ABSTRACT PROCEEDINGS BOOK



2nd INTERNATIONAL DATA ANALYTICS AND MACHINE LEARNING CONFERENCE

DATAMACLEA'25

5-6 May, 2025

ECONOMETRIC RESEARCH ASSOCIATION
ANKARA YILDIRIM BEYAZIT UNIVERSITY (AYBU)
INSTITUTE FOR INTERNATIONAL RELATIONS AND STRATEGIC RESEARCH (ULISA-IIRSR)

Editors

Sidika Basci, Ibrahim Demir, Elmas Bener Otaci & Muhammed Oruc



2nd International Data Analytics and Machine Learning Conference (DATAMACLEA'25)

Conference Overview

The Econometric Research Association (ERA) successfully organized the 2nd International Data Analytics and Machine Learning Conference (DATAMACLEA'25) on May 5–6, 2025. The event was held both face-to-face at Ankara Yıldırım Beyazıt University, Etlik Milli İrade Campus and online, ensuring broad international participation.

This year's main theme was:

"The Economics of Data: Foundations for Policy and Regulation."

The conference emphasized how data has become central to policymakers and regulators, serving as the "fuel" of the digital economy while also emerging as a key geopolitical issue. Despite the growing importance of data, the underlying "economics of data" remains underexplored. The conference aimed to foster a deeper understanding of data's economic features, such as its nature as an economic good and the value chain associated with it. The discussions stressed the need for sound economic reasoning to guide data policy, regulation, and the design of data spaces.

The event was organized in cooperation with Ankara Yıldırım Beyazıt University, Institute for International Relations and Strategic Research (ULISA- IIRSR).

Topics Covered

Participants presented original research papers and case studies aligned with, but not limited to, the following areas:

1. Data Economy and Policies

- Data policy and regulation of data spaces
- Data and the digital economy
- Economics of data
- The nature of data as an economic good
- Value chains associated with data

2. Machine Learning and Data Mining

- Machine learning models and algorithms (unsupervised learning, deep learning, reinforcement learning, ensemble methods)
- Data mining and big data analytics (feature engineering, dimensionality reduction, anomaly detection, text mining, web scraping)
- Scientific machine learning approaches
- Simulation and machine learning interactions
- Applications of machine learning approaches

3. Predictive Analytics and Forecasting

- Predictive analytics and modeling (demand forecasting, risk analysis, market dynamics, econometric modeling)
- Time series analysis and forecasting (econometric forecasting, signal processing, trend analysis, anomaly detection)

4. Natural Language Processing and Financial Data Analytics

- Natural language processing for economic insights (sentiment analysis, opinion mining, financial news analysis, chatbots)

5. Statistical Learning and Inference

- Bayesian methods, causal inference, machine learning interpretability, and statistical model selection

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May 2025



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ABSTRACT PROCEEDINGS BOOK

2ND INTERNATIONAL DATA ANALYTICS AND MACHINE LEARNING CONFERENCE (DATAMACLEA'25)

Matthias Finger*

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Regulating Data and Data Spaces

Data are becoming the key focus of policy makers and regulators, not only because they are the "fuel" of the digital economy, but also because they are turning into a geopolitical issue. However, the "economics of data" I still not well understood and even less so research, thus opening the ground for all kind of more or less justified policy interventions. I my keynote speech I will highlight the basic economic features of data, i.e., the nature of data as an economic good on the one hand and the value chain associated with data on the other hand. I will argue that any data policy and regulation and even more so of data spaces will have to be grounded in such solid economic reasoning, and I will outline what such economic reasoning will concretely mean for data policy and the regulation of data spaces.

Keywords: Data Economy, Digital Platforms, Regulation, Platformization, Network Effects.

JEL Codes: L86, L51, O33, D85.

Asad Zaman*

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Causality, Correlation, and the Illusion of Objectivity in Machine Learning

In the world of data analytics and machine learning, correlation is observable, but causation is not. While econometricians recognize that causality is embedded in the model—the story we construct about the data—machine learning often assumes that the data itself reveals the underlying structure of reality. However, causal inference is inherently flexible: given any observed correlation, one can construct multiple, conflicting causal narratives. This malleability challenges the widespread belief that machine learning can uncover objective causal relationships simply by processing vast amounts of data. Instead, AI models reflect the assumptions, biases, and narratives embedded in their training, rather than discovering an independent, data-driven truth. Through a concrete example, this talk will illustrate how the same dataset can support entirely different causal interpretations, highlighting the fundamental limitations of machine learning in uncovering causality. Understanding these limitations is crucial for developing responsible AI systems and avoiding misplaced trust in algorithmic decision-making.

Keywords: Causality, Correlation, Machine Learning, Counterfactuals, Algorithmic Bias.

JEL Codes: C18, C50, C81, D83, O33.

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Assessing the Moderating Role of Policy Effectiveness for Climate Neutrality: A Quantile-Based Panel Analysis

The European Union has been a leader in global climate action, driven by ambitious environmental policies and investments in green innovation. The relationship between economic development and climate change is particularly significant for EU countries, given their stage of development and the climate challenges they face. This study explores the mediating role of environmental policies in climate change mitigation. Specifically, this study investigates the Environmental Policy Stringency Index (EPS) as a mediator in promoting climate change mitigation technologies, focusing on public sector R&D and venture capital investments. The study also examines the impact of economic growth, trade openness, FDI, and green technology diffusion, using data from 30 EU countries spanning from 2000 to 2020. Through the application of panel quantile regression, the results show a positive mediating effect of EPS on public R&D across all quantiles, while a negative effect of EPS on climate change mitigation via venture capital is observed between the 10th and 80th quantiles. These findings emphasize the need for expanding environmental policies to create incentives and supportive frameworks that encourage venture capital investments in sustainable technologies while also increasing public R&D funding. This study underscores the crucial role of strong environmental policies in accelerating the EU's transition toward climate neutrality.

