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UVODNA RIJEČ UREDNIKA

Dragi čitaoci,

Dobrodošli u 29. broj časopisa Ekonomski izazovi, koji izlazi već četrnaest godina u kontinuitetu. U ovom broju donosimo vam zanimljive radove iz različitih disciplina, kako ste već navikli. Uveren sam da ćete uživati u čitanju i da ćete naučiti važne stvari o savremenim trendovima u nauci i poslovanju.

Posebno nam je zadovoljstvo da istaknemo kako je naš časopis kategorizovan kao M51 od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije, što nas svrstava među vodeće nacionalne časopise za 2024. godinu. Zajedničkim snagama možemo postići još više.

Do sljedećeg čitanja, želim vam svako dobro.

Glavni urednik: doc. dr Dženis Bajramović

FOREWORD BY THE EDITOR

Dear readers,

Welcome to the 29th issue of the journal Economic Challenges, which has been published continuously for fourteen years. In this issue, we bring you engaging papers from various disciplines, as you are already used to. I am confident that you will enjoy reading them and that you will gain valuable insights into contemporary trends in science and business.

It is our particular pleasure to highlight that our journal has been categorized as M51 by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, placing us among the leading national journals for the year 2024. Together, we can achieve even more.

Until the next issue, I wish you all the best.

Editor-in-Chief: assis. prof. Dženis Bajramović

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NAUČNI ČLANCI

SCIENTIFIC ARTICLES

THE INTEGRATED SYSTEM OF THE EUROPEAN UNION FOR ANALYZING THE FINANCIAL PERFORMANCE OF COMPANIES AND EARLY WARNING OF BANKRUPTCY RISK

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Abstract

The bankruptcy of an enterprise is a devastating phenomenon that affects not only the company undergoing bankruptcy, but also affiliated companies, investors, creditors, and society at large, and it can trigger a domino effect on the economy of the country in which the bankrupt company operated. Following the COVID-19 crisis period, during which the number of corporate bankruptcies in the EU declined due to massive EU and governmental supportive measures to mitigate the effects of the crisis, the fact that bankruptcies can be a lagging phenomenon, and the emergence of new macroeconomic and geopolitical destabilizing factors, the EU is facing a significant increase in the number of bankruptcies across most economic sectors and in the majority of its member states in the post-COVID period. At the same time, the EU is working on enhancing transparency in corporate operations by adopting new digitization strategies and designing a new system providing unified public access to information on company operations, including financial statements, namely the ESAP system. This paper presents a general platform model that utilizes Big Data technologies and machine learning algorithms, which expands the functionalities of the ESAP platform and additionally offers continuous analyses of the financial performance and risk of bankruptcy of specific companies, industries, economic branches, and sectors, national economies of member states, and the EU as a whole.

Keywords: bankruptcy, risk, management, sustainability



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INTEGRISANI SISTEM EVROPSKE UNIJE ZA ANALIZU FINANSIJSKIH PERFORMANSI PREDUZEĆA I RANO UPOZORAVANJE NA RIZIK OD BANKROTA

Apstrakt

Bankrotstvo preduzeća je razorna pojava koja targetira ne samo preduzeće koje je predmet bankrotstva, već i povezna preduzeća, investitore, kreditore, društvo i može imati domino efekat u ekonomiji zemlje u kojem je poslovalo bankrotirano preduzeće. Nakon perioda COVID-19 krize u kojem je umanjen broj bankrotstava preduzeća u EU, usled masivnih mera podrške EU za sanaciju efekata COVID-19 krize, činjenice da bankrotstva mogu biti kaskajući fenomen kao i pojave novih makroekonomskih i geopolitičkih destabilizujućih faktora, u 2024. godini EU se suočava sa značajnim problemom uvećanja broja bankrotstava u najvećem broju ekonomskih sektora i za najveći broj zemalja njenih članica, pri čemu je još u 2023. godini broj bankrotstava premašio razmere pojave ovog krajnjeg ishoda u poslovanju preduzeća iz pre-COVID perioda. EU istovremeno radi na unapređenju transparentnosti u poslovanju preduzeća, kroz donošenje novih strategija za digitalizaciju i projektovanje novog sistema za jedinstveni javni pristup informacijama vezanim za poslovanje preduzeća uključujući i njegove finansijske izveštaje. U radu se predstavlja opšti model platforme koji primenjuje Big Data tehnologije i algoritme mašinskog učenja, koja bi pored pristupa podacima o poslovanju preduzeća u EU obezbedila kontinuirani pristup analizama o uspešnosti u poslovanju partikularnih preduzeća, industrija, privrednih oblasti i sektora, nacionalnih ekonomija država članica i EU u celini.

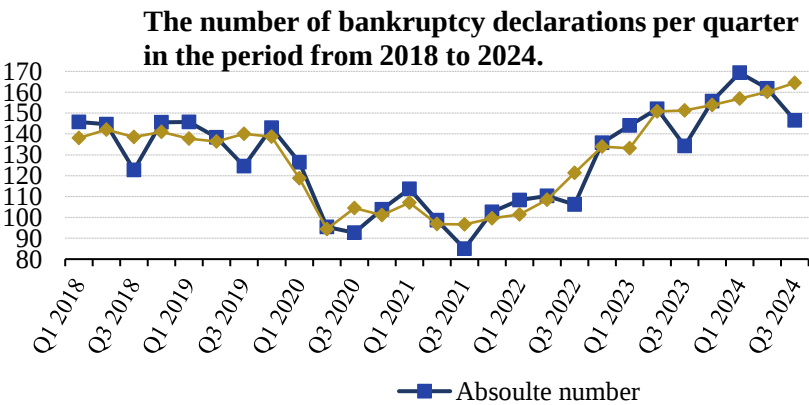
Ključne reči: bankrotstvo, upravljanje, održivost

THE CONCEPT OF BANKRUPTCY AND BANKRUPTCY TRENDS IN THE EU

The video game industry Corporate bankruptcy is a significant event with far-reaching economic and social consequences. Understanding its causes and effects, as well as applying appropriate models for prediction and early identification, is essential for improving the business environment and preventing negative impacts on the economy and society as a whole. Bankruptcy is a legally regulated situation in which a company finds itself when it is unable to meet its obligations to creditors, requiring the settlement of debts from the total value of the bankrupt debtor's assets. As a devastating outcome of insolvency proceedings, bankruptcy not only affects the company itself but also a wide network of its business partners and stakeholders, jeopardizing invested funds during lengthy insolvency procedures and potentially leading to financial deterioration or even loss of liquidity for partner companies. It imposes enormous costs on the bankrupt company, affiliated businesses, society, and the national economy, while also resulting in a prolonged and exhaustive legal process. Furthermore, it has a broader negative impact on the national economy, contributing to rising unemployment, reducing gross domestic product, and diminishing tax revenues. Credit risk is a related concept to bankruptcy, representing the probability of financial loss when a debtor is unable to repay a debt or fulfil contractual obligations (Brown & Moles, 2014). Credit risk analysis is crucial for ensuring the sustainability and profitability of financial institutions as well as the broader economic ecosystem (Gootkind, 2023). Also related to bankruptcy is the

concept of corporate failure, which is generally used to describe financial failure, insolvency, business inactivity, ownership changes, and bankruptcy (Li et al., 2019). On the other hand, company liquidation is a process in which a company is voluntarily or forcibly closed. Unlike bankruptcy, a liquidating company is not necessarily insolvent, meaning that after creditors are settled, owners and shareholders also receive payments, and the liquidation process does not necessarily involve a court (Business Registers Agency, 2023). In the post-COVID era, the importance of studying bankruptcy has been further emphasized, considering that bankruptcies are a lagging phenomenon (Dun & Bradstreet Worldwide Network, 2023). Massive government support measures to mitigate the effects of the COVID-19 crisis, along with temporary adaptations in corporate business policies, have potentially delayed the crisis's impact on bankruptcy occurrences (Matejić et al., 2022). The post-COVID-19 economic recovery has not been without challenges: regional and market segment disparities persist, labor shortages remain an issue, and supply and demand imbalances continue. Meanwhile, external macroeconomic factors such as high inflation rates and geopolitical tensions exert additional pressure on national economies (World Economic Forum, 2024). Furthermore, additional pressures on business survival arise from sophisticated consumer behavior, competitive activities, economic and political pressures, rising living costs, supply chain disruptions, reduced budgets, and higher taxes (Financier Worldwide Magazine, 2024). According to a report from the Eurostat portal (Eurostat, 2024), as shown in Figure 1, the number of bankruptcy declarations in the European Union declined in the first half of 2020, which can be attributed to support measures introduced at the onset of the COVID-19 crisis that temporarily prevented bankruptcies during this period. Until the end of 2021, the number of bankruptcies remained below pre-COVID levels. However, following this period, a rising trend in bankruptcies has been observed, culminating in the third quarter of 2024, with the highest number of bankruptcies initially recorded in the second quarter of 2023, followed by a continued period of steady growth, reaching a new peak in the third quarter of 2024.

Figure 1
Number of bankruptcy declarations in the eu per quarter

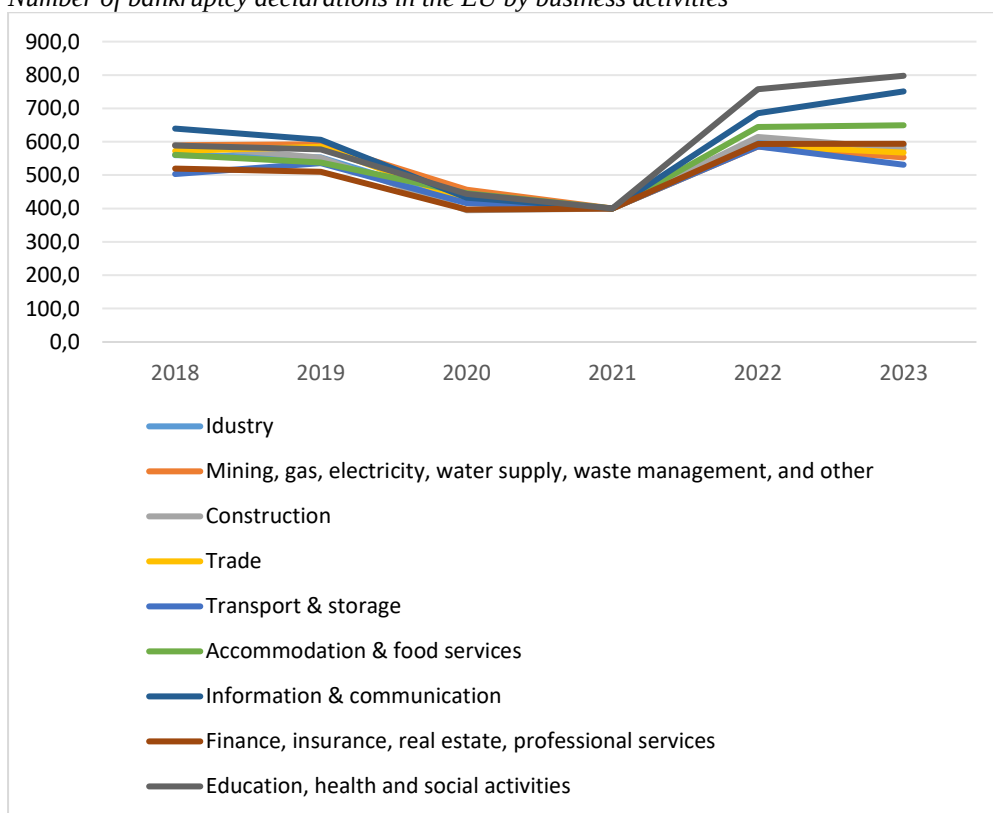


Source: Eurostat (online data code: (sts_rb_q))

As shown in Figure 2, in 2022, the number of bankruptcies in the EU increased across all types of businesses based on their activity. However, in 2023, the number of bankruptcies slightly decreased for a larger number of business sectors, remaining roughly at the same level as in 2021 in the financial services sector, real estate services, insurance, professional services, as well as accommodation and food services. In contrast, bankruptcies were significantly increased among companies involved in information and communication, education, healthcare services, and social activities (Eurostat, 2024). In the first three quarters of 2024, according to the Eurostat portal, for which data on bankrupt companies in the EU are available, the number of bankruptcies increased across all business activity groups compared to the first three quarters of 2023, except for companies engaged in education, healthcare services, and social activities. The largest percentage increase in bankruptcies was observed in the transportation and storage sector, which saw a 23.6% rise, followed by the accommodation and food services sector, which saw a 16.4% increase. The European Union is therefore facing an escalating problem with increasing bankruptcies, where early identification and transparency regarding business groups, economic sectors, national economies, and specific companies facing a heightened risk of bankruptcy can help reduce the number of bankruptcies and prevent wrong investments by creditors and investors.

Figure 2

Number of bankruptcy declarations in the EU by business activities



Source: Eurostat (online data code: (sts_rb_q))

EU INITIATIVES FOR ENHANCING CORPORATE TRANSPARENCY

Transparency is one of the key principles of the European Union, requiring the EU to make information on policy development and spending publicly available while upholding the principle of freedom of information. The Accounting Directive (2013/34/EU) and the Transparency Directive (2004/109/EC) are two fundamental EU regulations that work synergistically to improve transparency and harmonization in corporate reporting across the EU. These directives are continuously updated to align with broader EU legislation, including new standards for sustainability and transparency.

In the European Union, the obligation to submit financial reports, along with the structure and rules for corporate financial reporting, is currently regulated by Directive 2013/34/EU (the Accounting Directive). This directive applies to capital companies, including limited liability companies, public and private joint-stock companies, and other corporate forms that national laws in member states may equate with these entities. It covers subsidiaries of foreign companies but does not include non-profit organizations. The directive aims to enhance corporate transparency and improve comparability among financial reports of companies in EU member states. It mandates that companies, depending on their size and structure, maintain financial statements in a prescribed format, including a balance sheet, income statement, and various supplementary reports. Larger companies are also required to submit a management report on business performance. These financial reports must be filed annually with national registers defined by the member states. This directive establishes a common framework for corporate financial reporting across EU member states by defining a unified structure and reporting rules. However, member states have some flexibility in their implementation, particularly in setting thresholds for different categories of businesses with varying reporting requirements. This flexibility is especially evident for micro and small enterprises, which may receive some exemptions from reporting obligations. Additionally, member states define the rights, levels, and means of public access to these documents according to their national legislation. As a result, financial reporting and public availability of these documents vary across EU member states. For example, in Denmark, financial reports for limited liability companies and joint-stock companies are fully publicly accessible, whereas in Sweden and Finland, partial access is granted, or a fee is required to obtain financial statements. Furthermore, deadlines for submitting reports and specific reporting requirements may differ among member states.

The Transparency Directive (2004/109/EC) focuses on issuers of securities whose instruments are traded on regulated markets within the EU. This directive establishes rules for the disclosure of financial and non-financial information, including annual and semi-annual reports, significant market-impacting events, changes in ownership structure within joint-stock companies, and other relevant information affecting the price of issued securities. According to this directive, issuers of securities must submit their reports in the European Single Electronic Format (ESEF), and these reports must include consolidated financial statements in compliance with International Financial

Reporting Standards (IFRS). The primary goal of this directive is to enhance transparency for investors and protect financial markets from manipulation.

The Business Registers Interconnection System (BRIS) is a network linking business registers across EU member states, providing a single access point to company data via the E-Justice Portal. It is designed to facilitate easier access to information on companies registered in the EU, Norway, Iceland, and Liechtenstein, accelerating and simplifying data exchange, particularly in the case of cross-border transactions and legal proceedings (European Commission, 2017). BRIS is part of the EU's broader strategy to increase transparency and harmonization of business information within the Single Market. This system provides general company information, such as incorporation details, registration status, management data, and, in some cases, financial reports. In March 2023, the European Commission introduced a proposal to expand and improve the use of digital tools and processes. This proposal highlights that relevant information about businesses is still not sufficiently available on national business register platforms or through the BRIS platform, with existing challenges and limitations in data accessibility (European Commission, 2023). The proposal underscores that some crucial data, such as corporate governance details, principal places of business, or corporate group structures, remain unavailable at the EU level and are rarely accessible in national registers. Additionally, data on other economic entities, such as partnerships, which play a vital role in national economies, are not available at the EU level. This proposal includes several key measures, such as the implementation of a "once-only" principle, ensuring that companies do not need to resubmit information when registering a branch or subsidiary in another member state, more frequent data exchange between business registers via the BRIS platform, public and free access to company certificates containing basic company information, authorization for lawyers to represent companies in other member states, integration of the BRIS system with insolvency registers, and other improvements aimed at increasing transparency and efficiency.

As part of the new 2020 action plan, "Capital Markets Union for People and Businesses – New Action Plan" (CMU Action Plan, European Commission, 2020), the European Commission acknowledged the need to improve public access to corporate information, including that of companies, firms, and financial institutions. It also recognized the necessity of enhancing public access to financial and non-financial information of businesses within the EU by establishing a European Single Access Point (ESAP) for such data. The Digital Finance Strategy, introduced by the Commission in the same year, defined the general framework for digital financial transformation in the coming years, particularly in promoting data-driven finance. According to this 2020 strategy, the European Commission advocates for the creation of nine data spaces to stimulate innovation, market transparency, sustainable finance, and business access to financial resources through enhanced data sharing, thereby fostering a more integrated market (Cyber Risk GmbH (n.d.)). The goal is to establish a unified EU-level data space that protects personal and sensitive business information while ensuring open access to high-quality industrial data, thereby stimulating growth and value creation ((Cyber Risk GmbH (n.d.)).

ESAP aims to provide a centralized, digital, and unified access point for information and data from various sources across different EU member states. It seeks to enhance transparency and data availability for investors, companies, regulators, academia, and other stakeholders while supporting sustainable investments by facilitating access to information on companies' financial, environmental, social, and governance (ESG) aspects. The system is intended to cover companies already required to disclose financial and other reports under existing EU regulations, as well as small and medium-sized enterprises (SMEs) that can voluntarily make their information publicly available to increase transparency and attract investors. ESAP is designed to function as a two-layer system, where businesses first submit data to EU agencies, offices, and national authorities, which then transmit structured data to the ESAP platform. The system is planned to begin collecting data in July 2026, while public data dissemination – accessible via API or direct download – is set to commence after July 2027 (Cyber Risk GmbH (n.d.)).

MODEL OF A PLATFORM FOR BUSINESS PERFORMANCE ANALYSIS AND EARLY WARNING OF POTENTIAL CORPORATE BANKRUPTCY IN THE EU

The objective of the proposed technical system is the automatic integration of data from various national business registers in real-time, utilizing Big Data technologies for collecting, processing, and analyzing corporate financial performance data. Additionally, machine learning algorithms would be applied to identify companies, business groups, industries, and national economies with an increased risk of bankruptcy. Such a system could enhance the functionalities of the future ESAP system, which is currently under development. In addition to serving as a centralized access point for corporate business data, the proposed system would leverage Big Data analytics provided by EU authorities to offer continuous insights into the business performance of individual companies, industries, economic sectors, national economies of EU member states, and the EU as a whole. Furthermore, the system would enable the retrieval of data at various levels of processing for research purposes by academic and professional institutions. Moreover, this system envisions the implementation of early warning mechanisms to detect high-risk activities, corporate groups, and individual businesses that may face devastating bankruptcy scenarios. By providing such insights, the system would contribute to the development of strategic policies and action plans to support and stimulate various economic sectors across EU member states. It would also facilitate better coordination of economic policies within the EU and enable timely interventions by regulatory bodies, investors, management structures, and creditors regarding businesses with heightened financial risk and potential insolvency.

The proposed system is designed to collect, process, store, and analyze Big Data using a batch processing approach and machine learning algorithms to identify high-risk businesses, sectors, and national economies. It would also monitor bankruptcy risk trends and actual bankruptcies among companies operating within the EU. Additionally, it could potentially integrate companies from countries in the process of

joining the EU. Data is classified as Big Data when its volume, variety, and velocity reach levels that limit the effectiveness of traditional storage and processing techniques (Pflugfelder, 2013). Big Data has significant potential for improving financial decision-making, risk management, fraud detection, and operational efficiency (Sihombing *et al.*, 2023). It enables the extraction of relevant insights from large datasets using advanced analytics and facilitates timely financial reporting (Xie, 2022). A growing number of studies focus on methods for financial risk analysis, assessment, and prediction using Big Data technologies (Cheng *et al.*, 2021).

Bankruptcy prediction is a field in data science that continues to attract the attention of both the academic and professional communities due to the clear benefits of preventing bankruptcy, not only for companies at risk and their associated partners, creditors, and investors but also for the broader society and economy of a country. Through the development of advanced analytical techniques that incorporate machine learning and deep learning algorithms, the accuracy of bankruptcy assessment and prediction has improved over time (Wang *et al.*, 2024). A review of machine learning and deep learning techniques applied to bankruptcy prediction can be found in the study by Qu *et al.* (2019). Machine learning (ML) is a concept with significant potential, particularly when combined with Big Data, as large datasets allow ML algorithms to uncover more nuanced and subtle patterns, leading to more precise predictions and assessments of analyzed indicators. However, this integration also presents challenges related to the scalability of models and distributed computing (Zhou *et al.*, 2017). ML focuses on designing computer systems that automatically improve through experience (Gandomi & Haider, 2015). Despite its advantages, applying ML algorithms in combination with Big Data introduces numerous challenges that must be considered when developing systems that integrate these two concepts. As data volumes increase, algorithm performance becomes increasingly dependent on the architecture used for data storage. Some algorithms face difficulties in adapting to parallel processing, and issues may arise when dealing with imbalanced datasets, the "curse of dimensionality," model performance degradation due to data noise and heterogeneity, and other related problems (Zhou *et al.*, 2017). Additionally, one of the fundamental requirements of systems that use Big Data analytics and ML tools for bankruptcy prediction is the need for continuous updates of ML models based on new data (Hafiz *et al.*, 2015).

The general model of the EU's centralized platform for financial performance analysis and bankruptcy risk assessment, based on Big Data technologies and implementing machine learning, is presented in Figure 3 and includes several key components:

1. The Data Ingestion Module automatically collects data about companies from national registries of member countries relevant to the financial performance of businesses, including data on bankrupt companies, general company information such as size, number of employees, industry, sector, company type, management structure, and more, as well as macroeconomic and market indicators for the economy as a whole (e.g., inflation rate, unemployment, GDP) and for individual industries from national registries for statistical analysis and reporting (e.g., GDP share, number of employees, demand, etc.), as well as from other institutions for

macroeconomic analyses at the EU level using APIs (such as REST API, GraphQL, etc.). This module includes an API gateway, which serves as the central point for communication with the APIs of national registries and statistical offices, ensuring validation of requests, i.e., checking the correctness and integrity of input parameters, and API authorization and authentication using protocols such as OAuth 2.0, token-based authorization, and others. Additionally, this layer implements a framework for batch data retrieval from APIs and their storage first in the raw data storage and, after ETL (Extract, Transform, Load) processing, in the processed data storage. Technologies such as Apache NiFi or others can be used to define the data collection schedule, enable data retrieval automation, transformation, and the execution of ETL processes in real-time.

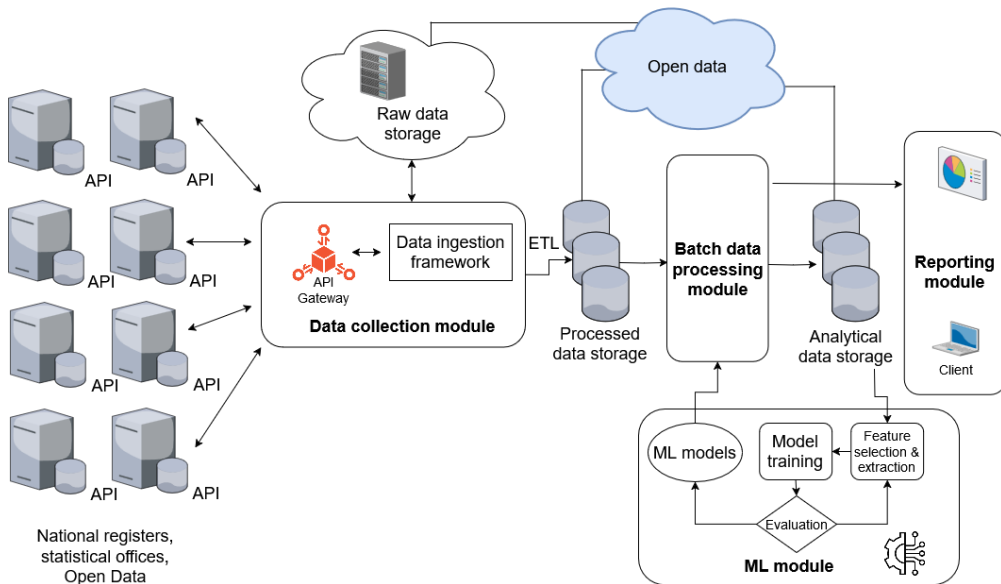
2. The Data Storage Module includes three storage layers: raw data storage, processed data storage, and analytical data storage. After data ingestion, the data is directly stored in raw data storage, which serves as a Data Lake that can be based on technologies such as Amazon S3, Google Cloud Storage, and Azure Blob Storage. These technologies provide storage for large volumes of structured, semi-structured, and unstructured data, ensuring scalability, flexible data analysis using various tools and technologies, and cost efficiency compared to traditional data warehouses. Once stored in this layer, the data collection module applies ETL processes to clean, transform, and standardize the data before moving it to processed data storage. In this architecture, ETL processes are not applied directly during data collection to ensure that data is stored in its original format, allowing for data verification and auditing at later stages, process reproducibility, retrieval, and use of raw data for additional analyses by third parties, and ensuring that ETL processes remain separate and independent from primary data collection. After ETL processing, data is stored in processed data storage in a format suitable for analytics. This storage can be based on technologies such as Data Lakes, Data Warehouses (using solutions like Redshift, BigQuery, Snowflake, etc.), SQL and No-SQL database management systems, or a combination of these solutions. After processing, data from the processed data storage is subjected to batch processing, during which aggregated, summarized, and prepared analytical data – resulting from statistical processing and descriptive analyses – is transferred to analytical data storage and the reporting module. The analytical data storage can implement solutions such as OLAP cubes (e.g., SSAS, Apache Kylin) and analytical Data Warehouses (e.g., Snowflake, BigQuery, etc.). Storing and separating data at different levels of processing and analysis not only provides better insight into potential processing errors and extends the scope of data analysis but also enables data sharing in various formats with the scientific community and the general public, who can use it for further analysis and research.
3. The Batch Processing Module performs statistical processing, grouping, descriptive and exploratory data analysis to identify patterns and trends in data (e.g., an increase in the number of businesses with an elevated risk of bankruptcy). The implementation of this module can use Big Data frameworks

such as Apache Spark, Hadoop Map Reduce, statistical analysis and processing tools such as R and Python, SQL, and OLAP and Business Intelligence tools such as Microsoft SQL Server Analysis Services, Snowflake OLAP, Apache Kylin, and others.

4. The ML Module covers key aspects of developing, training, validating, and deploying machine learning models, with a focus on anomaly detection, business clustering, and predictive analytics. This module includes processes such as (1) *feature engineering and selection*, identifying significant indicators using processed data from analytical data storage through methods like Principal Component Analysis and Feature Importance (using algorithms such as Random Forest, XGBoost, and Multiple Discriminant Analysis); (2) *model training*, including classification models such as Logistic Regression, Random Forest, Gradient Boosting, Artificial Neural Networks, scoring techniques such as Altman, Zmijewski, and Springate, bankruptcy time prediction using models like Cox proportional hazards, anomaly detection in time series using LSTM (Long Short-Term Memory), SARIMA, Autoencoders, as well as clustering algorithms like K-means and DBSCAN for business grouping; (3) *model testing and performance evaluation* using various accuracy indicators and technologies such as MLflow and TensorBoard; and (4) *model integration* into the batch processing workflow. This module can leverage technologies such as MLflow for experiment management, model training, and deployment, libraries such as Scikit-learn, TensorFlow, and PyTorch for model development, Kubeflow for orchestrating ML pipelines in Kubernetes environments, AWS SageMaker and Google Vertex AI for serverless training and model deployment, among others. The ML module utilizes data from analytical data storage, which has undergone multiple processing steps through ETL and batch processing to be optimized for machine learning algorithms.
5. The Reporting Module is responsible for generating visual and textual reports for users using tools such as Tableau and Power BI for reporting, graphic libraries such as D3.js and Plotly, and for generating bankruptcy risk alerts for businesses, industries, and sectors via Slack, Email, or SMS Gateway services.
6. The Orchestration & Monitoring Module is responsible for orchestrating all API calls, ETL, ML, and analytical processes, for which technologies such as Apache Airflow can be used to manage workflows and large-scale data processing. This module also includes components for infrastructure performance monitoring (e.g., Prometheus + Grafana), system logging and analysis (e.g., the ELK stack consisting of Elasticsearch, Logstash, and Kibana), and tracking machine learning processes and model performance using tools such as Evidently AI.

