliding window s given by $s \in \{1, \dots, (T - (n - 1))$ having a size of n = 500 observations to compute the time-varying FRM. Having introduced this notation, the quantile Lasso regression can be written as:

$$X_{j,t}^{s} = \alpha_j^s + A_{j,t}^{s,T} \beta_j^s + \epsilon_{j,t}^{s} \quad \text{(A.1)}$$

where $A_{j,t}^{s,T} = \begin{bmatrix} M_{t-1}^{s} \\ X_{-j,t}^{s} \end{bmatrix}$, while M_{t-1}^{s} is the vector of our macro-finance variables of dimension *m* and $X_{-j,t}^{s}$the vector of log-returns of the stock prices for the other banks except bank *j* at time *t* and for the windows s (with this latter vector having a dimension of *p-m*).

The estimation for this regression uses a L_1-norm quantile regression (Li and Zhu, 2008), which is formally written as:

$$\min_{\alpha_j^s, \beta_j^s} \{ n^{-1} \sum_{t=s}^{s+(n-1)} \rho_t (X_{j,t}^s - \alpha_j^s - A_{j,t}^{s,T} \beta_j^s) + \lambda_j^s \left\| \beta_j^s \right\|_1 \} \quad \text{(A.2)}$$

where, λ_j^s is a penalization parameter, while we define the function $\rho_\tau(u)$ as:

$$\rho_\tau(u) = |u|^c |I(u \leq 0) - \tau| \quad \text{(A.3)}$$

where, for *c* having a value of 1, we get the quantile regression.

For equation (2), the crucial choice is of the penalization parameter λ_j^s. One can use the Bayesian information criterion (BIC) or, following Yuan (2006), the generalized approximate cross-validation criterion (GACV), which is shown by Yuan and Lin (2006) to have a better performance from a statistical point of view. Hence, we determine λ_j^s using the GACV criterion, such that $\lambda_j^s$is the solution to this minimization problem:

$$\min GACV(\lambda_j^s) = \min \frac{\sum_{t=s}^{s+n} \rho_t (X_{j,t}^s - \alpha_j^s - A_{j,t}^{s,T} \beta_j^s)}{n - df} \quad \text{(A.4)}$$

where *df* measures the actual dimensionality of the fitted model.

Following this approach, we get a λ_j^s for each bank. The final λ_j^s, i.e., the FRM, is computed as a mean of the set of *k* banks:

$$\text{FRM} = \frac{1}{k} \sum_{j=1}^{k} \lambda_j^* \quad \text{(A.5)}$$

We construct the FRM not only for all banks in our sample, irrespective of market capitalization, but also for three categories of bank (small, medium, and large) classified based on the market capitalization of each bank, with details presented in the next section.

B. NONPARAMETRIC CAUSALITY-IN-QUANTILES TEST

In this sub-section, we briefly present the methodology for testing nonparametric causality based on the framework of Jeong et al. (2012).

Let y_t denote the FRM for the overall banking system, or for small, medium, and large banks, and x_t a particular climate risk, i.e., natural disaster, global warming, international summit, and US climate policy. Further, let $Y_{t-1} \equiv (y_{t-1}, \ldots, y_{t-p})$, $X_{t-1} \equiv (x_{t-1}, \ldots, x_{t-p})$, $Z_t = (X_t, Y_t)$, and $F_{y_t|\cdot}(y_t | \bullet)$ denote the conditional distribution of y_t given $\bullet$. Defining the θ-th conditional quantile function of the

lagged values of the variables ($Z_t = (X_t, Y_t)$) in the bivariate system as $Q_\theta(Z_{t-1}) \equiv Q_\theta(y_t|Z_{t-1})$ and $Q_\theta(Y_{t-1}) \equiv Q_\theta(y_t|Y_{t-1})$, we have $F_{y_t|Z_{t-1}}\{Q_\theta(Z_{t-1})|Z_{t-1}\} = \theta$ with probability one. The rejection of the null hypothesis indicates quantiles-based Granger causality, with the following testable hypotheses in the θ-th quantile:

$$H_0: \; P\{F_{y_t|Z_{t-1}}\{Q_\theta(Y_{t-1})|Z_{t-1}\} = \theta\} = 1 \qquad (B.1)$$

$$H_1: \; P\{F_{y_t|Z_{t-1}}\{Q_\theta(Y_{t-1})|Z_{t-1}\} = \theta\} < 1 \qquad (B.2)$$

Jeong et al. (2012) show that the feasible kernel-based (standard normal) test statistic has the format:

$$\hat{J}_T = \frac{1}{T(T-1)h^{2p}} \sum_{t=p+1}^{T} \sum_{s=p+1, s\neq t}^{T} K\left(\frac{Z_{t-1} - Z_{s-1}}{h}\right) \hat{\varepsilon}_t \hat{\varepsilon}_s \qquad (B.3)$$

where $K(\bullet)$ is the kernel function with bandwidth h, T is the sample size, p is the lag order, and $\hat{\varepsilon}_t = \mathbf{1}\{y_t \leq \hat{Q}_\theta(Y_{t-1})\} - \theta$ is the regression error, where $\hat{Q}_\theta(Y_{t-1})$ is an estimate of the θ-th conditional quantile, and $\mathbf{1}\{\bullet\}$ is the indicator function. The *Nadarya-Watson* kernel estimator of $\hat{Q}_\theta(Y_{t-1})$ is given by:

$$\hat{Q}_\theta(Y_{t-1}) = \frac{\sum_{s=p+1, s\neq t}^{T} L\left(\frac{Y_{t-1} - Y_{s-1}}{h}\right) \mathbf{1}\{y_s \leq y_t\}}{\sum_{s=p+1, s\neq t}^{T} L\left(\frac{Y_{t-1} - Y_{s-1}}{h}\right)} \qquad (B.4)$$

with $L(\bullet)$ denoting the kernel function.

The empirical implementation of this nonparametric causality-in-quantiles testing involves specifying: the bandwidth (h), lag order (p), and kernel types for $K(\cdot)$ and $L(\cdot)$. We use p = 1 based on the BIC, h is determined by the leave-one-out least-squares cross validation, and we employ Gaussian kernels for $K(\cdot)$ and $L(\cdot)$.

C. QUANTILE-ON-QUANTILE CONNECTEDNESS

The quantile-on-quantile (QQ) connectedness model developed by Gabauer and Stenfors (2024), which extends the quantile connectedness framework originally introduced by Chatziantoniou, Gabauer, and Stenfors (2021).

Let's define a $QVAR(p)$ model as follows:

$$y_t = \mu(\tau) + \sum_{i=1}^{p} B_i(\tau) y_{t-i} + u_t(\tau) \qquad (C.1)$$

y_t, and y_{t-i} are $N \times 1$ endogenous vectors across multiple dimensions, τ representing a vector of quantiles within the interval $[0,1]$. The parameter p refers to the lag length in the QVAR model. The conditional mean vector $\mu(\tau)$ has dimensions $N \times 1$, while the QVAR coefficient matrix $B_i(\tau)$ is of size $N \times N$. $u_t(\tau)$ represents $N \times 1$ dimensional error vector with a $N \times N$ dimensional variance-covariance

matrix, $F(\tau)$. By employing the Wold representation theorem, the QVAR model is converted into its QVMA form:

$$y_t = \mu(\tau) + \sum_{i=1}^{p} B_i(\tau) y_{t-i} + u_t(\tau) = \mu(\tau) + \sum_{i=0}^{\infty} A_i(\tau) u_{t-i}(\tau) \tag{C.2}$$

The consequences of an external jolt in series i on series j over H steps is quantified by the forecast error variance decomposition, as shown below:

$$\emptyset^{g}_{j\leftarrow i}(H) = \frac{\sum_{h=0}^{H-1}\left(e_j' A_h(\tau) F(\tau) e_j\right)^2}{F_{ii}\left(\sum_{h=0}^{H-1}\left(e_j' A_h(\tau) F(\tau) A_h(\tau)' e_j\right)\right)} \qquad gSOT_{j\leftarrow i,\tau}(H) = \frac{\emptyset^{g}_{j\leftarrow i}(H)}{\sum_{i=1}^{n} \emptyset^{g}_{j\leftarrow i}(H)} \tag{C.3}$$

in which e_j is a $N \times 1$ zero vector with j −th element set to one.

To compute the rescaled GFEVD, $gSOT_{j\leftarrow i,\tau}(H)$, we normalize $\emptyset^{gen}_{j\leftarrow i}(H)$ by calculating its proportion relative to the row sum.

The TO measure illustrates the influence that series j exerts on the remaining series, while the FROM measure reflects the impact that all other series have on series j. These connectedness measures are calculated as follows:

$$S^{gen,to}_{j\rightarrow *,\tau}(H) = \sum_{n=1, j\neq i}^{N} gSOT_{j\leftarrow n,\tau} \tag{C.4}$$

$$S^{gen,from}_{j\leftarrow *,\tau}(H) = \sum_{n=1, j\neq i}^{N} gSOT_{n\leftarrow j,\tau} \tag{C.5}$$

The NET total directional connectedness for series i is derived by deducting the total directional connectedness received (FROM) from the total directional connectedness given (TO) ;

$$S^{gen,net}_{j,\tau}(H) = S^{gen,to}_{j\rightarrow *,\tau}(H) - S^{gen,from}_{j\leftarrow *,\tau}(H) \tag{C.6}$$

The revised total connectedness index (TCI) as introduced by Chatziantoniou, Gabauer, and Stenfors (2021) calculated as:

$$TCI^{H}_{\tau} = \frac{N}{N-1}\sum_{n=1}^{N} S^{gen,from}_{n\leftarrow *,\tau} \equiv \frac{N}{N-1}\sum_{n=1}^{N} S^{gen,to}_{n\rightarrow *,\tau} \tag{C.7}$$

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IMPACT OF M&A ANNOUNCEMENTS ON THE ACQUIRER IN THE POST-COVID ERA

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ABSTRACT

This study investigates the impact of mergers and acquisitions (M&A) announcements on the acquirer stock performance within the context of the post-COVID era. Through analyzing abnormal returns and trading volumes across a diverse sample of recent transactions, it is found that relative deal size (transaction value scaled by the acquirer's market capitalization) exhibits a statistically significant positive relationship with abnormal trading volume and abnormal returns. The model calculates abnormal returns and trading volumes by comparing observed stock performance to market-adjusted benchmarks. Contrary to some pre-pandemic literature that put an emphasis on strategic alignment (vertical vs. horizontal deals), the findings of this study show no significant influence of merger type on market response. The results agree with those of previously published behavioral science theories, emphasizing managerial overconfidence and attention-driven trading in the volatile post-COVID markets. The changing dynamics of market efficiency of the post-pandemic economies are highlighted in this study.

Keywords: *Mergers and Acquisitions, Event Study, Abnormal Returns, Post-COVID Markets, Investor Attention.*

JEL Codes*: G14, G34, C58.*

1. INTRODUCTION

In a world characterized by technological disruption and consolidation, mergers and acquisitions have become a critical tool to create corporate growth. The post-pandemic market has experienced significant fluctuations with the S&P 500 index's movement being evidence of the volatile economy. Amid this uncertainty, many companies pursued M&A deals to adapt. Classic M&A theories stem from pre-pandemic contexts and usually conclude that acquirer shareholders earn either neutral or negative returns at announcement, due to insufficient due diligence on the acquirer's part or integration difficulties.

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The pandemic period, however, created new behavioral dynamics. Retail investor participation has surged, and the amount of information and its flow have grown in a similar manner, potentially altering market reactions to events. It is crucial to re-examine the announcement effects under these new conditions. This paper addresses the above by specifically focusing on deal characteristics as potential drivers of reactions. In doing so, this study contributes new evidence on post-pandemic M&A dynamics, examining whether deal attributes like size and merger type drive investor reactions in ways that differ from pre-pandemic patterns.

The remainder of this paper is organized as follows. First, a review of the relevant literature on market reactions to M&A announcements is conducted, highlighting theories and past findings on acquirer returns, deal size effects, and merger types. Next, the research methodology is outlined, including the event study design and regression models used to analyze the data. Then, the empirical results and discussion are presented, integrating the study's findings with insights from prior bibliography. Finally, the study cocludes with the implications, limitations, and suggestions for future research.

2. LITERATURE REVIEW

Research on mergers and acquisitions and the effects they have on the market has been going on for decades yet changing market conditions due to the pandemic have made it necessary to reexamine long-standing theories. This review integrates both previous and new research, emphasizing the relationship between deal characteristics, investor behavior, and methodological rigor, while also considering the current study's emphasis on relative deal size and strategic alignment.

2.1 Market Reactions to M&A Announcements

The "winner's curse" hypothesis, articulated by Jensen and Ruback (1983), proposes that acquirers overpay for targets, leading to negative or neutral returns. Moeller et al. (2005) then improved this framework by attributing significant acquirer losses to managerial hubris, especially in larger transactions that appear to indicate investor skepticism and increased scrutiny. This narrative was contested by Alexandridis et al. (2017), who demonstrated that post-2000 acquirers in tech-driven markets frequently see positive returns because of the scalability of the majority of tech products and the synergies of intangible assets.

Despite their limited explanatory power, short-term event studies continue to be the gold standard for examining announcement effects (MacKinlay, 1997). Kothari and Warner (2007) showed that noise causes even robust models to produce low R^2 (5–15%).

2.2 Deal Size: Proportionality and Investor Scrutiny

The debate over deal size centers on proportionality. Although Moeller et al. (2004) noted that scaling by acquirer size (e.g., deal-to-acquirer ratio) better captures economic impact, they did find a

strong correlation between raw deal value and abnormal returns. This metric gained popularity when Malmendier and Tate (2008) linked CEO overconfidence to large relative deals, which led to negative returns. Houston et al. (2001) reported no effects for deal size in banking mergers, while Hoberg and Phillips (2016) found that relative size significantly predicts returns in industries with high R&D needs (e.g., pharmaceuticals).

2.3 Strategic Alignment: Horizontal/Vertical Classifications

In modern markets, traditional synergy-based theories, such as Fan and Goyal's (2006) focus on vertical mergers for cost efficiencies, face challenges. Hoberg and Phillips (2016) argued that horizontal/vertical distinctions are less predictive in knowledge-based economies. Sector-specific studies further complicate this narrative. Ahern and Harford (2014) found horizontal deals more advantageous in fragmented industries (e.g., healthcare), while Maksimovic and Phillips (2001) reported 2–3% higher returns for vertical mergers in manufacturing. Bena and Li (2014), however, showed that the advantages of diversification frequently outweigh the benefits of strategic alignment, especially in post-crisis markets where resilience takes precedence over synergy.

2.4 Methodological Considerations: Noise in Event Studies

The acceptance of low R^2 values in event studies shows that the field prioritizes hypothesis testing over explanatory power. Brown and Warner (1985) work showed that even "clean" events yield R^2<10%. Baker et al. (2020) cautioned against complexity, noting that simpler models remain preferable for isolating causal effects in noisy data.

2.5 Behavioral and Post-COVID Dynamics

Behavioral theories provide a different outlook for interpreting noisy data. Roll's (1986) Hubris Hypothesis became relevant in pandemic-era studies, with Hu, Tsang, and Wan (2020) connecting CEO overconfidence to expensive "pandemic pivots". Furthermore, Barber and Odean (2008) attention-driven trading theory gained popularity, as platforms like Robinhood amplified volumes for mega-deals. These behavioral perspectives imply that in the post-COVID environment, heightened investor attention and managerial overconfidence could meaningfully shape market reactions to M&A news, potentially leading to unusual trading patterns or valuation effects beyond what traditional models predict.

3. DATASET

The study analyzes 88 M&A deals announced between 2020 and 2024, involving acquirer firms across various sectors. The sample is global, with deals spanning technology, healthcare, energy, finance, and consumer industries. The variety ensures that results are not heavily weighted towards one sector, while the focus on the *post-2020 period* captures the post-pandemic market dynamics. Each observation in the dataset is an acquiring company that announced a merger or acquisition (typically of a sizable,

corporate target) within the timeframe. The period begins with the pandemic and includes the subsequent economic recovery and boom in certain sectors, as well as instances of volatility. Focusing on this window allows this study to observe how investor and market reactions may differ from those documented in earlier decades.

Variables: For each deal, we compute the following key variables:

- Abnormal Return (AR) on day 0 (announcement date) and day 1 (the next trading day).
- Abnormal Trading Volume (AV) on day 0 and day 1.
- Deal Size Ratio
- Deal Type dummy variables
- Abnormal volume ratios on day 0 and day 1.

Data Sources: Stock price and volume data were collected from public sources (e.g., Yahoo Finance) using a computational R script, that utilized quantmod for stock price/volume data, lubridate for date handling, and tidyverse for data manipulation. Each acquirer's daily adjusted closing prices and trading volumes were retrieved, along with the corresponding market index (S&P 500) and a risk-free rate proxy for the same period. Deal information (announcement dates, values, and descriptions) was obtained from financial news releases (e.g., company press releases, SEC filings).

4. METHODOLOGY

4.1 Objectives of the Study

- To calculate abnormal returns (AR) and abnormal trading volumes for acquirer stocks on the announcement day (Day 0) and the subsequent trading day (Day 1).
- To evaluate the cumulative impact of M&A announcements on stock performance using event windows.
- To analyze the relationship between relative deal size (deal value scaled by acquirer market capitalization) and investor reaction.
- To test the statistical significance of deal type (horizontal vs vertical) on market responses.

4.2 Hypotheses

- Null Hypothesis (H_0): M&A announcements have no significant impact on acquirer stock returns or trading volumes, and neither deal size nor strategic types influence market reactions.
- Alternative Hypothesis (H_1): M&A announcements have a significant impact on acquirer stock returns or trading volumes, and deal size and strategic types influence market reactions.

4.3 Statement of the Problem

Mergers and acquisitions are events of great importance for the corporate world and have the potential to majorly affect stock performance. The post Covid M&A landscape is characterized by increased volatility and a rise in technology-driven deals, yet a lot of prior bibliography mostly focuses on pre-pandemic industrial and energy sectors. This current study addresses this gap in research by looking into whether deal magnitude or strategic alignment drive investor reactions to an M&A announcement in more recent years.

4.4 Need of the Study

Understanding post-pandemic M&A dynamics is critical for investors, corporations, regulators and academics navigating and investigating volatile markets. This research provides actionable insights into how deal size amplifies investor attention, aiding stakeholders in anticipating market reactions and refining valuation strategies in technology-inclusive economies. By looking into the reactions of stock prices to M&A announcements, the current study contributes to the understanding of investor attention and helps formulate corporate strategies, while adding to the academic discourse in finance.

4.5 MODEL FOR THE STUDY

4.5.1 Event Study Methodology

- Estimation Window: 90 trading days pre-announcement to model expected returns using a market-adjusted approach:

$$Ri,t = \alpha i + \beta iRm,t + \epsilon i,t$$

where Ri,tRi,t = stock return, Rm,tRm,t = market return (S&P 500 proxy), ϵi,tϵi,t = error term.

- Abnormal Return (AR):

$$ARi,t = Ri,t - (\alpha \hat{} I + \beta \hat{} iRm,t)$$

- Abnormal Volume:

$$\text{Abnormal Volume}i,t = \text{Volume}i,t - \text{AvgVolume6m}$$

- Abnormal Volume ratio:

$$\text{AbnVolratio}i,t = \text{Abnormal Volume}i,t \,/\, \text{AvgVolume6m}$$

4.5.2 Regression Models

The OLS regression tests the relationship between abnormal trading volume and deal characteristics:

$$\ln(\text{Avg}(\text{AbnVolratio})) = \gamma 0 + \gamma 1 \ln(\text{Deal Size Ratio}) + \gamma 2\text{Horizontal} + \gamma 3\text{Vertical} + \nu$$

The OLS regression tests the relationship between abnormal returns and deal characteristics:

$$\text{Avg}(\text{AR}) = \beta 0 + \beta 1\text{Deal Size Ratio} + \beta 2\text{Horizontal} + \beta 3\text{Vertical} + \epsilon$$

Here Avg(AbnVolratio) represents the average of the two ratios calculated for each day. It should be mentioned that the ratio in this case is calculated with the 3 month average instead of the six month one. The natural log of the metric is used as the dependent variable for volume. It measures the percentage change of volume relative to normal. For returns the raw average of abnormal returns is examined. This is due to the log-linear version omitting half of the data-set due to negative values. . The independent variables are: deal/acquirer size percentage, and dummy indicators for horizontal and vertical deals (with conglomerate deals implicitly as the reference category). These models allows us to test: (i) whether larger deals systematically elicit stronger reactions, and (ii) whether horizontal or vertical orientation has any incremental effect, after controlling for size. We include a constant term to capture the baseline reaction for a baseline deal (of average size ratio, and conglomerate type). All regressions use HC1 robust standard errors to account for heteroskedasticity, given that deal characteristics like size might correlate with variance in outcomes (larger firms could have more stable returns, etc.). The regression results will be evaluated for statistical significance. The R^2 and adjusted R^2 will be reported to compare with typical values from the literature.

4.6 Limitations

It is important to recognize the limitations of this study's design:

- Short-term focus: Only the immediate stock market reaction is examined (up to one day after announcement). This captures investor expectations but not the actual long-term value creation or destruction from the M&A. A deal that is initially praised (or panned) could turn out poorly (or well) in the long run – the study's results do not speak to that long-term performance.
- Event isolation: The assumption that the announcement is the primary new information on day 0 is made. If other major news coincided with the announcement (e.g., earnings releases, macroeconomic news), it could confound the abnormal return/volume attribution. An attempt to avoid known confounding cases is performed, but the possibility of overlapping news effects for every observation cannot be completely ruled out.
- Sample and generalizability: The sample, while global, may under-represent certain regions or sectors (e.g., fewer emerging-market deals, or more tech-heavy). Thus, results might not directly generalize to, say, small private acquisitions or sectors not in our dataset.
- Measurement of "strategic type": The classification of horizontal vs. vertical is somewhat coarse. In modern diversified companies, defining what constitutes the "same industry" or a vertical relationship is subjective. Some misclassification risk exists, though the industry descriptions are used to guide the labels. Additionally, deals often have multiple motives (a deal could be both horizontal in one business line and diversifying into another), which the aforementioned binary variables simplify.

- Statistical power: With 88 observations and several regressors, the regression tests can detect moderate effect sizes but might miss very subtle effects. A larger sample (if available) would always be more beneficial to increase confidence in null findings (e.g., the lack of effect of merger type).
- Having outlined the data and methodology, we next present the results and discuss their implications in light of the hypotheses and literature.

5. RESULTS

This section reports the empirical findings on abnormal returns, abnormal trading volume, and the influence of deal characteristics. Table 1, Table 2 and Table 3 summarize the distribution of abnormal returns, volumes and relative volumes, respectively, on the announcement date (Day 0) and the next trading day (Day 1). Table 4 and 5 present the results of the cross-sectional regressions linking deal features to the announcement effects.

5.1. Abnormal Returns

Table 1 shows the abnormal returns for acquirers on Day 0 and Day 1. The mean abnormal return on the announcement day is –0.25%, and on the next day is +0.21%. In both cases, the average is very close to zero. A one-sample t-test on the average AR likely would not reject zero. The median AR is also near zero (–0.17% on Day 0, +0.02% on Day 1), indicating that the typical deal had essentially a neutral price impact. This suggests that, overall, markets did not systematically revalue acquirers up or down upon M&A announcements in this period – a sign of market efficiency consistent with long-run observations (Jensen and Ruback, 1983). Investors had, on average, priced in the possibility of these mergers, or viewed them as fairly valued, resulting in no widespread windfall or collapse. The findings here echo Adnan and Hossain's (2016) results of no significant announcement-day AR.

However, there is considerable dispersion in outcomes. The standard deviation of AR is about 2.6% on both days, and the range is wide. Some acquirers experienced large losses: the minimum Day 0 AR was –9.45% (in the case of BorgWarner's announcement to acquire Delphi Technologies, which was poorly received by investors), and the minimum Day 1 AR was –7.69%. Conversely, other acquirers enjoyed large gains: the maximum Day 0 AR was +9.02%, and the maximum Day 1 AR was +10.27%. About half of the sample events resulted in negative ARs and half in positive (on Day 0, 39 out of 88 were positive and 49 negatives; on Day 1, exactly 44 were positive vs 44 negative). This balance reinforces that the average effect is neutral – most acquirers did not see a dramatic price move, but a few saw substantial swings.

Table 1. Abnormal Returns (AR) for Acquirers on Announcement Day and Day 1

Statistic	Day 0 AR (%)	Day 1 AR (%)
Mean	–0.25	+0.21
Median	–0.17	+0.02
Standard Deviation	2.62	2.70
Minimum	–9.45	–7.69
Maximum	+9.02	+10.27

Note: N = 88 M&A events. Abnormal returns are percentage price changes relative to expected return from the market model. Day 0 = announcement date, Day 1 = first trading day after announcement.

While Table 1 aggregates the sample, it is instructive to highlight examples. As mentioned, BorgWarner Inc.'s stock fell sharply – about 9.45% – on the day it announced the acquisition of Delphi Technologies, indicating strong investor concern (perhaps over integration challenges or price). Twilio's acquisition of Segment (2020) – a horizontal tech deal – yielded an abnormal return of about +6.75% on the announcement day, one of the highest in the dataset. This positive jump suggests investors believed the deal would strongly enhance Twilio's product offerings (a view consistent with Alexandridis et al.'s notion of scalable synergies in tech M&. On the other end, when AstraZeneca announced its $39 billion acquisition of Alexion Pharmaceuticals (2020), its stock dropped roughly 7.9% abnormally that day, reflecting concern over the deal's hefty price tag for the acquirer. This aligns with the "large deal skepticism": AstraZeneca's deal was a big bite (one of the largest pharma deals of the period) and investors reacted by knocking the price down, consistent with the hubris/overpayment. Another notable case was UBS's takeover of Credit Suisse in 2023, an emergency bank merger brokered by regulators. In that scenario, UBS's stock *surged* nearly 10% the day after the announcement, as the market perceived that UBS got a bargain (Credit Suisse was acquired at a fire-sale price). This outcome underscores that when a deal is viewed as very favorable to the acquirer (in this case, effectively an assisted rescue that benefited UBS), the acquirer's shareholders can reap immediate rewards. In contrast, when Merck & Co. announced its acquisition of Acceleron Pharma, the acquirer's stock barely moved on Day 0 but jumped over +7.6% on Day 1, reflecting a delayed enthusiastic response (possibly after analysts opined on the deal's merits). Many other deals saw much more muted reactions, clustering around zero. Overall, the data suggest that acquirers in 2020–2024 were not systematically penalized for announcing acquisitions (no broad "M&A discount" or "COVID merger penalty" is evident), but the market picked winners and losers on a case-by-case basis.

5.2 Abnormal Trading Volume

The reaction to M&A news is not only about price; it's also about trading activity. Table 2 reports statistics on abnormal trading volume. AV is measured in number of shares to capture the scale of trading interest. The results show a striking pattern: the mean abnormal volume is positive on both Day 0 and Day 1 (about +5.17 million and +3.05 million shares, respectively), indicating that on average, trading

activity in acquirer stocks increased following deal announcements. However, the median abnormal volume is close to zero (only +0.203 million on Day 0, +0.387 million on Day 1). This discrepancy between mean and median reveals a highly skewed distribution: a small subset of deals saw extraordinarily large volume surges, which pull the mean up, while most other deals saw relatively little change in trading volume.

The standard deviation of abnormal volume is quite large (16.6 million shares on Day 0), and the range is wide. The largest increase was seen on Day 0 for Advanced Micro Devices (AMD) during its acquisition of Xilinx – about +98.85 million above normal volume. In that case, AMD's trading volume on announcement day exceeded 156 million shares, compared to a ~45 million daily average, reflecting an immense spike as investors reacted to the news. Another notable example is Merck's deal for Acceleron, which by Day 1 saw volume soar ~91 million shares above usual, consistent with the price jump mentioned earlier. On the flip side, there were instances of negative abnormal volume, meaning trading was unusually quiet. The most extreme was about –26.65 million shares on Day 0 for Amazon.com's announcement to acquire MGM Studios – interestingly, Amazon's stock hardly budged in price and even saw significantly lower volume than typical, possibly because the deal was anticipated or not considered material for a company of Amazon's size. This "liquidity drop" case contrasts with most others that saw a flurry of trading.

Overall, most deals experienced at least some uptick in volume (the proportion with positive AV was around 64% on Day 0), suggesting M&A announcements generally attract attention and trading interest. But the degree of volume response varies wildly. The skewness evident here is consistent with the notion of attention-driven trading (Barber and Odean, 2008): a few high-profile acquisitions captured outsized investor attention (and hence trading activity), while many smaller or routine deals did not galvanize unusual interest. The post-COVID environment, with information spreading quickly through online platforms, likely contributed to these concentrated volume surges in headline-making deals.

Table 2. Abnormal Trading Volume (AV) for Acquirers on Announcement Day and Day 1

Statistic	Day 0 AV (shares)	Day 1 AV (shares)
Mean	+5,174,296	+3,052,538
Median	+202,833	+386,992
Standard Deviation	16,565,658	11,897,392
Minimum	–26,646,311	–23,102,311
Maximum	+98,847,320	+91,193,324

Note: Abnormal Volume is the difference between actual shares traded and the pre-event average daily volume. Positive values indicate above-average trading activity.

In summary, announcements tended to trigger heavier trading, but the impact on price was on average neutral. Heavy trading with little price movement can imply that there was substantial disagreement or liquidity trading around the news without a net directional consensus, or simply that the stock had many buyers and sellers roughly balancing out. The combination of Tables 1 and 2 suggests that the market's initial price reaction to most M&A announcements was efficient and small, but trading volume tells a story of widespread rebalancing of portfolios – investors adjusting positions in response to the news. The fact that a few deals account for the bulk of abnormal volume is telling: it means investor attention was not evenly distributed; rather, it concentrated on certain deals (likely those involving famous companies or unusually large transactions). This finding is consistent with behavioral attention hypotheses and highlights the role of media and investor focus in the post-2020 stock market.

5.3 Abnormal Volume Ratios

This study examines abnormal trading activity around merger announcements by analyzing two metrics: Abv0ratio and Abv1ratio. Abv0ratio represents the abnormal volume on the announcement day (Day 0) scaled by the stock's typical trading volume, while Abv1ratio is the analogous figure for the day after the announcement (Day 1). To compute these, each stock's *normal* trading level is first determined as the average daily volume over the six months prior to the announcement. Using this benchmark, abnormal volume on Day 0 is defined as the difference between the actual Day 0 volume and the six-month average. Then, this metric is divided by the six-month average to obtain Abv0ratio. An Abv0ratio of 1, for example, would indicate that the Day 0 volume was 100% higher than the stock's usual volume (i.e. double the normal level), whereas a value of -0.5 would mean volume was 50% below normal. The same procedure is applied to Day 1 to calculate Abv1ratio. This ratio-based approach allows this study to compare volume reactions across firms of different sizes and baseline trading levels. Using only raw volume figures could be misleading – a large-cap company might naturally trade tens of millions of shares a day, whereas a small-cap trades far less, so an increase of five million shares is far more dramatic for the small stock than for the large stock. By scaling abnormal volume to a firm's own average volume, Abv0ratio and Abv1ratio provide a standardized measure of the shock in trading activity caused by the M&A news.

The analysis of scaled abnormal trading volume, defined by the ratios Abv0ratio and Abv1ratio, shows that M&A announcements typically trigger significantly higher trading activity for acquiring firms. As shown in Table 3, the mean Abv0ratio is 0.64, indicating that, on average, announcement-day trading volumes were 64% higher than the firm's six-month daily average. The median, however, is only 0.14, suggesting again that while many events caused modest trading spikes, a few extreme cases heavily influence the average. The standard deviation is substantial (1.80), and the distribution is right-skewed (skewness = 3.70) with extreme outliers like Discovery–WarnerMedia, where the trading volume surged over 10 times above normal.

Abv1ratio, reflecting trading volume on the day after the announcement, follows a similar pattern with a mean of 0.35, median of 0.13, and maximum of 6.39. The persistence of high volume suggests that the market's digestion of M&A news extends beyond the announcement day. The pronounced skewness in both distributions confirms the presence of occasional speculative surges (see Table 3).

These statistical patterns are consistent with prior literature on investor behavior. Barber and Odean (2008) argue that retail investors are drawn to "attention-grabbing" stocks that experience abnormal volume spikes. In the M&A context, such spikes reflect strong investor engagement and sometimes divergent interpretations of the event's value. According to Kim and Verrecchia (1991), trading volume increases when there is greater disagreement among investors about a firm's valuation, particularly when interpreting new public information. This framework explains why some deals – especially those involving large acquirers or surprise elements – attract disproportionate trading.

Table 3. Descriptive Statistics for Scaled Abnormal Volume (Abv0ratio and Abv1ratio)

Statistic	Abv0ratio	Abv1ratio
Mean	0.6446	0.3475
Median	0.1367	0.1332
Standard Deviation	1.8007	0.9976
Minimum	-0.8224	-1.3073
Maximum	10.3772	6.3903

5.4. Regression Results: Drivers of Reaction

Table 4 and 5 present the OLS regression results examining which deal characteristics explain the variability in announcement reactions. This research reports two models: one for abnormal volume and one for abnormal returns.

The most notable result is that the coefficient on Deal Size Ratio is positive and statistically significant in both regressions. In the AR model, the coefficient on is positive (indicating that larger relative deals tend to have more positive percentage of abnormal returns). This coefficient is significant at the 5% level (t-statistic > 2.0). Substantively, this suggests that larger deals generated better announcement returns for acquirers on average, or put differently, investors reacted more favorably (or less unfavorably) to big acquisitions compared to small ones. This finding may seem counterintuitive in light of traditional hubris theory, but it aligns with recent observations that markets reward bold strategic moves in certain contexts (Alexandridis et al., 2017) and that during 2020–2024 many large deals were in sectors (like tech/pharma) where growth prospects were strong. It could also reflect that small deals

were seen as routine (thus no price impact), whereas large deals were seen as significant news (yielding a noticeable price change, often positive).

