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13th Istanbul Finance Congress (IFC-2024)

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13th ISTANBUL FINANCE CONGRESS (IFC) | December 23, 2024 | Istanbul

CONGRESS PROGRAM

13th Istanbul Finance Congress (IFC-2024) hosted by Işık University has participants from 15 different countries, namely; Turkiye, Jordan, USA, Italy, Morocco, Hungary, Turkish Republic of Cyprus, Kyrgyzstan, Romania, United Arab Emirates, Saudi Arabia, Norway, Nigeria, Tunisa and Cameroon. Hence, IFC-2024 is qualified an "International Congress" by the Higher Education Council of Turkiye.

Zoom for Opening Session
https://zoom.us/j/94235938458

OPENING SPEECHES | SESSION 1 | ROOM 1 | December 23, 2024, Monday	
10.00-10.10	Prof. Suat Teker| Isik University | Welcoming Speech, Congress President
10.10-10.20	Prof. Hasan Bulent Kahraman |Rector, Isık University |Opening Speech
10.20-10.40	**Keynote Speaker I -** Assoc. Prof. Guzhan Gulay | Executive Vice President, Borsa Istanbul
	Borsa Istanbul and Sustainability
10.40-11.00	**Keynote Speaker II -** Prof. Ghassan Omet | University of Jordan
	Financial Development and Artificial Intelligence: Some Regional Analysis

PRESENTATION SESSIONS

ZOOM LINK	https://zoom.us/j/94235938458	https://zoom.us/j/99433386028
11.00 - 13.00	**ROOM 1 | SESSION 2.1**	**ROOM 2 | SESSION 2.2**
	Chair: Prof. Elcin Alp, Istanbul Ticaret University	**Chair: Assoc. Prof. Cuneyt Dirican, Istanbul Arel University**
11.00-11.15	**Navigating financial awareness across generational shifts: Integrating agile management for future success**	**Social media sentiment and its effects on cryptocurrency price volatility**
	Kalman Botond Géza, Kodolanyi University, Hungary	Ozge Arabaci Urgenc, Istanbul Technical University, Turkiye
	Malatyinszki Szilárd, Kodolanyi University, Hungary	Oktay Tas, Istanbul Technical University, Turkiye
	Horváth Géza, Kodolanyi University, Hungary	
11.15-11.30	**The impact of financing agriculture from European funds on climate change**	**The role of environmental taxes in generating tax revenues and reducing greenhouse gas emissions in the European Union**
	Gabriela Badareu, University of Craiova, Romania	Fortea Costinela, University Dunarea de Jos of Galati, Romania
	Nicoleta Mihaela Doran, University of Craiova, Romania	Valentin Marian Antohi, University Dunarea de Jos of Galati, Romania
	Marius Dalian Doran, West University of Timisoara, Romania	Monica Laura Zlati, University Dunarea de Jos of Galati, Romania
11.30-11.45	**How green bonds affect clean energy investments and carbon emissions?**	**Factors reshaping investor risk perception: social media, news, and behavioral**
	Gulden Poyraz, Bandırma Onyedi Eylul University, Turkiye	Bahar Koseoglu, Bahcesehir University, Turkiye
	Tugba Guz, Istanbul Yeni Yuzyil University, Turkiye	
11.45-12.00	**Marketing aspects of the consumer culture theory**	**Gender difference in risk and confidence perception: implementation with logit model**
	Petra Platz, University of Gyor, Hungary	Dilek Teker, Isik University, Turkiye
		Suat Teker, Isik University, Turkiye
		Beyda Demirci, Isik University, Turkiye

12.00-12.15	**Measuring the sensitivity of different Monte Carlo models in forecasting airline stock prices**	**Understanding the mathematical background of modern portfolio theory**
	Olcay Olcen, Aviation Consulting Group, Turkiye	Ibrahim Kaya, Allbatross Asset Management, Turkiye
12.15-12.30	**Twitter sentiment analysis for optimal portfolio construction**	**Financial development and income inequality relationship: a study on Turkiye**
	Oktay Tas, Istanbul Technical University, Turkiye	Beyza Gunes, Bilgi University, Turkiye
	Burak Kucukaslan, Istanbul Technical University, Turkiye	Sema Tur Bayraktar, Bilgi University, Turkiye
12.30-12.45	**Winery tours and tasting experiences as key factors in a successfull wine marketing strategy – based on the analysis of family-owned wineries' in the Neusiedlersee DAC**	**Beyond linear regression: enhancing predictive accuracy in stock price prediction using ensemble methods**
	Petra Platz, University of Gyor, Hungary	Samir K. Safi, United Arab Emirates University, UAE
		Mariam Daiban, United Arab Emirates University, UAE
		Dania Awwad, United Arab Emirates University, UAE
12.45-13.00	**The impact of artificial intelligence on the audit process: automation and efficiency gains**	**Financial marketing through machine learning techniques and data analytics for customer behavior prediction**
	Samir Errabih, University of Sidi Mohamed Ben Abdellah, Morocco	Tugce Ekiz Yilmaz, Dokuz Eylul University, Turkiye
	Arabi Abdelbasset, University of Sidi Mohamed Ben Abdellah, Morocco	

13.00-16.45	**ROOM 1 | SESSION 3.1**	**ROOM 2 | SESSION 3.2**
	Chair: Prof. Oktay Tas, Istanbul Technical University	**Chair: Dr. Fahrettin Pala, Gumushane University**
13.00-13.15	**The use of social networking websites as a recruiting practice**	**Energy consumption-outward foreign direct investment-natural resource rents nexus: evidence from BRICS-T countries**
	Alexandra-Ioana Popescu, West University of Timisoara, Romania	Suat Mumcu, Gebze Technical University
	Denisa Abrudan, West University of Timisoara, Romania	Huseyin Ince, Gebze Technical University
13.15-13.30	**Rising value of data in contemporary higher education**	**Corporate governance and artificial intelligence: transition, responsibilities and prospects**
	Ali Eskinat, Netkent University, Turkiye	Antonio Tipaldi, Università degli Studi di Salerno, Italy
	Suat Teker, Işık University, Turkiye	
13.30-13.45	**Bitcoin prices using ARCH and GARCH models: a backcasting study**	**Economic competitiveness and population well-being in Europe: strategies for sustainable growth**
	Dilek Teker, Isik University, Turkiye	Alexandrina Brinza, University of Galați, Romania
	Suat Teker, Isik University, Turkiye	Cristea Dragos-Sebastian, University of Galați, Romania
	Esin Demirel, Isik University, Turkiye	Lăzărescu Ioana, University of Galați, Romania
13.45-14.00	**Cash flow, efficiency and financial stability analysis for sustainable business development**	**Enacting entrepreneurship and leadership: a longitudinal exploration of gendered identity**
	Lucian Gabriel Maxim, Transilvania University of Brasov, Romania	Mohamed Fitouri Fsegmahdia, University of Monastir and LISEFE, Tunisia
		Akram Belhadj Mohamed, Taif University Arabie Saoudite, Saudi Arabia
14.00-14.15	**The distance between the profit and the tax base for Hungarian enterprises consequences for the Hungarian accounting regulation**	**Impact of cross-border e-commerce on growth of Turkish SMEs**
	László Péter Lakatos, Budapest Corvinus University, Hungary	Irmak Orman, Isık University, Turkiye
		Suat Teker, Isık University, Turkiye
14.15-14.30	**A comparative analysis of hybrid midas-sarimax models for GDP forecasting: empirical evidence from Palestine**	**Transition to modular architecture in mobile finance applications**
	Samir K. Safi, United Arab Emirates University, UAE	Pinar Celdirme Kaygusuz, Turkcell, Turkiye
	Olajide Idris Sanusi, University of Wisconsin, USA	
	Umar Kabir Abdullahi, Ahmadu Bello University, Nigeria	

14.30-14.45	**The impact of business intelligence on administrative decision-making at Amman Arab University**	**Analysis of economic regulatory and supervisory authorities in Turkey in the context of public interest theory: the example of Banking Regulation and Supervision Agency -** *Türkiye'de ekonomik düzenleyici ve denetleyici otoritelerin kamu yararı teorisi bağlamında analizi : Bankacilik Düzenleme ve Denetleme Kurumu örneği*
	Mahmoud Hussein Abu Joma, Amman Arab University, Jordan	Ahmet Kavakli, Istanbul Commerce University, Turkiye
		Ali Osman Gurbuz, Istanbul Commerce University, Turkiye
14.45-15.00	**Evaluation of sustainable energy sources and sustainability reports: the case of Canadian solar -** *Sürdürülebilir enerji kaynakları ve sürdürülebilirlik raporlarının değerlendirilmesi: Canadian solar örneği*	**The impact of the widespread use of digital payment systems on individual spending habits and savings -** *Dijital ödeme sistemlerinin yaygınlaşmasının bireysel harcama alışkanlıklarına ve tasarruflarına etkisi*
	Merve Vaysal, Karabuk University, Turkiye	Fahrettin Pala, Gumushane University, Turkiye
15.15-15.30	**Financial fragility in resource-rich high-income economies -** *Yüksek gelirli kaynak zengini ekonomilerde finansal kırılganlık*	**Design and development of smart POS systems: commission optimization and transaction efficiency -** *Akilli POS sistemlerinin tasarimi ve geliştirilmesi: komisyon optimizasyonu ve işlem verimliliği*
	Sami Kucukoglu, Istanbul Ticaret University, Turkiye	Begum Al, Turkcell, Turkiye
	Elif Guneren Genc, Istanbul Ticaret University, Turkiye	Gamze Sezgen, Turkcell, Turkiye
15.30-15.45	**Analysis of the impact of climate policy and energy uncertainties on the stock exchange: the case of Turkiye and USA -** *İklim politikası ve enerji belirsizliklerinin borsa üzerindeki etkisinin analizi: Türkiye ve Amerika*	**The impact of fintech investments in Turkey on e-commerce -** Türkiye'deki fintek yatırımlarının e-ticarete etkisi
	Kübra Saka Ilgın, Erzincan Binali Yıldırım University, Turkiye	Anıl Atas, Firat University, Turkiye
		Gamze Ayca Kaya, Firat University, Turkiye
15.45-16.00	**Green finance: development, current situation and future in Turkiye and the world -** *Yeşil finans: Türkiye ve dünyada gelişimi, mevcut durumu ve geleceği*	**The relationship between social security policies and life insurance demand in OECD countries -** *OECD ülkelerinde sosyal güvenlik politikalarının hayat sigortası talebi üzerindeki yansıması*
	Esra Aksoylu, Maltepe University, Turkiye	Hasan Meral, Marmara University, Turkiye
16.00-16.15	**The effects of trade tariffs on inflation in Cameroon: the moderation effect of exchange rate**	**Mainstream economics and finance dogmas and neoclassical memorizations: examples of Milton Friedman, Eugene Fama and Nobel -** *Ana akım ekonomi ve finans dogmaların ve neoklasik ezberler: Milton Friedman, Eugene Fama ve Nobel örnekleri*
	Nzembanteh, University of Bamenda, Cameroon	Cuneyt Dirican, Istanbul Arel University
16.15-16.30	**Dynamic leadership in AI-driven economies: navigating disruption through strategic foresight and adaptive capabilities**	**Weather shocks and financial performance during the Covid-19 pandemic**
	Benja Stig Fagerland, USN School of Business, Norway	Dastan Aseinov, Kyrgyz-Turkish Manas University, Kyrgyzstan
16.30-16.45	**The impact of subsidies and incentives on firms' innovation performance**	
	Ahmet Iskender, Istanbul Technical University	
	Oktay, Tas, Istanbul Technical University	

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ABSTRACTS OF THE CONGRESS

TWITTER SENTIMENT ANALYSIS FOR OPTIMAL PORTFOLIO CONSTRUCTION

Burak Kucukaslan, Istanbul Technical University
Oktay Tas, Istanbul Technical University

This research investigates the efficacy of social media sentiment analysis in constructing alpha-generating investment portfolios. Specifically, the study examines whether Twitter-derived sentiment indicators can be leveraged to develop systematic trading strategies that generate risk-adjusted returns exceeding benchmark performance. The research aims to establish quantitative criteria for position initiation and termination based on sentiment metrics, with the ultimate objective of creating a portfolio that demonstrates significant outperformance relative to the reference index. The study encompasses 16 companies of the Nasdaq 100 index, selected to represent diverse market sectors while controlling for liquidity and market impact considerations. The dataset comprises 708,080 Twitter posts pertaining to the selected companies throughout the 2022 calendar year, extracted via programmatic data collection methodologies. Sentiment quantification was performed utilizing the Natural Language Toolkit (NLTK) in Python, generating normalized sentiment scores within a [-1, +1] interval. The investigation employed a sophisticated aggregation methodology to compute both daily and weekly sentiment indicators for each security, deliberately excluding neutral sentiment scores (0) to enhance signal clarity. A systematic portfolio construction framework was implemented, whereby securities were hierarchically ranked based on their aggregate sentiment scores on a weekly basis. Multiple portfolio permutations were tested, incorporating various combinations of long positions in top-ranked securities and short positions in bottom-ranked securities. Position entry and exit prices were determined using weekly opening and closing prices, respectively. Portfolio performance was evaluated through the calculation of weekly returns and cumulative performance metrics over the observation period. The empirical results reveal that portfolios constructed exclusively with short positions demonstrated superior cumulative returns compared to long-only portfolios. This observation can be contextualized within the broader market environment, specifically the Nasdaq 100's negative 33% return in 2022. The research identified statistically significant outperformance in portfolios implementing a combined long-short strategy, with these portfolios generating positive absolute returns despite the challenging market conditions. The empirical evidence substantiates the hypothesis that Twitter sentiment analysis can be effectively utilized as a signal generation mechanism for systematic portfolio construction. The results demonstrate statistically significant alpha generation capabilities, particularly when implementing a long-short strategy, suggesting potential applications for institutional investors and quantitative fund managers.

Keywords: Twitter, sentiment analysis, portfolio construction
JEL Codes: H30, H60, H62

ANALYSIS OF BANKING REGULATION AND SUPERVISION AGENCY (BRSA) ACTIVITIES IN THE CONTEXT OF THE PUBLIC INTEREST THEORY

Ahmet Kavakli, Istanbul Ticaret University
Ali Osman Gurbuz, Istanbul Ticaret University

In the literature, economic regulation theories are generally approached under two main headings: Public Interest Theory and Private Benefit Theory. Public Interest Theory examines public regulations in terms of the welfare provided to society and argues that regulations should be implemented for the purpose of maximizing social welfare by eliminating market failures arising from various reasons. Althought there is a dominant view in the literature regarding the difficulty of both defining and measuring public interest, the aim of this study is to analyze/evaluate the effects of the BRSA's activity (regulation and supervision) results on the Turkish banking sector and some macroeconomic aggregates in the context of the theory. By using the Bankometer Score (S-Score), which is a discriminant analysis method, the effects of BRSA's activity (regulation and supervision) results on the Turkish banking sector and some macroeconomic aggregates were analyzed I the context of the Public Interest Theory. For this purpose, in the first stage, S-Score calculations were made for the banking sector at the end of the year for the period 1989-2023, including the period before and after the BRSA, and the differences between the 2 periods were revealed. Then, using these S-Score results as a variable for the model (other variables are Capacity Utilization Rate of Manufacturing Industry, Reel Sector Confidence Index and Foreign Direct Investments) for quarterly periods in 2007 and beyond, Granger Causality test was applied through the Eviews program. In the pre-BRSA period (1989-2000), it was observed that the S-Score figure showed a steady worsening trend over the years starting from 1989. After BRSA became operational in 2000, S-Score results on a sectoral basis in the calculations made since 2001 have yielded much better results than before 2000. In addition, according to the results of the Granger Causality analysis conducted on Eviews in our model, it has been concluded that S-Score, which shows the robustness of the sector on which the BRSA has a very strong decisive position, is the cause of FDI, which might contribute to economic growth and productivity in Turkey. It has been concluded that the supervisory and regulatory activities carried out by the BRSA are very important in restoring the health of the Turkish banking sector and in maintaining the safe activities of the financial sector, and when looked at in terms of the dimension subject to analysis, the results of the BRSA's activities are in line with the Public Interest Theory.

Keywords: Public Interest Theory, Banking Regulation and Supervision Agency, Bankometer Score, Granger Causality
JEL Codes: A10, C32, G21

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FACTORS RESHAPING INVESTOR RISK PERCEPTION: SOCIAL MEDIA, NEWS, AND BEHAVIORAL BIASES

Bahar Koseoglu, Bahcesehir University

In the modern financial ecosystem, the rapid dissemination of information through social media and news outlets significantly influences investor decision-making. However, the impact of these information channels on investor risk perception remains underexplored, particularly from a behavioral finance perspective. In today's interconnected world, digital platforms like social media and online news have become pivotal sources of financial information, often surpassing traditional media in speed and accessibility. Platforms such as Twitter and Reddit allow for real-time dissemination of market news and opinions, empowering retail investors but also amplifying market volatility. While these platforms democratize financial knowledge, they also propagate misinformation, rumors, and emotional narratives that can distort investor perceptions of risk and reward. The influence of digital media in shaping financial behavior underscores the need to critically analyze its role in decision-making processes, particularly as markets become increasingly driven by collective sentiment. Unlike objective measures of risk, such as volatility, risk perception is highly subjective and shaped by cognitive and emotional factors, making it a key driver of investment behavior. Misjudged risk perception can lead to suboptimal decisions, such as overestimating market dangers during a downturn or failing to act on lucrative opportunities due to fear or overconfidence. Understanding how risk perception is formed and influenced is crucial for improving investment strategies and mitigating financial market inefficiencies. This study serves as a preliminary analysis for a larger research project aimed at understanding the influence of social media and news on investor risk perception. Drawing upon a comprehensive literature review, it explores the mechanisms through which these digital information sources reshape risk perception, emphasizing the role of key behavioral biases such as herding, framing effects, and representativeness bias. The outcome of this analysis is a proposed conceptual model that integrates these behavioral factors to form the foundation for a comprehensive project design. The model hypothesizes that media content impacts risk perception through behavioral biases, moderated by financial literacy levels. This framework sets the stage for future empirical validation and project development, ultimately contributing to the understanding of investor behavior in an increasingly digitalized financial environment.

Keywords: Investor risk perception, behavioral finance, social media, financial literacy
JEL Codes: G41, G53, D81

RISING VALUE OF DATA IN CONTEMPORARY HIGHER EDUCATION

Ali Eskinat, Netkent University
Suat Teker, Isik University

The purpose of this study is to reflect the importance of effective use of data to predict and improve academic success as an essential criterion for assessing the quality of higher education institutions in the 21st Century. This paper intends to clarify importance of data and its evaluation components, namely Educational Data Mining (EDM), Learning Analytics (LA), Artificial intelligence (AI) and Machine Learning (ML), as integral part of Fifth Generation Universities (UNIVERSITY 5.0) era in the globalized competitive higher education sector. For this reason, this paper advocates "Rising Value of Data in Contemporary Higher Education" for the university of the new age. The study employs a literature review aiming to reflect the new atmosphere and requirements in the higher education system based on selected topics. A comprehensive analysis on the game changer role of data in the higher education institutions was considered. The aim was to identify the difference created by effective use of data in higher education institutions to predict and improve academic success in the competitive academic environment of the new era. The analysis reveals that higher education institutions should understand the essential role of educational data with the expansion of digital revolution and rapid change in technologies in the 21st Century and design their strategies accordingly. Notably, it is clearly seen that the universities have not only effectively use educational data and its evaluation components namely Educational Data Mining (EDM), Learning Analytics (LA), Artificial intelligence (AI) and Machine Learning (ML) but also internalize the reality of their rising value to predict and improve academic success as well as creating a significant financial contribution to their development. As a matter of the fact, universities established many projects and effectively used their Learning Analytics (LA) tools. Besides, the emergence of Artificial intelligence (AI) and Machine Learning (ML) enhanced the efficiency and effectiveness of management operations. Findings may be concluded that universities need to apply the effective use of data particularly in the context of new era like Industry 5.0, Society 5.0 and University 5.0 to obtain academic success, which is considered as an essential criterion for assessing the quality of higher education institutions. Indeed, universities have to follow a data- driven culture as greater demands of universities already appeared for retention, completion and graduation rates of students to improve student success. As a matter of fact, the effective use of Educational Data Mining (EDM) and Learning Analytics (LA) is going on for the last two decades in higher education institutions. Indeed, Artificial intelligence (AI) and Machine Learning (ML) are effective in data management as two impressive game changers for universities changing educational world from the financial perspective. For this reason, it may be argued that the effective use of data and its evaluation components, namely Educational Data Mining (EDM), Learning Analytics (LA), Artificial intelligence (AI) and Machine Learning (ML) are considered as the integral part of Fifth Generation Universities (UNIVERSITY 5.0) era in the globalized competitive higher education sector of 21st Century.

Keywords: Higher education, educational data mining, learning analytics, artificial intelligence and machine learning, University 5.0
JEL Codes: A20, I23, M10, O31, O32

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NAVIGATING FINANCIAL AWARENESS ACROSS GENERATIONAL SHIFTS: INTEGRATING AGILE MANAGEMENT FOR FUTURE SUCCESS

Szilárd Malatyinszki, Kodolányi János University
Géza Horvath, Kodolányi János University
Botond Géza Kalman, Kodolányi János University

The purpose of this study is to explore the intersection of financial awareness, generational differences, and agile management practices in achieving organizational success within the context of rapidly changing economic realities and workforce dynamics. The study aims to understand how agile management can support financial literacy across different generational groups, thereby enhancing organizational adaptability and resilience. The study employs a mixed-method approach, combining quantitative surveys and qualitative interviews. The surveys evaluate financial literacy levels among employees across generational cohorts, while the interviews gather insights from management teams utilizing agile frameworks. This dual approach ensures a comprehensive analysis of the relationship between generational financial literacy and agile management practices. The analysis reveals significant generational differences in financial literacy, with younger employees demonstrating higher adaptability but lower financial literacy compared to their older counterparts. Agile management practices, characterized by flexibility, collaboration, and iterative learning, were found to effectively bridge these gaps. These practices facilitated continuous learning and enhanced cross-generational communication, fostering a more cohesive and financially literate workforce. Based on the analysis, it may be concluded that integrating agile management practices with targeted financial education programs significantly improves financial literacy across all generational cohorts. This integration not only equips organizations to navigate generational shifts more effectively but also strengthens their financial resilience and adaptability to evolving market dynamics.

Keywords: Agile management, financial literacy, generational differences, workforce adaptability, organizational resilience.
JEL Codes: M14, J24, G53

BACKCASTING BITCOIN VOLATILITY: ARCH AND GARCH APPROACHES

Dilek Teker, Isik University
Suat Teker, Isik University
Esin Demirel Gumustepe, Isik University

The primary purpose of this study is to model Bitcoin price volatility and forecast its future price returns using advanced econometric models such as ARCH and GARCH. The study aims to enhance risk management strategies and support informed investment decisions by addressing the time-varying nature of Bitcoin's volatility. The research explores the persistence of volatility shocks and the clustering of price movements to provide insights into market dynamics. This research examines daily Bitcoin closing prices over the period from January 2020 to October 2024. The data was preprocessed to ensure reliability, including applying logarithmic transformations to standardize the data and eliminate trends. Stationarity tests, such as the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and KPSS tests, were conducted to confirm the series' stationarity. The ARCH-LM test was utilized to detect volatility clustering which is essential for validating the use of ARCH and GARCH models. Following this, ARIMA models were employed to define mean equations and GARCH models were used to estimate conditional variance and capture volatility dynamics. The dataset was split into training and validation subsets with data from July to October 2024 reserved for validation. The findings demonstrate that Bitcoin's price movements exhibit significant volatility clustering and persistence of shocks which are key characteristics effectively captured by ARCH and GARCH models. These models provide valuable insights into the volatility patterns of Bitcoin, supporting their application in cryptocurrency analysis. Despite their robustness, the models face limitations in precise return forecasting during highly volatile periods, suggesting the need for further refinement or integration with advanced approaches. The research concludes that ARCH and GARCH models are effective tools for understanding and forecasting Bitcoin's volatility. The study underscores the importance of acknowledging volatility persistence and clustering effects when analyzing cryptocurrency price behavior. However, it also highlights areas for improvement in econometric modelling by including the exploration of hybrid models and the integration of macroeconomic factors to enhance forecasting accuracy.

Keywords: Bitcoin, ARCH Models, GARCH Models, Forecasting, ARIMA Models
JEL Codes: C58, G10, G12

THE IMPACT OF THE WIDESPREAD ADOPTION OF DIGITAL PAYMENT SYSTEMS ON INDIVIDUAL SPENDING HABITS AND SAVINGS

Fahrettin Pala, Gumushane University

The aim of the study is to examine the impact of digital payment systems on individual savings rates and spending habits in Türkiye. Additionally, it is to evaluate the impact of digital payment systems on individual spending and savings within the framework of the COVID-19 crisis.

The research aims to examine the impact of digital payment systems on individual savings rates and spending habits by adopting a quantitative approach. Additionally, as a sub-objective, it aims to evaluate the impact of digital payment systems on individual spending and savings within the framework of the COVID-19 crisis. In the study, quarterly data for the period 2016Q1-2023Q4 were analyzed using household consumption expenditures, gross savings amount, digital payment systems (mobile payment, online banking, contactless payments, and all other digital payment methods), consumer price index, deposit interest rate, consumer credit interest rate, and consumer confidence index. The Newey–West Standard Errors Estimator has been used for data analysis. It has been shown digital payment systems have a statistically significant and positive effect on household final consumption expenditures and gross savings. Again, it has been concluded the pandemic period had a statistically significant and negative impact on household final consumption expenditures and gross savings. Additionally, it has been observed digital payment systems had an impact on increasing household consumption expenditures and savings during the pandemic period. In the study, the effects of digital payment systems in Turkey on individual savings rates and spending habits were examined. The findings obtained indicate that digital payment systems have a statistically significant and positive impact on household final consumption expenditures and gross savings. In addition, it has been determined that the COVID-19 pandemic has a statistically significant and negative impact on household consumption expenditures and gross savings. Additionally, it has been observed that digital payment systems played a positive role in increasing individuals' consumption expenditures and savings during the pandemic period. These findings reveal how digital payment infrastructure shapes individuals' financial behaviors during times of crisis, providing an important foundation for future research examining the interaction between digital finance and crisis dynamics.
Keywords: Digital payment systems, household final consumption expenditure, gross savings rate, Covid-19 pandemic.
JEL Codes: D12, E21, E32

HOW GREEN BONDS AFFECT CLEAN ENERGY INVESTMENTS AND CARBON EMISSIONS?

Gulden Poyraz, Bandirma Onyedi Eylul University
Tugba Guz, Istanbul Yeni Yuzyil University

The negative effects of climate change and environmental degradation on national economies have led many countries to invest in renewable energy to create low-carbon economies globally. In this context, green bonds have emerged as a financing tool contributing to developing clean energy. This study aims to examine the impact of green bonds (GB) on clean energy investment (CEI) and carbon emissions (CO_2) in 28 countries that issued green bonds between 2014 and 2020. The System Generalized Method of Moment (GMM) is used in the study. Two different models with CEI and CO_2 as dependent variables are used. In the model where CO_2 is taken as the dependent variable, it is observed that the GBs significantly reduce CO_2 emissions with a coefficient of -0.024%. In this model, a significant and positive relationship was found between CO_2 and GDP and dirty energy consumption (dirty) taken as a control variable, and a significant and negative relationship was found between the urban population and CO_2. In the model where CEI was taken as the dependent variable, no significant relationship was observed between GB and CEI, while a significant and positive relationship was found between dirty energy consumption and CEI. No relationship was observed between CEI and other control variables in the model. This study primarily contributes to the growing literature on the market for green bonds. The study findings will also assist policymakers in creating inclusive policies to reduce CO_2 emissions and promote clean energy investments. Additionally, the ability of green bonds to direct capital towards environmentally friendly projects and enhance financing efficiency will encourage more countries to issue green bonds.
Keywords: Green bonds, clean energy investment, carbon emissions, finance, system GMM
JEL Codes: E44, G15, O16

ANALYSIS OF THE IMPACTS OF CLIMATE POLICY AND ENERGY UNCERTAINTIES ON THE STOCK EXCHANGE: THE CASE OF TÜRKİYE AND AMERICA

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It can be stated that global uncertainty indices, which were developed to measure the effects of global uncertainties on markets and the economy, may have the potential to affect risk perception and investment strategies in the markets. Determining the direction and intensity of the impact of uncertainty and risks on stock markets has become very important for stock market investors under these conditions. This paper aims to comparatively examine how the Climate Policy Uncertainty Index (CPUI) and Energy Uncertainty Index (EUI), which are relatively newer than global uncertainty indices and have been the subject of fewer studies, affect stock prices in Borsa Istanbul 100 (BIST100) and Standard&Poors 500 (S&P500) stock exchanges, in a developing and developed country stock exchange. The short and long-term relationships between global uncertainty indices and stock prices were investigated using the ARDL (Distributed Autoregressive Lag) Bounds Test. ARDL is an approach that has several advantages over classical cointegration methods. It was determined that CPUI and EUI significantly affected the S&P500 index both in the short and long term, positively and negatively, respectively. For BIST100, this effect was negative but statistically insignificant for both indices in the long-term. This paper has highlighted the impact of climate policy and energy uncertainty indices on stock prices, especially in developed countries. In this context, the study emphasizes that investors and policymakers in these countries, especially those considering investing in developed countries, should consider these uncertainty indices and closely monitor them to reduce risks in their risk assessments and optimize their investment strategies. The paper contributes to the existing literature by improving the understanding of

how climate policy uncertainty affects financial markets in developed and developing economies. The findings suggest that investors and policymakers should consider different effects when assessing the financial impacts of climate policy and energy uncertainty. Future research could investigate how firms respond to such uncertainties and the financial impacts of corporate strategies at the sectoral level.
Keywords: Uncertainty, climate policy uncertainty, energy uncertainty, stock exchange
JEL Codes: C32, G01, G11

SOCIAL MEDIA SENTIMENT AND ITS EFFECTS ON CRYPTOCURRENCY PRICE VOLATILITY

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Following its introduction in 2008, cryptocurrencies have attracted great deal of attention from the investors. Cryptocurrency market have grown rapidly in terms of transaction volumes and number of investors involved with the launch of different kinds of alternative coins (altcoins). Cryptocurrency markets show some differences from the stock market with less institutional investor involvement. With the high proportion of retail investors in the market, we assume sentiment would be one of the leading forces that can accelerate cryptocurrency price movements in both directions that leads to higher volatilities. In this study, we try to shed a light on social media sentiment and its effect on cryptocurrency price volatility for 9 different cryptocurrencies, namely Bitcoin, Ethereum, Ripple, Binance Coin, Dogecoin, Solana, Cardano, Litecoin, Avax. The study uses Google search volume index and number of tweets weekly collected from Twitter between the dates January 2020 to March 2023 as investor attention measures to attract social media sentiment in addition to economic policy uncertainty index (EPU), CBOE S&P 500 implied volatility index (VIX) and macro and micro indexes constituted by using the Google search volume indexes for micro and macro fears and taking the weekly sum of those indexes. We investigated investor attention measures and mentioned indexes' impact on cryptocurrency volatility by using seemingly unrelated regression. The analysis reveals that google search volume index has a significant positive impact on volatility of cryptocurrencies in addition to economic policy uncertainty index and micro pessimism measures. Number of tweets data has no significant impact on volatility in contrast to Google search volume index. Based upon the analysis, it may be concluded that google search volume index has better captured investor attention and might give an insight regarding cryptocurrency volatilities where number of tweets collected from Twitter has no significant impact on volatilities. Internal audit is important for the company's reputation in the market. International financial crises and especially scandals more clearly reveal the necessity of an effective internal audit system.
Keywords: Cryptocurrency, investor attention, social media sentiment, google search volume index, uncertainty index
JEL Codes: G10**,** G14, L86

TRANSITION TO MODULAR ARCHITECTURE IN MOBILE FINANCE APPLICATIONS

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A fintech company As user expectations and market demands continue to evolve, the application undergoes constant updates to ensure it remains both responsive to user needs and capable of delivering reliable and high-quality services. However, as applications grow in complexity, maintaining their scalability, flexibility, and manageability becomes increasingly challenging. In this context, adopting a modular software architecture emerges as a strategic solution, offering a more streamlined approach to reducing the intricacy of mobile applications while enhancing their adaptability and scalability. It provides a detailed analysis of how modularization can simplify development processes, improve application performance, and make updates more efficient. Furthermore, the study highlights the key advantages of this architectural shift, such as easier maintenance, faster feature deployment, and improved testing capabilities. In addition, specific criteria are outlined to guide the identification and definition of modules, ensuring that the modular design aligns with the application's objectives and delivers optimal benefits. Through this exploration, the study aims to provide a roadmap for successful modularization and demonstrate its value in modern mobile application development.
Keywords: Modular structure, refactoring, dependency injection, modularization, mobile finance application
JEL Codes: E44, G01, G32

FINANCIAL FRAGILITY IN RESOURCE-RICH HIGH-INCOME ECONOMIES

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The purpose of this study is to identify the economic, financial, and liberal factors affecting the financial fragility levels of resource-rich high-income economies and to analyze the interactions between these factors. The methodology of the study includes a panel data analysis for the period 2006-2023. The research focuses on resource-rich high-income economies with a Gross Domestic Product (GDP) per capita exceeding $14,005 (based on the World Bank's Atlas method) and natural resource exports accounting for more than 25% of their total exports, according to TradeMap data. The analysis aimed at determining the financial fragility levels of resource-rich high-income economies revealed that improvements in the rule of law and judicial effectiveness positively impact the financial fragility index, thereby supporting financial stability. Similarly, government expenditures, broad money supply, and the asset size of deposit banks were also found to have a positive effect on the financial fragility index, contributing favorably to stability. However, increases in financial liberalization scores were observed to negatively

affect the financial fragility index, weakening stability. Additionally, the lagged value of the financial fragility index showed a persistent effect on the current levels of fragility. Resource-rich high-income economies are distinguished not only by their vast natural resource reserves but also by their high-income levels and advanced economic structures. Ensuring sustainable financial stability in such economies necessitates adopting a holistic approach. Controlled implementation of financial liberalization, coupled with the establishment of adequate regulatory and supervisory mechanisms, can strengthen financial stability. Likewise, a robust rule of law and an effective judicial system can enhance the confidence of economic actors, contributing to reduced financial fragility. Effective and efficient management of public expenditures supports economic growth and resilience while ensuring the sustainability of these expenditures. Strengthening the banking sector's structure and aligning its size to contribute positively to economic stability can enhance the resilience of the financial system. In designing monetary supply policies, it is essential to manage risks such as inflationary pressures and asset bubbles while increasing liquidity. Policies should not only aim to reduce dependence on natural resources but also promote economic diversification, thereby supporting inclusive and sustainable growth.
Keywords: Camel analysis, fragility, resource-rich economies, liberalization, panel data.
JEL Codes: G00, G10, G15

ENERGY CONSUMPTION-OUTWARD FOREIGN DIRECT INVESTMENT-NATURAL RESOURCE RENTS NEXUS: EVIDENCE FROM BRICS-T COUNTRIES

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Huseyin Ince, Gebze Technical University

This research measures the impacts of population, economic development, outward foreign direct investment, and natural resource rent on energy consumption in BRICS-T countries (Brazil, Russia, India, China, South Africa and Turkey). The main objective of the study is to evaluate the impact of outward foreign direct investment and natural resource rents on environmental sustainability together and to examine the structure of the relationship between economic growth and energy consumption with the Environmentally Kuznet Curve (EKC) hypothesis. This analysis, which was carried out within the framework of the STIRPAT (Stochastic Impacts by Regression on Population, Affluence, and Technology) theoretical model, examined the effects of factors on energy consumption with Driscoll-Kraay standard error fixed effects estimator as a result of the determination of country heterogeneity and robustness tests. The analyses show that population and gross domestic product per capita are positively related to energy consumption. At the same time, outward foreign direct investment decreases energy consumption in BRICS-T countries through the reverse spillover effect. The findings on the positive relationship between natural resource rents and energy consumption indicate that energy consumption increases in BRICS-T countries through fossil fuel-intensive production processes. The study also found a statistically significant inverted u-shaped curve between energy consumption and economic growth, but detecting a turning point outside the data set suggests that the EKC hypothesis is not valid in BRICS-T countries. The findings of the study show that outward foreign direct investment makes possible the transfer of environmentally friendly technologies from host countries to the home country and increases energy efficiency in the production process. Therefore, BRICS-T countries need to see outward foreign direct investment not only as an economic gain but also as a tool for environmental improvement. The fact that natural resource rents encourage fossil fuel dependency suggests that some of these resources should be directed to renewable energy projects. In conclusion, it is recommended that BRICS-T countries adopt green growth strategies, gradually remove fossil fuel subsidies and implement environmental regulations such as carbon tax to achieve sustainable development goals.
Keywords: Stirpat Model, EKC hypothesis, natural resources, outward foreign direct investment, energy consumption.
JEL Codes: P18, P28, P48

THE IMPACT OF FINTECH INVESTMENTS IN TURKEY ON E-COMMERCE

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In this study, the diversity and development of fintech investments in the world and in Turkey were examined. Since financial technology investments are fintech investments developed specifically for the e-commerce system, the impact of fintech companies established in Turkey and the investments of currently operating companies on e-commerce were investigated. The data set of the study was created with the market share data, sales volumes and number of users of the e-commerce sector between 2019-2023, the data are obtained from the Republic of Turkey. Presidential Finance Office and T.R. It was obtained from the websites of the Ministry of Commerce and analyzed with the SPSS program and regression analysis was applied. The analysis model shows that the effect of the independent variable on the dependent variable is not significant. Analysis results reveal that Fintech investments alone are not sufficient for the development of e-commerce. The data that will be obtained with the increase in investments in the field of Fintech in the future will shed light on researches who will conduct research on a similar subject.
Keywords: Finance, technology, fintech, e-commerce.
JEL Codes: G00, O30, G21, L81

THE DISTANCE BETWEEN THE PROFIT AND THE TAX BASE FOR HUNGARIAN ENTERPRISES: CONSEQUENCES FOR THE HUNGARIAN ACCOUNTING REGULATION

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Financial statements are generated to provide stakeholders with a thorough insight into an entity's financial position and performance. A comprehensive framework of rules and regulations is essential to govern the content of statements, and the concepts or procedures utilized in their formulation, ensuring they fulfill their intended purpose. Such regulations can develop through two main approaches: the creation of overarching concepts or the development of detailed, thorough guidance. Previous studies in many jurisdictions have shown that businesses often display specific preferences for certain regulation methods. Certain businesses advocate for principle-based frameworks due to their flexibility and adaptability, whereas others prefer rule-based systems for their clarity and precision. These preferences encompass fundamental aspects of financial management, particularly the inclination of enterprises to voluntarily separate their tax base from their accounting profit, a notion generally known as tax-book conformity. This study aims to analyze these processes within the Hungarian corporate sector. The objective is to ascertain whether particular groups of Hungarian firms exhibit an increased propensity to voluntarily deviate their tax base from their accounting profit. Our research demonstrates that smaller firms exhibit greater transparency in tax-book conformance, resulting in a diminished willingness to differentiate between accounting values and tax values. This research elucidates the essential regulatory preferences of these firms through an analysis of their behavior. The study evaluates the Hungarian accounting regulatory framework to determine its conformity with either a principle-based or rule-based approach. Understanding this alignment is crucial, as it significantly impacts the quality and integrity of financial reporting. The results are expected to deepen the overarching discourse on regulation design and its impact on corporate practices, offering substantial insights into the effect of Hungarian accounting standards on financial decision-making and reporting quality. This research enhances the academic understanding of regulatory preferences and offers practical insights for politicians and regulators to augment the effectiveness of financial reporting standards.

Keywords: Tax-book conformity, accounting, regulation
JEL Codes: M40, M41, H25

DESIGN AND DEVELOPMENT OF SMART POS SYSTEMS: COMMISSION OPTIMIZATION AND TRANSACTION EFFICIENCY

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Traditional POS systems often result in high transaction costs, increased error rates, and insufficient customer satisfaction. To overcome these limitations, smart POS systems have been developed to optimize transaction processes using advanced routing algorithms. This study aims to examine the impact of smart POS systems on transaction efficiency, customer satisfaction, and the significant reduction of commission costs through intelligent routing and data-driven decision mechanisms. Dynamic routing mechanisms were utilized for commission cost optimization. Big data analytics tools, including Apache Spark and HDFS, were applied to process real-time transaction data, ensuring scalable and adaptive solutions. The findings demonstrate that smart POS systems significantly reduce commission costs, lower transaction error rates, and improve operational efficiency. Additionally, integrating customer behavior prediction models with intelligent routing strategies enhances customer satisfaction and financial performance. This study highlights the significant contributions of smart POS systems to the fintech sector by addressing gaps in transaction efficiency, commission cost management, and customer satisfaction. Future research should focus on refining predictive models and further optimizing routing strategies tailored to diverse transaction and asset types to maximize system performance.

Keywords: Smart POS systems, transaction efficiency, commission cost optimization, customer behaviour prediction, big data analytics
JEL Codes: D53, G21, L80

EVALUATION OF SUSTAINABLE ENERGY SOURCES AND SUSTAINABILITY REPORTS: THE CASE OF

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The increase in global energy demand and increasing environmental problems have accelerated the return to renewable energy and made sustainable energy production and reporting necessary. The aim of this study is to examine the sustainability report of Canadian Solar, one of the leading companies in the renewable energy sector, within the framework of ESG (environmental, social and governance) criteria and to determine its impact on financial performance. In this context, how ESG criteria are measured in sustainability reports and the impact of this measurement on financial performance were examined. In this study, Canadian Solar's sustainability report for 2023 was examined with the content analysis method and its impact on financial performance was evaluated through financial indicators. According to the relevant year's financial data, sustainability activities have positively affected profitability and capital efficiency by relatively reducing the company's costs. These activities have strengthened the company's capital structure while providing environmental awareness. In the study examining the effect of the sustainability activity report on financial performance, policies to increase the use of renewable energy resources and reduce carbon emissions more comprehensively positively affected the company image and improved the financial situation.

Keywords: Renewable energy, sustainability, financial performance
JEL Codes: Q56, Q20, G32

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GREEN FINANCE: DEVELOPMENT, CURRENT SITUATION AND FUTURE IN TURKIYE AND THE WORLD

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Today, the climate crisis has become one of the most urgent problems on a global scale. As a result of the search for solutions to this problem, the concept of 'green finance' has emerged. Green finance is a system that provides financing for projects developed to support sustainable development goals and reduce environmental risks. Especially with the deepening of global climate change, the importance of implementing sustainable initiatives has been better understood and various financial instruments have been developed to support these projects. This study aims to provide a comparative analysis of the development processes and current status of green finance practices in the world and in Turkey, and to provide recommendations for the improvement of existing policies. The study provides a comprehensive international literature review on green finance and comparatively analyses the practices in the world and in Turkey. The use of green finance instruments is becoming increasingly widespread on a global scale; innovative solutions such as green bonds, sustainable credit models, green funds and carbon finance are finding a place in financial markets. Although there are good examples of green finance practices in Turkey such as green bond issuances and green loans in the banking sector, the momentum in developed countries has not yet been achieved. Green finance in Turkey is still an emerging field. A number of policies and regulations are needed to develop the potential of this field. In particular, the effectiveness of green finance in financial markets can be increased by increasing incentives for green projects, diversifying green financial products, tax incentives for green bond issuances, increasing national and international cooperation, and facilitating regulations on green and sustainable finance. In this respect, the dissemination of green financing instruments in cooperation with both the public and private sectors will contribute significantly to Turkey's achievement of its sustainable development goals.

Keywords: Green finance, sustainable finance, green bond
JEL Codes: Q56, G23, G15

MEASURING THE SENSITIVITY OF DIFFERENT MONTE CARLO MODELS IN FORECASTING AIRLINE STOCK PRICES

Olcay Olcen, Aviation Consulting Group, ACG

Monte Carlo Models are widely utilised by scientific research in a variety. Two research models are argued and designed regarding the Quasi and Pseudo Monte Carlo models in this paper. The main research questions are formed here as “Which Monte Carlo model can give more effective results to USA Airline investors?”. There is a utilisation problem of Monte Carlo Models by investors. The research also will help to fill this gap. On the other hand, Sobol and Halton sequences are utilized to develop Quasi Monte Carlo Model. Quasi-Monte Carlo Models are given more real results than Pseudo Monte Carlo Models, especially in high number (5000) iterations. The results are specifically important for investors. The main disadvantage of the research is a random timespan that is out of a crisis or special event. According to research results of bias (the approximation to reality), the Quasi-Monte Carlo Model gives more efficient results than the Pseudo Monte Carlo Model regarding accuracy and sensitivity. Investors in the American Air Carriers financial market should be aware of this important reality.

Keywords: Monte Carlo models, American Airlines, stock price
JEL Codes: B26, O18, R11

FINANCIAL DEVELOPMENT AND INCOME INEQUALITY RELATIONSHIP: A STUDY ON TURKEY

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Financial development is of great importance for economic growth, social development and sustainable development especially in developing countries. Therefore, the relationship between financial development and income inequality has maintained its importance throughout history. The aim of this study is to contribute to the literature by analyzing the effect of financial development on income inequality in Turkey and to offer solutions in line with the results obtained. The original value of the study is to examine the relationship between financial development and income inequality in different layers with the control variables of institutional quality factors. Since Kuznets curve appears to have followed democratization, as shown by Acemoglu and Robinson's highly influential study in 2000, this study also adds some democracy indices as institutional control variables when studying the relationship between financial development and income inequality. Besides, in addition to the Gini coefficient, the shares of various income groups in the national income, including the lower, middle-, and upper-income groups, are also used as a measure of income inequality. In the current study, the relationship between Gini, G1, G10, G40, G50 and financial development index in existence of institutional control variables is assessed using the Autoregressive Distributed Lag (ARDL) model. The ARDL model is chosen due to its flexibility in accommodating variables that are integrated of order zero, I(0), or order one, I(1), without requiring them to be of the same order of integration. The model helps capture both the short-term and long-term dynamics of the relationship, allowing for a more comprehensive understanding of the effects over time. The results indicate the relationship between the Financial Development Index (FDI) and income inequality measures —namely, Gini, G1, G10, G40, and G50—is influenced by some of the specific institutional quality indicators. Significant long-term relationships are observed, with the effects of FDI on income inequality moderated by governance factors. Besides, the significance of institutional factors or democracy indices is not stable for different income groups. Gini, the general income inequality index is the one for which more significant long-term relationships between income inequality and institutional/democracy indices are observed. Namely, the accountability, electoral democracy index, rule of law, property rights , regimes of the world, academic freedom index are the

institutional/democracy factors that reveals long term relationship with income inequality index of Gini. The only institutional factor that shows a long term significant relationship for all incoöe groups is property rights. However, when the relationship is analyzed, the expected direction of the relationship is not observed for most of the instutional/democracy indices and the significance of the institutional factors are not stable but some similarities emerge. Overall, the findings show that while FDI has potential for growth and reducing inequality, institutional factors/democracy indices may also be important. Effective accountability mechanisms and democracy indices may also enhance FDI's capacity to reduce inequality, emphasizing the need for policy reforms to strengthen institutional quality. However, to make stronger suggestion that policymakers should focus on improving governance structures to maximize the equitable benefits of FDI -since the results are not strong and stable- research needs to be empowered by using longer data set or different institutional quality factors.
Keywords: Income inequality, income groups, financial development, democracy indices, institutional quality factors
JEL Codes: D7, D310, O430

GENDER DIFFERENCE IN RISK AND CONFIDENCE PERCEPTION: IMPLEMENTATION WITH LOGIT MODEL

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Suat Teker, Isik University
Beyda Demirci, Isik University

This study aims to understand individuals' behaviors and perceptions regarding investment preferences. Specifically, it examines the differences in investors' perceptions of "concerns about losing money due to investment decisions" and "confidence in their knowledge of portfolio creation and management" based on the gender variable. The study utilizes survey data from 69 participants (29 female and 40 male). It employs logit models to analyze two dependent variables: (1) the stress level due to concerns about investment decisions and (2) confidence in portfolio management and financial knowledge. Gender is the key independent variable, with marginal effects calculated for unambiguous interpretation. The results indicate that gender has a statistically significant impact on both stress and confidence levels. Women are 21.2% more likely than males to experience stress due to concerns about investment decisions. Conversely, females are 18.5% less likely to feel confident about their financial knowledge and portfolio management abilities than males. These findings reflect the gender-based differences in risk perception and confidence. The study highlights the critical role of gender in shaping investment behaviors. Women tend to exhibit higher risk aversion and lower financial confidence than men. To address this disparity, targeted financial education programs and awareness initiatives are recommended to enhance women's financial literacy and confidence. Bridging this gap can contribute to improved financial participation and decision-making among women.
Keywords: Logit model, investment behavior, risk perception, gender, confidence.
JEL Codes: C35, G11, G40

FINANCIAL MARKETING THROUGH MACHINE LEARNING TECHNIQUES AND DATA ANALYTICS FOR CUSTOMER BEHAVIOR PREDICTION

Tugce Ekiz Yilmaz, Dokuz Eylul University

The purpose of this study is to explore the application of machine learning techniques and data analytics in financial marketing for predicting customer behaviors and optimizing marketing strategies. The research aims to highlight the transformative role of these methods in enhancing customer acquisition, retention, and overall return on investment (ROI). The study employs various machine learning techniques, including time series analysis, regression models, and deep learning algorithms such as RNN and LSTM, to analyze and predict customer behaviors. Additionally, clustering algorithms like K-Means and DBSCAN are utilized for effective customer segmentation. Data analytics methods, including ROI analysis and causal impact evaluation, are integrated to measure and improve campaign performance. The analysis reveals that machine learning and data analytics significantly contribute to financial marketing by uncovering patterns in customer behaviors, improving targeting strategies, and providing actionable insights for personalized marketing. Applications in credit scoring, fraud detection, and customer journey mapping demonstrate the effectiveness of these approaches in real-world scenarios. Based on the analysis, it may be concluded that the integration of machine learning and data analytics into financial marketing enables businesses to make data-driven decisions, optimize marketing campaigns, and achieve higher ROI. The findings suggest that these methods are essential for staying competitive in the financial sector.
Keywords: Financial marketing, machine learning, data analytics, customer behavior prediction, ROI optimization.
JEL Codes: C45, M31, G21

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ENACTING ENTREPRENEURSHIP AND LEADERSHIP: A LONGITUDINAL EXPLORATION OF GENDERED IDENTITY

Mohamed Fitouri, University of Monastır
Akram Belhaj Mohamed, Taif University

The purpose of this study is to explore how gendered identities shape and influence the enactment of entrepreneurship and leadership over time. This research examines the dynamic process of identity construction among male and female entrepreneurs and leaders, focusing on the interaction between societal gender norms and personal leadership practices. By investigating the long-term experiences of individuals in leadership and entrepreneurial roles, the study aims to uncover how gender plays a pivotal role in shaping identity and influencing decision-making processes, leadership styles, and business success. The study employs a longitudinal qualitative research design, using in-depth interviews and case studies of 30 entrepreneurs and leaders (15 men and 15 women) over a five-year period. This approach allows for an exploration of the evolution of their identities in relation to their entrepreneurial and leadership activities. The participants are drawn from a diverse range of industries, and data collection includes interviews conducted at multiple intervals to capture changes in identity construction over time. Thematic analysis is used to identify recurring patterns and to understand the influence of gendered experiences on leadership and entrepreneurship. The analysis reveals that gendered identity significantly influences how individuals navigate entrepreneurial and leadership roles. Female entrepreneurs and leaders often face greater challenges in balancing societal expectations with their personal leadership styles, leading to adaptive behaviors and strategic identity shifts. Male participants, on the other hand, are found to engage in more assertive leadership practices that align with traditional gender norms, but they too experience pressures to conform to societal expectations. The study highlights how gender-based expectations shape risk-taking, networking, and decision-making in entrepreneurial and leadership contexts. Over time, both male and female participants exhibit identity flexibility, though women are more likely to integrate relational and transformational leadership approaches into their entrepreneurial activities. Based on the analysis, it may be concluded that gender plays a central role in the development of entrepreneurial and leadership identities. Gendered identity not only influences how individuals approach leadership challenges but also affects their ability to innovate and sustain business growth. Female entrepreneurs and leaders, in particular, demonstrate resilience and adaptability in navigating the dual pressures of conforming to gender norms while striving for success in traditionally male-dominated spheres. The study contributes to a deeper understanding of the complexities of gender and leadership, offering insights for promoting more inclusive and equitable entrepreneurial environments.

Keywords: Entrepreneurship, leadership, gendered identity, longitudinal study, identity construction.
JEL Codes: M10, M20, M50

THE RELATIONSHIP BETWEEN SOCIAL SECURITY POLICIES AND LIFE INSURANCE DEMAND IN OECD COUNTRIES

Hasan Meral, Marmara University

This study examines the relationship between social security coverage and life insurance demand in OECD member countries. Specifically, it explores how key social security indicators shape life insurance penetration. The study aims to highlight the impact of social security policies on life insurance coverage and emphasizes the importance of this relationship for policymakers and industry stakeholders. The dataset used in this study consists of the most up-to-date data obtained from the OECD and Sigma Explorer databases. OECD member countries are initially grouped based on their levels of life insurance penetration using K-Means clustering analysis. Relevant social security indicators are then analyzed, and the differences between the groups are evaluated through ANOVA testing. The findings show that countries with a higher share of public social security and healthcare expenditures in GDP also exhibit higher life insurance penetration. Moreover, an increase in the old-age dependency ratio positively influences life insurance demand. However, no significant relationship is observed between pension system indicators and life insurance demand. The study shows that social security policies and demographic structures have a significant impact on life insurance demand. The higher life insurance penetration in countries with substantial social expenditures suggests that welfare policies facilitate individuals' access to financial security mechanisms and enhance insurance inclusion.