Figure 3

The architecture of the integrated system for analyzing the financial performance of companies



Source: Authors

The proposed model should ensure the scalability of the infrastructure, for which Cloud platforms, service architecture, and Kubernetes can be used for orchestration and service scaling; robustness, i.e., a modular approach in developing its infrastructure, which can reduce errors in individual subsystems; automation to minimize manual work; and compliance with GDPR (General Data Protection Regulation) standards, which regulate the way personal data of EU citizens, who may be users of this system, are collected, processed, stored, and used at the EU level.

CONCLUSION

The European Union continuously demonstrates its commitment to increasing transparency in business operations and reporting as a key step toward enhancing trust, competitiveness, and sustainability in the common market. Transparency enables investors, regulatory bodies, and citizens to make informed decisions while providing businesses with a framework for aligning with high standards of corporate governance and sustainability. The EU's current and future measures, based on data digitization and interoperability, ensure better visibility of economic activities, reduce corruption and business fraud, and create a more favorable business environment in which all actors operate responsibly and in line with the EU's shared values.

The presented system enhances the EU initiative to build a single access point for business data (ESAP) through the integration of functions for analyzing business performance data, financial risks, and bankruptcy risks of companies and business groups, the incorporation of machine learning functionality for early identification of bankruptcy risks, and the possibility of sharing large volumes of data with these analyses and original data with the academic community and other stakeholders. In this way, transparency in business operations can be further improved, providing a foundation for enhancing strategies and action plans, as well as support measures to minimize the destructive and increasingly prevalent phenomenon of bankruptcy in the European economic space. This system enables the development of more efficient policies for managing the risk of bankruptcy at the EU level and improves transparency in the EU business space.

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REZIME

Rad se bavi problematikom porasta broja bankrotstava preduzeća u EU nakon perioda COVID-19 krize, tokom kojeg su masovne mere podrške privremeno smanjile ovaj negativni trend. Međutim, sa postepenim povlačenjem ekonomskih podsticaja i pojavom novih makroekonomskih i geopolitičkih izazova, dolazi do pogoršanja situacije po pitanju bankrotstva. U cilju povećanja transparentnosti poslovanja, EU donosi strategije za digitalizaciju i razvoj sistema za jedinstveni javni pristup podacima o preduzećima, uključujući njihove finansijske izveštaje. Predloženi model platforme zasnovan na Big Data tehnologijama i algoritmima mašinskog učenja omogućava pristup analizama poslovanja na nivou pojedinačnih preduzeća, industrijskih sektora i ekonomija država članica. Dodatno, sistem podržava inicijativu za izgradnju Evropske jedinstvene tačke pristupa poslovnim podacima (ESAP), integrišući analize finansijskih rizika i bankrotstava, kao i funkcionalnosti za rano otkrivanje finansijskih problema korišćenjem veštačke inteligencije. Time se jača okvir za odgovorno poslovanje, smanjuje prostor za korupciju i prevare, te unapređuju strategije za upravljanje rizicima bankrotstva na nivou cele EU. Ovaj pristup omogućava akademskoj zajednici i drugim zainteresovanim stranama pristup obimnim analizama, čime se dodatno osnažuje kreiranje politika koje mogu ublažiti negativne posledice bankrotstva u evropskom ekonomskom prostoru.

LIMITATIONS OF FREEDOM OF CONTRACT WITH SPECIAL REFERENCE TO FREEDOM OF CONTRACT OF BUSINESS ENTITIES

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Abstract

Freedom of contract is a fundamental principle of obligation law, but in modern legal systems it functions as a relative and normatively oriented category. The paper examines the theoretical foundations of this institute, starting from the liberal conceptual core of the autonomy of the will and its historical development, to the modern, functional concept that views contractual freedom in the broader framework of public law restrictions, market discipline, and protection of the weaker party. The analysis includes domestic and comparative law, including standards of European contract law and modern economic indicators (EFW index), in order to indicate the connection between economic and contractual freedom. Special attention is paid to the position of business entities, where contracting has a specific dimension due to their professional status, the complexity of market transactions, and pronounced information asymmetry. Through the analysis of imperative norms, standard and adhesion contracts, regulated markets, and unequal bargaining power, the key practical and systemic limits of business autonomy are pointed out. The results of the work show that these restrictions do not represent a negation of the freedom of contract, but a mechanism for its functional realization - through the provision of legal certainty, fair market conditions, protection of competition, and stability of the economic order. The paper contributes to a better understanding of the modern conception of contractual autonomy in the economy, indicating that the balance between freedom of disposition and public law regulation is the key assumption of an efficient, fair, and sustainable contractual system.

Keywords: freedom of contract; autonomy of the will; limitations of contractual freedom; imperative norms; business entities; public order; business contracts



OGRANIČENJE SLOBODE UGOVARANJA SA POSEBNIM OSVRTOM NA SLOBODU UGOVARANJA PRIVREDNIH SUBJEKATA

Apstrakt

Sloboda ugovaranja predstavlja osnovno načelo obligacionog prava, ali u savremenim pravnim sistemima funkcioniše kao relativna i normativno usmerena kategorija. U radu se razmatraju teorijske osnove ovog instituta, počev od liberalnog pojmovnog jezgra autonomije volje i njenog istorijskog razvoja, do savremenog, funkcionalnog koncepta koji slobodu ugovaranja sagledava u širem okviru javnopravnih ograničenja, tržišne discipline i zaštite slabije ugovorne strane. Analiza obuhvata domaće i uporedno pravo, uključujući standarde evropskog ugovornog prava i savremene ekonomske pokazatelje (EFW indeks), sa ciljem da se ukaže na povezanost ekonomske i ugovorne slobode. Posebna pažnja posvećena je položaju privrednih subjekata, kod kojih ugovaranje ima specifičnu dimenziju usled njihovog profesionalnog statusa, složenosti tržišnih transakcija i izražene informacione asimetrije. Kroz analizu imperativnih normi, standardnih i adhezionih ugovora, regulisanih tržišta i nejednake pregovaračke moći, ukazuju se ključna praktična i sistemska ograničenja poslovne autonomije. Rezultati rada pokazuju da ova ograničenja ne predstavljaju negaciju slobode ugovaranja, već mehanizam njene funkcionalne realizacije – kroz obezbeđivanje pravne sigurnosti, fer tržišnih uslova, zaštitu konkurencije i stabilnost privrednog poretka. Rad doprinosi boljem razumevanju savremenog shvatanja ugovorne autonomije u privredi, ukazujući na to da je ravnoteža između slobode raspolaganja i javnopravne regulacije ključna pretpostavka efikasnog, pravičnog i održivog ugovornog sistema.

Ključne reči: sloboda ugovaranja; autonomija volje; ograničenja slobode ugovaranja; imperativne norme; privredni subjekti; javni poredak; poslovni ugovori

INTRODUCTION

Public order and imperative norms set the limits within which the contracting parties can decide whether to conclude a contract, with whom to do so, and under what conditions. Within these frameworks, the freedom of contract develops, which represents one of the key expressions of the autonomy of the will, because the contractual obligation is based on the parties' own disposition, and not on an imposed rule (Kastrati, 2015, pp. 242-243). The role of the state in contractual relations is limited to ensuring basic formal assumptions and preventing violations of public order, while the contract itself, in the liberal understanding, is understood as an expression of the will of the contracting parties, which in their mutual relationship has the force of law (Douty, 2008, p. 58). Personal liberty allows everyone to commit (by contract) as they wish within the limits of public order. That is the essence of freedom of contract. How far this freedom will move in a society depends on important political and moral circumstances, but also economic and social factors (Ghestin, Goubeaux 1977, 82), whereby the sources of moral norms should be sought in man himself and not in some force outside him (Muratović et al., 2023). More than moral understandings and social customs, it is the law that limits this freedom through coercive norms.

Restrictions on freedom of contract arise from several sources: imperative norms, rules of public order, moral values, principles of conscience and honesty, as well as specific regulations governing economic activities. They ensure that contractual relations do not deviate from the structural values of the legal system or from the economic and social goals of the state. Restrictions related to economic entities are of particular importance, since business contracts are often concluded in conditions of increased market risk, unequal negotiating position, or regulatory requirements that protect competition, consumers, or market stability.

The subject of this paper is a systematic review of the institution of freedom of contract with an emphasis on the nature, scope, and legitimacy of its limitations, especially in the context of contractual relations between economic entities. The aim of the paper is to provide a clear picture of the extent to which the autonomy of the will is limited in modern obligation law and how these limitations are justified, through the analysis of the relevant doctrine, normative framework, and contemporary tendencies. Starting from the methodological framework, the work applies a normative, analytical, and to a certain extent comparative method, whereby the comparative approach does not go beyond the framework that would bring it closer to a full comparative analysis, but still enables an overview of the development of the institute in the domestic legal system and its economic context. After the methodological notes, attention is first directed to the theoretical and normative assumptions of freedom of contract, then to its limitations in the general rules of the law of obligations, and then to the specific limitations to which business entities are exposed in practice. In this way, a more complete overview of one of the central institutes of modern contract law and its role in preserving the stability and legal security of the economic system is provided.

FREEDOM OF CONTRACT AND ITS LIMITATIONS - THEORETICAL AND NORMATIVE FRAMEWORK

The basis of freedom of contract is the assumption that the contracting parties can shape their mutual legal relations independently and without restrictions, which is why this institution is considered one of the most important in modern obligation law. In legal doctrine, different authors define this institute in different ways: some single it out as a special principle of contract or obligation law (Đorđević, Stanković 1987, p.187-188), while others start from the broader idea of autonomy of will and within its framework observe freedom of contract as a technical rule that operationalizes that philosophical concept (Ripert, Boulanger 1957, p. 7). As a result of such an approach, the freedom of contract is defined in the literature as an integral part of the methods of regulation in civil law (Vodinelić 2012, p.38; Gams 1977, p.39). In accordance with that, the imperative norms of civil and narrow obligation law are considered a mechanism that enables the realization of this freedom in practice (Marković 1997, 199; Vodinelić 2012, 38). The modern understanding of freedom of contract is influenced by the understanding that the absence of formal state intervention is not enough if the contracting parties do not have a real opportunity to negotiate on an equal footing, with access to information and without economic pressure. For this reason, real freedom of contract exists only when negotiating positions are balanced,

and legal interventions prevent possible abuse of contractual power (Van Boom, 2025, p. 8-10).

In European private law, it is based on the position that freedom of contract is based on a balance between individual autonomy and social responsibility, which is why the autonomy of the will is limited by rules that ensure the protection of the weaker party, market balance, and public interest (Micklitz, 2015, p. 19). Traditionally, the starting point of this institute is the idea of autonomy of the will, i.e., the ability of the contracting parties to independently decide whether, with whom, and under what conditions they will conclude a contract. However, modern legal systems no longer see freedom of contract as an unlimited and absolute sphere of disposition, but as an institution that functions within a wider normative and social framework. Economic conditions, market development, the power relationship between contracting parties, as well as public law interests of the state, conditioned the gradual transformation of the classic liberal understanding of contractual freedom into the concept of limited, directed, and rationalized autonomy.

Within the framework of the classical-liberal approach, which marked the European legal thought of the 19th century, the contract was understood as a direct expression of the will of the contracting parties, and this will had the effect of law among them. The state had a very limited role in such a concept, reduced primarily to checking the fulfillment of formal assumptions and preventing violations of public order. The continental doctrine of that time emphasized the primacy of the will in relation to positive law, expressed through the position that "the contract stands above the law." Based on such a view, the content of the contract results from the autonomous decision of the contracting parties, and once the consent was given, it had the force of a binding rule among the contracting parties (Douty, 2008, p. 58)

In modern legal theory, the autonomy of the will still occupies one of the key places. Kastrati (2015) points out that it is a "fundamental principle of obligation law" because it allows the contracting parties to independently regulate the origin, changes, and termination of their contractual relations, within the limits prescribed by law. According to the same author, the limits of the contractor's will appear only when their actions would be contrary to imperative regulations, constitutional arrangements, or moral values of society. In this way, it is clearly indicated that the freedom of contract is not an unlimited category, but an institution that functions within the framework of the legal system and its rules.

Contemporary literature further deepens the notion of autonomy of the will. Van Boom (2025) distinguishes the traditional "principled" understanding of autonomy, which originates from liberal philosophy and emphasizes the absence of state interference, from the "substantive" approach that connects autonomy with a realistic balance of bargaining power and the availability of information. In his interpretation, complete autonomy exists only when the contracting parties have equal decision-making opportunities, while in conditions of economic imbalance and asymmetric information, the state has a legitimate reason to intervene in order to prevent exploitative contractual practices.

In the European context, freedom of contract is understood as an integral part of the right to personal self-determination. The Swiss doctrine connects freedom of contract

with the fundamental right of an individual to personal autonomy (Guillod, 2003, 122–123), while in the continental tradition it is emphasized that the contract "binds the parties as a law" (General Property Code for Montenegro, Art. 1007), which confirms the continuity of the idea of the binding force of the contract.

The full obligation of the contract, however, inevitably raises the question of how far the autonomy of the will of the contracting parties extends. Hiber (2022) believes that the limits of freedom of contract are manifested when imperative norms, which deviate from the general rule contained in the dispositive provisions, come into force. While dispositive norms represent a standard rule that the parties can freely change, imperative norms are applied in situations where it is necessary to protect the public interest, moral principles, the economically weaker party, or preserve the essential values of the legal order. In this way, modern legal systems recognize that legislative restrictions on freedom of contract aim to preserve the balance between individual autonomy and wider social interest (Hiber, 2022, 473).

Precisely because of this construction of contractual obligation, the question arises to what extent the will of the parties can act without the intervention of the law. Hiber (2022) emphasizes that these limits are made concrete through the application of mandatory legal norms, which function as an exception in relation to the dispositive character of most rules of obligation law. Dispositive provisions presuppose freedom of choice, while imperative provisions are applied when the law wants to ensure the protection of the weaker party, preserve public morals, or prevent the foundation of the legal system from being undermined. This emphasizes that the modern legislative framework does not restrict the freedom of contracting arbitrarily, but in order to establish a fair balance between the autonomy of the individual and the common interests of society.

Seen from a historical perspective, the concept of freedom of contract has undergone profound changes. In the classical liberal period, the understanding prevailed that contracting parties should enjoy almost unlimited freedom of disposition. However, the subsequent development of European legal systems is marked by increasingly pronounced state intervention, especially in areas that are considered socially sensitive, such as labor relations, consumer protection, and activities subject to regulatory supervision. This development shows that modern law has abandoned the earlier ideas of absolute contractual freedom and turned to a model in which the autonomy of the will is exercised within clearly defined limits. Đurđević and Pavić point out that the freedom of contract in socialist and transitional law developed through the model of "conditional and directed freedom" where the autonomy of the will remained declaratively preserved, but significantly limited by the obligations imposed by economic and planning instruments of the state (Đurđević & Pavić).

In modern legal theory, the position that restrictions are not the opposite of freedom of contract, but its prerequisite, is increasingly prevalent. Van Boom (2025) indicates that the legislator's interventions should not be seen as sporadic exceptions, but as "basic assumptions" that allow contractual autonomy to function in a healthy way, preventing unequal power relations, abuses of contractual position, and disruptions in market movements. Consequently, modern legal systems assume that freedom of contract can only work if it is framed by clear legal rules that ensure a fair relationship and stability.

In the context of domestic law, the Law on Obligations of the Republic of Serbia recognizes freedom of contract as one of the fundamental principles of the law of obligations, but at the same time consistently defines the limits of its validity. The parties are allowed to regulate the content of the contract at will, but this freedom lasts only as long as it does not conflict with mandatory regulations, public order, or rules of good practice. Imperative norms, nullity provisions, the principle of conscientiousness and honesty, the equivalence of actions, and the prohibition of abuse of rights act as corrective mechanisms that ensure balance in contractual relations. In this way, the ZOO shapes the concept of the so-called directed and limited freedom of contract: although the will of the contracting parties remains the starting point for the creation of an obligation, it cannot prevail over the rules that protect the fundamental values of the legal system, the balance of contractual obligations, and the interests of third parties. This model is particularly pronounced in commercial contracts, where economic and informational inequality among contracting parties most often comes to the fore.

In comparative law, especially in European contract law, a similar conceptual shift can be observed - from the classic, liberal understanding of almost unlimited contractual freedom to a model in which the autonomy of the will is realized primarily through the framework of informed and rational choice, with the simultaneous protection of market structures and the weaker party. Grundmann (2002) points out that the issue of party autonomy and its limits is one of the fundamental issues of contract and private law, but that in modern European regulation, the limits are increasingly determined at the supranational, European level, especially when it comes to the structure of the market, and not only the individual weakness of the contractor. There is an important twist: European contract law is progressively giving preference to mandatory information rules over classic imperative norms that directly prescribe the content of the contract. The idea is to enable the parties, especially the economically or informationally weaker party, to make an autonomous, reasonable decision based on complete and comprehensible information, instead of the state preliminarily narrowing the range of permissible contractual contents (Grundmann, 2002, pp. 272-282). This "information model" is clearly expressed in a large part of secondary EU law - in the area of financial services, consumer contracts, distance contracts, package arrangements, consumer loans, etc., where mandatory rules on the disclosure of key data, standardized way of presenting conditions and rights of withdrawal prevail, while the essential shaping of the contractual content is left to the contracting parties in principle. it is possible to ensure "meaningful information" of the contractor, preference should be given to information rules over rigid, substantive bans and orders, because such an approach simultaneously strengthens party autonomy, preserves market mechanisms, and respects the principle of proportionality.

Viewed from a broader systemic perspective, the ZOO of the Republic of Serbia fits into the same conceptual framework as contemporary European tendencies: the starting point is freedom of contract, but it is realized exclusively within the limits of imperative regulations, public order, good customs, and rules of conscience and honesty. In the more recent European theory, it is emphasized even more emphatically

that the information of the parties represents one of the key mechanisms for preserving and strengthening contractual autonomy, instead of reducing it to limiting the content through rigid legal prohibitions. It seems that the development of the institute of freedom of contract is today moving in a direction that is normatively based, but which also opens up certain controversial issues to which the doctrine still does not provide sufficiently precise answers.

The application of the information model and reliance on the corrective role of imperative norms undoubtedly strengthen the protection of the weaker party and contribute to preserving the balance in contractual relations. However, there is a real danger that autonomy of will turns into a formality if one assumes that every decision made with sufficient information is necessarily free, without taking into account the economic pressures, psychological factors, and market constraints under which the parties actually act. It seems that neither the domestic ZOO nor the relevant European regulatory frameworks still offer a precise line of demarcation between the legitimate protection of the economically weaker party and an excessively paternalistic approach of the state, which may have counterproductive effects. Excessive imposition of restrictions can potentially slow down the development of innovative business models and discourage the taking of business risks, which is a natural part of economic life. For these reasons, it seems to us that future development of doctrine and legislation should strive for a more subtle balancing of three key components: real, not just formal, autonomy of will; effective protection of contractual balance; and preservation of the stimulating, developmental role of freedom of contract in economic flows.

FREEDOM OF CONTRACT OF BUSINESS ENTITIES

In economic relations, freedom of contract takes on a different character, which is conditioned by the specifics of market trends, the volume and dynamics of business transactions, as well as the professional nature of the contracting parties. Although it rests on the same fundamental principle of autonomy of will, the position of economic entities differs from that of natural persons, because economic actors operate in an environment that assumes a higher degree of expertise, rationality, and the ability to assess risks. Economic traffic is characterized by rapid circulation of capital, repeated transactions, standardized contractual models, and market competition, which is why freedom of contract in the economy is often described as broader in terms of disposition but more strictly conditioned by the need to preserve market discipline and public interest. Starting from this understanding of economic relations, the importance of human capital and education takes a special place in the analysis of economic development. According to Cvjetković et al. (2025, p. 76), human capital is the driving force behind the economic growth of a country, with the state playing a key role in the development of the education system as a basic mechanism for long-term economic and social progress.

In modern legal systems, it is emphasized that economic freedom, including contractual autonomy, can only be realized if contracts are predictable, stable, and based on legal certainty. The literature points out that freedom of contract is one of the pillars of the market economy, but only if it is accompanied by the obligation of contracts and the consistent application of legal restrictions that prevent disruption of

the market balance. It is assumed that professional participants in the economy have the knowledge and ability to independently assess risks and bear the consequences of contractual provisions, but at the same time, it is recognized that legal intervention is necessary in situations where market conditions create an imbalance in the bargaining power of the contracting parties (Divanefendić, Hakić, Međedović, 2025). Eva Torok states that freedom of contract and economic freedom complement each other and that together they influence market development, business environment, and social progress of national economies. Based on a review of relevant legal and economic literature, the author emphasizes that freedom of contract is one of the pillars of modern private law and a market economy, since it allows parties to independently decide on the conclusion of a contract and thus stimulates economic activity. In the European context, the development of this institute is accompanied by the gradual harmonization of contract law under the influence of the European Union, especially in the areas of consumer law, corporate law, and cross-border business. At the empirical level of demand, the link between contractual and economic freedom can be illustrated through the Economic Freedom of the World (EFW) index, which is composed of five synthetic components: legal system and protection of property rights, state size, monetary stability, international trade freedom, and regulatory burden (Gwartney et al., 2024). state intervention in the economy and the intensity of regulatory barriers to entrepreneurial activity. The more efficient the legal system, the more predictable the regulatory framework, and the less burdened by arbitrary restrictions, the greater the scope for autonomous contracting and long-term planning of business arrangements. Conversely, a lower score on these dimensions typically signals the instability of the legal framework, a propensity for unpredictable state interventions, and formal, but not real, contractual freedom, which in practice is realized under conditions of increased risk and legal uncertainty. In this way, the EFW index provides a framework for understanding how the wider institutional quality and economic policy of the state affect the actual scope of freedom of contract of economic entities.

Van Boom emphasizes that market structures, especially the presence of dominant actors, monopolies, and asymmetric information, have a real impact on the autonomy of the will (Van Boom, 2025, p. 8-11). In such circumstances, small and medium-sized enterprises are often faced with standardized contractual conditions that they are unable to change, which leads to the so-called situation of "illusory autonomy". Formally, there is a choice, but materially, there is no possibility of negotiation. That is why modern legislators introduce mandatory rules that limit contractual clauses, protect weaker economic entities, and ensure minimum standards of market behavior. This approach is also confirmed by the European doctrine. Micklitz emphasizes that the limits of freedom of contract in the EU are not only based on the protection of individually weaker parties, but also on the protection of those who are structurally weaker in relations with large corporations, even when they are professional subjects (Micklitz, 2015, p. 19–21). This indicates that the weaker party in the economy is often the legal entity and not the consumer, which justifies the application of special restrictions in B2B relations as well. In modern obligation law, it is becoming increasingly important to clearly distinguish between situations in which it is justified

to provide protection to the "structurally weaker party" and those in which such intervention would represent unjustified paternalism. In contrast to consumer relations, where the weaker side is normatively determined in advance, in B2B relations, weakness is not a formal, but a material and factual category, and therefore requires precisely defined criteria. Based on the relevant legal doctrine and economic analysis, the structurally weaker party in professional relations can be recognized through the following indicators:

- Economic asymmetry - the difference in financial strength, market position, and degree of dependence of one entity on another (e.g., a small supplier versus a large retail chain).
- Information asymmetry - uneven access to information relevant to risk assessment, contract performance, and possible consequences of non-fulfilment.
- Bargaining power and the ability to influence the contractual provisions - is the weaker party in a realistic position to negotiate the content of the contract, or is it forced to accept pre-formulated conditions without the possibility of modification?
- Dependence on a long-term business relationship - cases in which the economic survival of a smaller entity depends on continued cooperation with a larger partner.
- Specialization and technical complexity of contracts - lower level of professional capacity to understand sophisticated contractual constructions (e.g., financial derivatives, IT outsourcing, complex investment projects).
- The degree of risk that one party assumes relative to its own capacity – especially when the burden of risk is shifted to the weaker party through disproportionate contractual limitations or liability clauses.

On the basis of these criteria, a clearer demarcation can be achieved between situations in which it is legitimate to protect the structurally weaker professional side – because the balance of the contractual relationship is seriously disturbed – and situations in which the state's intervention would represent an excessive limitation of the autonomy of will and an unjustified reduction of the business flexibility of professional actors (Hakić, Međedović, 2023). This approach enables a more subtle and theoretically consistent design of protection mechanisms, which simultaneously avoids excessive paternalism and strengthens the transparency of contractual relations in the economy. Grundmann adds that European contract law is increasingly moving from classic imperative restrictions to mandatory rules of information, which are aimed at ensuring real decision-making autonomy and preventing contractual abuses (Grundmann, 2002, p. 272-282). In such a model, negotiation equality is achieved through transparency, not just by banning certain clauses.

The domestic doctrine provides concrete examples of the specificity of commercial contracts. Hiber points out that in practice, contractual institutes from Anglo-Saxon law, such as representations and warranties or put options, are often adopted, in which case there is a collision with the imperative rules of the ZOO that protect legal certainty and the balance of the contractual relationship (Hiber, 2022, p. 452–456). These disputed institutes show that the freedom of contracting of economic entities is realized only to the extent that binding norms on responsibility and public order are respected, regardless of the professional status of the contractor. Kastrati also points

out that the autonomy of the will can be limited when it is contrary to the constitutional order or moral rules, which in the economy means that certain clauses cannot have an effect if they violate the structural values of the legal system (Kastrati, 2015, p. 242-243).

Regional authors, such as Đurđević and Pavić (2016), analyze in detail the position of economic entities in systems where freedom of contract developed under the strong influence of state regulation and a specific economic order. Their study shows that in the period of socialist and post-socialist law, the contractual freedom of business entities was based on the dualism of public law and private law norms, whereby public law elements often took precedence over the autonomous decisions of the contracting parties. The key thesis of this paper is that the so-called "conditioned" freedom of contract stemmed from the right of social enterprises to use socially owned funds, whereby the conclusion of the contract often depended on previous administrative acts or regulations that determined the very framework in which the contract could be created, and even its content. In that system, administrative acts were a factual prerequisite for concluding binding legal transactions, which made the contract legally "subordinate" to the imperative decisions of the state. It is important to mention the concept of "directed" freedom of contract, which arose in the phase of the so-called coordinated economy. Although the market logic was becoming more pronounced, the freedom of economic entities was still roughly guided by the norms of the economic order based on the Constitution, systemic laws, and basic principles of obligation law. The state, through economic and legal policies, still had a binding role in regulating the operations of social enterprises, so contracts in the economy were not exclusively a legal and technical manifestation of autonomy, but an instrument for the implementation of a broader economic policy (p. 90-95). What should be emphasized is that even in the modern conditions of the market economy, certain elements of "directed freedom" are still retained, especially in areas of strategic interest - energy, telecommunications, and sectors subject to regulation for reasons of public order or protection of competition. Đurđević and Pavić state that the modern economic and legal system still intervenes in the business decisions of economic entities through mandatory rules that protect the stability of traffic and market order. In this sense, even in today's law, the state maintains a corrective role, especially where public law interest is intertwined with private law dispositions of business actors (p. 95-104).

We are of the opinion that freedom in economic relations was never an absolute category, even among professional participants, but developed in constant contact with economic policies, regulations on economic management and rules that ensure security in legal transactions. We can say that the contemporary contractual autonomy of economic entities can only be properly understood if viewed in the broader framework of historical, institutional and regulatory influences that have shaped the business legal order on a global as well as a national level. It can certainly be concluded that the concept of freedom of contract in economic relations faces serious normative and practical challenges that are often neglected in the doctrine.

Although at the declarative level it is assumed that professional market participants contract "freely" and on an equal basis, in reality this autonomy often becomes limited

by the structural conditions of the market, the economic power of certain actors and the asymmetry of information. In such an environment, formal autonomy does not necessarily mean real contractual freedom, but is often reduced to an appearance that conceals inequality in negotiations and the dependence of weaker economic entities on economically dominant partners. In situations where one side de facto dictates the terms, the possibility of choice becomes more of a theoretical than a real category. What is specific is that in economic relations there is additional complexity that results from the increasingly frequent adoption of contractual institutes from other legal systems, especially the Anglo-Saxon one, while their complete legal compatibility with the domestic mandatory legal framework is neglected. This creates contractual constructions that, although attractive from the aspect of business practice, can undermine legal certainty and lead to conflicts with imperative norms that protect the market order. An examination of contemporary contract law shows that autonomy of will, even in commercial relationships involving professionals, cannot be achieved without the existence of clearly defined limitations designed to preserve the order and stability of legal relationships. It is therefore necessary to reconsider the classical, idealized notion of freedom of contract that has long dominated economic legal theory. Instead of such an approach, it is necessary to analyze the actual market conditions under which contracts are concluded, as well as the extent to which the contracting parties are truly able to understand the nature and scope of the risks arising from complex contractual provisions. The contemporary concept of freedom of contract involves an effort to ensure a balance between the space left to the contracting parties for the independent regulation of relations and protective instruments whose role is to guarantee the correctness, accessibility of information and certainty of the contractual process. It must be borne in mind that true market autonomy exists only if it is built on a solid legal framework and equal access to relevant data. Establishing such a balance is a key condition for the preservation and development of the institute of freedom of contract in commercial transactions within the framework of modern legal systems.