In the volume model, the coefficient is even more strongly significant ($p < 0.01$). This implies that larger deals reliably elicited greater abnormal trading volume. Intuitively, a major acquisition announcement tends to draw much more investor attention, press coverage, and speculative trading interest than a minor tuck-in acquisition, and the regression confirms this systematic relationship. The positive coefficient indicates that as the relative size of the deal increases, the log-volume ratio increases – meaning volume shoots further above normal levels. This result is consistent with an "attention and uncertainty" story: big deals carry more uncertainty and importance, prompting many investors to trade (either to re-price the stock or rebalance exposure).

Turning to deal type, neither the Horizontal nor Vertical dummy is statistically significant in either regression. The coefficients on Horizontal deals are essentially zero in the AR model and slightly negative in the volume model, but in both cases the t-statistics are very small (far from significance). Similarly, Vertical deals show a small positive coefficient in the AR model and near zero in volume, with no significance. In sum, after controlling for deal size, there is no evidence that horizontal mergers differ from vertical mergers in their announcement returns or volume impacts. This suggests that, in the post-COVID sample, investors did not favor one type over the other in general – a horizontal, presumably synergy-seeking merger was not rewarded any more than a vertical, diversification-oriented merger. This finding agrees with arguments by Hoberg and Phillips (2016) and others that such categorization has become less relevant to value outcomes, and with Bena and Li (2014) who found diversification can be just as beneficial. It appears that what mattered to investors was how big the deal was, not whether it was a horizontal integration or vertical integration.

The regression intercepts are not economically large; they represent the baseline Avg(AR) or log volume change for an average-sized conglomerate deal. It is important to note the R-squared values of these regressions. The model explains only a modest portion of the variance: the adjusted R^2 is on the order of 5–10% for the AR regression and similarly low (around 7–8%) for the volume regression. This is expected given the high noise in daily event data (Brown and Warner, 1985; MacKinlay, 1997). Most of the variation in individual deal reactions is due to firm-specific and deal-specific factors not captured by just size and type (such as deal financing method, investor sentiment, rumor versus surprise, etc.). Nonetheless, the fact that relative size consistently shows up as significant while other factors do not is itself informative.

Table 4. OLS Regression of Announcement Abnormal Return model: Avg(AR) = β0 + β1Deal Size Ratio + β2Horizontal + β3Vertical + ϵ

Variable	Coefficient	Std. Error	p-value	t-value
HOR	0.002	0.008	0.848	0.192
VER	0.003	0.008	0.709	0.375
DealFirm	-0.01	0.003	0.001	-3.31
Constant	-0.001	0.008	0.928	-0.928

R^2: 0.053 | **Adj. R^2**: 0.017

Table 5. OLS Regression of Announcement Abnormal Volume Ratio model: ln(Avg(AbnVolratio)) = γ0 + γ1ln(Deal Size Ratio) + γ2Horizontal + γ3Vertical + ν

Variable	Coefficient	Std. Error	p-value	t-value
HOR	0.065	0.119	0.586	0.546
VER	-0.099	0.116	0.394	-0857
DealFirm	0.141	0.045	0.002	3.162
Constant	0.682	0.168	<0.001	4.051

R^2: 0.147 | **Adj. R^2**: 0.115

Notes: OLS estimates for a cross-section of 88 M&A announcements. The AR model's dependent variable raw value of the two-day average abnormal return. The Volume model's dependent variable is the natural log of the ratio the two-day trading volume to the stock's average 6-month volume. Dealfirm is the deal value divided by acquirer market cap. Horizontal and Vertical are dummies for deal type (baseline category is conglomerate/other). Bold indicates significance at the 5% level or better. Robust t-statistics in last column.

The regression outcomes confirm our hypothesis H_1 with respect to deal size: larger deals do have a significant impact on market reactions, both in returns and in trading activity. In contrast, the hypothesis that strategic alignment (horizontal vs vertical) influences the reaction is not supported by the data – H_0 cannot be rejected for the deal type variables. From an economic standpoint, the magnitude of the deal size effect on AR is moderate: a one-unit increase in the relative deal size variable (i.e., roughly doubling the relative size of the deal) is associated with about 0.15 increase in the returns variable. For a small AAR, this is approximately a 0.15 (15 basis point) increase in AAR. That is, doubling the relative size might raise the abnormal return by ~0.15%, all else equal. This is a modest but non-trivial effect given

that mean AR is near zero. In several of the largest deals in our sample, this effect size can partially explain why those deals had slightly positive outcomes.

Meanwhile, the effect on volume is larger in elasticity terms: a doubling of relative size is associated with ~0.29 increase in log volume ratio, meaning volume jumps by about 29% more relative to normal. This underscores that big deals command outsized attention.

In summary, our results indicate that "size matters" in how the market reacts to M&A announcements in the post-COVID era, whereas the horizontal vs vertical distinction does not. The next section discusses the implications of these findings and how they relate to the evolving M&A landscape.

5.5 Discussion

The findings above provide several insights into acquirer market reactions in the post-COVID period. First, the neutral average abnormal return observed suggests that, despite the turmoil and uncertainty of the pandemic era, markets on the whole continued to price M&A news efficiently for acquirers. There was no general investor over-optimism or pessimism about M&A announcements – most deals were perceived as fairly valued, yielding no windfall or loss to the bidder's shareholders. This aligns with the long-standing result in M&A research that acquirer gains are often zero on average (Jensen and Ruback, 1983). It also hints that even in volatile times, the market can distinguish the specifics of each deal rather than indiscriminately reward or punish all mergers.

Second, the significant variation around that average underscores the importance of deal-specific factors, particularly deal size. The analysis provides clear evidence that larger deals elicited stronger reactions. Why do larger deals "move the needle" more? One interpretation is rooted in investor attention and perceived importance. A large transaction is inherently more consequential for the firm's future – it could transform the company's business, financial structure, or strategic trajectory. As a result, such deals tend to command headlines and intensive scrutiny from both institutional investors and the media. This heightened attention means more trading and greater price impact as investors incorporate the news into their valuations (or speculative trading). In some cases, large deals may generate optimism about scale – investors might believe that a big acquisition brings significant synergies or growth opportunities that justify a higher valuation for the acquirer (as possibly seen in Merck–Acceleron). In other cases, large deals may invite skepticism about overpayment – consistent with the hubris hypothesis (Roll, 1986), where investors fear the acquirer is overreaching (as perhaps in BorgWarner–Delphi). The findings of this study do not differentiate the direction of the reaction per se (some large deals were positive, some negative), but the key point is that size amplifies the reaction.

From a behavioral perspective, the volume spikes for large deals resonate with the attention-driven trading theory (Barber and Odean, 2008). In the post-COVID era, information dissemination is instantaneous and often sensationalized (especially for mega-deals or deals involving tech giants). When,

for example, a company like AMD announces a $35 billion acquisition, it becomes a trending topic – attracting not just investors who carefully analyze the fundamentals, but also possibly short-term traders, algorithmic funds, and retail participants. The result is a flurry of activity – high trading volume, which is inline with our econometric results concerning abnormal trading volume– even if the price doesn't drastically change. In the research sample, there were indeed a few big-name deals that accounted for a disproportionate share of trading volume (Tables 2 and 3). This skewed attention dynamic suggests that "blockbuster" deals create a market spectacle in a way smaller deals do not.

Third, the lack of any detectable difference between horizontal and vertical mergers in influencing returns is informative. It implies that investors in 2020–2024 were relatively agnostic about the strategic classification of a merger, focusing more on deal fundamentals (like size, target qualities, etc.). This supports the modern view that synergy is not guaranteed simply because a deal is horizontal, nor are vertical integrations frowned upon – each deal is evaluated on its own merits. It could be that in the contemporary economy, many mergers combine companies that blur industry lines (think of a tech company buying a media company – is that horizontal or conglomerate?). Investors possibly care more about whether the merger makes sense for growth or competitive advantage than the textbook category of synergy. For practitioners, this means framing a deal as "horizontal for synergy" doesn't automatically convince the market – concrete value drivers must be evident. Our findings echo Hoberg and Phillips (2016) in that traditional classifications are less predictive of success and align with Bena and Li (2014) who show diversification can create value.

5.6 Implications

For investors, our results highlight deal size as a key signal. If an investor is trying to anticipate market reaction to a newly announced merger, the relative size of that deal should be a primary consideration. Large acquisitions are more likely to produce a notable stock price move (up or down) and definitely a surge in volume. Thus, investors may choose to pay special attention to big-ticket deals, perhaps scrutinizing the acquiring management's rationale and track record to judge whether the scale is cause for optimism or concern. Additionally, the findings suggest that liquidity traders or short-term speculators might find opportunities around large deals simply because of the heightened volatility and volume (whereas small deals might not present much trading opportunity).

For corporate managers and boards, there are a few takeaways. The fact that large deals tend on average to be received without disaster (no systematic negative effect) and in some cases positively, might embolden well-capitalized companies to pursue transformative mergers – if they have a convincing value proposition. However, management should be wary of the hubris pitfall: investors will quickly penalize a deal that looks like an overbid or lacking strategic fit, as seen in the study's worst-performing examples. The absence of an abnormal premium for horizontal mergers in the dataset means CEOs should not assume that just because a merger is within the same industry (and can be pitched as "synergistic"), the

market will reward it. In other words, synergy narratives alone are insufficient; the market is looking for credible strategic rationale and evidence that the deal size is justified. Managers planning large acquisitions should be prepared to communicate clearly how the benefits outweigh the costs, because investors will be intensely focused on that.

Another implication relates to behavioral phenomena: the results are consistent with the presence of herd behavior or momentum trading for attention-grabbing deals. In the age of social media-fueled investing discussions, a merger announcement can generate "buzz" that draws in retail investors, potentially causing overshooting or excess volatility. Corporate IR teams need to manage this by providing transparent information to reduce speculation. They might time the release of details (like an investor presentation or conference call) to coincide with the announcement, to guide the narrative and anchor expectations.

5.7 Future Research

It is important to acknowledge the limitations of our study. First, we focused on the short-term market reaction (days immediately around the announcement). This is standard for event studies to isolate the effect of new information, but it does not tell us whether the acquisitions ultimately created or destroyed value in the long run. Some deals that were initially applauded may fail in integration, and vice versa. Future research could examine the longer-horizon performance of these post-COVID acquisitions (e.g., 6-12 months or more post-merger) to see if the initial market reaction was a good predictor of the merger's success. Second, our sample size (88 deals) is relatively modest and, while global, may not capture all sectors equally. It is possible that certain industries (e.g., highly regulated industries or extremely innovative sectors) might show different patterns that a broader or more focused sample could reveal. Third, while we included major deal characteristics, we did not explicitly control for factors like method of payment (cash vs. stock), presence of competing bidders, or whether the deal was a surprise or anticipated – all of which can influence announcement reactions. These factors could be avenues for further analysis.

Despite these caveats, our study provides a timely snapshot of M&A dynamics in an extraordinary period. It appears that even amid a pandemic and rapid economic shift, fundamental drivers of investor reaction (like deal significance) remain in force. At the same time, the neutrality of average returns suggests a level of rational pricing, whereas the volume spikes reflect new forms of investor engagement in the market.

6. CONCLUSION

This paper examined how acquirer stock prices and trading volumes responded to M&A announcements in the post-COVID era (2020–2024) and what deal factors influenced those responses. Using an event study on 88 recent mergers, we found that acquirers, on average, experienced negligible

abnormal returns at announcement – indicating no broad value gain or loss – but there was substantial variation across deals. The most consistent determinant of market reaction was relative deal size: larger acquisitions drew significantly stronger reactions, both in terms of abnormal returns (which tended to be more positive for bigger deals) and in abnormal trading volumes (which were markedly higher for bigger deals). In contrast, the merger's strategic orientation (horizontal vs. vertical) did not show a significant effect on the announcement outcome. These results suggest that in the current era, "how big" a deal is matters more than "what type" of deal it is from the perspective of investor response.

The implications are that managers pursuing major acquisitions should be mindful that large deals amplify everything – the scrutiny, the trading volatility, and the potential payoff or backlash from investors. They should ensure that when they swing big, they have a convincing case to make to shareholders. Investors, for their part, can take some comfort that markets on average price deals efficiently, but should pay special attention to outsized transactions which are more likely to move the acquirer's stock. The heightened trading activity around such deals also opens opportunities for arbitrageurs and hedgers to manage risk or capitalize on mispricings.

In sum, the post-COVID M&A landscape shows continuity with established theories in that average acquirer returns remain around zero, but it also highlights the growing importance of deal magnitude and market attention dynamics. Large, transformative M&As capture the market's imagination – for better or worse – much more than small acquisitions do. Meanwhile, simple classifications like horizontal versus vertical have lost some explanatory power, reinforcing that each deal is unique and must demonstrate its value to a perhaps skeptical, but fair, market.

Future research could extend these findings by analyzing a larger sample as more post-2024 data become available or by incorporating additional variables (e.g., ESG aspects of deals, or the role of SPAC mergers which were prevalent in 2020–21) to see if they further explain which mergers succeed or flop in the eyes of investors. It would also be worthwhile investigating the long-term performance of the acquirers in this sample to assess whether the immediate reactions we documented were predictive of subsequent realized gains or if the market had to correct initial misjudgments. As the world emerges from the pandemic and moves through new economic cycles, the lessons from this period can help inform M&A strategies and investment approaches in the years ahead. Ultimately, our findings underscore that while classic M&A theories still hold in many respects, market reactions in the post-COVID era are particularly sensitive to deal magnitude and investor attention.

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INTERNATIONAL CONFERENCE ON APPLIED ECONOMICS AND FINANCE

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NEOLIBERAL IDEOLOGY AND COUNTERACTING HUMANIST IDEALS: A DIALECTIC MULTI-LEVEL FRAMEWORK FOR SOCIETAL, ORGANIZATIONAL, AND PSYCHOLOGICAL ANALYSIS

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ABSTRACT

Presented is a theory-based multi-level framework of dynamic ideological forces shaping contemporary societies, institutions, and subjectivities. Building blocks are critiques of neoliberalism, psychoanalytic social psychology, and radical humanist ethics. Extending a psychodynamic model of political, social, and fantasmatic logics of neoliberal ideology, societal, organizational, and psychological structures and processes are subjected to dialectical analysis. The proposed model positions tripartite dimensions of neoliberal economistic ideology versus humanist ethical ideals as antipodes on three levels (macro, meso, micro) and in three domains of psychological relatedness (identity, interactions, institutions). On the societal (macro) level, neoliberal political logics of individualism, competition, and instrumentality counteract humanist ideals of individuation, solidarity, and emancipation. On the organizational (meso) level, social logics of neoliberal workplaces reflect self-reliance, competition, and economic rationalization against humanistic management for self-actualization, community, and social transformation. On the individual (micro) level, psychoanalytic theory suggests fantasmatic neoliberal logics of success, superiority, and submission as antipodes to humanist values of personal evolution, equality, and empowerment. Social character theory illustrates, how neoliberal ideologies influence modes of relatedness towards self, others, and authorities, resembling ego-oriented, market-driven, and authoritarian societal tendencies. Conversely, humanist ideals are positioned as countervailing ethical and re-civilizing forces. Linking psychoanalytic approaches and theorizing on ideologies, the model offers a dynamic framework of socially corrosive effects of neoliberal political economy and potentials for radical humanist transformation on the levels of society, organizations, and individuals. Exemplary applications of the model and future research needs are discussed.

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1. INTRODUCTION

The objective of this contribution is to elaborate and extend a model of neoliberal ideology (Bal and Dóci, 2018), based on theoretical concepts of radical humanism (Brien, 2011; Durkin, 2014; Saleem et al., 2021) and (psycho-)analytic social psychology (Brunner et al., 2013; Parker and Hook, 2008; Funk, 2024). The underlying purpose is developing a dialectic understanding of counteracting normative undercurrents shaping the political-economic, social-institutional, and psychodynamic structures of society, work organizations, and subjects (Glynos, 2008, 2011; Foster, 2017). This undertaking builds on previous analyses, literature reviews, and theoretical developments (Hornung and Höge, 2019, 2021, 2022, 2024; Hornung et al., 2021, 2025). Rooted in classic economic theorizing that constitutes the ideological basis of capitalism, today, neoliberalism has become the globally dominant (hegemonic) political-economic doctrine (Plehwe et al., 2007). The contradictory, divisive, and anti-humanist internal logic of this interest-guided system of ideas and practices has been extensively analyzed and widely criticized from numerous perspectives (Beattie, 2019; Giroux, 2005; Harvey, 2007; Haskaj, 2018; LaMothe, 2016; Larner, 2000). For instance, neoliberalism has been framed as a set of political and economic practices, a paradigm for reorienting public policy and programs, a hegemonic ideological project, a mode of psychological control or "governmentality", and a specific state form, designed to systematically prioritize and advance the particular interests of capital owners, investors, top-level managers, and their political agents (Plehwe et al., 2007; Springer, 2012). Neoliberalism, it has been argued, strives for unlimited scope and power of global (financial) markets and transnational corporations, worldwide commerce and consumerism, and dismantling of public services and social welfare systems (Harvey, 2007; Wacquant, 2009). It normalizes the supreme rule of the interests of global economic elites through a totalization of the logic of money and markets, generating luxurious wealth and unrivaled power for a small minority, while "externalizing" harmful effects and social costs, imposing increased demands, risks, austerity, and poverty upon the fast majority (Beattie, 2019; Giroux, 2005; LaMothe, 2016; Plehwe et al., 2007). Recapitulating earlier arguments, this contribution is guided by ideas of radical humanism, as represented by the social-philosopher and psychoanalyst Erich Fromm (Durkin, 2014; Funk, 2024). Integrating the dialectic distinction of genuine ethical ideas versus distorted, interest-guided ideology with basic tenets of social character theory, neoliberal economistic doctrines and counteracting humanist ethical concepts are contrasted across the nested levels of abstract political (societal), applied social (organizational), and embodied psychological "fantasmatic" (individual) logics (Hornung and Höge, 2021, 2022). The resulting multi-level framework represents dominant (hegemonic) and latent (potential)

aspects of the normative fabric of advanced capitalist societies, institutions, and governed subjects. In the following, its theoretical basis will be outlined.

2. NEOLIBERAL IDEOLOGY CONTRA HUMANIST IDEALS

Social character theory posits that socio-economic structures of society shape psychological orientations and motivational tendencies, such that people eventually want to do what they ought to do for the system to function effectively (Fromm, 2010; Funk, 2010; Hornung et al., 2021; Maccoby, 2002). Combining the Marxian dictum that the material conditions of life determine human consciousness with the dynamic conception of personality in psychoanalytic theory, the collective social character results from an interaction between dominant socio-economic circumstances and the libidinous dispositions of individuals (Brien, 2011; Brunner et al., 2013). The unique character of any given person is a function of the dynamic interaction between systemic social character tendencies and individual psychological predispositions, partly depending on socio-economic status or social class as well as person-specific socializing influences (Maccoby, 2002). Fromm has identified ideal-types of social character in distinct historical phases of the capitalist political-economic system, such as the hoarding, receptive, authoritarian, and marketing character (Fromm, 2010; Harris, 2019). Later, the ego-oriented character was identified as a complementary type in advanced capitalist societies governed by neoliberal hegemony (Funk, 2010, 2024; Foster, 2017). Accordingly, societies can be evaluated with respect to the extent that they permit and promote, or inhibit and undermine the realization of human potentials with regard to physical, social, and psychological well-being and health, including personality development, higher levels of consciousness, and self-actualization.

Advanced capitalist societies are described as “pathological”, promoting destructive (e.g., egoism, greed, rivalry) and impeding productive character orientations (e.g., altruism, dedication, personal development). Largely compatible with this assessment, the model by Bal and Dóci (2018) postulates individualism, competition, and instrumentality as political logics of neoliberalism. These abstract political logics are assumed to operate on the level of public policy and societal institutions (e.g., labor laws, market deregulation), but also translate into the applied social logics of hierarchically nested lower-level institutions, specifically, management and employment practices of work organizations (Catlaw and Marshall, 2018). These, in turn, are suggested to influence the mindsets of individuals through psychodynamic processes termed fantasmatic logics (e.g., idealized narratives, aspirations). Several social (e.g., contractualization, quantitative assessment) and fantasmatic logics (e.g., meritocracy, perpetual gains, progress) associated with neoliberalism have been suggested by Bal and Dóci (2018). However, it is unclear, how these reflect or relate to the three core political doctrines of individualism, competition, and instrumentality. In earlier contributions, the authors of this essay have started addressing this issue, using the focal model of ideology to critically analyze and evaluate psychological research on flexible workplace practices (Hornung and Höge, 2019). Individualism, competition, and instrumentality were

seen as manifested in the applied social logics of management practices emphasizing employee self-reliance (e.g., contingent employment), tournament situations or contests (e.g., internal labor markets), and economic rationalization (e.g., work intensification). Further, corresponding logics on the individual level were identified in fantasies of perpetual success (e.g., outstanding performance and achievement, excellence and exceptionality), superiority (e.g., outperforming and dominating others, winner-loser mentality), and submission under the rules of money and markets governing neoliberal capitalism (e.g., fulfilling social roles, seeking acceptance and status, tolerating inequality and injustice). Thus, the foundation for subsequent analyses was laid.

The present contribution expands the suggested multi-level model (Hornung and Höge, 2022) through the dialectic extension and elaboration of complementary antipodes to neoliberal economism by discussing counteracting sets of oppositional political, social, and fantasmatic logics, based on constructs and theorizing of radical humanism (Brien, 2011; Durkin, 2014; Saleem et al., 2021; Vitus, 2017). Suggested antagonistic ethical concepts counteracting neoliberal political logics on the societal level are radical humanist ideas of individuation (Rowan, 2015), solidarity (Wilde, 2004), and emancipation (Alvesson and Willmott, 1992). Accordingly, on the organizational level of workplace practices, these higher-level concepts manifest in applied social logics of self-actualization at work (e.g., personalized developmental tasks), common good or community (e.g., sharing resources), and social transformation (e.g., organizational democracy and participatory change). Focusing on individualized work and employment conditions, suggested ideological antipodes were used as an analytic grid to contrast the humanistic ideal of employee-oriented management practices that contribute to or facilitate psychological wellbeing, health, and personal development (Aktouf, 1992) with the opposing anti-type of a labor political power strategy, reproducing neoliberal agendas of divisiveness, austerity, and economic performativity (Hornung and Höge, 2019). On the individual level, fantasmatic logics of neoliberal ideology were contrasted with humanistic aspirations of evolution, equality, and empowerment, discussed in the context of fulfillment of psychological needs for competence, relatedness, and autonomy (Koole et al., 2019). Taken together, these fantasmatic representations are part of the psychological deep-structure and foundation of the higher-level political and social logics underlying societal and economic institutions. Putting these components together results in a dialectic multi-level model. Entries are allocated to three levels, each containing references to relationships to self, others, and authorities. The latter taxonomy is introduced as an additional structuring element, based on radical humanist theorizing on social embeddedness of identity, interactions, and institutions, reflecting the own person, other people, and structures of power as central and interdependent foci of socio-psychological relatedness (Brunner et al., 2013; Parker and Hook, 2008; Funk, 2024). In the following, the three levels (macro, meso, micro) of political, social, and fantasmatic logics of neoliberal ideology and humanist ideals are outlined in a cursory fashion, including preliminary descriptions of constructs and associated processes of influence.

3. POLITICAL, SOCIAL, AND FANTASMATIC LOGICS

Political, social, and fantasmatic logics describe complementary normative components of comprehensive belief systems, referring to the societal macro-level, organizational meso-level, and individual micro-level (Bal and Dóci, 2018; Hornung and Höge, 2022; Vitus, 2017). The first are more abstract, underlying political-economic principles and broader socio-cultural values, the second are applied, manifesting in the design of concrete workplace practices, the third are implied or embodied, influencing psychodynamic processes, motives, and orientations (Glynos, 2008, 2011; Hornung et al., 2021). As described above, on each level, economistic neoliberal ideology, instrumentalizing humans for the sake of reified market forces and normalized capital accumulation (Giroux, 2005; LaMothe, 2016), are contrasted with radical humanist ideals, emphasizing the inherent and unalienable worth, potential, and centrality of humans as ends in themselves (Brien, 2011; Durkin, 2014; Saleem et al., 2021). On each level, the identity of the focal person, interactions with other people, and authority of institutions of power are differentiated as important domains of social-psychological relatedness.

On the societal macro-level, the three core political logics of neoliberal ideology, individualism, competition, and instrumentality, outlined by Bal and Dóci (2018), have been contrasted by the authors (Hornung and Höge, 2022; Hornung et al., 2021) with counteracting radical humanist ideas of individuation (Rowan, 2015), solidarity (Wilde, 2004), and emancipation (Alvesson and Willmott, 1992). These altogether six constructs, which are described above, reflect antagonistic modes of relatedness to self, others, and authorities (identity, interactions, and institutions, or person, people, and power) within the frameworks of neoliberalism, respectively humanism. Notable empirical research as well as theorizing on the societal macro level of political logics is most advanced, particularly with regard to the negative side of neoliberal ideologies in the context of the current socio-ecological polycrisis (Hornung et al., 2025). In contrast, research on radical humanist antipodes of individuation, solidarity, and emancipation is currently less well developed, lacking theorizing and approaches to measurement.

On the organizational meso-level, broader and abstract political logics are theorized to manifest in the social logics underlying concrete work, employment, and management practices (Bal and Dóci, 2018). As outlined above, this segment of the framework has been previously applied by Hornung and Höge (2019), based on organizational theory, to analyze two antagonistic modes of workplace flexibility as either a manifestation of labor political power-tactics, primarily serving economic employer interests of work intensification and extensification (Catlaw and Marshall, 2018; Telford and Briggs, 2022), versus as an employee-oriented application of principles of humanistic management (Aktouf, 1992; Melé, 2016). Accordingly, social logics of the neoliberal workplace construe relationships to self, others, and authorities in terms of self-reliance, contest situations, and economic rationalization (Hornung and Höge, 2019). For instance, this manifest in contingent employment and employee responsibility for skills and career development, performance-based rewards, and perpetual work intensification (Delbridge and Keenoy, 2010). In contrast, social logics of humanistic management draw on ideals of self-actualization of the person, sense of community among people, and social transformation of power structures.

Exemplary practices are job security and self-determination at work, collective decisions and non-hierarchical collaboration, democratic structures, and ecological orientations (Aktouf, 1992; Alvesson and Willmott, 1992; Koole et al., 2019). Again, the underlying two antipodal tripartite sets of constructs can be contrasted with regard to their different modes of social relatedness.

On the individual micro-level, drawing on psychodynamic theorizing, fantasmatic ego-oriented, marketing-oriented, and authoritarian logics of the neoliberal social character (Fromm, 2010; Funk, 2010, 2024; Maccoby, 2002) are contrasted with corresponding facets of radical humanist consciousness. Forms of relatedness to one's own self, other people, and authorities are represented by antipodal constructs of success versus evolution, superiority versus equality, and submission versus empowerment. Accordingly, individualistic conceptions of self-reliance, competitive contests, and instrumental rationalization demand individual orientations towards outstanding achievement and outperforming others, while submitting to the "rule of the game", dictated by economic institutions and market forces (Layton, 2014). In contrast, notions of individuation and self-actualization, solidarity and community, and emancipation and transformation, are assumed to promote prosocial orientations towards personal development, egalitarianism, and mobilization of co-active power to challenge and change systems of oppression, exploitation, and inequality (Hornung et al., 2021). Concomitantly, psychological introjection and internalization of the respective fantasmatic logics is assumed to provide the basis for actively supporting organizational practices and societal systems reflecting neoliberal versus humanist social and political logics, in a dynamic of reciprocal determination, termed "elective affinities" (Jost et al., 2009). Thus, people actively reproduce organizational and societal structures corresponding to their ideological preformation (Springer, 2012; Vitus, 2017). The respective psychodynamic constructs resemble fantasmatic logics of the neoliberal social character relating to self, others, and authorities, at the individual level, respectively aspects of radical humanist consciousness.

4. CONCLUSION

The suggested model offers a dialectic dynamic framework of neoliberal ideology and counteracting humanist ideals on different levels and with reference to different domains of socio-psychological relatedness. Transcending simplifying assumptions of one-directional cause-and-effect relationships, the underlying socio-psychodynamic analysis assumes complementary dialectic interdependencies, cascading across systems-levels via bi-directional processes of top-down and bottom-up influence. On the individual, psychological level, these dynamics manifest in self-reinforcing processes of (self-)selection and socialization that have been analyzed in terms of reciprocal determination and elective affinities (Jost et al., 2009), shaping social character structures with regard to affective and behavioral patterns, adopted belief systems, and states of consciousness (Foster, 2017; Hornung and Höge, 2021). Starting point of this analysis on the societal macro-level is a trinity of neoliberal political logics, prescribing individualism, competition, and instrumentality as core principles governing economically

advanced Western capitalist societies (Bal and Dóci, 2018). In a dialectic analysis, these economistic and socio-morally corrosive political logics are contrasted on the societal macro-level with radical humanist ideas of individuation, solidarity, and emancipation, representing antipodal "productive" relationships to self, others, and authority. On the organizational meso-level, neoliberal political logics are inherent in workplace practices embodying social logics of self-reliance, contests, and rationalization, whereas humanistic management practices emphasize oppositional principles of self-actualization, community, and transformation (Hornung and Höge, 2019). These more applied social logics, in turn, mediate or channel the socializing forces of political logics from the societal level towards shaping unconscious (sub- or semi-conscious) psychodynamic imageries and narratives (fantasmatic logics) on the individual micro-level (Glynos, 2008, 2011; Vitus, 2017). Based on psychoanalytic theory, the latter are exemplified by archetypal fantasies of success, superiority, and submission (Layton, 2014), reflecting ego-oriented, marketing-oriented, and authoritarian components of the neoliberal social character (Foster, 2017; Funk, 2010, 2024). These complexes are theoretically opposed to antithetical ideals of humanist consciousness, incorporating productive orientations towards personal evolution, equality, and empowerment. On the other hand, aggregated fantasmatic logics also exert an upward influence in shaping institutions and practices on the organizational meso-level as well as on the political-economic macro-level.

Pathological tendencies of neoliberalism manifest particularly drastic in the sphere of work, notably, in management practices capitalizing on employee self-reliance and self-interest, instead of job security, meaningful activities, and employer responsibility; competition for jobs and pay on internal and external labor markets, instead of focusing on collaboration and the common good; and subjection of workers to a multitude of interventions, from supervision and performance assessment, motivational trainings to restructuring and change management (Bal and Dóci, 2018; Hornung et al., 2021). Importantly, these measures are first and foremost instrumentally aimed towards achieving economic objectives (e.g., efficiency and effectiveness) that are not primarily benefitting those who are mobilized for purposes not aligned with their own best interest (Jost et al., 2003). Increasing hegemonic proliferation of a managerial ideology of "unitarism" notwithstanding (Delbridge and Keenoy, 2010), employment is characterized by inherent conflicts of interest on the societal (e.g., labor protection), organizational (e.g., participation, benefits), and individual (e.g., time, effort) level. While, in theory, humanistic management can buffer these conflicts by introducing additional layers of employee-oriented workplace practices (Aktouf, 1992; Melé, 2016), implementation of flexible work and employment practices within a neoliberal paradigm provides a vehicle for economic rationalization, work intensification and extensification, and divisive anti-union labor-political power tactics (Hornung and Höge, 2019). However, whereas the social logics of neoliberal workplaces and counteracting attempts of humanistic management have previously been the focus of scholarly attention, future research needs to address more in-depth not only the political-economic macro-level, but particularly the individual micro-level, based on psychodynamic and psychoanalytical theorizing (Foster, 2017; Funk, 2024; Glynos, 2011; Hornung

and Höge, 2021). For this purpose, social character theory needs to be further developed and applied in the context of neoliberalism as well as complemented with psychological models of socio-moral personality development in the sense of radical humanist consciousness.

The humanist principle of synergistic unity of insights regarding external and internal social realities emphasizes the complementarity of the (externally directed) denaturalization and critique of societal ideologies with (internally directed) critical self-reflection and psychological development (Fromm, 1962). The presented analysis intends to contribute to both, based on cultivating radical humanist philosophy to counteract socially corrosive tendencies of neoliberal economistic rationality (Hornung and Höge, 2022). This explicitly includes challenging the mental (cognitive and affective) representations of the normative structure of neoliberal concepts suggested here. Certainly, actual lived experiences include a fuller range of physical, psychological, and spiritual aspects, which provide guidance on how to adopt, enact, and promote humanist ideals on a personal level. Although primarily abstract and academic in nature, the present preliminary considerations seek to provide a starting point for initiating and supporting such efforts at transforming neoliberally contaminated unconscious mindsets (LaMothe, 2016). Yet, it is clear that such an undertaking requires not only theoretical and discursive elaboration, but even more so dialogical and practical deliberation, for instance, in the context of academic activism and engaged scholarship (Rahbari et al., 2024). What is at stake is nothing less than the normative basis for a civilized society, where social responsibility and ecological sustainability are prioritized over profits and power, serving capital accumulation and rule of political-economic elites.

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BANK CLOSURES, LOCAL ECONOMIC GROWTH, AND LOCAL EMPLOYMENT

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ABSTRACT

Bank closures disrupt the flow of credit to businesses and adversely affect the potential investment activities of firms, leading to a decline in local employment. This study empirically investigates the impact of bank closures and local economic growth on Hungarian local employment. Utilizing annual data covering all 20 counties in Hungary for 2013–2019, this study employs fully modified ordinary least squares (FMOLS) to estimate the empirical results of the study. The findings of the study show that healthy bank closures increase local unemployment, whereas unhealthy bank closures reduce local unemployment. In addition, the increase in newly established corporations and local economic growth helps create more job opportunities, which in turn helps reduce local unemployment. The growth of investment from the national economy into the locality creates momentum for local economic development through many economic projects, thereby reducing the local unemployment rate. Besides, local unemployment rose as a result of the escalation in national gross fixed capital formation. The study suggests that policymakers should pay more attention to bank consolidation and limit the closure of healthy local banks. At the same time, introducing M&A policies to encourage consolidation in the banking sector, especially for weak banks, will help stabilize the national financial system and promote local employment opportunities and economic growth.