Keywords: Life insurance demand, social security policies, cluster analysis
JEL Codes: G22, H55, J14

UNDERSTANDING THE MATHEMATICAL BACKGROUND OF MODERN PORTFOLIO THEORY

Ibrahim Kaya, Allbatross Asset Management

Modern Portfolio Theory (MPT), pioneered by Harry Markowitz, provides a quantitative framework for portfolio optimization by balancing risk and return through diversification. This study focuses on applying MPT principles using Python and the PyPortfolioOpt library to construct optimized portfolios. The analysis involves selecting high-performing U.S. stocks over the past year, implementing advanced optimization techniques, and evaluating performance metrics such as Sharpe ratios. By leveraging these methodologies, the study aims to demonstrate how MPT, combined with Python's computational power, can enhance investment decision-making. The study incorporates a systematic approach to portfolio optimization. Data was collected from TradingView, focusing on high-performing stocks across various sectors. The optimization process utilized PyPortfolioOpt for mean-variance optimization, risk parity, and minimum correlation portfolio construction. Historical price

data was preprocessed for normalization, and statistical techniques such as correlation analysis and covariance matrix evaluation were applied to ensure robust portfolio allocation. Sharpe ratios were calculated to assess the risk-adjusted returns of the portfolios. This study demonstrates the practicality of Modern Portfolio Theory (MPT) when combined with python-based portfolio optimization techniques. Using the PyPortfolioOpt library, the analysis highlights how computational tools enhance portfolio construction by balancing risk and return. The optimized portfolio, based on high-performing U.S. stocks, achieved an expected annual return of 8.39%, annualized volatility of 17.36%, and a Sharpe ratio of 1.76, showcasing efficient risk-adjusted performance. Diversification emerged as a key factor in mitigating risk, with weights allocated to stocks from various sectors to balance returns and volatility. Assets with lower Sharpe ratios or high correlations were excluded, aligning with MPT's principles. Risk management strategies, including covariance matrix evaluation, ensured a robust portfolio structure. The results validate the effectiveness of python-driven optimization in building diversified portfolios that cater to investment objectives. This study reaffirms the relevance of Modern Portfolio Theory (MPT) in portfolio management while showcasing Python's capabilities for optimization. The optimized portfolio achieved a sharpe ratio of 1.76, exemplifying the balance between maximizing returns and minimizing risk. Diversification and systematic data analysis played pivotal roles, with weights favoring assets offering favorable risk-return profiles. The findings underline the value of combining MPT with computational tools like PyPortfolioOpt to construct portfolios that align with diverse financial goals. However, further research could explore dynamic market conditions, broader datasets, and alternative risk metrics to improve portfolio resilience and adaptability. This study highlights the potential of python-driven optimization to bridge financial theory and practical application, enabling robust and efficient portfolio management in dynamic markets.
Keywords: Modern Portfolio Theory, Portfolio optimization, PyPortfolioOpt, risk management, Sharpe Ratio
JEL Codes: C61, G11

IMPACTS OF CROSS-BORDER E-COMMERCE ON GROWTH OF TURKISH SMEs

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Cross-border e-commerce has emerged as a critical enabler for the globalization of small and medium-sized enterprises (SMEs), particularly in the wake of the COVID-19 pandemic. This study explores the transformative impact of digital marketplaces, innovative payment systems, and logistics advancements on the internationalization of Turkish SMEs. Leveraging a mixed-methods approach, the research combines quantitative data analysis with qualitative insights from industry stakeholders. The findings highlight the significant role of platforms such as Amazon and Alibaba in reducing market entry barriers, the importance of secure digital payment systems in fostering trust, and the contribution of logistics innovations to the growth of small-package exports. By aligning with global consumer trends and leveraging digital tools, Turkish SMEs can overcome traditional trade barriers, enhance competitiveness, and access broader markets. The study concludes with strategic recommendations for policymakers and SMEs, emphasizing the need for regulatory support and investment in digital infrastructure to maximize the benefits of cross-border e-commerce. The study was carried with a mixed-methods approach. Quantitative Analysis: Data from the Turkish Statistical Institute, Turkish Exporters Assembly (TİM), and global e-commerce platforms were analyzed to track export trends, marketplace performance, and consumer behavior. Qualitative Insights: Interviews with SME owners, e-commerce experts, and policymakers provided in-depth perspectives on challenges and opportunities. And as case studies, Successful Turkish SMEs from sectors like textiles and food were examined to identify strategies for internationalization. The COVID-19 pandemic has significantly accelerated e-commerce adoption in Turkey, leading to substantial growth in online spending and reshaping various sectors of the economy. Below are some of the main findings; platform Impact, global marketplaces significantly increase SME visibility and reduce market entry barriers; digital payment systems, enable secure, efficient transactions, fostering trust among international customers; small package exports, innovations in logistics, such as faster shipping, have fueled SME participation in global trade; post-Covid consumer behavior, the pandemic accelerated global e-commerce adoption, creating new opportunities for Turkish SMEs. Cross-border e-commerce represents a transformative opportunity for Turkish SMEs, enabling them to overcome traditional barriers and compete effectively in global markets. By leveraging digital platforms, payment innovations, and logistics advancements, SMEs can drive growth, internationalization, and competitiveness. Strategic support from policymakers will be crucial in maximizing the potential of this digital trade revolution.
Keywords: E-commerce, marketplaces, international trade, digital payment systems
JEL Codes: F23, L26, L81, O31

THE IMPACT OF SUBSIDIES AND INCENTIVES ON FIRMS' INNOVATION PERFORMANCE

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The purpose of this study is to investigate the impact of government incentives on firm innovation performance in Turkey, with the aim of providing an evidence-based framework for evaluating the effectiveness of these policies. By examining how various incentive mechanisms influence firms' research and development (R&D) investments, product innovations, and process improvements, the study seeks to identify the key factors that drive innovation performance across different sectors and firm sizes. This research will contribute to the academic literature by addressing the ongoing debate surrounding the efficiency and effectiveness of government incentives. It will also provide strategic insights for policymakers, enabling the design and implementation of more targeted and efficient support mechanisms. Ultimately, the findings aim to enhance the alignment of government policies with Turkey's broader goals of fostering innovation, improving global competitiveness, and achieving sustainable economic growth. The methodology of this study is designed to analyze the impact of government incentives on firm innovation performance in Turkey using a quantitative research approach. The primary dataset utilized is sourced from the World Bank's

Enterprise Survey (WBES), which covers over 150 countries and provides comprehensive information on various aspects of the business environment, such as financial access, corruption, infrastructure, competition, and firm performance. For Turkey, six separate surveys conducted between 2002 and 2019 were utilized. These surveys include data from firms of varying sizes, sectors, and regions, capturing both those that received government incentives and those that did not. Based on a thorough literature review, a model tailored to the dataset was developed. The dependent variable is the presence of innovation within firms, measured as a binary outcome, while government incentives serve as the primary independent variable. Firm-specific characteristics frequently highlighted in the literature, such as firm size, age, export intensity, and sectoral distribution, are included as control variables to ensure a comprehensive analysis. The statistical analysis was conducted using the Logit regression technique in Python, chosen for its suitability in estimating the probability of binary outcomes. Diagnostic criteria such as Pseudo R-squared, log-likelihood, LL-Null, and the likelihood ratio test (LLR p-value) were employed to evaluate model fit and statistical significance. The results reveal that government incentives have a statistically significant effect on the likelihood of firm innovation, alongside other firm-specific factors. This methodological framework provides a robust basis for understanding the relationship between government support and innovation performance, offering valuable insights for policymakers. The study reveals that R&D expenditures have the most significant impact on innovation, while the effect of firm size is relatively smaller. Government incentives and export ratios positively influence innovation likelihood, consistent with literature. Over time, firm age has shown a growing positive effect on innovation. In Turkey, the probability of innovation for incentivized firms reached 19% in 2019, compared to 6% for non-incentivized firms, though the overall impact of incentives remains limited. International comparisons highlight Turkey as having the lowest innovation probability among non-incentivized firms, with incentives providing modest improvements compared to other countries. The findings highlight the limited effectiveness of government incentives in Turkey compared to other countries with stronger incentive mechanisms, such as Slovenia and the Czech Republic. To address this, more strategic and targeted policies are needed to enhance the impact of incentives, reverse the declining innovation trends, and align incentive mechanisms with broader innovation strategies. These steps are critical for improving Turkey's innovation performance, fostering competitiveness, and driving sustainable economic growth.

Keywords: Innovation performance, incentive, subsidies, logit regression, enterprise surveys, R&D expenditure.
JEL Codes: O31, O32, O38

FINANCE DOGMAS AND NEOCLASSICAL MEMORIZATIONS IN MAINSTREAM ECONOMICS: EXAMPLES OF MILTON FRIEDMAN, EUGENE FAMA AND NOBEL

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During the post-pandemic exit period, while the Russia-Ukraine War was ongoing and the earthquake disaster was following, the fiscal policy in which macroprudential measures were implemented between December 2021 and May 2023 was frequently criticized in the mainstream and accused of being unscientific, claiming that it was an economic experiment (and heterodox economic literature was excluded or ignored). It was claimed that the economy would get back on track with a return to orthodox monetary policy and rationality. In the past period, when the inflation rate remained higher at the end of 1.5 years compared to May 2023, it is claimed and said by the mainstream that the money supply and public expenditures (fiscal policies) did not accompany the monetary policy. Therefore, it is claimed that the household's belief in inflation did not decrease (inertia) and they are not reducing their expenditures because of that situation. It was generally said (especially in social media posts and TV market channels) that locals (in academy and business the right usage is residents) did not act rationally by fueling inflation, especially service inflation, along with the minimum wage increase. (The name) “The Nobel Prize in Economics” and the beliefs and discourses in mainstream economics such as "*the money supply is always and everywhere inflationary*", "people and investors are rational" and "the importance of institutions in economic development and progress" are actually very different as declined/corrrected from/by its own sources, hence it was intended to be shown with scientific references and sources. In this study, examples were examined through a summary literature review, and it was shown that neoclassical memorization and dogmas were corrected by the owners (itselves) of these discourses, arguments and hypotheses, and were different from what is known in the mainstream (economics). In this way, it is a qualitative and conceptual study. Friedman, Fama and members of the Nobel Family corrected and rejected their own statements (hypotheses) and the facts mentioned in this study. The inflation-money supply relationship, the inflation and the investment relationship with (ir)rational households and investors, prize-winning theories such as the relationship between development and inflation, and real per capita income can still find firm supporters and a place in the mainstream and neoclassical understanding, although they have been revised by their main resources who first issued them. Although there are immutable rules in economics and finance, the financial policies implemented depending on the period and/or the dynamics of the countries may differ, and even if the policies are the same, the results may differ. While ignoring a (heterodox) literature in economics, not being aware of the developments and updates in the (orthodox) literature regarding the other (claimed as rational) understanding defended may not lead the proposed prescriptions and thus their results to the desired direction. In Türkiye, parallel to the World, these acceptances in mainstream (neoclassical) economics are a bitter prescription and cannot be a solution in the new economy. When data and graphs are presented by detaching them from the context of the facts and events of the relevant period, this is not economics but statistics (Dirican, 2024a).

Keywords: Money Supply, Efficient Market Hypothesis, Inflation, Nobel Economy Prize, Milton Friedman, Eugene Fama
JEL Codes: E13, E44, E51, E71

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SOCIAL MEDIA SENTIMENT AND ITS EFFECTS ON CRYPTOCURRENCY PRICE VOLATILITY

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ABSTRACT

Purpose- Following its introduction in 2008, cryptocurrencies have attracted great deal of attention from the investors. Cryptocurrency market have grown rapidly in terms of transaction volumes and number of investors involved with the launch of different kinds of alternative coins (altcoins). Cryptocurrency markets show some differences from the stock market with less institutional investor involvement. With the high proportion of retail investors in the market, we assume sentiment would be one of the leading forces that can accelerate cryptocurrency price movements in both directions that leads to higher volatilities. In this study, we try to shed a light on social media sentiment and its effect on cryptocurrency price volatility for 9 different cryptocurrencies, namely Bitcoin, Ethereum, Ripple, Binance Coin, Dogecoin, Solana, Cardano, Litecoin, Avax.
Methodology- The study uses Google search volume index and number of tweets weekly collected from Twitter between the dates January 2020 to March 2023 as investor attention measures to attract social media sentiment in addition to economic policy uncertainty index (EPU), CBOE S&P 500 implied volatility index (VIX) and macro and micro indexes constituted by using the Google search volume indexes for micro and macro fears and taking the weekly sum of those indexes. We investigated investor attention measures and mentioned indexes' impact on cryptocurrency volatility by using seemingly unrelated regression.
Findings- The analysis reveals that google search volume index has a significant positive impact on volatility of cryptocurrencies in addition to economic policy uncertainty index and micro pessimism measures. Number of tweets data has no significant impact on volatility in contrast to Google search volume index.
Conclusion- Based upon the analysis, it may be concluded that google search volume index has better captured investor attention and might give an insight regarding cryptocurrency volatilities where number of tweets collected from Twitter has no significant impact on volatilities.

Keywords: Cryptocurrency, investor attention, social media sentiment, Google Search Volume Index, Uncertainty Index
JEL Codes: G10**,** G14,L86

1. INTRODUCTION

Cryptocurrencies were first launched in 2008. Cryptocurrencies' decentralized nature enables peer-to-peer payments without the need for financial intermediaries. Cryptocurrency records are kept on a decentralized ledger, where an automated algorithm governs the issuance rate of new coins. Following the Bitcoin launch in 2009, the price steeply increased.

The significant rise in Bitcoin's value, followed by launching a wide range of alternative coins (altcoins) attracted more and more investors to the market and vast majority of transactions make cryptocurrency market deserve closer examination. As of 2024, there are approximately 13,217 cryptocurrencies listed globally, due to the fact that many of them are inactive or have minimal value. The total market capitalization of the cryptocurrency market fluctuates, with current estimates around $1.32 trillion. In addition to Bitcoin and Ethereum, which dominate market share, there are many other smaller cryptocurrencies that less significantly contribute to the overall value.

Attention is a scarce resource (Kahneman, 1973), and investors experience attention overload when many events wait for their focus, making it harder to concentrate on any single one. Whether attention has an impact, positive or negative, on cryptocurrency markets is unclear.

Cryptocurrencies, while sharing some similarities with stock markets, have different characteristics, particularly regarding the types of investors involved. Unlike equity markets that have substantial number of institutional investors, crypto markets attract more retail investors (Białkowski, 2020). This unique characteristic of cryptocurrency markets raises the question of how investor attention impacts price volatility.

As their popularity increased, cryptocurrencies have become a focal point for both investors and academic researchers, with "What drives Bitcoin?" being a prominent question. We propose that investor sentiment influences cryptocurrency prices for several reasons.

First, the unique market dynamics favour retail investors, who often make trading decisions based on sentiment rather than sophisticated valuations used by institutional investors. This sentiment-driven approach has the potential to significantly amplify price movements in both upward and downward directions.

Second, given the complexity and risks associated with cryptocurrencies, we expect a “flight-to-quality” behaviour during heightened market sentiment, leading investors to shift towards less risky assets. Previous studies support this view, suggesting that cryptocurrencies do not serve as a hedge during market downturns (Klein et al., 2018).

Finally, the relatively new nature of cryptocurrencies fosters emotional investment decisions, with some fearing missing out while others view them as speculative bubbles. This environment likely fuels sentiment-driven trading, often overshadowing rational decision-making.

Given these dynamics, it is essential to explore how investor behaviour influences cryptocurrency volatility. The main purpose of this thesis is to investigate the impacts of different investor attention measures and their relationship with cryptocurrency volatility. We use twitter sentiment as number of tweets as a measure of twitter sentiment. We analyse the effects of Google Search Volume Index and twitter sentiment at the same time. We believe we better capture the investor attention while considering both Google and Twitter sentiments.

We also follow the work of Burggraf et al. (2020) by constructing investor pessimism index (IPI) by using the Google Search Volume indexes for micro and macro fears, and taking the weekly average of those indexes, we constitute macro and micro indices. Macro and micro index make us measure both investors’ individual, household-level concerns as well as concerns related to the general economic status on the volatility of the nine cryptocurrencies, namely Bitcoin, Ethereum, XRP, BNB, ADA, DOGE,SOL, LITECOIN and AVAX.

Our work also incorporates two more measures of market uncertainty. First, we include the economic policy uncertainty (EPU) index as Baker, Bloom, and Davis (2016). This measure is based on the frequency of newspaper articles containing terms relating to a) uncertainty, b) economy, and c) policy.

Finally, we include the CBOE S&P500 implied volatility index (VIX) as an indicator of financial market uncertainty. This “fear index” has a well-documented negative relationship with stock market returns along with a positive relationship with realized volatility. A similar relationship is found for Bitcoin (Bouri et al., 2017) and other cryptocurrencies (Akyildirim, Corbet, Lucey, Sensoy, & Yarovaya, 2020) during periods of high financial market uncertainty.

2. LITERATURE REVIEW

Research on social media sentiment and its impact on cryptocurrency volatility has gained attention in recent years, as these markets are highly influenced by public sentiment and attention-driven factors. Numerous studies explore how online activity, such as Google search volumes, Twitter mentions, and other social media metrics, can serve as indicators of market movements. For instance, studies like those by Shen et al. (2019) and Mai et al. (2018) indicate that higher search volumes and tweet frequencies correlate with increased volatility and price shifts in cryptocurrencies. Similarly, findings by Smales (2019) highlight the predictive power of Economic Policy Uncertainty (EPU) indices on asset volatility, with particular relevance in the context of emerging and speculative markets. Micro-level sentiments, such as fear and greed indices, also emerge as significant predictors, as demonstrated by Balcilar et al. (2017), suggesting that investor psychology deeply affects crypto market behaviour. These studies collectively emphasize the complex role of digital attention and sentiment metrics in cryptocurrency markets, complementing the current research by offering insights into how specific attention-driven metrics contribute to market fluctuations. Similarly, Demir et al. (2018) show that EPU predicts Bitcoin returns, suggesting that cryptocurrency markets react strongly to global uncertainty. Bouri et al. (2020) and Burggraf et al. (2020) also examine Bitcoin's role as an asset class in periods of macroeconomic turbulence, indicating that while Bitcoin often serves as a diversifier, its performance as a risk hedge is limited.

Research utilizing Google Search Volume Index (GSVI) as a measure of investor attention has consistently highlighted its significant impact on cryptocurrency volatility and price movements. Studies have shown that increased search volume often correlates with heightened volatility in cryptocurrency markets, suggesting that spikes in investor interest can lead to more significant price fluctuations. For example, Jiang and Li (2021) found that heightened attention correlates with both increased trading volume and volatility. Similarly, Kristoufek (2018) demonstrated the predictive power of GSVI on cryptocurrency prices, reinforcing the idea that investor attention plays a critical role in market dynamics. Dyhrberg and Duffy (2018) highlighted the influence of investor sentiment on Bitcoin price dynamics, while Yousaf and Bukhari (2020) indicated that heightened sentiment directly contributes to increased price volatility. Collectively, these findings underscore the importance of investor attention in understanding cryptocurrency market behavior.

Additionally, Bouri et al. (2017) and Akyildirim et al. (2020) confirm that VIX, the “fear index” representing S&P 500 volatility expectations, is positively correlated with cryptocurrency volatility. This finding highlights the interconnectedness of cryptocurrencies with traditional financial markets, where heightened volatility in equities often spills over into digital assets, increasing their risk profile during turbulent times.

3. DATA AND METHODOLOGY

In this study weekly data is collected starting from 12 January 2020 until 3 March 2023.

To examine the effects of investor sentiment on cryptocurrency volatility, we use following volatility measure:

Return : $R_t = \ln(P_t) - \ln(P_{t-1})$

$Vol_t = |R_t|$

Where P_t represents the cryptocurrency price at the end of week t, R_t is the return calculated as weekly price changes. Vol1 is the first volatility measure which is simply the absolute return.

For Volatility:

$$|R_t| = \beta_0 + \beta_1 GSV_{i,t} + \beta_2 numberoftweets_{i,t} + \beta_3 \overline{EPU_{i,t}} + \beta_4 \overline{EPU_{i,t}} + \beta_5 VIX\max_{i,t} + \beta_6 VIX\max_{i,t} + \beta_7 \text{macro}_{i,t} + \beta_8 \text{micro}_{i,t} + \beta_9 fe\arg reed_{i,t} + \varepsilon_{i,t}$$

GSV denotes weekly Google Search Volume Index for the specific cryptocurrency, number of tweets measure is the weekly sum of number of tweets for each cryptocurrency. EPU is the weekly economic policy uncertainty index where Δ EPU is the weekly difference of Economic policy uncertainty index.VIX max is the weekly maximum value of CBOE S&P500 implied volatility index (VIX) where Δ VIX max is the weekly difference of VIX max. We also include fear greed index in the model to help better understand investor behaviour. We also follow the work of Burggraf et al. (2020) by constructing investor pessimism index (IPI) by using the Google Search Volume indices for micro and macro fears, and taking the weekly sum of those words' Google search volume indices, we constitute macro and micro indices.

4. FINDINGS

In this study, seemingly unrelated regression (SUR) is used to define the relationship between social media sentiment and cryptocurrency volatility. Below the tables, we explained the relationship among variables.

5. CONCLUSION

The SURMG regression results reveal significant relationships between specific attention and sentiment indicators and cryptocurrency volatility. Specifically, Google search volume (lgsv) and weekly economic policy uncertainty (lweeklyepuavg) positively impact volatility, suggesting that heightened attention and uncertainty correlate with market fluctuations. Micro-level pessimism (lmicropessimism) also shows a positive, significant effect, indicating that individual investor concerns contribute to increased volatility. In contrast, Twitter activity (lnumberoftweets) and other sentiment measures show non-significant effects, highlighting that not all attention metrics equally influence market movements. These findings underscore the complex role of sentiment and attention in driving cryptocurrency volatility.

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NAVIGATING FINANCIAL AWARENESS ACROSS GENERATIONAL SHIFTS: INTEGRATING AGILE MANAGEMENT FOR FUTURE SUCCESS

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ABSTRACT

Purpose – The purpose of this study is to explore the intersection of financial awareness, generational differences, and agile management practices in achieving organizational success within the context of rapidly changing economic realities and workforce dynamics. The study aims to understand how agile management can support financial literacy across different generational groups, thereby enhancing organizational adaptability and resilience.

Methodology – The study employs a mixed-method approach, combining quantitative surveys and qualitative interviews. The surveys evaluate financial literacy levels among employees across generational cohorts, while the interviews gather insights from management teams utilizing agile frameworks. This dual approach ensures a comprehensive analysis of the relationship between generational financial literacy and agile management practices.

Findings – The analysis reveals significant generational differences in financial literacy, with younger employees demonstrating higher adaptability but lower financial literacy compared to their older counterparts. Agile management practices, characterized by flexibility, collaboration, and iterative learning, were found to effectively bridge these gaps. These practices facilitated continuous learning and enhanced cross-generational communication, fostering a more cohesive and financially literate workforce.

Conclusion – Based on the analysis, it may be concluded that integrating agile management practices with targeted financial education programs significantly improves financial literacy across all generational cohorts. This integration not only equips organizations to navigate generational shifts more effectively but also strengthens their financial resilience and adaptability to evolving market dynamics.

Keywords: Agile management, financial literacy, generational differences, workforce adaptability, organizational resilience.
JEL Codes: M14, J24, G53

1. INTRODUCTION

The rapidly evolving global economy has necessitated a reevaluation of traditional management practices to accommodate shifting workforce dynamics and increasing financial complexities. Generational diversity within organizations—spanning Baby Boomers, Generation X, Millennials, and Generation Z—has introduced significant disparities in financial literacy and adaptability. Baby Boomers, shaped by the economic hardships of the 1970s, exhibit strong financial caution but lower adaptability to change. Conversely, Gen Z employees, emerging in a digitally transformative era, display exceptional adaptability but face challenges in financial literacy. These intergenerational gaps demand innovative solutions that leverage the strengths of each group while addressing their respective limitations.

Financial awareness has emerged as a critical competency for navigating modern economic realities. It not only enhances personal decision-making but also contributes to organizational resilience in fluctuating markets. Traditional management strategies often fall short in bridging generational gaps, highlighting the need for approaches that are both adaptive and inclusive. Agile management, with its emphasis on flexibility, collaboration, and iterative learning, presents a promising framework for addressing these challenges. By fostering cross-generational communication and continuous education, agile practices can unify diverse workforce segments, creating a cohesive and financially literate organizational culture.

This study seeks to explore the intersection of financial literacy, generational differences, and agile management. Through a mixed-method approach that combines quantitative surveys and qualitative interviews, it investigates how agile frameworks can support financial awareness across generations. Initial findings reveal that younger employees, while adaptable, lack the financial literacy of their older

counterparts. Agile management practices have demonstrated potential in closing these gaps by promoting knowledge-sharing and iterative learning processes.

The integration of agile methodologies with targeted financial education programs offers a strategic path forward. This approach not only equips organizations to handle generational shifts effectively but also builds a workforce that is both adaptable and financially resilient, ensuring long-term success amidst the complexities of a modern economy.

2. LITERATURE REVIEW: INTEGRATING AGILE MANAGEMENT TO BRIDGE GENERATIONAL GAPS IN FINANCIAL AWARENESS

Introduction

The dynamics of modern organizations are shaped by an increasingly diverse workforce spanning multiple generations. The study presented at the 13th Istanbul Finance Congress (IFC.2024) highlights a critical challenge faced by contemporary organizations: bridging generational gaps in financial awareness through the adoption of agile management. This literature review explores existing research on financial literacy, generational differences, and agile management, contextualizing the findings and strategies presented in the study.

Generational Differences in Financial Awareness

The generational cohort analysis from Baby Boomers to Gen Z reveals substantial disparities in financial literacy and adaptability. Baby Boomers, shaped by events such as the 1970s oil crisis, exhibit high levels of financial literacy but lower adaptability to technological change. In contrast, Gen Z, raised during the digital transformation era, demonstrates strong adaptability yet lower financial literacy. These discrepancies create challenges for organizations aiming to harmonize generational strengths while mitigating their weaknesses.

Research by Lusardi and Mitchell (2014) supports this observation, indicating that financial literacy decreases significantly among younger cohorts, exacerbating knowledge gaps in financial decision-making. Conversely, studies by Twenge and Campbell (2012) highlight younger generations' openness to learning and adapting to digital solutions, showcasing their potential for agile learning methodologies.

Agile Management and Its Principles

Agile management, rooted in iterative learning, collaboration, and flexibility, offers a robust framework for addressing these generational gaps. The emphasis on continuous learning aligns with younger employees' adaptability while fostering a structured environment for older generations to share financial expertise.

Empirical evidence supports the efficacy of agile management. A study by Khan et al. (2025) demonstrates that organizations employing agile frameworks experience improved cross-functional collaboration and faster adaptability to market changes. Additionally, agile management has been associated with higher employee satisfaction due to its inclusive and iterative approach, as noted by Dikert, Paasivaara, and Lassenius (2016).

Bridging the Generational Divide

One of the central themes of the IFC.2024 presentation was leveraging agile methodologies to bridge generational divides. Two key strategies emerge:

- Cross-Functional Collaboration: Agile frameworks encourage collaboration among diverse generational groups, fostering mutual learning. For instance, the case studies presented illustrate how financial workshops employing iterative cycles increased confidence in financial literacy among younger employees by 75%.
- Mentorship and Knowledge Sharing: Older employees' financial expertise can be leveraged through mentoring programs embedded within agile sprints, enabling knowledge transfer while promoting adaptability.

Academic literature corroborates these findings. Chau and Tam (2000) emphasize the importance of shared knowledge networks in enhancing organizational performance, while De Massis et al. (2018) underline the role of cross-generational learning in achieving innovation.

Case Studies: Evidence from Practice

The case studies presented at IFC.2024 exemplify the practical application of agile management in addressing generational gaps:

- Team A: Focused on improving financial literacy through iterative learning workshops, resulting in enhanced financial confidence among 75% of participants.
- Team B: Prioritized adaptability, achieving an 85% improvement in project flexibility by fostering intergenerational teamwork through agile sprints.

These cases align with findings from Lee and Edmondson (2017), who demonstrate that iterative processes reduce barriers to innovation and increase team cohesion.

Challenges and Limitations

While the integration of agile management shows promise, the study acknowledges several challenges. Resistance to change among older employees remains a high-risk factor. Furthermore, variability in the definition of financial literacy across demographic groups complicates

the standardization of educational initiatives. Literature by Villegas et al. (2024) underscores that successful change management necessitates tailored strategies for overcoming entrenched resistance.

Future Directions

The study proposes extending research into other industries and exploring digital tools to enhance financial awareness. Emerging technologies, such as AI-driven financial literacy platforms, hold promise for addressing generational gaps, as evidenced by Choi et al. (2020). Furthermore, broadening the adoption of agile methodologies could foster more inclusive and adaptive workplaces.

Conclusion

Integrating agile management offers a viable pathway for organizations to bridge generational gaps in financial awareness. By fostering collaboration, continuous learning, and adaptability, agile practices unify diverse generational strengths, ensuring long-term organizational success. The findings from IFC.2024 underscore the critical role of iterative methodologies in achieving generational harmony and financial resilience.

3. THE DATA AND METHODOLOGY

This study employed a mixed-method approach to investigate the intersection of financial literacy, generational differences, and agile management practices within the workforce. By combining quantitative and qualitative research techniques, the methodology aimed to provide a comprehensive understanding of how these factors interact to shape organizational adaptability and success.

The quantitative component consisted of surveys administered to employees across multiple generational cohorts. The surveys assessed financial literacy levels, focusing on key competencies such as budgeting, investment knowledge, and economic awareness. Participants included Baby Boomers, Generation X, Millennials, and Generation Z, enabling the study to identify generational trends and disparities. The data were analyzed using statistical tools to highlight patterns, particularly the contrasts in adaptability and financial literacy across different age groups.

The qualitative component involved semi-structured interviews with management teams experienced in implementing agile frameworks. The interviews explored how agile methodologies—characterized by flexibility, collaboration, and iterative learning—can address the identified gaps in financial literacy and adaptability. Questions focused on practical applications, such as fostering cross-generational communication and creating tailored financial education programs. Thematic analysis was employed to extract insights from the interview transcripts, ensuring that the findings reflected the nuanced experiences of managers in diverse organizational contexts.

Additionally, the study incorporated case studies to contextualize its findings. For instance, one case study detailed how agile workshops improved financial literacy among employees, with 75% of participants reporting increased confidence in understanding financial concepts. Another case demonstrated enhanced adaptability and resilience through intergenerational collaboration facilitated by agile sprints. These real-world examples provided tangible evidence of the effectiveness of agile management in bridging generational gaps.

This integrated methodology ensured that the research captured both statistical trends and practical applications, offering actionable insights for organizations seeking to foster financial awareness and adaptability in a multigenerational workforce. By leveraging diverse data sources, the study achieved a robust analysis that highlights the transformative potential of agile management practices.

4. FINDINGS AND DISCUSSION

Introduction

This study examines the intersection of financial literacy, generational differences, and agile management practices, focusing on how these elements can address challenges in workforce adaptability and financial awareness. By employing quantitative surveys and qualitative interviews, the research explores trends, challenges, and actionable solutions to foster a cohesive, adaptable, and financially resilient workforce. The findings reveal a striking dichotomy: younger employees exhibit remarkable adaptability but struggle with financial literacy, while older employees demonstrate deep financial expertise but face difficulties adapting to modern, technology-driven environments. Agile management emerges as a vital strategy to bridge these generational gaps.

Key Findings

The study highlights distinct generational trends in financial literacy and adaptability. Younger employees, primarily from Generation Z and Millennials, are highly adaptable due to their familiarity with technology and dynamic work environments, with adaptability scores averaging 85%. However, they perform poorly in financial literacy, with scores ranging between 40% and 50%. In contrast, older employees, particularly from Generation X and Baby Boomers, exhibit high financial literacy levels, often surpassing 80%, but struggle with adaptability, scoring around 40% to 50%. These findings underline the challenge for organizations to integrate these disparate strengths effectively, ensuring mutual growth and organizational coherence.

Agile management proves to be a transformative approach in this context, fostering flexibility, collaboration, and continuous learning. It encourages cross-generational communication and knowledge-sharing, enabling younger employees to benefit from the financial expertise of their older colleagues. Case studies conducted as part of this research provide clear evidence of agile management's impact. For example, Team A implemented iterative workshops focused on financial literacy, resulting in a 75% increase in participants' confidence in understanding financial concepts. Team B prioritized cross-generational collaboration through agile sprints, which led to an 85% improvement in project adaptability and enhanced resilience in responding to market changes.

Bridging the generational gap requires deliberate efforts to combine the strengths of each cohort. Agile methodologies facilitate this by creating environments conducive to iterative learning and mentorship. Younger employees gain financial literacy through targeted education programs, while older employees improve adaptability by working alongside tech-savvy colleagues. These strategies help unify diverse generational skills, creating a workforce that is not only cohesive but also equipped to navigate modern organizational challenges.

Discussion

The findings emphasize financial literacy as a critical organizational competency, beyond its role as a personal skill. Employees with strong financial literacy make better decisions, enhancing the organization's overall resilience in volatile markets. However, the generational disparity in financial literacy underscores the necessity of targeted interventions.

Agile management emerges as a key enabler in addressing these disparities. Its principles—flexibility, collaboration, and iterative learning—align with the varying needs of multigenerational teams. For example, agile workshops provide inclusive spaces for knowledge exchange, where younger employees can learn financial skills while older employees adapt to contemporary methodologies. Iterative feedback loops inherent in agile practices ensure continuous improvement, allowing organizations to tailor their strategies to the unique dynamics of their workforce.

The case studies further illustrate the practical benefits of agile management. In one instance, financial literacy workshops, led by financial experts, significantly boosted confidence among younger employees, enabling them to participate more actively in financial planning. Another example demonstrated how agile sprints fostered collaboration between older and younger employees, enabling the former to improve adaptability and the latter to gain insights into long-term financial strategies. These real-world applications underscore the value of agile management in addressing generational challenges.

However, integrating agile practices is not without challenges. Resistance to change, particularly among older employees, remains a significant obstacle. Many employees accustomed to traditional frameworks may be skeptical of adopting new methodologies. Additionally, implementing agile practices requires time and resources, which can strain organizations unprepared for the transition. Despite these challenges, the potential benefits far outweigh the drawbacks, particularly when organizations commit to comprehensive change management strategies.

Recommendations for Practice

To address these findings, organizations should focus on three key strategies. First, they should develop tailored financial education programs that address the specific needs and gaps of each generational cohort. Younger employees require foundational financial literacy training, while older employees benefit from workshops on modern financial tools and technology. Second, fostering cross-generational collaboration through mentorship programs can help bridge knowledge gaps and foster mutual understanding. Older employees can mentor their younger counterparts in financial literacy, while younger employees can assist older colleagues in adapting to digital tools and agile practices. Finally, leveraging digital tools, such as AI-driven platforms and e-learning modules, can provide scalable solutions for enhancing financial literacy across the organization.

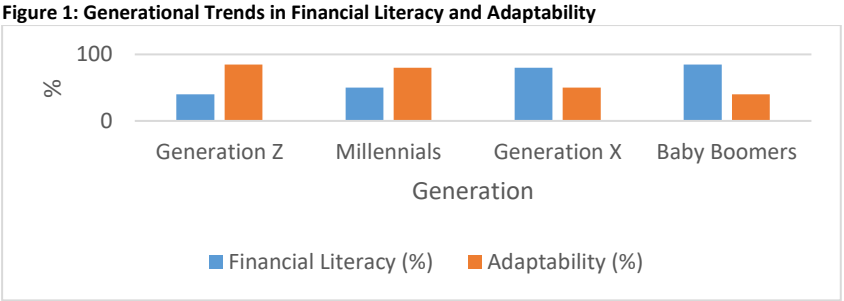
Figure 1 and Table 1 together illustrate the generational dynamics in financial literacy and adaptability. Each generation's strengths and challenges are reflected in these metrics, showcasing an inverse relationship: younger generations, such as Generation Z and Millennials, exhibit higher adaptability due to their tech-savvy nature but face challenges in financial literacy. Conversely, older generations, like Generation X and Baby Boomers, demonstrate strong financial literacy rooted in experience but struggle with adaptability to modern, fast-paced environments.

This visualization and tabular representation highlight the need for strategies, such as agile management and targeted financial education, to bridge these gaps. The data underscores the importance of leveraging each generation's strengths while addressing their specific challenges to create a cohesive, adaptable, and financially resilient workforce.

Table 1: Generational Trends Data

Generation	Financial Literacy (%)	Adaptability (%)	Key Challenges
Generation Z	40	85	Low financial literacy
Millennials	50	80	Moderate financial literacy and adaptability
Generation X	80	50	Moderate adaptability
Baby Boomers	85	40	Low adaptability

Figure 1: Generational Trends in Financial Literacy and Adaptability



5. CONCLUSIONS

This study underscores the critical role of agile management in bridging generational gaps in financial literacy and adaptability within modern organizations. By leveraging the flexibility, collaboration, and iterative learning inherent in agile methodologies, businesses can address disparities between the financial expertise of older employees and the adaptability of younger generations. The findings revealed that younger employees exhibit lower financial literacy but excel in adaptability, while older employees display the opposite trend. Agile management practices, such as iterative learning and cross-generational collaboration, were instrumental in mitigating these disparities.

Case studies demonstrated tangible outcomes, including a 75% increase in financial literacy confidence among participants and an 85% improvement in adaptability through agile sprints. These results highlight the practical benefits of integrating agile practices into financial education and organizational management. The research also emphasizes the importance of fostering cross-generational communication and continuous learning to build a cohesive and financially resilient workforce.

Ultimately, this study concludes that the intersection of agile management and financial education provides a sustainable strategy for navigating generational shifts and economic challenges. Organizations that embrace this integrated approach are better equipped to enhance workforce collaboration, improve financial literacy, and adapt to dynamic market environments, ensuring long-term success and resilience. Future research should explore industry-specific applications and the role of digital tools in advancing these objectives.

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TRANSITION TO MODULAR ARCHITECTURE IN MOBILE FINANCE APPLICATIONS

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ABSTRACT

Purpose- As user expectations and market demands continue to evolve, the mobile Finance applications undergoes constant updates to ensure it remains both responsive to user needs and capable of delivering reliable and high-quality services. However, as applications grow in complexity, maintaining their scalability, flexibility, and manageability becomes increasingly challenging. In this context, adopting a modular software architecture emerges as a strategic solution, offering a more streamlined approach to reducing the intricacy of mobile applications while enhancing their adaptability and scalability. This paper's objective is to show clear comparison between moduler structure and monolitic application design. After discussing the benefits of moduler structure, a guideline will be given in order to transition moduler architecture.

Mehodology- The current structure is analyzed in dependencies aspect. The modules and how to eliminate dependencies while forming modules which can simplify development processes, improve application performance, and make updates more efficient. Furthermore, the study highlights the key advantages of this architectural shift, such as easier maintenance, faster feature deployment, and improved testing capabilities.

Findings-Specific criterias are outlined to guide the identification and definition of modules, ensuring that the modular design aligns with the application's objectives and delivers optimal benefits.

Conclusion- The study shows the positive contribution of modularization in Finance applications to support the fast changing demands.

Keywords: Modular structure, refactoring, dependency injection, modularization, mobile finance application
JEL Codes: E44, G01, G32

1. INTRODUCTION

Mobile finance applications are advanced systems designed to help users perform financial transactions quickly and securely. As these applications evolve with new features, they can become monolithic, making them harder to maintain, scale, and update. This complexity often leads to slower development cycles and higher operational risks [1].

Modular software architecture offers a solution by dividing an application into smaller, independent modules that focus on specific functionalities. This approach simplifies development, improves maintainability, and enhances scalability by allowing individual components to be updated or replaced without disrupting the entire system.[2]

Modular architecture refers to a design principle where a system is divided into distinct modules that can be independently replaced or modified. This approach enhances the flexibility, scalability, and sustainability of applications, especially in complex environments like financial systems. By breaking applications down into smaller, manageable components responsible for specific functionalities, modular architecture simplifies development processes and allows teams to work on different modules simultaneously without affecting the overall system. This not only reduces complexity but also streamlines updates and maintenance.[7]

Key advantages of modular architecture include rapid updates, where new features or bug fixes can be swiftly implemented; performance improvements, achieved by eliminating unnecessary dependencies; ease of maintenance, as each module can be independently updated or replaced; and improved testability, where unaltered modules can be excluded from testing when creating new versions.[5][8][4] Furthermore, defining clear boundaries and interfaces for module communication is essential for determining how modules will interact and depend on one another, ensuring seamless functionality.[9]

This study examines the modularization of a fintech application, focusing on the methods used to transition from a monolithic structure to a modular one. It highlights the benefits of modular architecture in streamlining development, improving performance, and ensuring that the application remains adaptable to evolving user needs.[6] The Methodology section provides detailed information about modular architecture

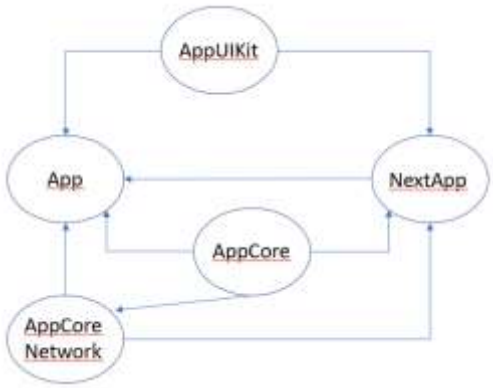
and its application in designing efficient and scalable systems, including strategies for managing dependencies. Finally, the Conclusions section consolidates the key findings of the study, evaluates its contributions to the fintech landscape, and discusses potential directions for future research.

2. METHODOLOGY AND ARCHITECTURE

2.1. Analysis of the Current Application

The first step is conducting a comprehensive analysis of the existing application architecture. This analysis identifies tightly coupled components and areas where modularization would provide the most benefit. It includes reviewing the application's functionality, performance metrics, and user requirements to ensure the modular design aligns with business objectives.[1]

Figure 1: Old hierarchy



Key Elements to Evaluate During Analysis:

Functional Components: Identify the core features of the application.

Dependency Map: Examine relationships between application components.[7]

Performance Data: Analyze the most frequently used features and performance bottlenecks.[5]

Following this evaluation, the next step is defining modular boundaries, which involves determining how to break the application into smaller, cohesive modules. These modules should work independently while seamlessly interacting with one another. This process often requires creating well-defined interfaces and communication protocols to maintain low coupling and high cohesion.[9]

2.2. Defining and Designing Modules

Modules should be identified and designed based on functionality. For the modular transformation of the fintech application, the proposed modules include:

Screens Module: Contains screens and algorithms working for the screens.

CoreNetwork Module: Includes the network layer, services, and request-response models.

Infrastructure Module: Handles core tasks like logging, linting, and managing various application managers.

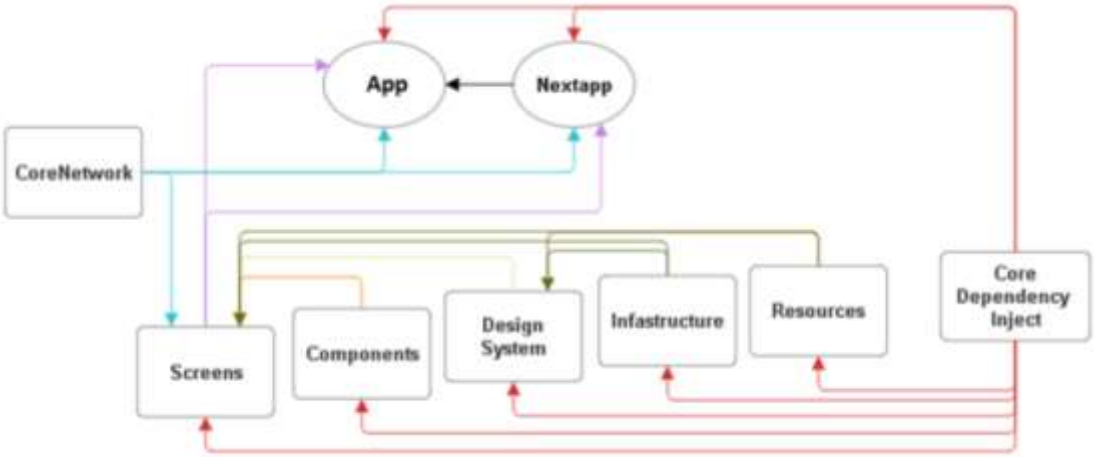
DesignSystem Module: Stores latest UI components.

Resources Module: Stores resources such as images and localization files used in the application.

Components Module: Contains former UI components to be used within screens.

Core Dependency Inject Module: Facilitates communication and integration between modules through dependency injection methods.

Figure 2: Modules after Defining and Designing



Once modular boundaries are established, the actual implementation of the modular architecture begins. This typically involves refactoring existing code to align with the new modular design. Some sections of the application may need to be rewritten to enhance modularity and ensure each module adheres to encapsulation and separation of concerns principles. Automated testing and continuous integration practices are also critical during this transition to provide rapid feedback and ensure the correctness of new modular components individually and as part of the broader system.[8]

2.3. Managing Dependencies

Managing dependencies is one of the significant advantages of adopting a modular architecture. By separating functionality into independent modules, developers can minimize the risk of one module's changes affecting others, thus reducing the likelihood of errors and increasing overall application stability. This modular approach also enables easier updates and improvements since individual modules can be modified or replaced without requiring an extensive overhaul of the entire system.[7]

2.4. Refactoring and Integration

Transitioning an application to a modular structure is not solely a technical undertaking; it often necessitates a significant cultural shift within the organization. This transformation requires teams to move beyond traditional development practices, embracing agile methodologies that promote flexibility, collaboration, and rapid iteration. An agile approach fosters a culture of continuous improvement and innovation, enabling teams to adapt quickly to evolving requirements and technological advancements. Such a shift is essential for ensuring that the modularization process not only achieves its technical goals but also aligns with the organization's broader objectives. For the fintech app, this cultural and technical alignment was facilitated by its existing agile framework, which provided a strong foundation for the modularization process. The organization demonstrated a comprehensive and dynamic transformation by undertaking code refactoring in parallel with ongoing feature development. This dual focus ensured that the application continued to evolve and meet user needs even as its architectural foundation was being restructured.

A phased transition plan was central to this success. Instead of attempting to overhaul the entire application in one massive update—a process that could disrupt user experience and introduce significant risks—the organization adopted an incremental approach. Modules were designed, integrated, and tested asynchronously, allowing the transformation to proceed smoothly and with minimal impact on the application's stability and performance. This method not only ensured a seamless user experience but also provided teams with valuable feedback at each stage, enabling continuous refinement and optimization of the modular architecture. Through this approach, the fintech company exemplified how organizations can effectively balance innovation with operational continuity during a arge-scale architectural transformation.

3. CONCLUSIONS

In conclusion, transitioning to a modular architecture offers numerous advantages, particularly in managing dependencies and increasing the overall agility of the application. The steps undertaken during the transition, from analyzing existing structures to defining and implementing modular components, play a decisive role in ensuring a successful transformation.

By adopting modularity, organizations can not only enhance operational efficiency but also better respond to evolving market demands and technological advancements. Modular architecture in mobile finance applications significantly simplifies dependency management. Each component in a modularized application can be developed and updated independently, introducing flexibility and speed into the software development process.

Key Steps in the Transition Process

Code Refactoring: Transforming monolithic structures into small, independent modules.

Reducing Dependencies: Isolating inter-module dependencies and employing dependency injection for required communication.

Gradual Integration: Executing the transition step-by-step without disrupting the user experience.

In summary, transitioning to modular architecture makes applications more sustainable, flexible, and manageable. This architectural approach supports the development of innovative solutions that meet user expectations.

Future work will focus on enhancing the modular architecture by implementing comprehensive automated testing for all modules. This will ensure that each module functions independently and integrates seamlessly with the broader system, reducing the risk of errors and speeding up deployment cycles. Additionally, efforts will be directed toward identifying and removing legacy code remnants that no longer align with the modular structure. Eliminating outdated code will not only improve maintainability but also enhance the overall performance and reliability of the application. These steps will help streamline development processes, maintain a clean codebase, and support the long-term scalability and sustainability of the project.

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BACKCASTING BITCOIN VOLATILITY: ARCH AND GARCH APPROACHES

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ABSTRACT

Purpose- The primary purpose of this study is to model Bitcoin price volatility and forecast its future price returns using advanced econometric models such as ARCH and GARCH. The study aims to enhance risk management strategies and support informed investment decisions by addressing the time-varying nature of Bitcoin's volatility. The research explores the persistence of volatility shocks and the clustering of price movements to provide insights into market dynamics.

Methodology- This research examines daily Bitcoin closing prices over the period from January 2020 to October 2024. The data was preprocessed to ensure reliability, including applying logarithmic transformations to standardize the data and eliminate trends. Stationarity tests, such as the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and KPSS tests, were conducted to confirm the series' stationarity. The ARCH-LM test was utilized to detect volatility clustering which is essential for validating the use of ARCH and GARCH models. Following this, ARIMA models were employed to define mean equations and GARCH models were used to estimate conditional variance and capture volatility dynamics. The dataset was split into training and validation subsets with data from July to October 2024 reserved for validation.

Findings- The findings demonstrate that Bitcoin's price movements exhibit significant volatility clustering and persistence of shocks which are key characteristics effectively captured by ARCH and GARCH models. These models provide valuable insights into the volatility patterns of Bitcoin, supporting their application in cryptocurrency analysis. Despite their robustness, the models face limitations in precise return forecasting during highly volatile periods, suggesting the need for further refinement or integration with advanced approaches.

Conclusion- The research concludes that ARCH and GARCH models are effective tools for understanding and forecasting Bitcoin's volatility. The study underscores the importance of acknowledging volatility persistence and clustering effects when analyzing cryptocurrency price behavior. However, it also highlights areas for improvement in econometric modelling by including the exploration of hybrid models and the integration of macroeconomic factors to enhance forecasting accuracy.

Keywords: Bitcoin, ARCH models, GARCH Models, forecasting, ARIMA models
JEL Codes: C58, G10, G12

1. INTRODUCTION

Bitcoin has emerged as a transformative force in the financial sector with its decentralized structure and significant price volatility. Unlike traditional assets, Bitcoin operates outside the control of central banks and this makes it an attractive alternative investment option. However, this independence also introduces high levels of uncertainty and complexity and requires sophisticated analytical approaches.

This study delves into the volatility patterns of Bitcoin by leveraging econometric tools to model its behavior. The primary focus lies on ARCH and GARCH models which are widely recognized for their capability to capture volatility clustering and persistence in financial time series. The research aims to provide actionable insights for investors, policymakers and researchers navigating the dynamic cryptocurrency landscape by applying these models to recent data.

2. LITERATURE REVIEW

The academic discourse on Bitcoin volatility has grown substantially as it reflects the increasing prominence of cryptocurrencies in global markets. This study builds on these findings by applying ARCH and GARCH models to recent Bitcoin data and offers an updated analysis of its volatility characteristics and forecasting potential. **Naimy and Hayek (2018)** explored Bitcoin's price behavior using GARCH models and demonstrated the effectiveness of EGARCH in accounting for asymmetric volatility. Similarly, **Shen et al. (2019)** evaluated the predictive performance of machine learning techniques compared to GARCH models and concluded that neural networks outperform traditional econometric methods during periods of heightened volatility. Further, **Yıldırım and Bekun (2023)** conducted a comparative study of ARCH, GARCH, and EGARCH models and identified GARCH (1,1) as the most reliable model for predicting Bitcoin's weekly return volatility. **Loureiro (2023)** underscored the role of EGARCH models in capturing asymmetric price movements and offered deeper insights into Bitcoin's unique volatility dynamics. Meanwhile**, Quan et al. (2023)** incorporated macroeconomic variables into GARCH frameworks and revealed how external factors such as inflation and market indices influence Bitcoin's price fluctuations.

3. DATA AND METHODOLOGY

The analysis employs a dataset comprising daily Bitcoin closing prices from January 2020 to October 2024. The data underwent preprocessing to ensure accuracy by including logarithmic transformations to remove trends and standardize the series. Stationarity tests were applied to validate the suitability of the data for time-series modeling with the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and KPSS tests confirming the return series' stationarity. Volatility clustering was detected using the ARCH-LM test which is a critical step in establishing the appropriateness of ARCH and GARCH models for analyzing Bitcoin's volatility dynamics.

The ARIMA models were used to define the mean equation of the series and formed a foundational basis for subsequent volatility modeling. GARCH models were then applied to estimate conditional variance and assess time-varying volatility and ensure the analysis accounted for both short-term shocks and long-term persistence. The dataset was divided into training and validation subsets with data from July to October 2024 excluded from the initial analysis to evaluate forecasting performance to enhance the model's robustness.

$$Y_t = c + u_t \quad (1)$$

In the ARCH model's equation (1), $\mathbf{Y_t}$ represents the return series, $\mathbf{c}$ is a constant, and $\mathbf{c} + \mathbf{u_t}$ denotes the error term which is assumed to follow a normal distribution with zero mean and variance .

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \quad (2)$$

In the GARCH model's equation (2), $\boldsymbol{\sigma_t^2}$ is the conditional volatility, and $\boldsymbol{\varepsilon_{t-1}^2}$ is squared unexpected returns for the previous period. $\boldsymbol{\omega}$ would be positive always; and $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ would be non-negative. $\boldsymbol{\varepsilon_{t-1}^2}$ are derived from a conditional mean equation that could be simple random walk model ($\mathbf{r_t} = \mathbf{c} + \mathbf{e_t}$), or AR (1) model ($\mathbf{r_t} = \mathbf{c} + \boldsymbol{\gamma}\mathbf{r_{t-1}} + \mathbf{e_t}$), or another ARMA model where rt is the returns from a financial series.

4. FINDINGS

The results reveal significant insights into Bitcoin's volatility dynamics, supported by both statistical analysis and forecasting performance evaluations. Before presenting the tables, it is essential to highlight the key findings and the methodological importance of each component.

The first table demonstrates the predictive performance of ARIMA models across different weeks in October 2024. This analysis provides a clear understanding of the models' strengths and weaknesses in handling volatility by examining actual versus forecasted maximum values and their correlations.

Table 1: Weekly Forecasting for Bitcoin (October 2024)

Week	Model	Maximum (Actual)	Maximum (Forecast)	Correlation
Week 1	ARIMA (1,0,0)	0.0019	0.0010	59.13%
Week 2	ARIMA (4,0,2)	0.005	0.001	43.39%
Week 3	ARIMA (6,0,6)	0.0045	0.0045	85.36%
Week 4	ARIMA (0,0,4)	0.0020	0.0004	71.11%

For Week 1, the ARIMA (1,0,0) model shows a modest match between forecasted and actual maximum values with a correlation coefficient of 59.13% and indicates moderate predictive strength. Week 2's results by using the ARIMA (4,0,2) model highlight a weaker correlation of 43.39% and reflect challenges in forecasting under heightened volatility. Week 3 delivers the strongest correlation (85.36%) with the ARIMA (6,0,6) model and shows its ability to capture patterns during stable periods. Finally, Week 4 with a 71.11% correlation from the ARIMA (0,0,4) model demonstrates decent accuracy, although maximum values remain challenging to predict precisely.

The Table 2 provides descriptive statistics for weekly forecasts and offers an in-depth perspective on the deviations between actual and forecasted values. The performance of the forecasting models is further clarified by analyzing the range of values including maximum, minimum, and standard deviation.

Table 2: Descriptive Statistics for Weekly Forecasts

Statistic	Week 1 (Actual/Forecast)	Week 2 (Actual/Forecast)	Week 3 (Actual/Forecast)	Week 4 (Actual/Forecast)
Maximum	0.0019 / 0.0010	0.005 / 0.001	0.0045 / 0.0045	0.0020 / 0.0004
Minimum	-0.0036 / -0.0028	-0.002 / -0.001	-0.0021 / -0.0003	-0.0021 / -0.0021
Std. Dev.	0.0018 / 0.0014	0.003 / 0.001	0.0019 / 0.0016	0.0015 / 0.0010

The descriptive statistics highlight the disparity between actual and forecasted values across the weeks. In Week 1, the forecast underestimates the range of variation as evidenced by lower standard deviations. Week 2 shows similar discrepancies where the forecast fails to capture extreme values adequately. However, Week 3 aligns more closely particularly in terms of maximum values and standard deviations and indicates the model's improved performance during stable market conditions. Week 4 shows mixed results with minimum values aligning well but a notable underestimation of the maximum value and emphasizes the challenges in capturing peak movements in volatile periods.

5. CONCLUSION

This study aims to model Bitcoin price volatility and forecast future price returns using ARCH and GARCH models. Bitcoin price returns from January 2020 to October 2024 were first analyzed with the ARIMA model for the mean equation followed by the GARCH(1,1) model to study volatility. Unit root tests confirmed the stationarity of the return series and made it suitable for further analysis. The GARCH(1,1) results showed that volatility shocks are persistent and meant that significant shocks in one period influence future periods. While the GARCH(1,1) model proved effective for modeling Bitcoin returns, it had limitations, especially for forecasting return values in the last quarter of 2024. Future research could explore non-linear or hybrid models to better capture Bitcoin's price dynamics and improve prediction accuracy. The study underscores the importance of understanding Bitcoin's volatility and calls for further research to enhance forecasting precision in a volatile market.

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TWITTER SENTIMENT ANALYSIS FOR OPTIMAL PORTFOLIO CONSTRUCTION

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ABSTRACT

Purpose- This research investigates the efficacy of social media sentiment analysis in constructing alpha-generating investment portfolios. Specifically, the study examines whether Twitter-derived sentiment indicators can be leveraged to develop systematic trading strategies that generate risk-adjusted returns exceeding benchmark performance. The research aims to establish quantitative criteria for position initiation and termination based on sentiment metrics, with the ultimate objective of creating a portfolio that demonstrates significant outperformance relative to the reference index.

Methodology – The study encompasses 16 companies of the Nasdaq 100 index, selected to represent diverse market sectors while controlling for liquidity and market impact considerations. The dataset comprises 708,080 Twitter posts pertaining to the selected companies throughout the 2022 calendar year, extracted via programmatic data collection methodologies. Sentiment quantification was performed utilizing the Natural Language Toolkit (NLTK) in Python, generating normalized sentiment scores within a [-1, +1] interval. The investigation employed a sophisticated aggregation methodology to compute both daily and weekly sentiment indicators for each security, deliberately excluding neutral sentiment scores (0) to enhance signal clarity. A systematic portfolio construction framework was implemented, whereby securities were hierarchically ranked based on their aggregate sentiment scores on a weekly basis. Multiple portfolio permutations were tested, incorporating various combinations of long positions in top-ranked securities and short positions in bottom-ranked securities. Position entry and exit prices were determined using weekly opening and closing prices, respectively. Portfolio performance was evaluated through the calculation of weekly returns and cumulative performance metrics over the observation period.

Findings- The empirical results reveal that portfolios constructed exclusively with short positions demonstrated superior cumulative returns compared to long-only portfolios. This observation can be contextualized within the broader market environment, specifically the Nasdaq 100's negative 33% return in 2022. The research identified statistically significant outperformance in portfolios implementing a combined long-short strategy, with these portfolios generating positive absolute returns despite the challenging market conditions.

Conclusion- The empirical evidence substantiates the hypothesis that Twitter sentiment analysis can be effectively utilized as a signal generation mechanism for systematic portfolio construction. The results demonstrate statistically significant alpha generation capabilities, particularly when implementing a long-short strategy, suggesting potential applications for institutional investors and quantitative fund managers.