SPECIAL FORMS OF LIMITATION OF FREEDOM OF CONTRACT FOR BUSINESS ENTITIES

The freedom of contracting of economic subjects is subject to a series of restrictions arising from the legal, economic, and institutional framework of the modern market. Imperative norms represent the strictest limitation of contractual autonomy, since no will of the contracting parties, not even that between professional participants, can derogate from the rules that protect public order, morality, legal certainty, and the interests of third parties. This is precisely why imperative norms in the economic sphere have a particularly emphasized role in areas such as banking, insurance, competition, and public services, where the legislator prescribes mandatory elements of contracts, limitations of liability, and nullity rules (Hiber, p. 2022). This confirms that the freedom of contract in the economy can never be absolute, but only functions within the framework that ensures the stability and predictability of the legal order. Public interest and regulatory regulations also limit the contractual autonomy of economic entities, especially in activities of strategic or infrastructural importance

such as energy, telecommunications, transport, and the financial sector. In these areas, the state has a constitutional and economic obligation to ensure the continuous functioning of services and protection of the wider community, which is achieved by prescribing mandatory tariff elements, quality standards, price limits, and control of contractual models. As Đurđević and Pavić (2016) point out, this is a model of "directed autonomy", in which the state maintains a corrective function even between professional subjects in order to preserve market discipline and public interest.

In modern business flows, contracts that are prepared in advance in the form of standard, formulaic, or adhesion models prevail, most often by the economically superior contracting party. Although formally, the possibility of accepting or rejecting the offered contract is left, in reality, the contracting party in a weaker position has almost no influence on any of its provisions, because the room for negotiation on the content of the contract is practically non-existent. Van Boom (2025) calls such relations "illusory autonomy" because the parties apparently agree, while in essence they have no influence on the contractual clauses. That is why the legal system applies stricter control of standardized contracts, especially in terms of liability, risk, and unfair provisions, which directly limits the freedom of contracting of economically stronger business entities.

The asymmetry of bargaining power represents another important limitation of contractual autonomy. Small and medium-sized enterprises, financially weaker partners, or entities that depend on certain suppliers are often forced to accept conditions dictated by large market players. The Economic Freedom Index (EFW Index, 2025) emphasizes that real autonomy exists only when parties have the ability to negotiate without economic coercion and with equal access to information. In practice, however, this equality rarely exists, so the market imbalance functions as a *de facto* limitation of contractual freedom.

Competition law sets additional restrictions, given that certain contractual clauses may distort market competition. Therefore, cartel agreements, price fixing, production limitation, exclusivity with anti-competitive effects, abuse of a dominant position, or agreements that segment the market are prohibited. Micklitz (2015) points out that European law especially emphasizes the importance of preventing contractual models that threaten the market order, and that competition law restrictions also work in B2B relations, because professional entities can also be structurally weaker.

Limitations on liability are an additional corrective to contractual freedom. Although business entities often attempt to contractually exclude or limit their liability, the law clearly prohibits pre-excluded liability for intent and gross negligence, as well as clauses that disturb the balance of the contract. Pinto-Monteiro (2015) emphasizes that continental law generally rejects contractual constructions that undermine the "structural fairness of contracts" even among professionals. Therefore, the contractual will in the area of responsibility cannot derogate from the mandatory rules that ensure the basic fairness of the contractual relationship.

In international business relations, an additional limitation is the adoption of Anglo-Saxon contractual institutions, such as representations and warranties, put option or indemnity clauses, which are often not compatible with the continental legal system. Hieber (2022) warns that these clauses may be in conflict with the ZOO, especially

with regard to liability and nullity regimes, which is why courts and arbitrations limit their effects or completely reject them. Thus, transnational contracting models become practically limited by national mandatory legal rules.

Financial and monetary stability also affects freedom of contract, as unstable currency, high inflation, foreign exchange restrictions, and economic crises put pressure on contractual relations. Török (2025) shows that monetary instability increases contractual risks and threatens the enforceability of obligations, which is why legislators introduce currency clauses, protective mechanisms and information obligations that limit the parties' complete freedom of disposition.

In addition to the above, the legal order of the European Union, as well as international agreements, introduces a number of restrictions that affect the scope of autonomy of will, in particular through mandatory information rules, prohibitions of discrimination, protection of the economically weaker subject, and harmonized contract models. Due to the primacy of EU law, national rules on contractual freedom must be harmonized with European standards. Peráček and Kaššaj (2025) emphasize that international treaties and EU law take precedence over national legislation, which directly affects the parties' ability to freely shape their contractual relations.

Freedom of contract is also limited by administrative requirements – required licenses, registrations, bureaucratic procedures, and regulatory barriers. According to the EFW index (2025), rigid administration increases transaction costs, slows down the conclusion of contracts and reduces business flexibility, which represents an indirect but strong limitation of contractual autonomy.

Finally, morals and good business practices are an essential part of the limitation of contractual freedom. Kastrati (2015) indicates that the autonomy of the will ends where the violation of social values, conscientiousness, and honesty begins. Case law is therefore not infrequently directed towards the annulment of entire contracts or individual contractual provisions which, although seemingly reflecting the consent of the parties, essentially violate good business practices and key principles of the law of obligations. In this way, the integrity of the legal system is ensured, while basic ethical standards in business practice are also protected.

The ability of economic actors to autonomously shape their contractual relations, although it represents one of the fundamental principles of market law, in modern conditions functions exclusively within the framework of clearly set limitations that serve to preserve legal certainty, fair market competition and stability of the business environment. The analysis shows that the professional status of the contracting parties does not eliminate the necessity of protective mechanisms, because economic relations, more than any other area, suffer the impact of market imbalance, information asymmetry, regulatory interventions, and transnational legal influences. Imperative norms, rules of public interest, competition law, prohibition of unfair clauses, limitations of liability, and judicial control of standardized contracts are key instruments to ensure that contractual freedom does not turn into a means of economic domination or legal uncertainty. At the same time, contemporary trends such as digitization, internationalization of business, and the takeover of Anglo-Saxon contractual institutes indicate that the boundaries of the autonomy of will in the economy are constantly shifting and require continuous adjustment of the normative framework. Therefore, it can be concluded that restrictions on contractual freedom in

the economy are not only inevitable but also necessary for the functioning of a stable, predictable, and fair market system, and that their purpose is not to restrict the autonomy of the contracting parties but to preserve the balance, transparency, and integrity of economic transactions.

CONCLUDING CONSIDERATIONS

Freedom of contract remains one of the key principles of the law of obligations, but contemporary theory and practice show that it can only be exercised within certain limits that ensure a balance between private autonomy and the wider legal, economic, and social order. The results of the analysis show that restrictions on freedom of contract are particularly pronounced in the economic sphere, where professional actors operate in conditions of strong market pressures, increased risks, and often unequal negotiating positions. In such an environment, restrictions on contractual freedom do not eliminate autonomy of will, but act as a necessary mechanism that contributes to fair treatment, greater predictability, and a higher level of legal certainty in business relations.

Imperative norms, public order, moral values, and specific regulations of commercial law set limits that prevent abuses of economic power, unfair clauses, unequal risk distribution and contractual constructions that contradict the fundamental principles of compulsory law. A particularly difficult challenge is represented by standard and adhesion contracts, standardized business clauses, as well as contractual models taken from Anglo-Saxon law, among which representations and warranties and put options stand out. Their application in domestic business practice often causes problematic legal consequences, because they are not fully compatible with the binding rules of national legislation, especially in the part related to nullity, liability, and protection of public interest. This indicates the need for clearer normative restrictions and interpretive guidelines that would enable safer application of contractual constructions in commercial transactions.

From a critical point of view, the current legislation on this issue gives the impression of security and stability, but in certain segments, it does not follow the dynamics of modern business. In particular, the insufficiently precise regulation of unfair clauses in commercial contracts, the lack of clear criteria for evaluating the balance of parties in professional relations, as well as the legal gap regarding digital platforms, automated contract processes, and new business models that appear under the influence of technology, are observed. At the same time, collisions between domestic law and transnational contractual practices – especially those taken from the common law system – contribute to legal uncertainty and make business more difficult.

Important questions that go beyond the traditional framework of obligation law are especially opened up for future researchers. Among them are the impact of algorithmic and automated decision-making on the autonomy of the will, the analysis of contractual relations in artificial intelligence systems, the implications of ESG standards on the formation of contractual obligations of economic entities, as well as the importance of soft law instruments (UNIDROIT, DCFR, PECL) on the harmonization of transnational business relations. Additional empirical research on

typical contracts that dominate the economic practice of the region would provide valuable insight into how the autonomy of will and limitations are really manifested in concrete business transactions.

In conclusion, it can be said that freedom of contract, although it remains a fundamental principle of contract law, in the modern economic environment necessarily functions in conjunction with rules that ensure a fair market, the stability of the economic system, and the protection of contracting parties. It is precisely the balance between autonomy and limitations that is the basis for the development of modern contract law and a key challenge for legislators, jurisprudence, and science.

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REZIME

Rad razmatra institut slobode ugovaranja kao jedno od temeljnih načela savremenog obligacionog prava, ukazujući da ova sloboda više ne predstavlja neograničenu sferu privatne autonomije, već normativno usmerenu i kontrolisanu kategoriju. Polazeći od klasičnog liberalnog shvatanja autonomije volje, rad prati njegov istorijski razvoj ka savremenim konceptima u kojima je ugovorna sloboda oblikovana imperativnim propisima, pravilima javnog poretka, moralnim vrednostima i ekonomskim uslovima pravnog sistema. Poseban akcenat stavljen je na položaj privrednih subjekata, čija se ugovorna autonomija ostvaruje u okruženju karakterističnom po profesionalnom statusu učesnika, dinamičnim tržišnim odnosima i potencijalnoj neravnoteži pregovaračke moći, adhezijone ugovore, strukturnu neravnopravnost između ugovornih strana, kao i povećanu regulatornu intervenciju države u određenim sektorima. Posebno se razmatra problem primene ugovornih instituta preuzetih iz anglosaksonskog prava, koji, ukoliko nisu usklađeni sa domaćim imperativnim pravilima, mogu izazvati pravnu nesigurnost i narušiti ravnotežu ugovornog odnosa. Rad zaključuje da savremeni koncept slobode ugovaranja ne podrazumeva odsustvo ograničenja, već njihovu funkciju u obezbeđivanju pravičnosti, transparentnosti i stabilnosti pravnog prometa. U privrednim transakcijama formalna autonomija volje često prikriva stvarne ekonomske i informacione asimetrije, zbog čega je neophodno dalje usavršavanje zakonodavnog i doktrinarnog okvira. Budući razvoj treba da teži finom usklađivanju autonomije volje, regulatornih mehanizama i zaštite ravnoteže ugovornih odnosa, kako bi institute.

ISLAMIC FINANCIAL INSTRUMENTS AND HOUSEHOLD ECONOMIC RESILIENCE IN DEVELOPING COUNTRIES

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Abstract

Household economic resilience represents a key prerequisite for the stability and long-term sustainability of societies in developing countries, especially under conditions of inflation, economic crises, income insecurity, and widespread poverty. In this context, the paper analyzes the potential of Islamic financial instruments such as zakat, waqf, qard hasan, takaful, mudaraba, and musharaka in strengthening household resilience and economic security. The research aims to determine how these instruments can contribute to reducing financial vulnerability, promoting social inclusion, and enhancing the overall stability of communities. The study applies a theoretical and analytical approach, along with a comparative review of institutional practices in countries with well-developed Islamic financial sectors, including Malaysia, Indonesia, Sudan, and Bosnia and Herzegovina. The findings indicate that adequately integrated and well-regulated Islamic financial mechanisms hold significant potential to contribute to poverty reduction, increased access to financial services, and the strengthening of long-term economic resilience among households in developing economies.

Keywords: household economic resilience, Islamic finance, zakat, waqf, qard hasan, takaful, developing countries

ISLAMSKI FINANSIJSKI INSTRUMENTI I EKONOMSKA OTPORNOST DOMAĆINSTAVA U ZEMLJAMA U RAZVOJU

Apstrakt

Ekonomska otpornost domaćinstava predstavlja ključni preduslov za stabilnost i dugoročnu održivost društava u zemljama u razvoju, posebno u uslovima inflacije, ekonomskih kriza, nesigurnosti prihoda i visokog nivoa siromaštva. U tom kontekstu, ovaj rad se bavi analizom potencijala islamskih finansijskih instrumenata kao što su zekat, vakuf, qard hasan, takaful, mudaraba i musharaka, u jačanju otpornosti i ekonomske sigurnosti domaćinstava. Cilj istraživanja je da se utvrdi na koji način ovi instrumenti mogu doprineti smanjenju finansijske ranjivosti, podsticanju socijalne inkluzije i unapređenju ukupne stabilnosti zajednica. U radu je primenjen teorijsko-analitički metod, uz poređenje institucionalnih praksi u zemljama sa razvijenim islamskim finansijskim sektorom, uključujući Maleziju, Indoneziju, Sudan i Bosnu i Hercegovinu. Dobijeni nalazi ukazuju na to da adekvatno integrisani i regulatorno podržani islamski finansijski mehanizmi imaju značajan potencijal da doprinesu smanjenju siromaštva, povećanju dostupnosti finansijskih usluga i jačanju dugoročne ekonomske otpornosti u zemljama u razvoju.

Ključne reči: ekonomska otpornost, islamske finansije, zekat, vakuf, qard hasan, takaful, zemlje u razvoju



INTRODUCTION

Household economic resilience is increasingly seen as a crucial pillar of sustainable development, especially in developing countries that face frequent economic and social shocks (Adger, 2000, p.347). In such settings, households form the basis of the economic structure and serve as the first line of defense against crises like inflation, unemployment, and natural disasters. Their ability to adapt and recover has a direct impact on the overall stability and progress of society. Yet, many households in developing countries still lack access to even the most basic financial services. Formal institutions often exclude the poor from the financial system, which further heightens their vulnerability and traps them in a cycle of poverty (Demirgüç-Kunt et al., 2018). Within that context, Islamic finance represents an alternative model of financial operations that is based on clearly defined ethical principles. The fundamental features of this system include the strict prohibition of interest (*riba*), which is considered impermissible in classical Islamic legal tradition (El-Gamal, 2006, p. 49-52). Also, the Islamic legal framework forbids transactions involving a high degree of uncertainty and speculation, known as *gharar*, as these are believed to undermine fairness and the security of contractual relations (El-Gamal, 2006, p. 58-61). In addition, Islamic finance promotes the principles of solidarity and partnership through contractual mechanisms such as *mudarabah* and *musharakah*, which entail the sharing of risk and profit among the contracting parties, thereby encouraging responsible, mutually beneficial, and fair economic behavior (El-Gamal, 2006, p. 117-125).

As part of the Sharia economic system, Islamic financial instruments such as *zakat*, *waqf*, *qard hasan*, *takaful*, *mudarabah*, and *musharakah* have the potential to improve access to capital, encourage inclusion, and increase household resilience (Iqbal & Mirakhor, 2011, p. 91-130). This paper aims to explore the role of Islamic financial instruments in strengthening the economic resilience of households in developing countries, with a focus on examples from Malaysia, Indonesia, Sudan, and Bosnia and Herzegovina. The key research question is: In what ways do Islamic financial instruments contribute to the economic resilience of households in developing countries? In addition to its theoretical contribution, the paper also aims to offer practical recommendations for improving policies in countries seeking to utilize Islamic instruments as part of their sustainable development strategies.

THEORETICAL-ANALYTICAL APPROACH AND COMPARATIVE ANALYSIS

With the aim of a deeper examination into the functionality and developmental capacities of Islamic financial instruments, particularly regarding the enhancement of household economic resilience in developing countries, this research employs a theoretical-analytical approach. The analytical framework of the study is grounded in contemporary theoretical and empirical contributions from the field of Islamic finance, which emphasize the need for models based on ethics, equitable resource distribution, and the connection between the financial sector and real economic flows. Particular emphasis is placed on participatory financing forms, such as *musharakah* and *mudarabah*, which are recognized as potentially effective mechanisms for

developing small and medium enterprises, enhancing entrepreneurial dynamics, and reducing inequality (Ali, 2014, p. 9-24). A comparative analysis of institutional arrangements from various national contexts confirms that Islamic finance, if normatively and regulatorily well-established and adapted to local conditions, can represent a powerful instrument for economic development and social inclusion. Additionally, the study highlights the development and implementation of redistributive instruments such as zakat, waqf, and qard hasan, which contribute to social stability, strengthen household resilience, and reflect core ethical and cultural values of the Islamic community (Ali, 2014, p. 89-108).

For a deeper analysis of institutional models, four countries representing different development paths have been selected: Malaysia, Indonesia, Sudan, and Bosnia and Herzegovina. Malaysia stands out due to the institutional integration of Islamic banking within its national financial system, supported by strong regulatory infrastructure and legislative solutions that enable the harmonized functioning of Sharia-compliant instruments (Iqbal & Mirakhor, 2011, p. 129-136). Indonesia has developed a decentralized approach, in which local religious and social organizations play a significant role in providing microfinance services, enhancing the inclusion of vulnerable groups, and relying on networks of trust and solidarity (Iqbal & Mirakhor, 2011, p. 134-136). Sudan stands out with the transformation of traditional instruments such as waqf into modern institutional forms for financing education, healthcare, and infrastructure (El-Gamal, 2006, p. 95-97). Bosnia and Herzegovina represents a unique case within the European context, as a secular state with a pluralistic legal system, in which Islamic financial institutions operate according to local regulations, yet strive to preserve Sharia principles, particularly in areas of microfinance and social entrepreneurship (Mešković & Aydin, 2018, p.17).

The analysis relies on qualitative data obtained through content analysis, with a focus on institutional structure, fund management, transparency, user profiles, and social impact. Factors influencing successful implementation, including political support, the level of digitalization of processes, and the availability of trained personnel, are also examined. According to World Bank reports (2020, p. 21-27), institutional capacity and regulatory clarity have a crucial impact on user trust and the effectiveness of instruments. Although this research does not use primary sources such as interviews or surveys, it draws upon extensive secondary literature, enabling the formulation of valid conclusions. UNDP (2017, p. 7-13) also highlights that Islamic instruments such as zakat and waqf can have a transformative effect on reducing poverty and increasing resilience, particularly in communities traditionally excluded from the formal financial system.

This theoretical-analytical and comparative framework allows Islamic financial instruments to be viewed not merely as religious norms but as practical tools for creating a more inclusive, equitable, and resilient financial system. Insights drawn from comparative practice offer guidelines for future policy interventions and sustainable development strategies, particularly within the context of marginalized communities in developing countries.

ZAKAT AND WAQF: PILLARS OF SOCIAL SECURITY

Zakat and waqf represent key pillars of Islamic social finance, whose functions include promoting economic justice, reducing poverty, and strengthening community resilience. Their role transcends the spiritual aspect; they are institutional tools for the equitable redistribution of wealth, enabling a more inclusive and sustainable social protection system (Iqbal & Mirakhor, 2011, p. 91-102). Zakat, an obligatory contribution from wealthy Muslims, has a clearly defined function within the Islamic economic system. The eight categories of recipients defined in the Qur'an represent groups typically facing existential risks. Iqbal and Mirakhor (2011, p. 97-100) emphasize that zakat is not merely a charitable donation, but a systemic instrument of social redistribution. It is utilized to reduce inequality, stimulate consumption among the poor, and stabilize local economies, particularly during periods of crisis.

Waqf, as the voluntary dedication of assets for public or humanitarian purposes, complements the role of zakat by ensuring long-term sustainability. Waqf assets are removed from private ownership and used to finance schools, hospitals, libraries, roads, and other projects. El-Gamal (2006, p. 58-63) notes that waqfs in classical Islamic society served as primary providers of social infrastructure and stable community income, significantly contributing to education and healthcare.

Contemporary examples of the successful institutionalization of these two instruments confirm their effectiveness. In Malaysia, the zakat system is integrated into state structures at the federal-unit level, featuring high transparency and digitized mechanisms. According to the World Bank (2020, p. 5-6), zakat funds are utilized to support the poor through education, self-employment initiatives, and healthcare. Waqfs invest in commercial projects, with generated income directed toward the maintenance and development of services.

In Sudan, traditional waqf models have been revitalized and adapted to local needs. UNDP (2017, p. 8-10) notes that waqf funds finance essential services in rural areas, including drinking water, basic education, and primary healthcare. However, political instability and weak regulatory frameworks limit their long-term sustainability.

Bosnia and Herzegovina represents a unique case in the European context. Although it has a rich tradition of waqf, its potential remains underutilized. According to Omerčić (2018), the Waqf Directorate operates without adequate legal and institutional support, which limits its developmental role. A lack of tax incentives and poor coordination with state institutions further complicate the inclusion of waqf in contemporary processes. Instead of becoming an active participant in sustainable development, waqf remains confined within the Islamic community framework (Omerčić, 2018, p. 87-99).

Common denominators of successful models include a clear legal framework, institutional transparency, community trust, and professional fund management. The World Bank (2020, p. 6) and UNDP (2017, p. 9) emphasize that these factors enable the full utilization of the potential of Islamic instruments for economically empowering marginalized groups. The combination of zakat as an emergency aid mechanism and waqf as a long-term resource creates a synergistic model of social security. When properly institutionalized and integrated with development policies, these two instruments can significantly contribute to poverty reduction, greater

financial inclusion, and the strengthening of household resilience, particularly in countries facing structural economic challenges (Iqbal & Mirakhor, 2011, p. 134-135).

QARD HASAN: INTEREST-FREE SUPPORT IN CRISIS SITUATIONS

Qard hasan, which translates to "benevolent loan," represents an interest-free credit extended to recipients based on trust, without any additional charges apart from the obligation to repay the principal amount. This form of financial assistance occupies a central position in Islamic microfinance, as it aligns with the fundamental Sharia principles prohibiting interest (riba) and encouraging social solidarity and mutual support (Obaidullah & Khan, 2008, p. 19-21). As a charitable instrument, qard hasan is not treated as a commercial transaction, but rather as a moral obligation of the wealthy towards those in need. Its purpose is not profit, but providing assistance during crisis situations, covering essential expenses, and supporting the poor and vulnerable. This model is particularly useful in microfinance as it allows access to capital without additional financial burdens, which is crucial for populations that do not qualify for conventional loans (Obaidullah & Khan, 2008, p. 20). Ahmed (2004) emphasizes that qard hasan is particularly relevant in developing countries, where high interest rates and unfavorable lending conditions exacerbate poverty. It is used to meet basic needs such as healthcare, education, and the launching of micro-businesses, thereby contributing to the empowerment of marginalized groups (Ahmed, 2004, p. 13-16).

In practice, qard hasan has been successfully implemented in Indonesia through organizations such as Baitul Maal wat Tamwil (BMT). Ascarya (2014) notes that these institutions collect funds through voluntary donations and use them to provide interest-free loans to recipients from low-income households. The effectiveness of the model is reflected in the high loan repayment rate, which confirms the presence of strong moral norms within the community. Beneficiaries often receive non-financial support as well, including education and counseling, which further enhances the impact of the assistance (Ascarya, 2014, p. 52-66).

A similar model exists in Malaysia, where qard hasan funds are integrated into the corporate social responsibility (CSR) frameworks of Islamic banks. Dusuki and Abdullah (2011) emphasize that such programs serve as a strategic tool for building client trust and preserving the ethical identity of Islamic banking. In this way, banks not only fulfill religious mandates but also actively demonstrate social responsibility by supporting the poor, students, the unemployed, and women (Dusuki & Abdullah, 2011, p. 37).

Nevertheless, despite its advantages, qard hasan faces institutional and operational challenges. A lack of professionalism, weak management, lack of transparency, and poor oversight represent weaknesses that can undermine the effectiveness and sustainability of microfinance institutions based on this model (Obaidullah, 2005, p. 6). Still, qard hasan remains one of the most ethical and effective instruments in Islamic finance.

TAKAFUL: ISLAMIC MODEL OF MUTUAL INSURANCE

Takaful represents the Islamic alternative to conventional insurance, developed in response to legal and ethical prohibitions in Islam, primarily *riba* (interest), *gharar* (uncertainty), and *maysir* (speculation) (Ayub, 2007, p. 44-61). Instead of risk being transferred to the insurer, as in conventional models, takaful is based on the principles of mutual assistance (*ta'āwun*) and voluntary contribution (*tabarru'*), whereby participants collectively cover incurred losses (Society of Actuaries, 2022, p. 2). In the takaful model, participants contribute to a common fund from which claims are paid, while the fund is managed by an operator who acts under a fee-based model (*wakala*) or profit-sharing arrangement (*mudarabah*) (BNM, 2019, p. 1-2). In this way, Sharia-prohibited elements are avoided, while still providing financial protection against risks such as illness, death, or loss of property.

Malaysia is at the forefront of takaful implementation. Bank Negara Malaysia has developed a comprehensive regulatory framework that defines relationships among participants, fund management, surplus distribution, and business transparency (BNM, 2019, p. 4-20). Companies such as Etiqa Takaful and Syarikat Takaful Ikhlas offer a wide range of products, including life and property insurance, as well as microinsurance targeted at socially vulnerable population groups.

In the context of developing countries, takaful can play an important role in strengthening household resilience, particularly where conventional models are inaccessible due to high premiums, low financial literacy, and a lack of trust in institutions (Dusuki & Abdullah, 2011, p. 30-35). Takaful offers potential for building social cohesion and economic security, thus contributing to the realization of the higher objectives of Sharia – protection of life, property, and dignity (Ayub, 2007, p. 420-422). However, the implementation of the takaful model faces a number of challenges, notably limited user awareness of the benefits of Islamic insurance, a shortage of qualified personnel trained in Sharia-compliant operations, and inconsistent regulatory frameworks across different jurisdictions. Additionally, Obaidullah warns of the risk of formalism – where products are marketed under the name of takaful that formally meet Sharia requirements but are, in essence, indistinguishable from conventional models (Obaidullah, 2005, p. 85). Takaful is not merely a financial instrument, but a social mechanism that promotes solidarity, fairness, and collective responsibility. Its further advancement depends on strong institutional support, regulatory consistency, and ongoing community education (Dusuki & Abdullah, 2011, p. 34).

MUDARABAH AND MUSHARAKAH: PARTNERSHIPS FOR MICROENTERPRISE DEVELOPMENT

Mudarabah and musharakah represent key investment instruments in Islamic finance, based on partnership, ethics, and fair distribution of risk and profit. Their distinct feature lies in enabling the financing of entrepreneurial initiatives without interest, thereby eliminating the exploitation of the indebted and encouraging growth in the real sector (Ayub, 2007, p. 319-322). In developing countries, these models are of

particular importance as they provide marginalized groups such as women, youth, farmers, and artisans with access to capital and contribute to local development (Obaidullah, 2005, p. 83-85).

Profit is shared according to a mutual agreement, while losses are borne solely by the investor, except in cases of negligence (Ayub, 2007, p. 323-324). This model benefits talented individuals who lack capital. Musharakah involves joint investment by both partners, where both profit and loss are shared proportionally to their respective contributions (Ayub, 2007, p. 312-316), making it suitable for projects involving shared decision-making.

In Malaysia, the organization Amanah Ikhtiar Malaysia (AIM) uses mudarabah to promote women's entrepreneurship, particularly in rural areas. Women receive capital, training, and mentoring support, which leads to the creation of microenterprises and the empowerment of families (Obaidullah, 2005, p. 83). In Indonesia, musharakah is applied in crafts and agriculture, especially through group projects supported by religious and microfinance institutions. These models enable joint investment and risk sharing, fostering sustainability and solidarity (Obaidullah, 2005, p. 84-85).

The advantage of these instruments lies in eliminating the imbalance between those with capital and those with knowledge. Instead of a creditor-debtor relationship, a partnership is established that promotes trust and shared responsibility (Dusuki & Abdullah, 2011, p. 32-33). This is essential in environments with high levels of poverty and limited access to conventional finance (Khan, 2010, p. 809). However, successful implementation requires an institutional framework – including legal regulation, standardized contracts, and investor protection (Islamic Financial Services Board, 2009, p. 7-9). Additionally, financial literacy and continuous user education are crucial for success (Khan, 2010, p. 810).

The integration of mudarabah and musharakah with support services such as training, marketing, and counseling further increases the chances of success and contributes to the inclusive development of communities (Obaidullah, 2005, p. 86-87). These models are not merely financial tools, but an expression of the Islamic economic philosophy rooted in justice, ethics, and mutual prosperity. Their implementation in developing countries can serve as a powerful mechanism for poverty reduction and the empowerment of marginalized groups (Dusuki & Abdullah, 2011, p. 34-35).

COMPARATIVE PRACTICE: MALAYSIA, INDONESIA, SUDAN, AND BOSNIA AND HERZEGOVINA

A comparative analysis of the application of Islamic financial instruments in Malaysia, Indonesia, Sudan, and Bosnia and Herzegovina shows that the success of their integration depends on institutional capacity, regulatory frameworks, and the level of public awareness. Although all instruments are based on universal Sharia principles, their effectiveness is conditioned by the local context.

Malaysia is a leader in the institutional integration of Islamic instruments. The zakat system is legally regulated and organized through professional institutions in each federal state, under the supervision of a Sharia board and with the use of modern technologies to ensure transparency (Ayub, 2007, p. 395-398). Waqf funds education,

healthcare services, and development projects, and is managed through professional and legally defined structures (Ayub, 2007, p. 406-407).