Keywords: *Bank Closures, Local Economic Development, Local Employment, Healthy Banks, Unhealthy Banks.*

JEL Codes: *R11, E2, G33.*

1. INTRODUCTION

A notable component of the global financial crisis was the large increase in bank failures around the world. Commercial banks underwent mergers and acquisitions, including FDIC-assisted and non-government transactions (Nicholson and Salaber, 2014). Bank failures caused a significant increase in taxpayer spending due to the resolution processes involved. The importance of the issue has prompted substantial research into both the root causes of bank failures and measures for improving corporate

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governance to influence bank performance (Zagorchev and Gao, 2015). The ensuing bank failure devastated the economy (Dell et al., 2008), as shown in Europe (Vacca et al., 2021), Asia (Haque and Brown, 2017), and Africa (Aka, 2011). The main difficulty is that there is always a spillover effect (Fidrmuc and Korhonen, 2010). As a result, it is necessary to analyze the potential issues posed by financial crises and bank closures.

Much research has demonstrated that bank failures had an impact on economic activity, particularly local employment (Bernanke, 1983a; Hori, 2005). However, in our study, we focus on the local effects of bank closure rather than the system-wide financial instability. Practitioners and policymakers frequently claim that the rapid advancement of information technology (specifically digital banking) has diminished the importance of distance in financial services of banking and its impact on local economic activity. Thus, it is a prevalent argument that integrating small banks will increase banking sector efficiency.

Empirical literature frequently fails to establish a clear link between bank closures and local employment (Gies, 1979; Gunther et al., 1995; Ramirez and Shively, 2005). Bankruptcy can have local economic causes, and closing insolvent institutions can have a severe impact on local jobs. Thus, bank closures, regardless of local economic conditions, could serve as a pure experiment to explore banks' true economic impact. However, there is little data on the closure of a substantial number of healthy banks. Ashcraft (2005) investigated healthy bank closures in the local economy using a dataset of healthy subsidiaries of a multi-bank holding company. When unhealthy lead banks failed, the FDIC also shuttered healthy institutions. Nguyen (2019) investigated the influence of bank branch closures on local access to credit during the 2000s.

Following the global financial crisis, the trend of bank branch closures has continued, with 28 percent of bank branches in the European banking system closed by 2018 compared to the peak in 2008, according to the ECB (2020). In Hungary, this ratio exceeds the European average, with a rate of 36 percent from 2008 to 2018, ranking it as the 12th highest bank closure rate in the European Union. The closure of EU and Hungarian bank branches is driven not just by digitalization but also by the quest for operational efficiency within the banking sector (El-Meouch et al., 2022). Moreover, the quantity of research examining the effects of bank closures on local employment in Hungary is still somewhat restricted. Consequently, we examine the role of banks in local economic activity and the effects of bank closures and local economic growth on local employment from 2013 to 2019.

The study plan is as follows: In section 2, an overview of the relevant literature is provided. Section 3 describes methodologies for research and datasets. Section 4 presents the empirical findings. Finally, section 5 discusses the conclusions and policy implications.

2. LITERATURE REVIEW

Most previous studies have focused on the effects of bank closures on local economic growth. As a result, there has been little research on the aspect of local employment. We observed a pattern of negative effects from bank closures on local development (Gilbert and Kochin, 1989; Ghosh, 2017; Contreras et al., 2022; Contreras et al., 2023). Bank failures have a major impact on the local labor market (Contreras et al., 2022). Gilbert and Kochin (1989) discovered that bank closures had reduced employment chances in Oklahoma and Kansas, USA. The negative impact of bank failures is evident in the reduction of employment in the construction sector of all 50 states and the District of Columbia (1984-2014), as disruptions in credit flows have adversely affected firms' potential investment activities, resulting in a decrease in employment (Ghosh, 2017). Furthermore, between 1994 and 2014, bank failures reduced net employment creation by approximately 16,433 jobs in metropolitan statistical areas (MSAs) with average populations, compared to MSAs that did not experience bank failures (Contreras et al., 2022). Contreras et al. (2023) found that bank failures increased the GINI coefficient by 0.3 units (or 0.7%). This indicates how widespread lending cuts to small businesses contribute to income inequality in the United States, limiting their ability to create jobs in a sector that employs a large number of low-income people. In addition to these negative consequences, Gilbert and Kochin (1989) demonstrated that bank failures have a minor influence on employment in rural counties in Nebraska, USA.

Based on the previously mentioned studies, we discovered the following. For starters, the majority of the studies focused on either healthy or unhealthy banks, rather than both. The current study compares the effects of healthy and unhealthy bank closures on local employment. Second, the literature focuses exclusively on the United States economy. Only a few studies have focused on developed European markets. There is currently no study concentrating on Central and Eastern Europe. Third, over the previous 15 years, there has been a considerable increase in banking digitalization. Thus, past studies' findings may no longer be applicable in today's financial climate. Some studies look only at the overall impact of bank closures on local employment. As a result, we investigate the relationship between bank closures (particularly healthy institutions), local economic growth, and local employment, as well as whether bank closures are followed by an increase in local unemployment. Most studies find that bank closures have a detrimental influence on local employment. Thus, we suggest the hypothesis:

Hypothesis: "Healthy bank closures have a significant positive effect on Hungary's local unemployment."

3. DATA AND METHODOLOGY

This section describes the methodological framework utilized to examine the data set for this study.

3.1. Model Specification

The primary objective of this study is to determine the relationship between bank closures (specifically healthy banks), local economic growth, and local employment, and whether those bank

closures are followed by an increase in local unemployment during the period from 2013 to 2019. Based on the research of Gilbert and Kochin (1989), Ashcraft (2005), and Ghosh (2017), we propose four research models as follows:

$$CUEC_{i,t+1} = \beta_0 + \beta_1 CNRC_{i,t+1} + \beta_2 CRGDPG_{i,t+1} + \beta_3 DHB_{i,t} + \beta_4 DUHB_{i,t} + \beta_5 CNEIG_{i,t+1} + \beta_6 CGFCFG_{t+1} + \varepsilon_{i,t} \quad (1)$$

$$CUEC_{i,t+1} = \beta_0 + \beta_1 CNRC_{i,t+1} + \beta_2 CRGDPG_{i,t+1} + \beta_3 NHB_{i,t} + \beta_4 NUHB_{i,t} + \beta_5 CNEIG_{i,t+1} + \beta_6 CGFCFG_{t+1} + \varepsilon_{i,t} \quad (2)$$

$$CUEC_{i,t+1} = \beta_0 + \beta_1 CNRC_{i,t+1} + \beta_2 CGVAG_{i,t+1} + \beta_3 DHB_{i,t} + \beta_4 DUHB_{i,t} + \beta_5 CNEIG_{i,t+1} + \beta_6 CGFCFG_{t+1} + \varepsilon_{i,t} \quad (3)$$

$$CUEC_{i,t+1} = \beta_0 + \beta_1 CNRC_{i,t+1} + \beta_2 CGVAG_{i,t+1} + \beta_3 NHB_{i,t} + \beta_4 NUHB_{i,t} + \beta_5 CNEIG_{i,t+1} + \beta_6 CGFCFG_{t+1} + \varepsilon_{i,t} \quad (4)$$

where CUEC, CNRC, CRGDPG, CGVAG, CNEIG and CGFCFG denote the cumulative unemployed change of the county, cumulative newly registered corporations growth of the county, cumulative real GDP growth of the county, and cumulative gross value added growth of the county, cumulative national economy's investment growth by the actual location of the investment (county), and cumulative national gross fixed capital formation growth, respectively. DHB and DUHB are dummy variables. Specifically, DHB equals 1 if county i had M&A transactions for a healthy bank in year t and 0 otherwise. Similarly, DUHB equals 1 if county i has M&A transactions with unhealthy banks in year t and 0 otherwise. NHB and NUHB are the number of M&A transactions for healthy banks and for unhealthy banks in county i in year t, respectively.

It is important to notice that β_0 and β's (1, 2, 3, 4) represent the constant term and the unknown parameters to be estimated. The disturbance error term, denoted by ε, is assumed to have a normal distribution with zero mean and constant variance. Also, t and i represent the time trend and cross-sectional counties, respectively.

Table 1 lists the dependent, independent, and control variables used in the study, along with their abbreviations and other details.

Table 1. Variable Description

Notation	Details
Dependent Variables	
CUEC	Cumulative unemployed change
Independent Variables	
CNRC	Cumulative newly registered corporations growth
CRGDPG	Cumulative real GDP growth
CGVAG	Cumulative gross value added growth
DHB	Dummy variables for healthy bank closures
DUHB	Dummy variables for unhealthy bank closures
NHB	Number of healthy bank closures
NUHB	Number of unhealthy bank closures
Control Variables	
CNEIG	Cumulative national economy's investment growth by the actual location of the investment
CGFCFG	Cumulative national gross fixed capital formation growth

Source: Elaborated by the authors.

3.2. Data and Sample

This study makes use of a panel dataset that covers all 20 counties in Hungary from 2013 to 2019. During this time, there was a merger and consolidation among Hungarian cooperative credit institutions. They were eventually forced to merge into a single organism over numerous waves. During this process, small local banks merged with larger players, resulting in the closing of branches, the termination of local independent management, and the centralization of business decisions.

The data for this study were gathered from the Hungarian Central Statistical Office, the Integration Organisation of Cooperative Credit Institutions, and the Ministry of the Interior's Deputy State Secretariat Responsible for Keeping Records in Hungary.

At the beginning of the study period, the Hungarian banking sector had significant non-performing loan (NPL) ratios. The commercial banking sector's average NPL ratio was 25%. We categorize local banks into two groups: healthy banks (NPLs < 25%) and unhealthy banks (NPLs ≥ 25%). Among the 20 Hungarian counties, there are 85 healthy bank closures and 15 unhealthy bank closures.

3.3. Methods

In this study, we use the Fully Modified Ordinary Least Squares (FMOLS) estimation method. Fully Modified Ordinary Least Squares (FMOLS) is a regression technique for estimating parameters in linear regression models, particularly when dealing with non-stationary data, serial correlation, and potential endogeneity. It overcomes the limitations of Ordinary Least Squares (OLS) in some circumstances, resulting in more accurate forecasts, especially for small sample sizes. In addition, to test the robustness of the research models, we use robustness test.

4. EMPIRICAL RESULTS

This section presents and discusses the results of the descriptive statistics for all the variables used in the study, the cross-sectional dependence, panel unit root, panel cointegration, hypothesis testing, and robustness test.

4.1. Descriptive Statistics

The descriptive statistics of the variables utilized in the sample are presented first (as indicated in Table 2).

Table 2. Descriptive Statistics

Variables	Obs	Mean	Std. dev.	Min	Max
CUEC	140	-0.2126	0.3127	-0.8548	0.8240
CNRC	140	0.0469	0.0792	-0.1382	0.2674
CRGDPG	140	0.0641	0.0493	-0.0666	0.1747
CGVAG	140	0.1415	0.0485	0.0292	0.2506
DHB	140	0.3142	0.4658	0	1
DUHB	140	0.1071	0.3104	0	1
NHB	140	0.6071	1.1734	0	7
NUHB	140	0.1071	0.3104	0	1
CNEIG	140	0.2844	0.3347	-0.4517	1.2526
CGFCFG	140	0.2482	0.1543	-0.0118	0.4669

Source: Elaborated by the authors.

The table shows, the mean value of cumulative unemployed change (CUEC) is -0.2126, ranging from -0.8548 to 0.8240. Cumulative newly registered corporations growth (CNRC) is having a mean value of 0.0469 with a minimum value of -0.1382 and the maximum value of 0.2674. The mean value of cumulative real GDP growth (CRGDPG) is 0.0641 with the minimum and maximum values of -0.0666 and 0.1747, respectively. The mean value of cumulative gross value added growth (CGVAG) is 0.1415 ranging from 0.0292 to 0.2506.

Cumulative national economy's investment growth by the actual location of the investment (CNEIG) is having a mean value of 0.2844 with a minimum value of -0.4517 and the maximum value of 1.2526. The mean value of cumulative national gross fixed capital formation growth (CGFCFG) is 0.2482 with the minimum and maximum values of -0.0118 and 0.4669, respectively.

4.2. Cross-sectional Dependence

The study uses the Pesaran CD test to find cross-sectional dependency in the data. Table 3 shows that the null hypothesis of "cross-sectional dependency" is rejected at 5% (p-value < 0.05), indicating that a shock in one of the selected counties transfers to other counties.

Table 3. Cross-sectional Dependence

Models	CD statistics	P-value	Decision
Model 1	5.407	0.0000	“Cross-Sectional dependence”
Model 2	5.724	0.0000	“Cross-Sectional dependence”
Model 3	11.874	0.0000	“Cross-Sectional dependence”
Model 4	13.414	0.0000	“Cross-Sectional dependence”

Source: Elaborated by the authors.

4.3. Panel Unit Root

Table 4 shows the results of the Levin-Lin-Chu unit-root test, which is used to ensure data stationarity. The test's null hypothesis is "nonstationary series". The results reveal that CUEC, CNRC, CRGDPG, CGVAG, DHB, NHB, CNEIG, and CGFCFG are stationary at a level of 0. DUHB and NUHB become stationary at the first difference by rejecting the null hypothesis of “non-stationary series” at the level of 5% (p-value < 0.05). This implies that DUHB and NUHB are integrated of order 1.

Table 4. Levin–Lin–Chu Unit-Root Test

Variables	Level	First-Difference	Order of integration
CUEC	0.0000	0.0000	I(0)
CNRC	0.0000	0.0000	I(0)
CRGDPG	0.0000	0.0000	I(0)
CGVAG	0.0000	0.0000	I(0)
DHB	0.0123	0.0000	I(0)
DUHB	0.4706	0.0000	I(1)
NHB	0.0000	0.0000	I(0)
NUHB	0.4706	0.0000	I(1)
CNEIG	0.0000	0.0000	I(0)
CGFCFG	0.0000	0.0000	I(0)

Source: Elaborated by the authors.

4.4. Panel Cointegration

Table 5 shows the results of the Pedroni test of cointegration, which is used to determine whether there is a long-term link between variables. The result shows that the null hypothesis of "no cointegration" is rejected at the level of 5% because the probability values of the Modified Phillips–Perron test, Phillips–Perron test, and Augmented Dickey–Fuller test are almost less than 0.05, indicating the existence of a long-term relationship among variables in all of the research models.

Table 5. Pedroni Panel Cointegration Test

Models		Modified Phillips–Perron test	Phillips–Perron test	Augmented Dickey–Fuller test
Model 1	Statistic	9.6012	1.0355	2.8884
	p-value	0.0000	0.1502	0.0019
Model 2	Statistic	9.4246	0.0740	2.1525
	p-value	0.0000	0.4705	0.0157
Model 3	Statistic	9.5597	3.5018	3.8230
	p-value	0.0000	0.0002	0.0001
Model 4	Statistic	9.3261	-4.7631	2.6528
	p-value	0.0000	0.0000	0.0040

Source: Elaborated by the authors.

4.5. Hypothesis Testing

The study applies FMOLS to examine the proposed hypothesis of the study. The results of FMOLS are shown in Table 6.

Table 6. Hypothesis Testing

Variables	Model (1)	Model (2)
$CNRC_{i,t+1}$	-0.4166 (0.100)	-0.3731 (0.107)
$CRGDPG_{i,t+1}$	-2.4097*** (0.000)	-2.4862*** (0.000)
$DHB_{i,t}$	0.0821* (0.070)	
$DUHB_{i,t}$	-0.1464** (0.030)	
$NHB_{i,t}$		0.0030 (0.850)
$NUHB_{i,t}$		-0.1073* (0.077)
$CNEIG_{i,t+1}$	-0.1019 (0.172)	-0.1122 (0.102)
$CGFCFG_{t+1}$	0.4866*** (0.003)	0.5041*** (0.001)
Constant	-0.1347*** (0.002)	-0.1129*** (0.004)
N	139	139
R^2	0.2298	0.2424

Source: Elaborated by the authors.

The results of FMOLS reveals that healthy bank closures have a positive impact on local unemployment (based on the Hungarian counties data level), particularly local entrepreneurial activities and the labor market. It is especially noticeable in employment and GDP growth rates (Ghosh, 2017). This effect can be explained by a significant decline in bank lending (Ashcraft, 2005). Furthermore, closings cause a steady drop in local small business credit, reducing net new small firm formation and employment creation capability (Contreras et al., 2023). These findings lend support to the empirical research conducted by Gilbert and Kochin (1989), Ghosh (2017), Contreras et al. (2022), and Contreras et al. (2023). This results supported the hypothesis of the study.

Unhealthy bank closures have a negative impact on local unemployment. Martín-Oliver et al. (2020) found that negative impacts are more pronounced and significant in the short term but also endure in the long run.

In addition, the growth of newly established corporations, local economic growth, and growth of investment from the national economy into the locality have a negative impact on local unemployment. Meanwhile, national gross fixed capital formation growth has a positive impact on local unemployment. This can be explained by the uneven growth of national gross fixed capital formation in the counties and the inappropriate allocation of resources. This leads to a negative impact on the local economic activity and increases unemployment.

4.6. Robustness Test

To test the robustness of the research models, we use the cumulative gross value added growth of the county instead of the cumulative real GDP growth of the county in the research models. The results of robustness test are shown in Table 7. Results show that the robustness test results also showed similar results.

Table 7. Robustness Test

Variables	Model (3)	Model (4)
$CNRC_{i,t+1}$	-0.4749** (0.048)	-0.4191* (0.057)
$CGVAG_{i,t+1}$	-1.4275*** (0.001)	-1.4737*** (0.000)
$DHB_{i,t}$	0.0999** (0.019)	
$DUHB_{i,t}$	-0.1595** (0.012)	
$NHB_{i,t}$		-0.0005 (0.972)
$NUHB_{i,t}$		-0.1077* (0.062)
$CNEIG_{i,t+1}$	-0.1049 (0.137)	-0.1178* (0.070)
$CGFCFG_{t+1}$	0.5362*** (0.001)	0.5599*** (0.000)
Constant	-0.1024* (0.078)	-0.0739 (0.162)
N	139	139
R^2	0.1494	0.1536

Source: Elaborated by the authors.

5. CONCLUSIONS

Bank closures impair the supply of credit to businesses, reducing firms' prospective investment activities and resulting in a decrease in local employment. This study aims to investigate the different effects of healthy and unhealthy bank closures and local economic growth on Hungarian local employment. There are only a few studies that look at developed European markets, and no study on Central and Eastern Europe. Our study was based on data from Hungary. The empirical investigations in the literature employed rather old data, as banking digitalization has progressed significantly over the last 15 years. More recent data, a pre-COVID dataset (2013–2019), is used by us.

We employ the fully modified ordinary least squares (FMOLS) estimation method and the robustness test to examine the relationship between bank closures, local economic growth, and local employment in Hungary from 2013 to 2019. Using 20 counties in Hungary, the results reveal that healthy bank closures increase local unemployment, whereas unhealthy bank closures reduce local unemployment. This study shows that bank closures have a detrimental impact on the supply of credit to local enterprises and the local economy's growth, resulting in higher unemployment. Increase in newly established corporations and local economic growth helps create more job opportunities, reducing local unemployment. Besides that, the growth of investment from the national economy into the locality creates momentum for local economic development through many economic projects, which reduces the local unemployment rate. In addition, local unemployment rose as a result of the escalation in national gross fixed capital formation.

M&A policies that favor banking sector consolidation, particularly for weak banks, would contribute to the national financial system's stability and economic growth. However, we recommend that authorities focus more on bank consolidation, which includes the closure of local banks (particularly healthy local banks). National economic benefits may conflict with local economic objectives. This negative effect could be minimized by a more diverse M&A policy that assures access to local funds and banking services. On the business side, we anticipate that this will act as a wake-up call to bank executives to focus more on local strategy in the bank's business operations rather than pushing the digitization of financial services.

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A COMPARATIVE ANALYSIS OF SPIKING AND TRADITIONAL NEURAL NETWORKS FOR ONLINE ADVERTISING

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ABSTRACT

This work investigates Spiking Neural Networks (SNNs) as a novel and biologically inspired approach to predict click-through rate (CTR) in personalized online advertising systems. CTR is a critical metric for assessing user engagement and advertisement profitability, directly influencing the effectiveness of online advertisements. A comparative analysis of contemporary methodologies has been implemented, encompassing Spiking Neural Network (SNN) architecture, s alongside traditional machine learning algorithms and Artificial Neural Network (ANN)-based architectures. The training and evaluation processes for these models have been conducted utilizing well-established public datasets to ensure reproducibility and relevance. To maximize robustness and reliability, all models have been subjected to rigorous testing and validation protocols, including k-fold cross-validation procedures and systematic hyperparameter optimization techniques. Moreover, the models have been engineered with an emphasis on interoperability and scalability, specifically designed to facilitate seamless integration and deployment within web-based platforms and distributed computing environments. The outcome of this research includes a comparative analysis of prediction accuracy between ANN and SNN models. Findings demonstrate that SNN-based models for CTR prediction are competitive with traditional ANN-based models. By being the first to explore the application of SNNs in CTR prediction, this research holds significant scientific and social implications, paving the way for future innovations in developing more efficient and accurate CTR prediction algorithms, and potentially transforming the landscape of personalized advertising.

Keywords: *Artificial Intelligence, Machine Learning, Click-Through Rate (Ctr), Artificial Neural Networks, Spiking Neural Networks.*

JEL Codes:

1. INTRODUCTION

Artificial Intelligence (AI) is driving a rapid unprecedented technological advancement revolutionizing society and transforming human lifestyles (Liu et al., 2018). The recent increase is accredited to neural networks (NNs) and the surge of Deep Learning (DL), one of AI's subfields. Neural Networks (NNs) are capable of processing and interpreting large amounts of data, making them

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remarkably effective for complex tasks such as forecasting, image recognition, natural language processing, and artistic creation (Gurney, 1997). AI aims to extend and augment mankind's capabilities and efficiency in several distinct areas such as business intelligence, health, transportation and more. An area that has seen a phenomenal boost is business analytics. In the business world, AI has significantly boosted competitive advantage by offering optimization and automation tools that accelerate delivery and enable the development of innovative products and services. A key application of this technology is in personalized advertising, where accurate prediction of click-through rates (CTR) is crucial for effective targeting and maximizing ad impact (Medeiros, Hoppen and Maçada, 2020).

Personalized Online Advertising Systems, also known as targeted advertising, represent a significant paradigm shift in the world of digital marketing and commerce. These systems use algorithms heavily trained on huge amounts of user data to tailor the advertisements humans see on online platforms to match their unique tastes and needs (Estrada-Jiménez et al., 2017). User data contain many aspects of information, such as search queries, website visits, previous purchases, location, and demographic information about users. Accordingly, these systems aim to display ads precisely when the user is most likely to be interested in them (Deng et al., 2019). According to Statista research, online advertising income in the US increased from $124.6 billion to $139.8 billion in 2020, a 12.2 per cent increase over 2019. By 2025, the industry for online advertising is anticipated to grow to $982.82 billion (Research and Markets Ltd., 2021). Click-based performance measurements, such as the number of clicks or click-through rate (CTR), are used in online advertising to measure how relevant advertisements are to the users (Yang and Zhai, 2022). CTR is the ratio of clicks to the number of times an advertisement is shown.

$$\mathbf{CTR} = \frac{\mathbf{clicks}}{\mathbf{impressions}} \times \mathbf{100}(\%) \qquad (1)$$

Improving CTR is considered an effective strategy for driving long-term growth in the online advertising ecosystem. An improved CTR can lead to more effective ad spending, higher conversion rates, and better resource allocation, translating into significant economic benefits (Robinson, Wysocka and Hand, 2007). Thus, industry experts and researchers use statistical and machine learning models to predict the likelihood that users would click on a certain link or element within a digital interface, such as a website, email, or advertisement (Oren and Keromytis, 2014). This problem is known as CTR prediction (Choi et al., 2020).

Neural Networks are computational machine learning models inspired by human brain dynamics. These models consist of artificial interconnected dotes, replicating brain neurons, that process and direct information. Most current Artificial Neural Network-based models are based on highly simplified brain dynamics. They have been used as powerful computational tools to solve complex pattern recognition, function estimation, and classification problems. However, due to the need for more powerful and biologically realistic models, Spiking Neural Network-based models have been developed which comprise spiking neurons instead of other traditional artificial neurons (Ghosh-Dastidar and Adeli, 2009).

The process of spiking signal transmission is quite sophisticated and differs from the traditional continuous values concept. The spikes (action potentials) travel along axons and activate synapses. These synapses release a neurotransmitter that quickly diffuses across the synaptic cleft to bind to receptors on the postsynaptic membrane, thereby transmitting the signal to the next neuron. the post-synaptic neuron. In the post-synaptic neuron, these neurotransmitters affect the neuron's membrane potential. With each incoming spike, the membrane potential of the neuron rapidly increases before slowly declining (inset). Suppose several spikes arrive in a short period of time. In that case, the membrane potential crosses a threshold, and a spike is generated and fired down the axon, simultaneously resetting its potential (Grüning and Bohte, 2009). SNNs offer advantages in processing real-time data (Tavanaei et al., 2018). Their ability to handle sparse and event driven data makes them well-suited for scenarios such as CTR prediction, where user actions and events are sporadic. SNNs' energy efficiency and potential for asynchronous processing also has practical benefits for large-scale implementations (Ponulak and Kasiński, 2011).

This research aims to tackle the challenge of CTR prediction problem using advanced SNN-based models and outperform exisitng state-of-the-art approaches. The objectives of this work are the following:

- Design and develop novel SNN-based models tailored to the specific requirements and challenges of personalized online advertising systems, considering several complex factors such as user behavior patterns and information.
- Investigate and understand the potential advantages of SNN-based models over traditional ANN-based models in predicting CTR in the context of personalized online advertising.
- Conduct empirical experiments and comparative analysis to quantitatively assess the performance of the SNN-based models in terms of CTR prediction accuracy, efficiency, and adaptability in comparison to traditional ANN-based models.
- Provide valuable insights for boosting advertising effectiveness for businesses and users. By refining CTR predictions, businesses can optimize their ad placements and targeting strategies, leading to better campaign performance and increased ROI. On the other hand, users will get more relevant ads, improving their overall online experience and engagement.

2. LITERATURE REVIEW

SNNs have recently begun to gain more attention in a variety of fields in the tech industry. Some of the most recent state-of-the-art applications SNNs include:

- **Detection of weather images.** The transmission of weather information from a location at specific time intervals has an impact on the living conditions of the people who live there, either directly or indirectly. Toğaçar et al (2020) in their study focus on whether it is possible to make

weather predictions based on weather images using today's technology and computer systems. They demonstrate that using SNNs in conjunction with deep learning models can achieve a successful result (Toğaçar, Ergen and Cömert, 2020; Malcolm and Casco-Rodriguez, 2023; Pietrzak et al., 2023).

- **Recognition of emotional states.** Luo et. al. (2020) propose an innovative method for recognizing emotion states by combining Spiking Neural Networks (SNNs) and electroencephalograph (EEG) techniques. Two datasets are used to validate the proposed method. The results show that using the variance data processing technique and SNNs can classify emotional states more accurately. Overall, this work achieves a better performance than the benchmarking approaches and demonstrates the advantages of using SNNs for emotion state classifications (Luo et al., 2020; Eshraghian et al., 2021; Skatchkovsky, Jang and Simeone, 2020).
- **Event-based optical flow estimation.** Kosta and Roy, (2023) focus on improving the task of optical flow estimation using SNNs with learnable Neuronal Dynamics. Experiments on the Multi-Vehicle Stereo Event-Camera dataset and the DSEC-Flow dataset show reduction in average endpoint error (AEE) compared to state-of-the-art ANNs (Kosta and Roy, 2023; Basel et al., 2022).

Regarding the domain of CTR prediction, multiple efforts have been made in recent years to improve the accuracy. Some of the most recent approaches include:

- **Combining Convolutional Neural Networks (CNNs) and Factorization Machine (FM).** Xiang-Yang and Wang. (2018) develop a model that extracts high-impact features with CNN and classifies them with FM, which can learn the relationship between feature components that are mutually distinct. The experimental results show that the CNN-FM hybrid model can effectively improve the accuracy of advertising CTR prediction when compared to the single-structure model (Xiang-Yang and Wang, 2018).
- **Optimized Deep Belief Nets (DBNs).** Qin et al. (2019) focus on increasing the training efficiency of a prediction model using DBNs by proposing a network optimization fusion model based on a stochastic gradient descent algorithm and an improved particle swarm optimization algorithm. The experiment results show that the fusion method improved the training efficiency of deep belief nets, resulting in a better CTR accuracy compared to the traditional models (Qin, Jie-Hao and Yi-Lun, 2019).
- **Enhanced Parallel Deep CTR model.** Current deep CTR models, such as Deep and Cross Networks (DCN), suffer from insufficient information sharing, which limits their effectiveness. Chen et al. (2021) propose an Enhanced Deep & Cross Network (EDCN) with lightweight, model-agnostic bridge and regulation modules, to enhance CTR prediction accuracy (Chen et al.,

2021; Elsayed and Schmidt-Thieme, 2022). Extensive testing and real-world deployment on Huawei's online advertising platform shows that EDCN outperforms the baseline models (QuY. et al., 2024).

- **Deep Field-Embedded Factorization Machines (Deep FEFMs).** Pande et al. (2023) showed that a Deep FEFM-based model, compared to other Field Factorization Machine-based models, has much lower complexity (Pande, 2021). Deep FEFM combines the interaction vectors learned by the FEFM component with a Deep NN and is, therefore, able to learn more order interactions. Also, after conducting comprehensive experiments on two publicly available real-world datasets, the results showed that Deep FEFM outperformed the existing state-of-the-art shallow and deep models.

3. DATA SET

The training and testing phases of deep learning models are heavily dependent on data. Therefore, various online datasets were thoroughly examined. After evaluating key parameters such as size (rows and columns), data variety, and the number of variables, two datasets were selected for training and testing the developed models. The first dataset has been released by Avazu technology Company, and therefore is usually referred to as the Avazu dataset. Avazu dataset contains over 40 million rows and 24 columns, including 23 features and 1 target column. The dataset includes various attributes related to online ad interactions. Each record is identified by a unique ad ID, with an outcome field indicating whether the ad was clicked or not. The dataset captures the timestamp of the interaction, formatted to show the exact hour, day, month, and year. It includes several anonymized categorical variables, along with information on the banner position, and details about the associated site and app, such as their IDs, domains, and categories. The dataset also records device-specific information, including the device's ID, IP address, model, type, and connection type. Additionally, there are multiple anonymized categorical variables that further describe the data.

The second dataset is the Digix dataset, released in 2010. The dataset includes the advertising user behavior data collected from seven consecutive days. It has over 41 million rows and 36 columns. Similarly to the Avazu dataset, there is one target column representing the user click and the rest of the columns represent the features. Features include fields that identify ad tasks, materials, and advertisers, as well as details about the ad's creative type, display form, and slot placement. User demographics such as age, city, occupation, and gender are captured, along with device-specific information like model, size, and network status during interactions. The dataset also classifies the apps involved in the ad tasks and provides information on app and device characteristics, such as storage size, release time, and ratings. Additionally, it includes data on user behavior, membership status, and activity levels, alongside details about the ad industry and the date of the recorded behavior.

In order to clean and restructure the data, the process known as data preprocessing has been performed. The data preprocessing is performed as follows: the datasets are saved into Comma-Separated Values (CSV) files in both author's Operating System and Google Drive. In the Digix dataset, the unique ID field has been excluded whereas in the Avazu dataset, the unique ad ID field along with Device ID and Device IP fields have been excluded. Next, from the stored CSV files, the data is extracted via the 'pandas.read_csv' function into a panda Data Frame (tabular data structure). The number of rows to be extracted is included in the read function as a parameter. The extracted columns from the dataset are split inside the Data Frame into target column and feature columns. Next, all the feature columns data are converted to categorical data types. At this point, the data in the Data Frame is properly integrated. Next, the Data Frame is split into two Data Frames, the first one named 'x' and the second one named 'y'. The 'x' Data Frame is composed of the categorical feature columns and the 'y' Data Frame is composed of the target column. At this point, One-Hot Encoding is performed on the 'x' Data Frame. One-Hot Encoding is a valuable preprocessing technique to handle categorical data in machine learning. Finally, the 'x' and 'y' Data Frames are split into 'x_train', 'x_test', 'y_train' and 'y_test' Data Frames, using the 'train_test_split' function from scikit-learn library, where the two training Data Frames contain 80% of the initial data while the two testing Data Frames contain 20% of the initial data. Furthermore, on the data preprocessing phase of the SNN-based models there is an additional step. The four aforementioned Data Frames are converted into multidimensional tensors which convert the data to a suitable format for Spiking Neural Network Architectures. This conversion is performed with the help of 'torch.tensor' function from PyTorch library.

4. METHODOLOGY

First, well-known advertising datasets from publicly available sources were selected. Data preprocessing (explain in 3. DATA SET) was conducted to ensure quality and consistency. Second, three traditional ANN-based models, a baseline machine learning algorithm and three SNN-based models were developed, specifically tailored for CTR classification prediction tasks. Third, the models were trained and tested on the datasets. All models were fine-tuned, exploring various neuron classes, learning rules, and network topologies to optimize performance for CTR prediction. Rigorous testing and validation were conducted using standard evaluation metrics, including AUC-ROC and accuracy. Throughout this process, iterative refinements were made based on experimental results to enhance the models' accuracy and efficiency. Finally, an extensive analysis of the results was performed to evaluate the effectiveness of SNN-based approaches for CTR prediction, highlighting their strengths and potential areas for future improvement in computational advertising.

To begin with, the developed ANN models include:

Deep Baseline Model - consists of multiple hidden layers. In this work, the Deep Baseline is built as a Sequential Keras model with four fully connected dense layers. The first layer is responsible for

inputting the data, two hidden layers, and the last layer is responsible for the output. The first three layers use the rectifier function which is known as ReLU activation function. The ReLU activation function is differentiable at all points except at zero. For values greater than zero, the max of the function is chosen. This can be written as:

$$f(x) = x^+ = \max(0, x) = \frac{x+|x|}{2} = \begin{cases} x, & if\ x > 0, \\ 0, & otherwise, \end{cases} \quad (2)$$

where x is the input to a neuron.