Keywords: Twitter sentiment analysis, algorithmic portfolio construction, market efficiency, natural language processing, behavioral finance
JEL Codes: H30, H60, H62

1. INTRODUCTION

In contemporary financial markets, equity securities represent a cornerstone investment vehicle for market participants across the global investment landscape. A fundamental challenge confronting investment decision-makers lies in the accurate forecasting of future security prices and the subsequent formulation of optimal investment strategies predicated upon these projections. The proliferation of mobile technology and widespread internet connectivity has catalyzed an unprecedented expansion in social media engagement, transforming these platforms into vital forums for real-time dissemination of investor sentiment and market perspectives. Twitter, in particular, has emerged as a preeminent platform for investment-related discourse among market participants. Given that price discovery in equity markets is fundamentally driven by the aggregate effect of buy and sell orders—effectively representing the culmination of supply and demand dynamics—this research posits that valuable predictive signals can be extracted from social media sentiment that has not yet been fully incorporated into market prices. Specifically, we hypothesize that systematic analysis of user-generated content on Twitter pertaining to publicly traded companies can yield actionable insights into emerging investor sentiment patterns. Furthermore, this study aims to demonstrate empirically that these sentiment indicators can be effectively utilized in the construction of optimized investment portfolios capable of generating risk-adjusted returns in excess of relevant market benchmarks. The theoretical foundation and empirical methodology of this research are predicated upon the efficient market hypothesis and its various permutations, while simultaneously incorporating elements of behavioral finance theory to account for the documented impact of investor sentiment on asset prices. By synthesizing traditional financial theory with contemporary developments in natural language processing and machine learning, this study seeks to bridge the gap between theoretical frameworks and practical applications in portfolio management. The remainder of this paper is structured as follows: Section 2

presents a comprehensive review of the extant literature, examining both theoretical foundations and empirical evidence regarding the relationship between social media sentiment and equity market dynamics. Section 3 delineates the methodological framework employed in this study, including detailed descriptions of data collection procedures, sentiment analysis techniques, and portfolio construction methodologies. Section 4 presents our empirical findings and provides a thorough analysis of the results within the context of existing theoretical frameworks. Finally, Section 5 synthesizes our findings and discusses their implications for both academic research and practical applications in investment management. This research contributes to the existing body of literature by providing empirical evidence of the predictive capability of social media sentiment in equity markets and demonstrating the practical application of these insights in systematic portfolio construction. The findings have significant implications for both academic researchers investigating market efficiency and practitioners seeking to develop innovative investment strategies.

2. LITERATURE REVIEW

Mendoza-Urdiales et al. (2022) examined the asymmetric effect of Twitter sentiment on stock prices, finding that negative news has a more pronounced impact than positive news. This asymmetry was supported by analyses using Transfer Entropy and EGARCH models.Yang et al. (2017) developed a sentiment-driven trading strategy using SentiWordNet and genetic algorithms, which outperformed other strategies. Similarly, Leow et al. (2021) enhanced robo-advisor performance by employing sentiment analysis using Google's BERT model, with their proposed models outperforming traditional portfolio models. Makrehchi et al. (2013) created a successful trading system using tweet sentiment, achieving higher returns than the S&P 500 index. Ranco et al. (2015) utilized event study methodology to demonstrate the value of Twitter data in understanding and predicting financial market movements. Oliveira et al. (2017) proposed a model to predict various financial variables using Twitter data, highlighting some advantages of microblog data over traditional sentiment measures. Granholm and Gustafsson (2017) investigated the potential for generating abnormal returns using tweet sentiment, based on an analysis of 40 companies in the Nasdaq 100 index. Azar and Lo (2016) examined the impact of Federal Open Market Committee (FOMC) meetings on investors, demonstrating that Twitter sentiment during these meetings can predict market reactions. Chamberlain et al. (2023) found that sentiment from both traditional and social media sources influences stock performance, particularly for firms with high short interest ratios. Sul et al. (2017) showed that tweets from users with fewer followers play a significant role in predicting future stock returns, with their proposed strategy yielding annual returns of 11-15%. Yu et al. (2022) demonstrated the effectiveness of using investor sentiment in managing portfolio rebalancing for S&P 500 companies. Düz Tan and Taş (2021) found that social media activity and sentiment are associated with trading volume and returns across various markets, with Twitter sentiment being more pronounced for smaller and emerging market firms. Gu and Kurov (2020) showed that company-specific Twitter sentiment can be used to predict stock returns. Fan et al. (2020) proposed using social media to measure political uncertainty faced by companies, finding that disagreement among tweets impacts stock price volatility and trading volume. Kraaijeveld and De Smedt (2020) demonstrated the potential of Twitter sentiment to predict cryptocurrency price returns. Dang et al. (2020) compared the performance of different deep learning models in sentiment analysis, offering guidance for researchers. Broadstock and Zhang (2019) and Affuso and Lahtinen (2018) both found that U.S. stocks' intraday returns are sensitive to social media sentiment, with negative tweets having a stronger effect than positive ones. Hung et al. (2023) proposed using deep learning and natural language processing methods to construct views in the Black-Litterman model, achieving a high annual return rate of 46.6%. However, Behrendt and Schmidt (2018) concluded that Twitter sentiment and activity are particularly unhelpful for stock valuation, especially for high-frequency traders.

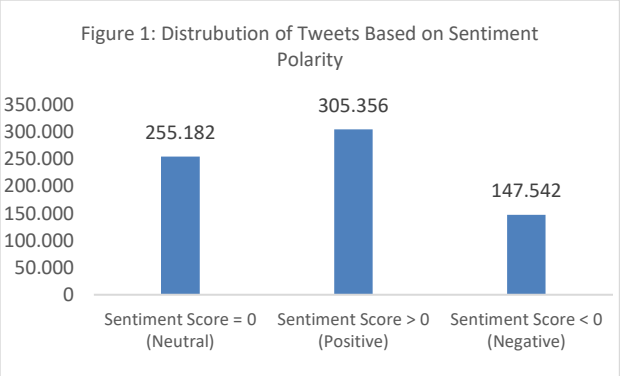
3. THE DATA AND METHODOLOGY

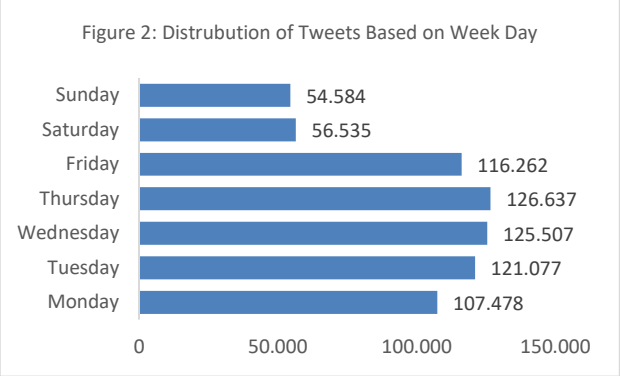
Tweets related to stocks of companies traded on Nasdaq 100 were accessed on Twitter by adding '$' and '#' symbols to their stock ticker symbols. A dataset was created using the tweets obtained from these search results. Table 1 presents the sectors in which the selected companies operate and the number of tweets for each company. Companies were chosen from among those with the highest market capitalization. The stock price data of the companies to be used in the study were obtained from the Yahoo Finance database using the Yfinance library of the Python programming language. The process of creating sentiment scores is a subdomain of natural language processing, and various methods and approaches exist in literature. While some studies classify texts into three categories as positive, negative, and neutral, another approach assigns a sentiment score of +1 to expressions with 100% positive meaning and -1 to those with 100% negative meaning. The method preferred in this study is to position all sentiment scores within the range of [-1, +1]. The Natural Language Toolkit library of the Python programming language was used to generate sentiment scores. Using the sentiment scores calculated for each tweet, daily and weekly average sentiment scores were computed on a company basis.

Table 1: Company and Number of Tweets

Company	Ticker	Sector	Number of Tweets	Company	Ticker	Sector	Number of Tweets
Tesla, Inc.	TSLA	Automotive and Technology	108.294	Alphabet Inc. (Class A)	GOOGL	Technology	38.265
Apple Inc.	AAPL	Technology	92.886	PayPal Holdings, Inc.	PYPL	Finance	22.714
Amazon.com, Inc.	AMZN	Retail and Technology	79.385	Costco Wholesale Corporation	COST	Retail	18.047
NVIDIA Corporation	NVDA	Technology	60.955	Intel Corporation	INTC	Technology	17.302
Advanced Micro Devices, Inc.	AMD	Technology	58.205	Starbucks Corporation	SBUX	Restaurants	14.860
Microsoft Corporation	MSFT	Technology	56.507	Pfizer Inc.	PFE	Health	14.722
Meta Platforms, Inc.	META	Technology	52.216	Micron Technology, Inc.	MU	Technology	14.282
Netflix, Inc.	NFLX	Entertainment	45.695	Salesforce.com, Inc.	CRM	Technology	13.745

The temporal aggregation of sentiment metrics followed a two-stage computational framework: first, daily sentiment indicators were computed through the arithmetic mean of tweet-level sentiment scores for each security; subsequently, weekly sentiment metrics were derived through the arithmetic averaging of daily sentiment indicators. This methodological approach ensures consistent temporal granularity in sentiment quantification while mitigating the impact of intraday volatility in social media sentiment. When constructing the portfolio, priority was given to Twitter sentiment scores. Long positions were taken for the top n companies ranked by sentiment scores, while short positions were taken for the bottom n companies. Within the scope of the study, the value of n was varied from 1 to 7, and portfolios consisting of 2, 4, 6, 8, 10, 12, and 14 companies in total were created. Table 1 presents detailed information about the companies used in the study and the number of tweets obtained. Figure 1 and Figure 2 present statistics related to the sentiments derived from tweets associated with the companies used in the scope of this study. It is observed that the number of positive tweets exceeds the number of negative tweets.





4. FINDINGS AND DISCUSSION

The empirical analysis reveals compelling evidence regarding the efficacy of sentiment-driven portfolio construction methodologies. As demonstrated in Table 2, the investigation reveals a notable non-linear relationship between portfolio size and cumulative returns, with the optimal portfolio configuration comprising six constituent securities (three long positions and three short positions), achieving a cumulative return of 1.323. This relationship is visually represented in Figure 3, which clearly illustrates the peak in portfolio performance at the six-security configuration. As evidenced by Table 2, the performance metrics exhibit diminishing marginal returns as the portfolio size increases beyond this optimal point, with cumulative returns declining to 1.314, 1.249, 1.212, and 1.217 for portfolios containing 8, 10, 12, and 14 securities respectively. This pattern strongly suggests that excessive diversification may dilute the predictive power of sentiment signals.

Table 2: Portfolio Statistics and Short & Long Portfolio Statistics

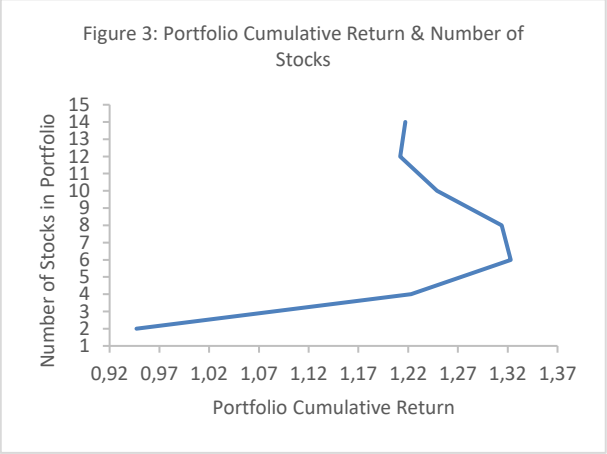
Portfolio Statistics		Short & Long Portfolio Statistics		
Number of Stocks in Portfolio	**Portfolio Cumulative Return**	**Number of Stocks in Portfolio**	**Short Portfolio Cumulative Return**	**Long Portfolio Cumulative Return**
2	0,947	1	1,771	0,423
4	1,223	2	1,955	0,677
6	1,323	3	2,003	0,785
8	1,314	4	1,963	0,796

10	1,249	5	1,796	0,786
12	1,212	6	1,817	0,739
14	1,217	7	1,838	0,738
Average	**1,212**	**Average**	**1,878**	**0,706**

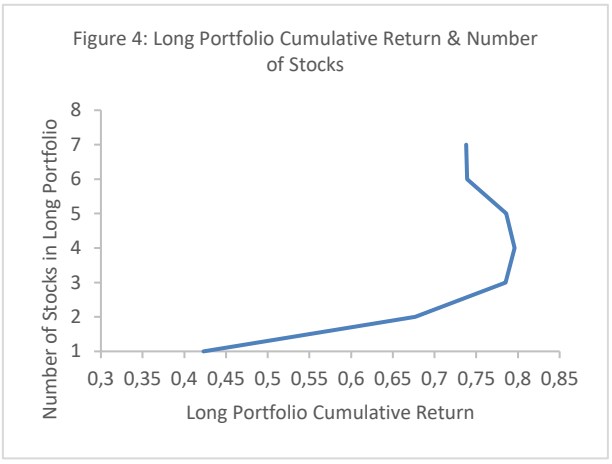
A particularly noteworthy finding emerges from the decomposition of portfolio returns into their constituent long and short components, as detailed in the right panel of Table 2. The short portfolios demonstrated remarkably superior performance compared to their long counterparts across all portfolio sizes, with the average cumulative return for short portfolios (1.878) substantially exceeding that of long portfolios (0.706). Figure 5 clearly illustrates this outperformance of short portfolios, showing a peak cumulative return of 2.003 for the optimal three-security configuration. In contrast, Figure 4 depicts the more modest performance of long portfolios, with even the best-performing long portfolio achieving a maximum return of only 0.796. This asymmetric performance pattern must be contextualized within the broader market environment of 2022, during which the Nasdaq 100 experienced a substantial decline of 33%.

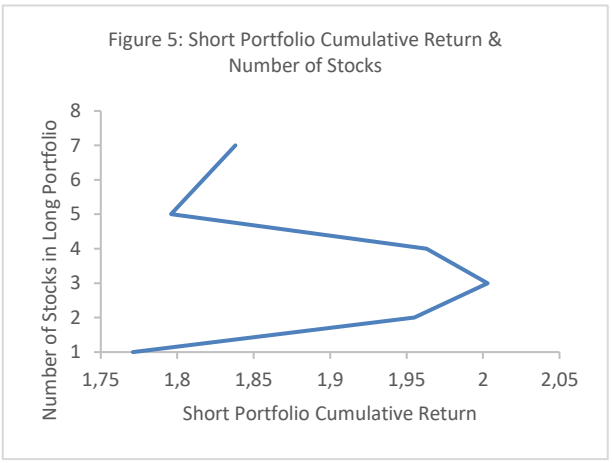
The relationship between portfolio size and performance exhibits distinct characteristics across different portfolio constructions, as evidenced by the comparative analysis presented in Table 2. In combined long-short portfolios, optimal performance was achieved with six securities, a pattern clearly visible in Figure 3's inflection point. Long-only portfolios, as shown in Figure 4, demonstrated peak performance with four securities (0.796), maintaining relatively stable performance in the three to five security range before experiencing diminishing returns. Figure 5 illustrates how short-only portfolios achieved maximum efficiency with three securities (2.003) and demonstrated robust performance across all portfolio sizes, exhibiting notably less sensitivity to portfolio size compared to long positions. These empirical findings, particularly the distinct patterns visible in Figures 3, 4, and 5, have important implications for market efficiency theory and practical portfolio management. The consistent outperformance of sentiment-driven portfolios suggests the presence of exploitable market inefficiencies, while the asymmetric performance of long and short positions indicates potential behavioral biases in market participants' reactions to negative sentiment.

The existence of an optimal portfolio size, clearly demonstrated in Table 2 and Figure 3, suggests limits to arbitrage in sentiment-based trading strategies, a finding that aligns with contemporary behavioral finance literature. The results provide compelling empirical support for the hypothesis that social media sentiment contains valuable predictive information not fully incorporated into market prices, particularly during periods of market stress. However, the diminishing returns observed with larger portfolios, as evidenced by the rightward decline in Figure 3, suggest that this informational advantage may be limited to a subset of securities with the strongest sentiment signals. This observation has significant implications for the scalability of sentiment-based trading strategies.



The findings also suggest that the integration of sentiment analysis into systematic trading strategies may be particularly valuable during periods of market turbulence, as evidenced by the superior performance of short positions during the 2022 market downturn, clearly visible in Figure 5. This temporal dimension of sentiment indicator efficacy warrants further investigation and may have important implications for dynamic portfolio management strategies. The comparative analysis of portfolio performance metrics presented in Table 2, coupled with the visual evidence in Figures 3, 4, and 5, suggests that future research might productively explore the interaction between market conditions and sentiment signal strength, potentially leading to more refined portfolio construction methodologies that account for varying market regime





4. CONCLUSIONS

This empirical investigation provides compelling evidence supporting the efficacy of Twitter-derived sentiment analysis in constructing alpha-generating investment portfolios. The findings are particularly salient given the challenging market conditions that characterized 2022, during which the Nasdaq 100 index experienced a substantial decline of 33%. The empirical results demonstrate that systematically constructed portfolios incorporating social media sentiment signals can generate statistically significant excess returns relative to conventional benchmark indices.

The methodological framework, which employed natural language processing techniques to quantify Twitter sentiment and subsequently utilized these metrics as primary portfolio allocation determinants, yielded several noteworthy insights. First, the research identifies an optimal portfolio configuration comprising six constituent securities (three long positions and three short positions), which achieved a cumulative return of 1.323. Second, the investigation revealed a marked asymmetry in the performance of long versus short positions, with short portfolios demonstrating superior risk-adjusted returns across all portfolio sizes. This asymmetric performance pattern suggests that Twitter sentiment may be particularly effective in identifying overvalued securities during periods of market stress.

However, these empirical findings must be interpreted within appropriate methodological constraints. The study's results are temporally bounded, focusing on a specific market environment characterized by substantial technological sector volatility. Furthermore, the observed

relationship between portfolio size and performance exhibits diminishing marginal returns beyond the optimal six-security configuration, suggesting potential limitations to the scalability of sentiment-driven investment strategies.

Several promising avenues for future research emerge from these findings. First, subsequent investigations should examine the robustness of sentiment-based portfolio construction methodologies across varying market regimes and economic cycles. Second, the integration of technical analysis indicators with sentiment metrics warrants exploration, potentially offering enhanced signal generation capabilities. Third, the development of dynamic sentiment score thresholds, calibrated using historical performance data, may improve the precision of position initiation and termination criteria.

Additionally, future research should investigate the microstructure mechanisms through which social media sentiment influences price discovery processes. This might include examining the temporal dynamics of sentiment diffusion across market participants and analyzing the relationship between sentiment intensity and trading volume patterns. In conclusion, while this investigation provides statistically significant evidence supporting the incorporation of social media sentiment in systematic portfolio management, it simultaneously highlights the necessity for continued empirical research in this domain. The synthesis of sentiment analysis with traditional quantitative metrics and technical indicators may offer a more comprehensive framework for investment decision-making in contemporary financial markets, characterized by increasingly complex information flows and rapid digital transformation. Future research efforts should focus on developing more sophisticated methodologies for sentiment quantification and exploring the interaction between sentiment signals and other established market factors. These findings contribute to the growing body of literature examining the intersection of behavioral finance, technological innovation, and market efficiency. The results suggest that social media platforms have evolved into significant venues for price discovery, warranting their inclusion in modern portfolio management frameworks. However, the practical implementation of sentiment-based strategies requires careful consideration of transaction costs, market impact, and the potential erosion of signal strength as these methodologies gain broader adoption within the investment community.

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GENDER DIFFERENCE IN RISK AND CONFIDENCE PERCEPTION: IMPLEMENTATION WITH LOGIT MODEL

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ABSTRACT

Purpose - This study aims to understand individuals' behaviors and perceptions regarding investment preferences. Specifically, it examines the differences in investors' perceptions of "concerns about losing money due to investment decisions" and "confidence in their knowledge of portfolio creation and management" based on the gender variable.

Methodology - The study utilizes survey data from 69 participants (29 female and 40 male). It employs logit models to analyze two dependent variables: (1) the stress level due to concerns about investment decisions and (2) confidence in portfolio management and financial knowledge. Gender is the key independent variable, with marginal effects calculated for unambiguous interpretation.

Findings - The results indicate that gender has a statistically significant impact on both stress and confidence levels. Women are 21.2% more likely than males to experience stress due to concerns about investment decisions. Conversely, females are 18.5% less likely to feel confident about their financial knowledge and portfolio management abilities than males. These findings reflect the gender-based differences in risk perception and confidence.

Conclusion -The study highlights the critical role of gender in shaping investment behaviors. Women tend to exhibit higher risk aversion and lower financial confidence than men. To address this disparity, targeted financial education programs and awareness initiatives are recommended to enhance women's financial literacy and confidence. Bridging this gap can contribute to improved financial participation and decision-making among women.

Keywords: logit model, investment behavior, risk perception, gender, confidence.
JEL Codes: C35; G11; G41

1. INTRODUCTION

Investment behavior is a complex process influenced by socio-demographic variables, including gender. Previous studies in behavioral finance suggest that female exhibit higher risk perception and lower confidence compared to male in financial decision-making. This study aims to analyze the gender-based differences in risk and confidence perceptions in investment preferences using survey data and logit models.

This study aims to understand individuals' behaviors and perceptions regarding investment preferences in Turkey. Specifically, it examines the differences in investors' perceptions of "concerns about losing money due to investment decisions" and "confidence in their knowledge of portfolio creation and management" based on the gender variable.

2. AID AND TAX REVENUE: LITERATURE REVIEW

The literature extensively explores the impact of gender on investment behavior. Hira and Loibl (2008) highlighted that females generally make more cautious investment decisions and exhibit lower risk tolerance compared to males. Similarly, Bayyurt, Karışık, and Coşkun (2013) found that male investors in Turkey prefer riskier investments such as stocks and real estate, while female investors tend to choose safer options like funds, term deposits, and gold.

Grable and Lytton (1999) examined financial risk tolerance and developed an assessment instrument to measure it, finding that females consistently display lower risk tolerance across various economic conditions. Barber and Odean (2001) showed that males engage in more frequent trading due to overconfidence, which often negatively affects their net returns. Croson and Gneezy (2009), in a meta-analysis, emphasized that females tend to be more risk-averse, especially in financial contexts.

Bacher (2024) provided recent insights into life-cycle investment behaviors in the United States, revealing that single females invest less in risky assets compared to their male counterparts, although this gender gap narrows over time.

Lastly, Demir, Cihangir, and Şak (2016) used a multinomial logit model to examine the influence of demographic factors on financial literacy in Turkey, identifying gender as a critical determinant. These studies collectively underscore the importance of understanding gender-based differences in investment behavior and financial decision-making.

3. THE DATA AND METHODOLOGY

Specifically, the study explores:

Concern about losing money due to investment preferences and its relationship with stress.
Confidence in portfolio creation and management knowledge.

This research contributes to the growing literature on gender disparities in financial markets with a focus on the Turkish context.
The study employs survey data collected from 69 participants (29 female, 40 male) in Turkey. Two logit regression models are used to examine gender effects:

Model 1:
Dependent Variable: Concern about losing money due to investment preferences
Independent Variable: Gender

Model 2:
Dependent Variable: Confidence in portfolio creation and management knowledge
Independent Variable: Gender

The logit model is the most commonly used model among qualitative choice models. In the logit model, the logistic distribution is utilized and is expressed as follows:

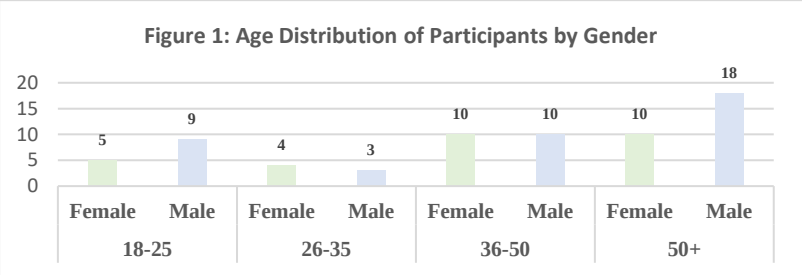
$$E(Y_i) = \frac{1}{1+e^{-\beta' X_i}} = \frac{e^{\beta' X_i}}{1+e^{-\beta' X_i}} \quad (1)$$

$E(Y_i) = P(Y_i = 1)$ $\beta' X$ takes value -∞ and +∞. $F(\beta' X_i)$ takes values between 0 and 1. This distribution closely resembles the cumulative normal distribution, except in the tails. However, it is easier to calculate. (Yerdelen Taoğlu, 2020, p.256)

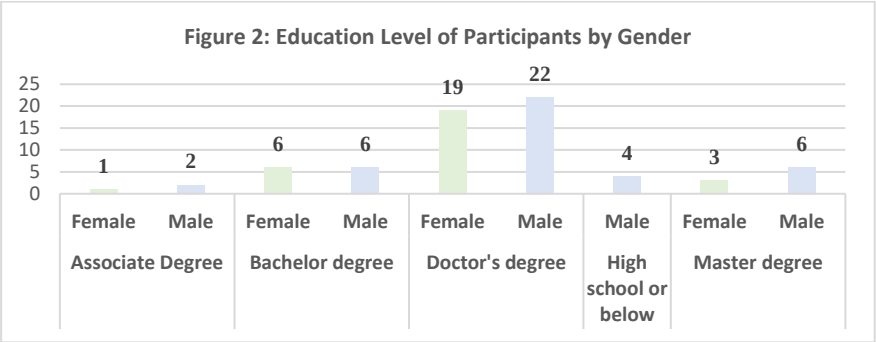
4. FINDINGS AND DISCUSSION

In this section, the age and education details of the participants are thoroughly examined first, followed by a gender-based analysis of their responses to stress and confidence-related questions. Secondly, the differences in financial risk perception, the impact on investment decisions, and confidence in financial knowledge between male and female participants are evaluated using a logit model.

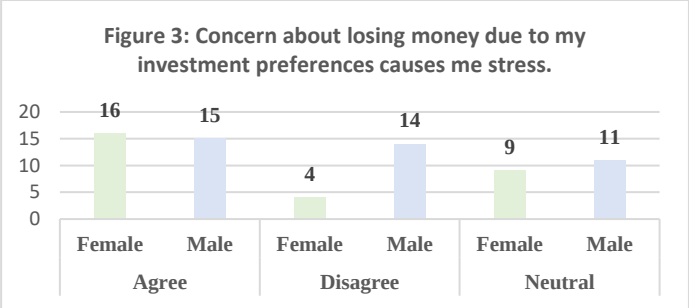
Figure 1 shows the age distribution of participants by gender, revealing notable differences. In the 18-25 age group, the number of male participants (9) exceeds that of females (5). In the 26-35 age group, females (4) slightly outnumber males (3). In the 36-50 age group, there is an equal distribution, with both genders having 10 participants each. However, in the 50+ age group, male participants (18) significantly outnumber females (10). Overall, older male participants dominate the distribution, while younger age groups also show a higher number of male participants.



The Figure 2 illustrates the education level of participants by gender, showing significant variations across categories. Among participants with an Associate Degree, males (2) outnumber females (1). In the Bachelor's Degree category, both genders are equally represented, with 6 participants each. For those holding a Doctor's Degree, males (22) slightly outnumber females (19), making this the most populated category. In the High School or Below category, only males (4) are represented, with no female participants. In the Master's Degree group, males (6) are double the number of females (3). Overall, while male dominate in most education levels, the Doctor's Degree category stands out as having the highest participation for both genders, albeit slightly favoring males.



The analysis of stress levels related to investment preferences reveals gender-based differences in risk perception. A higher proportion of female participants (16) agree that concerns about losing money cause them stress, compared to males (15). Conversely, among those who disagree with this statement, male participants (14) significantly outnumber females (4), reflecting that male experience lower levels of stress regarding financial risks. In the neutral category, female participants (9) are slightly fewer than males (11). These results indicate that female have a heightened sensitivity to financial risks and experience more stress from potential losses in their investment decisions.



The analysis of confidence levels in financial knowledge highlights a significant gender disparity. Only 9 female participants agree that they find their level of knowledge about portfolio creation and management sufficient, compared to 23 males. This indicates that male exhibit substantially higher confidence in their financial knowledge and decision-making abilities. Among those who disagree, females (9) outnumber males (5), reinforcing the lack of confidence among female. In the neutral category, female participants (11) are nearly equal to males (12). The results suggest that female, despite their higher levels of education, perceive themselves as less competent in financial matters compared to male. This lack of confidence may stem from limited practical experience or societal influences. Targeted financial education programs and mentoring initiatives can be implemented to enhance female's confidence and encourage active participation in investment activities.

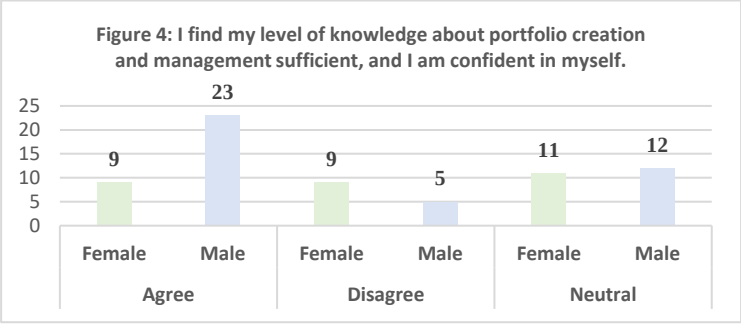


Table 1: Stress Model Result

Variable	Coef.	St.Err.	t-value	[95% conf. interval]	
Gender	1.214***	0.632	1.92	-0.026	2.453
Constant	0.619***	0.331	1.87	-0.031	1.269
Mean dependent var		1.029	**SD dependent var**		0.747
Pseudo r-squared		0.052	**Number of obs**		69

Chi-square	4.142	**Prob > chi2**	0.042
Akaike crit. (AIC)	79.065	**Bayesian crit. (BIC)**	83.533

Note.*** indicate 1% significance levels, respectively.

Table 1 show that gender variable is statistically significant in the model. The Pseudo R^2 is 5.2%. Since the model is a logit regression, it is more meaningful to calculate and interpret the marginal effects rather than interpreting the coefficients in their current form.

Table 2: Stress Model Marginal Effects Results

Variable	dy/dx	Std. err.	z	P>z	[95% conf. interval]		X
Gender	0.212	0.099	2.140	0.032	0.018	0.406	0.42

Holding other variables constant, it was found that female's stress levels due to concerns about losing money from their investment preferences are 21.2% higher compared to male.

Table 3: Confidence Model Results

Variable	Coef.	St.Err.	t-value	[95% conf. interval]	
Gender	-1.147*	0.624	-1.84	-2.371	0.076
Constant	1.945***	0.478	4.07	1.009	2.883
Mean dependent var		1.130	**SD dependent var**		0.726
Pseudo r-squared		0.051	**Number of obs**		69
Chi-square		3.541	**Prob > chi2**		0.06
Akaike crit. (AIC)		70.065	**Bayesian crit. (BIC)**		74.534

Note. * and *** indicate 10% and 1% significance levels, respectively.

Table 3 reveals that gender also has a statistically significant effect on participants' confidence in their knowledge about portfolio creation and management. The Pseudo R^2 is 5.1%.

Table 4: Confidence Model Marginal Effects Results

Variable	dy/dx	Std. err.	z	P>z	[95% conf. interval]		X
Gender	-0.185	0.100	1.840	-0.065	-0.382	0.011	0.42

Holding other variables constant, it was found that female are 18.5% less likely than male to perceive their level of knowledge about portfolio creation and management as sufficient and to have confidence in this regard.

5. CONCLUSIONS

This study demonstrates that gender significantly influences investment behaviors in Turkey, revealing notable differences in stress levels, risk perception, and confidence between male and female. Women experience 21% higher stress levels than male due to concerns about financial risks, reflecting a greater sensitivity to financial uncertainty and a higher tendency toward risk aversion. Moreover, female exhibit 18.5% lower confidence in their financial knowledge and portfolio management abilities compared to male, indicating a gap in perceived competence and self-assurance. These findings align with the behavioral finance literature, which consistently highlights female's cautious investment behaviors and risk-averse tendencies.

The results underscore the critical need for targeted financial education and awareness programs to bridge gender gaps in financial literacy and confidence. By enhancing female's financial skills and providing tools for risk assessment and management, such programs can empower female investors, reduce stress stemming from financial decisions, and foster greater participation in financial markets. Additionally, gender-inclusive financial policies that address societal and cultural barriers can further support female's financial engagement, contributing to both individual empowerment and broader economic inclusion. Addressing these disparities is essential for promoting equality in financial decision-making and improving overall financial well-being.

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UNDERSTANDING THE MATHEMATICAL BACKGROUND OF MODERN PORTFOLIO THEORY

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ABSTRACT

Purpose- Modern Portfolio Theory (MPT), pioneered by Harry Markowitz, provides a quantitative framework for portfolio optimization by balancing risk and return through diversification. This study focuses on applying MPT principles using Python and the PyPortfolioOpt library to construct optimized portfolios. The analysis involves selecting high-performing U.S. stocks over the past year, implementing advanced optimization techniques, and evaluating performance metrics such as Sharpe ratios. By leveraging these methodologies, the study aims to demonstrate how MPT, combined with Python's computational power, can enhance investment decision-making.

Methodology- The study incorporates a systematic approach to portfolio optimization. Data was collected from TradingView, focusing on high-performing stocks across various sectors. The optimization process utilized PyPortfolioOpt for mean-variance optimization, risk parity, and minimum correlation portfolio construction. Historical price data was preprocessed for normalization, and statistical techniques such as correlation analysis and covariance matrix evaluation were applied to ensure robust portfolio allocation. Sharpe ratios were calculated to assess the risk-adjusted returns of the portfolios.

Findings- This study demonstrates the practicality of Modern Portfolio Theory (MPT) when combined with python-based portfolio optimization techniques. Using the PyPortfolioOpt library, the analysis highlights how computational tools enhance portfolio construction by balancing risk and return. The optimized portfolio, based on high-performing U.S. stocks, achieved an expected annual return of 8.39%, annualized volatility of 17.36%, and a Sharpe ratio of 1.76, showcasing efficient risk-adjusted performance. Diversification emerged as a key factor in mitigating risk, with weights allocated to stocks from various sectors to balance returns and volatility. Assets with lower Sharpe ratios or high correlations were excluded, aligning with MPT's principles. Risk management strategies, including covariance matrix evaluation, ensured a robust portfolio structure. The results validate the effectiveness of python-driven optimization in building diversified portfolios that cater to investment objectives.

Conclusion- This study reaffirms the relevance of Modern Portfolio Theory (MPT) in portfolio management while showcasing Python's capabilities for optimization. The optimized portfolio achieved a sharpe ratio of 1.76, exemplifying the balance between maximizing returns and minimizing risk. Diversification and systematic data analysis played pivotal roles, with weights favoring assets offering favorable risk-return profiles.The findings underline the value of combining MPT with computational tools like PyPortfolioOpt to construct portfolios that align with diverse financial goals. However, further research could explore dynamic market conditions, broader datasets, and alternative risk metrics to improve portfolio resilience and adaptability. This study highlights the potential of python-driven optimization to bridge financial theory and practical application, enabling robust and efficient portfolio management in dynamic markets.

Keywords: Modern Portfolio Theory, Portfolio Optimization, PyPortfolioOpt, Risk Management, Sharpe Ratio
JEL Codes: C61, G11

1.INTRODUCTION

In the intricate and unpredictable world of finance, Modern Portfolio Theory (MPT) stands as a foundational framework for constructing efficient investment portfolios. Developed by Harry Markowitz in the 1950s, MPT revolutionized investment strategies by emphasizing diversification as a critical tool for optimizing the trade-off between risk and return. This theory provides a systematic approach to asset allocation, allowing investors to maximize returns for a specified level of risk or minimize risk for a desired return.

MPT fundamentally recognizes that pursuing higher returns often requires accepting greater levels of risk. However, through careful diversification across uncorrelated or minimally correlated assets, investors can construct portfolios that balance these competing objectives. This diversification reduces the overall portfolio risk without compromising returns, creating a more resilient investment strategy.

In recent years, python's robust computational capabilities have enabled the practical application of MPT on a larger scale. Libraries such as PyPortfolioOpt have emerged as powerful tools for portfolio optimization, offering algorithms for efficient frontier plotting, risk modeling, and performance evaluation. PyPortfolioOpt equips investors and researchers with a flexible and efficient platform for implementing MPT principles in real-world scenarios.

This study provides a detailed exploration of applying MPT principles using Python-based tools, specifically PyPortfolioOpt, to optimize a portfolio of diversified assets. It focuses on leveraging historical financial data, including adjusted closing prices, to calculate log returns,

evaluate asset correlations, and construct an optimized portfolio. The analysis incorporates constraints, such as asset weight limits, to reflect practical investment scenarios and enhance diversification.

The transformative potential of combining MPT with Python's computational power lies in its ability to provide actionable insights for portfolio construction. This research demonstrates the process of data preprocessing, covariance matrix computation, optimization using Sequential Least Squares Programming (SLSQP), and evaluating the resulting portfolio's performance.

By applying these methodologies, this study analyzes a diversified portfolio of high-performing stocks from various sectors, including technology, media, clean energy, and industrial innovation. The findings highlight how Python-based optimization tools can empower investors to align portfolio strategies with their objectives, balancing risk and return effectively. This research aims to contribute to the evolving landscape of portfolio management, offering practical insights and frameworks for both academics and practitioners in the field of finance.

2.LITERATURE REVIEW

Modern Portfolio Theory (MPT), introduced by Harry Markowitz in 1952, established a groundbreaking quantitative framework for portfolio selection and asset allocation. A central tenet of MPT is the concept of the efficient frontier, which represents the set of optimal portfolios delivering the highest expected return for a given level of risk (Markowitz, 1952). This theoretical foundation has significantly influenced modern investment practices and continues to guide portfolio management strategies.

The increasing availability of extensive financial datasets and advancements in computational tools, particularly Python, have enabled the practical implementation of MPT on a much larger scale. Python's comprehensive ecosystem, featuring libraries such as NumPy, pandas, scipy, and optimization-focused modules, provides a versatile platform for conducting portfolio analyses and simulations. These tools allow researchers and practitioners to integrate MPT principles with real-world financial data efficiently.

Several studies have highlighted Python’s utility in portfolio optimization. Hilpisch (2014) presents an extensive exploration of financial analysis and portfolio management techniques using Python, focusing on data retrieval, visualization, statistical evaluation, and optimization. Building on this foundation, Hilpisch (2019) delves deeper into advanced quantitative finance concepts, demonstrating their seamless application through Python’s functionalities.

Specialized research, such as Nguyen (2020), provides step-by-step methodologies for constructing investment portfolio optimization systems, emphasizing python's role in automating and enhancing these processes. Similarly, Lewinson (2021) offers practical insights into Python-based portfolio optimization techniques, demonstrating their relevance in solving complex financial problems.

Innovative approaches to portfolio optimization are also evident in academic research. Ardia, Hoogerheide, and van Dijk (2019) discuss Bayesian methods for managing financial risk and showcase how python can facilitate the integration of these advanced techniques into portfolio management. These studies highlight the flexibility of Python in adapting traditional portfolio theories to contemporary challenges in financial markets.

Recent empirical studies extend MPT by integrating Python-driven analyses with real-time data to construct and evaluate portfolios. These investigations often incorporate dynamic constraints, such as asset weight limits or correlation considerations, to align with specific investment objectives and risk tolerances. Additionally, the use of Python-based optimization algorithms, such as Sequential Least Squares Programming (SLSQP), underscores the effectiveness of these tools in achieving efficient portfolio construction.

The literature illustrates a growing interest in leveraging Python's computational capabilities to enhance the application of MPT. By combining theoretical rigor with practical implementation, these studies contribute to the evolving landscape of portfolio optimization, offering valuable insights for both academic research and practical investment management.

3. METHODOLOGY and RESEARCH HYPOTHESIS

This study examines the effectiveness of Python-based Modern Portfolio Optimization (MPO) in constructing an optimal portfolio of U.S. stocks, focusing on maximizing risk-adjusted returns over a one-year period. The methodology encompasses stock selection, data collection, portfolio construction, optimization, and hypothesis formulation, aligning with Modern Portfolio Theory (MPT) principles to balance risk and return effectively.

The optimization process employs Sequential Least Squares Programming (SLSQP), a robust method for solving constrained optimization problems. SLSQP is particularly well-suited for portfolio optimization as it accommodates both linear and nonlinear constraints, such as ensuring that the sum of portfolio weights equals one and imposing upper and lower bounds on individual asset weights. The method utilizes Karush-Kuhn-Tucker (KKT) conditions to identify optimal solutions while leveraging derivative information for enhanced precision. This capability to handle complex constraints makes SLSQP an ideal choice for MPT applications, where achieving a balance between risk and return involves navigating intricate interdependencies among assets. By integrating SLSQP into the optimization framework, the study achieves a sophisticated equilibrium of diversification and risk management, addressing the nuanced requirements of real-world portfolio construction.

The sample for this study consists of U.S. stocks traded on major exchanges, spanning sectors such as technology, healthcare, consumer goods, clean energy, media, and industrial innovation. Stocks were selected based on their cumulative returns over the past year, prioritizing top-performing assets within each sector. The dataset, sourced from Yahoo Finance, includes adjusted closing prices, trading volumes, and sector classifications, offering a comprehensive foundation for portfolio optimization. Leveraging this diverse dataset, the study constructed a portfolio of 38 stocks with initial equal weight allocation, ensuring unbiased asset distribution and setting the stage for subsequent optimization to refine the balance between risk and return.

The portfolio underwent optimization using Python's advanced computational tools, including libraries such as NumPy, pandas, and scipy. Log returns and a covariance matrix of the selected assets were calculated to measure performance and risk. The Sequential Least Squares Programming (SLSQP) algorithm was applied to maximize the sharpe ratio, a key metric of risk-adjusted returns. Constraints were incorporated to maintain realistic weight boundaries (0–0.4) and enforce a fully invested portfolio. By converting the Sharpe ratio into a minimization problem, the optimization process identified the optimal asset weights.

The research hypothesis (H1) posits that python-based MPO techniques can construct a portfolio with superior returns and lower volatility than a benchmark portfolio, leveraging sector-based diversification and risk mitigation strategies. The null hypothesis (H0) assumes no significant difference in performance between the optimized portfolio and the benchmark. Statistical analyses, such as t-tests, were designed to evaluate these hypotheses, ensuring robust validation of the findings.

The asset selection process incorporated a comprehensive evaluation of historical performance, fundamental characteristics, and inter-asset correlations. Metrics such as revenue growth, earnings stability, and market positioning were assessed alongside financial performance indicators. Correlation analysis revealed the co-movement between assets, prioritizing low-correlation stocks to enhance portfolio resilience and reduce systemic risk exposure.

To address the dynamic nature of financial markets, this study emphasizes the importance of adaptive asset allocation and periodic portfolio rebalancing. This ensures alignment with evolving market trends and investor preferences, optimizing risk-adjusted returns over time. Strategies for dynamic reallocation were explored to capitalize on emerging opportunities and mitigate potential downside risks.

The Sharpe ratio was central to this analysis, calculated as the difference between the portfolio's average return and the risk-free rate, divided by the standard deviation of returns:

$$SR = \frac{\bar{r_i} - \bar{r_f}}{\sigma_i}$$

where,
r_i*: Average return of the i fund,*
r_f*: Average risk-free interest rate,*
σ_i*: Standard deviation of the i fund,*

Portfolios with Sharpe ratios exceeding 1 were deemed efficient, signaling that the returns adequately compensated for the risks. This threshold informed sector prioritization, guiding the allocation to sectors with strong risk-adjusted performance.

By employing this selective approach, the study demonstrates the effectiveness of Python-driven MPO techniques in constructing robust portfolios that balance returns and risks. The findings underscore the value of leveraging computational tools and sector-based strategies in navigating complex financial markets and achieving sustainable investment success.

4.FINDINGS

The findings of this study emphasize the efficacy of Python-based Modern Portfolio Optimization (MPO) in constructing a diversified and efficient investment portfolio. Utilizing a dataset of 38 stocks from various sectors, the analysis focuses on maximizing the Sharpe ratio, a widely recognized measure of risk-adjusted returns. The optimized portfolio demonstrates a high degree of diversification, with significant weights allocated to assets exhibiting favorable risk-return characteristics, such as PMBPF (39.32%), NVDA (10.29%), and JNJ (18.86%). These allocations highlight the importance of balancing performance metrics with diversification to reduce systemic risks and enhance portfolio resilience.

Despite achieving an expected annual return of 71.19%, the portfolio's annualized volatility of 213.96% reflects substantial fluctuations, making it suitable primarily for risk-tolerant investors. The calculated Sharpe ratio of 0.31 underscores the portfolio's moderate efficiency in balancing risk and return. While high-return assets such as PMBPF and NVDA received significant weights, traditionally strong-performing stocks like TSLA, AAPL, and AMD were excluded from the optimized portfolio. This exclusion stems from optimization constraints and the higher correlation of these stocks with other assets, reinforcing the need for diversification over mere reliance on individual performance metrics.

The Sharpe ratios of the selected stocks reveal key insights into their individual contributions to portfolio efficiency. High-performing stocks such as SBNYL (3.11), TKLS (2.68), HQGE (2.54), and NVDA (2.48) exhibit superior risk-adjusted returns, making them critical components in high-efficiency portfolios. Conversely, stocks like SEDG (-1.55) and ALTNF (-0.18) demonstrate negative Sharpe ratios, indicating their inability to outperform the risk-free rate after adjusting for volatility. The inclusion of moderate performers, such as META (1.83) and NFLX (1.96), further illustrates the portfolio's balanced approach to risk management and return optimization.

A correlation analysis between optimal portfolio weights and sharpe ratios yielded a weak positive correlation coefficient of 0.148 with a p-value of 0.375, indicating that the relationship is not statistically significant. This suggests that factors beyond sharpe ratios, such as covariance structure and sector diversification, heavily influenced weight allocation. The optimization process's ability to consider these additional factors underscores its robustness in constructing portfolios aligned with Modern Portfolio Theory (MPT).

The optimization process also encountered potential numerical stability issues, as indicated by warnings regarding the covariance matrix. This issue may arise from high correlations among certain assets, impacting the optimization's precision. Addressing these challenges through regularization techniques or alternative optimization methods, such as Bayesian approaches, could enhance the portfolio's reliability.

The findings highlight the dynamic interplay between risk, return, and diversification in portfolio construction. While high-return assets dominate the portfolio, the moderate sharpe ratio and elevated volatility suggest a need for careful consideration of individual risk

tolerances. Future research could expand the analysis to include dynamic market conditions, alternative risk metrics, or sector-specific trends, further refining the portfolio's adaptability and efficiency.

Table: Optimal Portfolio Allocation and Sharpe Ratios

	Ticker	Company Name	Optimal Weights	Sharpe Ratios
1	AAPL	Apple	0	1.12
2	ALIF	Artificial	0	1.38
3	ALTNF	Altius	0	-0.19
4	AMD	AMD	0	0.79
5	AMZN	Amazon	0	1.25
6	BKNG	Booking	0.06	1.82
7	CPWR	Compuware	0	1.39
8	CSCO	Cisco	0	0.15
9	DIS	Disney	0.02	0.54
10	DMCOF	Dome	0	0.42
11	ENPH	Enphase	0	0.34
12	FONU	Fonu2	0	0.87
13	FUUN	Funtastic	0	1.81
14	GOOGL	Google	0	1.17
15	HIMR	Holloman	0.02	0.99
16	HQGE	HQ Global	0	2.54
17	INOTF	Inotiv	0	1.06
18	IQST	iQSTEL	0	0.38
19	JNJ	Johnson & Johnson	0.19	0.23
20	MCD	McDonald's	0	0.39
21	MDTC	MedTech	0	1.31
22	META	Meta	0.05	1.83
23	MNNGF	Marathon	0	-0.1
24	MSFT	Microsoft	0	1.01
25	NEOM	NeoMedia	0	1.21
26	NFLX	Netflix	0.08	1.96
27	NOKPF	Nokia	0	1.28
28	NVDA	NVIDIA	0.1	2.48
29	PMBPF	Pembina	0.39	1.34
30	ROBOF	RoboGroup	0	1
31	SBNYL	Sabine	0.04	3.11
32	SEDG	SolarEdge	0	-1.55
33	SNVFF	Senvest	0	0.46
34	SWVL	Swvl	0	1.56
35	TCPFF	TC Pipelines	0	0.39
36	TKLS	Takeda	0	2.68
37	TSLA	Tesla	0.02	0.58
38	ZTSTF	ZTEST	0	1.64

The optimized weight distribution reveals that specific assets like PMBPF play a pivotal role in achieving the desired risk-return balance, while others with high Sharpe ratios, such as HQGE and TKLS, receive minimal weights due to higher correlations or optimization constraints. This distribution reflects the nuanced trade-offs inherent in modern portfolio construction, ensuring that the portfolio aligns with both theoretical principles and practical investment strategies

5.CONCLUSION

This study demonstrates the implementation of Modern Portfolio Theory (MPT), introduced by Harry Markowitz in the 1950s, using PyPortfolioOpt, a Python library designed for portfolio optimization. MPT remains a cornerstone in finance, offering a quantitative framework for constructing diversified portfolios that balance the trade-off between risk and return. The key objective of this study was to leverage MPT principles to construct an optimal portfolio that aligns with investor preferences while maximizing risk-adjusted returns.

Through the use of PyPortfolioOpt, the study highlights a structured process for portfolio construction. This includes data preprocessing, where historical financial data is collected, cleaned, and prepared for analysis. The optimization phase integrates advanced techniques such as mean-variance optimization, risk parity, and minimum correlation portfolio construction. These methodologies are supported by PyPortfolioOpt's comprehensive suite of algorithms, risk models, and performance metrics, enabling the creation of portfolios tailored to specific investment objectives.

A core aspect of the analysis is risk management, which underscores the importance of diversification, hedging strategies, and controlling leverage. By employing tools to assess metrics like portfolio volatility, sharpe ratio, and maximum drawdown, the optimization process

ensures that risk exposure is minimized while maintaining alignment with target returns. PyPortfolioOpt's flexibility allows for the evaluation of these metrics in real time, equipping investors with actionable insights to refine their portfolios.

The study further evaluates portfolio performance through key indicators, including the Sharpe ratio and Jensen's alpha, to assess the effectiveness of investment strategies. These metrics provide critical insights into the efficiency of the portfolio in delivering returns relative to the risks undertaken. This evaluation highlights the practical benefits of integrating PyPortfolioOpt into investment decision-making.

By offering a roadmap for implementing MPT with Python, this research provides investors and researchers with a robust approach to constructing diversified and efficient portfolios. The findings underscore the potential of Python-driven optimization to enhance portfolio performance in real-world scenarios, accommodating varying risk preferences and financial goals.

While the results affirm the effectiveness of MPT principles, further validation and exploration are necessary. Future studies could expand on this methodology by incorporating dynamic market conditions, alternative optimization techniques, and additional financial metrics to improve portfolio resilience. This holistic approach could provide greater adaptability to changing market environments, ensuring continued alignment with investor needs and preferences. Ultimately, this study contributes to advancing the application of quantitative finance in portfolio management, bridging theoretical insights with practical execution.

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ANALYSIS OF THE IMPACTS OF CLIMATE POLICY AND ENERGY UNCERTAINTIES ON THE STOCK EXCHANGE: THE CASE OF TURKIYE AND AMERICA

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ABSTRACT

Purpose- It can be stated that global uncertainty indices, which were developed to measure the effects of global uncertainties on markets and the economy, may have the potential to affect risk perception and investment strategies in the markets. Determining the direction and intensity of the impact of uncertainty and risks on stock markets has become very important for stock market investors under these conditions. This paper aims to comparatively examine how the Climate Policy Uncertainty Index (CPUI) and Energy Uncertainty Index (EUI), which are relatively newer than global uncertainty indices and have been the subject of fewer studies, affect stock prices in Borsa Istanbul 100 (BIST100) and Standard&Poors 500 (S&P500) stock exchanges, in a developing and developed country stock exchange.
Methodology- The short and long-term relationships between global uncertainty indices and stock prices were investigated using the ARDL (Distributed Autoregressive Lag) Bounds Test. ARDL is an approach that has several advantages over classical cointegration methods.
Findings- It was determined that CPUI and EUI significantly affected the S&P500 index both in the short and long term, positively and negatively, respectively. For BIST100, this effect was negative but statistically insignificant for both indices in the long-term.
Conclusion- This paper has highlighted the impact of climate policy and energy uncertainty indices on stock prices, especially in developed countries. In this context, the study emphasizes that investors and policymakers in these countries, especially those considering investing in developed countries, should consider these uncertainty indices and closely monitor them to reduce risks in their risk assessments and optimize their investment strategies. The paper contributes to the existing literature by improving the understanding of how climate policy uncertainty affects financial markets in developed and developing economies. The findings suggest that investors and policymakers should consider different effects when assessing the financial impacts of climate policy and energy uncertainty. Future research could investigate how firms respond to such uncertainties and the financial impacts of corporate strategies at the sectoral level.

Keywords: Uncertainty, climate policy uncertainty, energy uncertainty, stock exchange
JEL Codes: C32, G01,G11

İKLİM POLİTİKASI VE ENERJİ BELİRSİZLİKLERİNİN BORSA ÜZERİNDEKİ ETKİLERİNİN ANALİZİ: TÜRKİYE VE AMERİKA ÖRNEĞİ

ÖZET

Amaç- Küresel düzeydeki belirsizliklerin piyasalardaki ve ekonomi üzerindeki etkilerini ölçmek amacıyla geliştirilmiş olan küresel belirsizlik endekslerinin piyasalardaki risk algısını ve yatırım stratejilerini etkileme potansiyeline sahip olabileceği ifade edilebilmektedir. Bu çalışma, küresel belirsizlik endekslerinden nispeten daha yeni geliştirilen ve daha az sayıda çalışmaya konu olmuş İklim Politikası Belirsizlik Endeksi (CPUI) ile Enerji Belirsizlik Endeksi'nin (EUI) Borsa İstanbul 100 (BİST100) ve Standard&Poors 500 (S&P500) borsalarındaki hisse senedi fiyatları üzerinde nasıl bir etki oluşturduğunun gelişmekte olan ve gelişmiş birer ülke borsası özelinde karşılaştırmalı olarak incelenmesini amaçlamaktadır.
Yöntem- Küresel belirsizlik endeksleri ile hisse senedi fiyatları arasındaki kısa ve uzun dönemli ilişkiler ARDL (Gecikmesi Dağıtılmış Otoregresif) Sınır Testi ile araştırılmıştır. ARDL klasik eş bütünleşme yöntemlerine göre çeşitli avantajlara sahip bir yaklaşımdır.
Bulgular- CPUI ve EUI'nin S&P500 endeksini hem kısa hem de uzun dönemde sırasıyla pozitif ve negatif olarak anlamlı bir şekilde etkilediği belirlenmiştir. BİST100 için ise bu etkinin uzun dönemde her iki endeks için de negatif fakat istatistiksel olarak anlamsız olduğu tespit edilmiştir.
Sonuç- Bu çalışma iklim politikası ve enerji belirsizlik endekslerinin özellikle gelişmiş ülkelerdeki hisse senedi fiyatları üzerindeki etkisini ön plana çıkarmıştır. Bu doğrultuda çalışma, özellikle gelişmiş ülkelere yatırım yapma düşüncesinde olan yatırımcı ve bu ülkelerdeki politika yapıcıların risk değerlendirmelerinde riskleri azaltabilmek ve yatırım stratejilerini optimize edebilmek için bu belirsizlik endekslerini dikkate almaları, yakından izlemeleri gerektiğini vurgulamaktadır.

Anahtar Kelimeler: Belirsizlik, iklim politikası belirsizliği, enerji belirsizliği, borsa
JEL Kodları: C32, G01,G11

1. GİRİŞ

1980'li yıllardan itibaren ekonomide yaşanan küreselleşme olgusu, finansal piyasaların liberalleşmesine öncülük etmiştir. Serbest piyasa ekonomisi ilkeleri benimsenmeye başlanmış ve sermaye hareketlerinin önündeki kısıtlamalar ortadan kaldırılmıştır. Bu gelişmeler uluslararası piyasalarda sermaye dolaşımının hız kazanmasına, yatırımcıların daha önce ulaşamadıkları piyasalarda erişmelerine ve yatırım portföylerinin çeşitlenmesine imkan tanımıştır. Küreselleşme ve serbestleşmenin etkisiyle evrilen ve entegre olan küresel finansal piyasalarda küresel risk ve belirsizliklerin de oldukça önemli risk faktörleri haline geldiği ifade edilebilmektedir. Herhangi bir ülkede baş gösteren küresel risk ya da belirsizlik faktörü hızla diğer ülkeleri de etkisi altına alabilmektedir. Son yıllarda Çin-ABD arasındaki ticaret savaşları, siyasi kutuplaşmalar, Ortadoğu'da hakim olan savaş ortamı, COVID-19 pandemisi ve Rusya-Ukrayna çatışması gibi küresel olaylar artan belirsizlik seviyeleri ile ilgili endişeleri zirveye taşımıştır.

İklim riski küresel boyutta son on yılın en önemli ve ele alınması gereken konularından biri olarak ortaya çıkmıştır. İklim riski ile baş edebilmek amacıyla dünya çapında hükümetler iklim değişikliğinin etkilerini azaltmayı amaçlayan çeşitli önlemler almış ve politikalar geliştirmiştir. Doğası gereği belirsiz olan iklim politikaları iş ortamını önemli ölçüde şekillendirebildiğinden dolayı kurumsal stratejileri ve finansal piyasalardaki yatırımcı davranışlarını etkileme potansiyeline sahiptir (Li vd. 2024). Enerji kaynaklı küresel belirzilik göstergesi olan enerji belirsizliği endeksinin hesaplanmasıyla enerji ile ilgili belirsizlikler finansal piyasalarda önemli bir etken haline gelmiştir (Wang vd. 2024). Küresel belirsizlik endeksleri olarak değerlendirilen İklim Politika Belirsizlik Endeksi, Gavriilidis (2021) tarafından; Enerji Belirsizlik Endeksi ise Dang vd. (2023) tarafından hesaplanan gazete verilerine dayanan endekslerdir. Gavriilidis (2021), iklim ve belirsizlik ile ilgili terimleri içeren önde gelen sekiz ABD gazetesine ait makaleleri analiz ederek küresel iklim politikası belirsizlik endeksini (CPUI) oluşturmuştur Dang vd. (2023), The Economist Intelligence Unit'in aylık ülke raporlarındaki belirsizlik ve enerjiyle ilgili terimleri analiz ederek, 28 gelişmiş- gelişmekte olan ülke için ve küresel olarak enerjiyle ilgili belirsizlik endeksleri (EUI) oluşturmuştur. Bu endeksleri kullanarak gerçekleştirilen araştırmalarda gazete verilerinden elde edilen politik, ekonomik veya finansal belirsizliklerle ilgili haberlerin hisse senedi fiyatları üzerinde önemli derecede etkili olabileceği üzerinde durulmaktadır (Das, vd. 2019).