Keywords: Environmental Policy, Climate Change Mitigation, Public R&D, Venture Capital, Panel Quantile Regression.

JEL Codes: O13, Q50, Q54, O52.

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Artificial Intelligence in Central Banking: A Nexus for the Future

The emergence of artificial intelligence (AI) marks a transformative shift in central banking, presenting new opportunities for economic forecasting, financial supervision, and operational efficiency. Traditionally, central banks have depended on structured frameworks and statistical models, but AI technologies—particularly machine learning and generative models—are redefining these core functions. AI models enhance central banks' ability to predict economic trends, detect financial irregularities, and streamline administrative tasks, supporting informed decision-making in complex, data-driven environments. Despite these advantages, AI adoption introduces significant challenges, including data security concerns, systemic risk, and algorithmic bias. Central banks must navigate these risks through robust data governance, ethical AI frameworks, and strategic human capital investments. This article examines AI's applications, risks, and strategic requirements in central banking, illustrating how early adopters like the European Central Bank and BIS Innovation Hub leverage AI for forecasting and regulatory compliance. By fostering international collaboration and transparency, central banks can responsibly harness AI's potential to strengthen financial stability and maintain public trust. This balanced approach underscores AI's role in enabling central banks to adapt to an evolving global financial landscape while safeguarding ethical standards and regulatory integrity.

Keywords: Artificial Intelligence, Central Banking, Economic Forecasting, Financial Stability, Regulatory Compliance.

Jel Codes: E58, G21, C45, C63.

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Machine Learning for Stock Return Prediction: Evidence from an Emerging Market

Stock return prediction has always become one of the popular areas of corporate finance. Traditional econometric techniques, such as the Capital Asset Pricing Model or Fama-French Tree Factor Model-based approaches, are frequently employed in the previous literature. Recent developments reveal the usefulness of machine learning (ML) techniques in stock price prediction as well as in other areas of corporate finance. This study aims to develop a predictive model based on analyzing the fundamentals of stocks traded in the Borsa Istanbul (BIST) stock exchange and investigates the usefulness of machine learning techniques in predicting stock returns within the scope of the Turkish stock market. Our primary contribution lies in applying ML techniques to analyze a large set of firm fundamentals' effect on the stock returns in the BIST to provide empirical evidence on the predictive power of these techniques within an emerging market context.

The dataset comprises quarterly data from January 2010 to December 2024, encompassing 378 stocks listed on Borsa Istanbul. Firm-level variables were collected from the Public Disclosure Platform of Türkiye, and macroeconomic variables were obtained from the Electronic Data Delivery System of the Central Bank of the Republic of Türkiye. Time and industry dummies are also used as predictive features. The final sample dataset with 16,762 observations is split into training and testing subsamples, with 75% allocated for training and 25% for testing to verify the developed model's predictive abilities.

The methodology employed to construct predictive models employs supervised ML techniques, specifically the least absolute shrinkage and selection operator (LASSO) and elastic net. Our results revealed that the LASSO and elastic net algorithms showed similar predictive capabilities with R-squares up to 0.40 in the test samples. Besides, the factors related to the firm profitability and value growth are detected as the most influential determinants of stock returns. Our findings suggest that ML techniques can effectively capture complex relationships within financial data, providing valuable insights for investors and firms.

Keywords: Asset Pricing, Machine Learning, LASSO.

JEL Codes: G12, C58.

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AQI Forecast: A Machine Learning Approach for Ankara

This study explores whether adding high-resolution meteorological data to standard pollutant measurements can enhance the accuracy of Air Quality Index (AQI) forecasts. We used hourly data for some relevant pollutants (PM2.5, PM10, CO, NO?, SO?, O?) and key meteorological factors (temperature, humidity, wind, pressure, solar radiation, precipitation), from different monitoring sites distributed throughout Ankara. We applied a careful preprocessing process with missing data imputation, normalization, and feature engineering. Then estimated newer machine learning models and used regression and classification metrics to evaluate their accuracy of prediction for AQI. Our research contributes to the literature by generating accurate AQI predictions using enriched data and robust modeling techniques for Ankara. Future extensions of our research will include applying these forecasts in different economics areas, such as health, environmental, and development economics, to support informed policymaking.

Keywords: AQI Forecasting, Urban Air Pollution (Ankara), Meteorological Data, Machine Learning, Environmental Modeling, Policy-oriented Analysis.

Jel Codes: Q53, Q58, C53, C55.

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Pricing Behavior in a Dynamic Duopoly

This paper experimentally investigates the pricing dynamics in a duopoly setting, focusing on the two equilibria proposed by Maskin and Tirole (1988): tacit collusion through monopoly pricing (the kinked demand equilibrium) and the Edgeworth price cycle. We designed a laboratory experiment closely following their framework, employing an alternating-move duopoly game where participants choose prices. The experiment consists of three treatments, differing in initial prices and discount rates. A fourth treatment introduces a capacity constraint for firms. Our results reject the kinked demand equilibrium as the null hypothesis based on observed price responses. Moreover, while some characteristics of Edgeworth cycles are visible, they do not emerge fully in the data. Across treatments, we observe a pattern of myopic price-cutting behavior, where participants predominantly lower prices to undercut competitors. This leads to convergence toward a low-markup equilibrium in most sessions. Overall, our findings suggest that participants tend to follow a myopic Bertrand strategy, resulting in prices just above marginal cost.

Keywords: Pricing Behavior, Imperfect Competition, Maskin-Tirole Model, Tacit Collusion, Edgeworth Cycle, Bertrand Undercutting.