The last layer (output layer) comprising of one neuron uses the sigmoid function. The sigmoid function can be written as:

$$\sigma(x) = \frac{1}{1+e^{-x}} = \frac{e^x}{1+e^x} = 1 - \sigma(-x) \quad (3)$$

The model is compiled using the Adam optimizer. Adam stands for Adaptive Moment Estimation and combines the focal points of two other prevalent optimizers: AdaGrad and RMSProp. Adam computes the first and second moments of the gradients to maintain adaptive learning rates for every parameter. Given parameters $w(t)$ and a loss function $L(t)$, where t indexes the current training iteration (indexed at 0), Adam's parameter update is given by:

$$\mathrm{m_w}^{(t+1)} \leftarrow \beta 1 \mathrm{m_w}^{(t)} + (1 - \beta 1)) \nabla \mathrm{w} L^{(t)} \quad (4)$$

$$\mathrm{v_w}^{(t+1)} \leftarrow \beta 2 \mathrm{v_w}^{(t)} + (1 - \beta 2))(\nabla \mathrm{w} L^{(t)})^{\ 2} \quad (5)$$

$$\widehat{m}_w = \frac{\widehat{m}_w{}^{(t+1)}}{1 - \beta^{(t)}{}_1} \quad (6)$$

$$\widehat{v}_w = \frac{\widehat{v}_w{}^{(t+1)}}{1 - \beta^{(t)}{}_2} \quad (7)$$

$$w^{(t+1)} \leftarrow w^{(t)} - \eta \frac{\widehat{m}_w}{\sqrt{\widehat{v}_w} + e} \quad (8)$$

where:

- e – represents a small scalar (e.g., 10^{-8}) used to prevent division by zero, and
- $\beta 1$ (e.g., 0.9) and $\beta 2$ (e.g., 0.999) represent the forgetting factors for gradients and second moments of gradients, respectively.

Wide & Deep Model - is a hybrid architecture of linear models (Wide) and deep neural networks (Deep), having the advantage of abusing strong points from both ML philosophies. In contrast to the Deep Baseline Model, the Wide & Deep model consists of two input layers, one wide layer and one deep layer. A single dense layer containing a single neuron is established for the wide component. The linear

connections between features are recorded by this layer. Multiple dense layers with ReLU activation functions are defined for the deep component. The output of each layer can be calculated as:

$$Z_i = ReLU(W_i \cdot Z_{(i-1)} + b_i \quad (9)$$

where:

- *Zi* represents the output of the *i-th* layer,
- *Wi* represents the weights of the *i-th* layer,
- *Zi*-1 represents the input to the *i-th* layer (output of the previous layer or input layer for the first layer), and
- bi represents the bias term for the *i-th* layer. A final dense layer defined as the output layer with a sigmoid activation function produces the final predictions of the model.

The output from the wide and deep components are concatenated together using the 'concatenate' layer, which is the final output. The model can identify intricate, non-linear patterns in the data because of its deep stack of layers.

Convolutional Model - is a popular type of machine learning model used for a wide variety of tasks, especially binary classification. In this work, the Convolutional model is created using the Sequential Keras API. The first layer is responsible for data input and an additional parameter in this layer is the input size. Convolutional models are known to have max-pooling layers included, mathematically, represented as:

$$Z_i = MaxPool(X_{i-1}, k) \quad (10)$$

where:

- Z_i represents the output of the max-pooling layer,
- X_{i-1} represents the input of the max-pooling layer, and
- k represents the size of the pool.

Convolutional models utilize the sigmoid as the activation function. Mathematically, it is represented as:

$$\widehat{y} = sigmoid(W_{output} \cdot Z_{concat} + b_{output}) \quad (11)$$

where:

- $\hat{y}$ represents the predicted probability,
- W_{output} represents the weights the output layer,
- Z_{concat} represents the output concatenation of the previous layers, and
- b_{output} represents the bias vector.

Logistic Regression - is a baseline statistical machine learning technique for binary classification problems is logistic regression. The purpose of logistic regression models is to simulate the likelihood that an input falls into a particular class. It is regarded as "logistic" because it uses the logistic function, sometimes termed the sigmoid function, to describe the likelihood. The logistic function translates any real-valued integer to the range (0,1). Mathematically, represented as:

$$\sigma(z) = \frac{1}{1+e^{-z}} \quad (12)$$

where z is equivalent to the linear combination of input features and their corresponding weights. The logistic regression model is created using the 'Logistic Regression' class from scikit-learn.

Regarding the developed SNN models, the following were developed:

RSynaptic Model – its neuron class is one of the most popular neuron classes in SNNs. The network is made of four linear fully connected layers followed by RSynaptic neurons, which represent spiking neurons with synaptic plasticity. Each spiking neuron layer is defined with specific parameters, including the number of neurons, initial membrane potential (V), learning thresholds (alpha and beta), and reset mechanism. The synaptic current jumps upon spike arrival, which causes a jump in membrane potential. Synaptic current and membrane potential decay exponentially with rates of alpha and beta, respectively. For $U[T] > U_{\text{thr}} \Rightarrow S[T+1] = 1.$ (13)

Whenever an RSynaptic neuron emits a spike:

$$\begin{aligned} I_{\text{syn}}[t+1] &= \alpha I_{\text{syn}}[t] + VS_{\text{out}}[t] + I_{\text{in}}[t+1] \\ U[t+1] &= \beta U[t] + I_{\text{syn}}[t+1] - R\big(\beta U[t] + I_{\text{syn}}[t+1]\big) \end{aligned} \quad (14)$$

where:

- I_{syn} – Synaptic current
- I_{in} – input current
- U – Membrane potential
- U_{thr} – Membrane threshold
- S_{out} – Output spike
- R – Reset mechanism
- α – Synaptic current decay rate
- β – Membrane potential decay rate
- V – Explicit recurrent weight

In RSynaptic architectures, the forward method implements the forward pass of the network. During each time step, input signals (x) are processed consequently through the layers. Spikes, synaptic weights, and membrane potentials are updated at each layer using the 'RSynaptic' neuron model.

Leaky Model - is another form of Spiking Neural Networks. It utilizes Leaky Integrate-and-Fire (LIF) neurons, a kind of spiking neuron model in which the dynamics of the membrane potential include a leakage factor. It is assumed that the input is an injection of current. By leveraging rate beta, membrane potential decays exponentially.

For $$U[T] > U_{\text{thr}} \Rightarrow S[T+1] = 1. \quad (15)$$

Whenever a Leaky neuron emits a spike:

$$U[t+1] = \beta U[t] + I_{\text{syn}}[t+1] - R(\beta U[t] + I_{\text{in}}[t+1]) \quad (16)$$

where:

- I_in - Input current
- U - Membrane potential
- U_thr - Membrane threshold
- R - Reset mechanism
- β - Membrane potential decay rate

The Leaky neurons have parameters such as beta (leakiness), threshold, and reset mechanism. The forward pass initializes the membrane potentials for each Leaky neuron in every layer. It iterates over time steps and then updates the membrane potentials at each step. Only the output of the last layer is recorded for each time step. The final layer includes the spike trains, and the membrane potentials of the previous layer fulfilled with the time dimension.

RLeaky Model - An RLeaky Spiking Network is an extensive format of the previously mentioned Leaky Network. Therefore, these two networks are remarkably similar in the way communication within the network happens. However, the main difference is that in the RLeaky Network the neurons utilize the Randomized Leaky function, which introduces randomness into the leakage process. It is assumed that the input is an injection of current appended to the voltage spike output. Similarly to the Leaky Network, by leveraging rate beta, membrane potential decays exponentially. However, compared to the Leaky network, there is a dynamic leak rate that varies randomly over time.

For $$U[T] > U_{\text{thr}} \Rightarrow S[T+1] = 1. \quad (17)$$

Whenever an RLeaky neuron emits a spike:

$$U[t+1] = \beta U[t] + I_{\text{in}}[t+1] + V(S_{\text{out}}[t]) - R\big(\beta U[t] + I_{\text{in}}[t+1] + V(S_{\text{out}}[t])\big) \quad (18)$$

where:

- I_{in} - Input current
- U - Membrane potential
- U_{thr} - Membrane threshold
- S_{out} - Output spike
- R - Reset mechanism
- β - Membrane potential decay rate
- V - Explicit recurrent weight

The forward pass function is similar to the Leaky pass function, with the exception of the dynamic leak rate.

Beginning with the training and the testing of ANN-based models, Keras library was used for this purpose. Metrics such as Area Under the ROC Curve and Accuracy were calculated to test their performance. On the other hand, to train and test the SNN-based models, snnTorch (an extension of Pytorch) library was utilized. Similarly, the same metrics such as Area Under the ROC Curve and Accuracy were calculated. To provide a fair comparison between SNN and traditional ANN-based models in the predicting CTR problem, the most effective configuration parameters were identified for every model. This is performed through hyperparameter tuning techniques. Hyperparameter tuning is a critical aspect and a proven validation method for model development. Due to their importance in defining structural and operational characteristics, hyperparameters can significantly influence the models' performance (Bardenet et al., 2013). Considering the complexity of personalized online advertising systems, the prediction models require meticulous hyperparameter tuning. This is performed by implementing various tuning techniques starting with simpler ones such as manual trial-and-error to more complicated tuning techniques such as grid search (Xiao et al., 2022). Grid search is done by manually selecting a subset of the hyperparameter space and testing (Yang and Shami, 2020). In this work, a combination of both was used in order to identify hyperparameters for every model. The grid search algorithm is developed by initializing the parameters as a dictionary, which is subsequently injected into the 'ParameterGrid' function from scikit-learn library, which creates a combination of hyperparameters. Firstly, based on extensive research, it is decided that a 4-layer network is a popular choice. Using the developed Grid Search algorithm, several optimal values of selected hyperparameters were found for both ANN and SNN models. (see Table 1).

Table 1. Optimal Values Using Grid Search

Parameter	Optimal Value
Model Architecture	256-128-64-1
Learning Rate	0.0001
Batch Size	1000
Number of Steps	10

In order to find optimal values for other hyperparameters, manual trial and error has been utilized (see Table 2).

Table 2. Optimal Values Using Manual Trial & Error

Parameter	Optimal Value
Number of Rows	1,000,000
Optimizer	Adam
Activation Function	ReLU
Reset Mechanism	zero

It is important to state that the number of rows has been set at 1,000,000 due to computational power restraints. This technique provides a fair and equal configuration to all the models and helps in identifying outperforming models (Weerts, Mueller and Vanschoren, 2020). Insights from the hyperparameter tuning process provide a hyperparameter standard contribution for future work focused on predicting CTR using neural network-based models.

Morover, cross-validation technique was used to test models' performance, using k-fold technique. The parameter k is the number of folds. This technique splits the dataset k times into two subsets, a bigger subset, and a smaller subset. The big dataset is used to train the model, and the small dataset is used to test the model. The chosen performance metric is saved. After this process is done k times, the average of the chosen performance metric is extracted (Nti, Nyarko-Boateng and Aning, 2021). See formula below:

$$Average\ Accuracy = \frac{1}{k}\sum_{i=1}^{k} Accuracy_i \tag{19}$$

where accuracy is the performance metric chosen. Average accuracy provides insights into how robust and generalizable the model is. The process is done for all models included in the comparison. In this work, for computational purposes, the k-value was set at 5. This means that the dataset containing 1,000,000 rows was split into five smaller datasets, with 200,000 rows each. The corresponding model was trained and tested for every fold. The procedure was repeated five times. Each time, the training and testing datasets were different. After Cross-validation was performed, the following results are shown in Table 3.

Table 3. Model Performance Results

Model	**AVAZU**		**DIGIX**	
Model Name	**AUC ROC**	**ACCURACY**	**AUC ROC**	**ACCURACY**
Deep Baseline	0.7356	0.8234	0.6564	0.9618
Wide & Deep	0.7366	0.8236	**0.6694**	0.9624
Convolutional	0.7323	0.8254	0.6599	0.9631
Logistic Regression	0.6711	0.8184	0.6323	0.9601
RSynaptic	**0.7399**	**0.8378**	0.6412	**0.9678**
Leaky	*0.6556*	*0.7831*	*0.5453*	*0.9403*
RLeaky	0.7098	0.8319	0.6319	0.9595

When training on the Avazu dataset, the three traditional ANN models demonstrate consistent and comparable performance in both AUC ROC and Accuracy. In contrast, Logistic Regression underperforms relative to all ANN models. Among the SNN models, RSynaptic achieves the highest performance across all models, while the Leaky model lags significantly behind the rest. On the Digix dataset, the ANN models again show stable performance across both metrics. In terms of AUC ROC, they outperform both the SNN models and Logistic Regression. Logistic Regression remains the weakest performer across both metrics. Within the SNN group, RSynaptic surpasses Logistic Regression in AUC ROC, though it still trails behind the ANN models. However, RSynaptic achieves the highest Accuracy among all models, highlighting its strength in classification precision. As observed with the Avazu dataset, the Leaky model continues to be the poorest performer by a notable margin.

Cross-validation provides robust assessment of performance metrics, demonstrating clear evidence that SNNs compete with traditional ANN models in predicting CTR for personalized online advertising systems (Berrar, 2019).

Table 4. Summary of Averages

Model Name	**AUC ROC**	**ACCURACY**
Deep Baseline	0.6960	0.8926
Wide & Deep	**0.7030**	0.8930
Convolutional	0.6961	0.8943
Logistic Regression	0.6517	0.8893
RSynaptic	0.6906	**0.9028**
Leaky	*0.6005*	*0.8617*
RLeaky	0.6709	0.8957

Finally, when averaging performance across both datasets and all metrics, the Wide & Deep model demonstrates the best overall AUC ROC, while the RSynaptic model achieves the highest Accuracy. In

contrast, the Leaky model consistently underperforms in both AUC ROC and Accuracy compared to all other models.

5. CONCLUSION

In this work traditional Artificial Neural Network (ANN) models and innovative Spiking Neural Network (SNN) models were developed, trained, and tested for predicting click-through rate (CTR) in personalized online advertising systems. Area Under the ROC Curve (AUC) and Accuracy, were used as performance metrics to evaluate and compare the models. Hyperparameter tuning using techniques like grid search and manual trial-and-error was critical in optimizing model performance. Cross-validation, specifically the k-fold technique, was implemented to ensure the robustness and generalizability of the models. When trained using the Avazu and Digix datasets, the RSynaptic model (SNN) along with the Wide & Deep model (ANN) showed the highest performance, whereas the Leaky model (SNN) showed to be the underperforming model.

The integration of SNN-based models into CTR prediction lays grounds for future research possibilities in the field. Subsequent studies may consider incorporating bionic features in SNNs to enhance their adaptability and responsiveness to the volatile online information landscape. Such detailed analysis may involve studying ways to improve the spike signal reception mechanism that is sensitive enough to detect slight differences in client behaviour resulting in better prediction of CTR. Continuous development can empower the project as a pioneer in machine learning advances for online advertising.

To sum up, the aforementioned advancements will not only study these problems but can also solve addressing existing problems in personalized online advertising systems. Future releases may focus on enhancing the characteristics of spiking neurons or comparing SNN-based models against other neural networks' models. The results of the following studies have the potential to influence the machine learning community by further including SNN-based models as serious candidates in predicting click-through rate.

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UNDERSTANDING EMPLOYEE AND NON-EMPLOYEE HAPPINESS USING PERSONALITY PROFILES APPROACH

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ABSTRACT

This study aims to examine the personality profiles of those who work in a job that generates income, those who do not work in a job that generates income (housewives, unemployed, retired, etc.) and those who are students (unlike these two groups) in Türkiye, depending on their happiness levels. The study was conducted in 2024 via a web-based form. The short-form Oxford Happiness Scale and the Big Five Personality Test-50 were used in the study. Those who did not work in a job that generates income (n = 162, 31.9%), students over the age of 18 (n = 172, 33.9%), and those who worked in a job that generates income (n = 174, 34.3%) were included in the study. Participants were between the ages of 18-75 (M = 29.20, s = 11.41) and 258 were female (%50.8) and 250 were male (%49.2). In the study, firstly, the participants were divided into two groups as below average (defined as unhappy group, n = 256, 50.4%) and above average (defined as happy group, n = 252, 49.6%) according to their total happiness scale score average (M = 3.53, s = 0.48). Then, working status (3 groups) and happiness (2 groups) groups (3 x 2) were compared in terms of five factor personality total scores with multivariate analysis of variance (MANOVA). In terms of working status, there was a statistically significant difference between the total scores of the personality factors Agreeableness and Emotional Stability of the three different groups. There was no statistically significant difference between the total scores of the personality factors Extraversion, Conscientiousness and Intellect / Imagination. In terms of happiness level, there was a statistically significant difference between the two groups Extraversion, Agreeableness, Conscientiousness, Emotional Stability and Intellect / Imagination personality factors total scores were found to be statistically significant. There was no interaction between the working status and happiness groups in terms of the five factor total scores. The most significant difference observed in the results in terms of the five factor total scores occurred between the two groups with low and high happiness. The results were discussed, and suggestions for future research were presented.

Keywords: *Personality, Happiness, Employee, Unemployed, Student.*

JEL Codes: *D23, D91, D2.*

1. INTRODUCTION

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The level of economic development of a country has a strong, independent positive effect on well-being, and the well-being created by economic growth increases it more in poor nations than in rich nations (Zagorski, Kelley and Evans, 2010). In recent years, the happiness level of the people in Türkiye seems to have decreased significantly due to economic conditions. In these economic conditions, whether or not one works in a job that brings income is also a determinant of happiness. Therefore, the focus of this study is to examine the role of personality traits in the mentioned relationship. Thus, in this study, it is planned to examine the personality profiles of those who do not work in a job that brings income (housewives, unemployed, retired, etc.), those who work in a job that brings income, and those who are students (unlike these two groups) in Türkiye by comparing them according to their happiness levels.

2. LITERATURE REVIEW

Happiness is defined as a state of well-being in which positive emotions dominate over negative emotions, encompassing different aspects of life such as emotional well-being, a sense of meaning and purpose in life, and life satisfaction (Momeni, Kalali, Anvari, Raoofi, and Zarrineh, 2011; Steptoe, 2019; Yang 2008). Happiness is also functional in the form of increasing general success, improving physical and mental health, and strengthening the immune system (Barak, 2006; Dfarhud, Malmir and Khanahmadi, 2014; Machado et al., 2015; Mahakud and Yadav, 2015; Momeni, Kalali, Anvari, Raoofi and Zarrineh, 2011; Zhang and Chen, 2019). In this context, generally happy employees have higher job performance and income than unhappy employees (Oishi, Diener, and Lucas, 2007).

3. METHODOLOGY

Participants

A total of 508 people, 258 females (50.8%) and 250 males, between the ages of 18-75 (M = 29.20, s = 11.41) participated in this study. Of the participants, 162 (31.9%) were unemployed (unemployed, retired housewives, etc.), 172 (33.9%) were students over the age of 18, and 174 (34.3%) were employed.

Tools

The short form Oxford Happiness Scale and the Big Five Personality Test-50 were used in the study.

The Big Five Personality Test-50 consists of five factors with 10 items in each factor and a total of 50 items. The test, which is a self-report type and includes 5-point Likert-type response options (Not Appropriate at All = 1, Very Appropriate = 5), consists of five factors: Extraversion, Agreeableness, Conscientiousness, Emotional Stability, and Intellect / Imagination (Goldberg, 1992). In the translation study of the test into Turkish, it was reported that the internal consistency reliability coefficients obtained for the two applications of the factors were between 0.65-0.79 and 0.68-0.79 (Tatar, 2017).

The Oxford Happiness Scale-Short Form is a scale with two items scored in reverse, including 5-point Likert-type response options (I Do Not Agree at All = 1, I Completely Agree = 5). The short form consists of seven items (Doğan and Çötok, 2011).

Application

The study was conducted in 2024 via a web-based form. The form first included a voluntary consent form that specified the inclusion and exclusion criteria. After the participants confirmed that they participated voluntarily, they were able to access the application form. The application for one person took approximately 5-10 minutes.

Data Analysis

In the study, descriptive statistics of scale scores, internal consistency reliability analyses of scales, and group comparisons in personality factor score were made.

Results

First, the internal consistency reliability coefficients of the measurement tools used in the study were determined. It was seen that the Big Five Personality Test-50 factors were between .69 and .84, and the short-form Oxford Happiness Scale was .79. Then, the descriptive statistics of the measurement tools used were obtained (Table 1).

Table 1. Descriptive Statistics and Cronbach's Alpha of Personality Factor Scores

Personality Factors and Happiness Scale (Cronbach's Alpha)	Happiness Groups - Working Status	n	Mean	s
Extraversion (.69)	Unhappy - unemployed	84	3.02	0.61
	Unhappy - student	87	3.10	0.61
	Unhappy - employee	85	3.01	0.59
	Happy - unemployed	78	3.27	0.56
	Happy - student	85	3.48	0.69
	Happy - employee	89	3.29	0.67
	Total	508	3.20	0.64
Agreeableness (.79)	Unhappy - unemployed	84	3.59	0.67
	Unhappy - student	87	3.49	0.76
	Unhappy - employee	85	3.45	0.60
	Happy - unemployed	78	4.22	0.50
	Happy - student	85	3.94	0.60
	Happy - employee	89	3.93	0.66

Personality Factors and Happiness Scale (Cronbach's Alpha)	**Happiness Groups - Working Status**	**n**	**Mean**	**s**
	Total	508	3.77	0.69
Conscientiousness (.84)	Unhappy - unemployed	84	3.38	0.84
	Unhappy - student	87	3.30	0.73
	Unhappy - employee	85	3.36	0.65
	Happy - unemployed	78	4.09	0.64
	Happy - student	85	3.87	0.71
	Happy - employee	89	3.88	0.78
	Total	508	3.64	0.79
Emotional Stability (.78)	Unhappy - unemployed	84	2.66	0.71
	Unhappy - student	87	2.82	0.51
	Unhappy - employee	85	2.84	0.61
	Happy - unemployed	78	3.40	0.67
	Happy - student	85	3.50	0.70
	Happy - employee	89	3.62	0.66
	Total	508	3.14	0.74
Intellect / Imagination (.75)	Unhappy - unemployed	84	3.47	0.72
	Unhappy - student	87	3.46	0.70
	Unhappy - employee	85	3.34	0.59
	Happy - unemployed	78	3.71	0.56
	Happy - student	85	3.82	0.62
	Happy - employee	89	3.67	0.67
	Total	508	3.58	0.66
The short-form Oxford Happiness Scale (.79)	Total	508	3.53	0.48

After that, the participants were divided into two groups as below average (defined as unhappy group, n = 256, 50.4%) and above average (defined as happy group, n = 252, 49.6%) according to their total happiness scale score average (M = 3.53, s = 0.48) (Table 1).

Table 2. Frequencies of Happiness and Working Status Groups

Happiness Groups - Working Status	f	%
Unhappy - unemployed	84	16,5
Unhappy - student	87	17,1
Unhappy - employee	85	16,7
Happy - unemployed	78	15,4
Happy - student	85	16,7
Happy - employee	89	17,5
Total	508	100,0

When the three groups determined according to working status and the two groups determined in terms of happiness were crossed, six groups were obtained (Table 2). Then, working status (3 groups) and happiness (2 groups) groups (3 x 2) were compared in terms of five factor personality total scores with multivariate analysis of variance (MANOVA).

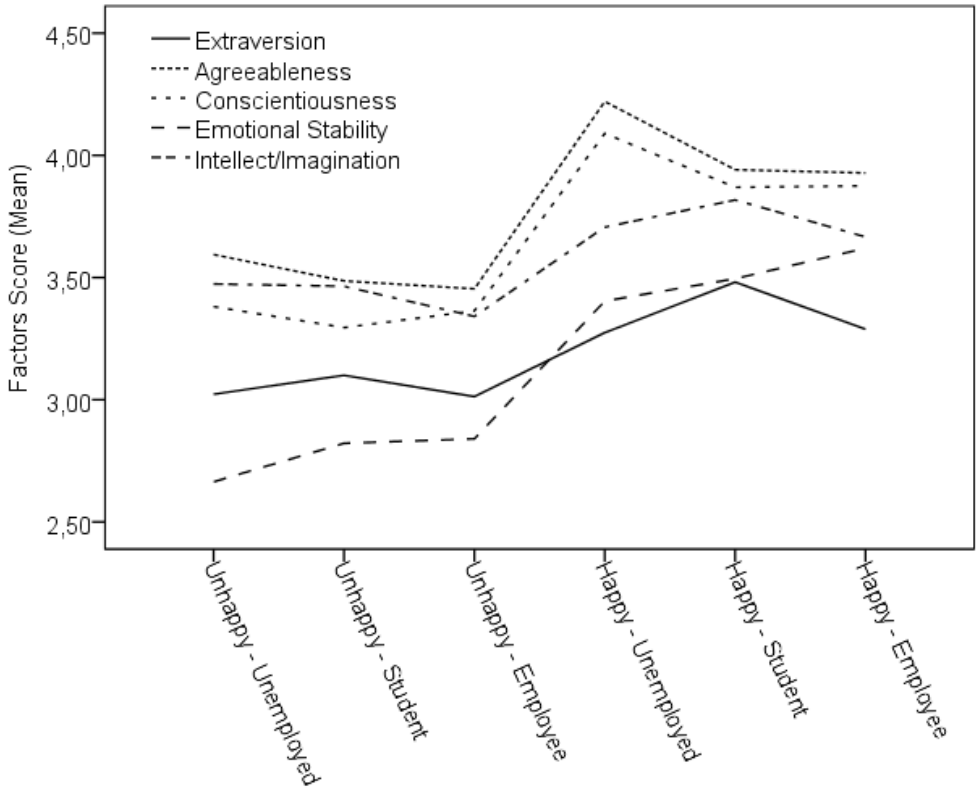
Table 3. Comparison of Working Status and Happiness Groups in Terms of Personality Factor Scores

Source	Personality Factors	F	p	Partial η^2
Working Status (3 Groups)	Extraversion	2.90	.056	.011
	Agreeableness	5.75	.003	.022
	Conscientiousness	1.98	.140	.008
	Emotional Stability	3.95	.020	.015
	Intellect / Imagination	1.99	.138	.008
Happiness Groups (2 Groups)	Extraversion	29.88	.000	.056
	Agreeableness	83.85	.000	.143
	Conscientiousness	85.06	.000	.145
	Emotional Stability	163.18	.000	.245
	Intellect / Imagination	27.90	.000	.053
Working Status x Happiness Groups	Extraversion	.52	.598	.002
	Agreeableness	.90	.408	.004
	Conscientiousness	.79	.454	.003
	Emotional Stability	.30	.740	.001
	Intellect / Imagination	.39	.675	.002

In terms of employment status, a statistically significant difference was observed between the total scores of the personality factors Agreeableness ($F(2, 502 = 5.75; p < .01$; partial $\eta^2 = .022$) and Emotional Stability ($F(2, 502 = 3.95; p < .05$; partial $\eta^2 = .015$) of the three different groups. However, no statistically significant difference was found in terms of the factors Extraversion ($F(2, 502 = 2.90; p > .05$; partial $\eta^2 = .011$), Conscientiousness ($F(2, 502 = 1.98; p > .05$; partial $\eta^2 = .008$) and Intellect / Imagination (F(2,

502 = 1.99; p > .05; partial η^2 = .008). In addition, Extraversion (F(1, 502 = 29.88; p < .001; partial η^2 = .056), Agreeableness (F(1, 502 = 83.85; p < .001; partial η^2 = .143), Conscientiousness (F(1, 502 = 85.06; p < .001; partial η^2 = .145), Emotional Stability (F(1, 502 = 163.18; p < .001; partial η^2 = .245) and Intellect / Imagination (F(1, 502 = 27.90; p < .001; partial η^2 = .053) personality factors total scores were found to be statistically significant between the two groups formed according to happiness level.

Graph 1. Comparison of Working Status and Happiness Groups in Terms of Personality Factor Scores



No interaction was observed between the working status and happiness groups in terms of the factor total scores of Extraversion (F(2, 502 = 0.52; p > .05; partial η^2 = .002), Agreeableness (F(2, 502 = 0.90; p > .05; partial η^2 = .004), Conscientiousness (F(2, 502 = 0.79; p > .05; partial η2 = .003), Emotional Stability (F(2, 502 = 0.30; p > .05; partial η^2 = .001), Intellect / Imagination (F(2, 502 = 0.39; p > .05; partial η^2 = .002) (Table 3, Graph 1).

4. CONCLUSION

This study aimed to examine whether the status of working in a job that generates income and the level of happiness differ in terms of personality traits. It is clear that the poor economic conditions in Turkiye have significantly reduced the happiness level of the people. However, it was considered to examine whether personality traits also contributed to this process. As a simple research design, three groups of participants with different statuses of working in a job that generates income were included in this study.

While a difference was observed only in terms of the total scores of the Agreeableness and Emotional Stability factors among the research participant groups, the most significant difference observed in the results in terms of the total scores of the five factors occurred between the two groups with low and high happiness. As expected, these results revealed the importance of happiness, not the working conditions, in personality differences. In other words, there was a difference between the low and high happiness groups in terms of all personality factors. However, since the change in the groups occurred in a similar way for all personality measurements, no interaction was observed between the working status and happiness groups (Graph 1).

The results obtained from this study revealed that personality traits should be taken into consideration in examining the happiness levels of those who work and those who do not work. When comparison is desired, groups that are not employed serve as references for groups that are employed. In this context, it has been understood that the job performance of employees is affected by their personality traits as well as their happiness, but the level of happiness is particularly decisive in the differences between groups.

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THE POTENTIAL OF NICHE TOURISM IN GREECE- AN EXPLORATORY STUDY ON DANCERS' PERCEPTIONS: THE CASE OF TANGO-TOURISM

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Eirini TSICHLA**

ABSTRACT

The following study explores the potential of tango tourism in Greece, through the lens of international tango dancers. Using quantitative and statistical research techniques to look upon the data, the study delves into dancers' motivators for participating in tango tourism, and the significance of different aspects in their decision. The results reveal that cultural exploration, passion for the dance and tango related touristic packages are the main drivers of tango tourism. This suggests that Greece has the potential to draw tango tourists by means of targeted marketing campaigns and touristic packages involving recreational offerings. The study provides insights for destination marketing organizations (DMOs), event organizers, travel agencies, and dancers themselves, in order to capitalize on this niche. Lastly discoveries of this study can set grounding foundations for future research to be conducted on the potential this niche has, or go more in depth on dancers' perceptions.

Keywords: *Tango, Tango Tourism, Tango Dancer, Motivations, Perceptions, Greece, Niche.*

JEL Codes: *Z32, Z33, L83.*

1. INTRODUCTION

Stopping to "be everything to everyone" and committing to a niche, has been a significant trend-shifter for many businesses nowadays, especially within the tourism industry (Chavez, 2023). The term "niche tourism" describes the process of adapting specific travel offerings to satisfy the demand of a certain consumer segment (Sert, 2017), in a specialized field. From its initial emergence as a concept back in the 1980s (Read, 1980), niche tourism has had a pivotal role in developing destinations that chose to "go niche". With growing importance placed on unique experiences (O'Regan, 2014), niche tourism is emerging as a major area of research for scholars and industry professionals.

Despite tourism industry making up for more than 18% of its GDP (Statista, 2023), season-extension in Greece is still sluggish (Krinis, 2024). Therefore, researching potential niches to penetrate

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into, would be useful for destination marketing organizations (DMOs)[1], Greek travel agencies and cultural event organizers of all scales.

In the realm of niche tourism, dance tourism is one of its most prevalent forms for destination development (Amorim et al., 2020). Empirical studies by Saftic et al., (2011) and O'Connor and Cronin (2003) highlight the financial and cultural benefits of dance tourism, demonstrating its potential to provide increased profits and promote dialogue between cultures in Croatia and Ireland respectively. Georgoula and Terkenli (2017) examine the elevated tourism profile, extended season and the strong positioning of two Greek towns - Drama and Kalamata - as a result of hosting international dance festivals for 22 consecutive years. Key drivers for dancers to participate in these events - ranging from physical needs, exploration, improvement of skills and self-fulfillment - showcase the relationship between tourism activities and one's perception or motives to engage in them. Particularly, tango-dancing stands out in the dance tourism arena, as a growing activity that draws the interest of an increasing number of individuals each year globally (Tornqvist, 2007). Drawing parallels from the positive impact of already established dance festivals in Greek destinations, this investigation in tango-tourism offers Greek tourism professionals an opportunity to broaden the range of travel options and enhance its position on the competitive international travel scene.

Although existing literature has investigated dance tourism and its implications for destinations' economic and cultural development, a research gap on Greece as a potential tango destination remains.

Consequently, this study will undertake an exploratory quantitative analysis with the purpose of adding to the existing literature on tango tourism, by exploring the potential of Greece as a viable and attractive destination. In particular, the main research questions to be addressed are:

1- What are the motivators of tango dancers - both foreign and local - to engage in tango related tourism in Greece?
2- To what extent do factors like quality, cost, recommendations, among other factors, contribute to the decision-making process of tango dancers in choosing Greece as a tango destination?
3- What are the opportunities and challenges that tango dancers associate with Greece as a destination for tango tourism?

[1] Destination Marketing Organizations (DMOs) are private or public institutions, responsible for advertising a particular destination—town, region, or nation—in order to attract travelers and increase tourism. Their main objective is to boost the amount of tourists and the tourism industry's financial contribution to the region (Ekstrom, 2023).