Indonesia has a decentralized model, where key roles are played by BAZNAS and legally recognized non-governmental organizations that manage zakat and waqf (Ayub, 2007, pp. 401-402). Micro-takaful and qard hasan are widely used in impoverished rural areas, and digitalization and local engagement have contributed to more effective aid distribution and the financing of small businesses (Ayub, 2007, p. 408-410).

Sudan was among the first countries to introduce an Islamic banking system, but the implementation of instruments has been limited by political instability and institutional weakness. Waqf and zakat play an important role in rural areas in the construction of schools, hospitals, and employment generation. However, concerns persist regarding corruption and lack of oversight (Khan, 2010, p. 809-810). Successful local initiatives demonstrate that, with adequate support, these instruments can contribute to economic resilience even under complex conditions.

Bosnia and Herzegovina serves as an example where Islamic financial instruments function almost exclusively within religious organizations, without formal institutional support from the state or integration into public policies. The Islamic Community independently manages zakat and waqf. Although the literature highlights the importance of cooperation between the state and the religious sector for greater effectiveness, such collaboration has yet to be established in Bosnia and Herzegovina (Dusuki & Abdullah, 2011, p. 32-33).

Common success factors include a clear regulatory framework, professional and transparent management, cooperation among key stakeholders, and user education. The absence of any of these elements significantly reduces the reach and effectiveness of the instruments.

DISCUSSION: INSTITUTIONAL INTEGRATION AND CHALLENGES

Although Islamic financial instruments offer significant advantages in terms of economic resilience, their implementation in developing countries faces numerous challenges, particularly concerning institutional integration into existing economic and regulatory systems (Iqbal & Mirakhor, 2011, p. 17). One of the key challenges is the lack of a regulatory and legal framework that would allow for their full institutionalization and inclusion in development strategies. Instruments such as zakat, waqf, qard hasan, and takaful often remain outside the formal regulatory system, which hinders their broader application (Islamic Financial Services Board, 2021, p. 94). The experience of Indonesia shows that the absence of a consistent regulatory approach can slow institutional development and the integration of these instruments into broader economic policies (Syarif, 2019, p. 80). These organizations often operate on the margins, without institutional support, tax incentives, or access to public funds (Obaidullah, 2005, p. 12).

Another challenge is weak coordination between the state, religious, and civil sectors. Islamic institutions often function in isolation and without integration into development policy, leading to duplicated efforts and inefficient resource allocation

(UNDP, 2017, p. 16). In contrast, Malaysia and Indonesia demonstrate that with institutional cooperation and strategic support, Islamic instruments can have systemic relevance and measurable impact (Syarif, 2019, p. 81). The third challenge is low financial literacy. Populations in rural and marginalized communities are often unfamiliar with concepts such as *mudarabah*, *qard hasan*, or *takaful*, which limits their application (Barus et al., 2024). Without educational and informational campaigns, broader user engagement is difficult to achieve.

The fourth challenge is insufficient digitalization. According to Obaidullah (2005, p. 19), most Islamic financial institutions in developing countries still rely on manual procedures and paper documentation, which hampers transparency and scalability. Successful models from Malaysia utilize IT tools such as online zakat collection platforms and microfinance applications, confirming the potential of digital transformation (Abdul Khir et al., 2025, p. 139). Additional challenges include limited human resources, political instrumentalization of religious funds, and the lack of a standardized international approach to Islamic finance (Iqbal & Mirakhor, 2013, p. 93). In countries with stable institutions, Islamic instruments demonstrate significant potential in reducing poverty and promoting microentrepreneurship (UNDP, 2017, p. 18). In contrast, in countries with weak infrastructure and no systemic support, these instruments remain confined to local initiatives with limited broader impact.

Successful institutional integration requires a multisectoral approach involving religious authorities, policymakers, the IT sector, and civil society. Only through the synergy of normative, operational, and educational frameworks can the full potential of these instruments be realized (Iqbal & Mirakhor, 2011, p. 23).

RECOMMENDATIONS FOR SYSTEM IMPROVEMENT

Based on the previously analyzed theoretical foundations, institutional practices, and challenges in the implementation of Islamic financial instruments across different countries, concrete recommendations can be drawn with the aim of improving existing systems and increasing their efficiency, sustainability, and impact on household economic resilience. Development of a clear regulatory framework

One of the key steps toward improving the system is the establishment of a comprehensive legislative framework that clearly defines the status, functions, and responsibilities of Islamic financial institutions. This includes legal recognition of organizations managing zakat, waqf, *qard hasan* funds, and *takaful* programs, as well as enabling their equal inclusion in broader economic and development policies (Iqbal & Mirakhor, 2011, p. 215-217). The regulatory framework should contain clear guidelines for fund management, user protection, tax incentives for donors, and oversight of the transparency and effectiveness of these institutions.

1. Increasing financial literacy

Given that a large number of potential users of Islamic financial instruments are unfamiliar with their functions and benefits, it is essential to implement national and local financial literacy campaigns (Barus et al., 2024, p. 18-19). Educational programs should be made available in schools, universities, local communities, and religious institutions, in order to promote the principles of Islamic finance, highlight the differences from conventional models, and demonstrate the practical benefits for

individuals and families (Obaidullah, 2005, p. 44). The use of visual and digital content, workshops, and public forums can significantly contribute to engaging a broader population and dispelling misconceptions about the “inefficiency” of faith-based financial instruments (UNDP, 2017, p. 12-15).

2. Digitalization of processes and institutional transparency

To enhance accessibility, efficiency, and accountability in the management of Islamic financial instruments, it is essential to digitalize key processes – from the receipt of funds and user registration to tracking fund utilization and reporting to donors and the public (Abdul Khir et al., 2025, p. 139-140). Developing mobile applications for zakat payments, interactive databases for waqf properties, online platforms for microfinance services, and digital tools for monitoring and evaluation would contribute to the modernization of the sector and reduce administrative burdens (Islamic Financial Services Board, 2021, p. 25-28). Transparent data management increases user trust and facilitates coordination among stakeholders (Abdul Khir et al., 2025, p. 139-140).

3. Establishing cooperation between sectors

Effective implementation of Islamic financial instruments requires synergy among religious institutions, government bodies, non-governmental organizations, and the private sector. It is recommended to establish councils or working groups that bring together representatives of all relevant stakeholders to harmonize policies, plan joint initiatives, and exchange experiences (Iqbal & Mirakhor, 2011, p. 198-200). At the local level, collaboration may include joint development projects, such as the construction of schools, training centers, and healthcare facilities that are financed through waqf funds, with technical and logistical support provided by the state and civil society (UNDP, 2017, p. 9-13). If well-coordinated, such models of cooperation can generate systemic effects that go beyond the capacities of individual organizations (Iqbal & Mirakhor, 2011, p. 199).

4. Integration of Islamic instruments into national development strategies

For Islamic financial instruments to become part of systemic solutions to issues such as poverty, unemployment, and inequality, they must be explicitly included in national strategies for economic development, employment, and social inclusion (Syarif, 2019, p. 79). Governments should recognize the potential of these instruments as a complement to existing systems of social protection and economic support. For example, qard hasan funds can be integrated into public self-employment programs, while zakat funds can be directed toward strategic sectors such as education, digital literacy, and rural development (Obaidullah, 2005, p. 80-85). This, however, requires not only political will but also institutional readiness for innovation and inclusiveness in the policymaking process (UNDP, 2017, p. 10-15). The recommendations presented in this paper aim to bridge the gap between the potential and the current reality of Islamic financial instruments. Their proper implementation can significantly contribute to strengthening household economic resilience, but only if efforts are made to integrate them into institutions, legislative frameworks, educational programs, and development policies. Only in this way can Islamic finance become a sustainable pillar of inclusive and equitable development in developing countries.

CONCLUSION

Islamic financial instruments represent a significant resource for strengthening household economic resilience in developing countries. Rooted in the ethical and legal principles of Islam, these instruments offer sustainable and equitable mechanisms of financial support aimed at vulnerable groups (Iqbal & Mirakhor, 2013, p. 8-11). Zakat and waqf facilitate wealth redistribution and the financing of socially beneficial projects. Their integration contributes to local development and the strengthening of social cohesion (Iqbal & Mirakhor, 2013, p. 9-11). Qard hasan, as an interest-free loan, provides emergency support without additional financial burden, relying on solidarity and trust within the community (Obaidullah, 2005, p. 44, 80-85). Takaful offers an affordable insurance model based on mutuality, which is particularly valuable for households excluded from the conventional system (Islamic Financial Services Board, 2021, p. 29). Mudarabah and musharakah support the development of microenterprises through participatory investment, especially in rural areas and among women (Syarif, 2019, p. 81). Comparative practices from Malaysia and Indonesia show that the success of these instruments depends on a sound legal framework, institutional support, and professional management (Abdul Khir et al., 2025, p. 139), while the example of Bosnia and Herzegovina highlights the challenges posed by the lack of systemic regulation (UNDP, 2017, p. 9-13). Islamic financial instruments are not a universal solution, but they offer sustainable alternatives for inclusive development. Their broader application requires institutionalization, digitalization, education, and cross-sector cooperation. With adequate support and strategic integration, these instruments can become a cornerstone of social security and more balanced economic growth.

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REZIME

Rad istražuje kako islamski finansijski instrumenti mogu doprineti jačanju ekonomske otpornosti domaćinstava u zemljama u razvoju, posebno u kontekstima obeleženim siromaštvom, socijalnom isključenošću i ograničenim pristupom konvencionalnim finansijskim uslugama. Kroz teorijsko-analitički okvir i uporednu

analizu, studija se fokusira na instrumente kao što su zekat, vakuf, kard hasan, takaful, mudaraba i mušaraka. Razmatraju se njihovi konceptualni temelji, operativni modeli i praktična primena u zemljama poput Malezije, Indonezije, Sudana i Bosne i Hercegovine. Posebna pažnja posvećena je načinu na koji ovi instrumenti funkcionišu kao mehanizmi etičke preraspodele bogatstva, podrške ranjivim kategorijama stanovništva i podsticanja lokalnog ekonomskog razvoja. Nalazi ukazuju na to da pravilno institucionalizovani i adekvatno regulisani islamski finansijski instrumenti mogu imati značajan uticaj na unapređenje održivog razvoja, finansijske inkluzije i socijalne sigurnosti. Njihova uloga u podršci mikropreduzećima, obrazovanju, zdravlju i očuvanju ekonomske stabilnosti zajednica pokazuje njihov širi razvojni potencijal. U radu se predlaže njihova integracija u okvire javnih politika kroz digitalizaciju, unapređenje finansijske pismenosti i jačanje međusektorske saradnje, kako bi se doprinelo izgradnji pravednijeg, otpornijeg i inkluzivnijeg ekonomskog sistema sposobnog da odgovori na savremene globalne izazove.

DETERMINANTS OF ENVIRONMENTAL EFFICIENCY: THE CASE OF THE CEFTA 2006 SIGNATORIES

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Abstract

This study analyzes 1) the environmental efficiency of CEFTA 2006 signatory countries using the DEA method and 2) the factors affecting environmental efficiency through a panel analysis for the period from 2010 to 2021. The balanced panel data used includes key variables such as the number of employees, energy consumption, production, and emissions of carbon dioxide (CO₂) and sulfur dioxide (SO₂). The DEA method enables the evaluation of the efficiency of different decision-making units (DMUs), taking into account both desirable and undesirable outcomes. The results show that Albania, Serbia, and Montenegro achieved the highest average environmental efficiency, while Bosnia and Herzegovina had the lowest. The data obtained with the DEA method were later used as the dependent variable of environmental efficiency in the panel analysis. The panel analysis shows that freight transport by road and rail has a positive influence on environmental efficiency, while passenger transport by road has a negative but statistically insignificant influence. The results indicate a positive impact of income per person and a negative impact of three variables (trade, industrial production, and renewable energy sources) on environmental efficiency. An examination of the impact of crisis periods, represented by binary variables for 2010 and 2020, indicates that the 2009 economic crisis had a positive effect on eco-efficiency. These results emphasize the importance of efficient transport, economic development, and careful policy planning to improve environmental efficiency.

Keywords: environmental efficiency, transport, emissions



DETERMINANTE EKOLOŠKE EFIKASNOSTI: SLUČAJ POTPISNICA CEFTA 2006

Apstrakt

Ova studija analizira 1) ekološku efikasnost potpisnica CEFTA 2006 korišćenjem DEA metodologije i 2) faktore koji utiču na ekološku efikasnost primenom panel analize za period od 2010. do 2021. godine. Korišćeni balansirani panel podaci obuhvataju ključne promenljive kao što su broj zaposlenih, potrošnja energenata, proizvodnja, i emisije ugljen-dioksida (CO₂) i sumpor-dioksida (SO₂). DEA metodologija omogućava ocenu efikasnosti različitih jedinica donošenja odluka (eng. decision making unit, DMU) uzimajući u obzir i poželjne i nepoželjne izlaze. Rezultati pokazuju da su Albanija, Srbija i Crna Gora ostvarile najvišu prosečnu ekološku efikasnost, dok Bosna i Hercegovina ima najnižu. Dobijeni podaci iz DEA metodologije su kasnije korišćeni kao zavisna promenljiva ekološke efikasnosti u panel analizi. Panel analiza otkriva da prevoz robe drumskim i železničkim saobraćajem pozitivno utiče na ekološku efikasnost, dok prevoz putnika drumskim saobraćajem ima negativan ali statistički neznačajan uticaj. Rezultati ukazuju na pozitivan uticaj dohotka po glavi stanovnika i negativan uticaj tri promenljive (trgovina, industrijska proizvodnja i obnovljivi izvori energije) na ekološku efikasnost. Analiza uticaja kriznih perioda, predstavljenih binarnim varijablama za 2010. i 2020. godinu, ukazuje na to da je ekonomska kriza iz 2009. godine imala pozitivan efekat na ekološku efikasnost. Ovi nalazi naglašavaju važnost efikasnog transporta, ekonomskog rasta i pažljivog planiranja politike za unapređenje ekološke efikasnosti.

Ključne reči: ekološka efikasnost, transport, emisije.

INTRODUCTION

The importance of environmental efficiency is growing in today's world, especially within regional trade agreements like CEFTA 2006 (Central European Free Trade Agreement). Environmental efficiency pertains to a country or region's capacity to reduce adverse environmental effects while maintaining an appropriate level of economic activity. Given the need for sustainable development and the alignment of environmental standards, environmental efficiency is vital within CEFTA 2006, which involves countries from Central Europe and the Balkans.

One of the most important sectors influencing environmental efficiency is transport. The transport sector, including passenger and freight transport by road, rail, and air, contributes significantly to greenhouse gas emissions and energy consumption. For this reason, it is essential to analyze the impact of transport on environmental efficiency in CEFTA countries. Bijelić et al. (2013) emphasize that the liberalization of interregional trade between the economies of the Western Balkans started in 2000 on the initiative of the EU and culminated in the signing of the agreement (CEFTA 2006). The agreement was signed by several European countries, as well as by the United Nations Mission in Kosovo (UNMIK), on behalf of the customs territory of Kosovo¹ **. With the signing of this document, interregional trade in goods has been

¹ **This designation is without prejudice to status and is in line with United Nations Security Council Resolution 1244 and the International Court of Justice's opinion on the Kosovo declaration of independence.

significantly liberalized, and a regional free trade area for goods, including agricultural products, has been created. Further liberalization of services and investments is planned for the future.

According to the IPCC, direct greenhouse gas emissions from the transport sector amounted to 8.7 GtCO₂-eq in 2019 (compared to 5.0 GtCO₂-eq in 1990) and accounted for 23% of global energy-related CO₂ emissions (Jaramillo et al., 2023). Of these emissions, road transport accounted for 70, while rail, shipping, and air transport accounted for 1, 11, and 12, respectively. In addition to importing and exporting, international trade also encompasses foreign direct investment. Kastratović (2019) demonstrates that in developing countries, FDI inflows can lead to increased CO₂ emissions. This conclusion can also be applied to the transport sector, as liberalization and increased investment in transport infrastructure can affect environmental efficiency in a similar way.

In this paper, dummy variables are used to assess the impact of two challenging periods: the global financial crisis and the COVID-19 pandemic. Global crises have a significant impact on trade and thus also on transportation, which is related to environmental efficiency. Bijelić et al. (2013) stated that the economic downturn slightly lagged in affecting the Western Balkan economies after it began in the US. This crisis transmission demonstrates the significant integration of Western Balkan countries into the global economy, primarily through imports and FDI inflows rather than exports to foreign markets. The economic openness of these economies was generally high, above 50%, except Albania, where it was around 40%. As a result, the decline in exports from the Western Balkans in 2008 was so significant that most regional economies had not even recovered by 2010. According to Popović-Petrović (2023), the global COVID-19 pandemic caused the deepest global recession since the Second World War, with a decline in global trade of almost 16% in the second quarter of 2020. This decline was greater than the impact of the global financial crisis. The pandemic had a strong impact on bilateral trade flows, especially for countries that were involved in regional trade agreements before the pandemic. The negative impact was particularly pronounced for exports from high-income countries. The pandemic caused a high level of general uncertainty, which was exacerbated by the speed of the outbreak of the crisis.

LITERATURE REVIEW

The impact of various modes of transportation is a significant concern due to their adverse effects on the environment. The use of energy should be aligned with environmental sustainability to promote economic efficiency, a resilient energy system, and improved societal well-being (Stošić & Mihajlović, 2018). It is important to maintain awareness of the environmental consequences associated with all decisions and actions undertaken (Aljković & Skenderović, 2020). Transportation activities directly affect the environment, making it essential to encourage transport companies to operate more responsibly (Bošković et al., 2020). The contribution of Industry 4.0 technologies to improving efficiency and reducing negative impacts aligns with EU regulations aimed at transitioning to zero-emission vehicles by 2035, further enhancing sustainability in transportation. This goal seeks to increase the

number of electric vehicles on the roads (Ljajić et al., 2024). Andersson (2016) emphasizes the importance of cross-border collaborations to promote sustainable transport networks through joint projects focused on sustainable development. Regarding this, to reduce the negative impact of transportation on the environment, it is important to establish a unified policy that will enable achieving the best performance in the CEFTA region. Policy measures such as promoting intermodal transport and enforcing stricter emission standards can significantly reduce the negative influence of the transportation sector (Rodrigue, 2013). Furthermore, economic tools like carbon pricing and subsidies for environmentally friendly technologies are essential for motivating a transition to more sustainable transportation methods, as noted by Baranzini & Carattini (2017), Boyce (2018), and Gelb & Mukherjee (2019). Recent research has identified road transport as a major contributor to carbon emissions and local pollutants, as noted by Sohrab et al. (2022), Kończak et al. (2020), and Colvile et al. (2001), highlighting the need for stricter emission standards and increased use of electric vehicles. Madadi et al. (2017) further elaborate that road transport not only generates high levels of carbon emissions but also contributes to noise pollution and landscape fragmentation. Santos et al. (2010) point out that the apparent cost-effectiveness and flexibility of road transport often obscure its substantial long-term environmental costs, presenting challenges for reform in this sector. Ercan et al. (2022) suggest that the adoption of autonomous electric vehicles could cut transportation-related greenhouse gas emissions by up to 34% by 2050. Rail transport, particularly when utilizing renewable energy sources, is frequently considered a more sustainable alternative, with studies by Limin et al. (2020) supporting this view. Chang et al. (2019) have shown that modern rail systems can drastically lower carbon footprints relative to roads and airplanes, while Janić (2021) reports that high-speed rail systems are more energy-efficient and produce fewer carbon emissions per ton-kilometer than road vehicles. Air transport, essential for global connectivity, faces significant challenges in emission reduction, being the most carbon-intensive transport mode with significant impacts like contrails and cirrus cloud formation discussed by Peeters et al. (2009). Hileman et al. (2013) and Staples et al. (2018) argue that a 50% reduction in aviation-related emissions by 2050 will require the rapid adoption of innovative aircraft designs and widespread use of alternative fuels that have lower lifetime greenhouse gas emissions.

METHODOLOGY

This chapter describes the methodologies used for analyzing environmental efficiency using the Data Envelopment Analysis (DEA) methodology and panel data. The models include pooled OLS, fixed effects (FE), and random effects generalized least squares (REGLS) models. Approaches and models used to assess environmental efficiency and the impact of transport for the signatories of the CEFTA 2006 agreement for the period from 2010 to 2021 are presented in detail. The countries examined include Serbia, Bosnia and Herzegovina, Montenegro, North Macedonia, Albania, and Moldova.

DEA METHODOLOGY

The DEA methodology was employed to evaluate the environmental efficiency of the CEFTA 2006 signatories. This approach assesses the ability of decision-making units to maximize outputs while minimizing inputs. This study is based on the approach of Sueyoshi & Goto (2010, 2012a,b,c) and Song et al. (2016). Managerial disposability refers to a situation where a DMU, using advanced clean coal technologies and environmental management strategies, can reduce the amount of undesirable outputs. This approach allows DMUs to apply management strategies when facing changes in environmental regulations. The study shows that measuring and evaluating the performance of DMUs should encompass two key aspects. The first aspect relates to operational efficiencies, i.e., the ability to produce desirable outputs with given inputs or to reduce production costs with constant outputs. The second aspect is environmental efficiency, which relates to the ability to reduce undesirable outputs in accordance with environmental regulations. The non-radial DEA methodology under managerial disposability is used to measure the unique efficiency of DMUs, considering changes in environmental regulations and evaluating environmental performance alongside operational efficiencies.

The inputs used are in the categories of labor and energy. For labor, the variable used is the number of employees, obtained from the World Bank database, while for energy, the variable used is the total energy consumption in terajoules (TJ) obtained from the International Energy Agency (IEA). The outputs are classified as desirable and undesirable. The desirable output is production (expressed in constant 2015 US\$), obtained from the World Bank database, while the undesirable outputs are carbon dioxide (CO₂) emissions and sulfur dioxide (SO₂) emissions, obtained from the Global Carbon Budget (2023) data sources.

PANEL ANALYSIS

This section describes the methodologies used to analyze the impact of passenger and freight transport on environmental efficiency. The analysis was conducted using panel data, and the models include pooled OLS, fixed effects (FE), and random effects generalized least squares (REGLS) models. Approaches and models used to assess environmental efficiency and the impact of transport are presented in detail below.

Starting equation (1):

$$y_{it} = \alpha + \beta X_{it} + \epsilon_{it}$$

where y_{it} is the dependent variable (environmental efficiency), X_{it} is a vector of independent variables (such as freight transport by road, freight transport by rail, passenger transport by road, passenger transport by rail, passenger transport by air, freight transport by air, per capita income, industrial production, trade, renewable energy sources) for country i at time t .

Following the estimation of the OLS model, we proceeded to estimate both the fixed effects (FE) and random effects (REGLS) models. After conducting the Hausman test,

it was determined that the random effects (REGLS) models are more suitable. The random effects model is:

$$y_{it} = \alpha + \beta X_{it} + u_i + \epsilon_{it},$$

where u_i is the random effect specific to each country.

In the panel models, environmental efficiency is the dependent variable obtained using the DEA methodology. The data for independent variables, including passenger and freight transport by road, rail, and air, are obtained from the national statistical offices of each country. The independent variable GDP per capita (constant 2015 US\$) is used as an approximation of the country's development, and the data are obtained from the World Bank database. Industrial production as a percentage of GDP is also sourced from the World Bank database. Trade, representing the total sum of imports and exports relative to GDP, is based on data from the World Bank database. Renewable energy sources, representing the share of renewables in final energy consumption, are obtained from the International Energy Agency database. The dummy variable for 2010 represents the economic crisis that began in the US in 2007-2008 and spread to the CEFTA region in 2010, while the dummy variable for 2020 approximates the impact of the COVID-19 crisis.

RESULTS AND DISCUSSION

DEA RESULTS

The data used in this analysis are balanced panel data for the signatories of the CEFTA 2006 agreement, specifically for Serbia, Bosnia and Herzegovina, Montenegro, North Macedonia, Albania, and Moldova, for the period from 2010 to 2021. This period was chosen to include the economic and environmental changes caused by the financial crisis that began in the world in 2007-2008 in the USA and spilled over into the CEFTA region in 2010, as well as the impacts of the COVID-19 pandemic, which was most pronounced in 2020, thereby allowing for a comprehensive assessment of environmental efficiency under different macroeconomic conditions.

To better understand the characteristics of the data used in this study, Table 1 presents descriptive statistics for the key input variables across different years. These statistics summarize the central tendency and dispersion of labor input (number of employees) and energy input (energy consumption), providing a foundational understanding of their variations over time and across countries. This overview serves as a crucial preliminary step before proceeding to the efficiency evaluation, as it highlights key trends and potential data heterogeneities that may influence the results.

Table 1
Descriptive statistics for relevant inputs by year

Year	Number of employees				Energy consumption			
	Mean	Standard deviation	Min	Max	Mean	Standard deviation	Min	Max
2010	1411840	950278.5	243784	3103533	63499.8	20515.43	30605.51	89848.73
2011	1432962	940646.2	244506	3091745	66828.31	21599.46	32112.76	93909.92
2012	1427001	945807.9	251895	3108558	62836.89	19732.05	28888.92	84782.7
2013	1418105	965114.3	252989	3157875	61252.88	18973.75	33661.87	87211.04
2014	1445784	967668.2	266788	3171544	59096.68	15448.32	33954.95	77958.22
2015	1446847	952302	272361	3135688	61343.6	19040.07	31903.42	87127.31
2016	1462009	982888.8	276767	3229602	63541.67	20613.63	32908.25	90686.09
2017	1457209	990451.5	277876	3256850	65314.08	20799.64	34541.1	93156.3
2018	1452893	995543.9	284888	3275646	67372.59	22651.5	34457.36	92109.6
2019	1465144	991024.7	292098	3272110	68216.93	21851.72	34206.16	92193.34
2020	1432125	979293	271119	3218733	66577.1	23841.85	31903.42	95961.46
2021	1481758	1042573	276234	3396557	70170.77	24394.54	33913.08	98641.01

Source: Authors' calculation

Table 2
Variables for the evaluation of environmental efficiency

Input/Output	Category	Variables
Input	Labor Input	Number of Employees
	Energy Input	Energy Consumption
Output	Desirable Outputs	Production
	Undesirable Outputs	Carbon Dioxide Emissions Sulfur Dioxide Emissions

Source: Authors

In accordance with the existing literature (Halkos & Tzeremes, 2009; Lv et al., 2012; Song et al., 2014; Song et al., 2016), the following two variables represent inputs: 1. the number of employees, and 2. energy consumption. The workforce and productivity are measured by the number of employees, while energy consumption is critical for understanding overall energy efficiency and its environmental impact. These inputs were chosen because they directly influence the production capacity and environmental footprint of the analyzed countries. As outputs, we used production as the desirable output and carbon dioxide (CO₂) and sulfur dioxide (SO₂) emissions as undesirable outputs. Production, expressed in constant 2015 US\$, represents the economic output and measures the efficiency of economic activities. The environmental impact of industrial and energy activities can be assessed by measuring CO₂ and SO₂ emissions (Table 2). Reducing these emissions is essential for improving environmental efficiency and sustainable development. By using these specific variables, our analysis provides a comprehensive insight into the environmental efficiency of CEFTA region countries, allowing for the identification of successful strategies and policies that can be applied to improve environmental performance under different macroeconomic conditions.

Table 3
Evaluation of efficiency by year

Year	Country					
	Serbia	Bosnia and Herzegovina	Montenegro	North Macedonia	Albania	Moldova
2010	1	0.984	1	1	1	1
2011	1	1	1	1	1	0.975
2012	0.965	1	0.965	1	0.986	0.964
2013	0.993	1	0.993	0.947	0.960	1
2014	0.993	1	0.993	0.943	1	0.908
2015	1	0.971	1	0.895	0.960	0.901
2016	0.919	0.959	0.919	0.912	0.926	0.915
2017	0.907	0.942	0.907	0.928	1	0.980
2018	0.9845	0.929	0.9845	1	0.968	1

2019	0.971	0.927	0.971	1	0.964	1
2020	1	0.904	1	1	1	0.984
2021	0.918	0.857	0.918	1	0.988	1
Average	0.970	0.956	0.970	0.968	0.979	0.968
Rank	2	4	2	3	1	3

Source: Authors' calculation

The environmental efficiency scores presented in Table 3 were obtained using the Data Envelopment Analysis (DEA) method, applying an output-oriented approach to assess how effectively countries convert resources into economic output while minimizing environmental costs. The analysis was conducted separately for each year, allowing for a dynamic assessment of efficiency trends over time. The model incorporates both desirable and undesirable outputs, using a set of key input and output variables. Specifically, the inputs include the number of employees as a measure of labor input and energy consumption as a critical resource variable. The desirable output is production, expressed in constant 2015 US dollars, representing the economic benefits of resource utilization. In contrast, undesirable outputs include carbon dioxide (CO₂) and sulfur dioxide (SO₂) emissions, which capture the environmental externalities associated with energy use and industrial activity. These variables, summarized in Table 2, form the basis for evaluating the relative efficiency of each country in balancing economic productivity with environmental sustainability.