Jel Codes: C92, D43, L13.

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Even Announcement Matters? The Effect of CBAM On Turkish Exports and Exporters

This study examines the impact of the first Carbon Border Adjustment Mechanism (CBAM) announcement on Turkish exports and exporters. Using firm-level data from 2019 to 2023, we analyze the effect of CBAM exposure on export values, product and destination diversification, unit prices, and firms' investment and credit decisions by employing a difference-in-differences framework.

Keywords: CBAM, Firm-Level Effects, Export, Investment.

Jel Codes: F18, H23, C33.

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The Choice for Econometrician, Statistician, Developer, User, and Outsourcer of Data Analysis

Data analysis has become an essential and integral part of daily life, scientific research, and business applications. This study delves into the choice of data analysis profession. Data analysis requires a complementary, combined, and interconnected set of knowledge, skills, experience, and equipment. Each set of skills requires significant amount of investment in education, training, and necessary equipment. However, despite the complementary nature of the skills and knowledge, utilizers of data analysis economize on skills and tend to choose the most cost-effective alternative. Thus, a utilizer faces with the choices being an econometrician, statistician, software developer, software user, or data analysis service outsourcer. Each of these choices comes with certain expectations, advantages and disadvantages, which have not been fully investigated. The study seeks answers for whether a data analyst must be equipped with the mathematical and statistical wiring behind the 'user-friendly' software interfaces and which disciplines and professions are more likely to choose a particular functional position for data analysis. The study also discusses how AI will affect the functional positionings in data analysis.

Keywords: Data Analysis, Econometrician, Statistician.

JEL Codes: C18, C80, C87.

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2ND INTERNATIONAL DATA ANALYTICS AND MACHINE LEARNING CONFERENCE (DATAMACLEA'25)

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The Validity of Fisher Effect in Inflation Targeting Regime in Some European Emerging Economies: Albania, Czech Republic and Romania

The aim of this study is to empirically analyse of Fisher effect under inflation targeting regime in emerging European economies Albania, Czech Republic and Romania. Fisher hypothesis states that nominal interest rates has one-to-one adjustment with inflation expectations. The validity of Fisher effect can be used as an indicator for evaluating effectiveness of monetary policy. If central bank implements a contractionary monetary policy to reduce inflation, money supply decreases. The decrease in money supply causes nominal interest rates to increase. Since inflation expectations can be directed by central bank, if monetary policy is effective, nominal interest rates will move in the direction of expected inflation rates. In this case, real interest rates remain constant and are not affected by changes in the money supply and inflation expectations.

The inflation targeting regime is a monetary policy regime widely used in both developed and developing countries. Inflation targeting regime is implemented by setting an inflation target or an inflation target range determined for a period of time and disclosing this target to public in order to achieve and maintain price stability. In countries where inflation targeting is implemented, inflation rates have fallen, inflation volatility has decreased, risk premiums and so nominal interest rates have fallen due to positive effects on expectations.

In this framework, the validity of Fisher effect is tested using central bank policy rate, deposit rate, lending rate, money market rate and treasury bill rate and inflation rate. To do that, Johansen cointegration test, Error Correction Models (ECMs) and Granger causality test are used. The Johansen cointegration test results show that interest rates and inflation rates are cointegrated in Albania and Czech Republic which means there is a long-run relationship between interest rates and inflation rates. In Romania, interest rates and inflation rates are not cointegrated which means no long-run relationship between interest rates and inflation rates.

The long-term estimation results show that there is not a long-term relationship between all the interest rates and inflation rates in Albania, Czech Republic and Romania. The coefficient of inflation rate variable is statistically insignificant in all interest rate estimates. An increase in inflation rate does not cause an increase in nominal interest rates. This result shows that the Fisher effect is not valid in the long term for all interest rates.

The estimation results of ECMs for Albania show that coefficient of ECMt-1 is negative and statistically significant for central bank policy rate and deposit rate. The value of ECMt-1 coefficient of central bank policy rate is 0.04 and the value of ECMt-1 coefficient of deposit rate is 0.03, which indicate 4 percent and 3 percent of deviations from long-term trend in central bank policy rate and deposit rate are adjusted in one month respectively. The value of ECMt-1 coefficient is statistically insignificant for other interest rates. In Czech Republic, coefficients of ECMt-1 are negative and statistically significant for all interest rates. The value of ECMt-1 coefficient varies between 0.05 and 0.09, which indicates 5-9 percent of deviations from long-term trend are adjusted in one month. In Romania, coefficient of ECMt-1 is negative and statistically significant only for lending rate. The value of ECMt-1 coefficient of lending rate is 0.04, which indicates 4 percent of deviations from long-term trend are adjusted in one month. The value of the ECMt-1 coefficient is statistically insignificant for other interest rates.

Granger causality test resuts show that there is no causality from inflation rate to any of the interest rates in all countries. The absence of causality from monetary policy rate to inflation rate shows that the central bank does inflation rates using the policy interest rate.

Granger causality test is also estimated to see the causality between different interest rates. In Albania, there is a causality from central bank policy rate to treasury bill rate and lending rate. The changes in the central bank policy rate lead to changes in treasury bill rate and lending rate. There is also causality from treasury bill rate to lending rate as well as from lending rate to deposit rate. In Czech Republic, there is a causality from central bank policy rate to deposit rate and money market rate. There is causality from lending rate to deposit rate and money market rate as well as money market rate to deposit rate. In Romania, there is a causality from central bank policy rate to deposit rate, lending rate, money market rate and treasury bill rate. It could be said that central bank can affect all interest rates using its policy rate. The money market rate can influence deposit rate and lending rate. The treasury bill rate can lead to changes in deposit rate.

Keywords: Fisher Effect, Interest Rate, Inflation Rate, Inflation Targeting.