2. LITERATURE REVIEW

2.1.The Impact of Niche Tourism in Developing Destinations

According to Lopes (2011), the beginnings of destination development stem not only from innovations in tourism, but also from the integration of quality services, niche events, and strong branding. This kind of niche-developments attract wealthy travelers looking for specialized experiences, such as wellbeing trips, e.g., retreats. Similarly, Novelli (2005) cited a case study in which a German area-although not specialized on it-capitalized on wine production to establish itself as a unique destination. This niche tourism attraction lures visitors to the region and, as a result, boosts the local economy, by therefore offering incentives for locals to organize these kinds of events more often. Studies show that events and festivals have played an essential part in prolonging the tourist season, attracting foreign direct investment, and supporting regional economies through creating new branches of income. According to Getz and Page (2019), niche events enhance destinations with sensory engagement and captivating atmosphere, thereby encouraging revisits in the same destination. In addition, by targeting a selected elite of people, niche events high-yield travelers; thus, making the event last longer in time. On the same note, Bunghez (2021) argues that niche tourists have statistically higher consumer spending, compared to a traditional tourist.

2.2.The Presence of Dance and Tango Tourism Worldwide

Several scholars have argued that dance-related tourism is a crucial component that enhances the tourism experience and has the potential to attract many travelers to explore new areas. There are numerous instances of nations organizing various dance events to attract visitors. Research by Saftic et al., (2011), studies the close relationship between dancers' strong desire to engage in cultural activities and increased tourism figures in Croatia. The same patterns have been observed in Ireland by O'Connor and Cronin (2003). Another study has investigated the Embera tribe, located in the town of Puru, which has transformed its traditional sacred dance rituals into a tourist-oriented dance spectacle. As a result, it has succeeded in projecting its cultural identity globally via dance tourism, and has leveraged this strategy to further welcome tourists in the region (Kringelbach & Skinner, 2012). Additionally, Goulimaris et al., (2010) states that Greece has increased its advertising spending throughout the years towards dance-related events, as a means to motivate and accelerate the niche. Furthermore, dances such as Tango in Argentina and the Flamenco in Spain, have considerable impact on the tourism sector of these countries (Zouni et al., 2019). Kanai (2014), Vilaadrich (2018) aand Tornqvist (2012) argue that the biggest financial incentives and support for organizing tango events in Buenos Aires, come from foreigners wanting to relive the "milongueros"[2] experience.

[2] A milonguero is someone who is involved in dancing in social tango events. The term originates from the word "milonga", which refers to a tango event.

2.3.Dancers' Perceptions and Motivators

The theory of embodiment highlights the influence of one's body on their feelings. It argues that people utilize their physical sensations to comprehend thoughts and feelings as well as emotions of others (Piran et al., 2023). Drawing from this theory, Tornqvist (2013) argued that for a dancer to sufficiently get involved as a tango-tourist, they must put forth a lot of effort to equip their bodies with the necessary physical abilities and routines. This suggests that the body should not merely be regarded as another variable, but rather as a condition for dancers to be part of the tango-tourism world. As a result, Tornqvist (2013) claims that gaining new and improved dance skills is one of the main drivers for tango dancers to participate in dance-tourism.

In a similar vein, Frisby and Getz (1989) argue that dancers' motivation to participate in dance tourism derives from the necessity to fulfill their acceptance, societal, cultural and physical needs. They claim that all those needs are fulfilled by dance-tourism processes whether those being technical (such as physical movement) or more emotional like self-confidence and the sense of belonging dance provides. On the other hand, through his study on Ohio dance festivals, Scott (1995) discovered that elements such as: stimuli, unity, habits and exploration affected the motivational reasoning of dancers, while Nicholson (2001) claims that dancers' motivation is closely correlated with the characteristics of the event. Zouni et al., (2019) in a comparative study of Greek and Russian dancers' approach to dance-tourism, show that escape and relaxation, altogether with desire to improve dancing skills are the top two motivators of participants.

3. METHODOLOGY

This study employs an exploratory, quantitative research methodology. The quantitative approach has been selected in order to scale dancers' perception of Greece as a tango destination, as scientific studies deem it as the most efficient method for discovering niche tourism destinations based on people's perceptions (Yoon et al., 2023). The study is assessed through a cross-sectional survey, as this approach is helpful for building preliminary data to guide further research on the field (Wand and Cheng, 2020), considering the exploratory nature of this study. An online questionnaire was distributed through Google forms from February 27th to March 12th through social media. In particular, Instagram, Facebook groups, LinkedIn groups, and WhatsApp were employed as these tools constitute a fast and cost-effective reach of the desired respondents. Moreover, this distribution method is chosen with the purpose of reaching a wider geographical area, in order to have a diversified sample. The questionnaire is made of close-ended questions, and one open-ended question, to further support the exploratory nature of the study, but still emphasize simplicity in answering. Borrowing from (Zouni et al., 2019 and Prini et al., 2023), and in accordance with prior literature; five-point Likert scales and attitude rating scales were implemented. To ascertain the accuracy of the terminology and measuring variables, the survey was content-validated by a professional tango dancer and milonga organizer. Additionally, five tango dancers from all levels of

expertise pilot tested the survey. The desired population is Greek and international tango dancers and the sample size was 115 tango dancers from all levels of expertise, making it an appropriate sample size for cross sectional surveys (Maier et al., 2023). This is a non-probability, convenience sampling as it enables the author to gather more responses which elevated the analysis process. Snowball sampling was also implemented through the assistance of two tango professors, as they are well-networked subjects in the community of tango dancers. The data collected were analyzed using descriptive and inferential statistics in order to better comprehend the link between behavioral variables. This research abides by ethical standards every time it is dealing with third parties, and guarantees anonymity of respondents in accordance with the Research Ethics Committee (RECs).

4. FINDINGS

The survey was completed by 123 tango dancers. After initial screening, 8 responses were discarded for not meeting the necessary screening requirement, which consisted of verifying whether the participants were tango dancers. Hence, the final sample comprised 115 respondents. The participants' demographic makeup consisted of 57.4% females and 42.6% males, providing gender-balanced viewpoints on tango-tourism's potential in Greece. The age spectrum mostly focused within the ages of 26 and 44, with 49.6% of this range comprising the sample. The other age categories,18 to 25 years old and 45 to 59 years old, made up for 27% and 21.7% of the sample, respectively. The wide variety of respondents' geography- 43.5% of whom are Greek and 56.5% internationals - broadens the exploratory reach of this study. In addition, 87% of respondents expressed a high interest in the tango discipline, ensuring the sample's appropriateness of the study.

4.1.RQ1: Tango Dancers' Motivators to Engage in Tango Tourism in Greece

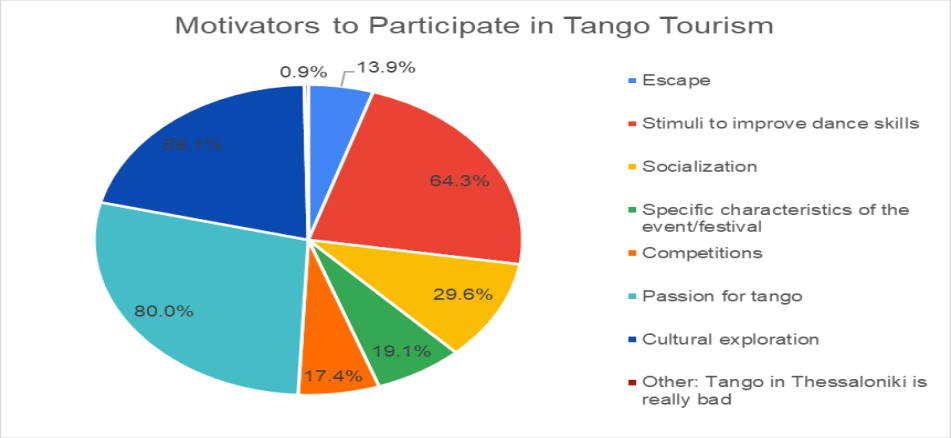
In order to address the first research question, respondents were initially assessed on their motivators for engaging in tango dance specifically. 67% of them related their passion for tango with the dance boosting their personal and professional growth, followed by 64.3% of them choosing self-expression through tango as a core motivator. Less respondents (49.6%, 46.1% and 33.9%) were driven by tango's culture, community and physical exercise respectively. Getting closer to exploring the fuel for tango tourism in dancers, 83.5% of them admitted they have traveled outside of their residence to participate in tango events. A cross-tabulation analysis combining dancers' experience and history of travel for tango purposes, showed that as the level of experience increases, dancers are more likely to have engaged in tango-tourism, with 100% of professional and advanced dancers having participated in tango tourism. The percentage drops to 94.92% for intermediate dancers and 42.86% for beginners. A Chi-square test indicates a statistically significant association between dancers' experience level and their participation in tango tourism, $X^2 = (44.64, p < .001, df = 3)$. This implies that dancers are far more likely to have engaged in tango tourist activities as their level expertise increases.

Table 1. Tango Tourism Engagement and Level of Experience

Have you engaged in any tango-related tourism before?	Count of: Level of Experience Advance	Beginner	Intermediate	Professional Dancer	Grand Total
No	0.00%	57.14%	5.08%	0.00%	16.52%
Yes	100.00%	42.86%	94.92%	100.00%	83.48%
Grand Total	100.00%	100.00%	100.00%	100.00%	100.00%

When asked for the specific motivators behind tango tourism, a big portion (80% of dancers) reported engagement in tango tourism because of their passion for tango, followed by 59.1% of them mingling their dancing time with cultural exploration of destinations. 64.3% of dancers are fueled by the socialization that tango events offer, and 19.1% are motivated by specific characteristics of the event itself. Motivators such as competitions (17.4%) and the feeling of escape (13.9%) seem to be less important (Figure 1).

Figure 1. Motivators for Tango-Tourism



Using bivariate analysis, the study examines the relationship of motivators across age group. The results indicate that the priorities between younger and older dancers differ (Table 2).

Table 2. Motivators Across Age Groups

Age Groups	Escape.	Improve Skills	Socialization.	Event Specific	Competitions.	Passion.	Cultural exploration.
18 - 25	37.50%	18.42%	**50.00%**	31.82%	15.00%	18.48%	14.71%
26 - 44	**43.75%**	**63.16%**	20.59%	**40.91%**	35.00%	**50.00%**	**63.24%**
45 - 59	18.75%	18.42%	23.53%	27.27%	**45.00%**	30.43%	20.59%
60+	0.00%	0.00%	2.94%	0.00%	5.00%	0.00%	0.00%
Below 18	0.00%	0.00%	2.94%	0.00%	0.00%	1.09%	1.47%
Grand Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

From the analysis conducted, it can be observed that the first age group (18-25), is more inclined to be motivated from socialization, with 50% of respondents within that age group selecting this motivator, and only 15% of them being motivated by competitions. Conversely, dancers belonging to the 45-59 age group, are motivated by competitions more than any other group (45%). Interestingly, the age group that is more prone to get motivated from cultural exploration, passion for tango and improvement of dance skills is the 26-44 age group, with 63.24%, 50%, and 63.16% of respondents selecting the above-mentioned motivators respectively. To determine whether there were any significant differences in the motivators for tango tourism across age groups, chi-square tests were performed. The results were statistically significant for "Improvement of Skills" ($X^2 = 23.54$, $p < .001$, $df = 4$) and "Cultural Exploration" ($X^2 = 25.58$, $p < .001$, $df = 4$), indicating that age plays a role in how these motivators are prioritized. However, no statistically significant relationships were found for "Socialization" ($X^2 = 7.67$, $p > .05$, $df = 4$), "Escape" ($X^2 = 6.41$, $p > .05$, $df = 4$), "Competitions" ($X^2 = 6.43$, $p > .05$, $df = 4$), "Passion" ($X^2 = 8.75$, $p > .05$, $df = 4$), or "Event Specific Factors" ($X^2 = 3.03$, $p > .05$, $df = 4$).

Furthermore, this study aims to explore if there are external drivers (beside internal motivators) that would push tango dancers to consider Greece as a tango destination. It was shown that 93.9% of respondents admitted they would extend their visit to other touristic activities if they visited Greece for tango events. Only 3.5% were not sure whether this would motivate them, whereas 2.6% would not undertake these actions (Table 3).

Table 3. Extended Tourism Frequency Table

Category	Count	Frequency
Yes	108	93.9%
No	3	2.6%
Not sure	4	3.5%
	115	100.0%

In a similar vein, 81.7% of surveyed dancers are willing to purchase tango-tourism packages that encompass Greek holiday experiences covering a wider range of touristic activities, as opposed to 11.3% of them, whereas 7% of the respondents were not sure if they would undertake this step.

Additionally, respondents were asked what they would gain if they participated in tango-tourism. 73% of the respondents value the networking opportunities that these events give, followed by 54.8% that prioritize improvement of skills. 52.2% would benefit from simply enjoying the event and a smaller amount (31.3%) are focused on achieving a sense of belonging to a like-minded group. In order to test

whether the preferences of Greek and foreign tango dancers vary, a chi-square test was conducted (Table 4).

Table 4. Benefits of Tango-Tourism

Motivator	Foreigners (n=135)	Foreigners (%)	Greeks (n=108)	Greeks (%)
Sense of belonging to a team	27	20	9	8.3
Improving skills	20	14.8	43	39.8
Enjoyment of the event	47	34.8	13	12
Networking Opportunities	41	30.4	43	39.8

The results were statistically significant X^2= (34.13, p. <.05, df=3) indicating that there is a relationship between motivation and nationality for tango-tourism. In particular, Table 4 shows that networking opportunities were identified as the main motivator overall (39.8% of Greek respondents and 30.4% of foreign respondents) amongst both groups. The next popular category, skill improvement, differed quite dramatically between the two groups with 39.8% of Greeks selecting this motivator in contrast with only 14.8% of foreign respondents. Foreigners also believed they valued more enjoyment of the event as it motivated them (34.8%), compared to the Greeks (12%). Lastly, the motivator of belonging to a community of like-minded individuals was very low for both groups, particularly the Greeks (8.3%).

4.2.RQ2: Factors Influencing Tango Dancers' Decision-Making

In order to explore the second research question, respondents have given their opinion on the importance of certain factors on their decision-making when choosing Greece as a tango destination. Accessibility is not a pain point with 90.4% of respondents' answers ranging in the somewhat accessible and very accessible categories. The remaining 9.6% of dancers consider Greece as "Neither Accessible or Inaccessible", or, "somewhat inaccessible" (Table 5).

Table 5. Greece's Perceived Accessibility

Category	Count	Frequency
Very Accessible	33	28.7%
Somewhat Accessible	71	61.7%
Neither Accessible nor Inaccessible	8	7.0%
Somewhat Inaccessible	3	2.6%
Very Inaccessible	0	0.0%
Total	115	100.0%

4.3.RQ3: Opportunities and Challenges of Greece

Opportunities and challenges that tango dancers associate with Greece aim to explore a part of their perception on what is incentivizing them (or not) to visit Greece for such events. A significant number of respondents (65.2%), think that fostering networking and cross-cultural exchange among tango dancers is an opportunity for Greece, aligning with the globalization of tango. Not far behind, integrating tango tourism with gastronomy and leisure activities is viewed as another top selected opportunity (63.5%). This indicates an appetite for a complete experience that enhances the allure of tango tourist packages by combining Greece's rich gastronomic traditions and leisure activities with tango. Selected by 60.9% of dancers, drawing off-season visitors and attracting a global audience, present opportunities for tourism diversification and touristic period extension, for a country heavily focused on the tourism industry. Interestingly, although 59.1% of respondents are motivated from cultural exploration to engage in tango-tourism, only 25.2% of them see taking advantage of Greece's enriched cultural heritage as an opportunity (Table 6).

Table 6. Opportunities of Greece

Category	Count	Frequency
Taking advantage of Greece's enriched cultural heritage	29	25.2%
Leveraging unique/scenic locations for tango events	33	28.7%
Attraction of global audience	70	60.9%
Fostering networking among tango enthusiasts worldwide	75	65.2%
Integrating tango tourism with gastronomy and leisure activities	73	63.5%
Establishing tango events all year round to draw visitors during off-season	70	60.9%
Positioning Greece as a leading dance tourist destination	23	20.0%
None of the above	2	1.7%
	115	100.0%

Regarding the challenges highlighting key areas for improvement for Greece from the perspective of tango dancers, the difficulty in attracting international tango instructors seems to be the most prevalent one, with 71.3% of respondents selecting this option. This indicates that Greece may not have easy access to top-tier tango specialists, which would make it difficult for Greece to become a global center for tango. Followed by other perceptions by the mass, 67.8% of dancers believe that tango events are not effectively

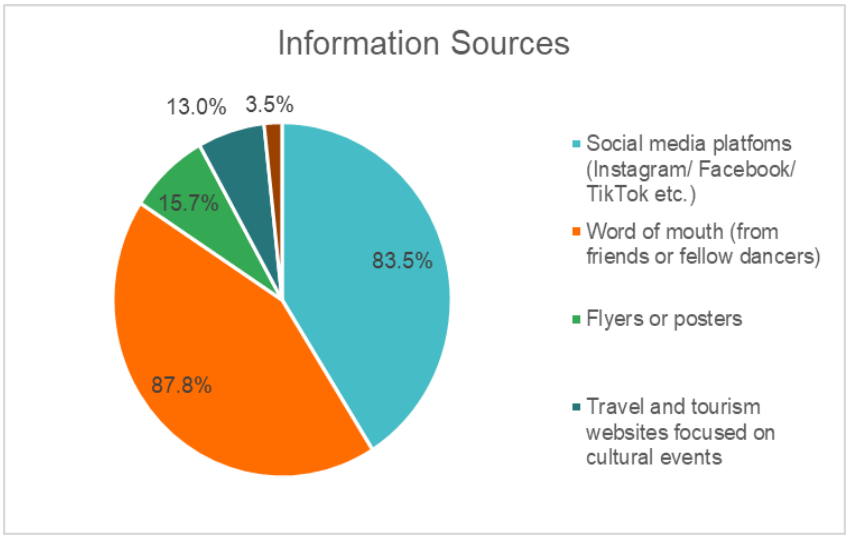
promoted in Greece. Surprisingly, although the majority of respondents (90.4%) classify Greece as either "Somewhat Accessible" or "Very Accessible" as a destination as showcased in table 5, 63.5% of them think that logistics and navigation present challenges. Less cited, 20% of respondents are concerned that the local community has little knowledge of tango, whereas only 16.5% of dancers are concerned about the possible lack of suitable venues to host tango events. This supports the finding related to RQ2, where with an average of 1.8260, venue was not the most important factor among dancers. Lastly, fewer respondents (2.6%) believe none of the challenges stand for Greece, whereas 1 respondent of Greek nationality mentions there is bad behavior from Greek dancers and organizers in these events (Table 7).

Table 7. Challenges of Greece

Category	Count	Frequency
The local community has little knowledge of tango culture	23	20.0%
Tango events are not sufficiently marketed and promoted	78	67.8%
Challenges related to tourist navigation and logistics	73	63.5%
Difficulty in attracting international tango instructors and perfo	82	71.3%
Lack of suitable venues	19	16.5%
None of the above	3	2.6%
Bad behaviour from Greek dancers and organizers	1	0.9%
	115	100.0%

In addition to the above insights, when asked about the source of tango events-related information, it is apparent that dancers are majorly informed through word of mouth (87.8%). To add to that, organizers of these events heavily utilize social media platforms for promoting tango events, with 83.5% of dancers claiming it as the source of their information. Flyers and travel websites constitute less utilized sources of information with 15.7% and 13% of dancers going with these options respectively, and less than 4% hear about such events in mass media. As word of mouth is considered a more traditional communication tool, this may present an opportunity for organizers to leverage more modern means of promotion that can yield greater reach and help develop the international base of tango in Greece.

Figure 2. Information Sources



The survey also presented respondents with the open-ended question: *"Please feel free to share any additional comments or suggestions regarding the potential of tango-tourism in Greece from your perspective as a dancer"*. To get meaningful insights for this question, qualitative content analysis was applied, by identifying three key themes among responses. The first pattern illustrated within the answer was the challenge of marketing and promotion of tango events. Characteristically, an Argentinian respondent points out the lack of widespread information:

"I have grown up with tango in Argentina and Greece seems nice for tango tourism but many in our community aren't aware of what Greece offers. It would be good to see more ads on Facebook or Instagram and maybe some traveling discounts. It's hard when you are this far to trust organizers just for one event."

Additionally, a Greek advanced dancer highlights the risk of over-commercialization, and recommends that promotional initiatives should strike the right balance between preserving the originality of tango and commercial attractiveness:

"When tango gets too commercial it is not tango anymore!"

The second theme that emerged is that of the enhancement of tourism experiences for tango dancers. Some remarks from respondents emphasize the desirability of including tango events within the larger touristic scene of Greece:

"I have never been out of France for tango events. Interested to get to know more about Greece.", quotes a French dancer.

Similarly, an advanced Italian dancer reinforces the previous comment quoting:

"I have visited Athens before, I think it will be beautiful to mix tango events with other cultural activities as you said. Greece has a lot to offer in cultural tourism. dancing by the beach would be beautiful too!"

Comments of the same nature come from international dancers who have visited Greece before for tango events, signaling successful past models. These observations are consistent with the quantitative results, which illustrated that encouraging intercultural dialogue and incorporating tango into other leisure activities were desirable possibilities for dancers.

"I have been to Athens for tango events. Very well organized and insightful teachers."

The exploration of these insights points out opportunities for Greek organizers to develop and design a unique tango-tourism strategy captivating dancers globally.

The third emerging theme is related to the economic impact that Greece can have from introducing tango as part of its tourism experience. According to an Italian dancer, tango tourism has the potential to boost local economies in Greece, if there is excellence in service:

"Tango-tourism could be a goldmine for Greece, especially in smaller towns if they take it seriously. I would pay a premium if I receive excellent service."

Another comment, also by a foreign dancer, enriches this discussion as they claim that Greece can actually capitalize on this niche, although upfront investment is required:

"... by hosting international tango festivals local businesses can profit a lot. But there is some investment needed in the beginning for sure."

Although the economic effect of tango tourism on the Greek economy was not considered to be investigated in this research, the qualitative responses have brought this variable to the surface, which can be explored in future studies.

5. DISCUSSION

The goal of this exploratory research was to discover more about the potential of tango tourism in Greece through the lens of Greek and international dancers, and their inner motivations. The findings provide new insights on a niche tourism sector that fuses the passion for tango with Greece's already established tourism industry.

The analysis' results support the body of existing research, which shows that dance tourism is greatly fueled by the dancer's passion for the dance discipline, as per Amorim et al. (2020). However, in order to fill the gap in the literature and contribute to the latter, this study further expands on existing findings, by delving deeper in exposing tango not only as a stimulus for personal growth, but also as a tool for socialization. The latter was discovered to be a more prominent motivator among younger dancers, a fact which can be explained with the need that age group has for companionship and social interactions,

as explained by Erikson's theory of the stages of psychosocial development (Gross, 2020). The cross examination of age and motivators further contributes to the literature by creating an understanding of the demographics of tango tourism. For instance, this study discovered that the 45-59 age group is more motivated by competitions, indicating a change of goals towards achievements as dancers age, which can guide practitioners into tailoring their services for different age groups. Furthermore, this study discovered cultural exploration as a new motivator for dancers, a variable which is not explored in existing literature (as per the analysis section RQ.1). This might be because of the specific focus the study has on Greece, considering the destination's association with a rich cultural environment. While Zouni et al. (2019) rates the feeling of escape as a top motivator among dancers, this research surprisingly has yielded opposite results, by ranking escape as the last motivator on the list. This might be attributed to differences in respondents' demographics, since the external research focuses solely on Greek and Russian dancers, whereas the present research has a wider range of nationalities and age groups. Drawing upon the theory of embodiment by Tornqvist (2013), although a highly selected motivator, improvement of skills was not the main motive of tango dancers. The study also unveiled a difference in the motivating influence of skill improvement between Greek and international dancers. This implies subtle distinctions in tango-tourism incentives among different geographies. Lastly, this research extends the work of Georgoula and Terkenli (2017), by supplying factual evidence of the motivational factors of local and foreign tango participants. In Georgoula and Terkenli's work, the authors were able to provide a broader description of the benefits of international dance festivals in Greece; however, did not touch upon the differences in motives between locals and foreigners. The current study indicates that Greeks are more inclined to participate only to develop their skill or network, while foreigners are more concerned with having a fun event experience. In such cases, it may be useful to develop event-specific strategies for each group depending on their motivation.

Exploring tango dancers' perceptions on different factors and the importance they put on them is crucial for yielding lucrative insights on the selection of Greece as a tango destination. There was consensus among participants when it comes to the accessibility of Greece's geographical position, aligning with several studies in the tourism industry which argue that accessibility is the primary criterion for choosing destinations, especially in the niche tourism realm where travelers are more particular (Eichhorn, 2011). The study discovers that the quality of the event and recommendations have a high importance among dancers. The importance of peers' recommendations can be connected with the fact that the majority of respondents said they get informed about tango events through word of mouth.

Opportunities and challenges tango dancers associate with Greece as a tango destination, deemed to be helpful in the exploration of dancer's perceptions. Discovering that networking and cross-cultural exchange among dancers is seen as the biggest opportunity, showcases the globalization of tango (Tornqvist, 2013). Furthermore, it was discovered that modern tourism activities are more prevalent among dancers in accordance with O'Connor and Cronin, (2003), as integrating tango with other leisure

and gastronomic activities in Greece was highly selected among participants. On the other hand, the most noted challenge was the difficulty in attracting international tango instructors, which could signify an area for further development. Should this finding display a tourism infrastructure issue, the relevant organizations ought to take precautions, as it directly affects Greece's global profile as a tango hub, altogether with logistical obstacles which remain a concern for dancers. Additionally, there is a perceived lack of tango culture among the local community. Interestingly, it is the local community itself who votes most in favor of this challenge, as foreigners are more supportive. Whether this comes from Greeks having more information on their culture, or foreigners romanticizing Greece, can be further investigated in future research.

6. MANAGERIAL IMPLICATIONS AND RECOMMENDATIONS

This study enhances the existing literature by exploring tango dancers' perceptions of Greece as a tango destination, as there is no existing literature on the potential Greece has to capitalize on this niche. Providing valuable insights on dancers' motivations, factors that influence their decisions, and opportunities and challenges that dancers associate with Greece, this study can assist practitioners of the field to introduce and then capitalize on this niche.

Specifically, this study discovered that younger tango dancers focus more on socialization; hence, they would be more inclined towards tango events that give them the opportunity to connect with peers. On the contrary, more mature age groups have other goals related to their tango dancing, focusing more on competitions. Hence, Destination Management Organizations (DMOs), event organizers and traveling agencies can take advantage of these discoveries and focus on organizing tango flash mobs or public performances to attract younger dancers, or emphasize master classes with maestros and competitions to attract mature age groups. Additionally, marketing agencies which collaborate with travel agencies and cultural event organizers can focus on these demographic's specific preferences, to target the right consumer/dancer with the right experience/event. Moreover, since this study discovered cultural exploration as a new motivator among dancers, and that the majority of dancers are willing to purchase touristic packages that further encompass Greek holidays besides tango events, travel agencies can use this as a unique selling proposition. Creating dynamic packages with tango events and cultural tours can help shape the image of Greece as a tango destination. Greater focus can be put on tango weekends or tango festivals, as these are the most preferred types of events among dancers. Furthermore, given that dancers consider the recommendations of other peers very important, event businesses can consider to include testimonials from past events, especially targeting dancers who are less experienced. These testimonials can be shared in social media platforms, as that was the most used tool for gathering information for tango dancers, after word of mouth. Lastly, the fact that dancers see attracting international tango instructors in Greece as an obstacle for the country, can signal tango schools that collaboration between them could be effective in tackling these challenges. Tango schools can start

exchange programs between instructors going to each other's countries for workshops, making them more familiar with different cultures and tango worldwide.

7. LIMITATIONS AND FUTURE RESEARCH

Although this research provides insightful discoveries on the motivators, perceptions and preferences of tango dancers about tango tourism in Greece, it has several limitations that need to be recognized, and perhaps improved by future research. While gathering responses from different nations in the world constitutes a strength of this research, the small sample of 115 responses might not represent the entire global tango community. The convenience sampling constitutes another limitation, refraining the study to generalize the findings. Since this study is focused on exploring attitudes and perceptions, self-report bias can be present as dancers might have subjectively interpreted survey questions and may have altered answers to fit in. Lastly, being exploratory research, the study has identified discoveries and valuable insights in the form of trends, but has not expressed causality on the findings, which might affect the implications for practitioners. All these limitations can be covered by future research that can build upon this study's exploration, starting by using a greater sample size. As the tango community continues to increase and spread globally (Tornqvist, 2013), stretching the longevity of the study could account for long-term behavioral shifts in dancers. Additionally, this study discovered valuable insights through the qualitative question posed at the end of the survey, especially regarding the economic impact that tango tourism can have for Greece, which was not the aim of this research. However, future studies can take this exploratory research as the setting stone to further focus more on the financial value this niche can generate. Finally, it is also suggested for future research to include qualitative approaches for richer insights.

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INTERNATIONAL CONFERENCE ON APPLIED ECONOMICS AND FINANCE

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HYSTERESIS EFFECT IN TURKISH LABOR MARKET: EVIDENCE FROM TRADITIONAL AND FOURIER UNIT ROOT TESTS

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ABSTRACT

Unemployment hysteresis is defined as a situation where the movement of unemployment rates is not stationary over time. In other words, it is a situation where shocks occurring in the economy cause permanent effects on the unemployment rate. In addition, the unemployment rate continues to increase due to the hysteresis effect after the shock. This study empirically tested the hysteresis effect in the Turkish labor market. The literature uses traditional unit root tests and Fourier function unit root tests to investigate unemployment hysteresis. For this purpose, ADF, KPSS, FADF, and FKPSS tests were used in the study. The findings obtained from the study confirm the validity of the hysteresis hypothesis in Türkiye. The findings provide recommendations for policymakers.

***Keywords**: Hysteresis, Unit Root Tests, Türkiye.*

***Jel Codes:** E24, J01.*

1. INTRODUCTION

Hysteresis theory was first used in economic literature to explain Western Europe's high and persistent unemployment rates. The hysteresis theory introduced by Blanchard and Summers (1986) is an essential approach to explaining the dynamic properties of unemployment rates. This approach proves that a negative shock to the economy has lasting effects on unemployment rates. A negative shock to the economy increases unemployment rates, and this process occurs even after the impact of the shock is over, with unemployment rates continuing to rise. Therefore, this approach provides evidence that a negative shock to the economy has lasting effects on unemployment rates.

The economic literature is based on three different approaches to explain the causes of the hysteresis in unemployment rates. The economic literature is based on three different approaches to explain the causes of the hysteresis in unemployment rates. Insiders are protected from competition from market-representative outsiders by labor turnover costs. This process, which significantly isolates the wage level

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of insiders from market conditions, leads to wage rigidity and prolongs the duration of unemployment. According to the physical capital view, a negative economic shock leads to a decline in capital stocks and a corresponding fall in labor demand. This reduction in labor demand leads to higher unemployment rates and longer unemployment durations. Another approach used to explain the hysteresis effect in unemployment is built on the human capital factor. Long-term unemployment leads to a decrease in labor qualifications, causing the unemployed to lose hope of finding a job and prolonging the duration of unemployment (Şak, 2021; Şahin Kutlu, 2023; Torun et al., 2023).

In the empirical literature, the hysteresis hypothesis, which theoretically states that unemployment rates do not tend to revert to the average, is tested through the following hypotheses.

$$H_0: natural\ rate\ hypothesis - I(0)$$

$$H_1: hysteresis\ hypothesis - I(1)$$

These hypotheses prove that the hysteresis hypothesis is valid if the unemployment series is non-stationary, i.e., if the series contains a unit root. The natural rate hypothesis is valid if the unemployment series is stationary (Güloğlu and İspir, 2011: 205). If the unemployment series follows a non-stationary process, it can be concluded that the shocks occurring in the economy have permanent effects on the unemployment rate. However, if the unemployment series follows a stationary process, the unemployment rate returns to its natural rate after a shock to the economy.

This study investigates whether the hysteresis hypothesis is valid in the Turkish labor market. For this purpose, the unemployment rates in Türkiye covering January 2005-March 2025 are used. Data were obtained from the CBRT (Central Bank of the Republic of Türkiye). ADF (Augmented Dickey–Fuller test), KPSS (Kwiatkowski-Phillips-Schmidt-Shin test), Fourier ADF (FADF), and Fourier KPSS (FKPSS) unit root tests are used as empirical analysis methods. Accordingly, the second section of the study presents the related literature, the third section presents the empirical findings, and the last section presents the study's conclusion.

2. LITERATURE REVIEW

The hysteresis hypothesis in unemployment has been the subject of numerous studies. Table 1 shows the literature review. As seen in Table 1, the empirical literature is based on unit root tests as an analysis method. Recent unit root tests have made the issue topical in the economic literature. At the same time, Table 1 reveals that the findings of the studies testing the unemployment hysteresis are varied. This diversity can be differentiated according to the methodology used. Indeed, analyses using standard unit root tests strongly support the hypothesis of hysteria in unemployment. On the contrary, analyses using unit root tests considering structural breaks and unit root tests with Fourier functions provide weaker evidence for the hypothesis of unemployment hysteresis. In addition to the method of empirical analysis, the country, the period, and the variable used are essential reasons why empirical findings differ.