Belirsizlik ve risklerin hisse senedi piyasalarına etkisinin yönü ve şiddetinin belirlenmesi bu koşullar altında borsa yatırımcıları için oldukça önemli hale gelmiştir. Piyasalarda risk ve belirsizlikler arttıkça yatırımcılar yatırım kararlarında daha temkinli davranmakta ve hisse senedi fiyatlarındaki volatilite artmaktadır (Şencan, 2024). Bunun yanı sıra belirsizliklerin arttığı dönemlerde yatırımcıların riskten korunmak amacıyla güvenli liman olarak gördükleri varlıklara yöneldiği ve hisse senedi piyasalarına olan güvenin sarsıldığı bu piyasalardan çıkışların yaşandığı ifade edilebilmektedir (Atıcı Ustalar ve Şanlısoy, 2021). Küresel düzeydeki belirsizliklerin piyasalardaki ve ekonomi üzerindeki etkilerini ölçmek amacıyla geliştirilmiş olan küresel belirsizlik endekslerinin piyasalardaki risk algısını ve yatırım stratejilerini etkileme potansiyeline sahip olabileceği ifade edilebilmektedir.

Bu çalışma, küresel belirsizlik endekslerinden nispeten daha yeni geliştirilen ve daha az sayıda çalışmaya konu olmuş İklim Politikası Belirsizlik Endeksi (CPUI) ile Enerji Belirsizlik Endeksi'nin (EUI) Borsa İstanbul 100 (BİST100) ve Standard&Poors 500 (S&P500) borsalarındaki hisse senedi fiyatları üzerinde nasıl bir etki oluşturduğunun gelişmekte olan ve gelişmiş birer ülke borsası özelinde karşılaştırmalı olarak incelenmesini amaçlamaktadır.

2. LİTERATÜR

İklim politikası belirsizliğinin hisse senedi fiyatları üzerindeki net etkisini belirlemede teoride iki farklı görüşün hakim olduğu ifade edilebilmektedir. Bir yandan, artan iklim politikası belirsizliğinin firmaların faaliyette bulunduğu iş ortamını ve makroekonomik ortamı kısıtlamaktadır. Getiri ortaklığı teorisi, yüksek iklim politikası belirsizliği dönemlerinde sistematik risk faktörlerinden kaynaklı artan hareketlerle hisse senedi fiyatlarının aynı yönde hareket etme eğiliminde olduğu ifade edilebilir. Bu görüşe göre iklim politikası belirsizliği ile hisse senedi fiyatları arasında pozitif bir ilişki öngörülmektedir. Diğer yandan, iklim politikasıyla ilgili belirsizlik firmaları gönüllü olarak daha fazla bilgi ifşa etmeye teşvik ederek iklim politikası belirsizliği ile hisse senedi fiyatları arasında negatif bir ilişki oluşturabildiği ifade edilebilir. Finansal kısıtlama teorisine göre yüksek iklim politikası belirsizliğinin yatırımcı endişelerini ve finansman maliyetlerini artırdığını ifade etmektedir. Olumsuz etkinin üstesinden gelmek ve yatırımcı güvenini sağlamak için firmalar daha fazla bilgi ifşa etme eğilimine girmekte ve bu durum da hisse senedi fiyatlarının azalmasına yol açabilmektedir. Bunun yanı sıra iklim politikası belirsizliğinin artması özellikle kirleticiliği fazla olan firmaları daha fazla firma riskine maruz bırakabilmekte ve bu da onları daha fazla nakit tutmaya, araştırma geliştirme yatırımlarını azaltmaya teşvik edebilmektedir. Dolaylı olarak bu görüşe göre hisse senedi fiyatlarında düşüş beklendiği ifade edilebilmektedir (Li vd. 2024). Bu iki farklı teori ve görüş göz önüne alındığında iklim politikası belirsizliği ile hisse senedi fiyatları arasındaki ilişkinin yönünün çalışmadan çalışmaya farklılık gösterebileceği ifade edilmelidir. İklim Politikası Belirsizlik Endeksi'nin hisse senedi fiyatlarını etkilediği yönünde bulgular elde eden bazı çalışmalar aşağıda özetlenmiştir:

Pastor vd. (2021) belirsizliğin arttığı dönemlerde yeşil hisse senetlerinin kahverengi hisse senetlerine göre daha iyi performans gösterdiğini belirtmiştir. Bouri vd. (2022), iklim politikası belirsizliğinin yeşil enerji hisselerinin performansının kahverengi enerji hisselerine göre daha önemli bir belirleyicisi olduğunu belgelemiştir. Ayrıca iklim politikası belirsizliğinin hisse senedi performansları üzerinde pozitif etkili olduğu ve bu etkinin kriz dönemlerinden etkilendiği belgelenmiştir. Lasisi vd. (2022) iklim politikası belirsizlik endeksinin borsa performansının öncü göstergesi olduğunu belirtmiştir.İklim politikası belirsizliğini gözlemlemenin daha iyi borsa tahmini yapmaya ve ekonomik kazanımların artmasına yol açtığını belgelemişlerdir. Li vd. (2024), Çin'e ait yıllık iklim politikası belirsizliğinin Çin hisse senedi fiyat senkronizasyonu üzerindeki etkisini 2000-2022 dönemi için analiz ederek iklim politikası belirsizliğinin hisse senedi fiyat senkronizasyonu üzerinde önemli olumsuz etkileri olduğunu ifade etmiştir. Bu olumsuz etkinin yüksek kirletici endüstrilerde daha belirgin olduğu belirtilmiştir.

Küresel enerji piyasası dalgalanmaları ve derinleşen ekonomik ve finansal küreselleşme ortamında enerjiye bağlı belirsizlik finansal piyasalarda önemli bir etken haline gelmiştir. Bu doğrultuda literatürde özellikle petrol fiyat şokları ile borsa faaliyetleri arasındaki ilişkiyi inceleyen çok sayıda çalışma bulunmaktadır. Enerji Belirsizlik Endeksi'nin hisse senedi fiyatlarını etkilediği yönünde bulgular elde eden daha sınırlı sayıda çalışma olmakla birlikte konu ile ilgili belli başlı çalışmalar aşağıda özetlenmiştir:

Doğan ve Doğan (2024), Küresel Temiz Enerji ve Enerji Belirsizlik Endekslerinin BİST Sürdürülebilirlik Endeksi üzerindeki etkisini etki-tepki ve nedensellik anaizleri ile incelemişlerdir. Enerji endekslerinden BİST Sürdürülebilirlik Endeksi'ne doğru tek yönlü nedensellik olduğu belirlenmiştir. Bu bulgu ilgili endekslerin BİST Sürdürülebilirlik Endeksi'ni etkilediğini göstermiştir. Enerji Belirsiz Endeksi'nin borsayı dönem başında negatif etkilediği fakat etkinin hızlı bir şekilde ortadan kalktığı görülmüştür. Salisu vd. (2024), ülkelere özgü ve küresel aylık enerji belirsizlik endekslerinin bu ülkelerin günlük borsa getiri oynaklığına etkisini incelemiştir. Küresel belirsizlik endeksinin ülkeye özgü belirsizlik endekslerinden daha fazla etkili olduğu fakat tüm bu enerji belirsizlik endekslerinin borsa getiri oynaklığı için tahmin gücüne sahip olduğunu belirlemişlerdir. Enerji belirsizlik endekslerindeki artışın borsa getiri oynaklığını artırdığı da elde edilen bulgular arasındadır. Wang vd. (2024), dokuz adet popüler ekonomik değişkenin yanısıra Çin, ABD ve küresel enerji belirsizlik endekslerinin Çin borsa getirileri üzerindeki etkisini araştırmıştır. Sonuç olarak borsa getirileri üzerinde enerji belirsizliklerinin diğer ekonomik faktörlerden çok daha fazla etkili olduğunu belirlemişlerdir. Bunun yanında etki derecesi değerlendirildiğinde Çin borsa getirileri üzerindeki enerji belirsizlik endekslerinin etki sıralaması Çin enerji belirsizliği, küresel enerji belirsizliği ve ABD enerji belirsizliğidir. İklim politikası belirsizliği ile Enerji belirsizlik endekslerini bir arada ele alarak hisse senedi piyasaları üzerindeki etkisini araştıran tek çalışma ise Kayani vd. (2024)'ne aittir. Kayani vd. (2024), CPUI ve EPUI'nin pozitif ve negatif şoklarının ABD sektörel hisse senedi getirileri üzerindeki etkisini incelemiştir. Bulgulara göre CPUI'daki pozitif şoklar uzun vadede hizmet, finans, endüstri, telekomünikasyon sektörel hisse senedi getirilerini olumsuz etkilemektedir. Pozitif (negatif) EUI şoklarının ise malzeme ve teknoloji sektörüne ait hisse senedi getirilerinin azalmasına (artmasına) neden olduğu belirlenmiştir.

Küresel İklim Politikası ve Enerji Belirsizlik endekslerinin diğer belirsizlik endekslerine göre nispeten yeni geliştirilen endeksler olması sebebiyle bu belirsizlik endeksleri ile hisse senedi fiyatları arasındaki ilişkiyi araştıran çalışmalar son dönemde artmaya başlamıştır. Literatürdeki bu boşluk ve Türkiye özelinde de az sayıda çalışmaya rastlanması çalışmanın motivasyonunu oluşturmuştur. Çalışma, gelişmiş ülke borsası örneği olarak S&P500, gelişmekte olan ülke borsası örneği olarak da BİST100 endekslerini ele alarak son zamanlarda geliştirilen İklim Politikası ve Enerji Belirsizlik Endeksleri'nin gelişmiş ve gelişen borsalara etkisini araştırmaktadır. Bu bağlamda çalışmanın literatüre katkı sağlayabileceği ifade edilebilir.

3. VERİ VE YÖNTEM

Bu çalışmanın amacı, Aralık 2014-Ekim 2022 dönemine ait aylık veri seti kullanarak küresel belirsizlik endekslerinden olan İklim Politikası Belirsizlik Endeksi (CPUI) ve Enerji Belirsizlik Endeksi (EUI)'nin S&P500 ve BİST100 Endeksleri üzerindeki etkilerini araştırmaktır. Ayrıca COVID-19 pandemisinin etkilerinin çalışmada göz ardı edilmemesi açısından salgının görülmeye başlandığı Aralık 2019 döneminden itibaren kukla değişken çalışmanın modeline dahil edilmiştir. Çalışma döneminin Ekim 2022'de sonlanmasının nedeni EUI'ya ait verilerin bu dönemde son bulmasıdır. Tablo 1, çalışmada kullanılan değişkenler, kısaltmaları ve veri kaynaklarını göstermektedir.

Tablo 1: Değişkenler ve Veri Kaynakları

Değişkenler	Kısaltma	Veri Kaynağı
Standard & Poor's 500 Endeksi	S&P500	https://tr.investing.com/
Borsa İstanbul 100 Endeksi	BİST100	https://tr.investing.com/
İklim Politikası Belirsizlik Endeksi	CPUI	https://www.policyuncertainty.com/
Enerji Belirsizlik Endeksi	EUI	https://www.policyuncertainty.com/

Çalışmanın amacına uygun olarak değişkenler arasındaki kısa ve uzun dönemli ilişkiyi araştırmak amacıyla kullanılacak olan modeller 1 ve 2 numaralı denklemlerde sunulmuştur:

$$lnS\&P500_t = \beta_0 + \beta_1 lnCPUI_t + \beta_2 lnEUI_t + \beta_3 DUM_t + \mu_t \quad (1)$$

$$lnBİST100_t = \beta_0 + \beta_1 lnCPUI_t + \beta_2 lnEUI_t + \beta_3 DUM_t + \mu_t \quad (2)$$

Çalışmanın analizinde değişkenler arasındaki eş bütünleşme ilişkisinin belirlenmesi ve aynı zamanda kısa dönemli ilişkilerin de tespit edilebilmesi amacıyla Pesaran vd. (2001) tarafından geliştirilen ARDL (Gecikmesi Dağıtılmış Otoregresif) sınır testi kullanılmıştır. ARDL sınır testinin avantajları; değişkenlerin durağanlık seviyelerinin (I(0) ya da I(1) olması) dikkate alınmaması (I(2) olmamak kaydıyla), kısıtsız hata düzeltme modeli kullanması dolayısıyla istatistiksel olarak daha doğru sonuçlar sağlaması ve küçük örneklem büyüklüklerinde de güvenilir sonuçlar vermesidir (Pesaran vd., 2001).

Bu doğrultuda denklem (1)'de oluşturulan genel modelin ARDL formu, (3) ve (4)numaralı denklem aracılığıyla tanımlanmıştır:

$$\Delta lnS\&P500_t = a_0 + \sum_{t=1}^{n} \beta_1 \Delta lnS\&P500_{t-i} + \sum_{t=1}^{n} \beta_2 \Delta lnCPUI_{t-i} + \sum_{t=1}^{n} \beta_3 \Delta lnEUI_{t-i} + \sum_{t=1}^{n} \beta_4 \Delta lnCOV19_{t-i} + \delta_1 lnS\&P500_{t-1} + \delta_2 lnCPUI_{t-1} + \delta_3 lnEUI_{t-1} + \delta_6 lnCOV19_{t-1} + \mu_t \quad (3)$$

$$\Delta lnBIST100_t = a_0 + \sum_{t=1}^{n} \beta_1 \Delta lnBIST100_{t-i} + \sum_{t=1}^{n} \beta_2 \Delta lnCPUI_{t-i} + \sum_{t=1}^{n} \beta_3 \Delta lnEUI_{t-i} + \sum_{t=1}^{n} \beta_4 \Delta lnCOV19_{t-i} + \delta_1 lnBIST100_{t-1} + \delta_2 lnCPUI_{t-1} + \delta_3 lnEUI_{t-1} + \delta_4 lnCOV19_{t-1} + \mu_t \quad (4)$$

3 ve 4 numaralı denklemdeki β_1, β_2, β_3 ve β_4 katsayıları hata düzeltme dinamiklerini yani değişkenler arasındaki kısa dönemli ilişkileri; δ_1, δ_2, δ_3 ve δ_4 katsayıları ise değişkenler arasındaki uzun dönemli ilişkileri ifade etmektedir.

4. BULGULAR

Analizde kullanılan değişkenlerin durağanlıklarının sınanması amacıyla Augmented Dickey ve Fuller birim kök testi yapılmış ve Tablo 2'de sunulmuştur.

Tablo 2: ADF Birim Kök Testi Sonuçları

Değişken	Seviye $t_{istatistik}$ (p olasılık)	Birinci Fark $t_{istatistik}$ (p olasılık)
S&P500	-2.956565 (0.1501)	-11.13056 (0.0000)
BİST100	0.323338 (0.9985)	-9.932012 (0.0000)
CPUI	-6.032860 (0.0000)	
EUI	-3.386383 (0.0595)	-14.00080 (0.0000)
Kritik Değerler	%1 -4.058619 %5 -3.458326 %10 -3.155161	

Tablo 2'den, %5 anlamlılık düzeyinde bağımlı değişkenler olan S&P500 ve BİST100'ün birinci farkları alındığında durağanlaştığı, bağımsız değişkenlerden ise CPUI'nin seviyede; EUI'nin ise birinci farkta durağan olduğu görülmektedir. Buna göre bağımlı değişkenlerin I(1) olması ve diğer tüm değişkenlerin I(2) olmaması dolayısıyla ARDL sınır testi için gerekli önkoşul sağlanmış olmaktadır.

İkinci aşamada modellere ait değişkenler için uygun gecikme uzunlukları AIC (Akaike) bilgi kriterlerine göre belirlenerek değişkenler arasında eş bütünleşme ilişkisinin olup olmadığını belirlemek amacıyla F-Bounds Sınır Testi uygulanmış ve Tablo 3'te sunulmuştur.

Tablo 3: F-Bounds Sınır Testi Sonuçları

Model	F_{BDS} İstatistiği	Kritik Değerler (Alt Sınır, Üst Sınır)
Model 1 (7,1,5,8)	6.946005	%1 (4.29, 5.61) %5 (3.23, 4.35) %10 (2.72, 3.77)
Model 2 (6,1,0,4)	5.215917	

Tablo 3 incelendiğinde, Model 1'in %1, Model 2'nin ise %5 anlamlılık seviyesinde F_{BDS} istatistik değerleri üst kritik değerlerden büyük olduğu için her iki model için de değişkenler arasında eş bütünleşme ilişkisinin olduğu ifade edilebilmektedir.

Çalışmanın modellerine ilişkin otokorelasyon, model kurma hatası ve değişen varyans problemlerinin olup olmadığının belirlenebilmesi için sırasıyla Breusch-Godfrey LM, Ramsey-Reset ve White testleri uygulanarak sonuçları Tablo 4'te sunulmuştur.

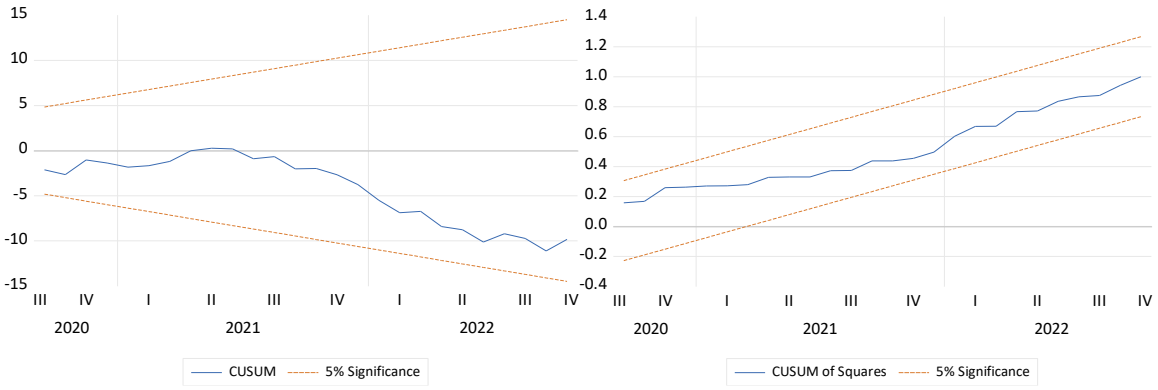
Tablo 4: Tanısal Test Sonuçları

Model	p olasılık (Breusch-Godfrey LM)	p olasılık (Ramsey Reset)	p olasılık (White)
Model 1 (7,1,5,8)	0.7410	0.1393	0.6072
Model 2 (6,1,0,4)	0.6719	0.0598	0.3547

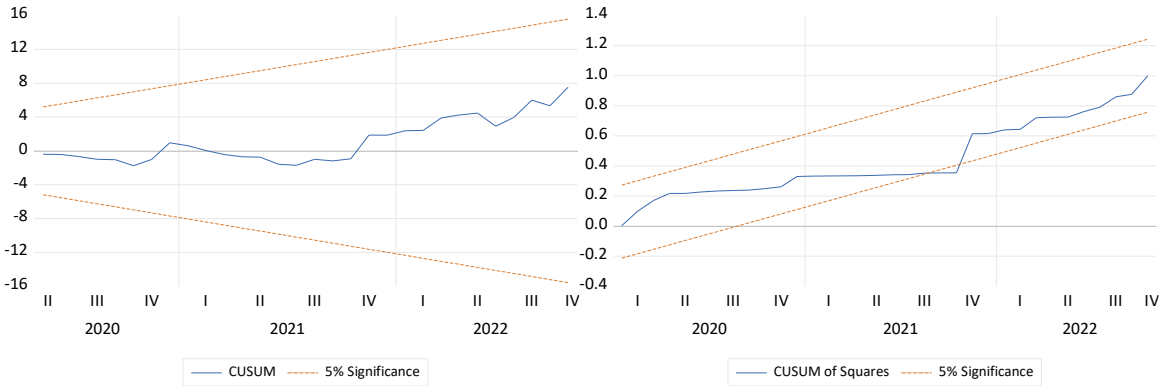
Tablo 4 incelendiğinde tanısal testlerin p olasılık değerleri 0.05'ten büyük olduğu için her iki model için de herhangi bir otokorelasyon, model kurma hatası ya da değişen varyans problemlerinin olmadığı görülmektedir.

Modellere ilişkin elde edilen parametrelerin %5 anlamlılık düzeyinde kritik sınırlar içinde olup olmadığının dolayısıyla modellerde herhangi bir yapısal kırılma olup olmadığının ve elde edilen katsayıların istikrarlı olup olmadığının anlaşılması amacıyla CUSUM ve CUSUM^2 testleri uygulanarak sonuçlar Şekil 1'de sunulmuştur.

Şekil 1: CUSUM ve CUSUM^2 Grafikleri



Model 1



Model 2

Şekil 1'de yer alan CUSUM ve CUSUM^2 grafikleri incelendiğinde Model 1 ve 2 için genel anlamda herhangi bir yapısal kırılmanın olmadığı ve elde edilen katsayıların istikrarlı olduğu görülmektedir.

Tablo 5: ARDL Tahmin Sonuçları

	Model 1	**Model 2**
Değişken	**Uzun Dönem Katsayısı**	**Uzun Dönem Katsayısı**
LCPUI	0.306323***	-0.949846
LEUI	-0.815311***	-0.814661
DUMMY	0.249147***	-0.699689
	Kısa Dönem Katsayısı	**Kısa Dönem Katsayısı**
D(LCPUI)	0.025293**	-0.014732**
D(LEUI)	-0.060217**	
D(LEUI(-1))	0.112901***	
D(LEUI(-2))	0.073345**	
D(LEUI(-3))	0.042949	
D(LEUI(-4))	0.071693***	
D(DUMMY)	0.095080**	0.032375
D(DUMMY(-1))	-0.039753	0.011448
D(DUMMY(-2))	-0.105192**	-0.211202***
D(DUMMY(-3))	-0.167789***	-0.239945***
D(DUMMY(-4))	0.031060	
D(DUMMY(-5))	0.042001	
D(DUMMY(-6))	0.041837	
D(DUMMY(-7))	0.104177**	
ECT(-1)	-0.171976***	-0.015871***

Not: ***, ** ve * sırasıyla %1, %5 ve %10 anlamlılık seviyelerini ifade etmektedir.

Tablo 5'teki ARDL tahmin sonuçları incelendiğinde; Model 1 için uzun dönemli katsayılara göre İklim Politikası Belirsizlik Endeksi (CPUI), Enerji Belirsizlik Endeksi (EUI) ve COVID-19 değişkenini temsilen modele dahil edilen kukla değişkenin (DUMMY) katsayılarının istatistiksel olarak anlamlı olduğu görülmektedir. Bu doğrultuda, CPUI'daki %1'lik değişimin S&P500 endeksini yaklaşık %0.30 oranında yükselttiği; EUI'daki %1'lik değişimin S&P500 endeksini yaklaşık %0.81 oranında düşürdüğü tespit edilmiştir. Kukla değişkenin ise S&P500 endeksini yaklaşık %0.25 oranında yükselttiği belirlenmiştir. Model 2 için uzun dönemli katsayılara göre CPUI, EUI ve DUMMY değişkenlerinin katsayılarının negatif fakat istatistiksel olarak anlamlı olmadığı dolayısıyla bu değişkenler ile BİST100 endeksi arasında uzun dönemde istatistiksel olarak anlamlı bir ilişki olmadığı gözlenmiştir.

Tablo 5'teki kısa dönemli analiz sonuçları incelendiğinde; Model 1'e ait bu sonuçların da uzun dönemli sonuçlara benzerlik gösterdiği CPUI ve EUI değişkenlerinin S&P500 endeksini kısa dönemde de sırasıyla pozitif ve negatif etkilediği belirlenmiştir. DUMMY değişkenin ise S&P500 endeksine etkisinin ilk dönemlerde negatif iken daha sonra pozitife döndüğü gözlenmiştir. Ayrıca Model 1'e ait hata düzeltme terimi katsayısı (ECT(-1)) beklendiği gibi negatif ve istatistiksel olarak anlamlı bulunmuştur. Bu da Model 1 için kısa dönemdeki sapmaların uzun dönemde dengeye ulaştığının kanıtı niteliğindedir. Model 2 için de EPUI için kısa dönemli katsayıların uzun dönemli katsayılara benzer şekilde istatistiksel olarak anlamlı sonuçlar vermediği görülmektedir. Dolayısıyla EUI belirsizlik endeksi ile BİST100 endeksi arasında kısa ve uzun dönemde anlamlı bir ilişki olmadığı, küresel enerji belirsizlik endeksinin BİST100 endeksini istatistiksel olarak anlamlı bir şekilde etkilemediği sonucu elde edilmiştir. CPUI değişkenine ait kısa dönemli katsayının negatif ve istatistiksel olarak anlamlı olması ise kısa dönemde küresel iklim politikası belirsizliğinin BİST100 endeksini negatif yönde etkilediğini göstermektedir. Ayrıca Model 2'ye ait hata düzeltme terimi katsayısı

(ECT(-1)) beklendiği gibi negatif ve istatistiksel olarak anlamlı bulunmuştur. Bu da Model 2 için kısa dönemdeki sapmaların uzun dönemde dengeye ulaştığını ifade etmektedir..

5. SONUÇ

Bu çalışmada CPUI'nin S&P500 endeksi üzerinde kısa ve uzun dönemde pozitif anlamlı etkileri olduğu tespit edilmiştir. Bu bulgunun getiri ortaklığı teorisi ile örtüştüğü ifade edilebilir. Nitekim, artan iklim politikası belirsizliği firmaların faaliyette bulunduğu iş ortamını ve makroekonomik ortamı kısıtlamaktadır. Getiri ortaklığı teorisine göre, yüksek iklim politikası belirsizliği dönemlerinde sistematik risk faktörlerinden kaynaklı artan hareketlilikle birlikte hisse senedi fiyatlarının aynı yönde hareket etme eğiliminde olduğu ifade edilebilir. Bu görüşe göre iklim politikası belirsizliği ile hisse senedi fiyatları arasında pozitif bir ilişki öngörülmektedir. Bu bulgunun literatürde pozitif yönde ilişki varlığı bulgusu elde eden çalışmalara paralel bir bulgu olduğu ifade edilebilir. Gelişmiş bir ülke borsası olan S&P500 için bu bulgunun beklenen bir sonuç olduğu belirtilebilir. EUI'nin S&P500 endeksi üzerindeki etkisinin de kısa ve uzun dönemde negatif ve anlamlı olduğu belirlenmiştir. Küresel enerji belirsizliklerindeki artışın hisse senedi piyasalarını olumsuz etkilediği yönündeki bulgu firmaların çoğunun hammaddesi olan enerji ve bu enerji fiyatlarındaki dalgalanmaların bu firmaların hisse senedi fiyatlarına yön vermesiyle açıklanabilir. CPUI'nin BİST100 endeksi üzerinde kısa dönemde nispeten daha az fakat negatif etkili olduğu, uzun dönemde ise herhangi bir etkisinin olmadığı belirlenmiştir. Küresel iklim politikası belirsizliğindeki artış kısa dönemde BİST100 fiyatlarını olumsuz etkileyebilmektedir. İklim politikalarının geleceğe yönelik düzenlemeleri konusundaki öngörememe durumunun Türk borsasında yatırımcıların borsaya duydukları güvenin sarsılmasına ve borsanın değer kaybı yaşamasına sebep olacağını ifade edebilir. Bu bulgu da İklim politikası belirsizliği ile hisse senedi fiyatları arasındaki negatif ilişki bulgusunu açıklayan teori ile örtüşmektedir. Finansal kısıtlama teorisi yüksek iklim politikası belirsizliğinin yatırımcı endişelerini ve finansman maliyetlerini artırdığını ifade etmektedir. Olumsuz etkinin üstesinden gelmek ve yatırımcı güvenini sağlamak için firmalar daha fazla bilgi ifşa etme eğilimine girmekte ve bu durum da hisse senedi fiyatlarının azalmasına yol açabilmektedir. Bunun yanı sıra iklim politikası belirsizliğinin artması özellikle kirleticiliği fazla olan firmaları daha fazla firma riskine maruz bırakabilmekte ve bu da onları daha fazla nakit tutmaya, araştırma geliştirme yatırımlarını azaltmaya teşvik edebilmektedir. Dolaylı olarak bu görüşe göre hisse senedi fiyatlarında düşüş beklendiği ifade edilebilmektedir. Gelişmekte olan bir borsa olan BİST100 endeksi için de bu bulgunun beklenen bir sonuç olduğu ifade edilebilir. EUI'nin ise hem kısa hem de uzun dönemde BİST100 üzerinde herhangi bir etki oluşturmadığı bulgusu küresel enerji belirsizliğindeki değişimlerin BİST100 endeksi üzerinde belirgin bir etkisinin olmadığı ve piyasanın küresel enerji belirsizliklerine karşı nispeten dayanıklı olduğu şeklinde yorumlanabilir. COVID-19 kukla değişkenin ise kısa dönemde her iki borsa endeksi üzerinde de negatif anlamlı etkileri olduğu fakat uzun dönemde bu etkinin BİST100 için ortadan kalktığı S&P500 için ise pozitife dönüştüğü ifade edilebilmektedir. Pandemi döneminde yaşanan olumsuz ekonomik ve sosyal koşulların özellikle dönemin ilk zamanlarında piyasalarda belirsizlik artışına yol açtığı fakat bu etkinin zaman içerisinde ortadan kalktığı şeklinde yorumlanabilmektedir.

Bulgular doğrultusunda özellikle ekonomik faaliyetleri iklim değişikliğini önemli derecede etkileyen büyük ve gelişmiş ekonomilerde, iklim politikası belirsizliklerinin gelecekteki yatırımlar üzerinde kapsamlı etkileri olabileceği düşünülmektedir. Bu çalışma iklim politikası ve enerji belirsizlik endekslerinin hisse senedi fiyatları üzerindeki etkisini ön plana çıkararak yatırımcı ve politika yapıcıların risk değerlendirmelerinde riskleri azaltabilmek ve yatırım stratejilerini optimize edebilmek için bu belirsizlik endekslerini dikkate almaları, yakından izlemeleri gerektiğini vurgulamaktadır. Çalışma, iklim politikası belirsizliğinin finansal piyasaları gelişmiş ve gelişmekte olan ekonomileri nasıl etkilediğine dair anlayışı geliştirerek mevcut literatüre katkıda bulunmaktadır. Bulgular, yatırımcı ve politika yapıcıların iklim politikası ve enerji belirsizliğinin finansal etkilerini değerlendirirken farklı etkileri göz önünde bulundurmaları gerektiğini göstermektedir. Gelecekteki araştırmalar, firmaların bu tür belirsizliklere nasıl tepki verdiğini, kurumsal stratejilerin finansal etkilerini sektörel düzeyde araştırabilir.

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RISING VALUE OF DATA IN CONTEMPORARY HIGHER EDUCATION

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ABSTRACT

Purpose - The purpose of this study is to reflect the importance of effective use of data to predict and improve academic success as an essential criterion for assessing the quality of higher education institutions in the 21st Century. This paper intends to clarify importance of data and its evaluation components, namely Educational Data Mining (EDM), Learning Analytics (LA), Artificial intelligence (AI) and Machine Learning (ML), as integral part of Fifth Generation Universities (UNIVERSITY 5.0) era in the globalized competitive higher education sector. For this reason, this paper advocates "Rising Value of Data in Contemporary Higher Education" for the university of the new age.

Methodology - The study employs a literature review aiming to reflect the new atmosphere and requirements in the higher education system based on selected topics. A comprehensive analysis on the game changer role of data in the higher education institutions was considered. The aim was to identify the difference created by effective use of data in higher education institutions to predict and improve academic success in the competitive academic environment of the new era.

Findings - The analysis reveals that higher education institutions should understand the essential role of educational data with the expansion of digital revolution and rapid change in technologies in the 21st Century and design their strategies accordingly. Notably, it is clearly seen that the universities have not only effectively use educational data and its evaluation components namely Educational Data Mining (EDM), Learning Analytics (LA), Artificial intelligence (AI) and Machine Learning (ML) but also internalize the reality of their rising value to predict and improve academic success as well as creating a significant financial contribution to their development. As a matter of the fact, universities established many projects and effectively used their Learning Analytics (LA) tools. Besides, the emergence of Artificial intelligence (AI) and Machine Learning (ML) enhanced the efficiency and effectiveness of management operations.

Conclusion - Findings may be concluded that universities need to apply the effective use of data particularly in the context of new era like Industry 5.0, Society 5.0 and University 5.0 to obtain academic success, which is considered as an essential criterion for assessing the quality of higher education institutions. Indeed, universities have to follow a data- driven culture as greater demands of universities already appeared for retention, completion and graduation rates of students to improve student success. As a matter of fact, the effective use of Educational Data Mining (EDM) and Learning Analytics (LA) is going on for the last two decades in higher education institutions. Indeed, Artificial intelligence (AI) and Machine Learning (ML) are effective in data management as two impressive game changers for universities changing educational world from the financial perspective. For this reason, it may be argued that the effective use of data and its evaluation components, namely Educational Data Mining (EDM), Learning Analytics (LA), Artificial intelligence (AI) and Machine Learning (ML) are considered as the integral part of Fifth Generation Universities (UNIVERSITY 5.0) era in the globalized competitive higher education sector of 21st Century.

Keywords: Higher education, educational data mining, learning analytics, artificial intelligence and machine learning, University 5.0
JEL Codes: A20, I23, M10, O31, O32

1. INTRODUCTION

Academic Success is considered as an essential criterion for assessing the quality of higher education institutions (Alyahyan and Düştegör, 2020) in the 21st Century. It is defined as concentrating on the most important six components as academic achievement, satisfaction, acquisition of skills and competencies, persistence, attainment of learning objectives, and career success (York et al., 2015).

For this reason, understanding new environment in higher education is critical, especially from the side of effective use of data in the era of digital transformation. Increase in educational data happened at a swift pace with the expansion of digital revolution and rapid change in technologies. Learning analytics (LA) appeared as a powerful tool for improving learning and teaching practices. Universities implemented LA have been successful at assessing and predicting student's performance, monitoring and motivating them discovering undesirable learning behaviors and their emotional states, helping educators and administrators to unlock big data potentials and then making quicker data driven

decisions. In today's world there is a close relation between Learning Analytics (LA), Educational Data Mining (EDM) research fields, since EDM and LA as to turn raw data into actionable insights making education-related decisions better. Based on the nature of the analysis of big data in the learning environment, both EDM and LA were aimed at improving quality education by improving interventions. Indeed, the era of digital transformation brought the emergence of a large collection of application / tools to conduct research in EDM and LA especially in online activities compared to traditional system. Furthermore, Artificial intelligence (AI) and Machine Learning (ML) appeared as mechanisms used in data management towards financial value.

This paper intends to examine the rising value of the data in contemporary higher education. For this reason, the impact and effective use of data and its components are analyzed and explained with their outcomes in the globalized as well as competitive atmosphere of this dynamic sector. The paper is organized as follows. The next section provides data and methodology. The following section covers findings. The final section includes the concluding remarks.

2. DATA AND METHODOLOGY

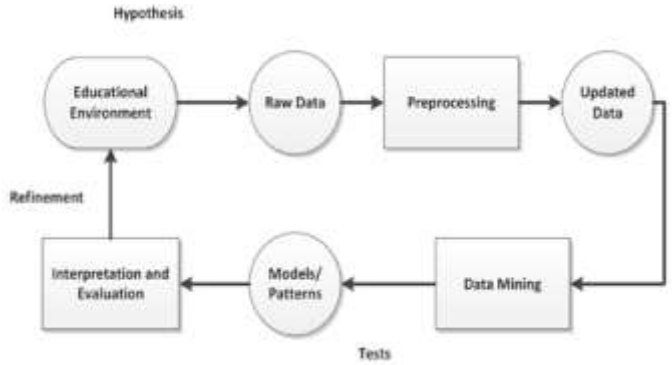
A literature review was conducted to reflect the advantage provided by the effective use of data and its component to predict and improve the academic success. The selected topics were Big Data in higher education, Educational Data Mining (EDM), Learning Analytics (LA) to predict and improve student success, Artificial Intelligence (AI) and Machine Learning (ML) in data management towards financial value, data management as an integral part of 5th Generation (University 5.0) universities. All the selected topics were deeply examined under the perspective related to the position of higher education institutions in front of the rising value of data. The aim was to analyze the outputs and reach findings concerning the requirement of a data-driven policy in the universities in the globalized competitive higher education sector.

3. FINDINGS

Globally, the landscape of higher education sector is under increasing pressure to transform its operational and governing structure; to accommodate new economic, social and cultural agendas; relevant to regional, national and international demands. As a result, universities are constantly searching for actionable insights from data to generate strategies they can use to meet these new demands. Big Data and analytics have the potential to enable institutions to thoroughly examine their present challenges, identify ways to address them as well as predict possible future outcomes (Daniel, 2017). The term Big Data refers to an exponentially increasing volume of heterogeneous data which is differentiated from traditional data based on its volume, variety, veracity, velocity, and value. The proliferation of mobile devices and the rapid development of information and communication technologies (ICT) have seen increasingly large volume and variety of data being generated at an unprecedented pace. Big Data have started to demonstrate significant values in higher education (Ang et al., 2020). The emergence of big data in educational contexts has led to new data-driven approaches to support informed decision making and efforts to improve educational effectiveness. Digital traces of student behavior promise more scalable and finer-grained understanding and support of learning processes, which were previously too costly to obtain with traditional data sources and methodologies. Types of big data are listed as Microlevel big data (clickstream data), Mesolevel big data (text data) and Macrolevel big data (institutional data) (Fischer et al., 2020).

The emergence of Educational Data Mining (EDM) played a significant role in discovering patterns of knowledge about educational phenomena and the learning process predicting student performance, retention, success, satisfaction, achievement and dropout rate. The process of EDM is an iterative knowledge discovery process that consists of hypothesis formulation, testing, and refinement (Moscoso-Zea et al., 2016 ; Sarala and Krishnaiah, 2015).

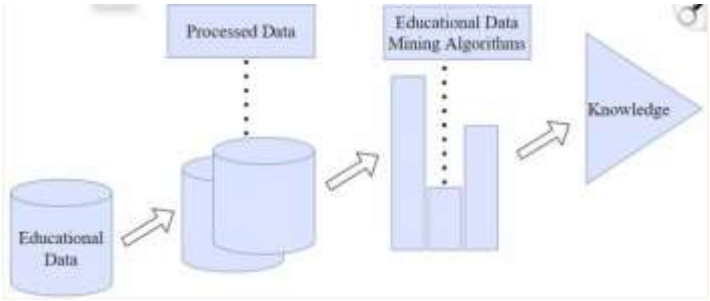
Figure 1: Knowledge Discovery Process in Educational Institutions



Source: Moscoso-Zea, O., Andres-Sampedro, & Lujan-Mora, S. (2016). Datawarehouse design for educational data mining. In 2016 15th International Conference on Information Technology Based Higher Education and Training (ITHET), (pp. 1–6).

Educational data Mining (EDM) is a specialized form of data mining focused on utilizing data derived from educational environments and aimed at addressing educational issues and enhanced the overall learning experience, performance, and outcomes. Its kick-off happened in the 21st Century due to the application of Data Mining in the education arena has given birth to the Educational Data Mining (EDM). It is used to classify, analyze, and predict the students' academic performance beside their dropout rate, as well as instructors' performance in order to improve teaching and learning process (Aulakh et al., 2023)

Figure 2: Extraction of Knowledge' Component of EDM



Source: Aulakh, K., Roul, R. K., & Kaushal, M. (2023). E-learning enhancement through educational data mining with Covid-19 outbreak period in backdrop: A review. International journal of educational development, 101, 102814.

The tremendous growth in electronic data of universities creates the need to have some meaningful information extracted from these large volumes of data. The advancement in the data mining field makes it possible to mine educational data in order to improve the quality of the educational processes Owing to digitization of academic processes, universities are generating a huge amount of data pertaining to students in electronic form. It is crucial for them to effectively transform this massive collection of data into knowledge which will help teachers, administrators and policy makers to analyze it to enhance decision making. Furthermore, it may also advance the quality of the educational processes by providing timely information to different stakeholders. The purpose of data mining methods is to extract meaningful knowledge from data (Han and Kamber, 2006). The application of data mining methods to educational data is referred to as Educational Data Mining (EDM) (Baker and Yacef, 2009). Baker (2010) also proposes five primary categories or approaches in EDM: prediction, clustering, relationship mining, discovery within models, and distillation of data for human judgment. The present work combines three approaches: prediction, clustering and, to some extent, distillation of data for human judgment.

Learning Analytics (LA) is an interdisciplinary scientific field which examines the way in which data can be used to improve the overall learning quality and to address a variety of educational challenges and issues. It is closely related to EDM and fulfill activities such as measurement, collection, analysis and reporting of students' data to predict performance and improve success (Kaur and Dahiya, 2023). Furthermore, it provides the process of collecting, evaluating, analyzing and reporting organizational data for decision making. The purpose is to improve learning processes developing more engaging and effective teaching and learning techniques. For this reason, LA plays a vital role in decision making support and selection of suitable timely intervention (Amare and Šimonová, 2021). Indeed, LA leverages leveraging learner related data to generate reliable and factual information for the purpose of enhancing decision making in higher education. It also allows faculty, institutions, and students to make data-driven decisions about student success and retention and cost saving (Okewu and Daramola, 2017).

LA offers the promise of more personalized learning enabling students to have more effective learning experiences providing benefits for all levels of stakeholders such as mega-level (governance), macro-level (institution), meso-level (teacher), micro-level (student) (Gaftandzhieva et al., 2018).

Table 1: Learning Analytics Tolls

Country	Institution	Case Study/Project	Summary
USA	Purdue University	Traffic Signals and interventions	Improve student's success at the course level;enhance student's retention rate.
	University of Maryland	LCMS (Blackboard)	Traces student's activities and predict their success rate; focus on early interventiom to improve student's trajectory.
	New York Institute of Technology	Identifying at-risk students using the STAR model	The aim was to enhance the retention rate of students by deploying a Student At-Risk model
	California State University	LMSS	Better predict student success via multiple demographic variables than using traditional methods
	University of Michigan	E2Coach	Leveraging analytics to support students with course decisions; acts as an intervention engine
	Rio Salado Community College	PACE (Progress and Course Engagement)	Track improvement of students in courses; early intervention to predict at-risk students
	Northern Arizona University	GPS (Grade Performance System)	Student alerts for resolving their educational issues and enhance their success

NETHERLANDS	Erasmus University Rotterdam	STELA (Successful Transition from secondary to higher Education using Learning Analytics)	Focuses on providing formative and summative feedback to students in the transition; scalability and transferability solutions
AUSTRALIA	Edith Cowan University	C4S (Connect for Success)	Improved retention and success rates of students
	University of New England	AWE (Automated Wellness Engine)	Aimed at early identification of students who were struggling with their study programs
	Open University Australia	PASS (Personalised Adaptive Study Success)	Track students' performance to enhance study success
	University of Wollongong	SNAPP (Social Networks Adapting Pedagogical Practice)	Support teacher to evaluate student behavioral patterns during the course; timely intervention
UK	University of Central Lancashire	Student performance, retention, and progression	Track student progress in course; intervention
	Open University	Student engagement, retention and progression	Track student progress in course; intervention
	University of East London	Student lifecycle and performance benchmarking	Track student progress in course; intervention
	University of Sheffield	Student admission and progression	Student support and intervention
	University of Manchester	Facilities and utility optimization	Student support and intervention
	University of Bedfordshire	Student engagement, retention and progression	Track performance of students and predict their success

Source: Hooda, M., & Rana, C. (2020). Learning analytics lens: Improving quality of higher education. International journal of emerging trends in engineering research, 8(5).

In the 21st Century Artificial intelligence (AI) and Machine Learning (ML) appeared as mechanisms evolved from data management and developing processes. Firstly, AI is the theory and development of computer systems to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages. Secondly, ML is a branch of AI and computer science focusing on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy. Incorporating these mechanisms into business became a trend in education industry as game-changers enhancing the efficiency and effectiveness of management operations. AI and ML have great potential in universities as online platforms and applications being more closely aligned with learners' needs and knowledge, making the educational process more efficient. Notably, they are considered as essential technologies enhancing learning, primarily through students' skills, collaborative learning in universities. Indeed, they altered the educational world, giving students new skills and providing a collaborative learning environment in the universities with great implications for the near future. So, they represent the present and future in both education and the world's progressive development according to most reputable universities. (Kuleto et al., 2021). Most reputable higher education institutions have understood that AI and ML represent the present and future in both education and the world's progressive development. Such technologies provide an interactive and advanced educational experience to their students. The results are impressive: 65 per cent of universities in the United States of America support AI and ML assisted learning. Moreover, these systems provide valuable assistance to teachers and lecturers in the best schools, facilitating and improving learning in various ways. For example, estimates indicate that AI in education in the United States increased by 47.5 per cent between 2017 and 2021. (Chang, 2017). AI and ML are also improving the security and efficiency of the institution, providing a peaceful, flexible, and accessible computing environment for research and developing skills among students, and a collaborative learning environment in the universities reinforces the importance of AI and ML to enhance customized learning (Kumar, 2021).

Quick rise in the use of AI happened in higher education in the last 5 years. In fact, AIEd (Artificial Intelligence in Education) is significantly used for assessment/evaluation, predicting, AI assistant, intelligent tutoring system, and managing student learning (Crompton, 2023). Expected goals have been to increase outcomes, access and retention as well as decrease cost of operations and time for completion (Klutka et al., 2018).

People also have noticed significant advancements in the higher education ecosystem due to ongoing digital transformation, particularly through the integration of AI and 5G wireless technology. Specifically, arguments on AI have been based on not only to enhance the efficiency and effectiveness of management operations within higher education institutions, but also to provide invaluable assistance to academics and students in the educational process enhancing academic output. Therefore, new and attractive learning experiences for students enables more personalized and adaptive learning approaches. Indeed, increase in access to education offers greater flexibility, mobility, and convenience in the globalized higher education market (Eskinat and Teker, 2024).

AI will open up many educational opportunities for higher education, and institutions that make the investment necessary to utilize it will realize significant benefits. The use of technology or teacher bots in higher education is an increasingly attractive solution as enrolment increases, and class sizes, staffing costs, and finances for universities grow (Popenici and Kerr, 2017). This became evident when massive open online courses (MOOC) enlightened the imagination of many university administrators. With these "open courses," there are no enrolment requirements or fees, and online students from anywhere in the world could enroll and participate. These two forces were a boon to universities in that they allowed them to market globally for students, leading to an enormous number of new students. Furthermore, algorithms are increasingly used in schools to market prospective students, estimate class size, plan curriculum, and allocate resources, like financial aid and facilities. Thus, AI is becoming increasingly important, as financial and enrolment pressures in higher education become more prevalent. This has necessitated the development of low-cost technologies capable of providing students with personalized support

and service. For example, chatbots and other instant self-service technologies can enable higher education institutions to be more innovative (Kuleto et al., 2021).

The importance of data management from the perspective of the business management process, where big data is the most crucial and pressing technical and business issue in the modern realm of technology. A data-driven culture in the organization with the help of strategizing in terms of data collection, analytics and data management by establishing governance and regulatory practices to ensure data security and integrity (Sabri and Amir, 2024).

As far as the structure of higher education is concerned there are currently five different generations of universities. The first-generation University 1.0 initiated as information transfer centers in the 11th Century. Later, the second-generation University 2.0 appeared as information transfer and research centers in the 19th Century. 1970s brought the third generation University 3.0 as information transfer, research and application (university-industry) centers. Then, the fourth-generation University 4.0 flourished as a digitalized university depending on the technological and social innovations under the storm of digital transformation age of the 2000s. Lastly, fifth-generation University 5.0 with its foreseen rise by the 2030s named as digital university targeting all world as a single market and providing all-education services in a translocal and transtemporal form globally are at the stage depending on digital transformation era's major technological innovations. (Eskinat and Teker, 2023). At this point, data management is considered as an integral part of the 5th Generation universities (University 5.0).

Analysis shows that, Big Data and EDM in discovering patterns of knowledge about educational phenomena and the learning process predicting student is effective in this era. The role of LA in predicting student performance will continue to have critical importance to better compete in the globalized higher education. Notably, rethinking and redesigning data management towards financial value and accepting the influence of AI and ML as game changer is a matter of fact in today's world of digital transformation. Then, increasing digitalized expectations of Generation Z, and a foreseen storm of Generation Alpha in the context of Industry 5.0 and Society 5.0. should also be taken into consideration (Eskinat, 2023).

4. CONCLUSION

Academic Success is considered as an essential criterion for assessing the quality of higher education institutions in the 21st Century. So, universities need to perform the effective use of data particularly in the context of new era like Industry 5.0, Society 5.0 and University 5.0. For this reason, higher education institutions have to follow a data- driven culture as greater demands of universities already appeared for retention, completion and graduation rates of students in the globalized competitive higher education sector announcing to improve student success.

The effective use of Educational Data Mining (EDM) and Learning Analytics (LA) is going on for the last two decades. Whereas EDM translates the data into meaningful actions to support and empower the learning steps, LA is a human-lead process predicting learners' performance as well as identifying potential problematic issues of students (Vaidya, A., & Saini, J. R. ,2021). Indeed, the essential role of EDM and LA higher education institutions worldwide is to improve the quality of learning, student success and retention, to delivery automatic and immediate feedback, and to provide a personalized experience for students. Furthermore, the influence of EDM and LA on the current educational system provides opportunities for new learner-centered tools and smart learning environments bringing customized experiences and meeting students' specific needs to be developed.

At this point, Artificial intelligence (AI) and Machine Learning (ML) are two mechanisms evolved from data management and developing processes. It may be argued that, AI and ML are two impressive game changers having great potential for universities altering educational world from the financial perspective.

As a result of this study, one should consider the effective use of data and its evaluation components, namely Educational Data Mining (EDM), Learning Analytics (LA), Artificial intelligence (AI) and Machine Learning (ML), as the integral part of Fifth Generation Universities (UNIVERSITY 5.0) era in the globalized competitive higher education sector.

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ENERGY CONSUMPTION-OUTWARD FOREIGN DIRECT INVESTMENT-NATURAL RESOURCE RENTS NEXUS: EVIDENCE FROM BRICS-T COUNTRIES

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ABSTRACT

Purpose- This research measures the impacts of population, economic development, outward foreign direct investment, and natural resource rent on energy consumption in BRICS-T countries (Brazil, Russia, India, China, South Africa and Turkey). The main objective of the study is to evaluate the impact of outward foreign direct investment and natural resource rents on environmental sustainability together and to examine the structure of the relationship between economic growth and energy consumption with the Environmentally Kuznet Curve (EKC) hypothesis.

Methodology- This analysis, which was carried out within the framework of the STIRPAT (Stochastic Impacts by Regression on Population, Affluence, and Technology) theoretical model, examined the effects of factors on energy consumption with Driscoll-Kraay standard error fixed effects estimator as a result of the determination of country heterogeneity and robustness tests.

Findings- The analyses show that population and gross domestic product per capita are positively related to energy consumption. At the same time, outward foreign direct investment decreases energy consumption in BRICS-T countries through the reverse spillover effect. The findings on the positive relationship between natural resource rents and energy consumption indicate that energy consumption increases in BRICS-T countries through fossil fuel-intensive production processes. The study also found a statistically significant inverted u-shaped curve between energy consumption and economic growth, but detecting a turning point outside the data set suggests that the EKC hypothesis is not valid in BRICS-T countries.

Conclusion- The findings of the study show that outward foreign direct investment makes possible the transfer of environmentally friendly technologies from host countries to the home country and increases energy efficiency in the production process. Therefore, BRICS-T countries need to see outward foreign direct investment not only as an economic gain but also as a tool for environmental improvement. The fact that natural resource rents encourage fossil fuel dependency suggests that some of these resources should be directed to renewable energy projects. In conclusion, it is recommended that BRICS-T countries adopt green growth strategies, gradually remove fossil fuel subsidies and implement environmental regulations such as carbon tax to achieve sustainable development goals.

Keywords: Stirpat model, EKC hypothesis, natural resources, outward foreign direct investment, energy consumption.
JEL Codes: P18, P28, P48

1. INTRODUCTION

Environmental degradation results from economic growth based on human activities has drawn the attention of scientists, organizations, and environmentalists over the last few decades. In this regard, this problem has become a multidisciplinary study focus that concerns many issues such as human health, food security, economic development, etc. In the early stages of their economic development, developing countries such as the BRICS-T, which show features such as growing populations, insufficient human capital development, and substantial economic instability (Osabuohien-Iraborand and Drapkin, 2024), are in a highly energy-dependent production process due to high industrialization. Energy consumption in BRICS-T countries, where economic growth is rapid, is mostly dependent on environmentally damaging energy resources such as fossil fuels. For this reason, considering the dependence of BRICS countries, which were responsible for 42% of global energy consumption in 2023, on fossil fuels, it is of great importance to examine their environmental damage (Enerdata, 2024).

Countries need to plan their developments carefully to minimize environmental problems. It is commonly acknowledged that foreign direct investment contributes positively to economic growth in emerging economies. Thus, foreign direct investment is thought to have a direct or indirect effect on increasing the environmental degradation of both host and home countries (Anyanwu, 2012; Chorn and Siek, 2017). The focus has generally been on the environmental impact of inward foreign investment in the host country (Arain et al., 2020; Huang et al., 2022; Seker et al., 2015; Wang and Zhang, 2022). However, limited study on the relationship between outward foreign direct investment and environmental quality for the home country existed till recently (Mohanty and Sethi, 2022; Osabuohien-Iraborand and Drapkin, 2024; Yang

and Zheng, 2021). These studies agree that foreign direct investment reduces environmental pollution in host countries. Parallelly, outward foreign by encouraging technology transfer, which reduces environmental pollution through knowledge and environmentally friendly technology spillover, outward foreign direct investment spillover may improve industrialization and energy efficiency in the host countries (Buckley et al., 2020).

The use of natural resources is an important factor that shapes the energy consumption structures of countries and the environmental impacts resulting from energy consumption. Although much research has been done to examine the factors associated with environmental problems, less focus has been placed on understanding how natural resources affect energy consumption. Extracting natural resources causes environmental deterioration by indiscriminately dumping waste chemicals into the atmosphere, land, and water, as well as increasing energy consumption even during extraction operations (Balcilar et al., 2023). Countries with high natural resources may develop their economies based on fossil fuel production and export, which may increase energy consumption at last. This may encourage energy-intensive production processes while also accelerating environmental degradation. However, if these revenues are channeled to renewable energy investments, they can support environmental sustainability. In this context, the impacts of natural resource rents on energy consumption and environmental deterioration may differ depending on the economic structure, policies, and technology utilization of countries.

The main purpose of this research is to analyse the impacts of outward foreign direct investment and natural resource rents on energy consumption in BRICS-T countries in a holistic framework. Although the environmental impacts of outward foreign direct investment on host countries have been extensively analyzed in the literature, the environmental consequences of outward foreign direct investment in home countries have been addressed in a more limited way. The innovative contribution of our research is to examine the simultaneous effects of these two important factors on energy consumption by considering outward foreign direct investment and natural resource rents together in the BRICS-T countries. In this context, the study aims to provide important implications for policymakers in line with sustainable development goals.

2. LITERATURE REVIEW

Over the past several decades, scientists have continued to examine the factors that cause environmental degradation to maintain environmental quality. In these studies, air pollution indicators (Lohwasser et al., in-press), water pollution indicators (Zhao et al., 2014), waste and solid waste indicators (Arbulu et al., 2017) and energy consumption indicators have been used to represent environmental degradation. Several empirical research have so far reported varying conclusions about environmental degradation using many parameters, including economic growth, population, urbanization, trade openness, etc. In this study, the effects of natural resource rents and foreign direct investments, which have been studied in the literature on environmental degradation but have not been emphasized as much as the mentioned factors, will be highlighted.