Table 3 shows the evaluation of environmental efficiency for CEFTA region countries from 2010 to 2021. Environmental efficiency is measured on a scale from 0 to 1, where 1 indicates maximum efficiency. The average values of environmental efficiency provide insight into the long-term performance of each country, while the ranking provides a comparison of the relative success in environmental efficiency between different countries. According to the presented data, Albania has the highest average environmental efficiency with a value of 0.979. Serbia and Montenegro share second place with an average value of 0.970, indicating similar levels of environmental efficiency. The third place is held by Moldova and North Macedonia, while the lowest average is recorded in Bosnia and Herzegovina. As shown in Table 3, countries maintained high environmental efficiency during the observed period, with intermittent declines due to particular challenges they faced. For instance, Bosnia and Herzegovina's efficiency decreased in recent years, and Moldova experienced declines but then regained high-efficiency levels. This information is crucial for understanding how different countries implement policies and technologies that impact environmental efficiency. They provide a basis for identifying successful strategies that can be applied in other countries to improve their environmental

performance. They also help in recognizing challenges that need to be addressed to achieve sustainable environmental efficiency at the regional level.

In 2010, environmental efficiency was high in most CEFTA region countries, which may be the result of measures taken in response to the 2007-2008 financial crisis that became evident in 2010 in the CEFTA 2006 region. These measures often included improvements in technologies and processes to reduce costs and increase efficiency, which had a positive impact on environmental efficiency. In 2020, environmental efficiency was also high in most countries, but there was a noticeable decline in some countries, which may be due to the spread of the virus. The pandemic resulted in a temporary decrease in gas emissions due to a decline in industrial production and logistics/transportation. However, the pandemic may lead to a decrease in investments in sustainable technologies, which could explain the decline in environmental efficiency in some countries.

PANEL ANALYSIS

In this chapter, we present the panel analysis results regarding the influence of transport (passenger and freight) on the level of eco-efficiency for the signatories of the CEFTA 2006 agreement. The models used include pooled OLS, fixed effects (FE), and random effects generalized least squares (REGLS). The analysis was conducted based on panel data covering relevant variables for the period from 2010 to 2021. Before conducting the panel analysis, descriptive statistics were performed for all key variables included in the analysis. This statistic provides a basic overview of the data and allows for insight into central tendencies, dispersion, and data distribution. Table 4 shows the basic descriptive statistics for the dependent variable, environmental efficiency, and independent variables such as passenger transport by road, freight transport by road, passenger transport by rail, freight transport by rail, passenger transport by air, freight transport by air, gross domestic product per capita (GDP per capita), industry, trade, and renewable energy sources.

Table 4

Descriptive statistics

Variable	Number of Observations	Mean	Standard deviation	Min	Max
Environmental efficiency	72	.969	.036	.857	1
Passenger transport by road	60	65611.15	87898.06	2697	273669
Freight transport by road	60	20556.93	20141.81	398	69395
Passenger transport by rail	72	5363.459	5097.042	76	13819
Freight transport by rail	72	1741.9	2004.346	18	7158
Passenger transport by air	66	989833.1	953913.1	385.1	3338147
Freight transport by air	66	2165.037	2052.856	.5	9850.269

Per capita	72	8.586	.295	7.798	9.155
Industry	72	3.064	.165	2.660	3.296
Trade	72	4.427	.195	3.959	4.870
Renewable energy sources	66	3.295	.341	2.649	3.898
Year 2010	72	.083	.278	0	1
Year 2020	72	.083	.278	0	1

Source: Authors' calculation

Equation (1) was initially evaluated in several forms: as a model with constant regression parameters using the pooled ordinary least squares (pooled OLS) method, as a fixed effects model (FE model), and as a random effects model using the generalized least squares method with random error components (REGLS). The variance inflation factor (VIF) for the model is 5.97. According to Hair et al. (2010), VIF values exceeding 10 indicate a potential multicollinearity problem. Since the calculated VIF is less than 10, we can conclude that there are no significant adverse effects of multicollinearity in the model. To test for the presence of heteroscedasticity in the model, White's test (1980) and the modified Wald test (Green, 2012) for groupwise heteroscedasticity were conducted. White's test results show a chi-square statistic of 55.00 with a p-value of 0.4365, which is considerably higher than conventional significance levels. Therefore, there is insufficient evidence to reject the null hypothesis of homoscedasticity, suggesting that the error variance is not statistically significantly heteroscedastic. Skewness and Kurtosis analyses further confirm the model's validity with p-values of 0.3507 and 0.1351. The modified Wald test for groupwise heteroscedasticity in the model indicates a chi-square statistic of 4.73 with a p-value below 0.05, suggesting insignificant differences in error variances among groups. The Baltagi-Li-Mak (ALM) test (Baltagi & Li, 1995) for serial correlation in the random effects model shows the following results: ALM ($\lambda=0$) = 2.23, $\text{Pr} > \chi^2(1) = 0.1350$. The null hypothesis (H_0) of this test is that the autocorrelation coefficient λ is equal to zero. Since the p-value is higher than 0.05, we fail to reject the null hypothesis, indicating no serial correlation in the random effects model. The Pesaran test (Pesaran, 2015) for weak cross-sectional dependence examines the dependence between residuals obtained from the regression model. The test results are as follows: CD = 0.529, p-value = 0.597. The null hypothesis (H_0) is that the errors are weakly cross-sectionally dependent. The errors are not significantly cross-sectionally dependent since the p-value is higher than 0.05. The combined results of these tests confirm that the proposed regression model satisfies the assumptions of homoscedasticity, normal error distribution, and lack of serial correlation in the model. The Pesaran test indicates no significant cross-sectional dependence, further confirming the model's validity.

We conducted the Hausman test (1978) to determine the appropriate model (fixed or random effects model). The Hausman test results showed a chi-square value of 1.47 with a p-value of 0.9617. Considering the p-value is greater than 0.05, the results suggest using a random effects model.

Table 5*Results of panel model evaluation*

Dependent variable: Environmental efficiency			
Variables	Pooled OLS	FE	REGLS
Passenger transport by road	-1.04 (1.19)	-6.29 (4.88)	-1.04 (1.19)
Freight transport by road	1.97*** (6.56)	2.57*** (8.47)	1.97*** (6.56)
Passenger transport by rail	3.08 (3.76)	2.56 (7.24)	3.08 (3.76)
Freight transport by rail	3.79* (2.23)	-2.88 6.93	3.79* (2.23)
Passenger transport by air	-1.46 (1.16)	-1.38 (1.70)	-1.46 (1.16)
Freight transport by air	2.39 (2.95)	3.30 (3.19)	2.39 (2.95)
Per capita	0.10*** (.02)	.07 (.06)	0.10*** (.02)
Industry	-0.27*** (.07)	-0.28** (.11)	-0.27*** (.07)
Trade	-0.13*** (.04)	-0.16*** (.05)	-0.13*** (.04)
Renewable energy sources	-0.05** (.02)	-0.04 (.02)	-0.05** (.02)
Year 2010	0.02* (.01)	.02 (.01)	0.02* (.01)
Year 2020	-0.001 (.01)	-0.007 (.02)	-0.001 (.01)
Intercept	1.64*** (.34)	1.99*** (.70)	1.64*** (.34)
Number of observations	55	55	55
Model significance	F (12, 42) = 4.04 p-value = 0.00	F(12,38) = 3.93 Prob > F = 0.00	Wald χ^2 (12) = 48.43 Prob > χ^2 = 0.00
Coefficient of determination	$R^2 = 0.535$ $R^2_{adj} = 0.402$	$R^2_w = 0.553$ $R^2_b = 0.0093$ $R^2_o = 0.159$	$R^2_w = 0.527$ $R^2_b = 0.949$ $R^2_o = 0.535$

Source: Authors' calculation

Note: Standard errors are given in parentheses. Asterisks denote significance levels as follows: *** significance level of 1%, ** significance level of 5%, * significance level of 10%. R^2 represents the coefficient of determination, R^2_{adj} the adjusted coefficient of determination, R^2_w variations within groups over time, R^2_b variations in averages between groups, and R^2_o the total variability.

Table 5 presents the results of evaluating environmental efficiency using three panel models. The REGLS model demonstrated a high level of statistical significance. The

coefficient of determination within groups is 0.527, between groups is 0.949, and the overall coefficient of determination is 0.535. These results confirm the adequacy and reliability of the model in explaining the variability of environmental efficiency.

THE IMPACT OF FREIGHT TRANSPORT BY ROAD AND RAIL

Freight transport by road shows a positive and statistically significant effect on environmental efficiency in all three models (pooled OLS, FE, REGLS). This finding suggests that improving efficiency in road freight transport can significantly contribute to reducing emissions per unit of transported goods. Route optimization reduces fuel consumption and vehicle emissions, while using more modern vehicles with advanced engines and lower emissions, as well as better logistics, contributes to reducing the environmental footprint of road transport. Freight transport by rail also shows a positive and statistically significant effect in the pooled OLS and REGLS models. Rail transport is often more energy-efficient and produces fewer emissions per ton-kilometer compared to road transport. The higher energy efficiency of rail transport means that less energy is used per ton of transported goods, as trains can carry larger quantities of goods at once, reducing the number of trips needed and overall energy consumption. Rail transport tends to emit fewer harmful gases per unit of transported goods, especially when electric trains are used, which can be powered by renewable energy sources. Using rail transport reduces the pressure on road infrastructure and can alleviate traffic congestion, further decreasing emissions that occur during delays and congestion in road traffic.

THE IMPACT OF OTHER VARIABLES

The variable approximating a country's development, namely per capita income, has a positive and statistically significant effect on environmental efficiency. Higher per capita income often leads to greater investments in clean technologies, better environmental regulations, and increased awareness of environmental protection, which contribute to enhanced environmental efficiency. Industrial production, trade, and renewable energy sources negatively impact environmental efficiency. Industrial production is often associated with high levels of pollution and energy consumption, which reduce environmental efficiency. Trade can increase the environmental footprint due to the intensive energy and resource consumption related to the transportation of goods and services. The unexpected negative impact of renewable energy sources may result from high initial installation and integration costs, as well as potential technical challenges within the current energy mix. The dummy variable for the year 2010 is statistically significant and positively impacts environmental efficiency. This variable represents the economic crisis that began in 2007-2008 in the USA and subsequently spread to the CEFTA region during 2009 and 2010. During the crisis, the reduction in industrial activity and energy consumption may have temporarily improved environmental efficiency.

CONCLUSION

The analysis results show that freight transport by road and rail are key factors that positively impact environmental efficiency, highlighting the importance of efficient transport for improving environmental efficiency. Passenger transport by road and rail, as well as passenger and freight transport by air, are not statistically significant. This study analyzed the environmental efficiency of the CEFTA 2006 signatories using DEA methodology and panel analysis for the period from 2010 to 2021. The data obtained using the DEA methodology were later applied as the dependent variable for environmental efficiency in the panel analysis. The DEA analysis results did not show significant differences in environmental efficiency among the countries, with Albania achieving the highest average environmental efficiency and Bosnia and Herzegovina having the lowest average value. The panel analysis results, conducted using fixed effects (FE) and random effects (REGLS) models, reveal key factors affecting environmental efficiency. In all models, road and rail freight transport have a positive impact on environmental efficiency, indicating that enhancing transport efficiency can reduce emissions per unit of transported goods. In contrast, passenger road, rail, and air transport have an insignificant influence. On the other hand, GDP per capita has a positive and statistically significant effect, which can be attributed to higher investments in clean technologies and better environmental regulations in more developed countries. Industrial production, trade, and renewable energy sources show a negative statistical impact on environmental efficiency. Industrial production is associated with high levels of pollution, while trade increases the environmental footprint due to the intensive energy consumption associated with transport. The negative impact of renewable energy sources may be due to high initial costs and technical challenges. The dummy variable for the year 2010, representing the economic crisis of 2007-2008, shows a positive impact on environmental efficiency, while the dummy variable for the year 2020, which represents the pandemic, is not statistically significant. The findings emphasize the crucial role of coordinated public policy aimed at improving eco-efficiency in this area.

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REZIME

Ova studija ima za cilj da pruži sveobuhvatnu analizu ekološke efikasnosti zemalja potpisnica sporazuma CEFTA 2006, kao i da identifikuje ključne determinante koje utiču na njen nivo u periodu od 2010. do 2021. godine. Istraživanje se zasniva na kombinaciji neparametarske i parametarske metodologije, čime se omogućava detaljno sagledavanje kako relativne efikasnosti pojedinačnih zemalja, tako i faktora koji tu efikasnost oblikuju u dinamičkom kontekstu. U prvom delu rada primenjena je Data Envelopment Analysis (DEA) metodologija radi procene ekološke efikasnosti zemalja kao jedinica donošenja odluka (DMU). Analiza se zasniva na balansiranom panel skupu podataka koji obuhvata ključne inpute, poput broja zaposlenih i potrošnje energenata, kao i poželjne i nepoželjne outpute, uključujući nivo proizvodnje i emisije zagađujućih gasova, konkretno ugljen-dioksida (CO_2) i sumpor-dioksida (SO_2). Primena DEA metodologije omogućava istovremeno razmatranje ekonomskih performansi i negativnih ekoloških eksternalija, čime se dobija realnija slika održivosti proizvodnih procesa. Rezultati DEA analize ukazuju na značajne razlike u nivou ekološke efikasnosti među posmatranim zemljama. Najviši prosečni nivoi ekološke efikasnosti zabeleženi su u Albaniji, Srbiji i Crnoj Gori, dok Bosna i Hercegovina ostvaruje najniže rezultate, što ukazuje na potrebu za dodatnim strukturnim i regulatornim reformama u oblasti zaštite životne sredine i energetske efikasnosti. Dobijeni indeksi ekološke efikasnosti zatim su korišćeni kao zavisna promenljiva u drugoj fazi istraživanja. U drugom delu rada primenjena je panel analiza kako bi se ispitali faktori koji utiču na ekološku efikasnost u posmatranim zemljama. Rezultati pokazuju da transport robe drumskim i železničkim saobraćajem ima statistički značajan i pozitivan uticaj na ekološku efikasnost, što može ukazivati na unapređenje logistike i racionalnije korišćenje transportnih kapaciteta. Nasuprot tome, transport putnika drumskim saobraćajem pokazuje negativan, ali statistički neznačajan efekat. Analiza dalje otkriva da rast dohotka po glavi stanovnika pozitivno utiče na ekološku efikasnost, što je u skladu sa pretpostavkama o većoj sposobnosti bogatijih ekonomija da ulažu u čistije tehnologije i ekološke standarde. Istovremeno, negativan uticaj trgovine, industrijske proizvodnje i obnovljivih izvora energije ukazuje na strukturne izazove i potencijalnu neefikasnost u njihovoj implementaciji i upravljanju. Poseban deo analize posvećen je uticaju kriznih perioda, modelovanih pomoću binarnih varijabli za 2010. i 2020. godinu. Rezultati sugerišu da je globalna ekonomska kriza iz 2009. godine imala pozitivan efekat na ekološku efikasnost, verovatno kao posledicu smanjenja industrijske aktivnosti i emisija zagađujućih materija. Zaključno, nalazi studije ukazuju na značaj efikasnog transportnog sistema, održivog ekonomskog rasta i pažljivo osmišljenih javnih politika u unapređenju ekološke efikasnosti zemalja CEFTA regiona. Rezultati mogu poslužiti kao relevantna osnova za kreatore politika u procesu usklađivanja ekonomskog razvoja sa ciljevima zaštite životne sredine i održivog razvoja.

EKONOMSKI MODEL CRNE GORE I NJEGOVA ODRŽIVOST: MAKROEKONOMSKA I SEKTORSKA ANALIZA ZA PERIOD 2013–2023.

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Apstrakt

Ovaj rad analizira ekonomski model Crne Gore i njegovu održivost u periodu od 2013. do 2023. godine, uzimajući u obzir istorijske, strukturne i institucionalne karakteristike male, visoko otvorene ekonomije. Poseban akcenat stavljen je na ulogu turizma, eurizacije i stranih direktnih investicija kao glavnih nosilaca ekonomskog rasta. Kroz detaljnu analizu makroekonomskih indikatora – BDP-a, inflacije, zaposlenosti, platnog bilansa i fiskalnih kretanja – utvrđeni su ključni faktori ranjivosti, kao i mogućnosti za diverzifikaciju i održiv razvoj. Sektorska analiza turizma, industrije i poljoprivrede pokazuje neophodnost strukturnih reformi radi jačanja konkurentnosti i smanjenja uvozne zavisnosti. U radu se takođe razmatraju izazovi klimatskih promjena, regionalnih i demografskih neravnoteža, te se uporednom analizom sa zemljama regiona definišu preporuke za unapređenje ekonomske politike. Zaključuje se da Crna Gora ima potencijal za dinamičan i održiv rast, ali da njegovo ostvarenje zahtijeva sveobuhvatne reforme, jačanje institucija i stratešku saradnju s međunarodnim partnerima.

Ključne reči: Crna Gora, ekonomski model, održivi razvoj, eurizacija, turizam, fiskalna politika

ECONOMIC MODEL OF MONTENEGRO AND ITS SUSTAINABILITY: MACROECONOMIC AND SECTORAL ANALYSIS FOR THE PERIOD 2013–2023.

Abstract

This paper analyzes the economic model of Montenegro and its sustainability in the period from 2013 to 2023, taking into account the historical, structural, and institutional characteristics of a small, highly open economy. Special emphasis is placed on the role of tourism, euroization, and foreign direct investment (FDI) as the main drivers of economic growth. Through a detailed analysis of key macroeconomic indicators – GDP, inflation, employment, balance of payments, and fiscal trends – the paper identifies critical vulnerabilities as well as opportunities for diversification and sustainable development. The



sectoral analysis of tourism, industry, and agriculture highlights the necessity of structural reforms to enhance competitiveness and reduce import dependence. The paper also addresses the challenges of climate change, regional and demographic disparities, and, through a comparative analysis with neighboring countries, provides policy recommendations. It concludes that Montenegro has the potential for dynamic and sustainable growth, but achieving this requires comprehensive reforms, institutional strengthening, and strategic cooperation with international partners.

Keywords: Montenegro, economic model, sustainable development, euroization, tourism, fiscal policy

UVOD

Razvoj ugovora o radu u Srbiji je put od privatnopravnog instituta preko kolektivističkog modela bez ugovora do savremenog mešovitog sistema u kojem se pokušava uspostaviti ravnoteža između fleksibilnosti tržišta rada i zaštite prava zaposlenih. Usklađivanje radnog zakonodavstva Republike Srbije sa pravom Evropske unije (*acquis communautaire*) odvija se u okviru procesa evropskih integracija, posebno u okviru Poglavlja 19 – Socijalna politika i zapošljavanje. Srbija je već delimično uskladila Zakon o radu (posebno izmenama 2014. i 2017. godine) sa direktivama Evropske unije, posebno sa direktivom 1999/70 o okvirnom sporazumu o radu na određeno vreme, ali je potpuno usklađivanje još uvek u toku.

Ekonomski model Crne Gore oblikovan je istorijskim razvojem, geografijom i visokom otvorenošću privrede. Nakon tranzicije i uvođenja eura, Crna Gora se oslanja na turizam i strane investicije kao glavne izvore rasta. Cilj rada je da kroz analizu podataka od 2013. do 2023. godine identifikuje prednosti, slabosti i mogućnosti za održivi razvoj. Rad analizira trenutni ekonomski model Crne Gore, sa naglaskom na njegovu održivost kroz fiskalne politike, institucionalni okvir, zavisnost od turizma i uvoza, zelene inicijative, kao i demografske i društvene izazove. Poseban fokus stavljen je na inicijative za diverzifikaciju, jačanje institucija i razvoj obnovljive energije. Crna Gora je mala i otvorena ekonomija koja se nakon obnove nezavisnosti 2006. godine oslanja na model privrednog rasta zasnovan na turizmu, uvozu i stranim direktnim investicijama. Crnogorski ekonomski model trenutno je ranjiv, ali posjeduje potencijal za održivu transformaciju. Ključni izazovi ostaju: zavisnost od turizma i uvoza, institucionalna slabost i fiskalni pritisci. Istovremeno, evropske integracije i zelena tranzicija nude istorijsku priliku za izgradnju otpornijeg modela. Ekonomija zasnovana na potrošnji i zaduživanju ne može biti dugoročno održiva. Prelazak na razvojne politike zasnovane na produktivnim ulaganjima i diverzifikaciji je neophodan. Politička stabilnost i institucionalne reforme ključne su za sprovođenje ekonomskih politika. Krize u pravosuđu i politička polarizacija umanjuju kredibilitet zemlje i odvrćaju investitore.

METODOLOGIJA

U radu se primjenjuju deskriptivna, analitička i komparativna metoda, uz analizu trendova makroekonomskih indikatora za period 2013–2023. Analiza se zasniva na zvaničnim sekundarnim podacima MONSTAT-a, CBCG-a i međunarodnih organizacija, što omogućava identifikovanje strukturnih obrazaca rasta i ranjivosti crnogorske ekonomije. Uporednom analizom sa zemljama regiona formulišu se preporuke ekonomske politike. Iako rad ne koristi ekonometrijske modele, metodološki okvir obezbjeđuje pouzdanu analitičko-deskriptivnu procjenu održivosti ekonomskog modela.

ISTORIJSKI RAZVOJ I KARAKTERISTIKE PRIVREDNE STRUKTURE CRNE GORE

Crna Gora je istorijski prošla faze od agrarne ekonomije, preko socijalističke industrijalizacije, do tržišne tranzicije i eurizacije.

Između dva svjetska rata, dominantna je bila poljoprivreda, uz slabu industriju i turizam u začetku. U socijalizmu, razvijena je teška industrija i energetika, ali uz slabu diverzifikaciju. Razvijena je infrastruktura, obrazovanje i turizam, što je oblikovalo današnju strukturu. Tranzicija 1990-ih i 2000-ih donijela je privatizaciju, liberalizaciju i usvajanje eura kao valute, čime je obezbijeđena monetarna stabilnost, ali uz gubitak monetarne politike. Industrija je izgubila značaj, dok su turizam i usluge postali dominantni.

Danas Crna Gora ima uslužnu ekonomiju, visoko zavisnu od turizma i uvoza, sa slabom domaćom industrijom i poljoprivredom (Fabris, 2021).

ODRŽIVI RAZVOJ, EKOLOGIJA I KLIMATSKE PROMJENE

Crna Gora, kao mala zemlja s otvorenom ekonomijom i ambicijom za integraciju u Evropsku uniju, suočava se s izazovima uravnoteženja ekonomskog rasta s principima održivog razvoja. Ovaj rad istražuje postojeći ekonomski model Crne Gore, analizirajući njegovu zavisnost od turizma i primarnih resursa, u kontekstu ekološke ranjivosti i klimatskih promjena. Takođe se ispituju institucionalni kapaciteti i strateški dokumenti u oblasti održivog razvoja i ekologije. Poseban fokus stavljen je na potencijal zelene ekonomije i cirkularnih praksi. Rad zaključuje da održivost crnogorskog ekonomskog modela zavisi od diverzifikacije, ekološke transformacije i efikasne implementacije međunarodnih standarda. Crna Gora je 2007. godine Ustavom definisana kao „ekološka država“, što predstavlja jedinstven slučaj u evropskoj praksi. Međutim, usklađivanje tog ustavnog načela s realnim ekonomskim praksama i razvojnim ciljevima predstavlja značajan izazov. Ekonomski model Crne Gore dominantno se oslanja na uslužni sektor, posebno turizam, te na eksploataciju prirodnih resursa, što je u direktnoj suprotnosti s principima održivog razvoja ako se ne primijene odgovarajuće zaštitne mjere.

Crna Gora je među prvim državama regiona koja je održivi razvoj ugradila u strategije. Usvojene su politike za zaštitu resursa i klimatsku adaptaciju, ali ekološki

izazovi ostaju veliki: zagađenje, niska reciklaža i prekomjerna eksploatacija resursa. Klimatske promjene utiču na turizam, poljoprivredu i energetiku (Fabris, 2021).

Klimatske promjene u Crnoj Gori manifestuju se kroz porast srednje godišnje temperature, promjene u režimu padavina, učestalost ekstremnih vremenskih pojava kao što su poplave, suše, toplotni talasi i bujice. Ove pojave direktno ugrožavaju ključne sektore kao što su poljoprivreda, šumarstvo, vodni resursi, energetika i turizam (Ministarstvo ekologije, 2022). Poljoprivreda je posebno osjetljiva zbog sve učestalijih sušnih perioda i smanjenja dostupnosti vode za navodnjavanje. Turizam, kao glavni oslonac ekonomije, trpi zbog promjena sezonalnosti i povećanog pritiska na obalnu infrastrukturu. Klimatske promjene utiču i na zdravlje stanovništva, pojavom novih bolesti, toplotnih udara i alergija. Nacionalni plan prilagođavanja klimatskim promjenama (NAP) predviđa niz mjera kao što su izgradnja sistema ranog upozoravanja, unapređenje infrastrukture otporne na klimatske promjene, podizanje svijesti i obrazovanje. Ipak, realizacija tih mjera zahtijeva jaču političku volju, bolje finansiranje, međusektorsku saradnju i uključivanje lokalnih zajednica u procese odlučivanja.

Zelena ekonomija nudi priliku za transformaciju crnogorske ekonomije ka modelu koji je manje destruktivan po životnu sredinu. Razvoj energetske efikasnosti, održive mobilnosti, eko-turizma i reciklažne industrije može značajno doprinijeti stvaranju „zelene radne snage“ i smanjenju ekološkog otiska.

Za poboljšanje održivosti ključne su zelene tehnologije, obnovljivi izvori energije, bolja reciklaža i jačanje ekološke svijesti (Fabris, 2021).

DEMOGRAFIJA I REGIONALNI RAZVOJ

Demografski trendovi pokazuju starenje stanovništva, pad nataliteta i migracije ka urbanim centrima, što stvara neravnomjeran razvoj. Sjever Crne Gore ima visoku nezaposlenost i odliv stanovništva, dok je primorje razvijenije.

Potrebne su investicije u infrastrukturu, poreske olakšice i iskorišćavanje EU fondova za smanjenje regionalnih razlika i zaustavljanje migracija (Fabris, 2021).

Makroekonomski pokazatelji crnogorske privrede (2013–2023)

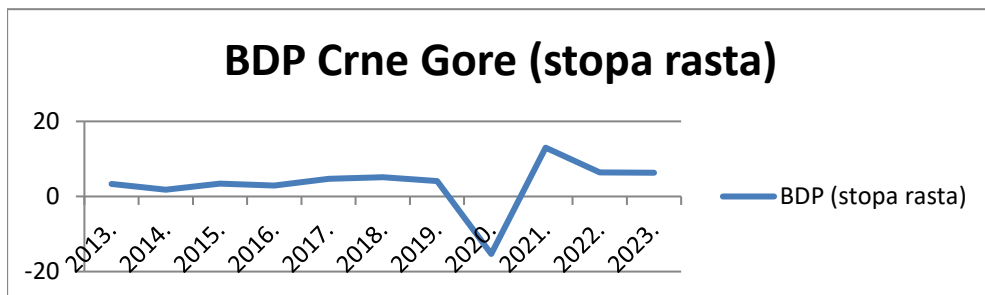
Makroekonomski pokazatelji predstavljaju osnovu za analizu dugoročnih ekonomskih trendova i stabilnosti privrednog sistema Crne Gore. Ova glava se fokusira na ključne indikatore ekonomskih performansi zemlje u poslednjoj deceniji, uključujući rast bruto domaćeg proizvoda (BDP), inflaciju i tržište rada.

Bruto domaći proizvod (BDP)

U godinama 2013–2019. ostvaren je prosječan godišnji rast od oko 3,6%, sa najvišim stopama u 2017. (4,7%) i 2018. (5,1%), što je rezultat snažnog turističkog sektora i velikih infrastrukturnih investicija. Tokom pandemije 2020. godine BDP je zabilježio pad od –15,3%, jedan od najvećih u Evropi. Već od 2021. godine uslijedio je snažan oporavak: rast je iznosio 13,0% u 2021. godini, zatim 6,4% u 2022. i 6,3% u 2023. godini (Slika 1).

Slika 1.

Stopa rasta BDP-a Crne Gore (2013-2023)



Izvor: Monstat

Struktura crnogorskog BDP-a dominantno je usmjerena ka uslužnom sektoru, koji čini približno 80% ukupne ekonomske aktivnosti, sa ključnim učešćem turizma, trgovine i finansijskih usluga. Industrija i građevinarstvo zajedno učestvuju sa oko 10–15%, dok poljoprivreda učestvuje sa oko 6% u BDP-u.

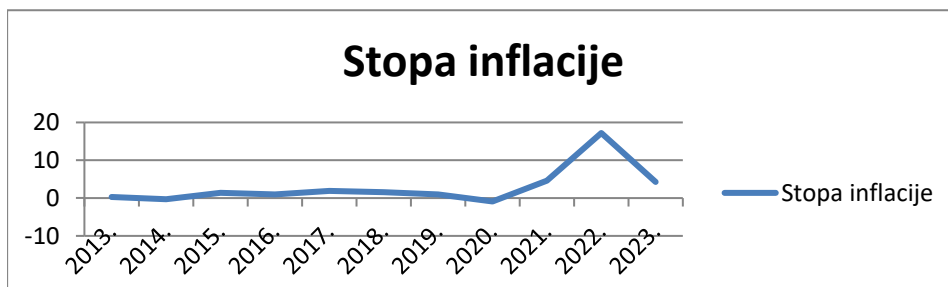
Glavni pokretači rasta su strane direktne investicije, turizam i javni investicioni projekti.