Jel Codes: E43, E31.

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Effect Of Education on Mental Health: An Application of the IV Causal Machine Learning

Education is considered one of the most influential factors in the "health—socioeconomic status (SES)" gradient. I investigate the education gradient of mental health using the Türkiye Health Survey 2022.

This study attempts to estimate conditional average treatment effects (CATE) to gauge the possible causality between an individual's educational attainment and having depression by proposing compulsory schooling as an instrumental variable controlling region, cohort effects and social support in the Turkish Health Survey 2022. I adapted the IV technique from econometrics to carry out the estimations. This study provides a novel approach by applying IV specification in machine learning.

Keywords: Social Determinants of Health, Education Gradient of Health, Causal Forest, Conditional Average Treatment Effects.

Jel Codes: C18, I10, I26.

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Exploring the Dynamics Between Inequality and Macroeconomic Variables: A VAR Analysis for Türkiye

In recent years, inequality has emerged as a significant research topic in evaluating the comparative performance of economies and examining its relationship with other macroeconomic variables. Numerous studies have investigated the link between inequality and key macroeconomic indicators, revealing that the nature and magnitude of these relationships vary across regions and countries. Moreover, the literature highlights that even within the same country, the direction and strength of the relationship between inequality and macroeconomic variables can shift across different time periods.

This study examines the relationship between inequality and various economic indicators in the context of the Turkish economy, focusing on per capita GDP, the Consumer Price Index (CPI), asset prices (Istanbul Stock Exchange - BIST100), the exchange rate (USD/TRY), and money supply (M1). Inequality is analyzed through both income and consumption dimensions. Using quarterly data spanning from 2006Q1 to 2022Q4, a Vector Autoregression (VAR) analysis is conducted.

The findings reveal strong and significant relationships between both income and consumption inequality and the selected macroeconomic variables.

Keywords: Income Inequality, Consumption Inequality, Economic Indicators, VAR Analysis.

Jel Codes: E25, E52, C32, E31.

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Tracking Turkish Lira Volatility through News Sentiment Analysis with NLP and Explainable AI

Exchange rates serve as critical indicators of economic health, influencing trade balances, investment flows, and monetary policy effectiveness. In Türkiye, the dramatic depreciation of the Lira against the US Dollar—from approximately 2 to almost 25 between 2015 and 2024—has underscored the urgency of understanding the drivers behind such volatility. This episode was not merely a financial phenomenon but had severe real-economy consequences: inflation surged, purchasing power eroded, and external debt servicing became increasingly burdensome. Traditional economic models often struggle to account for abrupt currency movements, particularly in emerging markets where sentiment and external perceptions play an outsized role.

This study investigates the relationship between media sentiment and exchange rate fluctuations, focusing on the Turkish Lira. Unlike prior research that relies predominantly on social media data, we incorporate both international and domestic news sources to assess their differential impacts. International outlets—The Economist, The New York Times, and The Guardian—are analyzed alongside local perspectives from Yeni Safak and Turkish Twitter discourse. Using natural language processing (NLP) and machine learning, we quantify sentiment and evaluate its predictive power over Lira volatility.

Methodologically, we employ FinBERT for sentiment extraction, followed by machine learning models (Gradient Boosting, Random Forest, and XGBoost) to forecast exchange rate movements. To ensure interpretability, we apply SHAP analysis, which reveals the relative importance of each sentiment source in driving predictions. The results demonstrate a clear divergence in influence: international news sentiment exerts a stronger effect on Lira volatility than domestic sources. Notably, The Economist and The New York Times exhibit the highest predictive power, suggesting that global investors prioritize these outlets when forming expectations about Türkiye's currency. In contrast, local media and Twitter sentiment play a marginal role, highlighting a potential disconnect between domestic narratives and international market reactions. This study contributes to the growing literature on NLP applications in financial economics and demonstrates that media sentiment can serve as a leading indicator of currency instability.

Keywords: NLP, Explainable Ai, Machine Learning, Exchange Rate, Volatility, News Sentiment.

Jel Codes: G17, G15, G00.

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A Fisher-Type Panel Unit Root Test for Bounded Time Series with Cross-Sectional Dependence

This study proposes a novel panel unit root test designed for bounded time series, which frequently arise in economic and financial contexts due to institutional, theoretical, or policy constraints. We adapt the unit root test developed by Cavaliere and Xu (2014), which accounts for bounded processes, to a panel data framework.

In order to take into account cross-sectional dependence, we employ the PANIC approach suggested by Bai and Ng (2004). Specifically, we first decompose the panel into common and idiosyncratic components. The common factor structure is estimated and removed from the original data, and the Cavaliere and Xu (2014) unit root test is then applied to each cross-sectional (idiosyncratic) unit. The p-values obtained are subsequently combined using Fisher's method to test the null hypothesis of a unit root in the panel.

This methodology offers a robust framework for testing unit roots in panel of bounded time series, accounting both for individual-specific bounds and cross-sectional dependence. The Monte Carlo simulations indicate that the proposed panel test shows good size and power properties.

Keywords: Bounded Series, Hypothesis Testing, Panel Data.

Jel Codes: C12, C23, C38.

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A Repeated Cross-Sectional Analysis for Digital Financial Inclusion in Organisation of Islamic Cooperation Countries

We analyzed repeated cross-sectional data available from the World Bank to identify the variables that contribute to digital financial inclusion for the Organization of Islamic Cooperation Countries. For each country the development stages of digital financial inclusion are investigated. The least squares dummy variable model is used to determine the fixed effects in time series panel data and the significant variables in digital financial inclusion.

Keywords: Digital Financial Inclusion, Organization of Islamic Cooperation Countries, Panel Data, Dummy Variable Regression.