2.1. Outward Foreign Direct Investment and Environmental Degradation Nexus

There is a small but steadily growing body of empirical research on the outward foreign direct investment and environmental deterioration relationship. However, the majority of the literature recently in publication concentrates on studies specific to a single nation, namely China. Some of these mentioned researchs are An et al. (2021), Cai et al. (2021), Kamal et al. (2023), Tan et al. (2021), Yi et al. (2018), and However, the results of the researchs vary. Yi et al. (2018) investigated the impacts of urbanization and outward foreign direct investment on CO2 emissions, covering the data from 1984 to 2016. From a low-carbon regime to a high-carbon regime, the findings demonstrate that outward foreign direct investment has a greater promotion effect on CO2 emissions. Similarly, Cai et al. (2021) indicate that China's outward foreign direct investment can increase CO2 emissions due to the threshold effect of population size, economic development level, technology level, and environmental regulations. Moreover, Kamal et al. (2023) investigated how institutional quality affects the environment of countries participating in the Belt and Road Initiative (BRI) in connection to China's outward foreign direct investment foreign direct investment with the system GMM technique. They concluded that environmental quality suffers as a result of outward foreign direct investment of China. Another striking result of their study is that the interaction effect of China’s foreign direct investment with institutional quality yields negative. Although the different stages of urbanization exhibit inverted U-shaped characteristics, Tan et al. (2021), demonstrate that interprovincial outward foreign direct investment has an effect on CO2 emissions with the double threshold effect of urbanization and that outward foreign direct investment expansion will increase CO2 emissions with urbanization.

Empirical studies of the impacts of outward foreign direct investment on environmental deterioration for a few other nations have also been published, aside from China's data. Osabuohien-Iraborand and Drapkin (2024) asserted that the effect of outward foreign direct investment on environmental deterioration is negative through the influence of home country institutions. This implies that home country institutions promote outward foreign direct investment spillover reduce CO2 emissions in emerging countries. Mohanty and Sethi (2022) focused on how outward foreign direct investment affects the link between energy use and environmental quality in the BRICS nations. The findings demonstrate that outward foreign direct investment decreases energy consumption and emission expanding the environmentally friendly and energy-efficient technologies in the host country.

2.2. Natural Resources Rent and Environmental Degradation Nexus

Few empirical studies have investigated the effects of natural resource rents on environmental deterioration using different models. The findings of these studies show that there are differences in the effects of natural resource rents on environmental deterioration. For example, Gyamfi et al. (2022) used the stochastic impact by regression on population, affluence, and technology (STIRPAT) model to exemine the impacts of natural resource rents and disaggregated energy consumption on the environmental quality of the G7 economies. Findings revealed that total natural resource rent shows a strong positive correlation with pollution, suggesting that G7 member nations' environmental quality declines as a result of revenue from the extraction and processing of raw materials. Hassan et al. (2019) calculates the impacts of natural resources and economic growth on Pakistan's ecological footprint. According to their empirical findings, natural resources

have a positive impact on the ecological footprint that degrades environmental quality. Ulucak and Ozcan (2020) measured the effects of natural resource rents on environmental degradation using CO2 emissions, ecological footprint, and carbon footprint variables as proxies for environmental deterioration in OECD. The findings displayed that the extraction of natural resources stimulates CO2 emissions but its contribution to the ecological and carbon footprints is not statistically significant. Another similar finding indicating the positive relationship between natural resources rent and environmental degradation is exibited by Kwakwa et al. (2020).

There are also studies in the literature showing the ameliorative impacts of natural resources on environmental deterioration. Voumik et al. (2023) displayed the relationship between natural resources and environmental deterioration in South Asian countries such as Bangladesh, Pakistan, India, Nepal, and Sri Lanka from 1972 to 2021 using the STIRPAT model. They found evidence of a negative correlation between natural resources and CO2 emission indicating the improving effect of natural resources on environmental degradation. Yang and Khan (2021) investigated same country groups as in the study of Voumik et al. (2023) except for Afghanistan and Bhutan. They reached also similar results that show the improving effect of natural resources rent on environmental degradation in this e South Asian Association for Regional Cooperation countries group. Moreover, Baloch et al. (2019) analyzed the effect of natural resources on environmental degradation in BRICS countries. The findings revealed that the plentifulness of natural resources reduces CO2 emissions in Russia but it increases emissions in South Africa.

3. DATA, ESTIMATION TECHNIQUE, AND MODEL

3.1. Data

Our research employs annual balanced panel data covering BRICS-T countries from 1993 to 2022. The countries used in this study consist of Brazil, the Russian Federation, India, China, South Africa, and Turkiye. The World Development Indicator database (WDI, 2024) provided the data employed in this study. The variables investigated in this study included energy consumption, total population, gross domestic product per capita, total natural resources rents, and outward foreign direct investment. Table 1 shows the definitions and sources of the variables.

Table 1: Definitions and Sources of the Variables

Variables	Definitions	Sources
ec	Energy use (kg of oil equivalent per capita)	WDI
pop	Population, total	WDI
gdp	GDP per capita (constant 2015 US$)	WDI
tnrr	Total natural resources rents (% of GDP)	WDI
ofdi	Foreign direct investment, net outflows (% of GDP)	WDI

3.2. Theoretical Model

The STIRPAT model serves as the theoretical and analytical framework of reference in our work, but we also take into account the economic theories that forecast the EKC hypothesis in relation to income. Ehrlich and Holdren (1971) put forward the IPAT (I=PAT) model of population, affluence, and technology as components that stimulate environmental degradation. In the equation, environmental impact is denoted by I, population by P, affluence by A, and environmentally damaging technology by T. The IPAT model, which shows a linear and deterministic structure, can be estimated as a stochastic model called STIRPAT suggested by Dietz and Rosa (1994). The model specification can be given as the following equation in the panel data form:

$$I_{it} = \alpha P_{it}^{\beta_1} A_{it}^{\beta_2} T_{it}^{\beta_3} e_{it} \quad \textbf{(1)}$$

where I, P, A, and T denote the environmental impact, population, affluence, and technology variables, respectively, α is the constant term and the parameters of β indicate the elasticities of the variables on environmental impact, and e denotes the stochastic error term. In the literature, the affluence (A) in the STIRPAT model is estimated by the gross domestic product per capita. However, many variables such as the share of the industry sector in gdp, the share of the service sector in gdp, energy intensity, research and development expenditures, and the number of patents have been used as proxies for technology Poumanyvong and Kaneko (2010), and Usman and Hammar (2021). In this study, we used natural resource rent, which has empirical application in the literature but has not been emphasized much, as a proxy of technology (T).

The factors determining a range of environmental impacts have been extensively examined using the STIRPAT model in the literature. Urbanization, trade openness, foreign direct investment, and similar variables are frequently used as additional factors in explaining their environmental impact Shahbaz et al. (2016) and Usman and Hammar (2021). Although the environmental impact of inward foreign direct investment was investigated in detail, the environmental effect of outward foreign direct investment studied in the literature are scarce. Thus, in this study, we try to explain the correlation between outward foreign direct investment and environmental impact including it to the STIRPAT model as an additional factor.

By taking the natural logarithm of the equation, we can convert the exponential function of the model into linear form. In line with all this information, we can show the panel model of energy consumption in equaition 2:

$$lnec_{it} = \beta_0 + \beta_1 lnpop_{it} + \beta_2 lngdp_{it} + \beta_3 lngdp_{it}^2 + \beta_4 lntnrr_{it} + lnofdi_{it} + \theta_i + u_{it} \quad \textbf{(2)}$$

where i refers to country dimension ($i = 1 - 6$) and t refers to time dimension ($t = 1993 - 2022$) in this study. pop stands for total population and gdp stands for gross domestic product per person. while $tnrr$ denotes natural resources rent which is the proxy of technology, outward foreign direct investment is represented by fdi in the equation. θ dummy variable capture the unobserved-country specific effect in the panel data, and u denotes idiosyncratic error term.

The STIRPAT model offers the opportunity to include not only population, affluence and technology variables but also other environmental determinants. In this framework, to test the validity of the EKC hypothesis in BRICS-T countries, the 'gdp^2' variable, which is the square of the gross domestic product per capita, is added to the model. According to the EKC hypothesis, there is a nonlinear relationship where environmental degradation increases in the early periods of economic development, while environmental deterioration diminishes in the later periods of development. This relationship can be evaluated within the framework of the following mathematical conditions:

if $\beta_2 > 0$ and $\beta_3 < 0$, then, an inverted u-shaped relationship between energy consumption and economic development arise.

if $\beta_2 < 0$ and $\beta_3 > 0$, then, a u-shaped relationship between energy consumption and economic development arises.

3.3. Estimation Technique

In this study, the energy consumption of BRICS-T countries is modeled by panel data analysis methods. In the first stage of the analysis strategy, the descriptive statistics of the variables were examined to gather preliminary information about the central tendency and distributions among the variables. Afterward, multicollinearity results between independent variables were obtained using a correlation matrix and variance inflation factors before deciding the panel models used in this study.

The second stage is to decide which panel data model to use. We performed calculations using pooled ols, fixed effect model, and random effect model in order, taking into account the panel data structure used in our study. The generic static panel model's specifications are as follows:

$$Y_{it} = \beta X_{it} + u_{it} \quad \text{pooled ols}$$

$$Y_{it} = a + \beta X_{it} + \mu_i + \gamma_t + u_{it} \quad \text{fixed effect}$$

$$Y_{it} = a + \beta X_{it} + v_{it}, \quad where \quad (v_{it} = \mu_i + \gamma_t) \quad \text{random effect}$$

Y_{it} represents the explained variable. X_{it} shows a vector of independent variables presumed to affect the variation on Y_{it}. While μ_i catches the individual-specific unobserved effects, γ_t captures the time-specific unobserved effects. u_{it} states the idiosyncratic error term. The pooled ols model assumes homogeneity across all cross-sectional and time-series units, without considering individual-specific or time-specific effects. While fixed effect model captures the unobserved individual heterogeneity across cross-sectional units and time units, the random effects model considers them random components, assuming that unobserved individual-specific and time-specific effects do not correlate with the independent variables (Tatoğlu, 2012). Since the time interval covers a wide range, time-specific effects were not detected in the model during the model selection process. Hence, the one way error component model was used as in Bangura and Saibu (2024).

In the third stage of the analysis, after the pooled ols, fixed effects, and random effects models adapted to the STIRPAT model were estimated, several diagnostic tests were applied to identify the model that would work best for this study. F-tests were conducted on fixed effects and pooled ols to select the appropriateness of these two models. Subsequently, Breusch-Pagan Lagrange multiplier tests were applied to determine whether pooled ols or random effect models are more appropriate. Lastly, the Hausman test was applied to decide whether the fixed effect or random effect model is more suitable for the analysis in the model selection process.

The robustness of the chosen model was evaluated in the last stage. To perform post-estimation diagnostic tests, the existence of autocorrelation, heteroskedasticity, and cross-sectional dependence, all of which potentially skew the efficiency of the chosen model, was examined. Firstly, we tested the existence of heteroscedasticity with the Wald test, which states that the null hypothesis of the panel is homoscedastic across units. To identify the autocorrelation, a modified Durbin-Watson test statistic was obtained which was proposed for the fixed effect model by Bhargava et al. (1982). In the final step of diagnostic checking, the presence of cross-sectional dependency was tested employing the Breusch-Pagan Lagrange multiplier test of cross-sectional independence. These problems have been identified in the selected model, and an estimator that eliminates these problems and satisfies the asymptotic requirements arising from the nature of our data has been found, and both safe and robust results have been obtained.

4. EMPIRICAL RESULTS

4.1. Descriptive Statistics and Multicollinearity Testing

Table 2 indicates the descriptive statistics of the variables employed in this research. The findings state that the energy consumption per capita has a low variability which is seen in the 0.79 standard deviations with the mean value of 9.79, displaying stable energy consumption among the countries analyzed. Another striking result is that the population variable has high variability, which is due to countries such as China and India increasing the dispersion in the data.

We used the pair-wise correlation matrix and variance inflation factors to capture multicollinearity in the data seen in table 3. The presence of multicollinearity among the independent variables can be proven if variables have below -0.8 and above 0.8 pair-wise correlations among them and variance inflation factors exceed 10 (Gujarati and Porter, 2009). Table 3 states the multicollinearity diagnostic results. Pair-wise correlation are quite low among independent variables other than lngpd and lnpop. When controlling variance inflation factors of lngpd and lnpop in particular, we can observe that they are not correlated. Therefore, there was no reason to exclude the independent variables used in the model due to the multicollinearity problem.

Table 2: Descriptive Statistics of Variables

Variables	Obs	Mean	Std. dev.	Min	Max
lnec	174	9.73	0.79	7.95	11.00
lnpop	174	5.44	1.27	3.75	7.25
lngdp	174	8.45	0.80	6.33	9.51
lntnrr	174	1.01	1.14	-1.94	3.07
lnofdi	174	2.61	0.91	-3.23	3.79

Table 3: Pair-wise Correlation and Variance Inflation Factors Results

Variables	lnec	lnpop	lngdp	lntnrr	lnofdi
lnec	1.00				
lnpop	-0.54	1.00			
lngdp	0.79	-0.61	1.00		
lntnrr	0.40	0.11	-0.06	1.00	
lnofdi	0.33	-0.31	0.48	0.13	1.00
VIF values		1.61	1.89	1.05	1.34

4.2. Econometric Model Selection

Initially, three static models were estimated which are fixed effect, random effect, and pooled ols models. Following that, we perform an array of diagnostic tests to identify the most effective model among the three estimated models.

Table 4 displays the test results used in determining the model. First, the appropriateness of either pooled or fixed panel estimations was assessed using the F test proposed by Moulton and Randolph (1989) after the estimation results were obtained. The pooled ols model's validity was tested against the fixed effect model capturing individual country-specific effects. If F-test results state the validity of the pooled ols model, as mentioned in the literature by Baltagi (2008), omitted variable bias may result from neglecting unobserved heterogeneity. However, The results confirm that the pooled ols produces a biased estimator by ignoring country heterogeneity. Consequently, it can be recognized country-specific heterogeneity is valid for our analysis.

Another capturing method of the existence of country or time heterogeneity is the Lagrangian multiplier test proposed by Breusch and Pagan (1980). This test, which is based on the assumption that the variance of the unit or time effects is zero as the null hypothesis, examines whether the country effects are distributed in the error term in the presence of heterogeneity. Thus, the pooled ols model can be tested against the random effects model with it. LM tests asserted the country heterogeneity in the panel model. This leads us to deduce the random effect model is a better fit for our panel data comparing it to pooled ols.

Table 4: Selection of the Econometric Model

Model comparison	Test	Statistics	Probability
pooled ols versus fixed effect	F test for all ui	F(5, 163)=610.67	0.0000
pooled ols versus random effect	Breusch-Pagan Lagrange Multiplier	chi2(1)=1259.44	0.0000
fixed effect versus random effect	Hausman	chi2(5)=159.49	0.0000

After concluding the panel has country heterogeneity, the Hausman specification test was applied to determine between the fixed effect model and the random effect model. When the null hypothesis of the Hausman specification test, which is that there is no correlation between the explanatory variables and the error term, is accepted, it can be concluded that both models produce consistent estimators. However, under the alternative hypothesis that the independent variables and the error term are correlated, the random effects estimators give inconsistent results and the fixed effects estimators give consistent results (Tatoğlu, 2012). The results show that the fixed effects model has consistent estimators.

4.3. Robustness Check of the Determined Model

In light of the strong evidence the fixed effect model has for being appropriate, our next step is to evaluate the fixed effect model's resilience by using tests for serial correlation, heteroscedasticity, and cross-sectional dependency.

Table 5 shows autocorrelation test, heteroscedasticity test, and cross-sectional dependence test results. Bhargava et al. (1982) proposed Durbin-Watson test statistics using AR(1) model for the detection of autocorrelation in fixed effect models. The null hypothesis of the test indicates that the error terms are not autocorrelated. The test statistic is 0.421, which is way below the threshold value of 2, indicating that there is autocorrelation in the fixed effects model used.

Modified Wald statistic for group-wise heteroscedasticity in the residuals of fixed effect model was carried out (Greene, 2000). According to the result, there is no group-wise heteroscedasticity hypothesis was rejected. Thus, we concluded fixed effect regression has group-wise heteroscedasticity.

In the final step of the robustness check of regression results, cross-sectional dependence was examined in the fixed effect model. To determine whether there were any indications of cross-sectional dependency in our data, we used the Breusch-Pagan LM test of independence. The main motivation for using this test is that it is suitable for testing cross-sectional dependence in cases where the time dimension is larger than the cross-sectional dimension (Tatoğlu, 2012). The test result suggests that the cross-sectional independent null hypothesis needs to be rejected. The conclusion is that fixed effect regression produces cross-sectional dependent residuals.

Table 5: Autocorrelation, Heteroscedasticity, and Cross-Sectional Dependence Test Results

	Mofied Durbin-Watson Test	Wald Test	Breusch-Pagan Lagrange Multiplier Test
Statistics	0.421	chi2 (6) = 323.70	chi2 (15)=63.997
Probability		0.0000	0.0000

Considering all results given in the table 5, It has became clear that estimators were needed that produced standard errors that would be robust to all common forms of cross-sectional and time-wise correlation in the model. In addition, it must be an estimator that gives reliable results in cases where the time dimension exceeds the cross-sectional dimension. Thus, it was decided to use the (Driscoll and Kraay, 1998) estimator, which produces robust standard errors for all these deviations from the assumptions that undermine efficiency using the fixed effects model and meets the necessary asymptotic requirements in this study.

4.4. Estimation Results

The results of the estimation of the fixed effect model using Driscoll-Kraay standard errors are shown in table 6. The joint significance of all the model's coefficients appears to be strongly supported by looking at the probability of F-statistic. In addition, although the impact of outward foreign direct investment on energy consumption is controversial in the literature, the effects of all other variables are consistent with a priori expectations of the STIRPAT model for the BRICS-T country group. It is observed that the effect of population, gross domestic products per person, the share of total natural resources rent in gdp, which are equivalent to population, wealth, and technology variables in the STIRPAT model, respectively, on energy consumption is statistically significantly positive.

The statistically significant negative coefficient of outward foreign direct investment shows that the spillover effect enhances environmental quality in BRICS-T countries by adopting energy-efficient technology in the home country. These results are consistent with the study of Mohanty and Sethi (2022) and Osabuohien-Irabor and Drapkin (2024) concerning the spillover effect of outward foreign direct investment on home countries.

The constant term, which has no definition of the theoretical effect on energy consumption in the model, turned out to be negative and statistically insignificant. The other coefficients represent elasticities due to the stochastic nature of the STIRPAT model. A 1% increase in the population creates an average increase of 0.44% in energy consumption in BRICS-T countries at a 1% level of significance. The elasticity of gross domestic product per person on energy consumption is 1.20 at a 1% level of significance. Even if the effects of the share of total natural resources rent in GDP and outward foreign direct investment are quite low on energy consumption of which the elasticities are 0.052 and -0.070, respectively, statistically significant at 1%.

There are two criteria for testing the EKC hypothesis. The first criterion is the presence of an inverted u relationship and the second is whether the turning point is within the defined data range. When we evaluate the first criterion, in the early stages of economic growth, as can be seen from the statistically significant positive coefficient (1.201), gross domestic product per capita has a feature that increases environmental degradation. The square of the gross domestic product per capita variable, with its statistically significant negative coefficient (-0.035), shows that it has a decreasing effect on environmental degradation in the second stage of economic development. These findings prove that the first criterion was valid for BRICS-T countries. However, the 29,689,491.51$ turning point calculated using the exp $(-\frac{\beta_3}{2\beta_4})$ formula is outside the data set range, indicating that the BRICS-T countries have not yet reached the stage of environmental degradation-reducing stage of economic development and the EKC hypothesis is not supported for this country group. The result also shows that energy-saving technologies stimulated by economic development are quite low in this group of countries. Ultimately, an inverted-u-shaped relationship between and gross domestic product has been revealed according to the results but the turning point proved that the EKC hypothesis was not valid, similar to the findings in the study of Maneejuk et al. (2020).

Table 6: Driscoll-Kraay Estimation Results

Variables	DK-Estimators
Constant	-0.149
	(0.536)
lnpop	0.437***
	(0.112)
lngdp	1.201***
	(0.150)
$lngpd^2$	-0.0349***
	(0.00820)
lntnrr	0.0518***
	(0.00928)
lnofdi	-0.0704***
	(0.0104)
Country Dummies	Yes
Year Dummies	No
Number of Observation	174
Number of Groups	6
F(5, 28)	4474.39
Prop>F	0.0000
Within R2	0.9397

Note: The numbers in the parentheses state the standard errors of coefficients.
*** indicate 1% level of significance.

5. CONCLUSIONS

Today, countries aim to continue their economic development with pro-environmental policies and technologies. Countries' effective use of their natural resources and their domestic, and foreign direct investments should be considered as an advantage for their economic development in the circumstances. Therefore, it is important to investigate the environmental impacts of natural resource utilization and investments of the so-called developing BRICS-T countries. Considering the demographic characteristics, economic structures, and geographical features of these countries, they have a very high ranking in natural resource utilization in the world. In line with practices followed by many other countries, these nations develop policies and technologies aimed at fostering growth through pro-environmental strategies. In this context, it is very important to investigate how successful the BRICS-T countries have been in implementing their pro-environmental policies in recent years. For this purpose, this study focuses on the effects of natural resource rents and foreign direct investments on energy consumption and conducts panel data analysis through the STIRPAT theoretical model. The findings indicate the existence of unit heterogeneity in BRICS-T countries. After the diagnostic tests, fixed effects estimators with Driscoll-Kraay standard errors were obtained which are appropriate for our data.

The findings suggest that outward foreign direct investment may have a reducing effect on energy consumption in BRICS-T countries that are home countries. This suggests that outward foreign direct investment may encourage more efficient production processes through capital and technology transfer or increase compliance with environmental regulations. On the other hand, natural resource rents are reached to have an increasing impact on energy consumption. This result supports the argument that in resource-dependent economies, income from natural resources may encourage energy-intensive production processes and increase dependence on fossil fuel use. This finding emphasizes the need for policymakers to direct natural resource revenues to more efficient and environmentally friendly projects in terms of environmental sustainability.

The study also investigated the EKC hypothesis to assess the nonlinear relationship between energy consumption and economic develpment. From our findings, we can infer that the economic growth in the BRICS-T countries has not yet reached a level that reduces energy consumption. Although the analyses point to a statistically significant inverted n-shaped curve in the BRICS-T country group that can confirm the EKC hypothesis, the fact that the turning point occurs at a very high-income level reveals that economic growth has not been achieved by using pro-environmental technologies. This finding indicates that energy consumption in BRICS countries will not decrease nonlinearly with economic growth and this process should be supported by policy interventions.

In this context, policy interventions are necessary to ensure environmental sustainability in BRICS-T countries. To reduce energy consumption, only clean production technology-induced economic growth should be adopted. In this direction, green R&D investments

should be supported and environmental taxation mechanisms should be established. Moreover, renewable energy investments should be increased and stricter environmental regulations should be introduced for environmentally damaging production processes in energy-intensive sectors to ensure that the turning point occurs at lower income levels. Outward foreign direct investment can be considered an opportunity to improve the energy efficiency of BRICS-T countries. Outward foreign direct investment should increase technology transfer policies to carry back environmentally friendly technologies and innovations from host countries (BRICS-T countries). In this context, firms investing abroad should be encouraged to import environmentally friendly technologies and the reverse spillover effect should be supported. In terms of natural resource rents, a portion of these revenues should be channeled to renewable energy projects and low-carbon infrastructure to reduce dependence on fossil fuels. Gradually removing fossil fuel subsidies, transferring natural resource revenues to 'green investment funds', and incentivizing energy efficiency projects in energy-intensive sectors are important steps to prevent environmental degradation.

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MEASURING THE SENSITIVITY OF DIFFERENT MONTE CARLO MODELS IN FORECASTING AIRLINE STOCK PRICES

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ABSTRACT

Purpose- Monte Carlo Models are widely utilised by scientific research in a variety. Two research models are argued and designed regarding the Quasi and Pseudo Monte Carlo models in this paper.
Methodology- The main research questions are formed here as "Which Monte Carlo model can give more effective results to USA Airline investors?". There is a utilisation problem of Monte Carlo Models by investors. The research also will help to fill this gap. On the other hand, Sobol and Halton sequences are utilized to develop Quasi Monte Carlo Model.
Findings- Quasi-Monte Carlo Models are given more real results than Pseudo Monte Carlo Models, especially in high number (5000) iterations. The results are specifically important for investors. The main disadvantage of the research is a random timespan that is out of a crisis or special event.
Conclusion- According to research results of bias (the approximation to reality), the Quasi-Monte Carlo Model gives more efficient results than the Pseudo Monte Carlo Model regarding accuracy and sensitivity. Investors in the American Air Carriers financial market should be aware of this important reality.

Keywords: Monte Carlo models, American Airlines, stock prices
JEL Codes: B26, 018, R11

1. INTRODUCTION

It is an undeniable and clear reality that investors should have some special mental, sentimental and emotional abilities to complete their strategic survival and evolution in complex financial markets and environments. In light of the arguments of the Efficient Market Hypothesis, it can be stated clearly that investors should have different information structures and tools to forecast the current situation of markets. Technical analysis, financial statement analysis, and econometric analysis are important financial tools for analysing different market levels regarding the amount of correct, deep and comprehensive information and knowledge.

This paper aims to measure the impact forecasting power of the different Monte Carlo models with different numerical sequences such as Halton, Sobol and Random sequences or numbers. The main causes of the selection of the financial market of USA airlines are counted as i) Vulnerability of this financial market to systematic or idiosyncratic financial, managerial and operational shocks, ii) The impacts of the oil prices, forex rates and other variables easily can be observed on the return structure of American air carriers financial prices although there are strict and sound hedging policies. Besides these, aviation is under great change, which can be named as an evolution with the impacts of the political, technological and economic variables. For example, a security problem like the 9/11 attacks can change a lot of the market variables in aviation or redefine the market structure as a whole including financial managerial and corporate structures. On the other side, a Monte Carlo simulation can present a lot of new information, if a correct structure designs it. In this context, it is expected to be hard to forecast or model a simulation considering the hard structure of American Air carriers' financial markets. However, benefits from Quasi and Pseudo Monte Carlo Simulations that are reasoned from Halton, Sobol and Random sequences, these problems are to be solved in this analysis. Also, the paper aims to complete a research gap on the efficiency of the different Monte Carlo Models in the forecasting of financial prices of USA Aircarriers by investors.

2. LITERATURE REVIEW

Monte Carlo analysis is a powerful tool in many fields of mathematics, physics and engineering. It is known that the algorithms based on this method give statistical estimates for any linear function of the solution by performing random sampling of a certain random variable whose mathematical expectation is the desired function (Atanassov and Dimov, 2008: 1477). In designing a Monte Carlo analysis, the scenarios or cases are very important. For example, Glasserman et al. (2001) show the importance of scenario creation in constructing a Monte Carlo VAR

analysis. The logic of a Monte Carlo method forms with different types, Bonate (2001:16) argues that the sampling distribution of the model parameters (inputs) must be defined a priori, for example, a normal distribution with mean μ and variance σ^2. Monte Carlo simulation repeatedly simulates the model, each time drawing a different random set of values (inputs) from the sampling distribution of the model parameters, the result of which is a set of possible outcomes (outputs) and underlines the critical importance of Random Number generation. At the same time, Random Number Generation is called as Pseudo-random Generators. Nonetheless, Ferson (1996: 990) underlines the problems of the Monte Carlo methods underlying 4 important emphases; i) Like most methods based on probability theory, Monte Carlo methods are data-intensive. Consequently, they usually cannot produce results unless a considerable body of empirical information has been collected, or unless the analyst is willing to make several assumptions in the place of such empirical information. ii) Although appropriate for handling variability and stochasticity, Monte Carlo methods cannot be used to propagate partial ignorance under any frequentist interpretation of probability. iii) Monte Carlo methods cannot be used to conclude that exceedance risks are no larger than a particular level. iv) Finally, Monte Carlo methods cannot be used to effect deconvolutions to solve back calculation problems such as often arise in remediation planning. There are different methodologies for the creation of Monte Carlo Models such as the Method of Maximum Likelihood, the Method of Moments and Nonlinear Optimisation (Raychaudhuri, 2008).

According to Chen and Hong (2007), the utilization of Monte Carlo Methods in financial management is formed by three steps as such i) generating sample paths, evaluating the payoff along each part, and calculating an average to obtain estimation. Financial decision analysis, financial risk assessment, financial risk management, financial portfolio management and optimisation, and financial strategic planning can be realised with Monte Carlo Methods. In classical evaluation criteria, a Monte Carlo method can be described regarding two dimensions such as data conformity, congruence of the analytical model and validation of the Mathematical model (Nawrocki, 2001: 93).

Halton sequences and Sobol sequences are assumed to distribute randomness (random walk) in space in an order, so a wide utilization example in probability science (Berblinger and Schlier, 1991; Halton, 1992; Sanaç ve Karçı, 2005). Also, in a Monte Carlo simulation context, the utilization of different sequences such as Faure, Halton and Vander Corput means the derandomization of the accuracy of the estimate (Weeraisnghe et al, 2016). In parallel with them, In essence, they are the production sequences with the utilisation of base numbers. Halton sequences are low discrepancy sequences, so reaching the numbers is relatively easy with practical computer algorithms (Dong and Lemieux, 2022; Drukker and Gates, 2006; Faure and Lemieux, 2007). On the other side, there are different ways to create a Halton sequence as in the randomized version of Wang and Hickernell (2000). Especially in financial calculations, Halton sequences give successful results (Faure and Lemieux, 2015). Train (1999) finds that the impacts of Halton sequences can change depending on the sampling largeness.

Sobol sequences are also low discrepancy sequences in the quasi-Monte Carlo approach (Faure and Lemieux, 2016). Like Halton sequences, Sobol sequences are products of development in computer science (Renardy et al., 2021). According to Gomez-Perez et al. (2013) and Kucherenko (2008), Sobol sequences, which are subjected to a quasi-Monte Carlo approach with a deterministic point set and especially, utilize financial calculations such as calculating and pricing financial derivatives (Harase, 2019) and insurance (Kreinin and Kucherenko, 2021) to increase sensitivity. Dimov et al. (2023) utilize the Sobol sequences for the calculation of air pollution depending on their high sensitivity. The utilization of sequences as such Sobol sequences in the Monte Carlo approach increases the impact of accuracy (Owen, 2020; Atanassov and Ivanovska, 2022)

3. THE DATA AND METHODOLOGY

Research data (the stock prices) is taken from investing.com for 10 big airlines in the USA. January, February, March and April months of 2018 are selected randomly. The research steps can be argued as follows. i) Three Monte Carlo algorithms are set for this database under the names of Quasi and pseudo-Monte Carlo Methods benefiting from standard deviation and mean values of the monthly database on Excel program, and ii) Quasi-Monte Carlo Algorithms are utilised with the Sobol and Halton sequences, one dimension (Matlab package program is used in the production of this sequences.) for 500, 1000 and 5000 iterations. At the end of the analysis, bias will be calculated for each month. Therefore, the approximation of different Monte Carlo Methods to the reality will be analysed for investors.

4. FINDINGS AND DISCUSSION

The findings can be tabled for different Monte Carlo Methods for ten airline companies' prices. In the first three tables, there are the mean, variance and standard deviation results of Pseudo Monte Carlo results for 500, 1000 and 5000 iterations of ten USA Airline Companies. The last column belongs to differences between the Monte Carlo Model Mean and an average of the stock price monthly.

Table 1: Pseudo Monte Carlo Results for 500 Iterations

Monte Carlo Model	Mean	Variance	Standard Deviation	Difference by mean
JANUARY				
AAL-500	54.8740324	6.650322255	2.578821873	0.028824747
ALGT-500	159.7196129	45.77666675	6.765845605	0.075625149
ALK-500	69.82080436	16.14344816	4.017891009	0.044909923
DAL-500	57.1797921	4.258142425	2.063526696	0.023065042
HA-500	38.09339707	1.033803659	1.016761358	0.011364837
JBLU-500	21.73389512	0.642871364	0.801792594	0.008962026
LUV-500	63.58447414	4.465931017	2.113274951	0.023621103
SAVE-500	43.889216	4.295110236	2.072464773	0.023164948
SKW-500	53.4909031	4.376205703	2.091938265	0.023382612
UAL-500	71.61429502	21.1623284	4.60025308	0.051419268

FEBRUARY				
AAL-500	51.81809696	3.47969146	1.865393111	0.020850407
ALGT-500	164.7366502	14.31969848	3.784137746	0.042297149
ALK-500	69.82080436	16.14344816	4.017891009	-4.971856994
DAL-500	57.1797921	4.258142425	2.063526696	-4.112949995
HA-500	37.35215849	0.968389439	0.984067802	0.010999405
JBLU-500	20.47668083	0.335790662	0.57947447	0.006477068
LUV-500	63.58447414	4.465931017	2.113274951	-5.78394782
SAVE-500	39.79816666	0.602414861	0.77615389	0.00867545
SKW-500	55.36623269	2.586940469	1.608396863	0.017977835
UAL-500	65.95102463	3.04408042	1.744729326	0.019501689
MARCH				
AAL-500	53.7842609	3.209583114	1.791530941	0.020024813
ALGT-500	171.4397415	24.65159379	4.965037139	0.055496637
ALK-500	64.1983768	3.420006017	1.849325828	0.020670815
DAL-500	55.00893212	1.447706886	1.203206917	0.013448829
HA-500	36.50959769	1.120330339	1.058456583	0.011830884
JBLU-500	21.73389512	0.642871364	0.801792594	-0.250561783
AAL-500	58.51887882	2.142100609	1.463591681	0.016359277
ALGT-500	41.88610119	6.79514272	2.606749455	0.029136907
ALK-500	56.94364682	4.241471301	2.059483261	0.023019847
DAL-500	69.30518151	2.777441299	1.66656572	0.018628016
HA-500	53.7842609	3.209583114	1.791530941	0.020024813
APRIL				
AAL-500	47.1460019	8.001234311	2.828645314	0.031617145
ALGT-500	157.3881516	157.8223112	12.56273502	0.140419804
ALK-500	63.27923487	9.568135026	3.093240215	0.034574651
DAL-500	53.58413775	1.256430626	1.120906163	0.012528914
HA-500	39.7659273	1.806945694	1.344226802	0.015025077
JBLU-500	19.68593687	0.164927934	0.406113204	0.004539325
AAL-500	54.66513931	1.063582624	1.031301423	0.011527358
ALGT-500	36.95846713	1.344677381	1.159602251	0.012961439
ALK-500	55.12646642	2.150342513	1.466404621	0.016390718
DAL-500	68.35686819	3.137437454	1.771281303	0.019798473

Table 2: Pseudo Monte Carlo Results for 1000 Iterations

Monte Carlo Model	Mean	Variance	Standard Deviation	Difference by mean
JANUARY				
AAL-1000	54.84130568	6.868243257	2.620733343	0.061551466
ALGT-1000	159.6337505	47.27669889	6.875805327	0.161487584
ALK-1000	69.76981504	16.67244454	4.083190485	0.095899249
DAL-1000	57.15360477	4.397675312	2.097063497	0.049252371
HA-1000	38.08049379	1.067679841	1.033285944	0.024268117
JBLU-1000	21.72371991	0.663937286	0.814823469	0.019137231
LUV-1000	63.55765547	4.612272822	2.14762027	0.050439766
SAVE-1000	43.86291525	4.435854502	2.106146838	0.049465706
SKW-1000	53.46435521	4.519607345	2.125936816	0.0499305
UAL-1000	71.55591519	21.85578589	4.675017208	0.1097991
FEBRUARY				
AAL-1000	51.79442406	3.593715686	1.895709811	0.044523308
ALGT-1000	164.6886274	14.78893334	3.845638223	0.090320013
ALK-1000	69.76981504	16.67244454	4.083190485	-4.920867668
DAL-1000	57.15360477	4.397675312	2.097063497	-4.086762666
HA-1000	37.33967011	1.000122096	1.000061046	0.023487786
JBLU-1000	20.46932697	0.346794014	0.588892192	0.013830929
LUV-1000	63.55765547	4.612272822	2.14762027	-5.757129157
SAVE-1000	39.78831682	0.622155085	0.788768081	0.018525285
SKW-1000	55.34582122	2.671710595	1.634536814	0.038389307
UAL-1000	65.92888302	3.143830332	1.773084976	0.041643298
MARCH				
AAL-1000	53.76152535	3.314756299	1.82064722	0.042760361

ALGT-1000	171.3767323	25.45938924	5.045729802	0.118505786
ALK-1000	64.17490781	3.532074441	1.879381399	0.044139813
DAL-1000	54.99366274	1.495146051	1.222761649	0.02871821
HA-1000	36.49616527	1.15704187	1.075658807	0.025263301
JBLU-1000	21.72371991	0.663937286	0.814823469	-0.240386579
LUV-1000	58.50030501	2.212294006	1.487378232	0.034933089
SAVE-1000	41.85302005	7.017809269	2.649114809	0.062218043
SKW-1000	56.9175108	4.3804579	2.092954347	0.049155862
UAL-1000	69.28403184	2.86845385	1.693651041	0.039777684
APRIL				
AAL-1000	47.11010478	8.263422658	2.874616958	0.067514266
ALGT-1000	157.2287234	162.9939097	12.76690682	0.299848067
ALK-1000	63.23997989	9.88166834	3.143512103	0.073829632
DAL-1000	53.56991282	1.297601958	1.139123329	0.026753851
HA-1000	39.7488683	1.866156572	1.366073414	0.032084081
JBLU-1000	19.68078306	0.170332373	0.412713428	0.009693133
LUV-1000	54.65205151	1.098434618	1.048062316	0.02461516
SAVE-1000	36.94375112	1.388740425	1.178448312	0.027677452
SKW-1000	55.10785691	2.220805985	1.490236889	0.035000228
UAL-1000	68.33438962	3.240246534	1.80006848	0.042277042

Table 3: Pseudo Monte Carlo Results for 5000 Iterations

Monte Carlo Model	Mean	Variance	Standard Deviation	Difference by mean
JANUARY				
AAL-5000	54.97571238	6.851992089	2.617631007	0.072855234
ALGT-5000	159.9863825	47.164836	6.867665979	0.191144364
ALK-5000	69.97922519	16.63299534	4.078356941	0.1135109
DAL-5000	57.26115459	4.387269833	2.094581064	0.058297443
HA-5000	38.1334868	1.06515357	1.032062774	0.028724895
JBLU-5000	21.76550888	0.662366323	0.813858909	0.022651734
LUV-5000	63.66779814	4.601359578	2.145077989	0.059702899
SAVE-5000	43.97093091	4.425358686	2.103653652	0.058549956
SKW-5000	53.57338582	4.508913359	2.123420203	0.059100109
UAL-5000	71.79567771	21.80407223	4.669483079	0.129963423
FEBRUARY				
AAL-5000	51.89164727	3.585212482	1.893465733	0.052699899
ALGT-5000	164.8858544	14.75394078	3.841085885	0.106907051
ALK-5000	69.97922519	16.63299534	4.078356941	5.130277817
DAL-5000	57.26115459	4.387269833	2.094581064	4.194312481
HA-5000	37.39095915	0.997755676	0.998877207	0.027801257
JBLU-5000	20.49952884	0.345973454	0.588195081	0.016370944
LUV-5000	63.66779814	4.601359578	2.145077989	5.867271821
SAVE-5000	39.82876951	0.620682984	0.787834364	0.021927406
SKW-5000	55.42964993	2.665388976	1.632601904	0.045439405
UAL-5000	66.0198173	3.136391616	1.770986057	0.049290983
MARCH				
AAL-5000	53.85489891	3.306913149	1.818491999	0.050613192
ALGT-5000	171.6355072	25.39914897	5.039756837	0.14026907
ALK-5000	64.2712936	3.523717088	1.87715665	0.052245976
DAL-5000	55.05637319	1.491608339	1.221314185	0.033992236
HA-5000	36.55133141	1.154304157	1.074385479	0.029902842
JBLU-5000	21.76550888	0.662366323	0.813858909	0.282175544
LUV-5000	58.57658656	2.207059427	1.485617524	0.041348461
SAVE-5000	41.98888232	7.001204209	2.645978875	0.073644227
SKW-5000	57.02484988	4.37009316	2.090476778	0.05818321
UAL-5000	69.37089228	2.861666711	1.691646154	0.047082754
APRIL				
AAL-5000	47.25753213	8.243870312	2.871214083	0.079913087
ALGT-5000	157.8834858	162.6082446	12.75179378	0.354914395
ALK-5000	63.40119778	9.858287012	3.139790919	0.087388254

DAL-5000	53.62833379	1.294531661	1.137774873	0.031667128
HA-5000	39.81892862	1.861741	1.364456302	0.03797624
JBLU-5000	19.70194944	0.169929345	0.412224871	0.011473252
LUV-5000	54.70580234	1.095835577	1.046821655	0.029135671
SAVE-5000	37.00418892	1.385454482	1.177053305	0.032760345
SKW-5000	55.18428507	2.215551266	1.488472796	0.04142793
UAL-5000	68.42670778	3.232579684	1.79793762	0.050041112

The Quasi-Monte Carlo method is utilized with Sobol numbers in place of random numbers. The results in the following three tables are taken. The last column belongs to differences between the Monte Carlo model mean and real-world means.

Tablo 4: Quasi-Monte Carlo Results for 500 Iterations with a Sobol Sequence

Monte Carlo Model	Mean	Variance	Standard Deviation	Difference by mean
JANUARY				
AAL-500	54.88328482	6.484583738	2.546484584	-0.019572319
ALGT-500	159.7438878	44.63582627	6.681004885	-0.051350303
ALK-500	69.83521996	15.74112312	3.967508427	-0.030494329
DAL-500	57.18719573	4.152021521	2.037650981	-0.015661416
HA-500	38.09704506	1.008039331	1.004011619	-0.007716848
JBLU-500	21.73677183	0.626849803	0.791738469	-0.006085314
LUV-500	63.59205625	4.354631632	2.086775415	-0.016038987
SAVE-500	43.8966517	4.188068025	2.046476979	-0.015729253
SKW-500	53.49840866	4.26714244	2.065706281	-0.015877049
UAL-500	71.63080004	20.63492344	4.542567935	-0.034914245
FEBRUARY				
AAL-500	51.82478971	3.392971016	1.842001904	0.014157654
ALGT-500	164.7502271	13.96282471	3.736686327	0.028720227
ALK-500	64.84049049	1.210647376	1.100294222	0.008456878
DAL-500	53.0567607	1.720440232	1.311655531	0.010081404
HA-500	37.35568918	0.944255356	0.971728026	0.007468716
JBLU-500	20.47875989	0.327422128	0.572208116	0.004398
LUV-500	57.79188994	1.262584623	1.123647909	0.008636375
SAVE-500	39.80095138	0.587401552	0.766421263	0.005890725
SKW-500	55.37200338	2.522469055	1.588228276	0.012207146
UAL-500	65.95728446	2.968216221	1.72285119	0.01324186
MARCH				
AAL-500	53.79068865	3.129594277	1.769065934	0.013597067
ALGT-500	171.4575553	24.0372297	4.902777763	0.037682823
ALK-500	64.20501191	3.334773046	1.826136097	0.014035709
DAL-500	51.06868098	2726.321266	52.21418644	3.953699969
HA-500	36.51339527	1.092409604	1.045184005	0.0080333
JBLU-500	21.47738362	0.599223638	0.774095367	0.005949709
AAL-500	58.52412997	2.08871544	1.445238887	0.011108128
ALGT-500	41.89545382	6.625795005	2.574061966	0.019784279
ALK-500	56.95103594	4.135765873	2.033658249	0.015630728
DAL-500	69.3111609	2.708222248	1.645667721	0.012648627
HA-500	53.79068865	3.129594277	1.769065934	0.014035709
APRIL				
AAL-500	47.15615066	7.80182853	2.793175349	0.021468387
ALGT-500	157.4332248	153.8890829	12.40520386	0.095346582
ALK-500	63.29033296	9.329679138	3.054452347	0.023476566
DAL-500	53.5881594	1.225118016	1.106850494	0.008507269
HA-500	39.77075019	1.761913215	1.32737079	0.010202192
JBLU-500	19.68739394	0.160817621	0.401020724	0.003082251
AAL-500	54.66883946	1.037076148	1.018369358	0.007827202
ALGT-500	36.96262761	1.311165496	1.14506135	0.008800959
ALK-500	55.13172767	2.09675194	1.448016554	0.011129477
DAL-500	68.36322329	3.059246622	1.749070216	0.01344338

Tablo 5: Quasi-Monte Carlo Results for 1000 Iterations with a Sobol Sequence

Monte Carlo Model	Mean	Variance	Standard Deviation	Difference by mean

JANUARY				
AAL-1000	54.8922211	6.564066759	2.562043473	0.010636041
ALGT-1000	159.7673332	45.18293777	6.721825479	0.027904917
ALK-1000	69.84914298	15.93406565	3.991749698	0.016571309
DAL-1000	57.19434637	4.202913795	2.050100923	0.008510768
HA-1000	38.10056839	1.020395099	1.010146078	0.00419351
JBLU-1000	21.73955025	0.634533243	0.79657595	0.003306897
LUV-1000	63.59937929	4.408007344	2.099525504	0.008715949
SAVE-1000	43.90383332	4.239402129	2.058980847	0.008547632
SKW-1000	53.50565777	4.319445778	2.07832764	0.008627948
UAL-1000	71.64674109	20.8878504	4.57032279	0.018973191
FEBRUARY				
AAL-1000	51.82478971	3.392971016	1.842001904	0.014157654
ALGT-1000	164.7502271	13.96282471	3.736686327	0.028720227
ALK-1000	64.84049049	1.210647376	1.100294222	0.008456878
DAL-1000	53.0567607	1.720440232	1.311655531	0.010081404
HA-1000	37.35568918	0.944255356	0.971728026	0.007468716
JBLU-1000	20.47875989	0.327422128	0.572208116	0.004398
LUV-1000	57.79188994	1.262584623	1.123647909	0.008636375
SAVE-1000	39.80095138	0.587401552	0.766421263	0.005890725
SKW-1000	55.37200338	2.522469055	1.588228276	0.012207146
UAL-1000	65.95728446	2.968216221	1.72285119	0.01324186
MARCH				
AAL-1000	53.79689676	3.167954427	1.779874835	0.007388954
ALGT-1000	171.4747604	24.3318596	4.932733481	0.020477699
ALK-1000	64.20501191	3.334773046	1.826136097	0.007627322
DAL-1000	51.06868098	2726.321266	52.21418644	3.770466792
HA-1000	36.51339527	1.092409604	1.045184005	0.004365477
JBLU-1000	21.47738362	0.599223638	0.774095367	0.003233206
LUV-1000	58.52412997	2.08871544	1.445238887	0.006036408
SAVE-1000	41.89545382	6.625795005	2.574061966	0.010751225
SKW-1000	56.95103594	4.135765873	2.033658249	0.008494091
UAL-1000	69.3111609	2.708222248	1.645667721	0.00687355
APRIL				
AAL-1000	47.16595264	7.89745732	2.810241506	0.011666408
ALGT-1000	157.4767579	155.7753365	12.48099902	0.051813491
ALK-1000	63.30105183	9.444035141	3.073114892	0.012757698
DAL-1000	53.59204362	1.240134567	1.113613293	0.004623043
HA-1000	39.77540828	1.783509387	1.335480957	0.005544102
JBLU-1000	19.68880123	0.162788799	0.403470939	0.001674965
LUV-1000	54.67241319	1.049787827	1.024591542	0.004253479
SAVE-1000	36.96664593	1.32723675	1.152057616	0.00478264
SKW-1000	55.13680913	2.122452307	1.45686386	0.00604801
UAL-1000	68.36936123	3.096744505	1.759756945	0.007305437

Tablo 6: Quasi-Monte Carlo Results for 5000 Iterations with a Sobol Sequence

Monte Carlo Model	Mean	Variance	Standard Deviation	Difference by mean
JANUARY				
AAL-5000	54.89887797	6.645045198	2.577798518	0.003979175
ALGT-5000	159.7847983	45.74034279	6.76316071	0.010439839
ALK-5000	69.8595146	16.13063827	4.016296586	0.006199689
DAL-5000	57.19967308	4.254763572	2.062707825	0.003184064
HA-5000	38.10319302	1.032983332	1.016357876	0.001568884
JBLU-5000	21.74161996	0.642361243	0.801474418	0.001237182
LUV-5000	63.60483441	4.462387284	2.112436338	0.003260827
SAVE-5000	43.9091831	4.291702049	2.071642355	0.003197856
SKW-5000	53.51105781	4.372733166	2.091108119	0.003227904
UAL-5000	71.658616	21.14553601	4.598427558	0.007098285
FEBRUARY				
AAL-5000	51.83606903	3.476930311	1.864652866	0.00287834
ALGT-5000	164.7731084	14.30833574	3.782636084	0.005839002

ALK-5000	64.84722803	1.240604926	1.113824459	0.001719336
DAL-5000	53.06479249	1.763012641	1.327784863	0.002049613
HA-5000	37.36163946	0.967621018	0.983677294	0.001518437
JBLU-5000	20.48226375	0.335524211	0.579244517	0.000894141
LUV-5000	57.79877049	1.293827364	1.137465324	0.001755829
SAVE-5000	39.80564448	0.601936843	0.775845889	0.001197621
SKW-5000	55.38172874	2.584887721	1.607758602	0.002481789
UAL-5000	65.96783416	3.041664931	1.744036964	0.002692153
MARCH				
AAL-5000	53.80152135	3.207036298	1.790820007	0.002764369
ALGT-5000	171.4875769	24.63203266	4.96306686	0.007661154
ALK-5000	64.21619407	3.417292228	1.848591958	0.002853548
DAL-5000	53.59493709	1.255433644	1.120461353	1.427443867
HA-5000	36.51979535	1.119441353	1.058036555	0.00163322
JBLU-5000	21.48212372	0.614051467	0.783614361	0.001209613
LUV-5000	58.53297974	2.140400844	1.463010883	0.002258352
SAVE-5000	41.91121583	6.789750747	2.605715017	0.004022268
SKW-5000	56.96348884	4.238105677	2.058665994	0.003177825
UAL-5000	69.32123798	2.775237389	1.665904376	0.002571545
APRIL				
AAL-5000	47.17325439	7.9948853	2.82752282	0.004364658
ALGT-5000	157.5091869	157.6970786	12.55774974	0.019384559
ALK-5000	63.30903659	9.560542674	3.092012722	0.004772933
DAL-5000	53.59493709	1.255433644	1.120461353	0.001729581
HA-5000	39.77887821	1.805511876	1.343693371	0.00207417
JBLU-5000	19.68984955	0.164797064	0.405952046	0.000626641
LUV-5000	54.67507535	1.062738667	1.03089217	0.001591319
SAVE-5000	36.96963928	1.343610374	1.159142085	0.00178929
SKW-5000	55.14059445	2.148636208	1.465822707	0.002262693
UAL-5000	68.37393354	3.134947885	1.770578404	0.002733124

The Quasi-Monte Carlo method is utilized with Halton numbers in place of random numbers. The results in the following three tables are taken. The last column gives the numerical differences between the Monte Carlo model mean and the real-world means of ten airline companies.

Tablo 7: Quasi-Monte Carlo Results for 500 Iterations with a Halton Sequence

Monte Carlo Model	Mean	Variance	Standard Deviation	Difference by mean
JANUARY				
AAL-500	54.88328482	6.484583738	2.546484584	0.019572319
ALGT-500	159.7438878	44.63582627	6.681004885	0.051350303
ALK-500	69.83521996	15.74112312	3.967508427	0.030494329
DAL-500	57.18719573	4.152021521	2.037650981	0.015661416
HA-500	38.09704506	1.008039331	1.004011619	0.007716848
JBLU-500	21.73677183	0.626849803	0.791738469	0.006085314
LUV-500	63.59205625	4.354631632	2.086775415	0.016038987
SAVE-500	43.8966517	4.188068025	2.046476979	0.015729253
SKW-500	53.49840866	4.26714244	2.065706281	0.015877049
UAL-500	71.63080004	20.63492344	4.542567935	0.034914245
FEBRUARY				
AAL-500	51.82478971	3.392971016	1.842001904	0.014157654
ALGT-500	164.7502271	13.96282471	3.736686327	0.028720227
ALK-500	64.84049049	1.210647376	1.100294222	0.008456878
DAL-500	53.0567607	1.720440232	1.311655531	0.010081404
HA-500	37.35568918	0.944255356	0.971728026	0.007468716
JBLU-500	20.47875989	0.327422128	0.572208116	0.004398
LUV-500	57.79188994	1.262584623	1.123647909	0.008636375
SAVE-500	39.80095138	0.587401552	0.766421263	0.005890725
SKW-500	55.37200338	2.522469055	1.588228276	0.012207146
UAL-500	65.95728446	2.968216221	1.72285119	0.01324186
MARCH				
AAL-500	53.79068865	3.129594277	1.769065934	0.013597067

ALGT-500	171.4575553	24.03722979	4.902777763	0.037682823
ALK-500	64.20501191	3.334773046	1.826136097	0.014035709
DAL-500	55.01324905	1.411627312	1.188119233	0.009131902
HA-500	36.51339527	1.092409604	1.045184005	0.0080333
JBLU-500	21.47738362	0.599223638	0.774095367	0.005949709
AAL-500	58.52412997	2.08871544	1.445238887	0.011108128
ALGT-500	41.89545382	6.625795005	2.574061966	0.019784279
ALK-500	56.95103594	4.135765873	2.033658249	0.015630728
DAL-500	69.3111609	2.708222248	1.645667721	0.012648627
HA-500	53.79068865	3.129594277	1.769065934	0.013597067
APRIL				
AAL-500	47.15615066	7.80182853	2.793175349	0.021468387
ALGT-500	157.4332248	153.8890829	12.40520386	0.095346582
ALK-500	63.29033296	9.329679138	3.054452347	0.023476566
DAL-500	53.5881594	1.225118016	1.106850494	0.008507269
HA-500	39.77075019	1.761913215	1.32737079	0.010202192
JBLU-500	19.68739394	0.160817621	0.401020724	0.003082251
AAL-500	54.66883946	1.037076148	1.018369358	0.007827202
ALGT-500	36.96262761	1.311165496	1.14506135	0.008800959
ALK-500	55.13172767	2.09675194	1.448016554	0.011129477
DAL-500	68.36322329	3.059246622	1.749070216	0.01344338

Tablo 8: Quasi-Monte Carlo Results for 1000 Iterations with a Halton Sequence

Monte Carlo Model	Mean	Variance	Standard Deviation	Difference by mean
JANUARY				
AAL-1000	54.8922211	6.564066759	2.562043473	0.010636041
ALGT-1000	159.7673332	45.18293777	6.721825479	0.027904917
ALK-1000	69.84914298	15.93406565	3.991749698	0.016571309
DAL-1000	57.19434637	4.202913795	2.050100923	0.008510768
HA-1000	38.10056839	1.020395099	1.010146078	0.00419351
JBLU-1000	21.73955025	0.634533243	0.79657595	0.003306897
LUV-1000	63.59937929	4.408007344	2.099525504	0.008715949
SAVE-1000	43.90383332	4.239402129	2.058980847	0.008547632
SKW-1000	53.50565777	4.319445778	2.07832764	0.008627948
UAL-1000	71.64674109	20.8878504	4.57032279	0.018973191
FEBRUARY				
AAL-1000	51.83125378	3.434559435	1.853256441	0.00769359
ALGT-1000	164.7633401	14.13397023	3.759517287	0.015607222
ALK-1000	64.84435171	1.225486557	1.107016963	0.004595659
DAL-1000	53.06136364	1.74152806	1.319669678	0.005478463
HA-1000	37.35909923	0.955829309	0.977665234	0.004058669
JBLU-1000	20.48076792	0.331435416	0.575704278	0.002389973
LUV-1000	57.79583311	1.27806041	1.130513339	0.004693201
SAVE-1000	39.80364095	0.594601467	0.771104057	0.003201153
SKW-1000	55.37757689	2.553387533	1.597932268	0.00663364
UAL-1000	65.96333039	3.004598324	1.733377721	0.007195927
MARCH				
AAL-1000	53.79689676	3.167954427	1.779874835	0.007388954
ALGT-1000	171.4747604	24.3318596	4.932733481	0.020477699
ALK-1000	64.2114203	3.334773046	1.826136097	0.007627322
DAL-1000	55.01741847	2726.321266	52.21418644	0.004962482
HA-1000	36.51706309	1.092409604	1.045184005	0.004365477
JBLU-1000	21.48010013	0.599223638	0.774095367	0.003233206
LUV-1000	58.52920169	2.08871544	1.445238887	0.006036408
SAVE-1000	41.90448687	6.625795005	2.574061966	0.010751225
SKW-1000	56.95817258	4.135765873	2.033658249	0.008494091
UAL-1000	69.31693597	2.708222248	1.645667721	0.00687355
APRIL				
AAL-1000	47.16595264	7.89745732	2.810241506	0.011666408
ALGT-1000	157.4767579	155.7753365	12.48099902	0.051813491
ALK-1000	63.30105183	9.444035141	3.073114892	0.012757698

DAL-1000	53.59204362	1.240134567	1.113613293	0.004623043
HA-1000	39.77540828	1.783509387	1.335480957	0.005544102
JBLU-1000	19.68880123	0.162788799	0.403470939	0.001674965
LUV-1000	54.67241319	1.049787827	1.024591542	0.004253479
SAVE-1000	36.96664593	1.32723675	1.152057616	0.00478264
SKW-1000	55.13680913	2.122452307	1.45686386	0.00604801
UAL-1000	68.36936123	3.096744505	1.759756945	0.007305437

Tablo 9: Quasi-Monte Carlo Results for 5000 Iterations with a Halton Sequence

Monte Carlo Model	Mean	Variance	Standard Deviation	Difference by mean
JANUARY				
AAL-5000	54.89887797	6.645045198	2.577798518	0.003979175
ALGT-5000	159.7847983	45.74034279	6.76316071	0.010439839
ALK-5000	69.8595146	16.13063827	4.016296586	0.006199689
DAL-5000	57.19967308	4.254763572	2.062707825	0.003184064
HA-5000	38.10319302	1.032983332	1.016357876	0.001568884
JBLU-5000	21.74161996	0.642361243	0.801474418	0.001237182
LUV-5000	63.60483441	4.462387284	2.112436338	0.003260827
SAVE-5000	43.9091831	4.291702049	2.071642355	0.003197856
SKW-5000	53.51105781	4.372733166	2.091108119	0.003227904
UAL-5000	71.658616	21.14553601	4.598427558	0.007098285
FEBRUARY				
AAL-5000	51.83606903	3.476930311	1.864652866	0.00287834
ALGT-5000	164.7731084	14.30833574	3.782636084	0.005839002
ALK-5000	64.84722803	1.240604926	1.113824459	0.001719336
DAL-5000	53.06479249	1.763012641	1.327784863	0.002049613
HA-5000	37.36163946	0.967621018	0.983677294	0.001518437
JBLU-5000	20.48226375	0.335524211	0.579244517	0.000894141
LUV-5000	57.79877049	1.293827364	1.137465324	0.001755829
SAVE-5000	39.80564448	0.601936843	0.775845889	0.001197621
SKW-5000	55.38172874	2.584887721	1.607758602	0.002481789
UAL-5000	65.96783416	3.041664931	1.744036964	0.002692153
MARCH				
AAL-5000	53.80152135	3.207036298	1.790820007	0.002764369
ALGT-5000	171.4875769	24.63203266	4.96306686	0.007661154
ALK-5000	64.21619407	3.417292228	1.848591958	0.002853548
DAL-5000	55.02052438	1.446558125	1.202729448	0.001856573
HA-5000	36.51979535	1.119441353	1.058036555	0.00163322
JBLU-5000	21.48212372	0.614051467	0.783614361	0.001209613
LUV-5000	58.53297974	2.140400844	1.463010883	0.002258352
SAVE-5000	41.91121583	6.789750747	2.605715017	0.004022268
SKW-5000	56.96348884	4.238105677	2.058665994	0.003177825
UAL-5000	69.32123798	2.775237389	1.665904376	0.002571545
APRIL				
AAL-5000	47.17325439	7.9948853	2.82752282	0.004364658
ALGT-5000	157.5091869	157.6970786	12.55774974	0.019384559
ALK-5000	63.30903659	9.560542674	3.092012722	0.004772933
DAL-5000	53.59493709	1.255433644	1.120461353	0.001729581
HA-5000	39.77887821	1.805511876	1.343693371	0.00207417
JBLU-5000	19.68984955	0.164797064	0.405952046	0.000626641
LUV-5000	54.67507535	1.062738667	1.03089217	0.001591319
SAVE-5000	36.96963928	1.343610374	1.159142085	0.00178929
SKW-5000	55.14059445	2.148636208	1.465822707	0.002262693
UAL-5000	68.37393354	3.134947885	1.770578404	0.002733124

5. CONCLUSIONS

According to research results of bias (the approximation to reality), the Quasi-Monte Carlo Model gives more efficient results than the Pseudo Monte Carlo Model regarding accuracy and sensitivity. Investors in the American Airlines market should be aware of this important reality. Thus, the main question of the research is answered and the research gap is completed. On the other side, the timespan of the research model gains importance. A strong, unexpected or undesired event can have different impacts on the Monte Carlo Model depending on the

volatility structure. It is another question if the investors are vulnerable regarding rational and emotional reasoning, as it is known that variables such as sustainability, branding and corporate governance structures have impacts on investors' decisions in airline financial markets of the United States.