Crnogorska privreda ostaje osjetljiva zbog snažne zavisnosti od turizma, visokog uvoza i nedovoljno razvijenih domaćih proizvodnih kapaciteta. Održivi ekonomski razvoj u narednom periodu zahtijeva strateške mjere usmjerene na:

- Diverzifikaciju privrede, kroz razvoj industrije, poljoprivrede i IT sektora;
- Transformaciju turizma ka održivom modelu, zasnovanom na kvalitetu, inovacijama i zelenim tehnologijama;
- Unapređenje poslovnog ambijenta, sa posebnim fokusom na privlačenje investicija u sektore veće dodate vrijednosti.

Inflacija

Inflacija, koja mjeri rast cijena, predstavlja ključni pokazatelj ekonomske stabilnosti. U periodu 2013–2019. bila je niska, ispod 2% godišnje. Tokom 2022. došlo je do snažnog skoka na 17,2%, prvenstveno zbog rasta cijena energenata i globalnih poremećaja. U 2023. inflacija se stabilizovala na 4,3%, ali i dalje značajno utiče na realne prihode stanovništva. Slika 2 jasno prikazuje kretanje stope inflacije u Crnoj Gori tokom ovog perioda.

Slika 2.*Stopa inflacije u Crnoj Gori (2013-2023)*

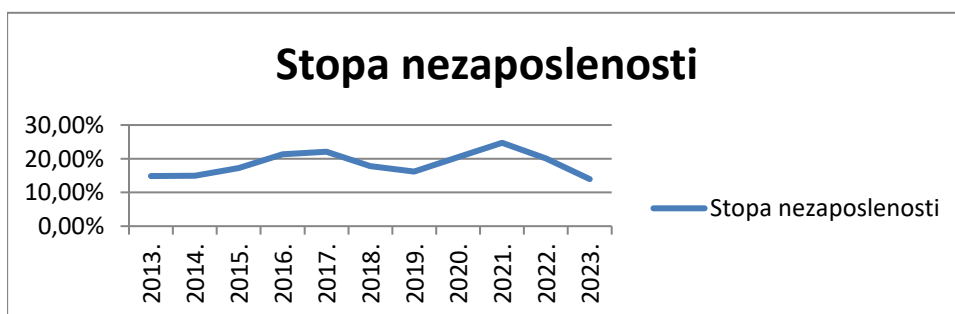
Izvor: Monstat

Glavni faktori inflacije uključuju uvoz inflacije iz eurozone, rast cijena energije i hrane usljed geopolitičkih kriza, kao i pojačan pritisak na cijene usljed oporavka potražnje nakon pandemije. CBCG nema instrumente za direktnu kontrolu inflacije, a zavisnost od uvoza dodatno povećava ranjivost privrede.

Smanjenje inflacije zahtijeva jačanje domaće proizvodnje, održavanje fiskalne discipline i veću konkurenciju u ključnim sektorima, što bi doprinijelo stabilnijim cijenama i očuvanju realnih prihoda građana.

Tržište rada

Stopa nezaposlenosti odražava sposobnost ekonomije da otvara nova radna mjesta. Prije pandemije, u periodu 2013–2019, nezaposlenost se kretala između 14% i 17%, uz blagi pad. Tokom pandemije 2021. dostigla je vrhunac od 24,7% usljed zatvaranja poslovanja, da bi se nakon oporavka u 2023. smanjila na 13,95%. Slika 3 prikazuje kretanje stope nezaposlenosti u Crnoj Gori u ovom periodu.

Slika 3.*Stopa nezaposlenosti u Crnoj Gori (2013-2023)*

Izvor: Monsat

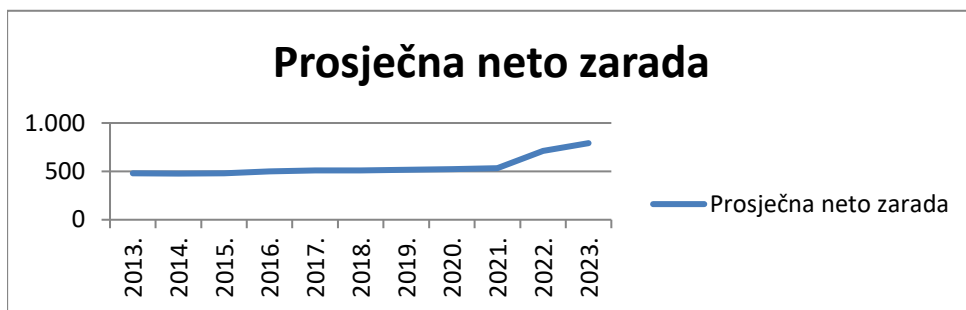
Struktura zaposlenosti pokazuje da turizam i ugostiteljstvo donose značajnu sezonsku zaposlenost, često uz veliki broj stranih radnika, dok javni sektor zapošljava oko 30%

radne snage. Industrija i građevinarstvo imaju stabilan, ali manji udio. Glavni izazovi uključuju sezonsku prirodu poslova, nedostatak domaće radne snage u turizmu i neusklađenost obrazovanja s potrebama tržišta, što posebno pogađa mlade.

Mjere za unapređenje uključuju reformu obrazovanja, podsticaje za zapošljavanje mladih i diverzifikaciju privrede kako bi se otvorila stabilna radna mjesta van turizma. Prosječna neto plata porasla je sa 479 € u 2013. na 792 € u 2023. godini, djelimično zahvaljujući programu „Evropa Sad“, što je prikazano na slici 4.

Slika 4.

Prosječna neto zarada u Crnoj Gori (2013-2023)



Izvor: Monstat

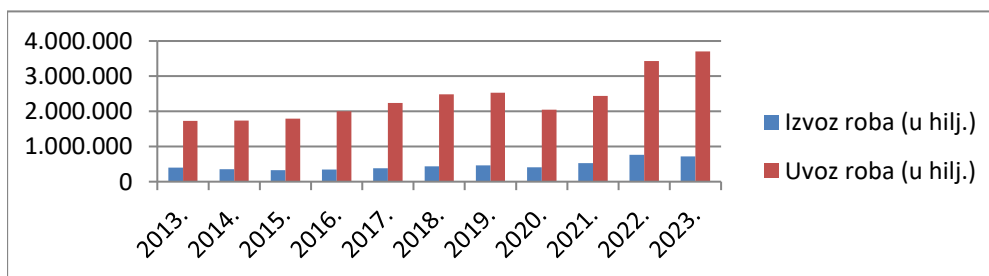
PLATNI BILANS I STRANE DIREKTNE INVESTICIJE

Platni bilans

Platni bilans Crne Gore odražava visoku spoljnu zavisnost ekonomije. Tekući račun je hronično u deficitu (–13% do –26% BDP), prvenstveno zbog visokog uvoza i slabog izvoza robe, dok turizam ublažava saldo usluga, ali nedovoljno da kompenzuje ukupni deficit. Najdublji pad bilježen je 2020. zbog pandemije, što se jasno vidi na slici 5 koja prikazuje kretanje izvoza i uvoza roba u Crnu Goru u periodu 2013–2023.

Slika 5.

Izvoz i uvoz roba u Crnu Goru (2013-2023)



Izvor: Monstat

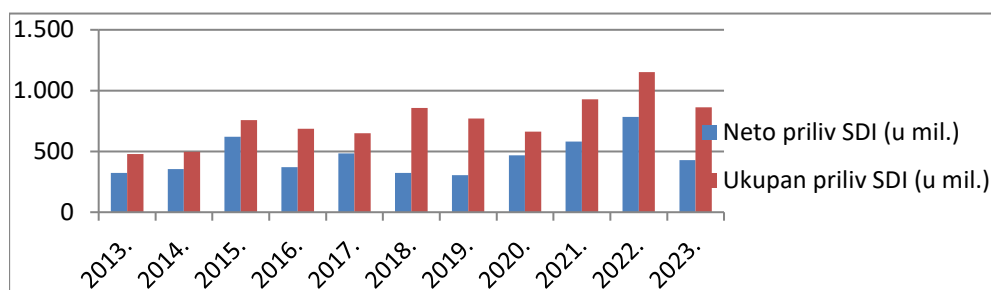
Kapitalni i finansijski račun bilježi suficit, dominantno kroz priliv stranih direktnih investicija (SDI), a devizne rezerve CBCG porasle su sa 393 mil. € u 2013. na preko 1,7 milijardi € u 2022., da bi u 2023. opale na 1,4 milijarde €, koristeći se za očuvanje stabilnosti bankarskog sistema i balansiranje priliva i odliva deviza.

Strane direktne investicije (SDI)

SDI predstavljaju ključni izvor kapitala za Crnu Goru, posebno zbog ograničenih domaćih izvora finansiranja. U periodu 2013–2019. priliv je bio stabilan, sa fokusom na turizam, nekretnine i energetiku. Tokom pandemije 2020. investicije su pale, ali su se u 2021–2023. obnovile, dostigavši vrhunac 2022. od 1,15 milijardi € ukupno, što je prikazano na slici 6.

Slika 6.

Neto i ukupan priliv SDI u Crnu Goru (2013-2023)



Izvor: Monstat

Najveći investitori dolaze iz EU (Njemačka, Italija), Rusije, Turske i UAE, a dominantni sektori su nekretnine, turizam, energetika i finansije. Pozitivni efekti SDI uključuju rast zaposlenosti, prenos znanja i poboljšanje infrastrukture, dok negativni efekti proizlaze iz dominacije neproaktivnih investicija, visoke zavisnosti od stranog kapitala i repatrijacije profita.

Izazovi i preporuke za unapređenje platnog bilansa i SDI

Glavni izazovi platnog bilansa i SDI su hronični deficit tekućeg računa, slaba domaća proizvodnja, prevelika oslonjenost na investicije u nekretnine i osjetljivost na globalne šokove. Preporučuje se diverzifikacija ekonomije kroz industriju, IT i poljoprivredu, povećanje izvoza i podsticanje lokalne proizvodnje, kao i usmjeravanje SDI u produktivne sektore i zelene tehnologije, što bi doprinijelo stabilnijem i održivijem rastu privrede.

MONETARNA POLITIKA CRNE GORE

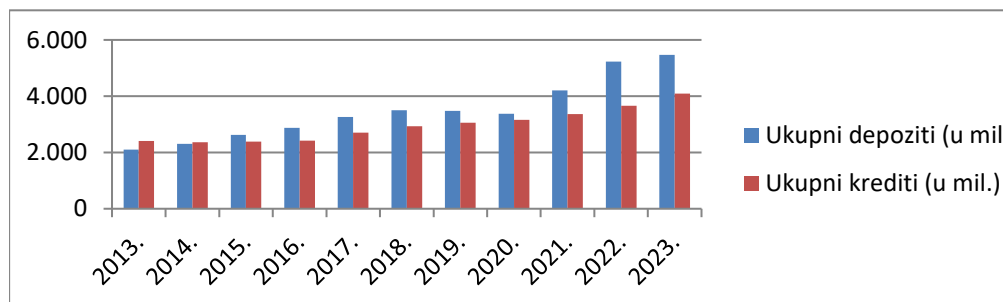
Crna Gora od 2002. koristi euro kao zvaničnu valutu, iako nije članica eurozone. Ovaj model unilateralne eurizacije donosi monetarnu stabilnost i veće povjerenje

investitora, olakšava trgovinu, ali istovremeno onemogućava vođenje sopstvene monetarne politike. Zemlja ne može samostalno kontrolisati inflaciju i kamatne stope, devalvirati valutu u krizama niti primjenjivati monetarne podsticaje.

Centralna banka Crne Gore (CBCG) nema funkciju emisije novca, ali nadzire bankarski sektor, upravlja deviznim rezervama i sprečava finansijske krize. Sa slike 7 vidi se da su ukupni krediti i depoziti kontinuirano rasli u periodu 2013–2023.

Slika 7.

Ukupni depoziti i krediti u Crnoj Gori (2013-2023)

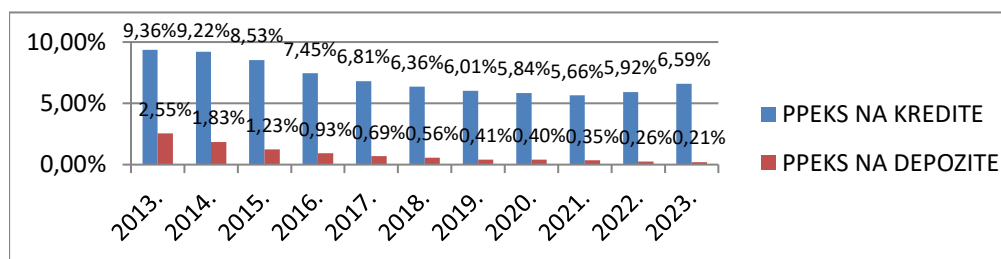


Izvor: Monstat

Od 2013. do 2023. godine kamatne stope su opale (na kredite sa 9,36% na 6,59%, a na depozite sa 2,55% na 0,21%) (slika 8). Udio loših kredita je smanjen sa 17,5% na 5%, što ukazuje na stabilizaciju sektora.

Slika 8.

PPEKS na kredite i depozite u Crnoj Gori (2013-2023)



Izvor: Monstat

Pristup finansiranju ostaje skuplji nego u eurozoni zbog viših rizika i dominacije stranih banaka.

FISKALNA POLITIKA CRNE GORE

Zbog nedostatka monetarne politike, Crna Gora koristi fiskalnu politiku kao glavni instrument stabilizacije, s ciljem održanja stabilnog budžeta, kontrole javnog duga i podrške ekonomskom rastu. Fiskalna politika mora ograničiti javnu potrošnju na

približno 25% BDP-a, uz obezbjeđivanje kvalitetnih javnih usluga i infrastrukturnih ulaganja, kako bi se stvorio konkurentan poslovni ambijent (Đurović, 2016).

Glavni izvori prihoda budžeta su PDV (oko 50%) i doprinosi za socijalno osiguranje (25%), uz akcize, carine i porez na dobit. Prihodi su rasli do 2019. godine, pali 2020. zbog pandemije, a od 2022. značajno porasli zahvaljujući programu „Evropa Sad“ i povećanoj potrošnji. Rashodi su najviše usmjereni na plate i socijalna davanja (oko 60%), kapitalne investicije i otplatu duga. Deficit je 2020. dostigao rekordnih –425 mil. €, dok je 2023. ostvaren suficit od 10,3 mil. €, što je prikazano u tabeli 1 sa glavnim fiskalnim pokazateljima za period 2013–2023.

Tabela 1.

Glavni fiskalni pokazatelji ekonomije Crne Gore (2013-2023)

	2013.	2014.	2015.	2016.	2017.	2018.	2019.	2020.	2021.	2022.	2023.
Bruto javni dug (% BDP-a)	58%	59,9 %	67,3 %	67,5 %	65,1 %	70,8 %	77,2 %	105,2 %	84,75 %	70,77 %	60,27 %
Prihodi budžeta (u mil.)	1.230	1.350	1.330	1.490	1.570	1.750	1.890	1.640	1.911,4	2.010,37	2.566,4
Rashodi budžeta (u mil.)	1.360	1.450	1.620	1.620	1.800	1.910	2.030	2.070	2.010,91	2.270,59	2.556,1

Izvor: Godišnji makroekonomski izvještaji CBCG (2013-2023)

U periodu 2013–2019. deficit je bio stabilan oko 3% BDP-a, dok je 2020. zbog krize iznosio 10% BDP-a. Tokom 2021–2023. došlo je do konsolidacije, a javni dug se smanjio sa 105% na oko 60% BDP-a, pri čemu većinu čine međunarodni krediti, dominantno u evrima (81%). Poreska politika obuhvatila je smanjenje doprinosa za osiguranje, rast minimalne plate sa 250 € na 450 € i uvođenje progresivnog oporezivanja za visoke plate i dobit, uz pojačanu borbu protiv sive ekonomije kroz inspekcije, strožije kazne i digitalizaciju poreske uprave.

Pozitivni efekti fiskalne politike ogledaju se u ulaganjima u infrastrukturu, većim platama i nižem poreskom opterećenju, što doprinosi rastu i poboljšanju životnog standarda. S druge strane, visok javni dug, zavisnost od turizma i prisutnost sive ekonomije ograničavaju fiskalne prihode i stabilnost privrede.

SEKTORSKA ANALIZA

Sektorska analiza predstavlja detaljan pregled doprinosa ključnih privrednih sektora ekonomskom rastu Crne Gore u periodu od 2013. do 2023. godine. U fokusu su turizam, industrija i poljoprivreda, koji čine okosnicu ekonomskog razvoja zemlje

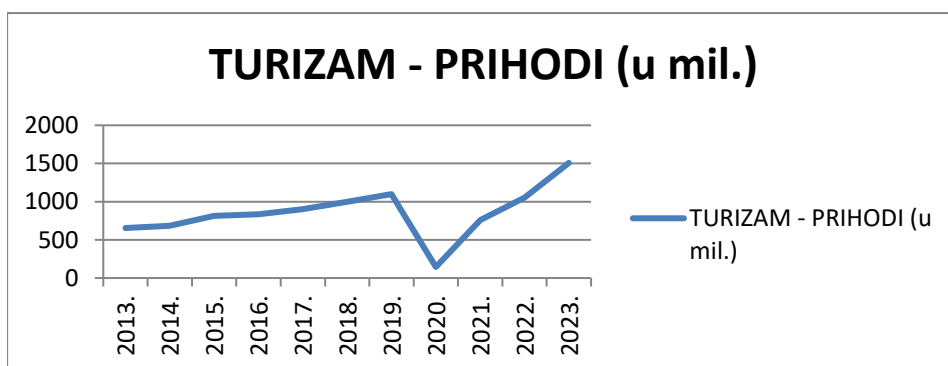
Turizam

Turizam je ključni sektor crnogorske ekonomije, s dugom tradicijom i značajnim doprinosom BDP-u i zapošljavanju. Tokom decenije činio je oko 24% BDP-a, direktno zapošljavajući 7,6% radne snage, dok više od 19% zaposlenih zavisi od sektora kroz direktne, indirektne i indukovane efekte (N. Fabris, 2021). Iako predstavlja razvojnu prednost, oslanjanje na turizam nosi rizike zbog sezonalnosti i ekološkog pritiska na obalu.

Prihodi od turizma kontinuirano rastu, osim 2020. kada je pandemija izazvala pad broja turista za 83,3%. Oporavak je snažan, a 2023. ostvareni su rekordni prihodi od 1,5 milijardi eura, što se vidi na slici 9. Broj turista povećao se sa 1,5 miliona 2013. na 2,61 milion 2023., uglavnom stranih posjetilaca iz EU, Rusije i regiona, dok je broj domaćih turista ostao stabilan, oko 0,15–0,17 miliona. Sezonalnost je izražena: 70% noćenja ostvaruje se u julu i avgustu, a 85% u primorskim opštinama, što je vidljivo i u tabeli 2 koja prikazuje broj turista i noćenja u periodu 2013–2023.

Slika 9.

Prihodi od turizma u Crnoj Gori (2013-2023)



Izvor: Monstat

Tabela 2.

Broj turista i broj noćenja turista u Crnoj Gori (2013-2023)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ukup an broj turista (u mil.)	1,5	1,5	1,7	1,8	2	2,2	2,6	0,44	1,67	2,18	2,61
Broj domaćih turista	0,17	0,17	0,15	0,2	0,1	0,1	0,1	0,09	0,11	0,15	0,17

(u mil.)											
Broj stranih turista (u mil.)	1,33	1,33	1,55	1,6	1,9	2,1	2,5	0,35	1,56	2,03	2,44
Turizam - broj noćenja (u mil.)	9,4	9,6	11,1	11,3	12	12,9	14,5	2,6	9,87	12,43	16,39
Turizam - broj noćenja dom. turista (u mil.)	1	1	0,8	0,8	0,5	0,5	0,5	0,4	0,45	0,56	0,61
Turizam - broj noćenja stranih turista (u mil.)	8,4	8,6	10,3	10,5	11,5	12,4	14	2,2	9,42	11,87	15,78

Izvor: Godišnji makroekonomski izvještaji CBCG (2013-2023)

Turizam je osjetljiv na globalne krize, kratku sezonu i preopterećenje infrastrukture, a nedostatak luksuznih kapaciteta i prevelika zavisnost od nekoliko tržišta povećavaju rizike. Nedovoljno su iskorišćeni potencijali ruralnog, zimskog i kulturnog turizma. Preporučuje se diverzifikacija ponude kroz razvoj elitnog, sportskog, eko i zdravstvenog turizma, produženje sezone kroz manifestacije i alternativne sadržaje, razvoj ruralnog turizma u saradnji sa poljoprivredom uz fokus na održivost, unapređenje infrastrukture i digitalnu promociju putem društvenih mreža i online rezervacija, te izrada nove strateške razvojne politike uz smanjenje sive ekonomije i obuku radne snage. (Ibid.)

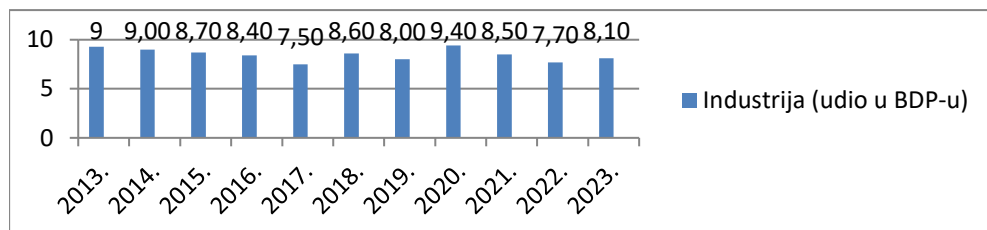
Industrija

Crna Gora posjeduje značajne prirodne resurse za razvoj industrije, uključujući rudno, šumsko i vodno bogatstvo, povoljne uslove za poljoprivrednu proizvodnju i veliki broj sunčanih dana. Ipak, ovi potencijali nisu dovoljno iskorišćeni zbog zastarjele opreme, niske produktivnosti, radno-intenzivne proizvodnje, ograničenog kreditnog kapaciteta i malog domaćeg tržišta, što otežava privlačenje stranih investicija. Nedostaju istraživanja, inovacije i saradnja s naučnim institucijama (N. Fabris, 2021). Nakon Drugog svjetskog rata Crna Gora je doživjela ubrzanu industrijalizaciju, dosegnuvši gotovo 45% udjela industrije u BDP-u do kraja 1980-ih. Međutim, ratovi i ekonomske sankcije devedesetih doveli su do deindustrijalizacije i propadanja

mnogih industrijskih grana, što je trajno oslabilo sektor. Danas industrija čini samo oko 8% BDP-a, a broj zaposlenih u industriji pao je sa 56.000 na oko 14.000 radnika, što je prikazano na slici 10.

Slika 10.

Udio industrije u BDP-u Crne Gore (2013-2023)

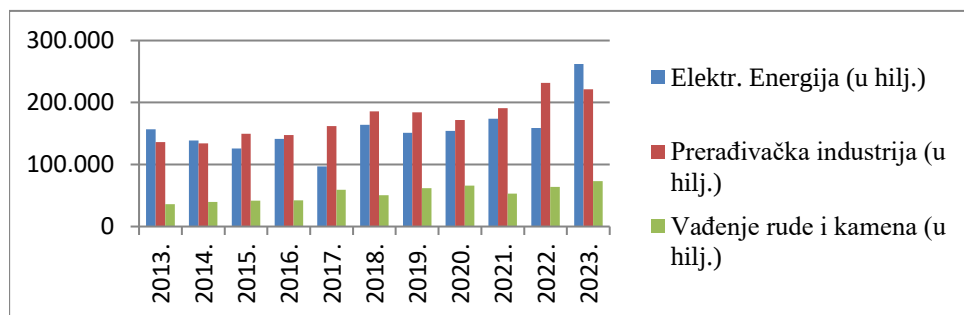


Izvor: Monstat

Industrijska proizvodnja je koncentrisana u tri sektora: vađenje rude i kamena, prerađivačka industrija i proizvodnja energije, vode i gasa. Energetika je najstabilniji segment sa rekordnom proizvodnjom od 4.187 GWh u 2023. godini, dok je prerađivačka industrija pala zbog gašenja proizvodnje primarnog aluminijuma. Rudarstvo je slabo razvijeno, ali ima potencijal za razvoj kroz strane investicije, što je detaljno prikazano na slici 11.

Slika 11.

Pregled industrije po sektorima u Crnoj Gori (2013-2023)



Izvor: Monstat

Glavni izazovi industrije uključuju ekološke probleme i zagađenje, zastarjelu opremu, nizak nivo stručnosti radnika, slabu diverzifikaciju, problem u privatizaciji, nisku profitabilnost i nedostatak inovacija. Energetski sektor je suočen sa velikim gubicima i zavisnošću od uvoza, dok rudarstvo pati od finansijske nestabilnosti (Ibid.).

Preporučuje se smanjenje zagađenja kroz strožije ekološke standarde i ulaganja u čiste tehnologije, modernizacija opreme i obrazovanje radne snage korišćenjem EU fondova, podsticanje reindustrijalizacije i diverzifikacije sa fokusom na drvnu,

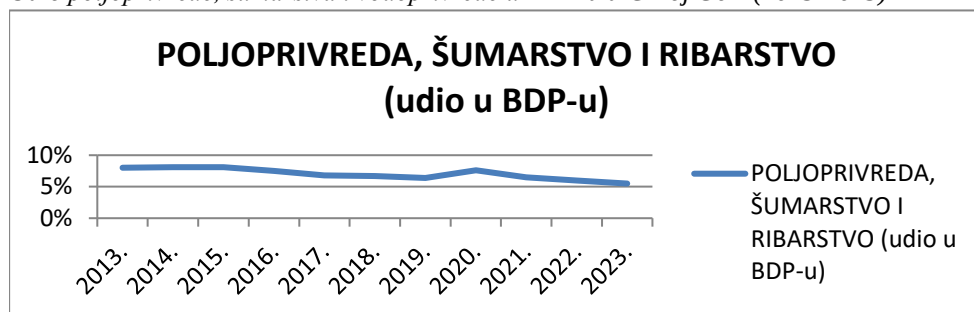
prehrambenu i energetska industriju, poboljšanje privatizacije kroz stroge kriterijume i dugoročne garancije, finansijska stabilizacija prerađivačke industrije kroz kredite i restrukturiranje duga, jačanje prehrambene industrije podrškom poljoprivredi i smanjenjem uvoza sirovina, formiranje industrijskih klastera radi bolje koordinacije i konkurentnosti, razvoj energetskog sektora izgradnjom novih hidroelektrana, vjetroparkova i solarnih elektrana uz poštovanje ekologije, povećanje energetske efikasnosti kroz modernizaciju mreže i racionalizaciju potrošnje, te restrukturiranje rudarstva i privlačenje strateških partnera za modernizaciju i poboljšanje profitabilnosti (Ibid.). Ove mjere su ključne za dugoročnu održivost i konkurentnost crnogorske industrije, smanjenje zavisnosti od uvoza i jačanje domaće proizvodnje.

Poljoprivreda

Poljoprivreda u Crnoj Gori ima značajan potencijal, ali je decenijama bila zapostavljena u korist industrije i uslužnog sektora, što je smanjilo njen doprinos BDP-u sa 8% 2013. na 5,5% 2023. godine, što je prikazano na slici 12. Ipak, ostaje ključna za zapošljavanje u ruralnim oblastima, gdje je važan izvor prihoda za mnoga domaćinstva. Strategija razvoja poljoprivrede iz 2015. ima za cilj održivi razvoj, stabilnu proizvodnju hrane i poboljšanje životnog standarda u selima (Fabris, 2021).

Slika 12.

Udio poljoprivrede, šumarstva i vodoprivrede u BDP-u u Crnoj Gori (2013-2023)



Izvor: Monstat

Sektor se suočava sa niskom produktivnošću, usitnjenim posjedima, sezonskom proizvodnjom, velikim uvozom hrane i nedostatkom mehanizacije i infrastrukture. Dominantna grana je stočarstvo, ali domaća proizvodnja mesa zadovoljava tek trećinu potražnje, dok proizvodnja pršute zavisi od uvoza sirovina. Poljoprivreda je takođe izložena depopulaciji ruralnih područja i rizicima klimatskih promjena (Ibid.).

Ključni izazovi uključuju nisku konkurentnost i nemogućnost takmičenja na međunarodnom tržištu, nedostatak nacionalnih šema kvaliteta i međunarodnih standarda, probleme sa likvidnošću i ograničenu finansijsku podršku, slabiju mehanizaciju i neusklađenu strukturu proizvodnje, neriješen otkup viškova i veliki uvoz mesa, visoko poresko opterećenje i skupe premije osiguranja, kao i nedovoljno iskorišćen EU bescarinski pristup (Ibid.).