Jel Codes: C23, C51, E42, E44, F65, G21, O16, O57.

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Regional Development with Tourism: Perspective of the Local People of Siirt Province

This presentation aims to examine the impact of tourism on regional development within the framework of Siirt province from the perspective of the local people. The presentation focuses on the perceptions, expectations, and social, economic, and environmental impacts of tourism on the local population in Siirt. The research reached 394 participants through an online survey, which consisted of 68 questions. The survey deeply explored the local community's attitudes towards tourism, their levels of participation, and their views on the relationship between tourism and regional development. The survey questions were designed around themes such as income, welfare, development, economy, tourism, infrastructure, quality of life, education, health, transportation, natural habitats, and accommodation, along with demographic information. These questions are adapted from the World Bank's 2023 resources. Hypotheses were developed based on the obtained data and analyzed using statistical methods such as the z-test and chi-square test. The theoretical foundations of the hypotheses are supported by literature sources. As a result of hypothesis testing, tourism did not have a statistically significant positive effect on regional development variables according to the majority of the public in a statistically significant way. This study aims to contribute to a sustainable development model in Siirt province. In the light of the findings obtained, this presentation can be a source for re-evaluating the place of tourism in regional development strategies.

Keywords: Regional Development, Tourism, Siirt, Local People.

Jel Codes: C12, C83, O18, Q56, R11, R15, Z32.

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The Impact of Internet Usage and Per Capita Income on Environmental Quality in Türkiye

The study aims to investigate the impact of the rate of individual internet usage in the total population and the per capita gross domestic product on environmental quality in Türkiye. The load factor capacity variable obtained by dividing the per-person biocapacity by the per-person ecological footprint is used to indicate environmental quality. Period data for the years 1923-2022 are used in this study. Long-run relationships are analyzed using the Augmented ARDL bounds test. In addition, by adding the squared effects of independent variables to the relevant models, it is also determined whether the effects of independent variables on environmental quality change in the long run after a certain threshold point. As a result of the A-ARDL bounds test, a significant cointegration (long-run) relationship was confirmed. According to the estimated long-run coefficients, per capita income initially decreases environmental quality but increases environmental quality after per capita income increases to 11291 US$. On the other hand, the increase in individual internet usage decreases environmental quality after the internet usage rate reaches 8.49%.

Keywords: Internet Usage, Per Capita Income, Environmental Quality, A-ARDL.

Jel Codes: C22, Q00, O13, O44.

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Impact of Distance on Student Preference among Turkish Provinces: A Gravity Model Approach

In Türkiye, students are admitted to universities through centralised examinations, which enable them to choose cities outside the residential town. Over the past two decades, Türkiye has expanded higher education by establishing new universities and augmenting the enrolment capacities of existing universities. Therefore, each province has at least one university, depending on the potential demand for higher education in corresponding region. The establishment of new universities around the country has led to an increase in student mobility among provinces.

We employ a gravity model to analyse higher education student mobility among Turkish provinces, positing that the distance and potential student population of both cities influence student movement between the provinces. We utilise the R package thestats, created by Cavus and Aydin (2023), which is based on the YOK-ATLAS data from 2018 to 2020. We expect that the gravity model will explain the student flows among the provinces of Türkiye.

Keywords: Higher Education, Gravity Model.

Jel Codes: I23, I28, C33.

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Cryptocurrency and Green Economy: Evaluating the Financial Dynamics of Renewable Energy Investments and Digital Assets for Sustainable Growth

In recent years, the convergence of cryptocurrency markets and green finance has increasingly attracted scholarly attention due to their potential to reshape sustainable investment landscapes. The financial mechanisms through which digital assets contribute to renewable energy financing remain underexplored, despite their growing role in alternative investment portfolios. In this study, the relationship between cryptocurrency markets and green energy investments is examined by assessing their impact on sustainable economic growth. The role of blockchain-based financing solutions, including tokenized green bonds and decentralized funding mechanisms, is evaluated in terms of their ability to mobilize capital for renewable energy projects. A quantitative analysis is conducted to explore the correlation between cryptocurrency market trends and investment flows into renewable energy sectors, utilizing econometric modeling to identify key financial linkages. We used the panel data analysis to examine the volatility and risk dynamics of digital assets are analyzed to determine their implications for long-term sustainability-focused investment strategies by using data from WorldBank between the years 2015-2024. Furthermore, the extent to which regulatory frameworks and policy incentives influence the integration of cryptocurrencies into green financing structures is investigated. The findings are expected to provide valuable insights for policymakers, investors, and financial institutions by highlighting the opportunities and challenges associated with leveraging digital assets for sustainable growth. By offering a systematic evaluation of the financial interactions between cryptocurrency markets and green investments, this study aims to contribute to the ongoing discourse on the role of emerging financial technologies in advancing global sustainability goals.

Keywords: Cryptocurrency and Green Economy, Renewable Energy Investments, Sustainable Growth.

Jel Codes: G10, D6, D60.

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A Review of the Intersection Between Behavioral Economics and Artificial Intelligence: Trends, Gaps, and Future Directions

As artificial intelligence increasingly shapes how decisions are made, there's a growing interest in what happens when it meets the often-unpredictable nature of human behavior. This paper explores how insights from behavioral economics—especially our cognitive biases, decision patterns, and irrational tendencies—are starting to influence the way AI systems are designed and applied. By reviewing over a decade of research, we identify major trends, including how AI is used to better understand and even influence human choices, often through personalized approaches. However, we also uncover several blind spots: ethical concerns, gaps in collaboration between fields, and a lack of transparency in how decisions are made by machines. Rather than offering final answers, this paper opens up new questions and directions for research, emphasizing the importance of responsible design, interdisciplinary thinking, and a broader look at how AI could impact society when guided by what we know about human nature.