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IMPACTS OF CROSS-BORDER E-COMMERCE ON GROWTH OF TURKISH SMEs

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ABSTRACT

Purpose- Cross-border e-commerce has emerged as a critical enabler for the globalization of small and medium-sized enterprises (SMEs), particularly in the wake of the COVID-19 pandemic. This study explores the transformative impact of digital marketplaces, innovative payment systems, and logistics advancements on the internationalization of Turkish SMEs. Leveraging a mixed-methods approach, the research combines quantitative data analysis with qualitative insights from industry stakeholders. The findings highlight the significant role of platforms such as Amazon and Alibaba in reducing market entry barriers, the importance of secure digital payment systems in fostering trust, and the contribution of logistics innovations to the growth of small-package exports. By aligning with global consumer trends and leveraging digital tools, Turkish SMEs can overcome traditional trade barriers, enhance competitiveness, and access broader markets. The study concludes with strategic recommendations for policymakers and SMEs, emphasizing the need for regulatory support and investment in digital infrastructure to maximize the benefits of cross-border e-commerce.

Methodology- The study was carried with a mixed-methods approach. Quantitative Analysis: Data from the Turkish Statistical Institute, Turkish Exporters Assembly (TİM), and global e-commerce platforms were analyzed to track export trends, marketplace performance, and consumer behavior. Qualitative Insights: Interviews with SME owners, e-commerce experts, and policymakers provided in-depth perspectives on challenges and opportunities. And as case studies, Successful Turkish SMEs from sectors like textiles and food were examined to identify strategies for internationalization.

Findings- The COVID-19 pandemic has significantly accelerated e-commerce adoption in Turkey, leading to substantial growth in online spending and reshaping various sectors of the economy. Below are some of the main findings; platform Impact, global marketplaces significantly increase SME visibility and reduce market entry barriers; digital payment systems, enable secure, efficient transactions, fostering trust among international customers; small package exports, innovations in logistics, such as faster shipping, have fueled SME participation in global trade; post-Covid consumer behavior, the pandemic accelerated global e-commerce adoption, creating new opportunities for Turkish SMEs.

Conclusion- Cross-border e-commerce represents a transformative opportunity for Turkish SMEs, enabling them to overcome traditional barriers and compete effectively in global markets. By leveraging digital platforms, payment innovations, and logistics advancements, SMEs can drive growth, internationalization, and competitiveness. Strategic support from policymakers will be crucial in maximizing the potential of this digital trade revolution.

Keywords: E-commerce, marketplaces, international trade, digital payment systems
JEL Codes: F23, L26, L81, O31

1. INTRODUCTION

Cross-border e-commerce has emerged as a transformative force in global trade, providing small and medium-sized enterprises (SMEs) with unprecedented opportunities to access international markets. Turkish SMEs, which play a vital role in the country's economy, stand to benefit significantly from the rise of global marketplaces and the digitization of trade. This article explores how cross-border e-commerce enables Turkish SMEs to thrive globally, examining key enablers, challenges, and strategies to optimize their internationalization efforts.

2. RESEARCH CONTEXT AND OBJECTIVES

Turkish SMEs represent a substantial portion of the economy, contributing to employment and GDP growth. However, their participation in global trade has traditionally been limited by barriers such as high costs, logistical hurdles, and complex regulations. With the advent of digital marketplaces like Amazon, Alibaba, and Trendyol, these barriers are being lowered, providing SMEs with direct access to global consumers.

Figure 1: International Dominant Marketplaces across the Globe

Source: Naspers

The primary objectives of this research are to analyze the role of international e-commerce platforms in SME growth, examine the impact of digital payment systems on secure and efficient global transactions, assess regulatory barriers and trade policies affecting Turkish SMEs, explore consumer trends in major markets and align SME strategies accordingly, provide actionable recommendations for policymakers and SMEs to enhance global trade participation. Key research questions are how has digitization impacted Turkish SMEs' global participation, what role do platforms like Amazon and Alibaba play in enabling SME internationalization, how do digital payment systems and logistics innovations support SMEs, what challenges do SMEs face in cross-border trade and how can Turkish SMEs align with post-COVID-19 e-commerce trends?

3. KEY AREAS DRIVING E-COMMERCE GROWTH FOR SMEs

Key enablers for SMEs to become exporters, especially for Turkish small and medium-sized businesses, revolve around accessibility, technology, and supportive policies. Digital marketplaces such as Amazon, Alibaba, and Trendyol have been transformative, offering Turkish SMEs global visibility without the need for expensive infrastructure. These platforms reduce traditional trade barriers by providing ready-made logistics and payment systems, enabling even the smallest businesses to reach international customers.

Innovations in digital payment systems, such as Iyzico and other payment solutions, ensure secure and seamless transactions, fostering trust among global buyers. Additionally, Turkey's strategic geographical location and its robust logistics network offer SMEs competitive shipping times to Europe, the Middle East, and beyond.

Government incentives for digitalization, such as grants and tax reliefs, further empower SMEs to adopt e-commerce and expand their reach. Finally, rising global demand for Turkish products, like textiles and food, paired with SMEs' ability to cater to cultural preferences and adapt to international market trends, positions them as strong players in the global export market.

Some of the key enablers of cross-border e-commerce are listed below:

1. Digital Infrastructure and Online Presence

- Website and Mobile Apps: A well-optimized website and mobile app act as the digital storefront for SMEs. These platforms should be user-friendly, mobile-responsive, and equipped with search engine optimization (SEO) to improve visibility.
- E-commerce Platforms: Marketplaces like Amazon, Alibaba, and Etsy provide SMEs with ready-made infrastructure to reach a global audience, reducing the need for significant upfront investment.
- Digital Marketing Tools: SMEs leverage tools like Google Ads, Facebook Ads, and email marketing to drive traffic and engage with customers effectively.

2. Payment Systems

- Secure and Diverse Payment Options: Offering multiple payment methods like credit cards, digital wallets (PayPal, Stripe), and local payment solutions builds trust and reduces cart abandonment.
- Financial Inclusion: Digital payment systems make global transactions accessible, even for businesses in developing regions.
- Subscription and Buy-Now-Pay-Later Models: These payment innovations attract customers by offering flexibility and convenience.

3. Logistics and Supply Chain Management

- Efficient Delivery Systems: Reliable shipping solutions, like same-day or next-day delivery, enhance customer satisfaction.
- Small Package Exports: Innovations in logistics, such as partnerships with global courier services, simplify international trade for SMEs.
- Inventory Management Systems: Digital tools for inventory tracking ensure that SMEs can meet demand without overstocking or delays.

4. Consumer Behavior and Personalization

- Changing Consumer Habits: The shift toward online shopping, particularly post-COVID-19, has made e-commerce essential for SMEs to remain competitive.
- Data-Driven Personalization: SMEs can leverage data analytics to understand customer preferences and offer tailored recommendations, increasing conversion rates.
- Customer Engagement: Features like chatbots, loyalty programs, and personalized offers enhance customer retention.

5. Technological Adoption

- Artificial Intelligence (AI): AI helps SMEs optimize pricing, predict demand, and personalize customer experiences.
- Big Data and Analytics: SMEs can analyze purchasing patterns and market trends to make informed decisions.
- Blockchain Technology: Blockchain enhances transparency in supply chains, builds trust, and ensures secure transactions.

6. Cross-Border E-Commerce Enablers (Culture Effect)

- Global Marketplaces: Platforms like eBay, Amazon, and Alibaba simplify international trade for SMEs, expanding their reach.
- Localization: Adapting products, websites, and marketing strategies to local markets improves success in international markets.
- Cultural Sensitivity: Understanding and catering to cultural preferences enhances competitiveness abroad.

7. Government Support and Policy Environment (Soft Powers)

- Incentives and Subsidies: Many governments provide incentives for SMEs to adopt e-commerce, such as grants for digital transformation or tax benefits.
- Trade Agreements: Free trade agreements and reduced tariffs facilitate cross-border e-commerce growth.
- Simplified Regulations: Streamlining customs and documentation processes makes it easier for SMEs to export goods.

8. Social Media and Digital Marketing

- Social Commerce: Platforms like Instagram and TikTok have become powerful channels for SMEs to sell directly to consumers.
- Influencer Marketing: Collaborating with influencers helps SMEs build brand awareness and reach niche markets.
- Content Marketing: Blogs, videos, and user-generated content improve SEO and engage potential customers.

9. Scalability and Sustainability

- Scalable Business Models: E-commerce allows SMEs to scale operations more effectively than traditional retail.
- Sustainable Practices: Offering eco-friendly products and packaging appeals to environmentally conscious consumers and builds brand loyalty.

10. Global Trust and Security

- Cybersecurity: Implementing secure payment gateways, SSL certificates, and robust data protection measures builds consumer trust.
- Authenticity and Reviews: Customer reviews and ratings on platforms build credibility, encouraging more purchases.

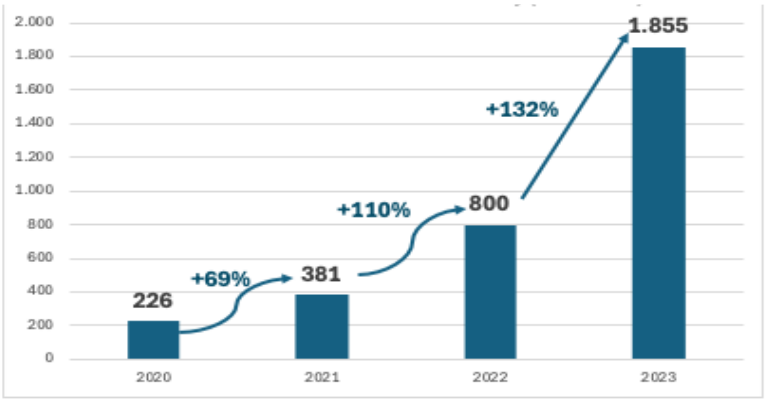
5. IMPACTS OF GROWTH

In 2023, Turkey's e-commerce volume reached approximately 1.85 trillion Turkish lira (around $57.5 billion), marking a 115% increase from the previous year. This surge reflects a broader shift towards online shopping, with e-commerce's share of total retail sales rising from 4% in 2016 to 18.3% in 2023.

Several sectors experienced notable growth in e-commerce during this period such as Fast-Moving Consumer Goods (FMCG) products. Online sales of FMCG tripled compared to European countries, driven by increased home cooking and a preference for local products during the pandemic. Travel and Hospitality also increased significantly in the past 5 years.

After an initial decline, these sectors rebounded post-pandemic, registering significant growth as consumers resumed travel and leisure activities.

Figure 2: Turkish E-Commerce Growth



Source: Ministry of Trade

The expansion of e-commerce has had several positive effects on Turkey's economy:

- **Increased Consumer Spending:** The convenience of online shopping has led to higher consumption levels, contributing to economic growth.
- **SME Growth:** E-commerce platforms have enabled small and medium-sized enterprises to reach broader markets, enhancing their revenue streams and resilience.
- **Employment Opportunities:** The e-commerce boom has created jobs in logistics, IT, and customer service sectors, aiding in economic recovery post-pandemic.

Overall, the pandemic-induced shift towards e-commerce has not only transformed consumer behavior in Turkey but also provided a significant boost to various sectors, fostering economic resilience and growth.

6. IMPLICATIONS AND RECOMMENDATIONS FOR TURKISH SMEs

Becoming exporters using international marketplaces provides enhanced market access to business of all sizes. Cross-border e-commerce bridges traditional trade gaps, enabling SMEs to access global consumers. Digital tools provided by the marketplaces, search engines like Google or digital payment systems help SMEs track their sales, inventory and financials where analytics and data-driven strategies help SMEs understand international demand and tailor offerings.

International logistics companies provide door-to-door solutions where the producer of a product can easily meet their end-user. Logistics companies work on continous innovation, faster delivery and streamlined customs processes which enhance competitiveness. Government see this growth as an opportunity and provide policy support with G2G agreements or specialy incentives for producers. Regulatory reforms and trade incentives can further integrate SMEs into global trade networks.

In order to fuel further growth and competitiveness, SMEs should:

- Invest in logistics and digital tools to optimize operations.
- Leverage platforms like Amazon and Alibaba for greater visibility.
- Align strategies with global consumer trends, focusing on trust and quality.

Policymakers who see these platforms as growth opportunities and export potential should implement regulatory reforms and trade incentives to reduce barriers, enhance digital infrastructure to support SME digitalization and facilitate government-to-government trade agreements to expand market access.

7. CONCLUSION

Cross-border e-commerce is a transformative force reshaping the global trade landscape, offering Turkish SMEs a pathway to overcome traditional barriers and achieve international growth. Digital marketplaces have democratized access to global markets, reducing the cost and complexity of international trade while enhancing visibility for smaller businesses. The adoption of secure digital payment systems and advancements in logistics, including faster shipping and streamlined customs processes, have further empowered Turkish SMEs to participate in global trade networks.

The COVID-19 pandemic accelerated the shift toward e-commerce, creating new consumer behaviors and opportunities. Turkish SMEs, particularly those in sectors like textiles, jewelry, and fast-moving consumer goods, have capitalized on these trends to expand their reach. However, challenges remain, including regulatory hurdles and the need for continuous investment in digital tools and infrastructure.

To sustain and amplify this growth, SMEs must prioritize product and market development, customer trust, adapt to target market preferences, and invest in technology and logistics capabilities. Policymakers play a crucial role in fostering this ecosystem by reducing trade barriers, providing financial incentives, and enhancing the digital infrastructure. Cross-border e-commerce is not just an opportunity but a necessity for Turkish SMEs to thrive in an increasingly interconnected world. By seizing these opportunities, SMEs can drive economic growth, innovation, and resilience in Turkey's challenging economy.

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THE IMPACT OF FINTECH INVESTMENTS IN TURKEY ON E-COMMERCE

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ABSTRACT

Purpose- In this study, the diversity and development of fintech investments in the world and in Turkey were examined. Since financial technology investments are fintech investments developed specifically for the e-commerce system, the impact of fintech companies established in Turkey and the investments of currently operating companies on e-commerce were investigated.
Methodology- The data set of the study was created with the market share data, sales volumes and number of users of the e-commerce sector between 2019-2023, the data are obtained from the Republic of Turkey. Presidential Finance Office and T.R. It was obtained from the websites of the Ministry of Commerce and analyzed with the SPSS 22 program and regression analysis was applied.
Findings- The analysis model shows that the effect of the independent variable on the dependent variable is not significant.
Conclusion- Analysis results show that fintech investments alone are not sufficient for the development of e-commerce. It is thought that this research will contribute to researches who will conduct research on a similar subject.

Keywords: Finance, technology, fintech, e-commerce.
JEL Codes: G00, O30, G21, L81

TÜRKİYE'DEKİ FİNTEK YATIRIMLARININ E-TİCARETE ETKİSİ

ÖZET

Amaç- Bu çalışmada, Dünyadaki ve Türkiye'deki fintek yatırımlarının çeşitliliği ve gelişimi incelenmiştir. Finansal teknoloji yatırımlarının, özellikle e-ticaret sistemine yönelik geliştirilen fintek yatırımları olması sebebiyle, Türkiye'de kurulan fintek şirketleri ve hâlihazırda faaliyet gösteren şirketlerin yatırımlarının e-ticarete etkisi araştırılmıştır. Çalışmanın amacı, fintek yatırımlarının e-ticaret üzerindeki etkisinin belirlenmesidir.
Yöntem- Çalışmanın veri seti, 2019 - 2023 yılları arasındaki e-ticaret sektörünün pazar payı verileri, satış hacimleri ve kullanıcı sayıları ile oluşturulmuş, veriler T.C. Cumhurbaşkanlığı Finans Ofisi ve T.C. Ticaret Bakanlığı'nın internet sitelerinden elde edilerek SPSS 22 programı ile analiz edilmiş ve regresyon analizi uygulanmıştır.
Bulgular- Araştırmada, fintek yatırım tutarının (bağımsız değişken) e-ticaret satış hacmi (bağımlı değişken) üzerinde anlamlı bir etkisinin olmadığı belirlenmiştir.
Sonuç- Analiz sonuçları, e-ticaretin gelişmesinde fintek yatırımlarının tek başına yeterli olmadığını göstermektedir. Bu araştırmanın, benzer konuda araştırma yapacak araştırmacılara katkı sağlayacağı düşünülmektedir.

Anahtar Kelimeler: Finans, teknoloji, fintek, e-ticaret.
JEL Kodları: G00, O30, G21, L81

1. GİRİŞ

Bilgisayar teknolojisindeki gelişmeler birçok alanda olduğu gibi işletmelerin de gelişimine ve değişime ayak uydurmasına katkı sağlamıştır. İşletmeler daha önce olmadığı kadar büyük veri olarak adlandırılan bir veriye sahip olmuşlardır. Basit istatistiksel ve matematiksel teknikler bu verilerin analizinde yetersiz kalmaktadır. İşletmelerin bu büyük veriyi analiz edip, hızlı ve etkin karar verme sürecinde kullanmaları için yapay zekâ tekniklerini kullanmaları gerekliliği ortaya çıkmıştır. Bunun sonucu olarak yapay zekâ tekniklerinin kullanımı ile uyumlu yeni iş modellerinin geliştirilmesi gerekmiştir. Finansal araçlar ve finansal piyasalar da yapay zekâ teknolojisinin yol açtığı bu değişimden en çok etkilenen alanlar olarak karşımıza çıkmaktadır. Yapay zekâ ile finansal piyasaların kesiştiği alan finansal teknoloji (fintek) kavramı ile ifade edilmiştir (Yıldız, 2022).

Fintek kavramı, finansal hizmetler alanında daha ulaşılabilir hale getiren yenilikçi iş modelleriyle teknolojiyi birleştiren işletmeleri ifade etmektedir (Sezal, 2020). Finteklerin geçmişi 1866'ya kadar gitmektedir. Fintek 1.0 olarak kabul edilen evre, telgraf ve ilk trans-atlantik

kablonun döşenmesiyle başlamaktadır. 1967 ve 2008 yıllarını kapsayan fintek 2.0 dönemi ise elektronik ödeme ve takas sisteminin kurulduğu, ATM ve online bankacılığın yaygınlaştığı dönem olarak kabul edilmektedir. 2008'den günümüze kadar olan evre ise fintek 3.0 olarak tanımlanmaktadır. Fintek 3.0 aşamasında finansal servis sağlayıcıları devreden çıkarılarak doğrudan müşteriye hizmet sunan servisleri içeren yeni teknolojilerin kullanımı yaygınlaşmaktadır (Demirdöğen, 2020).

Geleneksel finans yönetimine alternatif olarak fintek, dijital sistemlerin daha fazla kullanılmasına olanak sağlamaktadır. Günlük yaşantının bir parçası olan finans yönetimi, gelişen teknoloji ile birlikte fintek kavramının önemini günden güne artırmaktadır (Loomis ve Cockayne, 2024). Fintek şirketleri ve hâlihazırda faaliyet gösteren şirketlerin fintek yatırımları, tüm bu gelişmelere paralel olarak artış göstermektedir. Değişen tüketici davranışları, fintek şirketlerinin sunmuş olduğu ürün ve hizmet çeşitliliğini genişletmesine olanak sağlarken, ortaya çıkabilecek olumsuzlukların ve risklerin önlenmesi için bazı yasal zorunlulukları da beraberinde getirmektedir. Devletin kanun koyucu olarak finansal sistemin istikrarlı bir şekilde büyümesi adına düzenleyeceği yasalar ile birlikte finansal sitemin verimliliğinin artırılması hedeflenmektedir (Cao ve Zhai, 2022).

Fintek yatırımlarının büyük bölümünü oluşturan ödeme sistemleri yatırımları, geleneksel ticaretin yönünü e-ticarete çevirmektedir. Elektronik ticaret; mal ve hizmetlerin üretim, tanıtım, satış, sigorta, dağıtım ve ödeme işlemlerinin bilgisayar ağları üzerinden yapılmasıdır (Aliyeva, 2017). Bu araştırmada, fintekin tanımı, gelişimi, Türkiye'deki fintek yatırımları, e-ticaretin gelişimi ve bu konuda yapılan çalışmalar açıklandıktan sonra Türkiye'deki fintek yatırımlarının e-ticarete etkisi araştırılmıştır.

2. TÜRKİYE'DEKİ FİNTEK YATIRIMLARI VE E-TİCARETİN GELİŞİMİ

Ticari hayatta yer almaya başlayan e-ticaretin, geleneksel ticaretin yerini alıp almayacağı tartışmaları beraberinde getirmiştir. Ancak bu konudaki genel görüş, e-ticaretin geleneksel ticareti tamamlayan, kolaylaştıran ve iş görme şekillerini değiştiren yeni bir yöntem olduğu yönündedir. Bu çalışmada, literatür araştırması yapılmış ve Türkiye'deki fintek şirketlerinin finansal durumu incelenmiştir. Şirketlerin verileri üzerinde SPSS 22 istatistik programı kullanılarak basit doğrusal regresyon analizi uygulanmıştır.

Türkiye'deki fintek yatırımları ile e-ticaret verileri, T.C. Cumhurbaşkanlığı finans ofisi ve T.C. Ticaret Bakanlığı'nın istatistik verileri ile incelenmiştir. T.C. Cumhurbaşkanlığı finans ofisi verilerinden 2019 - 2023 yılları arasındaki fintek yatırımları, T.C. ticaret bakanlığı verilerinden ise aynı döneme ait genel ve perakende e-ticaret hacminin değişim grafikleri oluşturulmuştur. Türkiye'deki 2019 - 2023 yılları arasında fintek alanında yapılan toplam yatırım tutarı ile yatırım adedi Grafik 1'de gösterilmektedir.

Grafik 1: Fintek Yatırımları

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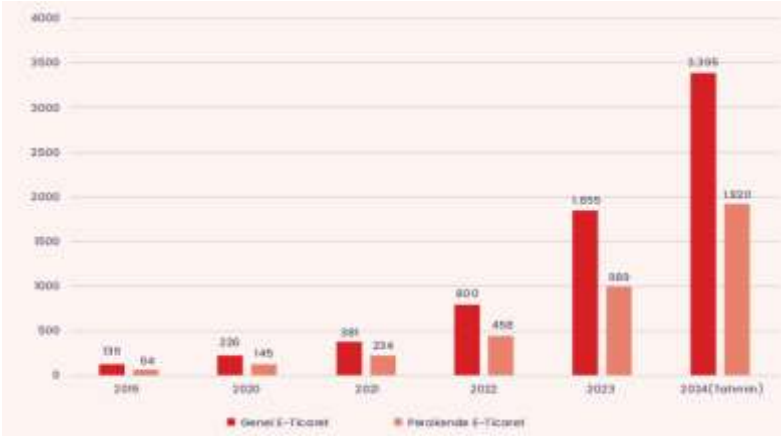
Grafik 1'de görüldüğü gibi 2019 yılında 4 milyon dolar olan fintek yatırımları 2022 yılında rekor seviyeye ulaşarak 91 milyon dolar seviyesine ulaşmıştır. 2023 yılında ise bu tutar 26 milyon dolardır. 2019 - 2023 yılları arasındaki genel ve perakende e-ticaretin yıllara göre değişim grafiği Grafik 2'de açıklanmaktadır.

Grafik 2: Genel ve Perakende E-Ticaret Hacminin Yıllara Göre Değişimi



Kaynak: https://eticaret.gov.tr, Erişim Tarihi: 14.09.2024.

Grafik 2'de görüldüğü gibi ülkemizde e-ticaret hacmi 2023 yılında bir önceki yıla göre %115,15 artarak 1,85 trilyon TL'ye (77,89 milyar ABD doları) ve işlem sayısı ise %22,25 artarak 5,87 milyar adede ulaşmıştır. Bununla beraber e-ticaret hacminin 2019 - 2023 yılları arasında bileşik büyüme oranı %92,17 olarak gerçekleşmiştir.

3. LİTERATÜR

Demirdöğen (2019), gelecekte finansal teknoloji yatırımlarının artarak devam edeceğini ve bu doğrultuda gerekli yasal düzenlemelerin hızlı bir şekilde hayata geçirilmesinin önemli olduğuna vurgu yapmıştır. Kömürcüoğlu ve Akyazı (2020), yaptığı çalışmada fintek kavramını ve Türkiye'deki gelişmelerini değerlendirmiş, son yıllarda fintek şirketleri sayılarında, yatırım miktarlarında ve işlem hacimlerinde hızlı bir gelişmenin olduğunu gözlemlemiştir. Iman (2020), yaptığı çalışmada firntek sektörünün henüz çok yeni ve gelişime açık bir alan olduğunu savunarak iş dünyasında daha fazla uygulanabilir alanının olabileceğini ve üzerine daha fazla yoğunlaşması gerektiğini tavsiye etmiştir.

Okoli ve Tewari'ye göre (2020), Afrika'da fintek ürünlerinin daha da geliştirilmesi ve yatırımların artırılması için ekonomik, finansal, psikolojik faktörler ve finansal okuryazarlık gibi etkenlerin gelişmesi gerekmektedir. Uzoma vd. (2020), finansal teknoloji ile birlikte özellikle dijital finansın geleneksel finans üzerindeki olumlu etkilerinden bahsetmiştir. Finansal teknoloji ile birlikte geleneksel finans ürünlerinin kullanım alanlarının azalacağı, dijital finans sistemine yeterli ulaşım sayesinde finansmana ulaşımın artacağını belirtmiştir. Böylece hem finansal eşitsizliğin azalacağı hem de kayıt dışı işlemlerin azalacağı sonucuna varmıştır.

Geylan'a göre (2021), bir fintekin başarıyı yakalaması ve sürdürülebilirliği için sosyal ve çevresel alanlarda belirli avantajlara sahip olmaları, ekonomik avantaj sağlamak için de sundukları iç görülerin değerine ve kalitesine dikkat etmeleri gerekmektedir. Erden ve Topal (2021), Türkiye ve dünyadaki fintekler ile İslami fintekler üzerine çalışmalar yapmıştır. Fintek ve İslami fintek sektörünün sağladığı düşük maliyet, sürekli erişilebilirlik, açık bankacılık, şeffaflık ve kullanım kolaylığı gibi avantajlar ile finans piyasalarındaki pazar payını artıracağını öngörmüştür.

Kanga vd. (2022), finteklerin yayılmasının ve finansal katılımın sağlanmasının, kişi başına düşen Gayri Safi Yurtiçi Hâsıla (GSYİH) üzerinde uzun vadede olumlu olacağını saptamıştır. Abakah vd, (2022), ABD'de pandemi döneminde finansal teknoloji ve yapay zekâ ürünlerinin, borçların hafifletilmesi ve maliye politikaları ile birlikte olumlu etkilendiği sonucuna varmıştır. Yıldız'a göre (2022), fintek yatırımları daha çok hisse senedi, altın vb. yatırım araçlarının tahmini için kullanılmaktadır. Ancak son çalışmalarda blokzincir ile beraber bitcoin fiyat tahminine yönelik daha ileri düzey analizler kullanılmakta ve çalışmalar hızla artmaktadır. Brown ve Piroska (2022)'nın çalışmasında, düzenleyici sanal alanların finteki tüketiciler için güvenli hale getirmedikleri sorunlarıyla karşılaştıklarını ve fintekin topluma daha fazla nüfus etmesi hususunda engeller olduğu sonucuna varmıştır.

Nguyen'e göre (2022), sürdürülebilirlik açısından fintek gelişimlerinin firmalar ve ülke bazında değerlendirilmesi gerekmektedir. Finansal teknolojiye yapılacak yatırımlarla birlikte iş dünyasının sürdürülebilirliği sağlanabilir. Cao ve Zhai (2022), makine öğrenmesinin finansal alanda derinlemesine araştırılması ve geniş çapta uygulanması ile birlikte finansal düzenin tamamen değişeceğini belirtmiştir. Aydemir ve Kalalı (2022), internet kullanımın artmasıyla birlikte firmaların dış pazarlara açılmalarının ve dış pazardaki rekabete ayak uydurmalarının daha kolay olacağı e-ihracat uygulamalarından dış pazara açılmak isteyen daha fazla girişimcinin yaralanabileceği sonucuna varmıştır. Werth vd. (2022)'nin çalışmasında, fintek yatırımları ile sürdürülebilirlik arasında anlamlı bir ilişki olduğu ortaya konmuştur.

McCarthy'e göre (2023), fintek yatırımlarının daha etkin hale gelmesi için gerekli düzenlemelerin tamamlanarak gelecek adına daha fazla bilimsel çalışma yapılmalıdır. Wu vd. (2023)'nin çalışmasında, bölgesel düzeyde mali durumun gelişimine paralel olarak fintek yatırımlarının endüstriye dâhil edilmesinin finansal verimliliği artıracağı sonucuna varmıştır. Akçetin (2023), yaptığı çalışmada Türkiye'nin fintek ve yapay zekâ gibi güçlü inovasyonlara odaklanması gerektiğini vurgulamıştır. Çin'in taklit ekonomisinden inovasyon ekonomisine geçişinin, Çin'i dünya devi haline getirdiği örneğinden hareketle, Türkiye'nin de fintek ve yapay zekâ alanındaki taklit ve yeniliklerle birlikte küresel bir ülke haline gelebileceği sonuca varmıştır. Ekmekçioğlu ve Göksel (2023)'in çalışmasında, teknolojik, finansal ve hukuki altyapının desteklenmesi gerektiği, kurucu ekibin çeşitliliğinin oluşturulması, sürdürülebilmesi için gerekli yeterliliklerin geliştirilmesi gerektiği vurgulanmıştır.

Wang vd. (2024), fintek yatırımlarının ticarete, ekonomik kalkınmaya ve büyümeye olan olumlu etkisinden söz ederek yasal düzenlemeler ve kanunlarla daha fazla desteklenmesi ve teşvik edilmesi gerektiği sonucuna varmıştır. Krah vd. (2024), yaptıkları çalışmada gelişmekte olan ülkelerde KOBİ'lerin fintek yatırımlarını benimsediği ancak gelecekte daha fazla yeniliğe ihtiyaç duyacakları ve sürekli olarak geliştirilmesi gereken bir alan olduğu sonucuna varmıştır. Loomis ve Cockayne (2024), yaptıkları çalışma ile satın alınan ürün ve hizmetlerin ileri vadede ödenmesinin fintek yatırımları sayesinde artacağını, firmaların pazarlama stratejilerinin fintek yatırımlarıyla değişeceğini ve daha fazla kazanç sağlayacağını tahmin etmektedir. Najaf vd. (2024), yaptığı çalışmada kriz dönemlerinde özellikle pandemi dönemini temel alarak, firmaların kurumsal yönetim ve fintek yatırımları sayesinde pazardaki yerini koruduğu ve ekonomik olarak büyüdüğü sonucuna varmıştır.

4. ANALİZ

Veri, yöntem ve bulgulara ilişkin elde edilen veriler açıklanmıştır. Türkiye'deki fintek yatırımlarının e-ticarete etkisini belirlemek amacıyla basit doğrusal regresyon analizi yapılmış ve analiz sonucunda elde edilen veriler sunulmuştur.

4. 1. Veri ve Yöntem

Fintek kavramının Türkiye'de köklü bir geçmişe sahip olmaması nedeniyle 2019 - 2023 yılları arasındaki veriler kullanılmıştır. Bu tarihler arasında fintek sektöründeki farklı yatırım türleri, kurulan şirket sayıları, fintek ürünlerinin ve hizmetlerinin gelişimi incelenmiştir. Çalışmanın veri seti, 2019 - 2023 yılları arasındaki e-ticaret sektörünün pazar payı verileri, satış hacimleri ve kullanıcı sayıları ile oluşturulmuş, veriler T.C. Cumhurbaşkanlığı Finans Ofisi ve T.C. Ticaret Bakanlığı'nın internet sitelerinden elde edilerek SPSS 22 programı ile analiz edilmiş ve basit doğrusal regresyon analizi uygulanmıştır. Çalışmada, bağımsız değişken olan fintek yatırım tutarının, bağımlı değişken olan e-ticaret satış hacmine etkisi araştırılmıştır.

Regresyon analizi; herhangi bir değişkenin bir veya birden fazla değişken arasındaki ilişkinin matematiksel bir fonksiyon şeklinde yazılmasıdır. Elde edilen fonksiyona ise regresyon denklemi denilmektedir (Tezcan, 2011). Doğrusal regresyon analizi, belirlenmek istenen değişkenden daha kolay ya da daha erken saptanabilen değişken olduğu gibi, değişkenlerden yola çıkarak belirlenmek istenen değişkeni tahmin eden bir modeldir (Kılıç, 2013). Çalışmanın amacı doğrultusunda iki hipotez oluşturulmuştur. Bu hipotezler aşağıda açıklanmaktadır:

H0: Fintek yatırımlarının e-ticarete etkisi yoktur.

H1: Fintek yatırımlarının e-ticarete anlamlı bir etkisi vardır.

4. 2. Bulgular

2019 - 2023 yılları arasındaki fintek yatırım tutarlarının aynı yıllar arasındaki e-ticaret satış hacimlerine etkisi SPSS 22 programı kullanılarak basit doğrusal regresyon yöntemiyle analiz edilmiş ve analiz sonuçları Tablo 1'de sunulmuştur.

Tablo 1: Fintek Yatırımlarının E-ticarete Etkisine İlişkin Regresyon Analiz Sonuçları

R	R^2	Sig (p)	F
0.393	0.154	0.513	0.548

Analiz sonuçları incelendiğinde, fintek yatırım tutarı ile e-ticaret satış hacmi arasında anlamlı bir ilişki olmadığı görülmektedir (R=0.393, R^2=0.154, F=0.548, p>0,05). Fintek yatırım tutarı ile e-ticaret satış hacmi arasında güçlü bir ilişki olmadığı belirlenmiştir. E- ticaret satış hacminin %15.4'ünün fintek yatırım tutarı ile açıklandığı ifade edilebilir.

5. SONUÇ

Teknolojik gelişmelerin beraberinde getirdiği yeniliklerle birlikte finans sektörü de söz konusu yeniliklerden etkilenmiştir. Fintek kavramı bu yeniliklerle birlikte literatürdeki yerini almıştır. Literatür araştırmasında, fintek yatırımlarının ekonomik büyüme, teknolojik gelişmeler ve geleneksel finans yöntemleri ile ilişkisinin incelendiği ancak konu üzerine daha fazla araştırma yapılması gerektiği görülmektedir.

Bu çalışmada, daha önce yapılmış çalışmalardan farklı olarak fintek yatırımları ve teknolojik gelişmelerle birlikte artış gösteren e-ticaret kavramı arasındaki ilişki incelenmiştir. Çalışmada fintek yatırımlarının e-ticarete etkisinin olup olmadığı araştırılmıştır. Elde edilen sonuçlara göre, fintek yatırım tutarının e-ticaret satış hacmi üzerinde anlamlı bir etkisinin olmadığı sonucuna varılmıştır. Bu bulgular, fintek yatırımlarının e-ticaret sektörü üzerindeki etkisinin sınırlı olduğunu ve bu iki faktör arasındaki ilişkinin beklenenin aksine güçlü olmadığını göstermektedir. Aniliz sonuçları, e-ticaretin gelişmesinde fintek yatırımlarının tek başına yeterli olmadığını göstermektedir. Bu araştırmanın, benzer konuda araştırma yapacak araştırmacılara katkı sağlayacağı düşünülmektedir.

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THE IMPACT OF SUBSIDIES AND INCENTIVES ON FIRMS' INNOVATION PERFORMANCE

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ABSTRACT

Purpose- The purpose of this study is to investigate the impact of government incentives on firm innovation performance in Turkiye, with the aim of providing an evidence-based framework for evaluating the effectiveness of these policies. By examining how various incentive mechanisms influence firms' research and development (R&D) investments, product innovations, and process improvements, the study seeks to identify the key factors that drive innovation performance across different sectors and firm sizes. This research will contribute to the academic literature by addressing the ongoing debate surrounding the efficiency and effectiveness of government incentives. It will also provide strategic insights for policymakers, enabling the design and implementation of more targeted and efficient support mechanisms. Ultimately, the findings aim to enhance the alignment of government policies with Turkiye's broader goals of fostering innovation, improving global competitiveness, and achieving sustainable economic growth.

Methodology- The methodology of this study is designed to analyze the impact of government incentives on firm innovation performance in Turkiye using a quantitative research approach. The primary dataset utilized is sourced from the World Bank's Enterprise Survey (WBES), which covers over 150 countries and provides comprehensive information on various aspects of the business environment, such as financial access, corruption, infrastructure, competition, and firm performance. For Turkiye, six separate surveys conducted between 2002 and 2019 were utilized. These surveys include data from firms of varying sizes, sectors, and regions, capturing both those that received government incentives and those that did not. Based on a thorough literature review, a model tailored to the dataset was developed. The dependent variable is the presence of innovation within firms, measured as a binary outcome, while government incentives serve as the primary independent variable. Firm-specific characteristics frequently highlighted in the literature, such as firm size, age, export intensity, and sectoral distribution, are included as control variables to ensure a comprehensive analysis. The statistical analysis was conducted using the Logit regression technique in Python, chosen for its suitability in estimating the probability of binary outcomes. Diagnostic criteria such as Pseudo R-squared, log-likelihood, LL-Null, and the likelihood ratio test (LLR p-value) were employed to evaluate model fit and statistical significance. The results reveal that government incentives have a statistically significant effect on the likelihood of firm innovation, alongside other firm-specific factors. This methodological framework provides a robust basis for understanding the relationship between government support and innovation performance, offering valuable insights for policymakers.

Findings- The study reveals that R&D expenditures have the most significant impact on innovation, while the effect of firm size is relatively smaller. Government incentives and export ratios positively influence innovation likelihood, consistent with literature. Over time, firm age has shown a growing positive effect on innovation. In Turkiye, the probability of innovation for incentivized firms reached 19% in 2019, compared to 6% for non-incentivized firms, though the overall impact of incentives remains limited. International comparisons highlight Turkiye as having the lowest innovation probability among non-incentivized firms, with incentives providing modest improvements compared to other countries.

Conclusion- The findings highlight the limited effectiveness of government incentives in Turkiye compared to other countries with stronger incentive mechanisms, such as Slovenia and the Czech Republic. To address this, more strategic and targeted policies are needed to enhance the impact of incentives, reverse the declining innovation trends, and align incentive mechanisms with broader innovation strategies. These steps are critical for improving Turkiye's innovation performance, fostering competitiveness, and driving sustainable economic growth.

Keywords: Innovation performance, incentive, subsidies, logit regression, enterprise surveys, R&D expenditure.
JEL Codes: O31, O32, O38

1. INTRODUCTION

The economic growth and global competitiveness of countries largely depend on their ability to innovate. Innovation adds dynamism to economic structures by developing new and improved products, processes, and services, playing a critical role in achieving sustainable

development goals. Moreover, innovation enables companies to adapt quickly to changing market conditions, enhancing their competitiveness in international markets. In this process, government incentives accelerate technological progress and increase economic growth potential by encouraging firms to invest in R&D and innovation activities (Romer, 1990). Examining the impact of government support on firm innovation performance is of strategic importance for designing more effective support mechanisms. Governments employ various policy tools to promote innovation, including direct financial support, tax incentives, grants, and subsidies. However, there is ongoing debate in academic and policy circles regarding the effectiveness of these incentives. While some studies indicate that government support strengthens firms' R&D activities, others argue that these incentives fail to deliver the expected outcomes or lead to misallocation of resources (Jones & Williams, 1998). These conflicting findings suggest that the effectiveness of incentives may vary depending on factors such as industry, firm size, and technological intensity (Guellec, 2003). The primary objective of this study is to analyze the effects of government incentives on firm innovation performance in depth. The research aims to evaluate the impact of incentives on firms' R&D investments, product innovations, and process improvements through analyses conducted on firms across different industries and scales. Analyzing other variables influencing firm innovation performance and comparing all results with selected international countries constitute the secondary objectives of this study. This study aims to provide a framework for understanding and evaluating the effects of government incentives on firm innovation performance in Turkiye. By offering an analytical basis for assessing the effectiveness of incentive programs at the firm level, this framework seeks to contribute to both academic discourse and policy-making.

2. LITERATURE REVIEW

Government support programs play a crucial role in fostering innovation and economic growth. Assessing the performance of these programs requires the use of various metrics, which can be broadly categorized into input, output, and outcome indicators. Input metrics focus on the resources allocated to R&D activities, such as funding, personnel, and infrastructure. These metrics provide insights into the scale and intensity of innovation efforts. However, some scholars argue that input metrics alone may not accurately capture the effectiveness of R&D support programs, as they do not measure the actual outcomes and impacts of innovation activities (Cohen & Levinthal, 1990).

Output metrics, on the other hand, measure the tangible outputs generated from R&D investments, such as the number of patents, publications, and prototypes developed. While output metrics provide valuable information about the immediate results of R&D efforts, they may not fully capture the long-term impacts and benefits of innovation (Mansfield, 1991). Outcome metrics assess the broader socio-economic impacts of innovation activities, including job creation, economic growth, and societal welfare. These metrics aim to evaluate the ultimate effectiveness and value of government support programs in achieving their intended objectives. However, measuring outcomes can be challenging due to the complex and long-term nature of innovation processes (Hall et al., 2010). Despite the importance of outcome metrics, some scholars argue that attributing socio-economic impacts solely to R&D support programs can be problematic, as other factors, such as market conditions and policy environment, also influence innovation outcomes (Mowery & Rosenberg, 1998).

Historically, the origins of R&D incentives date back to the late 19th and early 20th centuries. Particularly, in countries like the United Kingdom and Germany, the first R&D incentives were provided to promote industrial and military innovations (Smith & Johnson, 2010). Numerous studies indicate that technological progress and R&D activities enhance a country's competitiveness (Keller, 1997). Research demonstrates that as R&D expenditures increase, countries become more innovative and efficient, consequently enhancing their competitiveness (Branstetter, 2001). Research findings on the nature of the relationship between R&D expenditures and economic growth and country development vary. Some studies argue that R&D expenditures positively influence economic growth and country development (Eid, 2012).

There is a wide range of academic research on factors affecting innovation performance. Some scholars, such as Hottenrott and Lobes-Bendo (2016), highlight the critical role of financial resources in innovation. Others argue that the relationship between resources and innovation is complex (Çolpan et al., 2017). Human resource competency plays a critical role in the execution of innovative projects (Damanpour & Schneider, 2006). Among the factors influencing innovation performance, the importance of technological infrastructure is increasingly recognized (Wu & Wang, 2019). However, some studies suggest that its role in influencing innovative activities may be limited (Gölgeci & Kuşakçı, 2016). Carayannis and Campbell (2012), as well as Etzkowitz (2003), emphasized that university-industry collaboration in the United States enhances innovation and R&D performance and contributes to economic growth. Export activity has long been recognized as a factor influencing innovation and R&D performance for firms in Turkiye and worldwide (Wagner, 2008). In the literature, there are studies that favor small firms, those that favor large firms, and those indicating that innovation outputs are independent of firm size (Yılmaz & Ekinci, 2018). Aerts and Czarnitzki (2016) conducted research showing that firm size does not determine R&D outputs. Similarly, another study from Turkiye by Demir and Ustun (2018) found no significant difference in innovative outputs among firms of different sizes.

Academic research examining the impact of firm age on innovation performance constitutes an important area of study both in Turkiye and globally (Özdemir & Ekinci, 2018). Innovation culture, management practices, market conditions, and competitive factors are also key elements influencing innovation performance (Kim & Park, 2018). The literature suggests that the response of industrial sectors to incentive performance on innovation varies widely and is influenced by factors such as industry structure, technological complexity, and market conditions (Dechezleprêtre et al., 2017). Academic studies in Turkiye on government incentives and subsidies focus on various areas such as economic growth, export performance, and technological advancements. These studies emphasize the importance of promoting R&D activities while analyzing the impacts of government policies on the economy. Kalay and Kızıldere (2015), who conducted research with TUIK data, found that innovation performance is dependent on various factors. Studies such as Çetin and Gedik (2017), who found a strong relationship between firm age, number of employees, and innovation, as well as Ela (2019), who identified a correlation between tax incentives and innovation, also support this view. Furthermore, Canbay (2020a) concluded that there is a positive relationship between R&D expenditures and export performance. Mercan and Çetin (2019) highlighted that different institutions' incentives have varying effects on innovation.

3. DATA AND METHODOLOGY

In this study the data form the World Bank's Enterprise Survey conducted at the firm level across 150 countries worldwide were used. The World Bank conducted this survey for Turkiye in the years 2002, 2005, 2008, 2013, 2015, and 2019. Since the effect of incentives on innovation was intended to be examined in the econometric model; innovation (binary) was used as the dependent variable, incentives (binary) were used as the main independent variable and variables mentioned in the literature were used as control variables (Table 1). Model:

$$Inovation\_statusit = \beta 0 + \beta 1.Firm\_sizeit + \beta 2.Firm\_ageit + \beta 3.Export\_ratioit + \beta 4.R\&D\_expenditure\_ratioit + \beta 5.Incentive\_ratioit + \beta 6.Number\_of\_emp + \beta 7.Incentive\_statusit + \varepsilon it$$

β0 is the intercept. β1, β2, β3, β4, β5, β6, β7 is the slope coefficient. ε is the error term. i and t represent firm (i) data at the end of year t. While comparing the innovation performance of treated and untreated firms, the performance of firms treated and untreated in the same year has been compared due to changing economic conditions over the years (Hud and Hussinger, 2015, p. 1847). Logistic regression (Logit) is used to estimate the probability of an event occurring, such as the likelihood of innovation. It is used when the dependent variable is binary (0 or 1).

Calcutating Log-odds (Logit):

$$Log - odds = \beta 0 + \beta 1\, x\, X1 + \beta 2\, x\, X2 + \ldots + \beta n\, x\, Xn$$

Calculating Probability (p):

$$p = \frac{e^{log-odds}}{1 + e^{log-odds}}$$

Actual Probability in Logit Technique; The above probability calculations were made to show the effect of variables individually. To calculate the actual probabilities, it is necessary to combine the effects of all variables.

Table 1: Variables and Descriptions

Variables	Descriptions	Survey Question Number by Year					
		2002	2005	2008	2015	2013	2019
INOV	If innovation = 0; 0, else; 1	Q60a1	Q60a	Q1	H1-5	H1-5	H1-5
CSIZE	Size by number of employees	S4a2	S4b	A6b	A6b	A6b	A6b
AGE	Age of the company at the time of the survey	S1a	S1a	B5	B5	B5	B5
TSALE	Firm's annual total sales	Q82a	Q57a	D2	D2	D2	D2
EXPO	Percentage of Firm's annual direct and indirect export	Q14	Q7	D3	D3	D3	D3
RD	Total annual R&D expenses of the company	Q83b	Q58b	ECAo4	ECAo17 ECAo19	H8	H9
EMPX	Number of permanent full-time workers	Q91a1	Q66a	L1	L1	L1	L1
SUBS	During the last two years, did this establishment receive any direct or indirect government grant? (binary)	Q79a1 Q79a2 Q79a3	Q53a1 Q53a2 Q53a3	Q53	ECAq53	TU_h.4	BMk5a

5. FINDINGS AND CONCLUSION

In this study, seemingly unrelated regression (SUR) is used to define the relationship between social media sentiment and cryptocurrency volatility. Below the tables, we explained the relationship among variables. Logit refression results of Turkiye are shown in Table 2.

Table 2: Logit Regression Results of Turkiye

Variables	2002	2005	2008	2013	2015	2019
	Coef (p> |z|)	Coef (p> |z|)	Coef (p> |z|)	Coef (p> |z|)	Coef (p> |z|)	Coef (p> |z|)
Const.	-1,4533	-0,6874	-0,8163	-1,5558	-2,7788	-3,1727
	(0,000)	(0,004)	(0,000)	(0,000)	(0,000)	(0,000)
RD/TSALE	15,5922	35,3256	21,6824	30,072	19,4432	46,3369
	(0,184)	(0,029)	(0,000)	(0,011)	(0,000)	(0,000)
EXPO	1,4557	2,017	-0,2943	0,2478	0,9082	1,2231
	(0,000)	(0,000)	(0,176)	(0,309)	(0,000)	(0,000)
CSIZE	0,4354	0,2948	0,1597	0,0780	0,4228	0,0101
	(0,004)	(0,059)	(0,114)	(0,533)	(0,000)	(0,942)

SUBS	0,5469	0,5827	0,8266	1,0273	1,1758	1,2970
	(0,232)	(0,357)	(0,001)	(0,000)	(0,000)	(0,000)
AGE	-0,0038	-0,0029	0,0096	-0,0021	0,0034	0,0163
	(0,644)	(0,591)	(0,116)	(0,769)	(0,304)	(0,007)
EMPX	-0,0002	-9,15E-02	2,44E-03	0,0006	0,0001	5,83E-02
	(0,270)	(0,618)	(0,987)	(0,030)	(0,468)	(0,880)

The analysis reveals that the intercept terms are statistically significant (p-value < 0.05) and consistently negative across all years, indicating a low baseline probability of innovation (<50%) when all independent variables are zero.

Among the independent variables, RD/TSALE stands out as the most influential factor, with a high coefficient (>15) and near-zero p-values, suggesting a nearly guaranteed likelihood of innovation with increased R&D investments. Additionally, the Export Ratio (EXPO) significantly and positively impacts innovation (p-value < 0.05), except in 2008 and 2013. Its effect has grown over time, increasing innovation probability by 77.26% in 2019. Government incentives (SUBS) also demonstrate a strong positive relationship with innovation, with p-values close to zero in most years. By 2019, these incentives boosted innovation probability to 78.53%. Conversely, firm size (CSIZE) and number of employees (EMPX) show large coefficients but remain statistically insignificant (p-value > 0.05). Firm age (AGE), previously insignificant, became statistically significant in 2015 and 2019, indicating a growing positive influence on innovation in recent years.

These findings emphasize the dominant role of R&D and government support in driving innovation while highlighting the evolving significance of firm age and the limited impact of size and employee numbers.

Figure 1: Probability Graph based on Median and Mean Values of Firm Variables in Turkiye

To calculate the country average; the probabilities of firms in Turkiye innovating before and after treatment have been evaluated based on the mean and median values of the data for the relevant years (Figure 1). The analysis highlights that firms receiving government incentives exhibit higher innovation probabilities than non-incentivized firms in both median and mean calculations. Based on median data, incentivized firms in 2019 had an innovation probability of 19.16%, compared to 6.08% for non-incentivized firms, with a steady decline in probabilities for non-incentivized firms over time. The mean data further supports this trend, showing that treated firms consistently outperform untreated firms, though the innovation probability gap of 7-16% narrows over time. While government incentives significantly enhance innovation performance, the effect weakens as years progress. Notably, the elevated probabilities in 2002, particularly in the mean data, suggest potential data irregularities that require further investigation.

Same calculations repeated for selected international countries and the results is shown in Table 3.

Table 3: Rogit Regression Results for Selected International Countries

Variables	Turkiye	Azerbaijan	Georgia	Slovenia	Lithuania	Portugal	Italy	Russia	Malaysia	Poland	Czech Rep.	Romania	Hungary
	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)	Coef (p>|z|)
Const.	-3,1727 (0,000)	-2,6988 (0,000)	-0,8622 (0,035)	0,3054 (0,457)	-1,4569 (0,003)	-1,6594 (0,000)	-1,8105 (0,000)	-2,3909 (0,000)	-1,5290 (0,000)	-0,9294 (0,012)	-2,489 (0,000)	-0,9298 (0,001)	-1,5042 (0,000)
RD/TSALE	46,3369 (0,000)	14,1306 (0,333)	-0,6407 (0,741)	-1,3218 (0,492)	402,3668 (0,159)	9,0296 (0,099)	-7,2907 (0,472)	29,0114 (0,000)	77,8864 (0,000)	70,1906 (0,015)	3,2145 (0,422)	23,0054 (0,002)	23,2172 (0,000)
EXPO	1,2231 (0,000)	0,1718 (0,855)	-0,0624 (0,821)	0,0411 (0,915)	-0,5885 (0,108)	-0,1601 (0,488)	2,5601 (0,000)	0,7721 (0,133)	0,1566 (0,489)	0,1633 (0,000)	-0,324 (0,332)	1,6741 (0,000)	0,2085 (0,447)
CSIZE	0,0101 (0,942)	0,7851 (0,039)	0,1912 (0,242)	0,3792 (0,160)	0,5579 (0,005)	0,3090 (0,010)	-0,3985 (0,026)	0,0802 (0,453)	0,3140 (0,003)	-0.1957 (0,165)	1,0217 (0,000)	-0,0270 (0,807)	0,1901 (0,160)
SUBS	1,2970 (0,000)	0,3099 (0,512)	0,3602 (0,323)	20,0331 (0,999)	-0,9406 (0,319)	-0,2162 (0,649)	2,0860 (0,063)	1,3370 (0,003)	0,7132 (0,069)	1,4163 (0,001)	1,5008 (0,052)	0,9418 (0,048)	0,3322 (0,260)

AGE	0,0163 (0,007)	0,0225 (0,184)	0,0035 (0,740)	0,0039 (0,651)	-0,0106 (0,258)	0,0052 (0,145)	0,0081 (0,069)	0,0347 (0,000)	-0,0031 (0,590)	0,0066 (0,303)	-0,003 (0,578)	0,0056 (0,555)	-0,0089 (0,362)
EMPX	-5,83E-02 (0,000)	0,0018 (0,575)	0,0033 (0,039)	0,0029 (0,364)	-0,0003 (0,857)	0,0003 (0,598)	0,0009 (0,197)	4,60E-03 (0,966)	1,38E-02 (0,937)	-0,0003 (0,630)	-0,001 (0,094)	-2,73E-02 (0,940)	-0,0002 (0,758)

According to the analysis results, among the variables, the highest impact on innovation performance is the ratio of R&D expenditures to total revenue, except for Georgia, Slovenia, and Italy. The second highest impact is from incentives and subsidies. Although the export impact varies across countries, there is a significant positive relationship with innovation. No significant relationship was found between firm age and size with innovation performance.