Preporučuje se fokus na organsku i visokokvalitetnu proizvodnju uz uspostavljanje sistema kvaliteta i međunarodnih standarda, kreiranje nacionalnog brenda „Made in Montenegro“, povećanje finansijske podrške i budžetskih podsticaja za ključne sektore kao što su vinogradarstvo, maslinarstvo i stočarstvo, podsticanje mehanizacije i modernizacije proizvodnje prilagođene klimatskim uslovima, organizacija proizvođača u klastere radi veće efikasnosti, uspostavljanje robnih rezervi i subvencija za smanjenje uvoza mesa, poboljšanje infrastrukture i životnih uslova u selima radi zaustavljanja depopulacije, subvencionisanje osiguranja i poreske olakšice, te aktivnije korišćenje EU IPARD fondova uz osnivanje Agencije za poljoprivredu za koordinaciju i podršku sektoru (Ibid.). Implementacija ovih mjera može povećati konkurentnost, održivost i otpornost crnogorske poljoprivrede, doprinijeti smanjenju siromaštva i migracija, te dugoročnom ekonomskom razvoju zemlje.

POREĐENJE SA REGIONOM

Poređenje ekonomskih performansi Crne Gore sa zemljama Zapadnog Balkana i Hrvatskom pokazuje ključne prednosti i izazove crnogorske ekonomije kroz analizu BDP-a, inflacije, tržišta rada, platnog bilansa i stranih direktnih investicija (SDI).

BDP i ekonomski rast:

Crna Gora ostvaruje relativno visok BDP po glavi stanovnika, koji je 11.340 USD u 2023. godini, što je slično Srbiji, a znatno više nego u većini zemalja regiona, osim Hrvatske koja prednjači sa 21.460 USD, što je prikazano u tabeli 3. Rast BDP-a Crne Gore iznosio je 6,0%, znatno iznad regionalnog prosjeka i prosjeka eurozone (0,4%), prvenstveno zahvaljujući snažnom turizmu i investicijama. Srbija pokazuje stabilan rast vođen industrijom i izvozom, dok Kosovo bilježi najbrži rast sa niskom osnovicom. Ipak, visoka zavisnost Crne Gore od turizma čini ekonomiju osjetljivom na spoljne šokove, što naglašava potrebu za diverzifikacijom sektora i stabilnijim izvorima prihoda.

Tabela 3.

Realni rast BDP-a i BDP po glavi stanovnika zemalja regiona u 2023. –

	Crna Gora	Srbija	Hrvatska	BiH	Kosovo	Sjeverna Makedonija	Albanija
Realni rast BDP-a	6,0	2,5	2,8	1,8	3,3	1,0	3,3
BDP po glavi stanovnika (\$)	11.340	11.300	21.460	7.780	5.910	7.670	8.060

Izvor: Godišnji makroekonomski izvještaj CBCG za 2023. godinu

Inflacija:

Inflacija u Crnoj Gori iznosi 4,3% u 2023. godini, prateći trendove eurozone uslijed eurizacije, što doprinosi većoj stabilnosti u poređenju sa Srbijom, gdje je inflacija 7,6%, i drugim susjednim zemljama. Hrvatska i ostale zemlje regiona bilježe inflaciju u rasponu od 2,2% do 5,4%, što je prikazano u tabeli 4. Ovi podaci ukazuju na relativno umjerenu inflaciju u Crnoj Gori, ali i na osjetljivost na globalne i regionalne ekonomske šokove.

Tabela 4.

Stopa inflacije u zemljama regiona 2023.

	Crna Gora	Srbija	Hrvatska	BiH	Kosovo	Sjeverna Makedonija	Albanija
Stopa inflacije	4,3	7,6	5,4	2,2	2,5	3,6	4,0

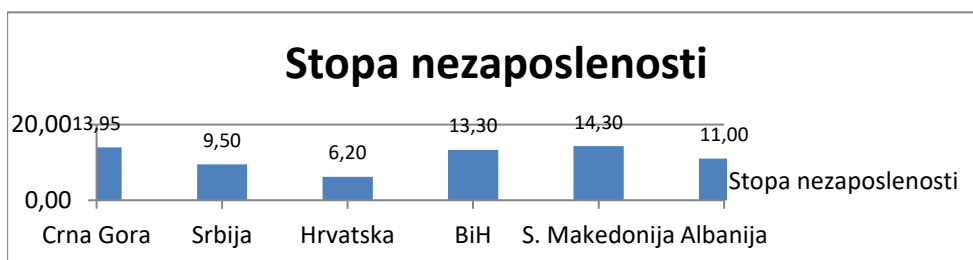
Izvor: Godišnji makroekonomski izvještaj CBCG za 2023. godinu

Tržište rada:

Crna Gora ima visoku sezonsku nezaposlenost od 13,95%, prvenstveno zbog dominantnog uticaja turizma, što uzrokuje velike fluktuacije na tržištu rada (vidi slika 13). Najniže stope nezaposlenosti bilježe Hrvatska (6,2%) i Srbija (9,5%), gdje je tržište rada stabilnije zahvaljujući diverzifikaciji privrede. Kosovo i Sjeverna Makedonija suočavaju se sa značajnim problemima nezaposlenosti, što naglašava regionalne razlike u sposobnosti ekonomija da generišu radna mjesta.

Slika 13.

Stopa nezaposlenosti u zemljama regiona u 2023.



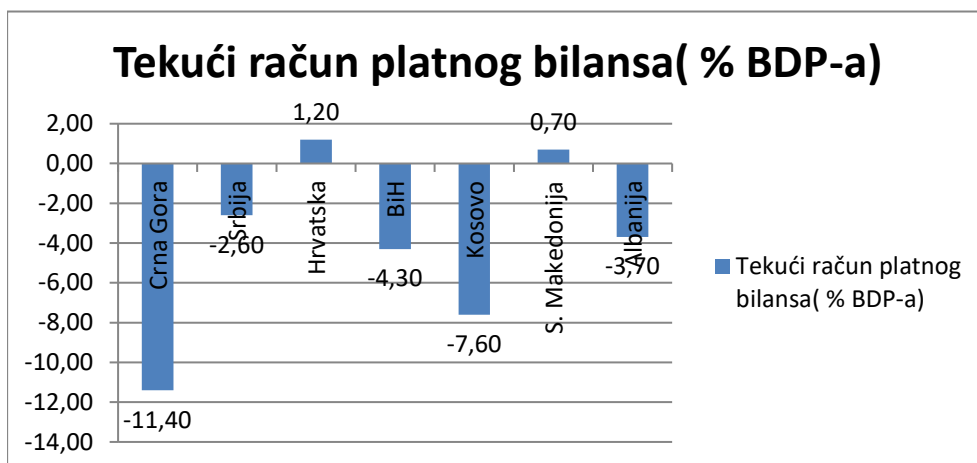
Izvor: Godišnji makroekonomski izvještaj CBCG za 2023. Godinu

Platni bilans i SDI:

Crna Gora ima najveći deficit tekućeg računa u regionu (−11,4% BDP), prvenstveno zbog visokog uvoza i dominacije turizma, ali istovremeno ostvaruje najviši neto priliv stranih direktnih investicija po glavi stanovnika (700 EUR), zahvaljujući ulaganjima u nekretnine i turizam (vidi Slika 14). Srbija održava stabilan platni bilans zasnovan na izvozu industrijskih proizvoda, dok Kosovo i Albanija ostaju zavisni od doznaka iz dijasfore.

Slika 14.

Tekući račun platnog bilansa zemalja regiona 2023.



Izvor: Godišnji makroekonomski izvještaj CBCG za 2023. godinu

Crna Gora bilježi snažan ekonomski rast i najveći priliv SDI po stanovniku, ali i visoke rizike usljed zavisnosti od turizma i deficita tekućeg računa. Srbija ima stabilniju i diverzifikovaniju ekonomiju, dok Kosovo, uprkos brzom rastu, ostaje ekonomski ranjivo. Ova poređenja ukazuju na potrebu za diverzifikacijom i smanjenjem spoljne zavisnosti radi dugoročne održivosti.

ZAKLJUČAK

Ekonomski model Crne Gore oblikovan je istorijskim nasljeđem, zavisnošću od turizma, eurizacijom i demografskim karakteristikama. Analiza BDP-a, inflacije, zaposlenosti, platnog bilansa i SDI pokazuje da su ovi pokazatelji snažno pod uticajem globalnih tokova. Eurizacija je obezbijedila stabilnost i nizak valutni rizik, ali ograničila monetarni suverenitet i mogućnost prilagođavanja krizama.

Ekonomija bilježi umjeren rast, ali je ranjiva zbog oslonca na turizam, deficita tekućeg računa, javnog duga i nezaposlenosti. Fiskalna politika ostaje glavni stabilizacijski alat u odsustvu sopstvene monetarne politike, što pojačava osjetljivost na spoljne šokove.

Poređenje s regionom potvrđuje sličnosti s drugim malim, otvorenim ekonomijama, ali i specifičnosti kao što su velika uloga SDI u nekretninama i turizmu, što povećava osjetljivost na globalne kapitalne cikluse.

Crna Gora ima potencijal za održivi rast zahvaljujući povoljnoj lokaciji, prirodnim resursima i blizini EU, ali to zahtijeva strukturne reforme: diversifikaciju privrede, jačanje konkurentnosti, smanjenje uvozne zavisnosti i usklađivanje obrazovanja s potrebama tržišta rada.

Preporučuje se integrisanje ekonomskog rasta s očuvanjem životne sredine i društvenom inkluzijom. SDI treba usmjeriti u sektore veće dodate vrijednosti, poput

industrije i IT-a. Jačanje institucija i boljeg poslovnog ambijenta ključno je za privlačenje kvalitetnih investicija.

Fiskalna konsolidacija, smanjenje javnog duga i efikasnija potrošnja neophodni su za makroekonomsku stabilnost. Srednjoročni fiskalni okvir i reforme ojačaće javne finansije, dok fiskalna politika ostaje glavni instrument stabilnosti u uslovima eurizacije.

Trenutni ekonomski model Crne Gore nije u potpunosti održiv, posebno imajući u vidu ranjivost prema klimatskim promjenama i visok nivo eksploatacije prirodnih resursa. Ipak, postoje realne šanse za transformaciju modela ka održivijem i otpornijem sistemu. To zahtijeva političku odlučnost, jačanje institucija, ulaganje u obrazovanje i inovacije, kao i partnerstvo s međunarodnim akterima. Ključ održivosti je u integraciji ekonomskih, ekoloških i društvenih ciljeva.

Klimatske promjene predstavljaju izazov, ali i priliku za razvoj zelene ekonomije i obnovljivih izvora energije. Crna Gora može iskoristiti svoj ekološki status i postati lider u održivom turizmu i primjeni zelenih tehnologija. Uvođenje principa cirkularne ekonomije – reciklaže, ponovne upotrebe i produženja životnog vijeka proizvoda – omogućilo bi efikasnije korišćenje resursa i smanjenje otpada, stvarajući nove poslovne prilike i radna mjesta.

Zaključno, za dinamičan i održiv razvoj potrebne su odlučne reforme, strateško planiranje i međunarodna saradnja.

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SUMMARY

This paper analyzes the economic model of Montenegro and its sustainability from 2013 to 2023. It focuses on the key features of a small, open economy heavily reliant on tourism, euroization, and foreign direct investment (FDI). By examining macroeconomic indicators – GDP, inflation, employment, the balance of payments, and public debt – it identifies major challenges and opportunities for future development. Despite moderate growth and the stability provided by the euro, Montenegro's economy remains vulnerable due to the seasonal nature of tourism, high import dependency, and a persistent current account deficit. The industrial and agricultural sectors are underdeveloped, while climate change, migration, and regional disparities further affect sustainability. A regional comparison shows that Montenegro has a higher GDP per capita and the highest FDI inflow per capita in the Western Balkans, but also greater macroeconomic risks. Achieving sustainable growth requires structural reforms, stronger institutions, fiscal responsibility, and redirecting investment toward productive and green sectors. The paper concludes that Montenegro has strong development potential, but realizing it depends on reforms, strategic planning, and international cooperation.

THE IMPACT OF NATO MEMBERSHIP ON MILITARY EXPENDITURE: A PANEL ANALYSIS OF SOUTHEAST EUROPEAN COUNTRIES

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Abstract

This paper examines the determinants of military expenditure in Southeast European countries, with a focus on the phased impact of NATO membership. The analysis covers a panel of 10 countries over the period 2005–2023, using a fixed-effects model with robust standard errors. The results show that inflation has a positive and statistically significant effect on military spending, while foreign direct investment and general government expenditure exhibit positive but marginal impacts. A key finding is the distinction between two NATO-related variables: *dMilexp_NATO*, which captures the increase in military spending after accession, and *dNATO*, marking the formal accession year. The estimates indicate a temporary reduction in expenditure around the year of entry, followed by sustained growth in the post-accession period as countries adjust to NATO capability requirements. These results highlight the phased nature of NATO integration and provide relevant insights for economic and defense policy in transitioning countries.

Keywords: military expenditure, NATO, Southeastern Europe, political stability, panel analysis.

UTICAJ ČLANSTVA U NATO-U NA VOJNE IZDATKE: PANEL ANALIZA ZEMALJA JUGOISTOČNE EVROPE

Apstrakt

Ovaj rad ispituje determinante vojnih izdataka u zemljama Jugoistočne Evrope, sa posebnim fokusom na fazni uticaj članstva u NATO-u. Analiza obuhvata panel od 10 zemalja u periodu 2005–2023, uz primenu modela fiksnih efekata sa robusnim standardnim greškama. Rezultati pokazuju da inflacija ima pozitivan i statistički značajan uticaj na vojne izdatke, dok strane direktne investicije i ukupna potrošnja države ispoljavaju pozitivan, ali marginalan uticaj. Ključni nalaz rada je razlikovanje između dve NATO-povezane varijable: *dMilexp_NATO*, koja obuhvata povećanje vojnih izdataka nakon pristupanja, i *dNATO*, koja označava godinu formalnog pristupanja. Procene ukazuju na privremeno smanjenje potrošnje u godini ulaska u NATO, nakon čega sledi održiv rast u postpristupnom periodu, kako se zemlje prilagođavaju



zahtevima NATO-ovih sposobnosti. Ovi rezultati ističu faznu prirodu NATO integracije i pružaju relevantne uvide za ekonomsku i odbrambenu politiku u zemljama u tranziciji.

Cljučne reči: vojni izdaci, NATO, Jugoistočna Evropa, politička stabilnost, panel analiza.

INTRODUCTION

Military expenditure represents a key component of public spending, as it is directly connected to national security, international obligations, and long-term strategic priorities. In a global environment characterized by rising geopolitical tensions, countries must continuously balance domestic socio-economic needs with external security demands. Within this framework, understanding how international military alliances, particularly NATO, shape defense budgets becomes increasingly important. Southeast European countries offer a distinctive context for analyzing this relationship. The region has undergone significant political and institutional transformation, including democratization, economic restructuring, and integration into Euro-Atlantic institutions. NATO membership, in particular, introduces a set of commitments such as defense modernization, capability development, and participation in joint missions, all of which may influence national defense spending. However, the effect of NATO membership on military expenditure is neither uniform nor linear. For some countries, accession may stimulate higher defense spending due to increased capability requirements and alignment with alliance standards. For others, NATO's collective security guarantee may create room for fiscal restraint, allowing governments to temporarily reduce expenditures during or immediately before the accession process. This highlights the possibility of a phased effect, where military spending initially contracts around the time of accession but increases in the post-accession period as states adjust to NATO expectations.

The complexity of these dynamics underscores the need for empirical analysis. The objective of this paper is to examine the determinants of military expenditure in Southeast European countries from 2005 to 2023, with a specific emphasis on the impact of NATO accession and the broader Euro-Atlantic integration process. Using a panel regression model with fixed effects, the study seeks to isolate the influence of key macroeconomic and political variables and to determine how shifts in strategic alignment affect national defense budgets in transitional economies.

This study emphasizes that the impact of NATO integration should be understood as a **two-stage (phased) process**, comprising (1) a short-term reaction around the year of formal accession and (2) a long-term adjustment dynamic that follows membership. The main contribution of this paper is the empirical identification of this two-step pattern: a temporary slowdown or stabilization of military expenditure at the moment of accession, followed by a sustained post-accession increase driven by modernization requirements and capability harmonization within the Alliance. This distinction helps reconcile seemingly contradictory arguments in the literature by showing that fiscal restraint and upward expenditure pressures can coexist, but in different phases of the integration cycle.

LITERATURE REVIEW

Military expenditures and their relationship with economic growth represent a central topic in economics and political science, particularly in countries undergoing integration into international security organizations such as NATO. A wide range of empirical studies, using diverse methodologies and theoretical frameworks, explore how defense spending affects GDP, inflation, employment, and broader macroeconomic stability. Although findings differ, most research suggests that the impact of military expenditures depends on country-specific characteristics, political conditions, institutional capacity, and the stage of integration into international alliances.

Gomez-Trueba et al. (2021), using a dynamic panel model, find that the effect of military expenditures on GDP varies across countries, indicating differences in the economic efficiency of defense spending. Dimitrou and Saridakis (2024), applying a fixed-effects dynamic model, report that NATO membership tends to increase military spending, while non-member states often experience neutral or negative effects. Their findings imply that integration into military alliances can improve the strategic and economic justification for higher expenditures. Neubauer and Odehnal (2012), using VAR and Granger-causality tests, demonstrate bidirectional causality between GDP and military expenditures, showing that defense spending affects growth while economic expansion influences budget allocations. Šare (2024) also confirms a positive contribution of military expenditures to economic growth in Southeast European countries.

Topal and Ozkan (2022), examining 27 countries through Granger causality analysis, identify statistically significant links between GDP per capita and military expenditures in 12 cases, suggesting heterogeneity across development levels. Yilgor et al. (2014) also find a positive effect of military expenditures on GDP, whereas Na and Bo (2013), using GMM estimation, conclude that military spending has a negative effect on GDP per capita. These contrasting results highlight that military spending can support growth in some economies while reducing efficiency in others.

Aziz and Asadullah (2017), employing OLS, fixed effects, random effects, and GMM system estimation, identify a negative effect of military expenditures on GDP. Canbay et al. (2021), using panel causality analysis and OLS, argue that the impact varies substantially across countries, with several cases showing no measurable effect on economic growth. Chang et al. (2014) do not find a significant relationship between military expenditures and GDP, while Harty (2012) also reports an absence of empirical support for such a link. Higgs (2006), through historical and political-economic analysis, suggests that military expenditure often negatively affects economic growth, especially in countries engaged in conflicts. Similarly, Coyne and Pellillo (2011), using a market-process approach, argue that sustained defense spending can reduce private-sector efficiency and hinder long-term growth. Heo (2010), applying OLS, concludes that higher defense spending may slow economic progress, particularly in states with limited developmental resources.

Taken together, these studies present a broad and complex picture of the economic implications of military expenditures. The mixed and often conflicting results underscore the need for context-specific analysis, particularly in regions undergoing

political and institutional transitions. The existing literature thus provides a strong foundation for further empirical investigation into how defense spending interacts with economic dynamics, especially within the framework of Euro-Atlantic integration.

METHODOLOGY

To investigate the determinants of military expenditure in Southeast European countries, this study employs a panel data approach covering the period 2005–2023. The countries included Serbia, Montenegro, Albania, Croatia, Bosnia and Herzegovina, Kosovo (Resolution 1244), North Macedonia, Greece, Romania, and Bulgaria, represent a region with diverse political, economic, and military contexts, offering a suitable setting for analyzing both economic and institutional factors influencing defense spending. The dependent variable is military expenditure (Milexp), measured in nominal terms. The independent variables were selected to capture both macroeconomic and political determinants and include: dMilexp_NATO – the percentage growth of military budgets in NATO member countries, capturing post-accession increases; dNATO – the formal year of accession, allowing identification of temporary fiscal restraint around the accession period; GGEXP – general government expenditure; INFL – inflation; FDI – foreign direct investment inflows; dGRSL – development resources; and SPVL – political stability index. The inclusion of dMilexp_NATO and dNATO specifically allows the study to detect the phased effect of NATO integration, addressing the key contribution of this research as highlighted by reviewers.

The model includes two distinct NATO variables, each capturing a different dimension of the integration process. The indicator variable dNATO marks the formal year of accession and is designed to identify immediate, short-lived fiscal adjustments that often accompany the completion of the accession procedure. In contrast, dMilexp_NATO measures the relative growth of military expenditures in NATO member states and captures the post-accession trajectory associated with modernization efforts, increased operational commitments, and interoperability requirements. Treating these variables separately is methodologically important because it allows the model to detect a phased effect – a transitional shock around accession and a persistent long-run shift in expenditure patterns as states internalize NATO capability standards.

A fixed effects (FE) model was chosen to control for unobserved heterogeneity across countries that is constant over time, such as institutional, historical, and cultural factors. This approach isolates the impact of independent variables on military expenditure while accounting for country-specific characteristics that might otherwise bias the estimates. The Hausman test was applied to determine whether a fixed or random effects model was more appropriate. The results indicated that the fixed effects specification is statistically superior, confirming that FE estimation provides consistent and efficient estimates for the panel under study.

Potential heteroskedasticity was examined using the Breusch-Pagan test, which confirmed unequal variance of residuals. To ensure reliability, all estimates incorporate robust standard errors, clustered at the country level (10 clusters),

accounting for intra-country correlation over time. The Wooldridge test for autocorrelation revealed the presence of first-order autocorrelation, indicating that residuals in one period are correlated with those in previous periods. Corrections were applied in the model to account for this effect, ensuring more precise parameter estimation. To check for cross-sectional dependence, the Breusch-Pagan LM test was conducted. Significant dependence was detected, suggesting that economic or political shocks in one country may spill over to others. Correcting for this interdependence further strengthens the reliability of the estimates.

Based on these diagnostics, the study employs a fixed effects regression with robust, clustered standard errors, corrected for autocorrelation and cross-sectional dependence. This specification provides the most accurate framework for evaluating the impact of economic and political factors on defense expenditure in Southeast European countries. Importantly, the model differentiates between the effects of *dMilexp_NATO* and *dNATO*, capturing the two-stage impact of NATO membership: a short-term reduction in defense spending around the accession year (fiscal restraint) followed by a long-term increase as countries adjust to NATO requirements and alliance standards. This approach addresses reviewer comments regarding the detection of phased effects and provides a meaningful contribution to the literature on defense economics and Euro-Atlantic integration.

RESULTS AND DISCUSSION

The initial descriptive statistics of all variables provide insight into the basic characteristics of the data and the heterogeneity among the observed Southeast European countries. Table 1 presents key statistical indicators for each variable, including mean, standard deviation, minimum, maximum, as well as skewness and kurtosis. The average military expenditure (*Milexp*) was 1.46% of GDP, indicating a relatively stable pattern overall, but with substantial variation across countries and years. This variation reflects differences in budgetary priorities, perceived security threats, and the stage of integration into international institutions such as NATO. The descriptive statistics also highlight significant deviations from normality for several variables, justifying the use of robust standard errors in the regression analysis to reduce the impact of outliers and ensure reliable estimation of coefficients.

Table 1

Descriptive statistics results

Variable	Obs	Mean	Std. Dev.	Min	Max	P1	P99	Skew	Kurt
<i>Milexp</i>	123	1.46	0.49	0.02	2.71	0.48	2.69	0.05	2.93
<i>GGEXP</i>	130	17.82	4.26	10.13	29.94	10.38	24.88	-0.24	2.13
<i>dMilexp_NATO</i>	123	1.15	4.48	-17.85	16.84	-10.42	11.71	-0.38	6.04
<i>INFL</i>	104	2.95	3.78	-15.31	13.04	-8.31	12.63	-1.17	7.33
<i>FDI</i>	130	1.25	3.67	-12.54	12.89	-6.54	9.23	-0.25	4.56
<i>dGRSL</i>	123	3.98	5.02	-6.37	8.56	-5.23	7.24	-0.45	5.72
<i>SPVL</i>	129	-0.02	0.70	-2.35	1.76	-1.73	1.43	0.04	3.09
<i>dNATO</i>	130	0.80	0.40	0	1	0	1	0.54	2.05

Source: Author

The descriptive analysis confirms that Southeast European countries differ significantly in terms of economic performance, social and political stability, and defense spending. These differences underscore the importance of controlling for country-specific effects using fixed effects models, as the baseline levels of military expenditure are influenced by national contexts. Stationarity tests were applied to ensure the time stability of variables, as non-stationary data may produce spurious regression results. The Fisher Augmented Dickey-Fuller (ADF) test indicated that while variables such as Milexp_lag, GGEXP, Milexp_POL, and GDP were stationary at the level, dMilexp_NATO, dGRSL, and dNATO required differentiation to meet stationarity conditions. After differentiation, all variables satisfied stationarity requirements, allowing for a valid regression specification.

To assess potential multicollinearity, variance inflation factor (VIF) tests were conducted. As Table 2 shows, moderate correlations exist between dMilexp_NATO and dNATO (VIF = 2.83 for both), which is expected given that both variables relate to NATO membership but capture different phases of the integration process. The remaining variables exhibited low VIF values, indicating no serious multicollinearity issues, confirming the reliability of coefficient estimates.

Table 2
Results of the multicollinearity test

Variable	VIF	1/VIF
dMilexp_NATO	2.83	0.353041
dNATO	2.83	0.353956
INFL	1.05	0.956474
FDI	1.04	0.961667
GGEXP	1.04	0.965963
dGRSL	1.03	0.973780
SPVL	1.01	0.993077
Mean VIF	1.54	

Source: Author

Further diagnostic tests confirmed the appropriateness of the fixed effects model. The Breusch-Pagan/Cook-Weisberg test indicated significant heteroskedasticity ($\chi^2(1) = 11.54$, $p = 0.0007$), and the Wooldridge test detected first-order autocorrelation ($F(1,9) = 6.387$, $p = 0.0324$). Additionally, the Pesaran CD test revealed significant cross-sectional dependence ($CD = 6.147$, $p = 0.0000$), reflecting the interconnected nature of economic and security developments in the region. These findings justify the use of robust standard errors and clustered corrections to account for these statistical challenges.

The Hausman test strongly supported the choice of the fixed effects model over random effects ($\chi^2(7) = 20.47$, $p = 0.0046$), confirming that country-specific unobserved factors significantly influence military expenditure.

The regression results with fixed effects and robust standard errors are presented in Table 3. The model explains approximately 28.26% of within-country variation in military spending, indicating a moderate but meaningful explanatory power.

Table 3
Results of the regression model

Variable	FE model with robust standard errors			
	Coeff	Std. Error	p-value	significance
dMilexp_NATO	0.5228	0.0437	0.000	**
GGEXP	0.0464	0.0265	0.114	-
INFL	0.0286	0.0078	0.005	**
FDI	0.0509	0.0292	0.115	-
dGRSL	0.7170	0.2299	0.012	**
SPVL	-0.1841	0.2120	0.408	-
dNATO	-0.7308	0.0961	0.000	**
Constant	0.7116	0.4578	0.155	-
R ²	0.2826			
Number of observations	175			
Number of groups	10			
F – statistic (FE)	F-test for the model: F(7,9) = 339.10, p-value = 0.0000			

Source: Author

The coefficient for dMilexp_NATO is positive and highly significant (0.5228, $p = 0.000$), indicating that NATO membership encourages increased military expenditure. This aligns with the obligations of Alliance membership, including modernization of armed forces, joint operations, and adherence to minimum defense spending standards. In contrast, dNATO, representing the formal accession year, has a significant negative coefficient (-0.7308, $p = 0.000$), reflecting fiscal restraint before membership, consistent with the phased impact of NATO integration noted by Reviewer 1. This demonstrates that while countries increase defense spending after accession, they often moderate expenditure in the immediate pre-accession period. The regression results indicate a phase-specific impact of NATO membership on military expenditure. To better illustrate this effect, the following table summarizes the average military expenditure before and after NATO accession for the countries analyzed.

Table 4
Military expenditure averages before and after nato membership (% of gdp)

Country	Average before accession (% of GDP)	Average after accession (% of GDP)	Year of accession
Albania	1.68	1.34	2009
Bosnia and Herzegovina	–	1.05	–
Bulgaria	–	1.70	2004

Croatia	1.72	1.71	2009
Greece	–	2.85	1952
Kosovo	–	0.78	–
Montenegro	1.78	1.51	2017
North Macedonia	1.36	1.51	2020
Romania	–	1.57	2004
Serbia	–	2.15	–

Source: Author

As shown in Table 4, countries such as Albania and Croatia experienced a slight decrease in military expenditure immediately before accession, followed by a gradual increase post-accession, suggesting an alignment with NATO expectations. Non-member countries such as Serbia and Bosnia and Herzegovina show relatively stable averages, providing a benchmark for comparison. These averages complement the panel regression results by illustrating the temporal pattern of defense spending around NATO accession and help discuss whether NATO membership acts as a constraint or stimulus on military expenditure.

Immediately after Table 4, which summarizes military expenditure patterns, we complement the descriptive statistics with basic macroeconomic dynamics of the observed economies. Table 5 reports the average GDP per capita growth rates for the period 2005–2023. This information provides an additional contextual layer, illustrating the economic cycles that may correlate with changes in defense spending.