Table 1. Literature Review Summary

Name (year)	Country/Data	Methods	Findings
Mitchell (1993)	15 OECD countries 1969-1991	PP unit root test	Unemployment has a hysteresis effect.
Arestis and Mariscal (2000)	22 OECD countries 1960-1997	PP unit root test	For 10 countries, they concluded that the hysteresis hypothesis is valid.
Camarero and Tamarit (2004)	19 OECD countries 1956-2001	Panel SURADF and MADF	The hysteresis effect does not apply to unemployment.
Chang et al (2005)	10 EU countries 1961-1999	Panel SURADF	The hysteresis hypothesis is confirmed for all European countries except Belgium and the Netherlands.
Gustavsson and Österholm (2006)	Australia, Canada, Finland, Sweden and the USA	KSS unit root test	There is no hysteresis effect on unemployment.
Romero-Avila and Usabiaga (2007)	USA and Spain 1976-2004	LS unit root test	They reported a hysteresis effect on unemployment in the Spanish economy.
Yılancı (2008)	19 OECD countries 1970-2008	KSS unit root test	The natural rate hypothesis holds in Belgium, Korea, Switzerland, the USA, the Netherlands, and Poland. In contrast, the hysteresis effect is present in Australia, Austria, Canada, Finland, Germany, Japan, Luxembourg, Norway, and Türkiye.
Yılancı (2009)	Türkiye 1923-2007	Perron, ZA, LP, LM unit root tests	The existence of a hysteresis effect in unemployment is accepted.
Güloğlu ve İspir (2011)	Türkiye 1988-2008	ADF, Levin-Lin-Chu (2002), Im-Pesaran-Shin (2003), Maddala-Wu (1999), Choi (2001) and Hadri (1999) unit root tests and Carrion-i Silvestre unit root test	The results of the unit root test without considering the structural break reveal a hysteresis effect in nine sectors in Turkey, while the results of the unit root test taking into account the structural break support the natural rate hypothesis.
Furuoka (2012)	12 Asia Pacific Countries 1980-2009	SURADF and MADF	The hysteresis hypothesis is valid for countries other than South Korea and New Zealand.
Saraç (2014)	Türkiye 2005-2013	ADF, PP, KPSS and LS unit root tests	The hysteresis hypothesis is valid in Türkiye.
Güriş et al (2015)	Türkiye 1970-2014	KSS and Kruse (2011) unit root tests	The hysteresis hypothesis is not valid for Turkey.
Özkan and Altınsoy (2015)	Türkiye 1988-2014	ADF, KSS, Fourier ADF, Fourier KSS unit root tests	The hysteresis hypothesis is valid in all age groups of female unemployment. In male unemployment, hysteresis is present in groups aged 45 and above.
Furuoka (2016)	Norway, Denmark, Finland and Sweden 2000-2014	ADF, FADF, ADF-SB, FADF-SB tests	The hysteresis hypothesis is not valid.
Taş and Uğur (2017)	Türkiye 1980-2013	ADF, PP and LS unit root tests	The hysteresis hypothesis is valid in Türkiye.

Marques et al (2017)	29 OECD countries 2000-2015	ADF-GLS unit root test	They concluded that there is a hysteresis effect on unemployment in all of the countries analyzed.
Tekin (2018)	Türkiye 2005-2017	FKPSS, KPSS and ADF unit root tests	There is a hysteresis effect on unemployment in Türkiye.
Güriş and Sedefoğlu (2019)	Türkiye 1988-2013	KSS, Sollis, Kruse, Christopoulos and Leon-Ledesma and Güriş (2018) unit root tests	The unemployment hysteresis hypothesis does not hold for male and female graduates.
Belke (2020)	28 EU countries 2003-2019	Fourier KSS unit root test	There is a hysteresis effect in total unemployment in Hungary and Portugal.
Çiçen (2020)	Türkiye 2005-2014	Fourier KSS unit root test	There is a hysteresis effect on unemployment rates for single men and married women.
Pata (2020)	15 OECD countries 1991-2019	Fourier-CBL panel stationarity test	While the hysteresis hypothesis is not valid for the whole panel, country-specific evaluations support the hypothesis in Germany, Türkiye, and Spain.
Khraief et al (2020)	29 OECD countries 1980-2013	ESTAR unit root test	The unemployment hysteresis hypothesis is firmly rejected.
Dedeoğlu (2021)	30 OECD countries 2001-2020	Pesaran, Smith, Hadri and Kurozumi, and Nazlıoglu-Karul (2017) Fourier panel unit root tests	The whole panel confirms unemployment hysteresis.
Samırkaş-Komşu and Komşu (2021)	BRICS-T countries 1991-2020	ADF, PP and ZA unit root tests	The results show that unemployment hysteresis exists in all countries except China.
Şak (2021)	Türkiye 1988-2018	Fourier Kruse unit root test	While there is a hysteresis effect in female unemployment, there is no hysteresis effect in male unemployment and total unemployment.
Azazi and Ateş (2022)	Türkiye 2014-2022	PP unit root test	The findings show that there is no hysteresis effect on unemployment.
Belliler and Demiralp (2022)	Türkiye 1923-2021	Hepsağ (2021) unit root test	It is concluded that the unemployment hysteresis hypothesis is not valid.
Kutlu (2023)	Türkiye 2005-2020	Fourier ADF	There is a hysteresis effect on the unemployment of young women.
Daştan (2024)	Türkiye 2005-2023	ADF, PP, ZA, LS, Narayan Popp, AARN-ADF unit root tests	There is a hysteresis effect on unemployment in Turkey.
Özen Atabey (2024)	Türkiye 1988-2021	Carrion-i-Silvestre, FADF and FKPSS unit root tests	The test results differ in terms of gender and age, and there is a hysteresis effect on the overall unemployment rates.
Karakuş (2025)	Türkiye 2006-2023	Panel CADF, Fourier Panel KPSS and Fourier KPSS	The hysteresis hypothesis is valid in the Turkish labor market. On the other hand, it is concluded that the youth unemployment rate series is stationary. The results differ in the regional-level analyses.

Note: PP: Phillips-Perron, SUR: Seemingly Unrelated Regression, ADF: Augmented Dickey-Fuller, PP: Phillips-Perron, LS: Lee-Strazicich, LP: Lumsdaine-Papell,.ZA: Zivot-Andrews, KPSS: Kwiatkowski-Phillips-Schmidt-Shin.

3. EMPIRICAL RESULTS

In the first stage of the empirical analysis, ADF and KPSS tests examine whether the hysteresis hypothesis is valid in the Turkish labor market. As seen in Panel A of Table 2, the ADF test cannot reject the null hypothesis of a unit root in the unemployment series. Thus, it is concluded that the series contains a unit root, i.e., it is non-stationary at level values in both intercept and intercept-trend models. These findings are confirmed by the KPSS test results presented in Panel B. The null hypothesis of stationarity for the unemployment series is rejected at level values in both intercept and intercept-trend models.

Table 2. ADF and KPSS Test Results

	ADF							
		level			first difference			remark
		test statistics	critical values		test statistics	critical values		
Panel A	intercept	-2.636	0.01	-3.435	-7.173	0.01	-3.442	I(1)
			0.05	-2.853		0.05	-2.859	
			0.10	-2.558		0.10	-2.564	
	intercept & trend	-2.562	0.01	-3.965	-7.227	0.01	-3.975	I(1)
			0.05	-3.403		0.05	-3.411	
			0.10	-3.116		0.10	-3.123	
	KPSS							
		level			first difference			remark
		test statistics	critical values		test statistics	critical values		
Panel B	intercept	3.563	0.01	0.740	0.223	0.01	0.740	I(1)
			0.05	0.463		0.05	0.463	
			0.10	0.348		0.10	0.348	
	intercept & trend	1.334	0.01	0.217	0.107	0.01	0.217	I(1)
			0.05	0.148		0.05	0.148	
			0.10	0.120		0.10	0.120	

In the second stage of the empirical analysis, two tests with Fourier functions, namely the FADF and FKPSS tests, are used to analyze the hypothesis of hysteresis in the unemployment series. The results are shown in Figure 3, and the first difference shows that the series is stationary. The findings from the FADF test confirm the findings from the ADF test. The null hypothesis of unit root cannot be rejected at level values. As shown in Panel B of Table 3, the FKPSS test rejects the null hypothesis of stationarity at level values. This reported finding confirms the findings obtained from the KPSS test. In conclusion, the findings from both standard unit root tests and Fourier function unit root tests suggest that the hysteresis hypothesis holds for the unemployment rate series in Türkiye.

Table 3. FADF and FKPSS Test Results

Panel A	**FADF**							
		level			first difference			remark
		test statistics	critical values		test statistics	critical values		
	intercept	-2.915	0.01	-3.740	-4.828	0.01	-3.930	I(1)
			0.05	-3.060		0.05	-3.260	
			0.10	-2.720		0.10	-2.920	
	intercept & trend	-2.910	0.01	-4.380	-5.142	0.01	-4.270	I(1)
			0.05	-3.770		0.05	-3.630	
			0.10	-3.430		0.10	-3.310	
Panel B	**FKPSS**							
		level			first difference			remark
		test statistics	critical values		test statistics	critical values		
	intercept	0.353	0.01	0.270	0.366	0.01	0.722	I(1)
			0.05	0.172		0.05	0.459	
			0.10	0.132		0.10	0.348	
	intercept & trend	1.658	0.01	0.210	0.112	0.01	0.217	I(1)
			0.05	0.142		0.05	0.148	
			0.10	0.114		0.10	0.119	

4. CONCLUSION

This study examines whether the hysteresis hypothesis is valid in the Turkish labor market. For this purpose, monthly data from the unemployment rate series in Turkey covering the period from January 2005 to March 2025 are used. Standard unit root tests (ADF, KPSS) and Fourier function unit root tests (FADF, FKPSS) are used as empirical analysis methods. ADF, KPSS and FADF and FKPSS test results showed that the hysteresis hypothesis is valid in unemployment in Türkiye. These results are consistent with the studies of Yılancı (2009), Saraç (2014), Taş and Uğur (2017), Tekin (2018), Pata (2020), Daştan (2024) and Karakuş (2025). On the contrary, the results differ from the findings of Güriş et al. (2015) and Azazi and Ateş (2022).

Due to the existence of the hysteresis effect in Türkiye, cyclical fluctuations increase the long-run unemployment rate and may leave lasting effects. The findings of this study have important policy implications. Since the effect of shocks on unemployment is permanent, intervention by policymakers becomes a necessity. It is essential to introduce effective regulations for the labor market and to implement structural reforms that will enable the economy to recover quickly aftershocks.

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EXAMINING THE IMPULSE CONTROL LEVELS OF EMPLOYEES ACCORDING TO THEIR PERSONALITY TRAITS WITH THE FIVE FACTOR PERSONALITY MODEL

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ABSTRACT

When persons control their behavior, they do not act on impulse. Thus, they can make a conscious effort to choose actions that lead to desired results. In the organizational field, self-control has been examined as a part of personality traits such as conscientiousness. The personality trait of conscientiousness, which is positively related to job performance, refers to being purposeful, determined, disciplined, organized, punctual, reliable and having a sense of duty. The personality trait of conscientiousness is also inversely related to inefficient work behavior. In this context, this study aims to examine the level of impulse control in employees according to their personality traits. In this way, it is aimed to show the importance of the impulse control levels of individuals with different personality traits in the work environment. A total of 868 people (working in a job that generates income), 497 males (57.3%) and 371 females (42.7%), between the ages of 18-73 (mean = 31.96, s = 11.24), participated in the study. Participants completed the 80-item lexical-based adjective checklist of the impulsivity scale and the 35-item form of the Big Five Inventory. The employees' five-factor personality scores (Extroversion, Agreeableness, Conscientiousness, Emotional Stability and Intellect) were divided into two groups as above average and below average, and the groups were compared in terms of impulse control scores using one-way analysis of variance (ANOVA). According to the results, differences in impulse control levels were determined between the five-factor groups. The impulse control levels of the groups above average in all five factors were determined to be high. The results showed that more studies are needed to reveal the differences to be observed in different occupational groups. The differences observed in the level of impulse control provide clues about determining the personality traits of the individuals to be selected for occupational groups. The current research reveals the relationships between the level of impulse control, personality traits and employee behavior.

Keywords: *Impulsivity, Personality, Five Factor Model, Employee.*

JEL Codes: *D23, D91, M51, D2.*

1. INTRODUCTION

Controlling impulses by inhibiting unwanted reactions, actions, or behaviors is important for task performance (Bari and Robbins, 2013; Edmonds, Bogg, and Roberts, 2009). In this way, inhibiting

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behaviors involves stopping the execution of purposeless or unproductive actions or eliminating the experience of inappropriate emotions (Knezevic, 2018). Thus, a conscious effort can be made to choose actions that will lead to desired results. Self-control as a personality trait in the organizational field means being responsible, purposeful, determined, disciplined, organized, punctual, reliable, and having a sense of duty. These characteristics are also inversely related to unproductive work behavior. These relationships have been previously examined in employees (Ayhan and Tatar, 2024). However, the small number of employees in this study is noteworthy. In this context, this study aims to examine the level of impulse control in employees according to their personality traits as a larger participant group.

2. LITERATURE REVIEW

Impulse control refers to the tendency to delay actions, reactions, and gratification, to be planned, to follow social norms, and to obey rules (Edmonds, Bogg, and Roberts, 2009; John and Srivastava, 1999; Roberts, Walton, and Bogg, 2005). Impulsivity refers to the absence of impulsivity, foresight, and the application of restraint as a component of Conscientiousness and a personality trait (John and Srivastava, 1999). In addition, delaying gratification, the tendency of an individual to prefer a near reward over a distant one, is conceptualized as an indicator of impulsive behavior (Edmonds, Bogg, and Roberts, 2009). In this way, the measurement of impulse control includes a broad assessment of thoughts, feelings, and behaviors, such as planning, resistance to inhibition and distraction, problem solving and strategy development, goal-oriented or deliberate action, maintenance of persistence toward goal attainment, and inhibitory control (Edmonds, Bogg, and Roberts, 2009; John and Srivastava, 1999).

3. METHODOLOGY

Participants

A total of 868 individuals, 497 male (57.3%) and 371 female (42.7%), aged 18-73 (mean = 31.96, s = 11.24) and employed in a gainful employment, participated in the study.

Tools

The Big Five Inventory-35 is a self-report measurement tool consisting of 35 items that do not contain reverse scoring and are evaluated on a dichotomous scale between 1 and 5 (a lot, a little, moderately, a little, and a lot). The inventory is assessed with five factors, each containing seven items: Extroversion, Agreeableness, Conscientiousness, Emotional Stability, Intellect (Goldberg, 1992). In the study where the inventory was translated into Turkish, the internal consistency reliability coefficients of the factors were reported between 0.66-0.83 in the first application and 0.64-0.88 in the retest application (Tatar, 2019).

The Impulse Control Scale is an 80-item form (Ayhan and Tatar, 2024) selected from the list of personality descriptive terms with a psycho-lexical approach in Turkish for the measurement of impulse

control (Tatar, 2020). 26 items of the scale are reverse scored and applied with a five-point Likert-type response option between Not Appropriate at All (1) and Very Appropriate (5) (Ayhan and Tatar, 2024).

Application

Participants filled out the form consisting of the Big Five Inventory-35 Impulse Control Scale and the socio-demographic questionnaire via web-based application and online application. Only those working in a job that generates income were included in the study, and those who did not meet this condition were not included. Participants were able to access the form items after the inclusion and exclusion criteria and voluntary consent were declared. The study was implemented in 2024.

Data Analysis

In the study, descriptive statistics of scale scores, correlation coefficient calculations between scale scores, internal consistency reliability analyses of scales, and group comparisons in terms of impulse control scale total score were made.

Results

First, the descriptive statistics and internal consistency reliability coefficients of the scales used in the study were calculated and it was seen that the Extroversion factor of the Big Five Inventory-35 showed a Cronbach alpha coefficient of .85, the Agreeableness factor .73, the Conscientiousness factor .82, the Emotional Stability factor .63, the Intellect factor .80, and the Impulse Control Scale .92 (Table 1). Then, the relationship levels of the total score of the Impulse Control Scale with the total factor scores of the Big Five Inventory-35 were calculated with Pearson correlation analysis. It was determined that the Impulse Control Scale total score had a statistically significant correlation with the Extroversion factor total score of .10 ($p < .01$), with the Agreeableness factor total score of .37 ($p < .001$), with the Conscientiousness factor total score of .58 ($p < .001$), with the Emotional Stability factor total score of .44 ($p < .001$), and with the Intellect factor total score of .38 ($p < .001$) (Table 1).

Later in the study, two groups were defined for each factor as above average and below average using the factor total scores of the Big Five Inventory-35 (Table 1). The group below the average was defined as the “Below Average Group” and the group above the average was defined as the “Above Average Group”.

Table 1. Descriptive Statistics, Internal Consistency Reliability Analysis and Correlations Between Scale Scores

Scales (n = 868)	Factors	Minimum	Maximum	M	s	Cronbach's Alfa	r
The Big Five Inventory-35	Extroversion	7	35	25.94	6.10	.85	.10**
	Agreeableness	9	35	26.80	4.98	.73	.37***
	Conscientiousness	7	35	27.32	5.53	.82	.58***
	Emotional Stability	8	35	23.10	4.79	.63	.44***
	Intellect	9	35	28.26	5.01	.80	.38***
The Impulse Control Scale		157	369	283.06	36.46	.92	-

Notes: **p < .01; ***p < .001.

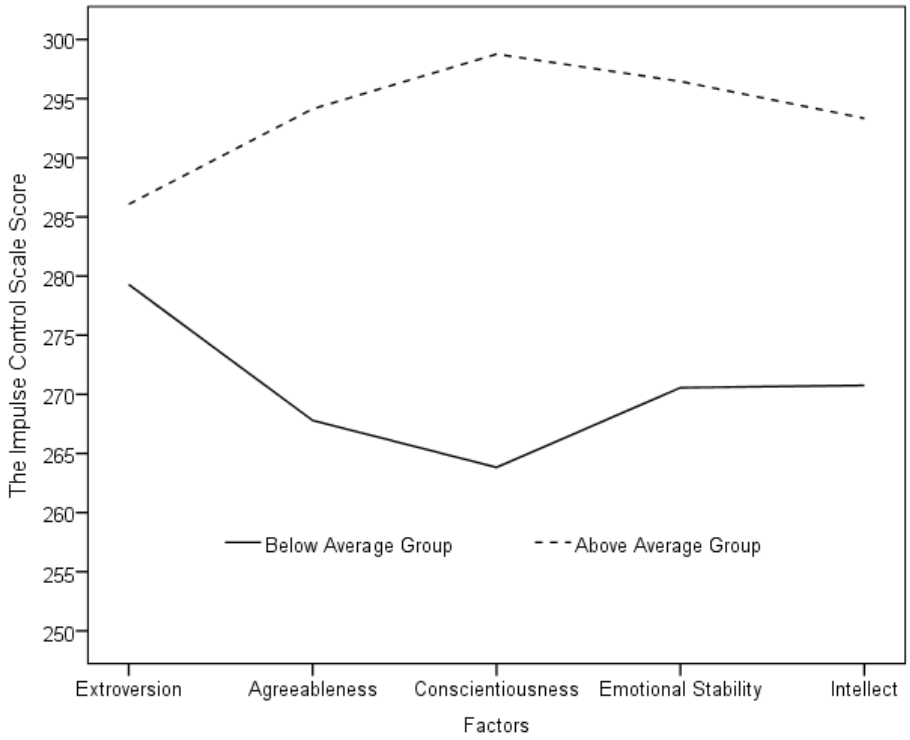
These groups were then compared in terms of impulse control scores using one-way analysis of variance (ANOVA). According to the results, there are statistically significant differences between the groups regarding the factors Extroversion ($F(1, 866) = 7.50$; $p < .01$), Agreeableness ($F(1, 866) = 126.34$; $p < .001$), Conscientiousness ($F(1, 866) = 254.96$; $p < .001$), Emotional Stability ($F(1, 866) = 124.82$; $p < .001$) and Intellect ($F(1, 866) = 91.12$; $p < .001$) (Table 2).

Table 2. Comparison of Impulse Control Scores of Groups Created According to Factor Scores

Factors	Group	n	M	s	F(1, 866)	p
Extroversion	Below Average Group	385	279.28	36.40	7.50	.006
	Above Average Group	483	286.07	36.27		
	Total	868	283.06	36.46		
Agreeableness	Below Average Group	365	267.79	37.50	126.34	.000
	Above Average Group	503	294.13	31.38		
	Total	868	283.06	36.46		
Conscientiousness	Below Average Group	390	263.82	33.92	254.96	.000
	Above Average Group	478	298.76	30.48		
	Total	868	283.06	36.46		
Emotional Stability	Below Average Group	449	270.56	34.65	124.82	.000
	Above Average Group	419	296.45	33.53		
	Total	868	283.06	36.46		
Intellect	Below Average Group	395	270.75	36.69	91.12	.000
	Above Average Group	473	293.33	32.96		
	Total	868	283.06	36.46		

In all factors, the average impulse control score of the above average group is higher than the average impulse control score of the below average group (Table 2, Graph 1).

Graph 1. Comparison of Impulse Control Scores of Groups Created According to Factor Scores



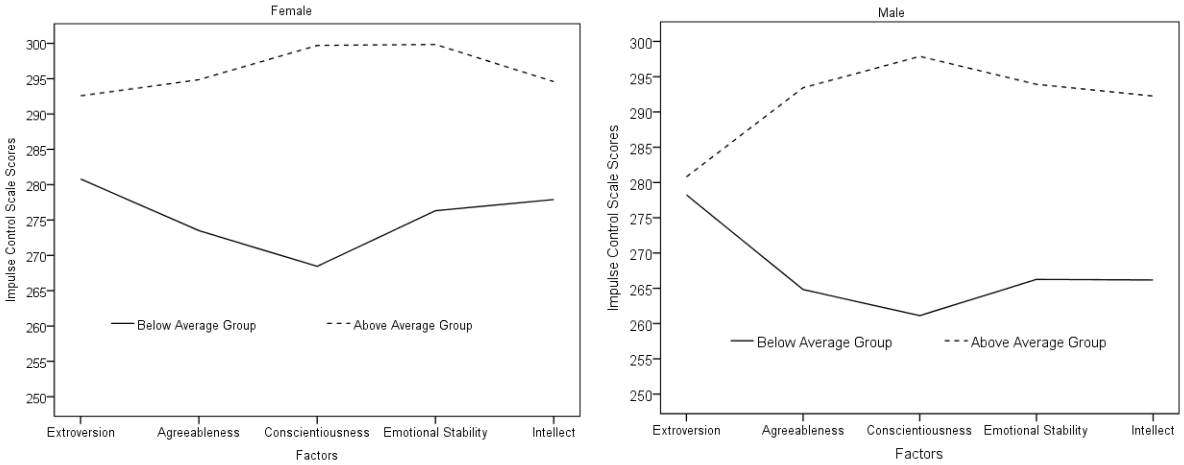
Finally, two-way ANOVA was performed by taking the groups formed according to the factor total scores and the gender groups together. In the comparison made in terms of impulse control scores, no statistically significant interaction was observed between all factor score groups and gender groups. Only between the Intellect factor groups and gender groups, a limiting p value (.050) was obtained (Table 3).

Table 3. Comparison of Impulse Control Scale Scores of Groups Created According to Factor Scores and Gender

Interaction	F(1, 864)	p	Partial Eta Squared
Extroversion Factor Groups x Gender Groups	3.39	.066	.004
Agreeableness Factor Groups x Gender Groups	2.27	.133	.003
Conscientiousness Factor Groups x Gender Groups	1.51	.219	.002
Emotional Stability Factor Groups x Gender Groups	.79	.374	.001
Intellect Factor Groups x Gender Groups	3.86	.050	.004

No statistically significant interaction was observed between factor score groups and gender groups in terms of impulse control scores. In other words, similar results were obtained for all groups separately in the female group and the male group (Graph 2).

Graph 2. Comparison of Impulse Control Scores of Groups Created According to Factor Scores and Gender



4. CONCLUSION

In this study, it was predicted that there would be a difference in terms of impulse control levels among the groups formed according to the five factor total scores. It was also aimed to examine whether the personality factor groups, and gender groups would interact in terms of impulse control levels.

The results revealed that the impulse control levels of the groups forming the five factor total scores below average and above average were different. In all factor groups, the impulse control total score of the group above average was determined to be higher than the impulse control total score of the group below average. In addition, no interaction was observed between the personality factor groups and gender groups in terms of impulse control total score. Accordingly, the results were similar in women and men, and the impulse control total score of the group above average in the factor groups was higher than the impulse control total score of the group below average.

When the study results were evaluated in general, it was understood that more studies were needed to reveal the differences to be observed in different occupational groups. This study reveals the importance of the relationships between impulse control level, personality traits and employee behaviors. Therefore, the differences observed in the impulse control level indicate that the personality traits of the individuals to be selected for some occupational groups should be taken into consideration.

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INTERNATIONAL CONFERENCE ON APPLIED ECONOMICS AND FINANCE
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THE DYNAMIC RELATIONSHIP BETWEEN TURKIYE'S ECONOMIC POLICY UNCERTAINTY AND THE BIST 100: EVIDENCE FROM THE DCC-GARCH APPROACH

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ABSTRACT

Recently, Turkey has experienced an atmosphere of economic uncertainty due to global economic fluctuations and changes in domestic politics. Economic uncertainties directly affect investors' risk perception and expectations, causing fluctuations in capital flows and the stock market. Although the interplay of economic uncertainties on financial markets has been frequently addressed in the literature for developed economies, it constitutes a critical research area especially for emerging economies with high economic vulnerability. This paper analyses the dynamic change in the impact of economic uncertainty on the stock market over time. Accordingly, the study analyzes the dynamic relationship between the Türkiye Economic Policy Uncertainty Index (Türkiye-EPU), which is based on the content analysis of local media news in Türkiye, and the BIST 100 index using the Dynamic Conditional Correlation (DCC -GARCH) method. The study utilizes monthly Türkiye-EPU and BIST 100 data covering the period 2006M1-2024M12. The empirical findings of the study show that dynamic correlation strengthens during periods of intense uncertainty such as the COVID-19 pandemic and the Russia-Ukraine conflict, as well as global uncertainties such as the Gezi Park events, referendums and elections specific to the Türkiye economy. During such periods, the BIST 100 index experienced significant declines and high volatility was observed in investor behavior.

Keywords: *BIST 100 Index, Türkiye's Economic Policy Uncertainty Index, DCC-GARCH.*

JEL Codes: *C22, D80, G11.*

1. INTRODUCTION

In recent years, global economic crises, changes in trade policies, the COVID-19 pandemic and geopolitical tensions have affected financial market dynamics, making economic policy uncertainty (EPU) one of the main indicators that attract the attention of both academia and policymakers. Many studies have analysed the effects of EPU on different economic outcomes: Unemployment (Caggiano, Castelnuovo, & Figueres, 2017), exchange rate (Beckmann & Czudaj, 2017), bank credits (Nguyen, Le, & Su, 2020), firm performance (Iqbal, Gan, & Nadeem, 2020), global trade flows (Tam, 2018), housing

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market (Antonakakis, Gupta, & Andre, 2015) and inflation (Istrefi & Piloiu, 2014). According to these studies, the EPU has a significant impact on economic activities.

Baker, Bloom and Davis (2016) constructed the first index to measure EPU based on the frequency of occurrence of certain keywords in newspaper news and presenting a multidimensional structure with uncertainties in macroeconomic forecasts. Although this index is adapted and applied to many countries, considering the unique economic dynamics and policy process of each country, the use of a local index that reflects the characteristics of the countries yields more meaningful results. For this reason, the Türkiye-EPU index developed by Kiliç and Balli (2024) is taken into account in this study. This index is based on the methodology of Baker et al. (2016). The index is constructed using 94 Turkish keywords related to economy and uncertainty. Data were taken from major national newspapers (Cumhuriyet, Dünya, Hürriyet, Milliyet, Sabah, and Zaman) and expert surveys supported the keyword selection. For the index, matching keywords from approximately one and a half million articles were counted using SQL programming and the methodology of Baker et al. (2016) was used for standardisation and normalisation of the resulting numbers. Unlike indices based on English-language sources, it better reflects Türkiye-specific economic dynamics. The peaks signalling an increase in uncertainty correspond to events in the economy as shown in Figure 1. Some of these peaks are as follows (Kiliç and Balli, 2024):

- The CBRT sold foreign exchange three times in June 2006.
- According to economic development figures, net foreign direct investment inflows fell to $15.1 billion in 2008.
- In September 2010, the average interest rates applied by banks to vehicle and housing loans and commercial loans decreased.
- COVID-19, which started in China in December 2019, has rapidly spread across China and the world, with the first case recorded in Turkey on 11 March 2020.

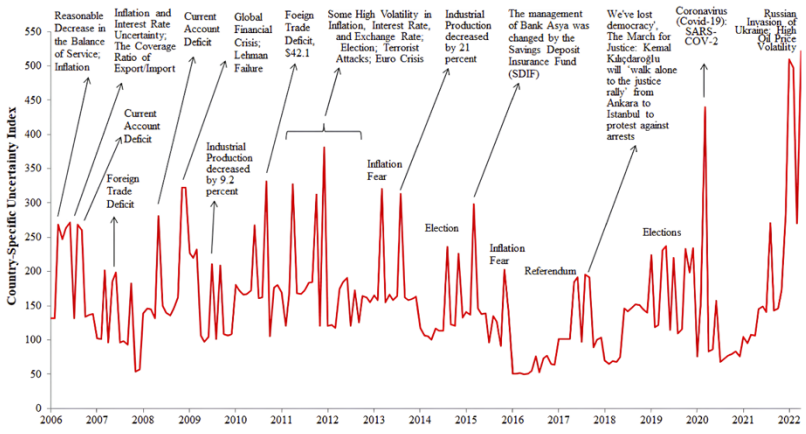

Figure 1. Country-specific Economic Uncertainty in Türkiye (2006-2022)

Source: Kiliç and Balli (2024).

EPU adversely affects decision-making mechanisms through its effects on investors' attitudes and behaviours. In periods of increased uncertainty, volatility in financial markets increases and price stability weakens. In the literature, there are various studies investigating the impact of EPU on stock markets: Chen, Jiang and Tong, 2017; Balcilar, Gupta, Kima and Kyei, 2019; Istiak and Alam, 2020. Volatility is more pronounced in the developing countries' stock markets such as Türkiye, which is particularly vulnerable to uncertainty (Korkmaz and Güngör, 2018; Sadeghzadeh Emsen and Aksu, 2020; Gürsoy, 2021).

The purpose of this paper is to investigate the impact of Turkey's EPU index on the BIST100 index. The study is analysed using the DCC-GARCH framework. This method is very effective in observing changes in the volatility and correlation structure of financial time series (Engle, 2002). In this respect, the impact of uncertainty shocks on BIST 100 is analysed not only in a static framework but also with the dynamics of change over time. The use of the EPU index developed for Türkiye in this study is expected to provide a unique perspective to the literature in the analysis of local investor behaviour during political and economic fluctuations. The remainder of this paper is organized as follows five main chapters. The second section discusses a comprehensive review of the existing literature on the subject. The third section contains the data set and methodology used in the study. The fourth section presents the empirical findings in detail. Finally, an overview of the study and conclusions are presented.

2. LITERATURE REVIEW

In related literature, the theoretical work of P´astor and Veronesi (2012, 2013) has driven many studies analysing the relationship between EPU and the stock market. Based on a structural VAR model, Kang and Ratti (2013) show that an unexpected increase in uncertainty in policy has a significantly negative effect on real stock returns for the US. Ko and Lee (2015) analysed the relationship between EPU and stock market prices in 11 countries using wavelet analysis. As a result of the study, they find that EPU and stock market show a negative relationship only in some sub-sample periods and do not always behave together. Analysing the 1900-2014 period, Arouri, Estay, Rault and Roubaud (2016) argue that US stock market returns decreased significantly in the long-term due to the increase in EPU and that the negative relationship obtained is permanent. Chen, Jiang and Tong (2017) predicted future stock market returns in China negatively in their analysis with the EPU measure they developed. Hoque and Zaidi (2019), based on the Markov-Switching model, show that global economic policy uncertainty (GEPU) on stock returns in the Malaysian stock market varies across regime states, sectors and natural effects. Karim and Ahmed (2019) investigated the effect of EPU in different countries on the long-term volatility of the Moroccan stock market with the GARCH-MIDAS model. As a result of the research, they have found that only after the 2008 crisis, the EPU of selected countries can significantly explain the long-term volatility of the Moroccan market, but it has no significant effect before the crisis. Luo and Zhang (2020), based on the traditional capital asset pricing model, concluded in their cross-sectional test that

EPU increases the risk of a decrease in stock price of Chinese. Kundu and Paul (2022)'s study for G7 countries is based on the Markow Switch VAR model. As a result of the study, it is found that the effects of EPU on stocks are not heterogeneous and are significant in the bear markets and insignificant in the bull markets. Mamman, Wang and Iliyasu (2023) used the panel GARCH model in research. The findings of the study showed that the GEPU significantly increased the volatility of BRICS stock markets.

Studies examining the relationship between EPU and the stock market in Türkiye have focused on the GEPU index, and the main studies conducted in this context are summarised below: Korkmaz and Güngör (2018) examined GEPU's impact on BIST Electricity, BIST Chemicals, Petroleum, Plastics, BIST Metal Main Return Index series traded in Borsa Istanbul with the GARCH model. As a result of the study, when GEPU index increases, it is determined that the return volatility of the stocks in the related sector indices increases. Sadeghzadeh Emsen and Aksu (2020) used ARDL and NARDL models and found that there is no symmetric relationship between GEPU and BIST-100 indices, while there is an asymmetric relationship. Gürsoy and Kılıç (2021) utilised the DCC-GARCH model and found that GEPU index causes volatility in BIST Banking Index stock prices and has a negative effect. Gürsoy and Zeren (2022) examined the relationship between GEPU and stock prices in G7 and BRIC countries using the Konya Causality Test and the findings of the study showed that there is a unidirectional causality relationship for the UK, the USA, and Brazil, and a bidirectional causality relationship for Germany. Any causality finding was not found in other countries. İlhan and Bağcı (2024), in their study with ARDL Bounds Test, reached the conclusion that the effect of GEPU on the BIST100 index in the short run is weak, but its effect on the BIST100 Index in the long run is strong and negative. Şencan (2024) analysed the relationship between GEPU and the stock indices of MIST countries and used the BEKK GARCH model. The study concluded that index of GEPU has a positive effect on the cross-volatility spillover effect of stock indices of MIST countries.

In the literature, the relationship between EPU and stock markets has been frequently analysed, especially in the post-2010 period, and most studies have found that this uncertainty has negative impacts on stock market. Most of the studies on Türkiye are based on global EPU data. The use of Türkiye - specific EPU index in this study is important in terms of taking local uncertainties into account. Moreover, the time-varying correlation structure with the DCC-GARCH model makes it possible to capture market reactions more precisely, especially during periods of crisis and uncertainty.