Table 4: **Probability Results based on Mean and Median Values of Selected International Countries**

Countries	**Mean**		**Median**	
	SUBS=0	SUBS=1	SUBS=0	SUBS=1
Turkiye	11,46%	32,13%	6,09%	19,17%
Malaysia	43,51%	61,12%	34,71%	52,03%
Poland	24,61%	63,64%	22,36%	54,28%
Czech Rep.	62,73%	88,30%	59,09%	86,63%
Romania	36,67%	65,97%	24,92%	51,86%
Hungary	29,67%	37,03%	24,93%	31,65%
Azerbaijan	32,25%	39,35%	32,17%	39,26%
Georgia	48,70%	57,64%	46,22%	55,20%
Slovenia	81,34%	100,00%	78,00%	100,00%
Lithuania	93,26%	84,38%	44,57%	23,89%
Portugal	33,19%	28,58%	30,89%	26,48%
Italy	10,98%	49,83%	11,95%	52,23%
Russia	16,41%	42,77%	16,39%	42,74%

According to the results of the study, Turkiye ranks among the lowest in performance compared to the countries being analyzed. While outliers boost the success of incentives, the impact of incentives remains limited compared to other countries. In countries that show 50% performance even without incentives, Turkiye stands at around 10%. In the Czech Republic, Azerbaijan, Portugal, Slovenia, and Russia, the impact of outliers on performance was negligible.

The results of this study indicate that government incentives and subsidies have a positive effect on firm innovation performance. Additionally, the impact of firm R&D expenditures and export ratios is also positive. However, no significant effect was found for firm age and size. The results are consistent with the literature review. If the study is further enriched with different variables from the literature and updated, and if in-depth case studies and concrete firm data are tested, it is believed that the likelihood of success for firms applying for incentives could be predicted by the incentive provider.

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FINANCIAL FRAGILITY IN RESOURCE-RICH HIGH-INCOME ECONOMIES

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ABSTRACT

Purpose- The purpose of this study is to identify the economic, financial, and liberal factors affecting the financial fragility levels of resource-rich high-income economies and to analyze the interactions between these factors.

Methodology-The methodology of the study includes a panel data analysis for the period 2006-2023. The research focuses on resource-rich high-income economies with a Gross Domestic Product (GDP) per capita exceeding $14,005 (based on the World Bank's Atlas method) and natural resource exports accounting for more than 25% of their total exports, according to TradeMap data.

Findings- The analysis aimed at determining the financial fragility levels of resource-rich high-income economies revealed that improvements in the rule of law and judicial effectiveness positively impact the financial fragility index, thereby supporting financial stability. Similarly, government expenditures, broad money supply, and the asset size of deposit banks were also found to have a positive effect on the financial fragility index, contributing favorably to stability. However, increases in financial liberalization scores were observed to negatively affect the financial fragility index, weakening stability. Additionally, the lagged value of the financial fragility index showed a persistent effect on the current levels of fragility.

Conclusion- Resource-rich high-income economies are distinguished not only by their vast natural resource reserves but also by their high-income levels and advanced economic structures. Ensuring sustainable financial stability in such economies necessitates adopting a holistic approach. Controlled implementation of financial liberalization, coupled with the establishment of adequate regulatory and supervisory mechanisms, can strengthen financial stability. Likewise, a robust rule of law and an effective judicial system can enhance the confidence of economic actors, contributing to reduced financial fragility. Effective and efficient management of public expenditures supports economic growth and resilience while ensuring the sustainability of these expenditures. Strengthening the banking sector's structure and aligning its size to contribute positively to economic stability can enhance the resilience of the financial system. In designing monetary supply policies, it is essential to manage risks such as inflationary pressures and asset bubbles while increasing liquidity. Policies should not only aim to reduce dependence on natural resources but also promote economic diversification, thereby supporting inclusive and sustainable growth.

Keywords: Camel analysis, fragility, resource-rich economies, liberalization, panel data.
JEL Codes: G00, G10, G15

YÜKSEK GELİRLİ KAYNAK ZENGİNİ EKONOMİLERDE FİNANSAL KIRILGANLIK

ÖZET

Amaç- Bu çalışmanın amacı, yüksek gelirli kaynak zengini ekonomilerin finansal kırılganlık düzeylerine etki eden ekonomik, finansal ve liberal faktörleri belirlemek ve bu faktörler arasındaki etkileşimleri analiz etmektir.

Yönetm- Araştırmanın metodolojisi, 2006-2023 dönemi için bir panel veri analizi uygulamasını içermektedir. Çalışma, Dünya Bankası Atlas yöntemine göre kişi başı Gayrisafi Yurtiçi Hasılası (GSYİH) 14,005 ABD dolarını aşan ve TradeMap verilerine göre doğal kaynak ihracatlarının toplam ihracatlarının %25'inden fazla olan yüksek gelirli kaynak zengini ekonomilere odaklanmaktadır.

Bulgular- Yüksek gelirli kaynak zengini ekonomilerin finansal kırılganlık düzeylerini belirlemeye yönelik yapılan analizde, hukukun üstünlüğü ve yargı etkinliğindeki artışların finansal kırılganlık endeksini pozitif yönde etkilediği ve finansal istikrarı desteklediği görülmüştür. Benzer şekilde, hükümet harcamaları, geniş para arzı ve mevduat bankalarının aktif büyüklüklerinin de finansal kırılganlık endeksini pozitif etkileyerek istikrarı olumlu etkilediği tespit edilmiştir. Bununla birlikte, finansal liberalleşme skorundaki artışların finansal kırılganlık endeksini negatif etkileyerek istikrarı zayıflattığı gözlemlenmiştir. Ayrıca, finansal kırılganlık endeksinin bir dönem gecikmeli değeri, mevcut dönemdeki kırılganlık düzeyleri üzerinde devam eden bir etki göstermektedir.

Sonuç: Yüksek gelirli kaynak zengini ekonomiler, geniş doğal kaynak rezervlerine sahip olmalarının yanı sıra yüksek gelir seviyeleri ve gelişmiş ekonomik yapıları ile dikkat çekmektedir. Yüksek gelirli ve doğal kaynak zengini ekonomilerde, sürdürülebilir finansal istikrarın sağlanması için bütüncül bir yaklaşım benimsenmesi gerekmektedir. Finansal liberalleşmenin kontrollü bir şekilde uygulanması, yeterli düzenleyici ve

denetleyici mekanizmaların oluşturulmasıyla finansal istikrarı güçlendirebilir. Aynı şekilde, güçlü bir hukukun üstünlüğü ve etkin yargı sistemi, ekonomik aktörlerin güvenini artırarak finansal kırılganlığın azalmasına katkı sağlayabilir. Kamu harcamalarının etkin ve verimli bir şekilde yönetilmesi, ekonomik büyümenin ve dayanıklılığın artırılmasına destek olurken, bu harcamaların sürdürülebilirliği de göz önünde bulundurulmalıdır. Bankacılık sektörünün sağlam bir yapıya kavuşturulması ve büyüklüğünün ekonomik istikrara katkı sağlayacak şekilde düzenlenmesi, finansal sistemin dirençli bir yapıya kavuşmasını destekleyecektir. Para arzı politikalarının tasarımında ise likiditeyi artırırken enflasyonist baskılar ve varlık balonları gibi riskler dikkatle yönetilmelidir. Uygulanacak politikalar, yalnızca doğal kaynaklara bağımlılığı azaltmakla kalmamalı, aynı zamanda ekonomik çeşitliliği artırarak kapsayıcı ve sürdürülebilir büyümeyi desteklemelidir.

Anahtar Kelimeler: Camel analizi, kırılganlık, kaynak zengini ekonomiler, liberalleşme, panel veri.
JEL Kodları: G00, G10, G15

1. GİRİŞ

Finansal liberalleşme, sermaye akışlarının serbestleşmesi ve finansal piyasaların deregülasyonu yoluyla ekonomik büyümeyi teşvik etmeyi amaçlar. Liberalleşme süreci, kaynak zengini ekonomiler için hem fırsatlar hem de riskler barındırmaktadır. Çalışmada Trade Map verilerine göre doğal kaynak ihracatı, toplam ihracatının %25 ve üzerini oluşturan ve Dünya Bankası, ülkeleri kişi başına düşen Gayrisafi Millî Hasıla (GSMH) verilerine dayanarak "yüksek" gelirli 10 kaynak zengini ekonomi belirlenmiştir. Dünya Bankası'nın bu gelir sınıflandırmaları, ülkelerin kalkınma düzeylerini değerlendirmede önemli bir referans noktasıdır. Dünya Bankası düzenli aralıklarla sınıflandırma kriterlerini ve güncel listeleri güncellemektedir; bu bilgilere resmi internet sitesinden ulaşılabilir. Söz konusu kaynaklar, bir araştırmacı ya da politika yapıcı için ülkeleri ekonomik koşullarına göre karşılaştırmalı bir analiz yapmasında son derece muteberdir (World Bank, 2023).

Doğal kaynak zengini ülkeler, doğal kaynaklardan elde edilen gelir sayesinde bazı ekonomik ayrıcalıklara sahip olsa da, bu durum finansal sistemin kırılganlığı açısından bazı riskleri de beraberinde getirmektedir. Bu bağlamda, doğal kaynak fiyatlarındaki oynaklık ve dış dünyaya olan bağımlılık, bir ekonominin finansal sağlamlığını tehdit etmektedir. Sermaye hareketlerinin hızını artıran finansal serbestleşme süreci, ani sermaye çıkışlarına yol açarak finansal kırılganlık oluşturabilir ve ekonomik refahın istikrarını engelleme potansiyeline sahiptir. Bu çalışmanın amacı, doğal kaynak zengini ekonomilerde finansal liberalleşme sürecinin yarattığı kırılganlıkları tartışmaktır. Daha spesifik olarak, finansal liberalleşme ile oluşan finansal kırılganlık arasındaki ilişkide çeşitli ekonomik, özgürlük ve yönetişim endekslerinin rolünü araştırmaktır. Bu çerçevede, araştırma konusuna dahil olan yüksek gelirli 10 doğal kaynak zengini ekonominin finansal kırılganlığına yönelik belirleyicileri analiz edilmiştir.

2. LİTERATÜR TARAMASI

Finansal liberalleşme, sermaye hareketlerinin serbestleşmesi ve finansal piyasaların deregülasyonu yoluyla ekonomik büyümeyi teşvik etmeyi amaçlayan bir süreçtir. Ancak, bu süreç özellikle kaynak zengini ekonomilerde finansal kırılganlıkları artırabilir. Finansal liberalleşme, ekonomik büyüme ve finansal istikrar arasındaki ilişkiler, özellikle doğal kaynaklara bağımlı ekonomilerde, akademik literatürde geniş bir şekilde incelenmiştir.

McKinnon (1973) finansal liberalleşmenin tasarrufları ve yatırımları artırarak ekonomik büyümeyi desteklediğini öne sürmüştür. Bu görüş, finansal baskıların kaldırılmasının kaynakların daha verimli dağılımını sağlayacağı ve böylece büyümeyi hızlandıracağı varsayımına dayanır. Daha sonraki kanıtlar ise, bu tür ilişkilerin mutlaka doğrusal olmadığını öne sürmüştür. Demirgüç-Kunt ve Detragiache (1998), uygun düzenleyici ve denetleyici önkoşullar sağlanmadan gerçekleşen finansal serbestleşmenin, aslında bankacılık krizlerinin önkoşullarını yaratabileceğini ortaya koymuştur.

Kaminsky ve Reinhart (1999), finansal liberalleşme sonrası bankacılık krizlerinin genellikle döviz krizleriyle eşzamanlı olarak ortaya çıktığını ve bu durumun "ikiz krizler" olarak adlandırıldığını tespit etmişlerdir. Söz konusu krizler, finansal sistemi dış şoklara karşı daha kırılgan hale getirmenin yanı sıra ekonomik istikrarı da daha fazla tüketmektedir. Buna ek olarak, emtia fiyatlarındaki oynaklık, doğal kaynak açısından zengin ekonomilerde derin finansal kırılganlıklara dönüştürebilmektedir.

Nitekim, Hartwell'in (2016) geçiş ekonomilerinde finansal serbestleşmenin etkilerini kaydeden analizi, böyle bir sürecin sonucunun doğrusal olmadığını göstermektedir. Bu süreçte, ekonomik serbestleşmenin başlangıcında ekonomiler zarar görebilse de uzun vadede büyümeyi teşvik ettiği sonucuna varılmıştır. Öte yandan, Kaminski ve Schmukler (2007), finansal serbestleşmenin ilk etkilerinin piyasa oynaklığı şeklinde gözlemlendiğine, ancak zamanla finansal piyasa gelişimini sağladığına işaret etmişlerdir. Latib ve Mohamad (2023) ise bir meta-analiz yaklaşımıyla, finansal serbestleşmenin genel olarak ekonomik büyüme boyutlarında olumlu etkileri olduğunu, ancak bu etkinin büyüklüğünün ülkeye özgü faktörlere göre değişebileceğini saptamışlardır.

Misati ve Nyamongo (2012), Sahra Altı Afrika ülkelerinde finansal liberalleşmenin finansal kırılganlık üzerindeki etkilerini analiz etmiş ve liberalleşmenin yetersiz düzenleyici çerçeveler altında finansal istikrarsızlığa yol açabileceğini bulmuşlardır. Iftikhar (2015) ise panel veri analizi kullanarak, finansal reformların finansal kırılganlığı artırabileceğini, özellikle bankacılık sektörünün yeterince düzenlenmediği durumlarda bu etkinin daha belirgin olduğunu belirtmiştir. Hussain ve arkadaşları (2022), finansal gelişme, liberalleşme ve ekonomik büyümenin finansal istikrarsızlık üzerindeki etkilerini inceledikleri çalışmalarında, finansal liberalleşmenin finansal istikrarsızlığı artırabileceğini, ancak bu etkinin finansal gelişmişlik düzeyine bağlı olduğunu ifade etmişlerdir.

Argitis ve Nikolaidi (2014), Yunanistan örneğinde, finansal kırılganlığın kamu sektörü krizine nasıl katkı sağladığını analiz etmişlerdir. Białowolski ve arkadaşları (2021), finansal kırılganlık ve bireylerin finansal kontrolünün genel refah üzerindeki etkilerini incelemiş ve finansal kırılganlığın bireylerin refahını olumsuz etkilediğini bulmuşlardır. Boratyńska (2021), Orta ve Doğu Avrupa ülkelerinde ekonomik kırılganlığın belirleyicilerini analiz etmiş ve finansal faktörlerin ekonomik kırılganlık üzerinde önemli bir etkisi olduğunu belirtmiştir.

Pina (2018), makro ve mikro düzeyde finansal liberalleşmenin tasarruflar ve ekonomik büyüme üzerindeki etkilerini analiz etmiştir. Sonuçlar, finansal liberalleşmenin tasarruf oranlarını artırarak ekonomik büyümeyi destekleyebileceğini, ancak bu etkinin ülkelerin ekonomik yapıları ve politikaları tarafından belirlendiğini göstermektedir. Rehman ve diğerleri (2021), gelişmekte olan ülkelerde sermaye hesabı liberalleşmesi, kurumsal yapı ve ekonomik büyüme arasındaki ilişkileri incelemişlerdir. Bulgular, sermaye hesabı liberalleşmesinin ekonomik büyümeyi teşvik ettiğini, ancak bu etkinin kurumsal yapıların kalitesine bağlı olduğunu ortaya koymaktadır. Wen-xuan (2020), Çin ve Japonya'daki finansal serbestleşmenin ekonomik kalkınma üzerindeki etkilerini karşılaştırmıştır. Sonuçlar, finansal serbestleşmenin her iki ülkede de ekonomik kalkınmayı desteklediğini, ancak etkinin büyüklüğünün ülkeye özgü faktörlere ve uygulanan politikalara bağlı olduğunu göstermektedir.

Bhattacharyya ve Hodler (2014), doğal kaynak gelirlerinin finansal gelişme açısından olumsuz etkiler yaratabileceğini ve bunun politik kurumsal yapının kalitesine bağlı olduğunu belirtmişlerdir. Mlachila ve Ouedraogo (2017), doğal kaynağa dayalı ekonomilerde kaynak gelirlerinin finansal sektörün gelişimi üzerinde olumsuz bir etki yaratabileceğini ve bunu "finansal kaynak laneti" olarak adlandırmışlardır. Yıldırım ve diğerleri (2022), doğal kaynak rantlarının finansal gelişme üzerindeki etkisini asimetrik bir analizle ele alarak, doğal kaynak gelirlerinin finansal gelişmeyi etkileyebileceğini göstermişlerdir. Boucekkine ve diğerleri (2021), doğal kaynağa bağımlı ekonomilerde kurumsal dinamiklerin stokastik analizini yaparak, kaynak bağımlılığının kurumsal kalitenin gelecekte bozulmasına ve buna bağlı olarak düşük büyüme performanslarına neden olabileceğini vurgulamışlardır.

3. VERİ VE YÖNTEM

Söz konusu çalışmaya dahil olan yüksek gelirli kaynak zengini ülkelerin liberalleşme, yönetişim ve ekonomilerine ilişkin gerekli veriler; Dünya Bankası, IMF, UNCTAD ve Heritage Foundation gibi uluslararası kuruluşlar tarafından yayınlanan istatistikler ve veri tabanlarından elde edilmiştir. Finansal liberalleşme sürecinin yarattığı dinamikler ve buna bağlı olarak oluşan kırılganlıklar, literatürde geniş kabul gören panel veri regresyonu ve ölçüm endeksleri yardımıyla analiz edilmiştir.

Dünya Bankası verilerine göre, kişi başı GSYİH'si 14,005 ABD dolarını aşan ve toplam ihracatlarının %25'inden fazlası doğal kaynaklara dayanan 10 kaynak zengini ekonomi (Bahreyn, Birleşik Arap Emirlikleri, Katar, Kuveyt, Norveç, Rusya, Suudi Arabistan, Şili, Trinidad ve Tobago, Umman) çalışmada incelenmiştir. Bağımlı değişken olan Finansal Kırılganlık Endeksi, CAMEL göstergelerinin her birine 0.20 ağırlık verilerek uluslararası veri tabanlarından elde edilen verilerle oluşturulmuştur. Endeksin yükselmesi finansal istikrarı, düşmesi ise finansal kırılganlığı göstermektedir. Analizde kullanılan değişkenlerin tanımsal istatistikleri aşağıdaki tabloda sunulmuştur.

Tablo 1: Değişkenlerin Tanımsal İstatistikleri

Değişken	Gözlem	Ort.	Standart Sapma	Min	Max	Değişken	Gözlem	Ort.	Standart Sapma	Min	Max
finfrag	180	0.479	0.098	0.28	0.78	**ihre1**	180	0.056	0.256	-0.45	1.17
libskor	180	0.667	0.072	0.5	0.79	**ihre2**	180	0.065	0.255	-0.51	0.9
mhak	180	0.603	0.175	0.2	1	**ihre3**	180	0.016	0.101	-0.31	0.47
yet	180	0.574	0.169	0.19	0.97	**fdi1**	180	0.026	0.034	-0.07	0.16
hdur	180	0.547	0.186	0.21	0.97	**fdi2**	180	1.246	14.794	-47.4	188
vyuk	180	0.893	0.148	0.5	1	**gdp1**	180	0.029	0.046	-0.09	0.26
hhar	180	0.625	0.179	0.03	0.9	**gdp2**	180	0.029	0.046	-0.09	0.26
fsag	180	0.727	0.275	0	1	**yetk1**	180	-0.12	2.772	-30.3	7.25
iozg	180	0.704	0.102	0.48	0.95	**yetk2**	180	0.679	0.167	0.26	0.99
cozg	180	0.673	0.12	0.4	0.97	**ithe1**	180	0.058	0.183	-0.37	0.63
pozg	180	0.754	0.066	0.57	0.91	**ithe2**	180	0.032	0.149	-0.33	0.57
tozg	180	0.794	0.065	0.44	0.89	**enf2**	180	0.037	0.036	-0.05	0.16
yozg	180	0.55	0.17	0.25	0.9	**enf3**	180	0.047	0.115	-0.28	0.34
fozg	180	0.57	0.132	0.3	0.9	**isgucu**	180	0.033	0.052	-0.08	0.27
dnug	180	0.059	0.143	-0.37	0.45	**regt1**	180	0.026	1.692	-14.3	12.4
dnugk	180	0.033	0.135	-0.37	0.43	**regy2**	180	0.672	0.171	0.13	0.97
gdpt	180	0.109	0.068	0.01	0.34	**hukust**	180	-0.03	2.274	-28	9.15
m21	180	0.676	0.177	0.32	1.15	**dkayg**	180	0.222	0.134	0.03	0.59
m22	180	0.094	0.094	-0.07	0.41	**issiz**	180	0.036	0.024	0	0.11
m23	180	0.097	0.094	-0.07	0.41	**iozghes**	180	-0.02	0.094	-0.68	0.16
enf1	180	0.036	0.035	-0.05	0.16	**kırılgan**	180	0.059	0.074	0	0.23
yolsuz	180	-0.06	1.3	-9.46	8.18	**ban1**	180	1.18	0.374	0.56	2.14
gdpban	180	0.727	0.322	0.26	1.64	**ban2**	180	0.346	0.113	0.19	0.95
isveren	180	0.02	0.015	0	0.05	**ban3**	180	0.861	0.377	0.3	2.46

Finansal Kırılganlık Endeksi (finfrag): Ortalama değeri 0.479 ve standart sapması 0.098 olan bu endeks, minimum 0.28 ve maksimum 0.78 değerleri arasında değişmektedir. Tanımsal istatistikler finansal kırılganlık seviyelerinin ülkeler arasında ve zaman içinde belirgin farklılıklar gösterdiğine işaret etmektedir.

Liberalleşme Genel Skoru (libskor): Ortalama 0.667 ve standart sapma 0.072 olup, değerler 0.5 ile 0.79 arasında değişmektedir. Tanımsal istatistikler, incelenen ekonomilerin liberalleşme düzeylerinde nispeten homojen bir dağılım olduğunu göstermektedir.

Hukukun Üstünlüğü (hukust): Ortalama değeri -0.03 ve standart sapması 2.274 olan bu değişken, -28 ile 9.15 arasında geniş bir aralıkta değişmektedir. Bu geniş varyasyon, ülkeler arasında hukukun üstünlüğü algısında büyük farklılıklar olduğunu göstermektedir.

Mevduat Bankalarının Aktifleri/GSYH (ban3): Ortalama 0.861 ve standart sapma 0.377 olup, değerler 0.3 ile 2.46 arasında değişmektedir. Tanımsal istatistik, bankacılık sektörünün ekonomideki rolünün ülkeler arasında değişkenlik gösterdiğini ifade etmektedir.

Geniş Para Arzı (m22): Ortalama 0.094 ve standart sapma 0.094 olan bu değişken, -0.07 ile 0.41 arasında değişmektedir. Tanımsal istatistik, para arzının ekonomiler arasında farklılık gösterdiğini ve bazı ülkelerde negatif değerlere ulaştığını göstermektedir.

Hükümet Harcamaları (hhar): Ortalama 0.625 ve standart sapma 0.179 olup, değerler 0.03 ile 0.9 arasında değişmektedir. Tanımsal istatistik, hükümet harcamalarının GSYH'ye oranının ülkeler arasında önemli ölçüde farklılık gösterdiğini ifade etmektedir.

4. BULGULAR

Panel veri analizinde otokorelasyon tespit edildiğinden, modelin dinamik yapısını yansıtmak için bağımlı değişkenin bir dönem gecikmeli değeri modele dahil edilmiştir. Ayrıca, heteroskedastisite nedeniyle tahminlerin güvenilirliğini artırmak amacıyla dirençli (robust) standart hatalar kullanılmıştır. Yatay kesit bağımlılığının olmadığı belirlenen model, sabit etkiler (fixed effects) yöntemiyle tahmin edilmiş ve gözlemlenmeyen sabit birim özelliklerinin etkisi izole edilmiştir. Bu metodolojiler, panel veri analizlerinde yaygın olarak kabul edilmektedir (Wooldridge, 2010; Baltagi, 2005). Detaylı bulgular aşağıdaki tabloda sunulmuştur.

Tablo 2: Yüksek Gelirli Kaynak Zengini Ekonominin Panel Veri Analiz Sonuçları

finfrag	Katsayı	Robust Standart Hata	t-değeri	p-değeri
hukust	0.0053884	0.0010423	5.17	0.001
ban3	0.0362268	0.0071379	5.08	0.001
m22	0.0524956	0.0236174	2.22	0.053
libskor	-0.3578612	0.076175	-4.7	0.001
yet	0.0509221	0.0156599	3.25	0.01
hhar	0.0840713	0.0205286	4.1	0.003
finfrag L1.	0.3696873	0.0712253	5.19	0.001
rho	0.79580287			
R-sq	0.7492			

**** p<.01, ** p<.05, * p<.1*

Hukukun üstünlüğü (hukust): Katsayısı 0.0054 olup, p-değeri 0.001'dir. Bu, hukukun üstünlüğündeki bir birimlik artışın finansal kırılganlık endeksini %0.54 artırdığını ve bu etkinin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olduğunu göstermektedir.

Mevduat bankalarının aktifleri/GSYH (ban3): Katsayısı 0.0362 olup, p-değeri 0.001'dir. Bu, mevduat bankalarının aktiflerinin GSYH'ye oranındaki bir birimlik artışın finansal kırılganlık endeksini %3.62 artırdığını ve bu etkinin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olduğunu göstermektedir.

Geniş para arzı (m22): Katsayısı 0.0525 olup, p-değeri 0.053'tür. Bu, geniş para arzındaki bir birimlik artışın finansal kırılganlık endeksini %5.25 artırdığını, ancak bu etkinin %5 anlamlılık düzeyinde sınırda istatistiksel anlamlılık taşıdığını göstermektedir.

Liberalleşme Genel Skoru (libskor): Katsayısı -0.3579 olup, p-değeri 0.001'dir. Bu, liberalleşme skorundaki bir birimlik artışın finansal kırılganlık endeksini %35.79 azalttığını ve bu etkinin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olduğunu göstermektedir.

Yargı etkinliği (yet): Katsayısı 0.0509 olup, p-değeri 0.01'dir. Bu, yargı etkinliğindeki bir birimlik artışın finansal kırılganlık endeksini %5.09 artırdığını ve bu etkinin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olduğunu göstermektedir.

Hükümet harcamaları (hhar): Katsayısı 0.0841 olup, p-değeri 0.003'tür. Bu, hükümet harcamalarındaki bir birimlik artışın finansal kırılganlık endeksini %8.41 artırdığını ve bu etkinin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olduğunu göstermektedir.

Finansal kırılganlık endeksinin bir dönem gecikmeli değeri (finfrag L1.): Katsayısı 0.3697 olup, p-değeri 0.001'dir. Bu, finansal kırılganlık endeksinin bir önceki dönem değerindeki bir birimlik artışın mevcut dönem finansal kırılganlık endeksini %36.97 artırdığını ve bu etkinin %1 anlamlılık düzeyinde istatistiksel olarak anlamlı olduğunu göstermektedir.

Modelin determinasyon katsayısı (R^2) 0.7492 olup, bağımsız değişkenlerin finansal kırılganlık endeksindeki değişimin %74.92'sini açıkladığını göstermektedir. Bulgular, liberalleşme genel skorundaki artışın finansal kırılganlığı artırdığını, diğer değişkenlerdeki artışların ise finansal kırılganlığı azalttığını göstermektedir. Özellikle, hukukun üstünlüğü, mevduat bankalarının aktifleri, yargı etkinliği ve hükümet harcamalarının finansal kırılganlık üzerinde pozitif ve istatistiksel olarak anlamlı etkileri bulunmaktadır. Geniş para arzının etkisi ise sınırda anlamlılık göstermektedir. Ayrıca, finansal kırılganlık endeksinin bir dönem gecikmeli değeri, mevcut dönem finansal kırılganlık üzerinde pozitif ve anlamlı bir etkiye sahiptir.

5. SONUÇ

Finansal liberalleşmenin artmasının finansal kırılganlığı artırabileceği analiz sonuçlarından anlaşılmaktadır. Söz konusu bulgu, finansal piyasaların serbestleşmesinin, özellikle yeterli düzenleyici ve denetleyici mekanizmaların bulunmadığı durumlarda, finansal sistemin istikrarını zayıflatabileceğini ortaya koymaktadır. Bu nedenle, finansal liberalleşme politikalarının uygulanmasında temkinli olunmalı ve gerekli kurumsal altyapı güçlendirilmelidir. Ayrıca, güçlü hukukun üstünlüğü ve etkin yargı sistemlerinin varlığı, finansal kırılganlığı azaltarak finansal istikrarı desteklemektedir. Bu unsurlar, ekonomik aktörlerin güvenini artırarak finansal sistemin daha istikrarlı bir şekilde işlemesine olanak tanımaktadır. Dolayısıyla, kurumsal yapıların güçlendirilmesi, finansal istikrarın korunması açısından temel bir unsur olarak değerlendirilmelidir. Bununla birlikte, artan hükümet harcamalarının finansal kırılganlığı azaltmada olumlu bir etkiye sahip olabileceği görülmektedir. Kamu harcamalarının etkin ve verimli bir şekilde yönetilmesi, ekonomik büyümeyi destekleyerek finansal sistemin dayanıklılığını artırabilir; ancak, bu harcamaların sürdürülebilirliği ve finansmanı dikkatle ele alınmalıdır.

Mevduat bankalarının aktiflerinin GSYH'ye oranındaki artışın finansal kırılganlığı azaltıcı bir etki yaratabileceği de ifade edilmektedir. Güçlü ve sağlam bir bankacılık sektörü, finansal sistemin genel istikrarına katkı sağlamakta ve ekonomik dalgalanmalara karşı direnç oluşturmaktadır. Ancak, bankacılık sektörünün büyüklüğü kadar risk yönetimi ve düzenleyici çerçevenin etkinliği de önemlidir. Geniş para arzındaki artışın finansal kırılganlık üzerindeki etkisi ise istatistiksel anlamlılık sınırında kalmaktadır. Para arzındaki artış ekonomik büyümeyi teşvik edebilir ve likiditeyi artırarak finansal sistemin işleyişini destekleyebilir, ancak kontrolsüz artışlar enflasyonist baskılara, varlık balonlarına ve finansal sistemde dengesizliklere yol açabilir. Bu nedenle, para politikalarının tasarımında dikkatli olunmalı ve potansiyel riskler göz önünde bulundurulmalıdır.

Ayrıca, finansal kırılganlık endeksinin bir dönem gecikmeli değerlerinin mevcut dönemdeki finansal istikrar üzerinde anlamlı bir etkisi olduğu görülmektedir. Diğer bir ifadeyle, önceki dönemlerde finansal kırılganlık endeksinde gözlemlenen artışlar, mevcut dönemde de benzer eğilimlerin devam ettiğini göstermektedir. Bu bağlamda, finansal istikrarı artırmaya yönelik politikaların uzun vadeli ve sürdürülebilir olması, elde edilen olumlu sonuçların kalıcılığını sağlamak açısından önemlidir. Sonuç itibarıyla, yüksek gelirli ve doğal kaynak zengini ekonomilerde finansal istikrarın sağlanması ve sürdürülebilir olması için finansal liberalleşme politikalarının dikkatle uygulanması, kurumsal yapıların güçlendirilmesi, kamu harcamalarının etkin yönetimi ve bankacılık sektörünün sağlamlığına önem verilmesi gerekmektedir. Bu unsurların bütüncül bir yaklaşımla ele alınması, finansal kırılganlığın azaltılması ve ekonomik istikrarın korunmasında belirleyici bir rol oynayacaktır.

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DESIGN AND DEVELOPMENT OF SMART POS SYSTEMS: COMMISSION OPTIMIZATION AND TRANSACTION EFFICIENCY

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ABSTRACT

Purpose- Traditional POS systems often lead to high transaction costs, increased error rates, and insufficient customer satisfaction. To address these limitations, smart POS systems have been developed to optimize transaction processes using advanced routing algorithms. This study aims to examine the impact of smart POS systems on transaction efficiency, customer satisfaction, commission cost reduction, and their influence on employee task allocation towards more strategic and value-added roles through intelligent routing and data-driven decision mechanisms.

Methodology- Dynamic routing mechanisms were utilized for commission cost optimization. Big data analytics tools, including Apache Spark and HDFS, were applied to process real-time transaction data, ensuring scalable and adaptive solutions.

Findings- The findings indicate that smart POS systems significantly reduce commission costs, lower transaction error rates, and improve operational efficiency. Additionally, integrating customer behavior prediction models with intelligent routing strategies enhances customer satisfaction and financial performance. The results further suggest that automation and data-driven approaches reduce manual interventions in transaction processes, enabling employees to allocate more time to strategic roles and value-added tasks. This shift contributes to organizational adaptability and innovation.

Conclusion- This study highlights the contributions of smart POS systems to the fintech sector by addressing gaps in transaction efficiency, commission cost management, and customer satisfaction. The findings demonstrate that data-driven decision-making and dynamic routing mechanisms not only optimize transaction processes but also positively impact customer experiences, financial outcomes, and employee engagement in strategic tasks.

Keywords: Smart POS systems, transaction efficiency, commission cost optimization, customer behavior prediction, big data analytics
JEL Codes: D53, G21, L86

AKILLI POS SİSTEMLERİNİN TASARIMI VE GELİŞTİRİLMESİ: KOMİSYON OPTİMİZASYONU VE İŞLEM VERİMLİLİĞİ

ÖZET

Amaç- Geleneksel POS sistemleri, yüksek işlem maliyetleri, artan hata oranları ve yetersiz müşteri memnuniyeti gibi sınırlılıklar nedeniyle eleştirilmektedir. Bu sınırlamaları aşmak amacıyla, gelişmiş yönlendirme algoritmaları kullanan akıllı POS sistemleri geliştirilmiştir. Bu çalışma, akıllı POS sistemlerinin işlem verimliliği, müşteri memnuniyeti ve komisyon maliyetlerinin azaltılması üzerindeki etkilerini ve çalışanların daha stratejik ve katma değerli görevlere zaman ayırmalarına olan katkısını incelemeyi amaçlamaktadır.

Yöntem- Komisyon maliyetlerini optimize etmek için dinamik yönlendirme mekanizmalarından yararlanılmıştır. Ayrıca, Apache Spark ve HDFS gibi büyük veri analitiği araçları, gerçek zamanlı işlem verilerini işlemek için uygulanmıştır.

Bulgular- Araştırma sonuçları, akıllı POS sistemlerinin komisyon maliyetlerini önemli ölçüde azalttığını, işlem hata oranlarını düşürdüğünü ve operasyonel verimliliği artırdığını göstermektedir. Ayrıca, müşteri davranışlarını tahmin eden modellerin akıllı yönlendirme stratejileriyle entegrasyonu, müşteri memnuniyetini ve finansal performansı iyileştirmektedir. Otomasyon ve veri odaklı yaklaşımların, işlem süreçlerindeki manuel müdahaleleri azaltarak çalışanların daha stratejik rollere ve katma değerli görevlere zaman ayırmalarını sağladığı görülmüştür. Bu değişim, organizasyonların adaptasyon yeteneğini ve yenilik kapasitesini artırmaktadır.

Sonuç- Bu çalışma, akıllı POS sistemlerinin fintech sektöründeki işlem verimliliği, komisyon maliyeti yönetimi ve müşteri memnuniyeti gibi boşlukları doldurduğunu vurgulamaktadır. Araştırma, veri odaklı karar verme ve dinamik yönlendirme mekanizmalarının yalnızca işlem süreçlerini optimize etmekle kalmayıp, müşteri deneyimlerini ve finansal sonuçları da olumlu yönde etkilediğini göstermektedir. Ayrıca, çalışanların daha stratejik görevlere odaklanmasıyla organizasyonların yenilik ve sürdürülebilirlik hedeflerine katkı sağladığı belirtilmektedir.

Anahtar Kelimeler: Akıllı POS sistemleri, işlem verimliliği, komisyon maliyeti optimizasyonu, müşteri davranışı tahmini, büyük veri analitiği
JEL Kodları: D53, G21, L86

1. GİRİŞ

Günümüzde dijital ödeme sistemleri, hızla gelişen finansal teknolojilerin merkezinde yer almakta ve işletmeler için stratejik bir öneme sahip olmaktadır (Tan vd., 2019). İşlemlerin hızla gerçekleşmesi, maliyetlerin optimize edilmesi ve işlem doğruluğunun artırılması gibi faktörler, dijitalleşme sürecinin temel başarı kriterlerini oluşturmaktadır (Baier vd., 2022). Bununla birlikte, işlem hataları ve yüksek komisyon maliyetleri, dijital ödeme altyapılarında yaygın olarak karşılaşılan iki kritik sorun olarak öne çıkmaktadır (Miglionico, 2022). Bu sorunlar, hem finansal performansın hem de müşteri memnuniyetinin olumsuz etkilenmesine neden olmaktadır.

Bu çalışma, dijital ödeme süreçlerindeki bu temel sorunlara yönelik olarak geliştirilen akıllı POS sistemlerinin tasarımı ve geliştirilmesini ele almaktadır. Özellikle komisyon maliyetlerinin optimize edilmesi ve işlem doğruluğunun artırılması hedeflenmektedir. Bu bağlamda, makine öğrenmesi algoritmaları ve veri analitiği teknikleri kullanılarak işlemlerin en uygun banka ve POS terminalleri üzerinden yönlendirilmesi sağlanmıştır. Söz konusu yaklaşımla, yalnızca maliyetlerin düşürülmesi değil, aynı zamanda operasyonel süreçlerde daha yüksek bir verimlilik seviyesine ulaşılması amaçlanmaktadır.

Çalışma, iki ana boyutta katkı sağlamayı hedeflemektedir. Birincisi, komisyon maliyetlerinin optimize edilmesiyle elde edilen finansal kazanımların ve işlem verimliliğinin değerlendirilmesidir. Bu durum, akıllı algoritmaların dijital ödeme süreçlerindeki etkinliğini ortaya koyan deneysel bir bağlam sunmaktadır. İkincisi, ödeme altyapılarında sağlanan verimlilik artışının organizasyonel süreçlere olan etkilerinin incelenmesidir. İşlemlerin otomasyonu, çalışanların daha stratejik ve katma değerli görevlere odaklanmasına olanak sağlamaktadır (Katz, 2023). Bu durum, organizasyonel etkinlik ve genel iş süreçleri üzerinde önemli bir etki yaratmaktadır.

Bu bağlamda, dijital ödeme süreçlerindeki optimizasyon tekniklerini ele alan bu çalışma, literatürde hem teorik hem de uygulamalı açıdan katkı sunmayı amaçlamaktadır. İşlem doğruluğunun artırılması ve komisyon maliyetlerinin optimize edilmesi konularına odaklanan bu araştırma, dijital ödeme altyapılarının finansal ve operasyonel etkilerini incelemektedir. Bu çalışma ile, dijitalleşme ile finansal süreçler arasındaki ilişkiyi ele alarak, dijital ödeme sistemleri tasarımına dair özgün bir çerçeve sunmak hedeflenmektedir.

2. LİTERATÜR

Dijital ödeme sistemleri, işletmelerin finansal süreçlerini daha şeffaf ve verimli hale getiren temel bir teknoloji olarak değerlendirilmektedir. Bu sistemler, maliyet etkinliği ve operasyonel kolaylık sağlama kapasiteleriyle dikkat çekmekte, aynı zamanda finansal süreçlerde güvenilirliği artırmaktadır (Sahu vd., 2018). Literatürde, büyük veri analitiği ve makine öğrenmesi algoritmaları, işlem verimliliğini artırmak için kullanılan başlıca yöntemler olarak öne çıkmaktadır (Tosi vd., 2024; L'heureux vd. 2017; Wang vd., 2024). Bu yaklaşımlar, yalnızca finansal süreçlerin doğruluğunu artırmakla kalmayıp, aynı zamanda operasyonel yükleri azaltarak işletmelerin genel performansını güçlendirmektedir. Büyük veri analitiği, ödeme işlemleri sırasında ortaya çıkan devasa miktardaki verinin anlamlı bilgilere dönüştürülmesini sağlar (Frankel vd., 2018, Shi., 2022). Bu süreç, işlem hatalarını önleme (Aktan, 2018), gecikmeleri minimize etme ve işlem sürelerini kısaltma gibi operasyonel avantajlar sunmaktadır. Bu tür modeller, müşterilere daha hızlı ve sorunsuz bir işlem deneyimi sunarak müşteri memnuniyetine de katkıda bulunmaktadır. Dijitalleşme, organizasyonların iş süreçlerini yeniden yapılandırarak operasyonel verimliliği artırmada önemli bir rol oynamaktadır (Vasilev vd., 2020; Nikmehr vd., 2021). Literatürde, rutin iş yüklerinin otomasyonu ve süreç optimizasyonu, dijital ödeme sistemleriyle sağlanan en belirgin avantajlar arasında yer almaktadır. Bu bağlamda, otomasyon teknolojileri ve veri odaklı yaklaşımlar, işletmelerin daha hızlı ve maliyet etkin bir şekilde faaliyet göstermesini mümkün kılmaktadır (Klein, 2020). Operasyonel verimlilik, genellikle zaman, maliyet ve kaynak tasarrufu bağlamında ele alınmaktadır (Şahinaslan, 2023). Dijital ödeme sistemlerinde makine öğrenmesi algoritmalarının kullanımı, işlemleri otomatize ederek manuel müdahale ihtiyacını ortadan kaldırmaktadır (Altan ve Zafer, 2024). Bu, yalnızca işlem doğruluğunu artırmakla kalmayıp, aynı zamanda çalışanların daha stratejik ve yaratıcı görevlerde yer almasını mümkün kılmaktadır. Literatürde, otomasyonun rutin iş yüklerini hafifleterek çalışanların katma değerli alanlara odaklanmasına olanak sağladığı vurgulanmaktadır. Bununla birlikte, dijital teknolojilerin iş süreçlerine entegrasyonu, organizasyonel dönüşümü destekleyen bir araç olarak da değerlendirilmektedir. Örneğin, dinamik işlem yönlendirme mekanizmaları sayesinde, kaynakların daha etkin bir şekilde kullanılması sağlanmakta ve bu durum, genel iş süreçlerinde esneklik yaratmaktadır. Ayrıca, büyük veri analitiğiyle desteklenen karar verme süreçleri, yöneticilere daha doğru ve zamanında bilgi sunarak stratejik karar alma yetkinliklerini güçlendirmektedir (Uladi ve Arı, 2023).

Sonuç olarak, dijital ödeme sistemlerinde sağlanan operasyonel verimlilik, yalnızca finansal süreçlerin iyileştirilmesini değil, aynı zamanda organizasyonel işleyişin daha etkin bir hale getirilmesini de sağlamaktadır. Literatürde, dijitalleşmenin operasyonel mükemmeliyet üzerindeki etkileri sıklıkla vurgulanmakta ve bu teknolojilerin organizasyonların sürdürülebilirlik hedeflerine ulaşmasında kritik bir rol oynadığı belirtilmektedir.

3. VERİ VE YÖNTEM

Bu çalışma, dijital ödeme sistemlerinde işlem doğruluğunu artırmak ve komisyon maliyetlerini optimize etmek için geliştirilen makine öğrenmesi tabanlı bir sistemin tasarımına ve uygulanmasına odaklanmaktadır. Çalışma, nicel verilerin analizi ve algoritma performanslarının değerlendirilmesi yoluyla, dijital ödeme süreçlerinin optimize edilmesine yönelik deneysel bir yaklaşımı benimsemektedir. Araştırma, hem sentetik hem de gerçek işlem verileriyle yapılan testlerden elde edilen bulgulara dayanmaktadır. Araştırmada kullanılan veri seti bir finansal teknoloji kuruluşuna aittir. Bu veri seti, ödeme işlemlerine dair hata oranları, işlem süreleri, komisyon oranları ve yönlendirme sonuçlarını içermektedir. Veriler, ödeme süreçlerindeki sorunları belirlemek ve algoritmaların performansını değerlendirmek için yapılandırılmıştır. Veri kaynakları, müşteri gizliliği ve güvenlik ilkelerine uygun şekilde anonimleştirilmiş ve işlenmiştir.

Makine öğrenmesi tabanlı sistem, banka ve POS terminalleri arasındaki en uygun yönlendirme işlemlerini gerçekleştirmek üzere tasarlanmıştır. Algoritmalar, işlem doğruluğunu artırmak ve maliyetleri minimize etmek amacıyla geliştirilmiştir. Uygulama süreci şu adımları kapsamaktadır:

Veri Ön İşleme: Verilerin temizlenmesi, eksik değerlerin giderilmesi ve analiz için uygun formata getirilmesi.

Model Geliştirme: Farklı makine öğrenmesi algoritmalarının geliştirilmesi ve performanslarının karşılaştırılması.

Simülasyon ve Test: Algoritmaların, simülasyon ortamında ve gerçek verilerle test edilerek doğruluk ve maliyet etkinliği açısından değerlendirilmesi.

Optimizasyon: Algoritma parametrelerinin optimize edilmesi ve en iyi sonuçları veren modelin seçilmesi.

Araştırmada kullanılan analitik yaklaşım, makine öğrenmesi algoritmalarının performansını ölçmek için doğruluk oranı, işlem süresi ve komisyon maliyetleri ve ciro yönetimi gibi temel metriklere odaklanmaktadır. Ayrıca, algoritmaların işlem yoğunluğuna göre performansını değerlendiren dinamik bir analiz modeli uygulanmıştır. Bu yaklaşım, algoritmaların hem statik hem de dinamik işlem ortamlarında sağladığı katkıları ortaya koymaktadır.

4. BULGULAR

Bu çalışmada sunulan bulgular, dijital ödeme sistemlerinde kullanılan makine öğrenmesi algoritmalarının komisyon maliyetlerinin optimize edilmesi, işlem doğruluğunun artırılması ve işlem sürelerinin kısaltılması üzerindeki etkilerini kapsamlı bir şekilde analiz etmektedir. Elde edilen veriler, algoritmaların finansal sürdürülebilirlik ve operasyonel verimlilik açısından kayda değer katkılar sunduğunu ortaya koymaktadır. Bulgular, dijital finansal hizmetlerin performansının iyileştirilmesine yönelik stratejik karar alma süreçlerinde veri odaklı yaklaşımların önemini vurgulamaktadır. Makine öğrenmesi algoritmalarının uygulanması sonucunda, ödeme sistemlerindeki komisyon maliyetlerinde önemli bir düşüş sağlanmıştır. Algoritmaların, bankalar ve POS terminalleri arasında gerçekleştirilen işlem yönlendirmelerinde dinamik analizler yaparak en uygun komisyon oranlarını belirlediği görülmüştür. Bu durum, uzun vadede maliyetlerin azaltılmasına ve karlılığın artırılmasına olanak tanımaktadır. Pilot uygulama sonuçlarına göre, ortalama komisyon maliyetlerinde %20 oranında bir azalma kaydedilmiş ve hedeflenen tasarruf oranının %30 seviyesine ulaşarak başlangıç öngörülerini aştığı tespit edilmiştir. Toplamda 5 milyon TL'lik maliyet tasarrufu sağlanmış olması, dijital finansal hizmet sağlayıcıların sürdürülebilirlik stratejileri açısından bu tür optimizasyon yöntemlerinin kritik bir role sahip olduğunu göstermektedir.

Elde edilen ikinci önemli bulgu, işlem doğruluğunun artırılmasına yönelik algoritmaların etkinliğidir. Çalışma kapsamında geliştirilen algoritmaların, işlem yoğunluğuna bağlı olarak doğru POS terminali seçimi yaparak hatalı işlem oranlarını minimuma indirdiği tespit edilmiştir. Bu kapsamda, hatalı işlem oranlarında %25 oranında bir azalma kaydedilmiştir. İşlem doğruluğundaki bu artış, müşteri şikayetlerinde azalma sağlamakla kalmamış, aynı zamanda kullanıcı deneyimini iyileştirerek müşteri memnuniyeti üzerinde pozitif bir etki yaratmıştır. Doğruluk oranlarının iyileştirilmesi, ödeme sistemlerinin güvenilirliğinin artırılmasına katkı sağlamaktadır. Çalışmanın bir diğer önemli bulgusu, işlem sürelerinin kısaltılmasına yönelik algoritmaların etkisi olmuştur. Dinamik yönlendirme mekanizmalarının, işlem sürelerinde belirgin bir azalma sağladığı ve özellikle yoğun işlem saatlerinde bu azalmanın daha yüksek seviyelere ulaştığı tespit edilmiştir. Veriler, işlem sürelerinin kısalmasının yalnızca işlem süreçlerini hızlandırmakla kalmayıp, aynı zamanda müşteri memnuniyetini artırarak genel kullanıcı deneyimini olumlu yönde etkilediğini göstermektedir. Finansal ve operasyonel performans açısından değerlendirildiğinde, dijital ödeme süreçlerinde kullanılan algoritmaların hem maliyet azaltımı hem de işlem doğruluğu ve süresi üzerinde kayda değer etkileri olduğu görülmüştür. Pilot uygulama sonuçlarına göre, toplam işlem hacminin 540 milyon TL seviyesine ulaştığı ve operasyonel verimlilikte %20 oranında bir artış sağlandığı tespit edilmiştir. Bu bulgular, dijital finansal hizmet sağlayıcıların sürdürülebilir büyüme stratejileri doğrultusunda makine öğrenmesi ve veri analitiği tabanlı yaklaşımların benimsenmesinin önemini vurgulamaktadır. İşletmelerin bu tür teknolojik çözümleri uygulamaya koyması, finansal performanslarını iyileştirirken aynı zamanda müşterilere daha hızlı, doğru ve güvenilir hizmet sunmalarına da katkı sağlamaktadır.

Sonuç olarak, bu proje kapsamında geliştirilen makine öğrenmesi algoritmaları, yalnızca finansal ve operasyonel metriklerin iyileştirilmesiyle sınırlı kalmamış, aynı zamanda dijital ödeme süreçlerinde çalışan deneyimi üzerinde de olumlu etkiler yaratmıştır. Özellikle operasyonel süreçlerin dijitalleşmesi ve otomasyon seviyesinin artırılması sayesinde rutin ve tekrarlayan görevlerin büyük ölçüde azaltıldığı görülmüştür. Bu değişim, operasyon ekibi çalışanlarının daha stratejik ve katma değer sağlayan işlere odaklanmasına imkan tanımış ve böylelikle iş süreçlerinde inovasyon ve proaktif karar alma kültürünün yaygınlaşmasına katkı sağlamıştır. Bu dönüşüm, sadece iş verimliliğini artırmakla kalmamış, aynı zamanda çalışanların iş tatmini, motivasyonu ve organizasyona bağlılıklarını da güçlendirmiştir. Literatürde de vurgulandığı gibi, dijitalleşme süreçlerinin bu tür etkileri, uzun vadede hem çalışan performansı hem de motivasyonu artırıcı niteliktedir (Troshina ve Mantulenko, 2020; Bastari vd., 2020; Cai vd., 2020; Henry ve Lamb, 2019; Zahoor vd., 2024).

5. SONUÇ

Bu çalışma, dijital ödeme sistemlerinin tasarımı ve geliştirilmesine yönelik makine öğrenmesi tabanlı yaklaşımların, finansal ve operasyonel süreçler üzerindeki etkilerini ortaya koymaktadır. Komisyon optimizasyonu, işlem doğruluğunun artırılması ve işlem sürelerinin kısaltılması gibi hedefler, ödeme sistemlerinin performansını artırmak ve işletmelere stratejik avantajlar sağlamak için kritik öneme sahiptir.

Bulgular, makine öğrenmesi algoritmaları ve dinamik yönlendirme mekanizmalarının komisyon maliyetlerini %20 oranında azaltarak işletmelerin finansal sürdürülebilirliğine katkı sağladığını göstermektedir. Bunun yanı sıra, işlem doğruluğundaki %25'lik artış ve işlem sürelerindeki azalma, operasyonel süreçlerde kayda değer bir iyileşme yaratmıştır. Bu sonuçlar, dijital ödeme altyapılarının, yalnızca işlem süreçlerini optimize etmekle kalmayıp, aynı zamanda müşteri memnuniyetini artıran ve finansal performansı güçlendiren bir dönüşüm aracı olduğunu ortaya koymaktadır.

Çalışma, dijital ödeme sistemlerinin organizasyonel işleyiş üzerindeki etkilerini ele alarak, teknolojik yeniliklerin rutin görevleri otomatikleştirme ve çalışanların stratejik rollere odaklanmasını sağlama potansiyeline dikkat çekmektedir. Bu bağlamda, dijitalleşmenin yalnızca teknik süreçlere değil, aynı zamanda organizasyonel dinamiklere de önemli katkılar sağladığı vurgulanmaktadır.

Sonuç olarak, dijital ödeme sistemlerinde kullanılan makine öğrenmesi tabanlı çözümler, işletmelerin rekabet avantajını artırmak ve finansal süreçlerini daha sürdürülebilir hale getirmek için kritik bir araç olarak konumlanmaktadır. Literatürde bu tür teknolojik yeniliklerin dijitalleşmenin sunduğu fırsatları en üst düzeye çıkarma potansiyeline sahip olduğu sıkça belirtilmektedir. Gelecekte, dijital ödeme

sistemlerinin daha geniş bir kullanıcı tabanına hitap edecek şekilde geliştirilmesi ve bu teknolojilerin farklı sektörlerde uygulanabilirliğinin incelenmesi, literatüre yeni katkılar sağlayacaktır.

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FINANCE DOGMAS AND NEOCLASSICAL MEMORIZATIONS IN MAINSTREAM ECONOMICS: EXAMPLES OF MILTON FRIEDMAN, EUGENE FAMA AND NOBEL

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ABSTRACT

Purpose- During the post-pandemic exit period, while the Russia-Ukraine War was ongoing and the earthquake disaster was following, the fiscal policy in which macroprudential measures were implemented between December 2021 and May 2023 was frequently criticized in the mainstream and accused of being unscientific, claiming that it was an economic experiment (and heterodox economic literature was excluded or ignored). It was claimed that the economy would get back on track with a return to orthodox monetary policy and rationality. In the past period, when the inflation rate remained higher at the end of 1.5 years compared to May 2023, it is claimed and said by the mainstream that the money supply and public expenditures (fiscal policies) did not accompany the monetary policy. Therefore, it is claimed that the household's belief in inflation did not decrease (inertia) and they are not reducing their expenditures because of that situation. It was generally said (especially in social media posts and TV market channels) that locals (in academy and business the right usage is residents) did not act rationally by fueling inflation, especially service inflation, along with the minimum wage increase. (The name) “The Nobel Prize in Economics” and the beliefs and discourses in mainstream economics such as "*the money supply is always and everywhere inflationary*", "people and investors are rational" and "the importance of institutions in economic development and progress" are actually very different as declined/corrrected from/by its own sources, hence it was intended to be shown with scientific references and sources.
Methodology- In this study, examples were examined through a summary literature review and it was shown that neoclassical memorization and dogmas were corrected by the owners (itselves) of these discourses, arguments and hypotheses, and were different from what is known in the mainstream (economics). In this way, it is a qualitative and conceptual study.
Findings- Friedman, Fama and members of the Nobel Family corrected and rejected their own statements (hypotheses) and the facts mentioned in this study.
Conclusion- The inflation-money supply relationship, the inflation and the investment relationship with (ir)rational households and investors, prize-winning theories such as the relationship between development and inflation, and real per capita income can still find firm supporters and a place in the mainstream and neoclassical understanding, although they have been revised by their main resources who first issued them. Although there are immutable rules in economics and finance, the financial policies implemented depending on the period and/or the dynamics of the countries may differ, and even if the policies are the same, the results may differ. While ignoring a (heterodox) literature in economics, not being aware of the developments and updates in the (orthodox) literature regarding the other (claimed as rational) understanding defended may not lead the proposed prescriptions and thus their results to the desired direction. In Türkiye, parallel to the World, these acceptances in mainstream (neoclassical) economics are a bitter prescription and cannot be a solution in the new economy. When data and graphs are presented by detaching them from the context of the facts and events of the relevant period, this is not economics but statistics (Dirican, 2024a).