Keywords: Behavioral Economics; Artificial Intelligence; Cognitive Bias; Algorithmic Design; Behavioral Modeling; Ethical AI; Interdisciplinary Research; AI Ethics; Predictive Analytics.

Jel Codes: D90, D91, O33, C53.

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Demand Deficiency and Inflation in the G20 Countries

In this research, we examine the relationship between nominal and real GDP growth across G20 countries over the period 1990 to 2023. A preliminary visual analysis of the data suggests the existence of a threshold: beyond this point, the relationship between nominal and real GDP growth shifts from positive to flat. Additionally, real GDP growth appears more volatile at higher nominal growth rates. To formally test for the presence of a two-regime nonlinearity, we will employ the Sup F test proposed by Andrews (1993). Given the presence of heteroskedasticity in the data, we will also utilize the Sup MZ test developed by Ahmed et al. (2017), which accommodates unknown change points and allows for heteroskedasticity. These findings can carry important implications for ongoing policy debates surrounding nominal GDP targeting.

Keywords: Growth, Inflation, Macroeconomic Policy, Unknown Structural Change Tests, Nominal GDP Targeting.

Jel Codes: E01, E12, E31, C52.

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Do High Margin Episodes in Turkish Banking Coincide with the Turkish Competition Authority's Investigation Window: Insights from Two- and Three-State Hidden Markov Models

In this research, we examine the relationship between nominal and real GDP growth across G20 countries over the period 1990 to 2023. A preliminary visual analysis of the data suggests the existence of a threshold: beyond this point, the relationship between nominal and real GDP growth shifts from positive to flat. Additionally, real GDP growth appears more volatile at higher nominal growth rates. To formally test for the presence of a two-regime nonlinearity, we will employ the Sup F test proposed by Andrews (1993). Given the presence of heteroskedasticity in the data, we will also utilize the Sup MZ test developed by Ahmed et al. (2017), which accommodates unknown change points and allows for heteroskedasticity. These findings can carry important implications for ongoing policy debates surrounding nominal GDP targeting.

This paper investigates whether episodes of elevated net interest margins in T□rkiye's banking sector coincide with the period of alleged coordinated pricing examined by the Turkish Competition Authority (TCA) between August 2007 and September 2011. Building on qualitative and structural analyses in the TCA's 2013 decision, we offer the first quantitative regime-switching assessment of both consumer and commercial deposit margins using weekly data from the Central Bank of the Republic of Türkiye spanning June 2006 through January 2024.

We construct two series of interest-rate spreads-consumer and commercial net interest margins-by taking the difference between lending rates (consumer or commercial loans) and the overall deposit rate. While these constructed margins cannot fully align loan and deposit maturities, they nevertheless serve as high-frequency proxies for banks' funding cost versus return differentials. We then apply Gaussian Hidden Markov Models (HMMs) with two and three latent regimes to each margin series and estimate all model parameters (initial state probabilities, transition matrix, and state-specific Gaussian means and variances) via the Baum-Welch algorithm. Regime decoding is performed via the Viterbi algorithm, and posterior ("soft") state probabilities are computed to visualize uncertainty in state assignment.

Our two-state specification-interpreting Regime 0 as "normal/competitive" margins and Regime 1 as "elevated" margins-yields a striking result: almost every observation falling within the TCA's investigation window is classified into the lower mean state, with only fleeting excursions into the high margin regime around late 2009/early 2010. Sustained high-margin episodes emerge only after the formal inquiry, notably in narrow pulses around 2011-2012 and more persistently after 2018 (for consumer margins) and 2021 (for commercial margins). Posterior probability plots confirm that the likelihood of the high-margin state remains essentially zero throughout 2007-2011.

We then extend the consumer margin model to three regimes-low, mid, and high. Under this framework, the entire alleged collusion period occupies the mid-margin regime, never entering the highest-margin state. The mid-period classification reinforces the conclusion that the TCA window corresponds to moderate, not peak, margin levels. A three-state model for commercial margins yields a parallel story: the period under scrutiny lies overwhelmingly in the mid-regime, with true high-margin spells only manifesting well after 2011.

These findings challenge the hypothesis that the TCA's alleged coordinated practices caused a sustained structural shift to elevated deposit margins. Instead, the timing of regime transitions aligns more closely with broader macro financial cycles-global liquidity shocks, monetary policy tightening and loosening phases, and exchange rate pressures-than with the period of regulatory scrutiny. While a purely descriptive HMM cannot categorically rule out fleeting or highly localized collusive behaviors, it does demonstrate that any such effects failed to produce a detectable, persistent jump into high-margin regimes at the aggregate level.

Our analysis contributes to both antitrust methodology and banking sector research. Methodologically, it illustrates the utility of regime-switching models as screening tools in competition investigations, complementing documentary and structural evidence.

Keywords: Turkish Banking; Banking Competition; Collusion; Net Interest Margins; Hidden Markov Model.

Jel Codes: G21; G28; L41; L13; C22.

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NonLinear Cointegration Analysis of Export-Import Coverage Ratio in Türkiye between 2013-2024

The non-stationarity of multivariate series is one of the important topics in time series analysis. If two series (say Xt and Yt) are non-stationary of order d and the linear function of these series are stationary, then the series are said to be cointegrated. Engle-Granger and Johansen methods are the most popular methods used to check the cointegration relationship between two series. A similar method based on the periodogram is also used by Akdi (1995), which is a nonlinear technique to check the cointegration relationship between these two series. In this study, we will consider another nonlinear method for analyzing the cointegration of these non-stationary series e.g Xt / Yt. When Xt and Yt represent the export and import series the ratio turns out to the covered of export by import.