3. DATA SET AND METHODOLOGY

This study aims to examine the dynamic structure of the relationship between economic uncertainty and stock market over time. For this purpose, the relationship between the Türkiye-EPU, which is constructed based on the analysis of news content in local news media in Türkiye, and the BIST 100 index is analysed through the DCC-GARCH model. The data set consisting of monthly frequency data covering

from January 2006 to December 2024 is used in the study. Summary information about the variables is given in Table 1.

Table 1. Summary Information on Variables

Variable	Symbols	Source
Economic Policy Uncertainty Index	TURKIYE-EPU	Economic Policy Uncertainty
Borsa Istanbul 100 Index	BIST 100	Investing

This study analyses the dynamic correlation and dynamic regression relationship between BIST-100 index and Türkiye-EPU. The DCC-GARCH method proposed by Engle (2002) was used to determine the dynamic correlation between the variables and to examine its trend over time. This method was developed to model the conditional correlations between variables and attracts attention with its capacity to reveal the time-varying correlation structure. The DCC-GARCH model is basically a generalised version of Bollerslev's (1990) approach based on a constant conditional correlation estimator. The DCC-GARCH method offers three important advantages. The first one is that the correlation coefficients are estimated based on standard errors. Second, it identifies possible changes in the correlations between variables over the sample period. Finally, the method provides accurate results as it takes into account the effect of varying variance (Chiang, Jeon ve Li, 2007). The representation of the DCC-GARCH model is as follows:

$$x_t = \mu_t + \varepsilon_t \varepsilon_t \sim N(0, H_t) \tag{1}$$

$$\varepsilon = H_t^{\frac{1}{2}} \varepsilon_t \mu_t \sim N(0, I) \tag{2}$$

$$H_t = D_t R_t D_t \tag{3}$$

In equation (3), D_t ve R_t denote changing conditional variances and dynamic conditional correlations in m x m dimensions. In addition, the conditional means represent the standardised error residuals, both of $m\ x\ 1$ dimensions (Mishra ve Ghate, 2022).

In this study, Kalman Filter Model based on the classical model of Harvey (1989) is used to obtain the dynamic regression coefficients. The Kalman filter approach is expressed in equations (4) and (5).

$$y_t = c_t + Z_t \alpha_t + \varepsilon_t \tag{4}$$

$$\alpha_{t+1} = d_t + T_t \alpha_t + v_t \tag{5}$$

In equation (4), the variables c_t, Z_t, d_t ve T_t are adaptive vectors and matrices, while the variable α_t represents the vector of unobservables of size $2x1$. In addition, zero-mean Gaussian distributed error terms are denoted by the variables ε_t ve v_t. In equation (5), the unobservable state vector $\alpha_t$is assumed to vary over time as a first-order vector auto-regression. The Kalman Filter model, which iteratively

estimates the parameters by updating them with each additional observation, is expressed in equations (6) and (7).

$$\boldsymbol{LBIST100_t = a_0 + a_{1,t} LTurkiye - EPU_t + \varepsilon_t} \quad (6)$$

$$\boldsymbol{\alpha_{i,t} = \alpha_{i,t-1} + v_{i,t}} \quad (7)$$

4. EMPIRICAL FINDINGS

The dynamic correlation findings between the BIST-100 index and the Türkiye-EPU index are presented in Figure 2.

Figure 2 shows the time-varying correlations between the BIST 100 Index and the Turkish Economic Uncertainty Index, estimated using the DCC-GARCH model. The correlation fluctuates significantly over the sample period, ranging from negative to highly positive values. Notably, in mid-2013, the correlation peaks around 0.7, which coincides with major political and financial events such as the Gezi Park protests and the U.S. Fed's recessionary signals. During the early COVID-19, the correlation initially dropped due to rising uncertainty but then surged as global risk perceptions intensified. Another sharp increase is observed in early 2022, during the onset of the Russia-Ukraine conflict, where the correlation approaches 0.6. These findings suggest that geopolitical and global uncertainty significantly strengthen the co-movement between the two variables.

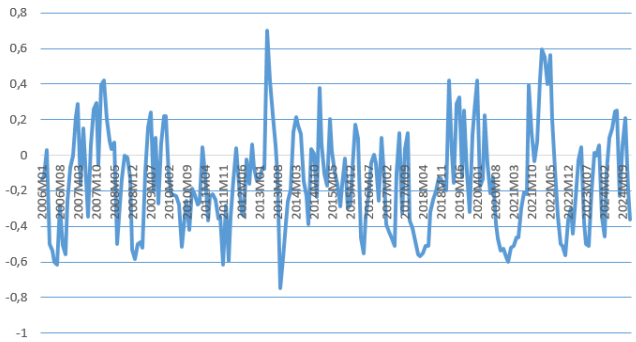

Figure 2. Dynamic Correlation Coefficients Obtained from DCC-GARCH Model

The dynamic regression coefficients obtained using the Kalman Filter Model are presented in Figure 3.

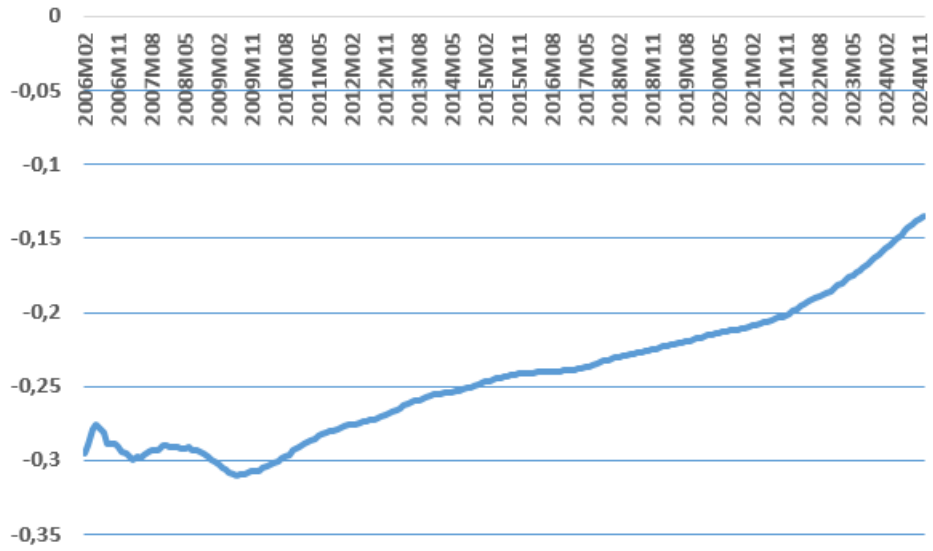

Figure 3. Dynamic Regression Coefficients Obtained from Kalman Filter Model

Figure 3 presents the dynamic regression coefficients estimated via the Kalman Filter. These coefficients reflect the changing impact of the EPU on the BIST 100 index over time. The coefficients remain negative throughout the period, indicating that increased uncertainty generally exerts downward pressure on the stock market. A clear upward trend is visible, especially after 2020, as the COVID-19 pandemic escalated uncertainty and market sensitivity. This upward movement continues during the Russia-Ukraine war in 2022, with coefficients nearing -0.15. This trend suggests that the influence of uncertainty on stock returns has become stronger over time.

5. CONCLUSION

This study investigates the dynamic relationship between the BIST 100 Index and the Turkish Economic Uncertainty Index using two complementary econometric approaches: the DCC-GARCH and the Kalman Filter models. Both models provide strong empirical evidence that economic uncertainty has a significant and time-varying influence on stock market dynamics in Türkiye.

The DCC-GARCH results show that the correlation between uncertainty and stock returns intensified during periods of heightened geopolitical and global risk, such as the recessionary signals in 2013, the COVID-19 pandemic and the Russia-Ukraine war. These increases in correlation imply that financial markets become more sensitive to uncertainty during crises, leading to stronger co-movements and possibly increased volatility. The Kalman Filter findings also reveal that the impact of uncertainty on the BIST 100 Index has gradually increased over time. The upward trend in the regression coefficients suggests that Turkish financial markets have become more reactive to economic uncertainty, which may reflect a structural vulnerability in investor sentiment and market resilience.

The findings suggest that economic policy uncertainty has negative effects on both financial markets and investment decisions, while reducing this uncertainty may contribute to limiting uncertainty-

induced effects by stabilising investor expectations, especially during exogenous shocks. In this regard, it should be considered as a strategic priority in terms of providing continuity in policy implementations and maintaining market stability.

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THE RELATIONSHIP BETWEEN GROWTH AND CURRENT ACCOUNT DEFICIT: EVIDENCE FROM QUANTILE CAUSALITY APPROACHES

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Abstract

The relationship between economic growth and current account deficit continues to be debated in the economics literature. The frequent co-occurrence of high growth periods with increasing current account deficits brings decision makers face to face with the question of "growth or current account?". This study examines the relationship between economic growth and the current account deficit in Turkey, a developing economy, during the 2000–2024 period. In the research, the quantile Granger causality test and the quantile-on-quantile Granger causality test are jointly employed, based on the assumption that the connection between economic growth and the current account deficit is not independent of the levels of either variable. The quantile Granger causality technique assumes that causal relationships may vary at different levels of economic growth (i.e., relationships by quantiles rather than by the mean). According to the findings, no statistically significant relationship is detected in the lower and middle quantiles (τ = 0.1–0.7), whereas in the higher quantiles (τ = 0.80–0.90) -in other words, during periods of strong economic growth- it is concluded that the current account deficit is a Granger cause of economic growth. This finding indicates that the current account deficit is a decisive factor that cannot be overlooked in periods of high economic growth. However, since the quantile Granger method is insufficient to precisely determine at which levels of the current account deficit the link with economic growth occurs, the quantile-on-quantile Granger causality analysis has also been applied. The results obtained through this method also reveal causality relationships in periods of high economic growth.

Additionally, it is found that high levels of current account deficits are also a Granger cause of growth. In conclusion, both techniques demonstrate a significant relationship between the current account deficit and economic growth during high-growth periods. Moreover, the finding that high levels of current account deficits may also trigger high growth constitutes a notable contribution of the quantile-on-quantile analysis. These findings suggest that policymakers should consider the pressure on the current account balance when developing sustainable economic growth policies.

Keywords: *Quantile-On-Quantile, Causality, Current Account Deficit*

JEL Codes: *C14, C21, C22.*

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1.Introduction

A current account deficit is a fundamental external balance problem that arises when a country consumes more goods and services than it produces. In other words, a current account deficit reflects a situation in which income earned from the rest of the world is insufficient to cover external payments (Seyidoğlu, 2009; Carbaugh, 2009). The current account is one of the four main components of a country's balance of payments, which records its external economic transactions. This account is typically evaluated based on its deficits in a macroeconomic context. If the sum of the trade balance, services balance, primary income balance, and net transfers is positive, it is referred to as a current account surplus; if negative, it is defined as a current account deficit (Yardımcı, 2023).

Developing countries often face current account deficits due to their need to import intermediate and capital goods during economic development. Countries with current account deficits in their balance of payments typically attempt to offset these imbalances through capital inflows. However, if foreign capital inflows prove insufficient, the current account deficit may lead to a depletion of foreign exchange reserves (Çiftçi, 2014). If such deficits are due to short-term and temporary factors, they can be financed through foreign exchange reserves. Nevertheless, as is frequently observed in developing countries, when these deficits become chronic, countries either become dependent on continuous foreign capital inflows or require permanent structural reforms. These reforms must be carefully planned, considering their potential adverse effects on economic growth. Furthermore, current account deficits tend to expand during periods of economic expansion—when domestic demand and market expectations rise—and contract during periods of stagnation (Roubini and Wachtel, 1998).

The influence of numerous macroeconomic factors shapes the current account deficit. Among the most prominent of these variables are growth rates, energy prices, changes in the income levels of foreign trade partners, interest rates, public borrowing, budget deficits, and capital movements (Karabulut & Danışoğlu, 2006). The differences in current account deficit dynamics between developed and developing countries stem from the structural economic characteristics of these economies. Turkey, in particular, has long experienced macroeconomic vulnerabilities due to its persistent current account deficit problem. It is widely accepted that the economic crises of 1994 and 2001 were linked to the current account deficit surpassing a certain threshold relative to gross domestic product (GDP), and therefore, the current account deficit has often been regarded as a crisis indicator (Erdoğan & Bozkurt, 2009; Nkuna & Kwalingana, 2009).

Although a temporary decline in the current account deficit was observed after the 2001 crisis due to a contraction in domestic demand, the deficit began to grow again in 2006. The expansionary monetary and fiscal policies implemented in the post-global crisis period increased capital inflows to Turkey and significantly expanded the volume of imports. In the case of Turkey, the fundamental reason for the current account deficit lies in the persistent lag of export growth behind import growth, making the trade deficit a structural issue. In particular, the heavy dependence of production processes on imported inputs means that efforts to reduce imports often require a compromise on economic growth (Çiftçi, 2014).

In this context, analyzing the relationship between the current account deficit and economic growth is critically important for achieving sustainable growth. Especially in countries like Turkey, where production is highly dependent on foreign inputs, accurately identifying this relationship's nature and direction is essential for maintaining external balance and reaching growth targets.

This study adopts the Quantile-on-Quantile Granger Causality (QQGC) approach to analyze the causal relationship between economic growth and the current account deficit in Turkey, offering a significant methodological innovation by departing from the standard causality methods frequently used in the literature, which rely on averages and standard assumptions. While traditional causality tests often provide limited findings based on average effects, the QQGC method allows for modeling relationships across the entire distribution of both variables. It can capture distributional heterogeneity and asymmetric interactions. Thus, rather than solely examining the causal effects of the current account deficit on economic growth, the study identifies the specific segments in which the relationship between economic growth and the current account holds, under which levels of growth and current account conditions the relationship is valid.

The structure of the study is as follows: The second section reviews previous studies that have examined the relationship between economic growth and the current account deficit, along with their findings. The third section introduces the econometric techniques adopted in the analysis and explains their theoretical foundations. Finally, the last section presents the empirical findings of the research and offers policy recommendations based on the results.

2. Literature review

Blanchard (2007) states that current account deficits have significantly increased over the past two decades in wealthy countries, particularly the United States and Euro Area countries. The study emphasizes that private savings and investment decisions mainly drive current account deficits, while public deficits play a relatively limited role. During periods of economic growth—especially in countries like Portugal and Spain—it is noted that the increase in private spending leads to an expansion of the current account deficit. In the case of the U.S., low private savings rates and rising private consumption have played a significant role in widening the current account deficit. Moreover, it is argued that growth dynamics affect the current account directly through the private sector's consumption and investment decisions. The study also suggests that expanding the current account deficit during growth periods does not necessarily require direct government intervention. Instead, the primary intervention area should be the structural distortions in goods, labor, and financial markets.

Calderón et al. (1999) investigated the relationship between the current account and a broad set of economic variables using a panel dataset covering annual data from 1966 to 1995 for 44 developing countries. The study, which also examined causality relationships, found that increases in domestic output growth contribute to expanding the current account deficit. Telatar and Terzi (2009) examined the Turkish economy using quarterly data from 1991:Q4 to 2005:Q4. Using Granger causality and VAR analyses, they identified a one-way and statistically significant causality from growth rate to current account balance.

Yanar and Kerimoğlu (2011) analyzed whether the current account deficit results from economic growth, and whether growth leads to an increase in energy consumption. Using data from 1975 to 2009 for Turkey, they used cointegration tests to examine the relationships among energy consumption, economic growth, and the current account. The findings revealed a long-term relationship among the three variables. Moreover, results from a vector error correction model showed that economic growth increases energy consumption, and the rise in energy consumption, in turn, contributes to the expansion of the current account deficit. Regarding causality, they found strong causality from energy consumption to growth, and a bidirectional but weak relationship between growth and the current account deficit.

Çiftçi (2014) viewed Turkey's current account deficit as a crisis indicator and examined the relationship between the current account, real exchange rate, and economic growth using cointegration methods. The study, which employed VAR and Johansen cointegration techniques, found a cointegrating relationship among the variables. It also concluded that changes in GDP and the real exchange rate were causes of the current account deficit.

Lebe et al. (2009) examined Romania and Turkey for 1997–2007 using the Structural Vector Autoregression (SVAR) model. Their findings indicated that economic growth significantly impacted the current account deficit. Similarly, Erbaykal (2007) focused on the Turkish economy from 1987:Q1 to 2006:Q3. Using the Toda-Yamamoto causality approach, the study found a unidirectional causality running from economic growth and exchange rate to the current account deficit.

Kasman et al. (2005), using Turkish data from 1984 to 2004, found through bounds testing analysis that increases in economic growth and exchange rates led to higher current account deficits. Calderón (2001) also presented results from various countries supporting the idea that economic growth positively affects current account deficits.

De Mello et al. (2011) investigated the long-term effects of current account adjustments on economic growth and the role of macroeconomic policies in this process. The study analyzed data from over 100 countries between 1971 and 2007 and constructed a chronology of current account corrections using real GDP growth rates. The findings from the ordered probit models indicated that current account corrections resulting from improvements in external positions increased the likelihood of sustained growth. On the other hand, corrections following deteriorations in external positions decreased the possibility of growth accelerations. The study also noted that large budget deficits weaken the positive effect of current account improvements on growth. In contrast, tight monetary policy responses to deteriorating current accounts may help support economic growth.

Dinçer and Yaşar (2014) analyzed Turkey's current account deficit issue for 1987:Q1–2011:Q4 using a VAR model within the framework of transmission mechanisms between growth and financial variables. They emphasized that Turkey is a small, open economy vulnerable to growth volatility, and argued that the current account problem should be analyzed through multiple transmission channels. Their findings indicated that credit growth increased both GDP growth and the current account deficit; higher growth rates led to an appreciation of the real exchange rate, which boosted imports and, in turn, widened the current account deficit. Furthermore, the study found that Turkey's growth dynamics and financial flows directly and indirectly affected the current account.

Yurdakul and Uçar (2015) examined the relationship between the current account deficit and economic growth in Turkey using quarterly data from 1999:Q1 to 2014:Q2. Applying Granger causality and VAR analyses, they identified a unidirectional relationship from the growth rate to

the current account deficit, suggesting that a shock in the growth rate significantly affects the current account.

3. Methodological framework

This section outlines the theoretical foundations of the methodology adopted in the study. The analysis begins by examining the time series properties of the variables through a structured research process that first applies unit root tests, followed by linearity assessments. In the final step, the study investigates the causal relationships between the variables using the QQGC framework.

3.1.Unit root and linearity

Stationarity refers to a process whose mean, variance, and covariance remain constant over time, implying that the series converges toward a stable value (Gujarati, 2021). Most econometric tests and estimators rely on the assumption of stationarity and produce reliable results only under this condition. Therefore, identifying the stationarity properties of the series is essential for both the validity and robustness of econometric analyses. Among the most widely used methods for testing stationarity are the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979; 1981) and the Phillips-Perron (PP) test (Phillips and Perron, 1988).

The ADF test offers three different model specifications depending on the presence of a constant and a deterministic trend. A significantly negative slope coefficient indicates stationarity in the series. The computed *t*-statistics are interpreted by comparing them against the critical values proposed by MacKinnon (1996). As an alternative to the ADF test, the PP test provides more robust results in the presence of autocorrelation and heteroskedasticity in the error terms. This test is also applied under specifications with none, intercept, and intercept with trend, while testing the same null hypothesis of a unit root (Çağlayan and Saçaklı, 2006).

Another essential property of time series that must be assessed is linearity. In the fourth stage of the analysis, the study applies the linearity test developed by Brock et al. (1996) to determine whether the variables exhibit linear or nonlinear behavior. The BDS test operates on the residuals of the time series to examine the validity of the assumptions of independence and randomness. Rejection of the null hypothesis implies the existence of nonlinear dependencies in the series and suggests that linear models may be inadequate to define the series' structure fully.

3.2.Quantile-on Quantile Granger causality (QQGC)

This study adopts the QQGC technique to evaluate the causal relationship between variables across the entire distribution. The QQGC approach builds on the modeling framework developed by Troster et al. (2018), generalizing the standard Granger causality analysis by incorporating

quantile sensitivity for both the dependent and independent variables. This technique is particularly effective when the underlying relationship is heterogeneous, meaning that the magnitude and direction of effects differ across levels of the variables.

The QQGC method determines whether a corresponding quantile of the lagged values of the independent variable significantly influences a particular quantile of the dependent variable. In this context, the Granger causality component of the model focuses on predicting future dynamics using lagged values. At the same time, the quantile-on-quantile dimension evaluates how predictive power varies across different segments of the distribution. As such, the QQGC framework relaxes the constant average-effect assumption of the standard Granger model and allows for asymmetric, conditional, and context-specific relationships. In practical terms, the QQGC method relies on models that assess whether the lagged values of the independent variable at quantile θ can explain the value of the dependent variable at quantile τ. This structure enables the analysis to distinguish, for example, a current account behavior that is predictive only during high-growth episodes from its dynamics in low-growth regimes.

4.Data and findings

The analysis begins by testing the stationarity properties of the series and performing the ADF and PP unit root tests. Next, the BDS test evaluates the linearity structure of the series. Finally, the QQGC method investigates causality relationships across quantiles between the dependent (lnGDP) and the independent (lnCA) variables.

4.1.Data and model

This study employs a dataset collected from the Electronic Data Delivery System (EVDS) of the Central Bank of the Republic of Turkey (CBRT). Covering the period from 2006:Q1 to 2024:Q4, the dataset includes the current account (CA) variable, represented by the current account balance in Turkish lira, and the real economic growth (GDP) variable, measured by the seasonally adjusted annual percentage change in expenditure-based real GDP. The analysis applies the log-modulus transformation proposed by John and Draper (1980) to eliminate scale differences across variables and enable logarithmic transformation of negative values. The notation "ln" refers to this transformation. The closed-form representation of the model is written in Equation (1).

$$lnGDP_t = f(lnCA_t) \quad (1)$$

Table 1 presents the summary statistics of the macroeconomic variables considered in the analysis. The summary measures are computed based on the original and log-transformed versions of the CA and GDP variables to enable a comparative assessment of the series' characteristics.

Table 1. Summary statistics

	Original scale		Logarithmic scale	
Variables	**GDP**	**CA**	**lnGDP**	**lnCA**
Mean	4.991842105	-69.11039474	1.4929	-0.4129
Median	5.53	-4.765	1.8765	-1.7469
Max.	22.35	695.9	3.1506	6.5466
Min.	-14.54	-2093.44	-2.7435	-7.6470
Std. deviation	5.097360287	330.7754961	1.2286	4.3496
Skewness	-0.862900845	-3.325031326	-2.0493	-0.0042
Kurtosis	7.005111536	20.78506324	6.4257	1.3593
JB statistic	60.23***	1141.68***	90.36***	8.52**
SW statistic				

Note: **** shows 1% significance level.*

The analysis employs a preliminary correlation assessment to identify the strength and direction of the linear relationship between the variables. Table 2 displays the Spearman rank-order correlation matrix for lnGDP and lnCA, given that neither variable conforms to a normal distribution. The findings reveal a statistically significant negative correlation of approximately 0.38 between lnGDP and lnCA.

Table 2. Spearman rank-order correlation matrix

Variables	**lnGDP**	**lnCA**
lnGDP	1	
lnCA	-0.3795***	1
	(0.0000)	

Note: **** shows 1% significance level.*

4.2. Findings

4.2.1. Unit root test results

To detect the presence of a unit root in the series, the analysis applies the ADF and PP tests, which are widely recognized as benchmark procedures in the literature. Table 3 presents the test results. For both the lnCA and lnGDP series, the null hypothesis indicating the existence of a unit root is rejected at the 1% significance level based on the ADF and PP test outcomes.

Table 3. Summary of unit root test results

	ADF Test		**PP Test**	
Variables	τ statistic Intercept	τ statistic Int. & trend	Adj. τ statistic Intercept	Adj. τ statistic Int. & trend
lnCA	-5.3342***	-5.2786***	-3.8818***	-3.8444***
lnGDP	-4.0246***	-4.0066***	-4.0562***	-4.0066***

Note: **** shows 1% significance level.*

Based on the results of the unit root tests, the analysis finds evidence that both lnCA and lnGDP are stationary at levels. At this step, proceeding with the level values of the variables in the subsequent analysis does not pose any methodological concern.

4.2.2. Linearity test results

This section applies the BDS test to examine the linearity properties of the lnCA and lnGDP series. Table 4 reports the test results.

Table 4. BDS test results

Variables	M=2	M=3	M=4	M=5	M=6
lnCA	0.0757*** (0.0000)	0.1031*** (0.0000)	0.1138*** (0.0000)	0.1159*** (0.0000)	0.1111*** (0.0000)
lnGDP	0.0865*** (0.0000)	0.1249*** (0.0002)	0.1427*** (0.0004)	0.1591*** (0.0004)	0.1566*** (0.0008)

Note: *i.*** *shows 1% significance level. ii "[]" parentheses show bootsrap p-values. iii."M" shows dimensions.*

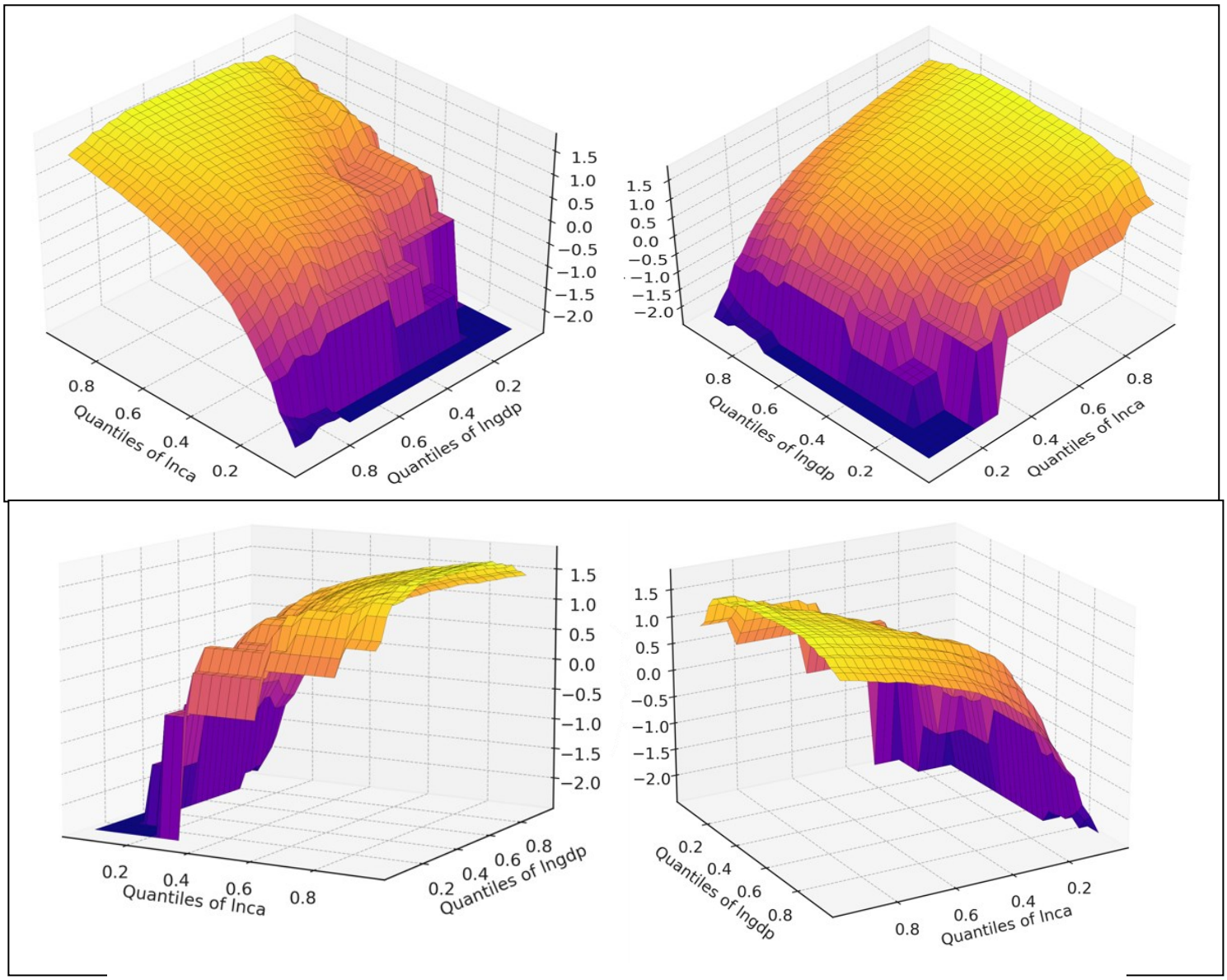
According to the BDS test results, the null hypothesis asserting that the lnCA and lnGDP series are linear is rejected. This outcome indicates that both series exhibit nonlinear characteristics.

4.2.3. Quantile-on-quantile Granger Causality analysis

The variable-specific findings (namely, the non-normal distribution and nonlinear structure of the series), along with the research question, necessitate using the QQGC technique. This method can capture nonlinear dependencies and distributional heterogeneities in the relationship between lnGDP and lnCA.

Fig. 1 presents 3D plots with four varying perspectives, providing initial evidence that the predictive power of the current account for economic growth significantly varies across different quantiles of both variables. The findings imply that the current account and economic growth relationship is neither linear nor constant, but instead exhibits Granger causality of varying intensity across the distribution. In the middle quantile range (0.40-0.70), lnCA shows a stronger Granger causal effect on lnGDP, suggesting that during periods of moderate economic growth, the current account serves as a more effective predictor of future growth dynamics. In contrast, the flatter surface observed in lower quantiles (0.05-0.25) and the weakening predictive power indicate that the causality from the current account to economic growth diminishes during low-growth periods. In upper quantiles (0.75-0.95), the causal pattern becomes more volatile and unstable, implying that the predictive power of the current account during high-growth phases is more complex and highly conditional.

Fig. 1. Quantile on quantile Granger causality 3D plots



This study investigates the relationship between the current account and economic growth in Türkiye over the period 2006:Q1-2024:Q4. By adopting the QQGC approach, the analysis avoids assuming independence between distributional heterogeneity and causal dynamics. The findings indicate that the current account exerts a statistically significant Granger causal effect on economic growth; however, the strength and direction of this relationship vary depending on the level of economic growth. The QQGC 3D plots reveal that the predictive power of the current account is notably stronger in the middle quantile range, while it significantly weakens in lower quantiles. This suggests that during periods of low economic growth, the current account serves only as a limited indicator. In contrast, it provides a more effective signal for forecasting future growth under more stable growth conditions.

Another noteworthy result is the continued but more volatile and fragile causal link observed in the upper quantiles. During high economic growth periods, the explanatory power of the current account becomes more conditional and is largely accompanied by simultaneity effects. In other words, instead of driving growth, the current account tends to act as an external imbalance that evolves with high economic expansion. These insights derived from the QQGC analysis substantially support the initial hypothesis of the study-that during periods of high growth, the current account tends to widen and often moves in synchronization with economic expansion. Consequently, the quantile-specific causality findings underscore the importance of evaluating macroeconomic balance not merely through nominal growth rates but by considering the structural conditions under which economic growth occurs and the external dynamics that accompany it.

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THE NEED OF GENDER BUDGET TO SUPPORT THE ADOPTION OF GENDER EQUALITY PLANS: THE CASE OF ALEKSANDËR MOISIU UNIVERSITY OF DURRËS

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Ela Golemi**

Abstract

This paper is aimed at inquiring into the Leaky Pipeline phenomenon in the case of Aleksandër Moisiu University of Durrës (UAMD) as it is identified as a content gap from the analysis of the Gender Equality Plan (GEP) document for a four-year period (2022–2025). Pursuing a qualitative approach it will be applied the thematic analysis of the GEP document related to the five main areas established as a focus in this plan, to evaluate the extent to which gender equality objectives are supported by budget allocations. Moreover, we will expand the method by using the comparative content analysis of UAMD GEP related to the GEP of the University of Tirana as the pioneer in the implementation of the GEP and Gender Budgeting approach. The main results will show that UAMD has been committed to accomplishing in this period a great number of positive actions that will all be financed by internal and external gender budget allocations. From the content analysis has been realized that the gender-related objectives are also in compliance with many important Sustainable Development Goals (SDGs).

Keywords: *Gender Equality Plan, Gender Budget, Leaky Pipeline, Sustainable Development Goals, Higher Education Institutions.*

JEL Codes: *C14, C21, C22.*

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1. INTRODUCTION

Nowadays, gender equality in Albanian academia has become a necessary foundation for the sustainable development of Higher Education Institutions (HEIs). The adoption of Gender Budgeting (GB) in alignment with the gender-related objectives involved in the Gender Equality Plan (GEP) document is considered by field experts as an effective tool for the practice and fulfillment of GEP's strategy on gender equality.

Aleksandër Moisiu University of Durrës (UAMD) is among many other universities in Albania that have prepared their first Gender Equality Plan (GEP) for a four-year period (2022–2025). We will conduct a context analysis of the university, as it is identified as a content gap from the analysis of the Gender Equality Plan (GEP) document. Carrying out this analysis, we will provide relevant evidence regarding the representation of women and men at different levels of the academic career and in particular, in the leadership positions.

Based on a literature review and the Gender Equality Plan documents of UAMD and UT, the main research objectives stated in this paper are:

- The identification of the leaky pipeline phenomenon through a context analysis of the UAMD scientific composition.

- The analysis of the linkage of GEP's focus areas with the gender-related SDGs based on GEP's documents.

- The examination of the extent to which gender budget allocations have been planned to support the achievement of GEP's objectives in the context of UAMD, by comparing its compliance with the line pursued by UT, which is the first Albanian institution to implement the GEP (LeTSGEPs' project, 2022).

2. LITERATURE REVIEW

Under Horizon Europe, the key funding programme for research and innovation, the European Commission (EC) introduced as a basic requirement gender equality plans (GEPs). The EC defines GEPs as "a set of commitments and actions that aim to promote gender equality in an organisation through a process of structural change". The expected results of GEPs' implementation will ensure a sustainable organizational change towards better gender equality, diversity, and inclusion.