Keywords: Money Supply, Efficient Market Hypothesis, Inflation, Nobel Economy Prize, Milton Friedman, Eugene Fama
JEL Codes: E13, E44, E51, E71

ANA AKIM EKONOMİDE FİNANS DOGMALARI VE NEOKLASİK EZBERLER: MILTON FRIEDMAN, EUGENE FAMA VE NOBEL ÖRNEKLERİ

ÖZET

Amaç- Pandemi sonrası çıkış döneminde Rusya-Ukrayna Savaşı sürerken ve deprem felaketi takip ederken, 2021 Aralık ve 2023 Mayıs dönemi arasında makro ihtiyati tedbirlerin uygulandığı mali politika ana akımda sıkça eleştirildi ve bilim dışı olmakla itham edilerek iktisat deneyi yapıldığı iddia edilerek (ve heterodoks iktisat literatürü dışlanarak veya yok sayılarak) ortodoks para politikasına ve rasyonelliğe dönüşle ekonominin tekrar rayına gireceği iddia edildi. Geçen süreçte enflasyon oranı devir alınan Mayıs 2023’e göre 1,5 senenin sonunda daha

yukarıda kalınca, ana akımda para arzının ve kamu harcamalarının (maliye politikalarının) para politikasına eşlik etmediği, bu yüzden hane halkının enflasyona dair inancının düşmediği (atalet) ve harcamalarını kısmayarak asgari ücret artışı ile birlikte başta hizmet enflasyonu olmak üzere enflasyonu körükleyerek rasyonel davranmadığı, genel olarak (başta sosyal medya paylaşımlarında ve TV piyasa kanallarında) iddia edildi ve söylendi. Bu inanış ve söylemlere baz teşkil eden "*para arzının her zaman ve her yerde enflasyonist olduğu*", "insan ve yatırımcının rasyonel olduğu" ve "ekonomik kalkınmışlık ve gelişimde kurumların önemi" ile Nobel Ekonomi Ödülünün (adının) aslında bilinen ana akım ve neoklasik ezber ve dogmalardan farklı olduğunu bilimsel referanslar ve kaynaklarla gösterilmek istenmiştir.

Yöntem- Bu çalışmada özet literatür taraması ile örnekler incelenmiş ve neoklasik ezber ve dogmaların bizzat bu söylemlerin, argümanların ve hipotezlerin sahipleri (kendileri) tarafından düzeltilerek ana akımda (ekonomide) bilinenden farklı olduğu gösterilmiştir. Bu şekilde nitel ve kavramsal bir çalışmadır.

Bulgular- Friedman, Fama ve Nobel Ailesi üyeleri bu çalışmada yer alan bizzat kendi söylemlerini (hipotezlerini) ve adı geçen olguları düzeltmişler ve ret etmişlerdir.

Sonuç- Enflasyon para arzı ilişkisi, rasyonel hane halkı ve yatırımcı ile yatırım ve enflasyon ilişkisi, kalkınmışlık ve enflasyon, kişi başına düşen reel gelir ilişkisi gibi ödüllü teoriler bizzat ilgilileri tarafından revize edilmesine rağmen ana akımda ve neoklasik anlayışta hala kendine sıkı taraftar ve yer bulabilmektedir. Ekonomi ve finansta değişmez kurallar olmakla birlikte döneme göre ve/veya ülkelerin dinamiklerine göre uygulanan mali politikalar farklılık arz edebilir, politikalar aynı bile olsa sonuçları farklılık arz edebilir. Ekonomide (heterodoks) bir literatürü yok sayarken, (rasyonel diye) savunulan diğer ortodoks anlayışa dair literatürdeki gelişmelere ve güncellemelere hakim olmamak önerilen reçeteleri ve haliyle sonuçlarını arzu edilen tarafa götüremeyebilir. Türkiye'de dünyaya paralel olarak ana akım (neoklasik) iktisattaki bu kabuller acı reçete olarak yeni ekonomide çözüm olamamaktadır. Veriler ve grafikler ilgili dönemin olgu ve olayların bağlamından koparılarak sunulduğunda bu iktisat değil istatistik olmaktadır (Dirican, 2024a).

Anahtar Kelimeler: Para arzı, etkin piyasalar hipotezi, enflasyon, Nobel ekonomi ödülü, Milton Friedman, Eugene Fama
JEL Kodları: E13, E44, E51, E71

1. GİRİŞ

Fed para politikasının 2016 yılından sonra değişimi ile birlikte dolarizasyon sorunu yaşayan Türkiye'de, özellikle 2021 Aralık ve 2023 Mayıs dönemi arasındaki uyguladığı mali politika ana akımda sıkça eleştirildi ve bilim dışı olmakla itham edilerek iktisat deneyi yapıldığı iddia edildi. Pandemi sonrası açılmalar ile yaşanan küresel arz ve enerji enflasyonunda, cari açık, büyüme gibi nedenlerle Çin'in yerine geçmek istenirken, "büyük koşu" ile yurtiçi yerleşiklerin (başta hane halkı) dolar talebi, kuru negatif reel faiz endişesi ile hızla yükseltince "Kur Korumalı Mevduat (KKM)" ile makro ihtiyati tedbirler devreye alınmak durumunda kaldı. Aynı dönemde yaşanan Rusya-Ukrayna Savaşı enerji ve emtia fiyatlarını körüklerken, sonrasında yaşanan "Yüzyılın Depremi" uygulanmak istenen "Türkiye Ekonomi Modelini" iyice sekteye uğrattı. Bu dönemde dış ticaret açığının ağırlıklı enerji ve altından kaynaklandığı "Ödemeler Dengesi" verilerinde izlenebilmektedir.

Arz ve enerji enflasyonu ile maliyet enflasyonunun küreselde ön planda olduğu bu dönemde, rasyonel iktisat uygulamasına dönüşle ve ortodoks para politikasının salt doğru olduğu iddiası ile bilime geri dönmenin Türkiye'de enflasyonu düşüreceği, yabancı sermayeyi çekeceği, makro ekonomik sorunları çözeceği ana akımda başta sosyal medya olmak üzere sıkça dile getirildi. Mayıs 2023 sonrasında ortodoks para politikası ile geçen 1.5 yılda enflasyonun alınan seviyenin üzerinde 2024 yılını kapatması üzerine, para arzının ve maliye politikasının para politikasına yeterince eşlik etmediği, yapısal reform olmadığı, politika faizinin yeterince ve hızlı yükseltilmediği gibi birçok argüman ile gerçekleşmeyen ve iyileşmeyen makro gelişmeler açıklanmaya çalışıldı. Asgari ücretin, kamu harcamalarının yani para arzı artışının talebi ve enflasyonu körüklediği, hane halkının ataletinin ve enflasyona dair inancının zayıf olması nedeni ile harcamalarında rasyonel davranmadığı gibi ana akım söylemler yine ön plana çıkarıldı. Bu çalışmada "*Enflasyon, her zaman ve her yerde parasal bir olgudur*" diyen Milton Friedman (Galbraith, 2008), rasyonel yatırımcıyı dikkate alan "Etkin Piyasalar Hipotezi" ile Eugene Fama'nın bizzat kendi söylemlerini düzelten açıklamaları ile ana akım ekonomideki finans dogmaları ve neoklasik ezberlerin yeni ekonomide neden işlemediğine dair bir hatırlatma yapılmak istenmiştir. Benzer şekilde "Nobel Ekonomi Ödülü" olarak bilinen ödülün aslında Nobel Vakfı (Akademisi) tarafından değil İsveç Merkez Bankası (Riksbank) tarafından aynı dönemde benzer süreçlerle verilen bir ödül olduğu hatırlatılmak istenmiştir.

2. VERİ VE METODOLOJİ

"Türkiye Ekonomi Modeli" olarak adlandırılan ve heterodoks iktisat denilen (aslında ortodoks olmayan) dönem için ana akımda sıkça "rasyonel değil, bilim dışı, bilimden kopuş, deney yapılıyor, en pahalı deney" gibi söylemler ve sıfatlar yer aldı (Birgun.net, 2024; Patronlardunyasi.com, 2024; 10haber.net, 2023; paraanaliz.com, 2022; indyturk.com, 2021).

"American Economic Association" Jel Kodlarında neoklasik iktisat düşüncesi "B. History of Economic Thought, Methodology, and Heterodox Approaches" başlığında B1-B13 altında yer almaktadır. Heterodoks anlayış ise aynı maddenin altında B5 başlığında yer almaktadır. Epistemolojik kopuş söylemi nedeni ile dönemi, söylemi ve politikayı sıkça eleştiren ana akımın neoklasik ortodoks (para) politika(sı) anlayışında "serbest piyasa" ve "bağımsız merkez bankası" söylemlerinin karşılığına yakın sayılacak neoliberal düşüncenin sahibi Avusturya Okulu da (heterodoks) B5 başlığı altındadır. Daha önemlisi ortodoks politikaya dair bir başlık ve Jel kodu bulunmamaktadır (aeaweb.org, ET: 2024).

Smith ile başlayan, Ricardo ve Marshall ile devam eden klasik iktisat anlayışının istihdam ve mali politikalarla örtüşmemesi ve yeni ekonomik durumlara cevap verememesi üzerine Keynes'in iktisadi anlayışını da dikkate alan iktisadi düşünceye "Neoklasik İktisat" denmiştir (Birol & Gencer, 2014). Neoklasik iktisat günümüzde hala hakim iktisadi anlayış olarak görülmekle birlikte toplumdaki gelişimi göz ardı etmektedir (Kapıcı, 2020). Friedman, Samuelson gibi neoklasikler özellikle 20. Yüzyılın 2. yarısını özellikle bilimsellik ve nesnellik kelimelerini kendileri ile

bağdaştırarak domine etmişlerdir ve bu yolla başta akademi, dergiler, literatür, departmanlar olmak üzere politik arenada da söz sahibi olmuşlardır. Genelde bu ekopolitik dominans nedeni ile ana akım olarak görülmektedirler. Ve neoklasik anlayışın iktisatta ana lisan haline gelmesi nedeni ile neoklasik düşünceye karşı çıkmak önleyici moda, bilim dışılık, alakasız politikalar olarak görülmektedir (Morgan, 2016). "Ortodoks İktisat" deyimi genelde yakın dönem hakim düşünce okulunu ifade etmektedir ve ana akım ve neoklasik iktisat ile birlikte anılmaktadır. Ancak ekonominin dinamik, gelişen ve değişen süreçleri kapsamında ana akım zaman içerisinde değişik düşünce okullarını içerisinde barındırabilir (Bilir, 2019).

2.1. Milton Friedman Enflasyon ve Para Arzı İlişkisi

Financial Times yazarı Simon London ile Milton Friedman San Francisco's North Beach Restaurant röportaj için buluşmuşlar ve Friedman burada kendi söyleminde hatalı olduğunu kabul etmiştir. 91 yaşındaki Friedman için "*itiraf vakti gelmiştir*" denilen durum piyasalarda ve ekonomide birçok kişinin günümüzde kullanmaya devam ettiği "*enflasyon her zaman ve her yerde para arzı ile alakalıdır*" cümlesi ile ilgilidir. Friedman yemekteki konuşmalarında "(merkez bankalarının) para (arzı) miktar hedefininin başarılı olmadığını, bugün olsaydı bu konuda eskisi gibi ısrarcı olmayacağını" belirtmiştir. 1980'de İngiltere'de Thatcher döneminde monetarizmin başarısız uygulaması kapsamında iki profesör Galbraith ve Friedman'ın tartışması teklif edilmiş ancak bu gerçekleşmemiştir. Öte yandan Friedman Galbraith'in The Observer yazısına karşılık, Thatcher'ın durgunluk dönemlerinde kamu borçlanmasının az tutulması düşüncesinden uzak kalınması ile ilgili görüşünü içeren Avam Kamarasına mektubunu paylaşmıştır (Keegan, 2003).

Monetarizm Friedman tarafından "*enflasyon her zaman ve her yerde parasal bir olgudur*" önermesi ile tanımlanabilir. Bu inanışa göre fiyatlar ve para arasında bir bağ vardır. Daha ötesinde Friedman için para bir para politikası değişkenidir ve merkez bankaları istediği zaman yaratabilir veya öldürebilir. 1980'lerde Friedman'ın bu görüşü akademik tarafta sönerken, yeni gelişmelerle Ben Bernanke'nin enflasyon hedeflemesi ile yeni parasalcı anlayış öne çıkmıştır. Bu anlayışa göre; para politikası tek başına enflasyonu yenebilir, kararlı bir bağımsız merkez bankası kredibilitesi ile düşük enflasyona ulaşabilir, iyi zamanlanmış bir agresif faiz artışı durgunluk yaratmadan enflasyon beklentilerini söndürebilir. Ancak 2008 krizi göstermiştir ki kapitalizmin dengesizliği, spekülatörlerin sorumsuzluğu, mevzuat boşluğu, (piyasalara) müdahale gereksinimi bunları Friedman'ın söylemine göre daha bile anlamsız kılmaktadır (Galbraith, 2008).

1960'larda Friedman'ın para miktarı teorisi ile enflasyonu kontrol edebilen Bank of Canada, 1990'larda aynı yöntem işe yaramadığı için para miktarı (arzı) hedefi yerine enflasyon hedefini öne almıştır. Ekonomi profesörü John McCallum Friedman'ın kendisinin para miktar hedefini başarısız olarak kabul etmesi ile yine de bunun geçerli olması için para arzı ve enflasyon arasında istikrarlı bir ilişki olması gerektiği ancak bunun artık bir devamlılık arz eden durum olmadığını söylemiştir (Demont, 2009).

Yeni Keynesyen modeller kamu harcamalarının artışının enflasyonist olduğunu öngörürler. Buna göre kamu harcamalarının enflasyonist etkisi maaşlarda (asgari ücrette) düşüş, (şirketlerin) kar marjında düşüş ve verimlilikte artışla azaltılabilir. "Structural Vector Autoregressive (SVAR)" modeli ile yapılan 1966-2008 arası verilerin analiz sonucunda ABD'de kamudaki mali genişleme sonucunda fiyatlarda bir yükselme görülmemiştir. Modellerinde normal dönemlerden farklı olarak "Likidite Tuzağında" artan kamu harcamaları Yeni Keynesyen modellerden farklı olarak (enflasyonda) bir çarpan olmamaktadır (Jørgensen & Ravn, 2022).

2008 küresel krizi sonrasında 2009 yılında ABD'de "the American Recovery and Reinvestment Act" mali kurtarma (teşvik) programı devreye alınmıştır. Kamu harcamalarının (bütçe giderlerinin) bu şekilde enflasyon yaratacağı düşüncesine karşılık 2. Dünya Savaşı sonrasındaki benzer dönem incelenmiş ve 1980 öncesi 20 yılda çok az, 1980 sonrasında daha çok etkili olduğu bulunmuştur. 2009'daki yeni destek paketinin bu şekilde istihdam ve enflasyon etkisi ve ilişkisi incelenmiş ve beklenen enflasyonda çıktı çarpanının düşük olduğu, Iowa ve Georgia örnekleri üzerinden eyalet bazında farklı etkiler yaratabileceği sonucuna varılmıştır (Dupor & Li, 2015).

ABD gibi gelişmiş ekonomilerde para politikasındaki enflasyona yönelik (merkez bankası) bağımsız karar alma süreci bütçe açıkları ile enflasyon arasındaki ilişkinin düşük olduğunu göstermektedir. Az gelişmiş ülkelerde ise yüksek enflasyon ile yüksek bütçe açıkları birlikte görülmektedir. Bunun nedeni bütçe açıklarının finansmanı için merkez bankalarının senyoraj gelirlerine bağımlılığıdır (Sill, 2005).

Federal Reserve Bank of San Francisco CEO'sunun "Western Economic Association International" sunumundan özetlenen makaleye göre, Federal Reserve bankaların kendisinde tuttuğu rezervlere faiz öderse para çarpanı sıfıra yakınlaşır. Bu durumda neoklasik anlayıştaki rezervler, para arzı, enflasyon arasındaki linklerin varlığı geçersiz olur (Williams, 2012).

2.2. Eugene Fama Etkin Piyasalar Hipotezi ve Rasyonellik

Fama'ya göre bir piyasada rasyonel aktörler, karar vericiler (agent, ajan) varsa etkindir. Gelecekteki fiyatları herkese eşit serbest bilgi akışı ile tahmin etmeye çalışan, rasyonel çok sayıdaki ve karını maksimize etmek isteyen yatırımcının rekabet ettiği piyasalar etkindir. Fama ve Samuelson fiyatların rassal oluşumunu etkin piyasaların bir sonucu ve hisse fiyat değişimlerini rasyonel davranışların bir sonucu olarak açıklamaktadırlar. Bu şekilde Charles Dow tarafından ortaya konulan tekrarlanan trendleri (teknik analizde kullanılan dalga teorilerini) sorgulamaktadır. "Journal of Business" dergisinde 1965 yılında "Behavior of Stock Market Prices" makalesinde ilk kez etkin piyasa kavramını kullanmıştır. "Rassal Yürüyüşü" hisse fiyat değişimlerinin serbest olmasının en önemli açıklayıcı nedeni olduğunu savunmuştur (Delcey, 2019).

Piyasadaki oynaklığın çok yüksek olduğunu istatistiki modeli ile makalesinde yazan Robert Shiller ve matematik, istiatistik ve bilgisayarlı hesaplama yöntemleri ile piyasa davranışlarını inceleyen Nobel Ödüllü Lars Peter Hansen Fama'nın hipotezine karşı olarak piyasaların irrasyonel olduğunu göstermişlerdir. Shiller 1996'da dönemin Fed başkanı Alan Greenspan tarafından görüşü nedeni ile yemeğe davet edilmiş ve hisse piyasasının aşırı değerli olmasının irrasyonel davranışlarla alakalı olabileceği düşüncesini Greenspan dinlemiş ve tarihi konuşmasında bu duruma değinmiştir (Harford & Alexander, 2013).

Financial Times (FT) yazarı Wigglesworth, Friedman'ın Financial Times röportaj yemeğine benzer bir şekilde, Eugene Fama ile pandemi sonrasında Chicago Üniversitesindeki ofisinde buluşmuş ve sandviç eşliğinde yaptıkları sohbetlerini FT'de Ağustos 2024'de makale haber olarak yayınlamıştır. Bu haber makalede yer alan bilgiler şu şekilde özetlenebilecektir: 1965 tarihli "Random Walks in Stock Market Prices" makalesinde ilk kez etkin piyasa tanımını kullanmıştır. Üniversite koridorunda bir başka Nobel Ödüllü davranışsal iktisatçı Richard Thaler ile tabloları karşıya karşıya bulunmaktadır. "Davranışsal İktisat" "Etkin Piyasalar Hipotezinin" zıttı, antitezi olarak görülmektedir. Fama ise bunu "*verilerde hemfikir oldukları ancak yorumlarken anlaşamadıkları*" şeklinde anlatmıştır. Davranışsal iktisat ile ilgili görüşü olarak tüm ekonominin davranışlarla ve davranış bilimi ile alakalı olduğunu, farkın ise davranışın rasyonel veya irrasyonel olarak düşünülmesi olduğunu belirtmiştir. Konu kendi "Etkin Piyasalar Hipotezine" geldiğinde şaşırtıcı bir şekilde "*hipotezinin sadece bir model olduğunu, bir yerde bir derecede yanlış olduğunu*" ve "*Etkin piyasaların sadece bir hipotez olduğunu, gerçek olmadığını, bununla yaşayabileceğini*" söylemiştir ve "etkin" kelimesine olan itirazlara yönelik olarak "*daha iyi bir kelime bulamadığı için bunu kullanmayı tercih ettiğini*" eklemiştir (Wigglesworth, 2024).

Fama, Chicago Üniversitesi Booth İşletme Okulu'nda kendisi gibi öğretim üyesi olan Nobel Ödüllü Richard H. Thaler ile Youtube tartışmalarında, Thaler'in "*benden daha fazla davranışsal taraftasın*" cümlesine FT'dekine benzer şekilde ama tarih olarak daha önce, "*ekonominin davranışsal olduğunu, bunun şüphe götürmeyeceğini, Thaler'le farkının onun irrasyonel davranış tarafında olduğu, kendisinin sadece davranış tarafında olduğu*" şeklinde cevap vermiştir. Thaler ise bunun üzerine "*davranışın rasyonel bir model ile öngörülemeyeceğini eklemek istediği*" cümlesine Fama "*katılıyorum*" şeklinde cevap vermiştir (Chicago Booth Review, CBR, 2016).

2.3. Nobel ve Ekonomi Ödülü

Nobel Ödülleri fizik, kimya, psikoloji, tıp ve edebiyat alanında Alfred Nobel'in vasiyetinde belirttiği şekilde verilmektedir. 1968 yılında Sveriges Riksbank (İsveç Merkez Bankası) üçyüzüncü yıl dönümünde Alfred Nobel anısına ekonomi ödülü ("*the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel"*) vermeye başlamış, ilk ödül 1969'da verilmiştir (Nobelprize.org, ET: 2024).

Ekonomi alanındaki en prestijli ödül olarak kabul edilse de "*The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel*" bir Nobel Ödülü değildir (Indianexpress.com, 2018).

Profesör Peter Söderbaum Ekim 2009 tarihinde Fransız iş dergisi "Challenge" talebi üzerine Nobel Ekonomi Ödülü için görüşlerini açıklamıştır. "İktisat bilim midir?" tartışmasında bilim olduğunu düşünmekle birlikte Nobel Ekonomi Ödülü için, neoklasik iktisadın dünyanın her yerinde akademide baskın olduğunu, neoklasik ekonominin sadece bir bilim değil aynı zamanda ideoloji olduğunu söylemiştir. Ekonomide bu yüzden çeşitliliğe yer verilmediğini aktarmıştır. Neoliberalizm ile neoklasik ideolojinin benzerliğini ifade etmiştir. Nobel Ekonomi Ödülü olarak bilinen "*Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel*" ödülün isminin "*Bank of Sweden Economics Prize in neoclassical theory and ideology*" olarak güncellenmesi gerektiğini ve ödülün Alfred Nobel'in vasiyetinde yer almadığı için Nobel kelimesinden arındırılması gerektiğini ifade etmiştir (Söderbaum, 2010).

Peter Nobel, Alfred Nobel'in kardeşi Ludwig'in büyük oğlu ve üç kuzeni Nobel isminin ekonomi ödüllerinde kullanılmamasını istemiştir. Alfred Nobel'in vasiyetinde yer almaması ve ödülün ruhuna aykırı olması nedeni ile ödülün adının "Riksbank Prize" olarak düzeltilmesini istemişlerdir (Thompson, 2001).

Peter Nobel, "Nobel Ekonomi Ödülü adının ekonomistler tarafından kendi reklamları için bir darbe" olarak tanımlamaktadır. Peter Nobel, Alfred Nobel'in her zaman için insanlığın faydasına barışı hayal ettiğini, toplumun iyiliğini her zaman (şirket) karların önüne koyması nedeni ile hiçbir zaman ekonomi alanında bir ödül (vermek) istemeyeceğini düşüncesi olarak söylemiştir. Ödülün genelde borsa spekülatörlerine (konularına) verildiğini, Alfred Nobel'in ruhunun insanlığın durumunun iyileşmesine bu isimle aracılık etmediğini belirtmiştir (https://web.archive.org/, http://www.thelocal.se/, 2005).

3. BULGULAR

Literatür taraması ışığında yukarıdaki kaynaklar net, somut ve açık bir şekilde ana akımda, neoklasik (ve neoliberal) iktisat anlayışında yer alan ve günümüzde hala öne çıkarılan (özellikle ortodoks para politikasındaki) kabullerin aslında bizzat ortaya koyan, tanımlayan kişiler tarafından düzeltildiğini, yanlış olduğunun veya geçersiz olduğunun kabul edildiğini ve itiraf edildiğini göstermektedir. Politika yapıcıların ve bürokratların mali politika setlerinde önemli yer tutan bu kabullerin, felsefi olarak iktisatta bir güncel teoriden çok artık iktisat tarihi olarak kabul edilmesi gerekliliğini göstermektedir.

Özetlemek gerekirse, monetaristlerin idolü Friedman kendi para miktarı enflasyon ilişkisini çürütmüştür. Benzer şekilde, finans dünyasının idol isimlerinden Eugene Fama yatırımcının yani insanın irrasyonel ekonomik kararlar aldığını kabul etmiş, kendi hipotezindeki Rassal Yürüyüşe dayalı rasyonel insan kabulünü düzeltmiştir. Bir diğer önemli husus, prestijli bir ödül olmakla birlikte Riksbank tarafından verilen Alfred Nobel anısına ekonomi ödülünün, her ne kadar "The Royal Swedish Academy of Sciences" tarafından Nobel Ödülleri sürecine uygun olarak değerlendirilip veriliyor olsa da bir Nobel Ödülü olmadığıdır.

Paranın eksojen veya endojen olması tartışması neoklasikler ile Post-Keynesyenler arasında tartışma konusudur. Oysa farklı faktörlere göre her ikisi de olabilecektir (Sieroń, 2019). Bu şekilde kendisinden olmayan diğer okulları başta heterodoks iktisat ve "Modern Para Teorisi (MMT)" olmak üzere genelde yok sayan ya da dışlayan ana akım neoklasik iktisat anlayışının (genelde ortodoks iktisat ve neoliberalizmle birlikte anılır) aslında savunduğu konularda literatüre ve bilime hakim olmadığı veya en iyi ihtimalle güncel olmadığı şeklinde yorumlanabilecektir. Genelde ve dünyada farklı örnekleri ve istisnaları olsa da en azından Türkiye özelinde bu bulguyu önermek başta sosyal medyadaki ve piyasa kanallarındaki hakim ana akım bilgi akışı ve veri kirliliği noktasında zor olmamaktadır.

4. SONUÇ

Ana akım neoklasik iktisat öğretisinin doğruları kadar günümüzde güncelliğini yitirmiş olanları ve yanlışları da bulunmaktadır. Genelde ortodoks iktisat politikalarının (ki gelişmekte olan ülkelerde, Washington Konsensüs esintili neoliberal politikaların da) reçete veya çözüm olarak sunduğu veya baz aldığı bazı kabullerde bilinenlerden farklı durumların olduğu yukarıdaki bu üç örnek üzerinden tespit edilmiştir. Ezber ve dogmaların varlığı bilimin önündeki en büyük engeldir. Galileo'dan bu yana ve hatta akademinin kuruluşu Platon'dan bu yana epistemoloji bilimin kalbidir. Ancak 2021 yılı sonrasında Mayıs 2023 tarihine kadar geçen süreçte nöro iktisat, heterodoks iktisat ve epistemolojiye atıfla başlayan ekonomik sürecin, talihsiz bir şekilde ekopolitiğin ikinci kısmına çekilerek yok sayılması ve daha da ileri gidilerek bilim dışı, deney olarak tanımlanması, istenilen ekonomik sonuçlara varılsın veya varılmasın Türk Akademisi ve İktisat Literatürü açısından bir talihsizlik olarak görülmelidir. Kaldı ki deneysel iktisat heterodoks iktisadın bir alt dalıdır. Deneysel iktisatta istenilen sonuçlara varılamaması mı yoksa "kural bazlı iktisat" denilerek bazı yanlış argümanlar, kabuller, dogma ve ezberlerin ana akımda bilim olarak sunulması mı daha kötüdür sorusu felsefenin alanına da girse geçilen dönem itibarı ile Türkiye ekonomisinde sorgulanması gereken bir başlıktır. Mutlaka heterodoks iktisadın da cevap veremediği konular veya çözüm olamayacağı durumlar vardır ve olacaktır. Bu çalışmada geçen örneklerin yarattığı tezatların bir gün farklı iktisat okulları ve düşünceleri için oluşması bu yüzden normal kabul edilmelidir. Bilimde paradokslar bu yüzden vardır. Hatta buradaki üç örnek ileride zaman içinde olasılık olarak yine kendini doğrulayabilir de. Bu paradoksun oluşması halinde bu çalışmanın bugünkü güncelliği ve doğruluğu o gün için yanlışı olarak kalabilir. Ama hiç olmamıştır demek ve dışlamak bu çalışmada olduğu gibi eleştirilmesi gereken esastır.

Konuların bağlamından koparılarak salt rakamsal veriler ile grafiklerle sunulması iktisadın değil istatistiğin konusudur (Dirican, 2024a). Prestijli endekslerde (WoS, Scopus) heterodoks iktisat ile ilgili yayınlar ortodoks iktisattan daha fazla görülmüştür (Dirican, 2024b). Doğaldır ki, bilimde hipotez, tez ve antitez vardır. Zaman içerisinde farklı okulların farklı görüşleri farklı ülkelerde farklı dinamikler altında farklı sonuçlar yaratabilir. Keskin bir şekilde dogma ve ezbere dayalı iktisat kurallarını salt doğru olarak kabul etmek veya ettirmeye çalışmak bu anlamda istenilen sonuçları doğurmayabilecektir. Nitekim Mayıs 2023 sonrasında izlenen ortodoks para politikası ile enflasyonun devir alındığı seviyenin üstünde geçen 18 ay sonrasında hala kalıyor olması buna bir örnek olarak gösterilebilecektir. Maliye politikasının giderler ve bütçe harcamaları ile para politikasına eşlik etmediği, hane halkının irrasyonel davranarak ataletle (inertia) enflasyonun düşeceğine inanmaması gibi açıklamalar rasyonel iktisat politikalarına dönüş iddiasında istenilen yerden uzak olunmasının açıklamaları olarak sunulmaktadır ancak yukarıdaki bu duruma yönelik ana akım baskın örnekleri olarak görülebilecektir.

İnsan irrasyonel bir varlıktır, doğal olarak ekonomi ile ilgili kararları da irrasyonel olabilir, davranışsal finans ve iktisat kapsamında bu yüzden piyasalar ve ekonomi etkin olmayabilir, rasyonel çıktılar elde edilemeyebilir. Para arzını ve bütçe harcamalarını kısmak her zaman enflasyon üzerinde istenilen etkiyi veya katkıyı sunmayabilir. Nobelli kurumların ve kurumsal kavramların önemine dikkat edilmeli diyen ana akım anlayışın prestijli de olsa bir merkez bankasının verdiği ödülü diğer 5 tanesi arasında olmamasına rağmen diğer Nobel Ödülleri ile aynı yere koyması ve bu durumun genel olarak kabul edilmesi kural bazlı iktisat ve kurumların önemi söylemi ile ters düşmektedir. Wikipedia'da dahi Nobel Ekonomi Ödülünün bu anlamda doğru adı ve ailesinin üyelerinin bu isme itirazı yer almaktadır. NobelPrize X hesabından yapılan duyurularda örneğin "Watch the Nobel Prize lectures in chemistry" ile "Watch the prize in economics science lectures" ifade farkı ödülün verildiği yer farkından olmaktadır. Bu durumu, IMF'in 2013 tarihli "International Reserves and Foreign Currency Liquidity Guidelines" dokümanından farklı olarak dünyada ve akademide olmayan "Swap Hariç Net Rezerv" kavramının yine Türkiye'de ana akımdaki kullanımına benzetebiliriz (Dirican, 2022). Kullanımda olması bilimsel olarak doğru olabileceği veya kabul edilebileceği anlamına gelmemektedir. Astroloji ve astronomi arasındaki fark ile Galileo bu konuda en popüler örnekler olarak gösterilebilir.

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THE IMPACT OF THE WIDESPREAD ADOPTION OF DIGITAL PAYMENT SYSTEMS ON INDIVIDUAL SPENDING HABITS AND SAVINGS

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ABSTRACT

Purpose - The aim of the study is to examine the impact of digital payment systems on individual savings rates and spending habits in Türkiye. Additionally, it is to evaluate the impact of digital payment systems on individual spending and savings within the framework of the COVID-19 crisis.

Methodology - The research aims to examine the impact of digital payment systems on individual savings rates and spending habits by adopting a quantitative approach. Additionally, as a sub-objective, it aims to evaluate the impact of digital payment systems on individual spending and savings within the framework of the COVID-19 crisis. In the study, quarterly data for the period 2016Q1-2023Q4 were analyzed using household consumption expenditures, gross savings amount, digital payment systems (mobile payment, online banking, contactless payments, and all other digital payment methods), consumer price index, deposit interest rate, consumer credit interest rate, and consumer confidence index. The Newey–West Standard Errors Estimator has been used for data analysis.

Findings - It has been shown digital payment systems have a statistically significant and positive effect on household final consumption expenditures and gross savings. Again, it has been concluded the pandemic period had a statistically significant and negative impact on household final consumption expenditures and gross savings. Additionally, it has been observed digital payment systems had an impact on increasing household consumption expenditures and savings during the pandemic period.

Conclusion - - In the study, the effects of digital payment systems in Turkey on individual savings rates and spending habits were examined. The findings obtained indicate that digital payment systems have a statistically significant and positive impact on household final consumption expenditures and gross savings. In addition, it has been determined that the COVID-19 pandemic has a statistically significant and negative impact on household consumption expenditures and gross savings. Additionally, it has been observed that digital payment systems played a positive role in increasing individuals' consumption expenditures and savings during the pandemic period. These findings reveal how digital payment infrastructure shapes individuals' financial behaviors during times of crisis, providing an important foundation for future research examining the interaction between digital finance and crisis dynamics.

Keywords: Digital payment systems, household final consumption expenditure, gross savings rate, Covid-19 pandemic.
JEL Codes: D12, E21, E32

1. INTRODUCTION

The shift to digital payments has significantly transformed consumer spending habits. With the convenience of mobile wallets, online banking, and contactless payments, consumers have increasingly adopted cashless transactions. This change has not only facilitated the payment process but also encouraged more frequent and impulsive purchases. (Bhoopathy and Kanagaraj, 2023). These developments have also raised concerns regarding privacy and security.

The rapid proliferation of digital payment systems has led to fundamental changes in individuals' spending habits and saving tendencies. Mobile wallets, online banking, and contactless payment, with the convenience they offer through innovative technologies, enable consumers to make faster and more accessible transactions. This change has simplified spending processes while also encouraging instant gratification and impulsive purchases. However, digital payment systems increase financial awareness and support responsible spending by offering features such as real-time expense tracking. (Bhoopathy and Kanagaraj, 2023). The COVID-19 pandemic has been a turning point that rapidly increased the adoption rate of digital payment systems. Because during this period, digital payment systems have been at the forefront. The social distancing rules implemented during the pandemic have reduced the need for physical money while increasing interest in digital payment methods. In this context, the pandemic process has caused significant changes in both individuals' spending habits and saving behaviors. This study aims to analyze the impact of digital payment systems on individual savings rates and spending habits. Additionally, it aims to evaluate the impact of digital payment systems on individual spending and savings within the framework of the COVID-19 crisis. The study is expected to contribute to the literature by revealing the impact of digital financial products on individuals' financial decisions, providing new insights for both banks and financial service providers, and serving as an important resource for academics and policymakers who seek to understand the effects of digitalization on financial behaviors.

The study consists of five sections in line with its purpose. The first section is the introduction, while the second section consists of the literature review and the formulation of hypotheses. In the third section of the study, the dataset and methodology are introduced. In the fourth chapter, the research findings and interpretations of these findings are presented. As the sixth and final section, the study was completed with the conclusion and evaluation..

2. LITERATURE REVIEW

According to the general arguments of the literature and theoretical framework, the following hypotheses have been developed:

H1: The widespread use of digital payment systems reduces individual savings rates.

H2: The widespread adoption of digital payment systems increases the amount individuals spend.

H3: The use of digital payment systems has a negative effect on individuals' consumption tendencies.

H4: The effect of digital payment systems is independent of deposit interest rates.

H5: The effect of digital payment systems is independent of consumer loan interest rates.

H6: The widespread adoption of digital payment systems increases the inflation rate.

H7: The adoption rate of digital payment systems is negatively related to the consumer confidence index.

H8: The adoption rate of digital payment systems leads to an increase in gross savings values

Table 1: Literature Review

Authors	Data Set	Methodology	Variables	Findings
Duramaz and Dündar (2014)	Türkiye and İtaly	Comparison Method	Electronic payment tools	As a result of the study, it was found with the most commonly used card payment systems today, more spending is made in Turiye compared to Italy.
Ağan (2020)	Türkiye, 2019-2020	Granger Causality Test	Credit card spending and GDP	The study concludes that the Granger causality test indicates a one-way causality from GDP to credit card spending, with no evidence of a second-way causality between them.
Musyaffi et al., (2021)	Indonesia, 457 digital payment users	Structural Equation Model (SEM)	Performance expectancy, effort expectancy, social influence, facilitating condition, perceived security, personal innovativeness, behavioral intention to use digital payment, digital payment usage	The study concluded technological and personal mental factors influenced the adoption of digital payments, especially during the COVID-19 pandemic.
Saroy et al., (2022)	India, March 24 to June 2021	Logistic regression	Transacted digitally for the 1st time during the pandemic, income, age, gender, education, distance to bank, access to bank agent, owns a debit card and abandoned digital payments in the past	As a result of the study, it was concluded the transition to digital payment systems during the Covid-19 pandemic period was significantly shaped by the level of awareness of digital methods, access to smartphones and bank cards, and the social assistance provided as pandemic aid.
Brown et al., (2023)	It was obtained from three relevant consumer surveys conducted by the Swiss National Bank between mid-August and November 2020. Data obtained from 2,126 individuals were used.	OLS estimator	Consumption, Card Intensity, Withdrawal Frequency,	As a result of the study, it was concluded consumers who are focused on the present tend to spend more the more they use cashless payment tools.

Liu et al., (2023)	Chinese People, 2017-2019	Benchmark regression	The improvement in the consumption structure of rural households, mobile payment, the age of the head of the household, the square of the age divided by 100, gender, health status, marital status and education level, household size, per capita savings, and per capita income.	As a result of the study, they concluded mobile payments significantly contributed to the improvement of the consumption structure within rural households.
He et al., (2024).	China, General Social Survey data.	Augmented Inverse Probability Weighting Estimator	Four household spending categories (clothing, durable goods, consumables, and cultural and leisure activities) and four subjective well-being indicators (life satisfaction, satisfaction, income satisfaction, and depression).	As a result of the study, it was found the use of mobile payments significantly increases spending on household consumables and cultural and leisure activities, while it increases spending on clothing and durable goods.
Shah et al., (2024).	Data obtained from 503 individuals using digital payment methods in Pakistan	Structural Equation Model: Smart-PLS 4	Digital payments, Cash payments, Digital Financial Literacy and spending behavior	As a result of the study, they concluded both digital and cash payments significantly affect spending behavior.

3. THE DATA AND METHODOLOGY

The aim of this study is to analyze the impact of digital payment systems (such as mobile payments, digital wallets, and contactless cards) on household savings rates and spending habits in Türkiye. For this purpose, quarterly data from the years 2016Q1-2023Q4 have been used. Information regarding the variables included in the research is provided in Table 2.

Table 2: Data Set

Variables	Variable Type	Symbol	Source
Household final consumption expenditures	Dependent Variable	HFCE	TUIK
Gross Savings Value	Dependent Variable	GSV	TUIK
Digital Payment Volume	Independent Variable	DPV	TUIK and BKM
Consumer Price Index	Control Variable	CPI	TCMB
Deposit Interest Rate	Control Variable	DIR	TCMB
Consumer Interest Rate	Control Variable	CIR	TCMB
Consumer Confidence Index	Control Variable	CCI	TCMB
Pandemic	Dummy Variable		
Digital payment volume pandemic_interaction	Dummy Variable		

In the study, a pandemic dummy variable was included in the model to specifically observe the impact of the pandemic crisis on expenditures and savings. Similarly, to observe the impact of digital payment systems during the pandemic period, the variable digital payment volume pandemic_interaction has been included in the model. In the study, the natural logarithm of the variables was taken, and the work continued.

3.2. Method

Since the study requires time series analysis, it is extremely important to first determine whether the series is stationary. In this context, the stationarity condition of the series has been examined using the KPSS (Kwiatkowski-Phillips-Schmidt-Shin) and Elliott-Rothenberg-Stock (ERS) DF-GLS unit root tests (Kwiatkowski et al., 1992; Elliott et al., 1996). After the stationarity condition of the series was met, the presence of autocorrelation and heteroscedasticity in the models was examined using some autocorrelation and homogeneity tests. The presence of autocorrelation in the models was examined using the Durbin-Watson and Breusch–Godfrey LM tests, while the presence of heteroscedasticity was investigated using the Breusch–Pagan/Cook–Weisberg and White's tests. According to the test results, it was concluded that both models exhibited autocorrelation, while heteroscedasticity was not present. Therefore, the relationship between the variables was examined using the Newey–West Standard Errors Estimator, which accounts for autocorrelation.

3.3. Model

The natural logarithmic models of the research have been created as follows.

$$\ln HFCE_t = \beta_0 + \beta_1 \ln DPVL_t + \beta_2 \ln CPI_t + \beta_3 \ln DIR_t + \beta_4 \ln CIR_t + \beta_5 \ln CCI_t + \beta_6 Pandemic_t + \beta_7 DPV\_pandemic\_interaction_t + \varepsilon_t \quad (1)$$

$$\ln GSV_t = \beta_0 + \beta_1 \ln DPVL_t + \beta_2 \ln CPI_t + \beta_3 \ln DIR_t + \beta_4 \ln CIR_t + \beta_5 \ln CCI_t + \beta_6 Pandemic_t + \beta_7 DPV\_pandemic\_interaction_t + \varepsilon_t \quad (2)$$

4. FINDINGS AND DISCUSSION

4.1. Descriptive Statistical Information

In Table 3, the Jarque-Bera test results, which show the number of observations, mean, standard deviation, minimum and maximum values, and whether the variables included in the research exhibit normal distribution, are presented. When examining the table, it is observed that, apart from the Interaction term, the variable with the highest average is the gross savings amount (lnGSV) at 18.61299, while the variable with the highest standard deviation is the digital payment systems (lnDPS) at 0.9717745. It is observed that the variable with the lowest average is the deposit interest rate (lnDIR) with -1.837086, and the variable with the lowest standard deviation is the consumer confidence index (lnCCI) with 0.0914656. When examining the results of the Jarque-Bera test, it can be said that all variables except for the dummy variables Pandemic and Interaction_term have a probability value greater than the critical value of 0.05, indicating that the series follows a normal distribution

Table 3: Descriptive Statistics Information

Variable	Obs	Mean	Std. dev.	Min	Max	Jarque-Bera	Prob.
lnGSV	32	18.61299	.6020199	17.9715	19.79715	4.162	.1248
lnHFCE	32	14.21829	.7774305	13.23781	15.94747	5.459	.0652
lnDPV	32	15.40088	.9717745	13.91746	17.35478	2.238	.3266
lnCPI	32	-1.640947	.7646221	-2.620039	-.1809225	3.408	.1819
lnDIR	32	-1.837086	.3772954	-2.556188	-.813283	1.379	.5018
lnCIR	32	-1.501538	.3999257	-2.207275	-.5419723	2.838	.242
lnCCI	32	4.409491	.0914656	4.191925	4.53475	1.116	.5724
Pandemic	32	.25	.4399413	0	1	7.704	.0212**
DPV_pandemic_interaction	32	1446531	2740293	0	1.07e+07	23.44	8.1e-06**

Note: (***, **) indicate significance at the 5% and 10% levels, respectively.

4.2. Unit Root Test Results

When the KPSS test results given in Table 4 are examined, it is observed that the variables GSV, EO, MFO, TFO, TGE, pandemic, and DÖS_pandemi_interaction are stationary at the I(0) level, while the other variables become stationary at the I(1) level after taking their first differences. Similarly, when the DF-GLS test results are examined, it is observed that none of the variables are stationary at the I(0) level, and when first differences are taken, all variables meet the stationarity condition at the I(1) level.

Table 4: KPSS (Kwiatkowski-Phillips-Schmidt-Shin) and Elliott-Rothenberg-Stock (ERS) DF-GLS Test

Model	Variables	Method	Test statistic I(0)	Test statistic I(1)	Critical values		
					%1	%5	%10
Constant and Trend	lnHFCE	KPSS	0.233(3)	0.132(3)**	0.119	0.146	0.216
		DF-GLS	-1.516[4]	-6.662[2]***	-3.770	-3.080	-2.754
	lnGSV	KPSS	0.208(3)*	-	0.119	0.146	0.216
		DF-GLS	-1.946 [4]	-5.362[1]***	-3.770	-2.962	-2.620
	lnDPV	KPSS	0.218(3)	0.112(3)***	0.119	0.146	0.216
		DF-GLS	-0.835[1]	-3.841[1]***	-3.770	-3.400	-3.058
	lnCPI	KPSS	0.111(3)***	-	0.119	0.146	0.216
		DF-GLS	-2.284[1]	-3.280[1]*	-3.770	-3.400	-3.058
	lnDIR	KPSS	0.123(3)**	-	0.119	0.146	0.216

		DF-GLS	-2.112[1]	-4.495[3]***	-3.770	-3.400	-3.058
	lnCIR	KPSS	0.149(3)*	-	0.119	0.146	0.216
		DF-GLS	-2.177[3]	-3.826[5]***	-3.770	-3.195	-2.866
	lnCCI	KPSS	0.107(3)***	-	0.119	0.146	0.216
		DF-GLS	-2.432[1]	-3.455[1]**	-3.770	-3.414	-3.067
	Pandemic	KPSS	0.152(3)*	-	0.119	0.146	0.216
		DF-GLS	-1.471[1]	-2.557[7]*	-3.770	-3.400	-2.453
	DPV_pandemic_interaction	KPSS	0.144(3)**	-	0.119	0.146	0.216
		DF-GLS	-1.613[1]	-4.183[1]***	-3.770	-3.414	-3.067

Note: (***, **, *) indicates significance levels of 1%, 5%, and 10%, respectively. The values in square brackets represent the appropriate lag lengths determined using the general-to-specific t-significance method; the values in parentheses indicate the bandwidth determined using the Bartlett-Kernel method.

4.3. Newey–West Standard Errors Estimation Results

In Table 5, the results of the Newey–West Standard Errors estimator along with the diagnostic tests and their results for the model are presented. When Table 6 is examined, it is observed that digital payment systems have a statistically significant and positive effect on household final consumption. According to this result, a 1% increase in digital payment systems can be said to cause an approximately 83% increase in household final consumption. As a control variable, no statistically significant relationship has been found between the consumer price index, deposit interest rate, consumer loan interest rate, and consumer confidence index included in the model and household final consumption. To see the independent effect of the pandemic period, a pandemic dummy variable has been added to the model. It is observed that the pandemic period has a statistically significant and negative impact on household final consumption expenditures. According to this result, it can be said that the increase during the pandemic caused a decrease of approximately 15% in household final consumption expenditures. To observe the impact of digital payment systems during the pandemic, the term DPS pandemic interaction has been included in the model. It is observed that there is a statistically significant and positive relationship between DPS pandemic interaction and household final consumption expenditures. According to this conclusion, it can be said that digital payment systems had an increasing effect on household final consumption expenditures during the pandemic period.

Table 5: Estimation Results of Newey–West Standard Errors for Model 1

lnHFCE	**Coefficient**	**Std. err.**	**t**	**P>|t|**	**[95% conf. interval]**	
lnDPV	.821549	.0609471	13.48	0.000***	.6957604	.9473377
lnCPI	-.1186442	.0714469	-1.66	0.110	-.2661034	.0288149
lnDIR	-.1941789	.2098097	-0.93	0.364	-.6272049	.238847
lnCIR	.3083278	.2212336	1.39	0.176	-.1482759	.7649314
lnCCI	-.192041	.2809437	-0.68	0.501	-.7718803	.3877983
Pandemic	-.1533685	.0427688	-3.59	0.001***	-.2414525	-.0652844
DPV_pandemic_interaction	1.12e-07	2.10e-08	5.33	0.000***	6.89e-08	1.55e-07
_cons	2.334271	1.13461	2.06	0.050**	-.002503	4.671044
F(7, 24)	647.93	**Durbin–Watson d-statistic**			1.051713	
Prob > F	0.0000	**Breusch–Godfrey LM**			chi2=10.288	Prob > chi2 0.0013
Number of obs	32	**Breusch–Pagan/Cook–Weisberg**			chi2=3.42	Prob > chi2 0.0644
Maximum lag	4	**White's test**			chi2=26.52	Prob > chi2 0.5442

Note: (***, **) indicate significance at the 1% and 5% levels, respectively.

When examining the diagnostic test results, the F probability value being less than the critical value of 0.05 (Prob > F=0.000) indicates that the model is significant. The Durbin–Watson value, which tests for autocorrelation in the model, being less than the two critical values (1.051713) and the probability value of the Breusch–Godfrey LM test being less than the 0.05 critical value (Prob > chi2= 0.0013) indicates that there is autocorrelation in the model. Since the p-values of the Breusch–Pagan/Cook–Weisberg test and the White test, which test for heteroskedasticity in the model, are greater than the 0.05 critical value (0.0644 and 0.5442), it can be said that there is no heteroskedasticity in the model.

Table 6: Estimation Results of Newey–West Standard Errors for Model 2

lnGSV	**Coefficient**	**Std. err.**	**t**	**P>|t|**	**[95% conf. interval]**	
lnDPV	.5643892	.1083702	5.21	0.000***	.340724	.7880544
lnCPI	.1951416	.1359508	1.44	0.164	-.0854471	.4757304

lnDIR	.1346285	.2217465	0.61	0.549	-.3230338	.5922909
lnCIR	-.2213265	.254387	-0.87	0.393	-.7463554	.3037024
lnCCI	.9710136	.4634798	2.09	0.049**	-.0062008	1.948228
Pandemic	-.4583119	.2015556	2.27	0.030**	-1.075062	.1584386
DPV_pandemic_interaction	5.25e-08	1.76e-08	2.98	0.006***	1.65e-08	8.86e-08
_cons	5.920672	2.290512	2.58	0.016**	1.193286	10.64806
F(7, 24)	153.17	**Durbin–Watson d-statistic**			1.382553	
Prob > F	0.0000	Breusch–Godfrey LM			chi2=13.354	Prob > chi2 0.0097
Number of obs	32	Breusch–Pagan/Cook–Weisberg			chi2=2.450	Prob > chi2 0.1175
Maximum lag	4	**White's test**			chi2=30.31	Prob > chi2 0.3484

Note: (***, **) indicate significance at the 1% and 5% levels, respectively.

In Table 6, the results of the Newey–West Standard Errors estimator, along with the diagnostic tests and their results for the model, are presented. When Table 7 is examined, it is observed that digital payment systems have a statistically significant and positive effect on the gross savings value. According to this result, a 1% increase in digital payment systems can be said to cause an approximately 56% increase in the gross savings value. As a control variable, no statistically significant relationship has been found between the consumer price index, deposit interest rate, and consumer loan interest rate included in the model and the gross savings value. However, among the control variables, it is observed that there is a statistically significant and positive relationship between the consumer confidence index and the gross savings value. According to this result, it can be said that a 1% increase in the consumer confidence index leads to an approximately 97% increase in the net savings value. To observe the independent effect of the pandemic period, a pandemic dummy variable has been added to the model. It is observed that the pandemic period has a statistically significant and negative impact on the household gross savings value. According to this result, it can be said that the increase during the pandemic caused a decrease of approximately 46% in household savings. To see the impact of digital payment systems during the pandemic, the term DPS pandemic interaction has been included in the model. It is observed that there is a statistically significant and positive relationship between DPS pandemic interaction and household final consumption expenditures. According to this conclusion, it can be said that digital payment systems had an enhancing effect on household gross savings during the pandemic period.

When the diagnostic test results are examined, the F probability value being less than the critical value of 0.05 (Prob > F=0.000) indicates that the model is significant. The Durbin–Watson value, which tests for autocorrelation in the model, being less than the two critical values (1.382553) and the probability value of the Breusch–Godfrey LM test being less than the 0.05 critical value (Prob > chi2= 0.0097) indicates that there is autocorrelation in the model. Since the p-values of the Breusch–Pagan/Cook–Weisberg test and the White test, which test for heteroskedasticity in the model, are greater than the 0.05 critical value (0.1175 and 0.3484), it can be said that there is no heteroskedasticity in the model.

5. CONCLUSIONS

The aim of this study is to analyze the impact of digital payment systems (such as mobile payments, digital wallets, and contactless cards) on household savings rates and spending habits in Turkey. For this purpose, quarterly data from the years 2016Q1-2023Q4 have been used. In the analysis of the obtained data, the Newey–West Standard Errors Estimator, which is a robust estimator, has been utilized. In the study, the gross savings value and household final consumption expenditure were used as the dependent variable, while digital payment systems were used as the independent variable. The consumer price index, deposit interest rate, consumer loan interest rate, and consumer confidence index, which are considered to have a direct and indirect effect on household final consumption expenditures with the gross savings value, have also been used as control variables. Again, to examine the effects of the Covid-19 pandemic crisis on the dependent variables, the pandemic dummy variable and the digital payment systems pandemic interaction term have been included in the models.

The aim of this study is to analyze the impact of digital payment systems (such as mobile payments, digital wallets, and contactless cards) on household savings rates and spending habits in Turkey. For this purpose, quarterly data from the years 2016Q1-2023Q4 have been used. In the analysis of the obtained data, the Newey–West Standard Errors Estimator, which is a robust estimator, has been utilized. In the study, the gross savings value and household final consumption expenditure were used as the dependent variable, while digital payment systems were used as the independent variable. The consumer price index, deposit interest rate, consumer loan interest rate, and consumer confidence index, which are considered to have a direct and indirect effect on household final consumption expenditures with the gross savings value, have also been used as control variables. Again, to examine the effects of the Covid-19 pandemic crisis on the dependent variables, the pandemic dummy variable and the digital payment systems pandemic interaction term have been included in the models.

According to the findings of the research, it has been concluded that digital payment systems generally have a statistically significant and positive impact on household final consumption expenditures. According to this result, the H2 hypothesis stating that "the widespread adoption of digital payment systems increases individuals' spending amounts" has been supported. Similarly, it has been concluded that digital payment systems have a statistically significant and positive impact on household gross savings values. According to this result, the H1 hypothesis stating that "the widespread use of digital payment systems reduces individual savings rates" has not been supported. According to these two results, the H3 hypothesis, which states that "the use of digital payment systems has a negative impact on individuals' consumption tendencies," has been supported. Among the control variables, no statistically significant relationship has been found between the deposit interest rate and household final consumption expenditures and gross savings values. According to this result, the H4 hypothesis, which states that "the impact of digital payment systems is independent of deposit interest rates," has been supported. No statistically significant relationship has been detected between consumer loan interest rates and household final consumption expenditures and gross savings values. According to this result, the H5 hypothesis stating that "the impact of digital payment systems is independent of consumer

credit interest rates" has been supported. No statistically significant relationship has been found between the consumer price index and household final consumption expenditures and gross savings values. According to this result, the H6 hypothesis, which states that "the widespread adoption of digital payment systems increases the inflation rate," has not been supported. Finally, no statistically significant relationship has been identified between the consumer confidence index and household final consumption expenditures. According to this result, the H7 hypothesis, which states that "the adoption rate of digital payment systems has a negative relationship with the consumer confidence index," has not been supported. It has been concluded that there is a statistically significant and positive relationship between the consumer confidence index and the gross savings values. According to this result, the H8 hypothesis, which states that "the adoption rate of digital payment systems leads to an increase in gross savings values," has been supported.

When the pandemic dummy results were examined, it was concluded that the pandemic had a statistically significant and negative impact on both household final consumption expenditures and gross savings values. It is believed that various factors are influential in the formation of this result. These factors; due to the pandemic, as people were forced to stay at home, spending on travel, dining out, entertainment, and other social activities significantly decreased. This situation led to a decrease in overall consumer spending. People avoided holiday and entertainment expenses that required large amounts and tended to spend less. Due to restrictions and social distancing measures, people have focused their spending on meeting basic needs. Therefore, while spending in areas such as clothing, entertainment, and luxury consumption decreased, spending in areas such as food and basic necessities remained stable or increased. During the pandemic, many people lost their jobs or experienced a loss of income. This situation caused people to experience cash flow problems. Instead of saving, they had to use their available resources to meet their basic needs. Additionally, their tendency to save decreased because they focused only on basic needs to make a living with government support. In some countries, the economic support provided helped people meet their basic needs, but this support was generally temporary and did not affect long-term saving habits. While people were trying to survive with these supports, they couldn't find enough resources to save. The term "DPV_pandemic_interaction" refers to a variable that examines the interaction of digital payment systems with the impact of the pandemic. In other words, it is a term created to analyze or evaluate the impact of the pandemic on the use of digital payment systems. It has been concluded that this term is statistically significant and positively effective both with household final consumption expenditures and with gross savings values. During the pandemic period, the use of digital payment systems increased. These systems made shopping easier and allowed people to quickly purchase the products they needed. Especially due to the necessity of staying at home, the widespread use of online shopping has increased household consumption expenditures. However, at the same time, there may have been a period when people increased their savings due to staying at home and having fewer opportunities to spend money outside. This situation may have been supported by the increase in household spending along with the use of digital payment systems.

Training programs and campaigns can be organized to inform the public about the advantages and security of digital payment systems. This facilitates users' transition to digital payments and enhances their sense of security. It is important to develop the necessary infrastructure to increase the accessibility of digital payment systems. Investments should be made to increase access to digital payments, especially in rural areas and low-income regions. To ensure the security of digital payment systems, regulatory frameworks should be established, and strict security measures should be taken to protect users' data. This increases consumer confidence. Financial support and incentive programs can be created for businesses and consumers adopting digital payment systems. This can direct both businesses and individuals towards digital payments. By developing programs that encourage saving habits, individuals can be supported in achieving their savings goals through expenditures made via digital payment systems. Consumers can be advised to review their spending habits and set savings goals while using digital payment systems. This helps reduce unnecessary expenses. Consumers can be encouraged to use budget management applications to track their spending habits on digital platforms. These applications help keep expenses under control. It is recommended that they use savings accounts and automatic savings programs integrated with digital payment systems. Such applications strengthen the habit of saving. For future studies; long-term effects can be examined, different demographic groups can be analyzed, global comparisons can be made, and the impacts of digital payment systems during economic shocks and crises can be investigated. Again, digital payment systems can be examined separately rather than as a whole.

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