Keywords: Export, Import, Cointegration, Stationarity, Forecasting.

Jel Codes: C49, F17.

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Determinants of Dollarizations for Türkiye: Evidence from Augmented ARDL Test

The phenomenon of dollarization has attracted considerable attention from economists and policymakers. This study investigates the determinants of dollarization in T□rkiye over the period from July 1996 to October 2024 by employing an augmented ARDL cointegration test that accounts for both sharp and smooth structural breaks. This enhanced econometric approach allows for a more precise analysis of long-run relationships by addressing potential non-linearities and structural changes in the data. The focus of the study is on the effects of inflation and the real effective exchange rate (REER) on dollarization. The empirical results indicate that inflation significantly contributes to increased dollarization, suggesting that rising price levels diminish public trust in the domestic currency and encourage the use of foreign currency-denominated assets. In contrast, a higher REER-reflecting a real appreciation of the Turkish lira-is associated with lower levels of dollarization. In essence, the depreciation of the domestic currency appears to intensify dollarization tendencies. Furthermore, the time-varying causality analysis shows that the effects of inflation and the real effective exchange rate on dollarization are not constant over time. These relationships appear only in certain periods and differ in strength, indicating that the impact of these variables depends on changing economic conditions.

Keywords: Dollarization, Inflation, Exchange Rate, Augmented ARDL.

Jel Codes: E41, C22, E64.

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Value Systems and Community Welfare: An ABM Based Exploration

This research paper investigates the impact of values ranging from absolute hedonism to absolute eudemonism on societal well-being, utilizing agent-based modeling (ABM) through NetLogo to create a simulated environment. The model features a population of "turtles" that embody diverse socio-economic characteristics, including materialism, altruism, and cooperation, which influence their individual well-being and energy levels. As these turtles navigate an ecosystem with both renewable and non-renewable resources, their interactions and consumption behaviors directly affect their personal well-being and the collective energy of the community. The simulation employs varying value indices, revealing a significant beta coefficient of 0.62, indicating a strong correlation between societal values and overall well-being. The findings underscore the importance of understanding how different value orientations influence not only individual behaviors but also community welfare and resource sustainability. This study has critical implications for policymakers and social planners, as it highlights the need to foster values that promote collective well-being and sustainable resource management. By elucidating the relationship between value systems and societal health, the research contributes to ongoing discussions about the ethical foundations of social structures and the role of individual choices in shaping communal outcomes.

Keywords: Agent-Based Modeling, Value Systems, Community Welfare, Social Norms, Computational Economics.

Jel Codes: C63, D02, D64, I31, Z13.

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Forecasting the XBANK Index in Türkiye Using Macroeconomic Indicators: A Model Comparison with Ensemble Learning Methods

The objective of this study is to predict the monthly closing prices of the BIST Bank Index (XBANK) utilising macroeconomic and financial indicators. The explanatory variables encompass the real exchange rate, inflation, the consumer confidence index, the policy rate of the Central Bank of the Republic of Türkiye (CBRT), the growth rate of M2 money supply, CBRT reserves, deposits, the industrial production index, the Türkiye CDS spread, and the VIX fear index. In the initial evaluation, three machine learning models – GradientBoosting, XGBoost, and RandomForest Regressor – with the highest predictive power were identified using the LazyRegressor method, and hyperparameter optimization was performed on these models. The performance of the models was evaluated using the R^2 and RMSE criteria. The most successful result was obtained with the GradientBoosting model, which had an R^2 score of 0.99. Pursuant to feature importance analysis, it was determined that inflation (37%), policy interest rate (29%), and Central Bank of the Republic of Türkiye (CBRT) reserves (13%) were the variables exerting the most influence on the movements of the banking index. The findings of this study suggest that monetary policy and macroeconomic stability exert a significant influence on the stock performance of the Turkish banking sector.

Keywords: Stock Market Prediction, Machine Learning, XBANK, Gradient Boosting.

Jel Codes: C53, G17, E44.

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Consistency of the Central Bank of the Republic of Türkiye's Policy Stance with Its Discourses: A Fuzzy Logic Analysis

The study applies fuzzy logic to assess the CBRT's monetary policy stance from 2011:09 to 2019:12. Using mutual information for variable selection, fuzzy C-means clustering classifies the stance as loose, moderate, or tight. While the CBRT maintained a rhetoric of tightness, only the period between June 2018 and July 2019 aligned with model results. In other periods, declared stances and model outputs were inconsistent, revealing gaps between discourse and action.

Keywords: Monetary Policy, Central Banking, Mutual Information, Fuzzy Logic, Fuzzy C-Means.

Jel Codes: E52; E58; C69.

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Efficiency and Cross-Country Convergence in Circular Economy: A Comparative Analysis of EU Member States

In 2019, the European Commission introduced the European Green Deal, aiming to make the EU the first climate-neutral continent. This ambitious initiative underscores the EU's commitment to addressing environmental challenges and achieving sustainable development. Central to this effort is the transition to a circular economy, which plays a vital role in advancing the EU's environmental and economic agenda. However, this transition is both complex and costly, leading to uneven performance among member states due to national idiosyncrasies, varied political legacies, and economic conditions. This study examines circular economy efficiency in the EU countries from 2010 to 2021, employing Data Envelopment Analysis (DEA) to rank the performance of member states. The analysis highlights efficiency improvements and identifies best practices. Additionally, the paper compares country groups and clusters based on their performance. By examining convergence and divergence dynamics over time, this study provides insights essential for designing tailored policies and enhancing their implementation across the EU.

Keywords: Circular Economy, Ranking, İnternational Economics, Data Envelopment Analysis, European Countries.

Jel Codes: F64, Q50, Q55, Q58, O52, O57.