Gender Equality Plan of the Aleksandër Moisiu University of Durrës (UAMD) promote gender equality concept through appropriate measures in five main areas: 1) Mainstreaming the Gender Dimension into Teaching and Research Activities; 2) Mainstreaming the Gender Dimension into Teaching and Research Activities; 3) Gender Balance in Leadership and Decision-Making Bodies; 4) Work- Life Balance and Organisational Culture; and 5) Measures Against Gender Based Violence and Sexual Harassment (UAMD-GEP, 2022-2025).

Based on evidence of gender inequalities in Albanian higher education institutions, Leskaj and Gjika (2024) recommend that these institutions begin evaluating their gender situation through gender context analysis.

Addabbo, Naciti, Noto, and Vermiglio (2020) concluded in their study that Gender Budgeting is a process that provides Research Performing Organisations (RPOs) with the opportunity to link gender equality plans with budget cycles, fostering decision-making processes that acknowledge gender equality issues at all organisational levels.

In another study on the sector of Higher Education in Albania, based on the gender contextual analysis conducted, the authors Llaftiu and Shuli (2024) concluded that to improve internal decision making processes with the aim of furthering gender equality and increasing the presence of women in key positions, the activities involved in the GEP should be integrated with gender budgeting. These authors' analysis shows that, even if gender equality exists at lower levels, there are far fewer women in leadership positions.

3. METHODOLOGY

This paper is aimed at inquiring into the existence of the Leaky Pipeline phenomenon, which refers to the progressive disappearance of women as they advance in their careers. Pursuing a qualitative approach it has been applied the thematic analysis of the GEP document related to the five main areas established as a focus in this plan, to evaluate the extent to which budget allocations support gender equality objectives.

Moreover, we will expand the method by using the comparative content analysis of UAMD GEP related to the GEP of the University of Tirana, as the pioneer in the implementation of the GEP and Gender Budgeting approach in Albanian academia. The discussion will be concentrated in two main components: financial allocations and the methodology applied. In this context, the analysis has demonstrated the serious work done by the UAMD team engaged in the preparation

of GEP, as the final section points out the important relationship of the undertaken GEP's actions with SDGs.

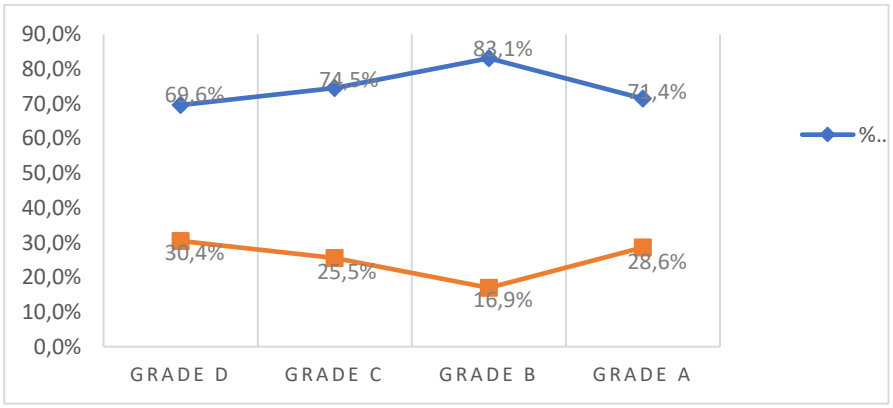
This study uses a mixed method, the qualitative analysis has been integrated with a small portion of quantitative data computed by the authors, in relation to identify the actual context of gender equality in the UAMD. Methodology is based on secondary data provided by previous research articles in the same field in the context of Albanian academia, and international journal articles as well. The key data was gathered from the GEP document and the website of UAMD. For the comparative analysis, some data have been provided from the UT second GEP document.

4. FINDINGS AND DISCUSSION

4.1 An analysis of the academic context in UAMD

In this section has been conducted an analysis of the academic context in UAMD. Mainly, from this analysis have been identified the rates of women's and men's participation in the ranks of the academic career progression (see Figure 1). The main scope of this was to identify if the "leaky pipeline" phenomenon exists in the UAMD scientific context. The leaky pipeline model is considered to profoundly affect women's academic careers (Dubois-Shaik and Fusulier, 2015) as it limits the vertical advancement of women (Kuptsch and Charest, ILO, 2021). Moreover, the analysis of this concept has been expanded to the highest positions by identifying if there are gender imbalances in decision-making positions (see Figure 2).

Figure 1: Participation of women in academic ranks

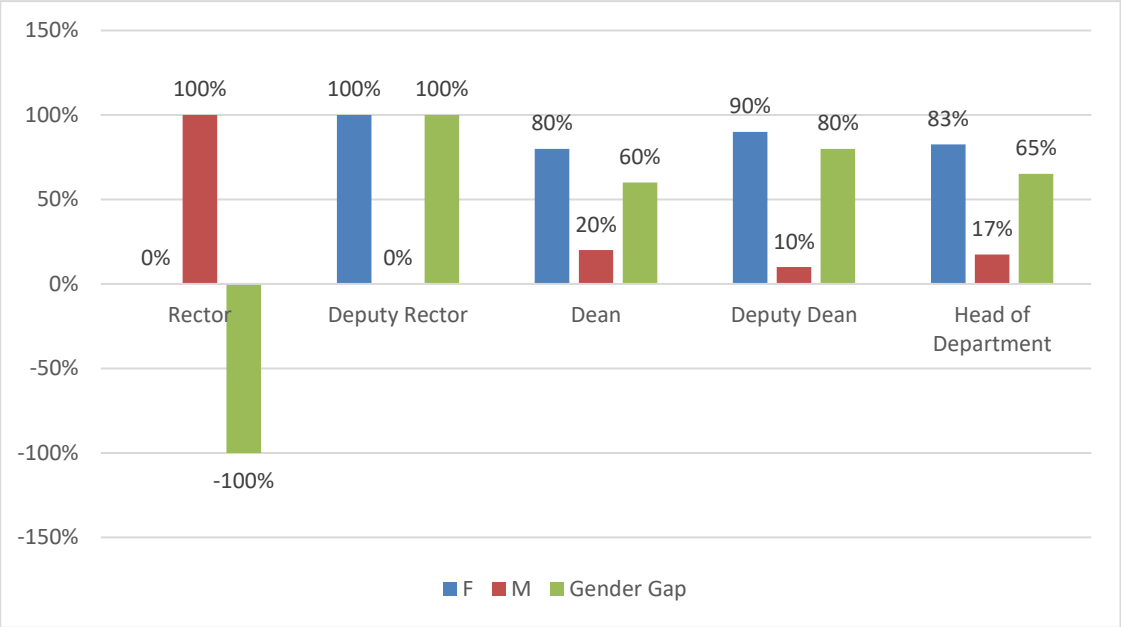


Source: Elaborated by the authors (with data from UAMD website)[8]

[8] https://uamd.edu.al/)

The results in Figure 1 show an increase in the proportion of women from Grade C to Grade B, which does not automatically lead to an increase in the proportion of women among Grade A. Despite this decline in women's representation in the highest rank, the overall results show that men remain underrepresented in all ranks. As the Gender Gap is in favor of women, the "Glass Ceiling" Index is expected to be less than 1, indicating that women are overrepresented in A-grade positions.

Figure 2: Participation of women in leadership positions



Source: Elaborated by the authors (with data from https://uamd.edu.al/)

The data analysis in Figure 2 shows that gender equality is not achieved in any of the management positions. There are great improvements regarding the overrepresentation of women among deputy rectors, deans, deputy deans, and heads of department, with a reversal of the Gender Gap 100% in the Rector position in favor of men.

4.2. GEP importance relies on the Gender Budget allocations

In this section has been conducted a thematic analysis with a focus on gender budget allocations and the methodology planned to be applied in UAMD-GEP. To enrich the analysis, we have compared these components to the UT-GEP based in previous studies. The summary of results is shown in Table 1:

Table 1. Thematic analysis of GEP through budget allocations

Themes of GEPs	Gender Budgeting	
	Allocations	Methodology

Mainstreaming the Gender Dimension into Teaching and Research Activities	UAMD- Allocation of internal financial resources through the budgetary process to reduce gender imbalances/promote gender equality, and external financial resources provided by local donors like UN Women. UT- Allocation of internal financial resources through the existing budget to reduce gender imbalances/promote gender equality. - Appointed a gender focal point at the University level. - Integrated the Gender Budgeting topic in the curricula.	UAMD -The inception activities of the Gender Equality Unit at UAMD may be funded through a pilot project under the respective budget line. UT- Analyzing the UT Mid-term Budget 2022-2024 with gender lenses
Mainstreaming the Gender Dimension into Teaching and Research Activities		
Gender Balance in Leadership and Decision-Making Bodies		
Work- Life Balance and Organisational Culture		
Measures Against Gender Based Violence and Sexual Harassment		

Source: elaborated by the authors (data by UAMD-GEP and UT-GEP)

The thematic analysis results in Table 1 indicate that in both GEPs, the gender-related actions are planned to be supported by financial allocations. In UAMD-GEP, we see a commitment to using the external budget funds for some measures, provided by local donors like UN Women. Related to the methodology intended to be applied, UT is a pioneer in the field, and its approach represents a reclassification of expenses and revenues according to their impact on gender equality (Shuli and Llaftiu, 2022), providing a model more gender-sensitive than just a pilot project under the respective budget line (UAMD-GEP). The gender budget analysis is the second phase and the essential part of the overall gender budget process. The improved approach of UT is the tool to lead the gender budgeting towards a gender-responsive engagement.

4.3 GEP's focal areas supporting SDG policies

Analysis in this section has been expanded based on the model pursued by Llaftiu (2023) for the analysis of UT-GEP, showing even the linkage of the Gender Equality Plan of UAMD with gender-related Sustainable Development Goals (SDGs), and comparative results show that this significant relationship has been considered and reported only at the UAMD-GEP (Table 2), which was not included in the GEP of UT.

Table 2. The linkage of GEP's areas with gender-related SDGs

Themes of GEPs	Sustainable Development Goals (SDGs)
Mainstreaming the Gender Dimension into Teaching and Research Activities	SDG 4 Quality Education SDG 5 Gender Equality SDG 10 Reduced Inequalities SDG 16 Peace, Justice and Strong Institutions SDG 17 Partnerships for the Goals
Mainstreaming the Gender Dimension into Teaching and Research Activities	SDG 5 Gender Equality SDG 10 Reduced Inequalities SDG 16 Peace, Justice and Strong Institutions SDG 17 Partnerships for the Goals
Gender Balance in Leadership and Decision-Making Bodies	SDG 5 Gender Equality SDG 10 Reduced Inequalities SDG 16 Peace, Justice and Strong Institutions SDG 17 Partnerships for the Goals
Work- Life Balance and Organisational Culture	SDG 3 Good Health and Well-being SDG 4 Quality Education SDG 5 Gender Equality SDG 8 Decent Work and Economic Growth SDG 10 Reduced Inequalities SDG 11 Sustainable Cities and Communities SDG 17 Partnerships for the Goals
Measures Against Gender Based Violence and Sexual Harassment	SDG 5 Gender Equality SDG 16 Peace, Justice and Strong Institutions SDG 17 Partnerships for the Goals

Source: Elaborated by the authors (data by UAMD-GEP)

The actions undertaken in the GEP, related to each focus area as shown in Table 2, will ensure simultaneously the engagement in the fulfillment of most of the SDGs[9], as described below:

SDG 3: Good health and well-being

It aims to ensure a healthy life and promote well-being for all people of all ages

SDG 4: Quality Education

This goal is a commitment to positive change, emphasizing the transformative power of education in fostering a sustainable and equitable world.[10]

SDG 5: Gender Equality

[9] https://sdgs.un.org/goals

[10] https://www.unesco.org/sdg4education2030/en/about-us).

Achieve gender equality and empower all women and girls as a necessary foundation for a peaceful, prosperous, and sustainable world.[11]

SDG 8: Decent Work and Economic Growth

It aims to promote sustained, inclusive, and sustainable economic growth, full employment, and decent work for all. Ensuring mainly fair working conditions and providing professional development opportunities.[12]

SDG 10: Reduced Inequalities

This goal addresses inequalities within and among countries. It focuses on addressing disparities in income, access to resources, education, and opportunities, with a particular emphasis on vulnerable and marginalized groups.[13]

SDG 11: Sustainable Cities and Communities

The focus of this goal is about making cities and human settlements inclusive, safe, resilient, and sustainable. It aims to renew and plan cities and other human settlements in a way that offers opportunities for all.[14]

SDG 16 Peace, Justice and Strong Institutions

This goal calls for peaceful and inclusive societies based on respect for human rights, protection of the most vulnerable, the rule of law and good governance at all levels.[15]

SDG 17: Partnerships for the Goals

This goal aims to strengthen the means of implementation and revitalize the global partnership for sustainable development. It highlights the importance of macroeconomic stability for improved and more equitable trade.[16]

5. CONCLUSION

Gender inequity persists in all academic ranks of UAMD by indicating a surprising underrepresentation of men. Women advance along the academic career ladder at higher rates than men, concluding that the phenomenon described as a “leaky pipeline” is not present in the UAMD scientific research area from grade D to Grade B, but we see just a decrease in women's representation in grade A,

[11] https://www.un.org/sustainabledevelopment/gender-equality/
[12] https://datatopics.worldbank.org/sdgatlas/goal-8-decent-work-and-economic-growth/
[13] https://aiforkids.in/class-10/sdg/
[14] https://ec.europa.eu/eurostat/statistics-explained/index.php/SDG_11_-_Sustainable_cities_and_communities
[15] https://ec.europa.eu/eurostat/statistics-explained/index.php/SDG_16_-_Peace,_justice_and_strong_institutions%23Access_to_justice
[16] https://ec.europa.eu/eurostat/statistics-explained/index.php/SDG_17_-_Partnerships_for_the_goals

which represents a normal shape of the career progression ladder. Moreover, the representation of women in Grade A is higher than the start grade D in the academic career.

The first developed GEP by UAMD shows that the institution is committed to gender equality, and in all action areas, the gender-related objectives are translated into budgetary terms, in coherence with the UT commitments in GEP. According to the methodology, we suggest the importance that UAMD should pursue the gender budget analysis as the UT, and in the future, integrates the wellbeing gender budgeting approach as a more effective tool to reduce gender inequalities.

The GEP of UAMD provides an interaction between gender equality objectives of GEP, budget allocations, and the gender-related SDGs, setting in this manner as a requirement the equitable distribution of financial resources among men and women.

The social commitment of UAMD to gender equality has been involved even in the budget process as a demonstrative and a promising way to promote, in the future the sustainable development.

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THE NEED OF GENDER BUDGET TO SUPPORT THE ADOPTION OF GENDER EQUALITY PLANS: THE CASE OF ALEKSANDËR MOISIU UNIVERSITY OF DURRËS

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Abstract

This study examines the dynamic relationships between food imports, food exports, energy consumption, temperature, and water withdrawal in Türkiye over the period 1992–2021. Using the Autoregressive Distributed Lag (ARDL) approach, the analysis employs an effective sample covering 1996–2021 due to the lag structure of the models. The results confirm the existence of long-run cointegration for both food imports and exports. In the case of food imports, energy consumption and water withdrawal significantly influence import levels in the long run, while water availability emerges as the key short-run driver. The error correction model indicates a relatively fast adjustment speed of 25% per year toward the long-run equilibrium. Conversely, for food exports, although cointegration is confirmed, individual long-run coefficients are statistically insignificant. Short-run dynamics reveal that food exports are highly sensitive to fluctuations in energy consumption, with a slower adjustment speed of 8.43% per year. These findings provide practical insights for policymakers, exporters, and importers considering the critical links between water management, energy consumption, climate change, and food markets. The results highlight the interconnectedness of energy production and consumption, food imports and exports, and water availability—finite and vital resources that, if mismanaged, could exacerbate the risks of famine and resource conflicts. Governments should carefully consider these patterns when designing policies, recognizing that informed, integrated strategies can mitigate risks, strengthen food security, and promote more sustainable resource use for the benefit of humanity..

Keywords: *Energy Consumption, Food Trade, Climate, ARDL, Türkiye.*

JEL Codes: *Q18, O13, Q25.*

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1. INTRODUCTION

The interconnections among energy, water, climate, and food have become one of the most pressing areas of academic and policy concern. This nexus captures the complex and multidimensional relationships among natural resources, production systems, and socio-economic dynamics. In an era defined by climate change, growing populations, and rising resource demands, the water-energy-food (WEF) nexus provides a framework for understanding both emerging risks and opportunities for sustainable development. Its significance is particularly evident in middle-income countries such as Türkiye, where rapid growth, demographic change, and environmental stress converge. Exploring these relationships is therefore essential not only for diagnosing the challenges created by resource scarcity but also for identifying effective policy solutions that promote resilience and long-term sustainability.

The WEF nexus entered the global agenda through the 2008 World Economic Forum, which emphasized the necessity of considering economic development from an integrated resource perspective. This momentum was reinforced by the 2012 United Nations Conference on Sustainable Development, whose outcome document The Future We Want prioritized water and food security, sustainable energy, and climate adaptation as mutually reinforcing objectives. These milestones institutionalized the nexus as both a conceptual framework and a guiding principle for international policymaking.

Türkiye exemplifies the urgency of adopting this perspective. The country's geopolitical location between Europe, Asia, and the Middle East makes it an important player in global food markets, simultaneously dependent on imports and active in exports. At the same time, Türkiye faces significant environmental challenges. Rising average temperatures, recurrent droughts, and increasingly irregular precipitation patterns undermine agricultural production. Water scarcity is becoming more acute, placing pressure on irrigation-dependent farming systems. The agricultural sector, central to both domestic food security and trade, is also highly energy-intensive, linking production directly to fluctuations in energy supply and prices. These features make Türkiye an ideal case for examining how resource use, climate variability, and food trade interact.

The international literature highlights multiple channels through which these linkages operate. Groundwater over-extraction, often incentivized by subsidies, contributes to resource depletion and rising energy demand, undermining both food and energy security (Khair, 2013). Climate variability has been shown to affect food security, with international trade potentially serving as a stabilizing mechanism by redistributing surpluses to deficit regions (Baldos & Hertel, 2015). Econometric studies also demonstrate that reliance on non-renewable energy exacerbates sustainability risks, whereas renewable energy use and agricultural policy interventions can reduce emissions and improve resilience (He, 2023). At the same time, improvements in energy efficiency may generate rebound effects that offset expected environmental benefits and constrain economic growth (Chen et al., 2024). These

findings highlight the multidirectional, and at times contradictory, nature of the nexus, underscoring the importance of country-specific empirical analysis.

Food systems, which span production, distribution, and consumption, depend heavily on water availability. Both crop and livestock production require large volumes of water, meaning agricultural practices directly affect water quality and supply (Karri et al., 2026; Albrecht et al., 2018). Despite this, policy interventions aimed at addressing water scarcity often remain fragmented, lacking coordination across sectors (Filho et al., 2022). Climate change exacerbates these challenges by altering hydrological patterns and increasing evaporation rates, thereby reducing effective water availability (Döll et al., 2015). Scholars therefore advocate adaptive management strategies that account for multiple scenarios and acknowledge the socio-economic context of water governance (Arnell et al., 2011; Yang et al., 2018).

Within this broader context, Türkiye's dual role as both importer and exporter of food highlights the importance of understanding how environmental and resource-related variables shape trade outcomes. Imports reflect both supply-side vulnerabilities and shifting consumption patterns, while exports depend on resource availability and competitiveness in global markets. Exploring how energy consumption, water withdrawal, and climate variability influence these flows can provide valuable insights into the country's food security and economic stability.

Methodologically, addressing these questions requires econometric models capable of capturing both short-run adjustments and long-run relationships. This study fills the gap by employing ARDL models on annual data covering 1992–2021, with food imports and exports as dependent variables and energy consumption, temperature, and freshwater withdrawal as key explanatory factors. The results reveal distinct dynamics. For food imports, energy consumption and water withdrawal are significant long-run determinants, while water availability is the most influential short-run factor. Imports also display rapid adjustment toward equilibrium, with a correction speed of 25% per year. For exports, cointegration is confirmed, but individual long-run coefficients are insignificant, suggesting weaker structural dependence. Nonetheless, exports are highly sensitive to short-run fluctuations in energy consumption, with slower adjustment toward equilibrium at 8.43% per year.

By situating these findings within the broader literature, the study contributes fresh evidence from Türkiye to the nexus debate. The results highlight the critical roles of water and energy in shaping both domestic consumption and trade flows, while underscoring the risks of resource mismanagement in the face of climate uncertainty. More broadly, this research advances the literature by demonstrating how the WEF nexus manifests in a strategically important, environmentally vulnerable economy. Ultimately, the study emphasizes the urgent need for integrated policies that coordinate energy, water, and food strategies to strengthen resilience and promote sustainable development.

2. LITERATURE REVIEW

The interrelationships among energy, climate, water management, and food represent one of the most prominent areas of concern for both scholars and policymakers. In recent years, a growing body of research has revealed the considerable influence of climate variability and water governance on patterns of food consumption as well as on the dynamics of food imports and exports (Molajou et al., 2023; Yoon et al., 2022; Karri et al., 2026). The origins of this debate may be traced back to the 2008 World Economic Forum, during which the multifaceted effects of economic development were examined through the interconnected perspectives of water, energy, and food. Moreover, the outcome document of the United Nations Conference on Sustainable Development, entitled The Future We Want (2012), further reinforced this global agenda by underlining the importance of water, energy, and food security while simultaneously stressing the urgency of adaptation strategies in the face of accelerating climate change.

Khair (2013) argues that the over-extraction of groundwater, combined with subsidies that encourage such practices, leads to the depletion of vital resources and the intensification of energy demand, thereby posing serious risks to both food and energy security. In parallel, Baldos et al. (2015) approached the matter through the lens of climate change and emphasized the critical interplay between climatic shifts and food security. According to their analysis, policy-driven adjustments in food trade over both annual and decadal horizons could enable the redistribution of surpluses from food-abundant regions toward areas facing shortages as a result of climate pressures. Similarly, He (2023), employing ARDL models for the period 1990–2020 in the South Korean context, demonstrated that non-renewable energy consumption exerts adverse effects on the sustainability of food security, while renewable energy sources and agricultural policy interventions not only reduce emissions but also contribute positively to sustainability outcomes. These findings point toward the existence of a bidirectional causal relationship between food and energy, in which each domain both influences and is influenced by the other. At the same time, agricultural policies appear to exert a unidirectional short-term positive effect on greenhouse gas emissions, indicating that their environmental implications are not uniformly beneficial. On the other hand, rising energy efficiency and intensity, which are frequently celebrated as mechanisms for environmental improvement, can paradoxically produce unfavorable outcomes by exacerbating ecological degradation while simultaneously constraining long-term economic growth (Chen et al., 2024).

Food systems, encompassing every stage from agricultural production to distribution and final consumption, are complex structures that depend on numerous interlinked factors, among which water is often considered the most essential. Both crop cultivation and livestock production require substantial volumes of water, and this reality underscores the inescapable nexus between water management and food security. Accordingly, agricultural practices exert direct and significant influence over water resources, shaping not only their availability but also their quality and long-term sustainability (Karri et

al., 2026; Albrecht et al., 2018; De Amorim et al., 2018). Despite this evident interconnection, Filho et al. (2022) maintain that contemporary interventions aimed at addressing water scarcity remain insufficient and are often undermined by a lack of systematic coordination across sectors and institutions.

Climate change is considered a major pressure factor affecting water management, along with numerous economic and social challenges (Allan et al., 2013; Dettinger et al., 2015; Yang et al., 2016). However, Döll (2014) contends that it is impossible to deterministically quantify the effects of climate change on freshwater systems because other socioeconomic factors also affect water management. Therefore, rather than depending exclusively on deterministic projections of future hydrological conditions and their impacts, water managers should include future freshwater risks and hazards when making decisions. This suggests that a range of possible hydrological changes, taking into account various emission and socioeconomic scenarios, must be taken into account in order to manage water under climate change. Furthermore, even though climate change has resulted in increases in regional rainfall, the primary challenges of water management are thought to be the decline in water supplies brought on by evaporation and other anomalous causes as well as the difficulty in obtaining water (Arnell et al., 2011; Sesena et al., 2021; Rezaei et al., 2023).

As a result, it is seen that intricate nexus among water, energy, climate and food exist. A bunch of econometric models (e.g., panel data models, general circulation models (GCMs), vector autoregression models, ADRL models) have been used to investigate these linkages. In conclusion, while the current literature investigates the nexus among the given variables, this is the first study has been conducted in terms of Türkiye. Therefore, we contribute to the literature with new evidence by examining Türkiye, which has strategic key importance.

3. METHODOLOGY

3.1. Data

This study utilizes annual data covering the period from 1992 to 2021 for Türkiye. The variables used include food imports, food exports, energy consumption, temperature, and freshwater withdrawal. All variables are transformed into their natural logarithms where appropriate to stabilize variance and to allow interpretation of coefficients as elasticities. Due to the lag structure inherent in the ARDL model specification, the effective sample used for estimations covers 1996–2021.Data sources include national statistical institutes, international organizations such as the World Bank and FAO, and various secondary databases..

3.2. Model Specification

Given the small sample size and the different orders of integration among variables (stationary at levels I(0) and first differences I(1)), the Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran et al. (2001) is employed.

Two separate models are specified:

Model 1: Food imports as the dependent variable.

Model 2: Food exports as the dependent variable.

The general ARDL(p,q1,q2,...,qn) form used is:

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \beta_i Y_{t-p} + \sum_{j=1}^{q} \gamma_i X_{t-j} + \epsilon_t$$

where Yt represents the dependent variable (food imports or exports), Xt-j represents lagged independent variables (energy consumption, temperature, freshwater withdrawal), and ϵt is the error term.

The empirical strategy consists of:

Testing for the presence of a long-run relationship using the ARDL Bounds Test.

Estimating both short-run and long-run coefficients.

Estimating the Error Correction Model (ECM) to capture the speed of adjustment toward equilibrium.

Conducting diagnostic tests (Breusch-Godfrey serial correlation LM test, Breusch-Pagan-Godfrey heteroskedasticity test, and Ramsey RESET test) to ensure model adequacy.

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4. ANALYSIS & FINDINGS

The ARDL bounds test confirmed the existence of a long-run relationship for both food imports and food exports with energy consumption, temperature, and freshwater withdrawal. For food imports, the selected model was ARDL(2,1,1,4), while for food exports, the selected model was ARDL(3,4,0,0). Table 1 presents the bounds test results and the estimated long-run coefficients for both models.

Table 1. Bound Test Results & Long-Run Coefficients

Category	**Food Import (LFIMPORT)**	**Food Export (LFEXPORT)**
Sample Period	1996–2021	1996–2021
Model Selected	ARDL(2,1,1,4)	ARDL(3,4,0,0)
Bounds Test F-statistic	8.9622	6.8866
Bounds Test t-statistic	-4.0934	-1.3369
Cointegration Decision	Cointegration confirmed	Cointegration confirmed
Long-Run Coefficients		
LENERGY_CONS	+3.9119 (**p** = 0.0248)	+3.8992 (**p** = 0.5559)
LTEMP	+3.3923 (**p** = 0.1595)	-20.6599 (**p** = 0.2472)
LWATER_WITHDRAWEL	-3.7767 (**p** = 0.0434)	+1.4405 (**p** = 0.7425)
Interpretation of Long-Run Coefficients	Energy and water withdrawal significant; temperature weak	None individually significant

In the long run, energy consumption and water withdrawal were found to significantly influence food imports. Higher past energy consumption increases imports, while greater freshwater withdrawal reduces them, reflecting water scarcity impacts on import behavior. Temperature effects were positive but weaker and only marginally significant.

In the short run, water withdrawal emerged as the dominant variable affecting food imports. The short-run dynamics and adjustment speeds are summarized in Table 2.

In the case of food exports, although the bounds test confirmed the presence of a long-run relationship, the individual long-run coefficients for energy consumption, temperature, and water withdrawal were not statistically significant. This suggests that food exports are less structurally dependent on these environmental and resource-related variables over the long term compared to imports.

However, short-run dynamics revealed a strong and complex influence of energy consumption on food exports. Immediate and lagged changes in energy consumption alternately reduced and increased exports, highlighting the sensitivity of food export performance to fluctuations in the energy sector. Past values of food exports themselves also significantly influenced current exports.

The short-run dynamics for both models are summarized in Table 2.

Table 2. Short-Run Dynamics

Category	**Food Import (LFIMPORT)**	**Food Export (LFEXPORT)**
Sample Period	1996–2021	1996–2021
Model Selected	ARDL(2,1,1,4)	ARDL(3,4,0,0)
Error Correction Term (ECT) Coefficient	-0.2501 (**p** = 0.0011)	-0.0843 (**p** = 0.0000)
Speed of Adjustment	25.01% correction per year	8.43% correction per year
Short-Run Significant Drivers		
D(LFIMPORT(-1))	Positive effect (p = 0.0694, marginal)	Positive effect (p = 0.0002)
D(LENERGY_CONS)	Negative but not significant (p = 0.2177)	Strong negative (p = 0.0022)
D(LTEMP)	Positive but not significant (p = 0.6706)	(Zero lag term significant in levels, no difference term significant)
D(LWATER_WITHDRAWEL)	Significant negative (p = 0.0468)	Not significant (p = 0.7515)
D(LWATER_WITHDRAWEL(-2))	Positive significant (p = 0.0310)	
D(LWATER_WITHDRAWEL(-3))	Positive significant (p = 0.0040)	
D(LENERGY_CONS(-1))	–	Positive (p = 0.0665, marginal)
D(LENERGY_CONS(-2))	–	Negative (p = 0.0776, marginal)
D(LENERGY_CONS(-3))	–	Positive strong (p = 0.0027)
Constant (C)	Significant (p = 0.0005)	Significant (p = 0.0001)

The error correction term for food imports was negative and highly significant, with a coefficient of -0.2501, implying that approximately 25% of the disequilibrium from the previous year is corrected annually. This suggests a relatively fast convergence toward the long-run equilibrium for food imports.

For food exports, the error correction term was also negative and highly significant, but smaller in magnitude, with a coefficient of -0.0843, implying that only 8.43% of disequilibrium is corrected each year. This indicates a slower speed of adjustment toward the long-run equilibrium for food exports.

Diagnostic tests were conducted to ensure the reliability of the ARDL models. The results are summarized in Table 3.

Table 3. Diagnostic Tests

Diagnostic Test	**Food Import (LFIMPORT)**	**Food Export (LFEXPORT)**
Serial Correlation (Breusch-Godfrey LM Test, F-statistic)	1.1110 (p = 0.4037)	1.8325 (p = 0.1929)
Serial Correlation (Obs*R-squared Chi-Square)	7.9996 (p = 0.0916)	10.3971 (p = 0.0342)
Serial Correlation Conclusion	No serial correlation detected	No major serial correlation issue (borderline in Chi-Square)
Heteroskedasticity (Breusch-Pagan-Godfrey Test, F-statistic)	0.7653 (p = 0.6678)	1.4561 (p = 0.2473)
Heteroskedasticity Conclusion	Homoskedastic residuals	Homoskedastic residuals
Model Specification (Ramsey RESET Test, F-statistic)	0.1794 (p = 0.6788)	1.5614 (p = 0.2320)
Model Specification Conclusion	Correctly specified model	Correctly specified model
Durbin-Watson Statistic	2.0095	2.0496
Durbin-Watson Conclusion	No autocorrelation (DW ≈ 2)	No autocorrelation (DW ≈ 2)

Overall, the diagnostic tests confirmed that the estimated ARDL models for both food imports and exports are statistically robust, free from serial correlation, heteroskedasticity, and model misspecification. Therefore, the results obtained from these models can be considered reliable for further interpretation and policy analysis.

5. CONCLUSION

This study examined the interdependencies among food trade, energy consumption, temperature, and water withdrawal in Türkiye over the period 1992–2021 using an ARDL framework. The results provide robust evidence of long-run cointegration for both food imports and exports, while revealing marked asymmetries in the underlying dynamics.

For food imports, both energy consumption and water withdrawal emerge as significant long-run determinants, with water availability also exerting a powerful influence in the short run. The relatively fast adjustment speed—approximately 25% per year—indicates that imports are highly responsive to disequilibria, quickly realigning with long-run equilibrium. This highlights the vulnerability of import dependence to shifts in energy use and water scarcity, but also suggests that policy interventions can have relatively rapid effects.

Food exports, by contrast, display weaker long-run linkages. Although cointegration is confirmed, none of the individual explanatory variables are statistically significant over the long term. Instead, export performance is shaped primarily by short-run fluctuations in energy consumption. The sensitivity of exports to energy shocks reflects the sector's structural dependence on energy-intensive agricultural

production and logistics. The slower adjustment speed of 8.43% per year suggests that the export sector is less adaptable to shocks, with imbalances persisting for longer periods.

The implications of these findings are multifaceted. First, they demonstrate the necessity of integrated resource governance. Policies addressing food security must simultaneously engage with energy and water management, recognizing that sectoral interventions in isolation risk unintended consequences. Second, the results emphasize the urgency of transitioning from non-renewable to renewable energy sources and of aligning agricultural policies with sustainability goals. Doing so can reduce emissions while enhancing resilience in both domestic and international food markets. Third, the findings underscore the centrality of water governance. Given the significant role of water withdrawal in shaping food imports, comprehensive strategies for water efficiency, allocation, and conservation are indispensable for sustaining agricultural production and trade.

For Türkiye, these challenges and opportunities are particularly acute. Its dual role as both food importer and exporter makes it simultaneously vulnerable to domestic resource scarcity and exposed to global market volatility. Mismanagement of water and energy resources could exacerbate risks of food insecurity, economic instability, and social tension. Conversely, effective and integrated policymaking can transform these vulnerabilities into strengths, enabling Türkiye to leverage its strategic position, agricultural potential, and trade networks to promote resilience and sustainable growth.

In conclusion, this study contributes to the literature by offering the first ARDL-based analysis of the WEF nexus in Türkiye, generating evidence with both theoretical and practical significance. The results reinforce the need for policies that bridge the food, energy, and water sectors, recognizing their deep interconnections. For policymakers, the message is clear: food security cannot be achieved in isolation from resource management. Instead, coordinated strategies are essential to safeguard sustainability, reduce vulnerability to climate and market shocks, and secure a more stable and prosperous future.

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