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Introducing The Synergy Based Approach for Forecasting the Crude Oil Prices with Traditional and Machine Learning Econometric Models

This study forecasts synergy-based results of crude oil prices using convnetional econometric and machine learning TOOLS. The daily data used from 2018 to 2024, employing the Ensemble Empirical Mode Decomposition (EEMD) technique and spectral analysis, synergy-based models optimised through Bayesian method. Results were compared through loss functions like MAE, RMSE, MAPE and forecasting accuracy verified by Diebold Mariano test.

Keywords: EEMD, Spectral Analysis, ARIMA, LSTM, XGBOOST, Hybrid Econometric Models, Synergy.

Jel Codes: C32, C45, C53, Q41, Q47.

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Can Religion Nudge people to Lower Smoking: Evidence from Ramadan

In this study, we examine whether religiosity affects people's levels of smoking. We use the month of Ramadan as an exogenous change for religiosity. Individual level data from the survey shows that full fasters reduce their smoking by 53% during Ramadan compared to the pre-Ramadan sample. Cigarette sales drop as much as 14% in the month of Ramadan in Türkiye overall. A regular Ramadan day lowers cigarette sales around 0.8%. Reduction in Ramadan is much higher in more religious provinces.

Keywords: Smoking, Nudge, Choice Environment, Ramadan.

Jel Codes: I12, Z12, D03.

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A Review of Composite Time Series Analysis Methods

This study presents a systematic review and bibliometric analysis of the scientific literature in the field of compositional time series analysis. Compositional time series involve the temporal analysis of data whose components sum to a constant and are inherently constrained in nature. By examining publications from 2000 to 2025 obtained from Web of Science database, we identify research trends, influential works, collaboration networks, and emerging sub-domains in the field. Bibliometric network analysis reveals increasing applications of compositional time series particularly in environmental sciences, econometrics, and health domains. Our findings demonstrate methodological advancements based on Aitchison geometry, as well as the growing utilization of machine learning and artificial intelligence techniques in compositional time series forecasting and classification. Co-citation and bibliographic coupling analyses reveal an evolution from theoretical foundations to applied studies, with a significant increase in publication volume over the last decade. This study comprehensively evaluates the current state of compositional time series research, aiming to shed light on future research directions.

Keywords: Composite Time Series, Bibliometric Analysis, Review.

Jel Codes: Z00, C22, C80.

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Connectedness Among the Sectors Listed in BIST

This study examines the financial connectedness among 26 sector indices listed in Borsa Istanbul (BIST) from January 5, 2010, to April 7, 2024. The analysis is divided into three distinct periods: pre-COVID-19, during COVID-19, and post-COVID-19, allowing for a comprehensive assessment of how sectoral interconnections evolved throughout these critical phases.

Methodologically, we employ a Post-Double-Selection procedure approach to develop valid post-selection tests for Granger causality. This is complemented by partial contemporaneous correlation networks to capture different dimensions of connectedness.

The findings reveal significant variations in network density across periods. During the COVID-19 period, the network exhibited the highest connectivity with 85 edges, compared to 58 edges pre-pandemic and 78 edges post-pandemic. The central sectors also shifted across periods: Basic Metals (XMANA) dominated the pre-COVID network with the highest degree (10), Information Technology (XBLSM) became extraordinarily central during COVID with 20 connections, and Financial (XUMAL) emerged as the most connected sector post-COVID with 13 connections.

Notably, the Holding and Investment sector (XHOLD) maintained consistently high centrality across all periods, appearing among the top five sectors in degree, closeness, and betweenness centrality metrics. This indicates its structural importance within the Turkish financial ecosystem regardless of market conditions.

Our analysis demonstrates how sectoral relationships transformed during times of crisis and recovery, with increased interconnectedness during pandemic turbulence followed by partial normalization. These insights contribute to understanding systemic risk dynamics in emerging markets and have implications for portfolio diversification strategies, regulatory frameworks, and financial stability monitoring.

Keywords: Connectedness, Network Analysis, Sectoral Stock Returns.

Jel Codes: C32, G10, D85

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Impact of Conflict on Concern for Environment

The climate change, pollution, and other environmental issues continue to have a substantial impact on people's well-being and the health of the planet as a whole, environmental concern has become an issue that is of rising global importance. When individuals express concern for the environment, they can put pressure on politicians and corporations to take action. This may lead to new policies and regulations that promote sustainability and protect the environment. Besides, individuals who are concerned about the environment can raise awareness and educate others about the importance of protecting the environment. This can lead to a ripple effect, as more people become informed and take action to protect the environment. Empirical evidence shows that conflict and military activities significantly affect environment and individuals' attitudes toward environmental issues. In addition to the direct and indirect impact of conflict on environment, conflict may also weaken governance structures and undermine policy effectiveness, including the environmental protection policies. Given the potential impacts of conflict on environmental concern, it is important to better understand this relationship in order to develop effective policies and interventions for environmental protection. Yet, there is a paucity of research assessing the relationship between conflict and environmental concern. This paper aims to contribute to the literature by investigating the impact of conflict on individuals' concern for environment. For this purpose, a unique dataset is employed, linking micro level data from World Values Survey (WVS) Wave 7 to UCDP One-sided Violence Dataset version 22.1. The environmental concern measure is taken from WVS, that asks participants to choose between setting environmental protection against economic growth. Initial empirical findings show that conflict hampers individuals concern for environment. Therefore, efforts to promote environmental awareness may need to be tailored to be effective in conflict affected areas, focusing on conflict resolution and peacebuilding attempts as a means of creating a more stable and secure environment in which individuals are more likely to prioritize environmental concerns.

Keywords: Conflict, Terrorism, Türkiye, World Values Survey.

Jel Codes: Q56, Q51, D74, O13, H56.