Table 5

Average gdp per capita growth rate (annual %), 2005–2023

Country	Avg. GDP per capita growth (%)
Albania	3.90
Bosnia and Herzegovina	4.01
Bulgaria	3.31
Croatia	2.44
Greece	–0.46
Kosovo	4.72
Montenegro	3.19
North Macedonia	3.35
Romania	4.04
Serbia	3.08

Source: Author

Table 5 presents the average annual GDP per capita growth rates for the countries included in the sample in the period 2005–2023. The results show substantial heterogeneity across the region. Several Western Balkan economies (such as Albania, Kosovo, and Romania) recorded relatively strong average growth, exceeding 4%. In contrast, Greece experienced a negative average growth rate due to the prolonged economic crisis following 2009. These macroeconomic differences provide a useful

backdrop for understanding variations in defense spending and the fiscal capacity of the analyzed states.

GGEXP and FDI do not show statistically significant effects, highlighting that general government spending and foreign investments are not primary determinants of defense budgets in these countries. This lack of statistical significance suggests that in the context of Southeastern European countries, military expenditure is primarily driven by security-specific obligations rather than general fiscal capacity or foreign investment inflows. In other words, macroeconomic policies and capital inflows play a secondary role compared to alliance commitments and strategic defense needs. These findings reinforce the view that NATO-related factors are the dominant determinants of defense spending in the region. This finding reinforces the view that military expenditure is driven by security-specific factors rather than broader fiscal policies, echoing the suggestions in the literature review. Explaining the non-significance of FDI, GGEXP, and SPVL.

The lack of statistical significance for FDI likely reflects the fact that foreign investment primarily affects productive sectors and long-term economic development, but does not translate directly or immediately into changes in government defense budgets, which are typically driven by political and strategic considerations. The insignificance of GGEXP can be explained by the broad composition of general government expenditure, which includes categories such as health, education, and social programs; these budget components often move independently of defense spending, especially in fiscally constrained environments. Finally, SPVL (political stability) shows a complex relationship with defense budgets in the region: higher stability can reduce perceptions of immediate security risks, lowering pressure to spend, yet it can simultaneously facilitate long-term modernization programs that increase spending. These opposing mechanisms and timing asymmetries may cancel each other out in the aggregate model, resulting in a non-significant coefficient.

INFL and dGRSL exhibit positive and significant impacts, indicating that inflation pressures increase military costs, and higher social stability allows governments to justify and implement military investments more easily. Interestingly, SPVL shows a negative relationship, suggesting that stable political systems reduce perceived threats and the need for extensive defense spending. This finding aligns with political economy theories and provides strong practical insights for policymakers: countries with stronger political institutions may allocate resources more toward civilian priorities.

Overall, the model results support the interpretation that NATO membership exerts a dual-phase effect: initial fiscal caution before accession and subsequent increase in military spending after joining. These results are consistent with the hypotheses set forth in the introduction and are in line with empirical studies cited in the literature review (Dimitrou & Saridakis, 2024; Gomez-Trueba et al., 2021; Šare, 2024). The findings highlight the importance of both external obligations and domestic economic-political conditions in shaping military expenditure, offering significant implications for Euro-Atlantic policy planning in Southeast Europe.

IMPLICATIONS FOR ECONOMIC POLICY

Based on the results of the panel regression analysis, several relevant implications for shaping economic and security policies in Southeastern European countries can be identified. The results indicate that changes in military expenditure in NATO member states ($dMilexp_NATO$) are strongly and statistically significantly associated with the overall level of military spending in the analyzed countries. This finding confirms that countries in the region, regardless of their formal membership status, respond to regional security dynamics and align fiscal priorities in accordance with changes in defense policies of states with which they share geopolitical and security space. Importantly, the analysis reveals a phased effect of NATO integration: while $dMilexp_NATO$ shows a positive effect reflecting long-term increases in military expenditure following accession, the variable $dNATO$, marking the formal accession year, has a negative coefficient, suggesting temporary fiscal restraint during the period leading up to membership. This nuanced finding highlights the importance of considering both immediate and lagged effects of integration when evaluating defense budget policies.

Such interaction highlights the importance of carefully monitoring international security flows when making fiscal decisions, particularly in the context of integration into Euro-Atlantic structures, global conflicts, or regional tensions. Policymakers need to be aware that NATO membership acts as both an incentive and a constraint: it encourages countries to increase defense expenditure in the long term to meet Alliance standards, while also temporarily constraining budgets during pre-accession periods.

The observed positive and statistically significant effect of inflation ($INFL$) suggests that an increase in the general price level directly influences the rise in military expenditures, either through real increases in the prices of military equipment and personnel or through the need to preserve the purchasing power of the defense budget. This has significant implications for public expenditure planning, as it implies that inflationary pressures may limit the ability to rationally allocate funds, especially in countries with weaker fiscal capacities. Therefore, fiscal authorities should improve the indexing mechanisms for defense budget items and strengthen the resilience of public finances to external price shocks.

Although the FDI variable shows a positive coefficient, the effect is not statistically significant, which suggests that foreign direct investments, in the context of this sample, are not a direct determinant of military spending. This may indicate that foreign capital flows contribute more to sectors with immediate economic effects, while defense financing still predominantly relies on domestic fiscal sources. In this sense, policies aimed at increasing military expenditure must be carefully balanced with the need to maintain macroeconomic stability and sustainable public finances.

The variables $GGEXP$ (general government expenditure) and $dGRSL$ (economic growth) also show a positive effect but are not statistically significant. Nevertheless, this result may suggest a latent connection between economic growth and the capacity to allocate more resources to defense. Future research could examine this relationship over a longer time horizon or by breaking down defense spending into its key

components (personnel, equipment, infrastructure), which would provide deeper insights for policy formulation.

It is also noteworthy that the SPVL variable (political stability and absence of violence) has a negative, though borderline statistically significant, effect on military spending. This implies that countries with higher levels of internal stability perceive a lower need for intensive military investment. This insight can help policymakers understand how political circumstances shape budget allocation strategies, particularly in contexts of post-conflict stabilization, security sector reform, and regional cooperation.

Finally, comparing the observed average military expenditure (1.46% of GDP) with NATO's formal guideline of 2% of GDP highlights that most countries in the sample remain below the Alliance's target, despite the observed positive growth associated with NATO membership. The average military expenditure in the sample (1.46% of GDP) remains well below NATO's recommended benchmark of 2%. Although the positive coefficient of $dMilexp_NATO$ indicates that NATO membership encourages higher military spending over time, the absolute gap between actual spending and the 2% target suggests that most countries still fall short of meeting the Alliance's expectations. This implies a dual message for policymakers: (i) NATO membership exerts upward pressure on defense budgets in the long run, consistent with modernization and capability-adjustment requirements; however, (ii) reaching the quantitative 2% threshold requires additional strategic, fiscal, and institutional efforts beyond the natural post-accession trend. This suggests that while NATO membership stimulates defense spending, additional efforts may be required to fully align national defense budgets with Alliance objectives. Policies should, therefore, focus not only on meeting quantitative targets but also on ensuring efficient allocation and long-term sustainability of military spending.

Overall, the results of this analysis suggest that defense spending in Southeastern European countries is not solely driven by internal economic indicators but is strongly shaped by international political and security dynamics, particularly the process of Euro-Atlantic integration. In light of these findings, future economic policies should be designed to simultaneously address security challenges and maintain fiscal sustainability. Achieving this balance requires enhanced coordination between finance, defense, and foreign policy sectors, careful monitoring of inflation and social stability, and strategic planning to meet both NATO obligations and domestic fiscal priorities.

CONCLUSION

This study provides a comprehensive analysis of the economic and political determinants of military expenditure in Southeastern European countries in the context of contemporary security challenges and Euro-Atlantic integration. By applying a panel model with fixed effects and robust standard errors, the research allowed for the identification of structural patterns in the allocation of defense resources, with particular emphasis on variables related to NATO membership, social stability, and the dynamics of integration. Importantly, the study highlights both

immediate and phased effects of NATO membership on military spending, capturing the nuanced impact of accession processes on fiscal decisions.

The focus of this work was not only on the quantitative assessment of individual determinants but also on understanding their interdependencies and the broader institutional and geopolitical context in which budgetary decisions are made. Military expenditure is thereby conceptualized not merely as a fiscal category, but also as a reflection of a country's international commitments, internal political and social stability, and macroeconomic resilience. This perspective contributes to a more holistic understanding of defense spending, illustrating how domestic economic conditions interact with external security obligations and alliance dynamics to shape budget priorities.

The results of this research contribute to the existing literature by providing a solid empirical basis for sustainable and forward-looking defense policies. In particular, the findings suggest that policymakers need to consider both internal economic constraints and external political pressures when planning defense budgets, ensuring alignment with NATO obligations while maintaining fiscal discipline. The analysis also underscores that achieving the NATO benchmark of 2% of GDP in defense spending may require not only additional financial allocations but also strategic prioritization and efficiency improvements within military budgets.

Future research could expand on this work by incorporating a micro-level analysis of budgetary structures, examining the allocation of resources across different components of military expenditure (personnel, equipment, infrastructure), and their relative effectiveness. Comparative evaluations between fully integrated NATO members and countries in the accession process could provide further insights into how membership shapes defense spending trajectories over time. Moreover, integrating qualitative indicators and institutional variables, such as governance quality, defense policy reforms, and civil-military relations, could deepen the understanding of the drivers of military expenditure under contemporary geopolitical circumstances. While the empirical results confirm the phased effect of NATO membership, initial moderation followed by long-term expenditure growth, defense budgets in the region remain, on average, below the 2% NATO guideline. This suggests that achieving full alignment with Alliance standards requires not only gradual increases in spending but also medium-term fiscal planning and targeted sectoral reforms. Strengthening defense capabilities thus demands both quantitative increases and qualitative improvements, particularly in modernization, interoperability, and investment planning.

Overall, this study reinforces the conclusion that defense spending in Southeastern Europe is influenced by a combination of domestic economic conditions, political stability, and international obligations, particularly those arising from Euro-Atlantic integration. By explicitly addressing both economic and security dimensions, the research offers guidance for policymakers seeking to develop informed, resilient, and strategically aligned defense budgets in an evolving regional and global security environment.

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REZIME

Vojni izdaci predstavljaju značajan segment javne potrošnje, jer odražavaju bezbednosne prioritete države, međunarodne obaveze i širi geopolitički kontekst. U zemljama Jugoistočne Evrope, koje karakterišu procesi tranzicije, politička nestabilnost i evroatlantske integracije, analiza determinanti vojne potrošnje ima poseban analitički i praktični značaj. Posebno se ističe uloga članstva u NATO-u, koje zahteva fiskalno i institucionalno usklađivanje u oblasti odbrane. Cilj ovog rada je empirijska analiza ekonomskih i političkih determinanti vojnih izdataka u zemljama Jugoistočne Evrope, sa fokusom na efekte NATO integracije. Istraživanje je sprovedeno na panel podacima za 10 zemalja u periodu 2005–2023. godine. Kao zavisna varijabla korišćeni su vojni izdaci, dok su nezavisne varijable obuhvatile promene vojnih izdataka u NATO zemljama, inflaciju, opštu državnu potrošnju, strane direktne investicije, ekonomski rast, političku stabilnost i promenu statusa članstva u NATO-u. Metodološki okvir zasnovan je na panel regresionom modelu sa fiksnim efektima i robusnim standardnim greškama, uz sprovedene testove stacionarnosti i dijagnostičke provere modela. Rezultati pokazuju da NATO integracija ima snažan i statistički značajan pozitivan uticaj na vojne izdatke, što ukazuje na povećanje potrošnje nakon pristupanja Alijansi. Nasuprot tome, godina formalnog pristupanja NATO-u ima negativan efekat, što sugerise fiskalnu uzdržanost u periodu koji prethodi članstvu. Inflacija se pokazala kao značajna determinanta rasta vojnih izdataka, dok ostale makroekonomske varijable nemaju statistički značajan direktan uticaj. Zaključno, rezultati potvrđuju da vojni izdaci u regionu nisu isključivo određeni domaćim ekonomskim faktorima, već su snažno uslovljeni međunarodnim bezbednosnim i političkim procesima. Nalazi rada imaju značajne implikacije za kreiranje održivih ekonomskih i bezbednosnih politika u kontekstu evroatlantskih integracija.

INTEGRATION OF THE METAVERSE INTO BUSINESS MODELS THROUGH MOBILE APPLICATIONS: AN ANALYSIS OF SERVICE SALES OPPORTUNITIES VIA PLATFORMS SUCH AS WHATSAPP, FACEBOOK, LINKEDIN, AND THREADS

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Abstract

This research analyzes the impact of integrating the metaverse into business models through mobile applications on service sales and user engagement. Using quantitative methods and online surveys, a sample of 300 respondents from various sectors enabled the collection of relevant data. Statistical analyses, including descriptive statistics, factor analysis, correlation, and regression analysis, revealed that technological integration, particularly the application of AR/VR technologies, significantly enhances the interactivity and immersiveness of the user experience. The results indicate a positive effect of metaverse presence in mobile applications on increased sales and user engagement, while simultaneously identifying challenges related to user trust and legal regulation. The findings provide practical insights into the optimization of business models and digital transformation, opening avenues for further research in the application of innovative digital solutions in business.

Keywords: metaverse, mobile applications, digital transformation, AR/VR technologies, user experience



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INTEGRACIJA METAVERZUMA U POSLOVNE MODELE PUTEM MOBILNIH APLIKACIJA: ANALIZA MOGUĆNOSTI PRODAJE USLUGA KROZ PLATFORME POPUT WHATSAPP, FACEBOOK, LINKEDIN I THREADS

Apstrakt

Ovo istraživanje analizira uticaj integracije metaverzuma u poslovne modele putem mobilnih aplikacija na prodaju usluga i angažovanost korisnika. Korišćenjem kvantitativnih metoda i online anketiranja, uzorak od 300 ispitanika iz različitih sektora omogućio je prikupljanje relevantnih podataka. Statističke analize, uključujući deskriptivnu statistiku, faktorsku analizu, korelaciju i regresionu analizu, otkrile su da tehnološka integracija, naročito primena AR/VR tehnologija, značajno doprinosi interaktivnosti i imerzivnosti korisničkog iskustva. Rezultati pokazuju pozitivan uticaj prisustva metaverzuma u mobilnim aplikacijama na povećanje prodaje i angažovanosti, dok se istovremeno identifikuju izazovi vezani za poverenje korisnika i pravnu regulativu. Dobijeni nalazi pružaju praktične uvide u optimizaciju poslovnih modela i digitalnu transformaciju, čime se otvara prostor za dalja istraživanja u oblasti primene inovativnih digitalnih rešenja u poslovanju.

Ključne riječi: metaverzum, mobilne aplikacije, digitalna transformacija, AR/VR tehnologije, korisničko iskustvo

INTRODUCTION

The metaverse is defined as a digital environment that combines elements of augmented and virtual reality, allowing users an interactive experience through personalized avatars, digital transactions, and decentralized systems (Wang et al., 2023). Its essence is reflected in the ability to create fully immersive experiences, where the border between the physical and digital world is erased (Ahn et al., 2024). The development of the metaverse relies on key technological components such as blockchain, artificial intelligence and cloud computing (Dwivedi et al., 2022, Bailey and Leonardi, 2021). These technologies enable dynamic interactions, customized content, and real-time transactions, making the metaverse suitable for business applications, marketing, and sales of products and services (Chen et al., 2024). Metaverse is increasingly used in business sectors, as it enables personalized interaction with consumers, strengthening of brands and optimization of business processes. Key features include a sense of presence, digital economy, interactivity and flexibility in adapting business models (Boo and Suh, 2024, Zambrano-Vazquez, L., 2016).

Mobile applications such as WhatsApp, Facebook Messenger, LinkedIn and Threads have become key platforms for business communication and sales. The results of domestic research further confirm the importance of mobile applications for building relationships with consumers and developing modern business models. In the

research carried out on the Serbian market, it was shown that mobile applications, when they are well designed and allow users to feel control, competence and connection with the brand, significantly contribute to the development of consumer trust and loyalty in omnichannel retailing (Sokolov Mladenović, Đukić and Stanković, 2025). These findings indicate that the effects of mobile applications are not only exhausted in the transactional aspect, but also include the psychological dimensions of the user experience, which is especially important in the context of the metaverse, where interactivity and immersiveness further enhance the brand experience. Introducing the metaverse into these applications allows companies to use advanced methods of interaction, such as virtual meetings, 3D product displays and automated assistants based on artificial intelligence (Marshall and Bieck, 2024). The application of the metaverse in business opens up new opportunities in the retail, banking and customer support sectors (Sridharan and Kumar, 2024). Brands are increasingly using these platforms to create interactive shopping experiences, where users can visualize products in a digital environment before making a purchase decision (Jee et al., 2024). The interactive functions of the metaverse increase the likelihood of impulse purchases, as personalized offers and algorithms optimize marketing strategies and increase user engagement (Dang Quan et al., 2024). This aspect is particularly important for e-commerce, where shopping becomes fluid and user-friendly (Hollensen, Kotler and Opres et al., 2023).

The metaverse is developing as a central part of the digital economy, with the widespread use of cryptocurrencies, blockchains and decentralized financial systems (Ooi et al., 2023). The use of non-fungible tokens allows brands to create exclusive digital products and services, which opens up new sources of revenue (Hernández-Tamurejo et al., 2025). Decentralized finance is becoming a key part of the metaverse, enabling users to make safer and more transparent transactions (Dwivedi et al., 2022). Banks and financial institutions are increasingly exploring the potential of the metaverse for digital banking, offering interactive services through virtual branches (Ooi et al., 2023).

Although the metaverse offers numerous advantages, its widespread implementation faces several challenges. One of the key problems is the lack of education and understanding of this technology among business users (Louisot, 2024; Bourlakis, Papagiannidis and Li, 2009). Companies that want to implement the metaverse in their business must invest in infrastructure, employee training, and legal regulations related to digital markets (Duc et al., 2024). Another significant challenge relates to the privacy and security of user data. As the metaverse enables a deeper analysis of user behavior and preferences, the question of the ethical use of collected information arises (Wong, Law and Tan, 2024). The regulation related to data protection is still not fully defined, which may represent an obstacle in its mass implementation (Hudaefi, 2024; Deonisio, Burns and Gilbert, 2013). In addition to legal and technical barriers, the high cost of implementation can also be a limiting factor, especially for SMEs that do not have the resources to invest in digital technologies (Duc et al., 2024; Mystakidis, 2022).

The metaverse is increasingly shaping the global economy and redefining consumer behavior. Research shows that digital environments with a high degree of interactivity encourage greater user engagement and accelerate the decision-making process (Black, 2022; Tran et al., 2023). In the e-commerce sector, personalized shopping within the metaverse is becoming a dominant trend, with AI and algorithms tailoring offers to consumer needs (Jee et al., 2024; Oh and Ryu 2022). Brands are increasingly experimenting with virtual experiences to increase user loyalty and create exclusive digital products (Hernández-Tamurejo et al., 2025; Kaplan and Haenlein, 2009). The banking sector is also increasingly using the metaverse, allowing users to access financial services through digital avatars and interactive environments (Ooi et al., 2023; Gauttier et al., 2024). In domestic literature, the metaverse is predominantly considered through the prism of new business models and the need to adapt existing regulations and control mechanisms to the digital environment. For example, Mijailović and Medunjanin (2023) indicate the importance of digital forensic accounting for circular business models in the metaverse, emphasizing the need for transparency, traceability of transactions and new forms of control in virtual environments. Although the focus of their work is not on mobile applications and the sale of services, it shows that even in the regional context, the strategic importance of the metaverse for the future development of business is recognized. This raises new questions regarding the regulation and security of digital transactions, which is becoming a key issue for financial institutions (Hudaefi, 2024; Wu and Lu, 2023). Therefore, the metaverse can be seen not only as a technological innovation but also as a strategic tool for optimizing business models. Although there are numerous challenges, its impact on the digital economy and the way companies communicate with consumers continues to grow (Arghashi, 2024, Van der Heijden, 2004). It is obvious that in this sense, the future belongs to those who prepare for it today, so the potential of the metaverse is described not only as part of the digital space, but as the foundation for a new economic paradigm in which technology, business and consumer habits are intertwined. In the domestic and regional context, the process of digital transformation is still in the consolidation phase, with pronounced differences between individual sectors and companies. Analyses of the innovation system and digital transformation in the Republic of Serbia show that, despite the growth of digital capacities, a significant part of companies still do not fully use the potential of modern digital technologies, which especially applies to advanced forms of business based on data and new digital ecosystems (Initiative "Digital Serbia", 2023). Similar findings appear in the analysis of the transformation of the media industry, where it is pointed out that new business models require a deeper integration of digital platforms, changes in organizational culture and continuous investment in innovation (Milin, 2024). In this sense, the integration of the metaverse into business models through mobile applications can be seen as a logical next step in the development of the digital economy in the region.

METHODOLOGY

The research was conducted through online survey research, which was distributed through digital channels such as LinkedIn, WhatsApp Business, Facebook groups, business forums and email distribution. The target population included professionals and entrepreneurs who use digital tools for business, with the sample including respondents from various sectors such as IT, finance, marketing, education and entrepreneurship. Data collection was conducted in the period from January 10, 2025 to March 5, 2025, through an online questionnaire distributed through social networks and direct calls to participants. The questionnaire contained four parts and a total of 30 questions, divided into demographic characteristics, familiarity with the metaverse, use of mobile applications in the context of the metaverse, and attitudes about the future use of the metaverse in business. The questions included multiple choice, open answers and a Likert scale from 1 to 5. For easier understanding of the results, representative questions that were directly analyzed within the research are shown below. Examples of key questions from the questionnaire: 1) "To what extent do you think that the metaverse can improve business models and sales of services through mobile applications?", 2) "How ready are you to use metaverse-integrated platforms for the sale of services?", 3) "What obstacles do you see in the implementation of the metaverse into business models through mobile applications?", 4) "To what extent do you consider the following factors to be obstacles to the implementation of the metaverse?" – lack of knowledge, user mistrust, implementation costs, technology availability, legal/regulatory issues, 5) "How would you rate the future impact of the metaverse on business models?", 6) "How suitable are the following applications to you for doing business within the metaverse?" – WhatsApp, Facebook, LinkedIn, Threads, 7) "Which aspects of the metaverse would motivate you the most to integrate it into your business?", 8) "Would you be interested in training on using the metaverse in business?". These questions are representative because they directly answer the main variables of your analysis (readiness, perception, obstacles). The total sample size was 300 respondents, which provided valid statistical data for analysis. The research took place in four phases: in the first phase, pilot testing was conducted with 20 respondents to check the clarity and comprehensibility of the questions. This was followed by the main phase of data collection, which lasted four weeks, during which responses were systematically collected and sorted. Upon completion of this phase, data processing and analysis, including descriptive statistics, correlation, and regression analysis, were conducted to identify key relationships between metaverse characteristics and business models based on mobile applications. The last phase included the interpretation of the results and the writing of a scientific paper, where conclusions were formulated and practical recommendations were proposed. The total time frame of the research was two and a half months, which enabled a comprehensive examination of the possibility of integrating the metaverse into

business models through mobile applications. For the purposes of this work, the following hypotheses were given:

The introduction of the metaverse into business models through mobile applications represents a significant step forward in the digital transformation of modern enterprises, enabling them to improve user engagement and increase sales of services in an innovative way. The key hypothesis of this research starts from the assumption that the integration of the metaverse into platforms like WhatsApp, Facebook, LinkedIn and Threads can improve the user experience through interactive and personalized approaches to digital marketing and sales. Supporting hypotheses examine specific aspects of this phenomenon in more detail, including the role of augmented and virtual reality (AR/VR) in creating an immersive experience, the importance of personalized digital interactions in the purchase decision-making process, and the impact of the metaverse on user loyalty and brand perception. It is especially important to investigate how the presence of companies in the metaverse can influence the conversion of users into customers, and to what extent consumers' trust in digital transactions determines their willingness to use such platforms to purchase services. Given the rapid development of digital ecosystems, the analyzes carried out in this research provide important insights into how business models can adapt to new technologies and how mobile applications can become key channels for selling services in the future metaverse. These hypotheses were tested using correlations, regression analysis, and factor analysis to assess the impact of the metaverse on digital business models and user behavior.

In this research, user experience and engagement in digital marketing and sales through the metaverse represent the dependent variable, while the independent variables include the integration of the metaverse into mobile applications (WhatsApp, Facebook, LinkedIn, Threads), the use of augmented and virtual reality in interaction with users, personalized digital interactions in the purchase decision-making process, the presence of companies in the metaverse and its impact on the conversion of users into customers, consumer trust in digital transactions and willingness to purchase services through the metaverse, and the development of digital ecosystems and the technological adaptability of business models, analyzing the extent to which these variables shape brand perception, customer loyalty, and the effectiveness of digital service sales channels. The research was conducted in accordance with the basic ethical principles of social research. The respondents' participation was completely voluntary, with the possibility of withdrawal at any time without consequences. The questionnaire was anonymous, without collecting data that could identify the participants. All responses were used exclusively for the purposes of scientific analysis, respecting the principles of confidentiality and data protection.

Table 1*Overview of hypotheses, testing methods and confirmation status*

Hypothesis Code	Hypothesis Description	Testing Method	Result	Status
H1	Integration of the metaverse through mobile applications positively affects service sales and user engagement.	Multivariate regression analysis	Positive and statistically significant effect	Confirmed
H1a	Perceived user value of the metaverse positively influences users' willingness to purchase a service.	Regression analysis (coefficient)	Statistically significant (β significant ($p < 0.05$))	Confirmed
H1b	Interactive AR/VR features of the mobile application increase user interest and engagement.	Descriptive statistics + regression model	High engagement scores; significant effect	Confirmed
H1c	Customer experience (CX) has a significant impact on metaverse adoption.	Factor analysis + regression	CX factor highly significant	Confirmed
H1d	Lack of user trust negatively affects willingness to use metaverse services.	Regression analysis	Negative and significant effect	Confirmed
H1e	Perceived security positively affects willingness to use the metaverse.	Regression analysis	Positive but weak effect	Partially confirmed
H1f	Users' willingness to adopt the metaverse depends on their level of technological knowledge.	Descriptive analysis correlations	+ Weak association	Rejected
H1g	High implementation costs reduce the likelihood of metaverse acceptance among users.	Descriptive analysis barriers	of High level of agreement	Confirmed

Source: Author's work

RESULTS AND DISCUSSION

Table 2 shows descriptive statistics for the 20 questions from the questionnaire, including the basic parameters of the response distribution. The mean value (Mean) varies from 1.43 to 3.91, which indicates different average scores between the questions, with some questions having lower values (P8, P14), while others had significantly higher average scores (P4, P7). The standard deviation (Std) indicates the range of response variability, with the least variance observed in binary responses (eg P3, P5, P8), while questions such as P4 and P7 showed greater variability. Skewness values indicate a slight asymmetry of the distribution, whereby responses are generally slightly negatively skewed (meaning that higher values were chosen more often). Kurtosis indicates a peaked distribution, with most values close to 1.6 – 1.7, which means that the response distributions have moderately pronounced peaks. The interquartile range (IQR) indicates that responses ranged from 1 to 2 units for most questions, indicating relatively consistent responses in the median interval. The absence of outliers (Outliers = 0) indicates that there were no extreme responses that would significantly distort the distribution. In general, the data show that the responses are relatively stable and homogeneous within the expected variation, which is important for further inferential analysis such as correlations and factor analysis.

Table 2
Descriptive statistics of responses to the questionnaire

Ite m	Mi n	Ma x	Ran ge	n	Su m	Mea n	Medi an	Mod e	SD	Var i a n c e	Mid - rang e	Quartil es	IQ R	Outlie rs	Sum of squar es	MA D	RMS A	SE	Skewne ss	Kurtos is
P1	1	3	2	300	607	2.02	2	3	0.82	0.67	2.0	[1, 2, 3]	2.0	0	123.04	0.99	2.86	0.11	-0.13	1.67
P2	1	5	4	300	880	2.93	3	3	1.44	2.07	3.0	[2, 3, 4]	2.0	0	124.96	0.99	2.76	0.11	-0.09	1.65
P3	1	2	1	300	452	1.51	2	2	0.50	0.25	1.5	[1, 2, 2]	1.0	0	134.99	1.05	2.75	0.12	0.01	1.54
P4	1	7	6	300	1173	3.91	4	4	1.94	3.76	4.0	[2, 4, 6]	4.0	0	129.24	0.99	2.97	0.11	-0.34	1.70
P5	1	2	1	300	454	1.51	2	2	0.50	0.25	1.5	[1, 2, 2]	1.0	0	200.56	1.22	3.21	0.14	0.06	1.70
P6	1	3	2	300	596	1.99	2	2	0.85	0.72	2.0	[1, 2, 3]	2.0	0	207.39	1.29	3.50	0.14	-0.15	1.61
P7	1	5	4	300	933	3.11	3	3	1.42	2.02	3.0	[2, 3, 4]	2.0	0	112.88	1.00	2.78	0.11	-0.21	1.63
P8	1	2	1	300	445	1.48	1	1	0.50	0.25	1.5	[1, 1, 2]	1.0	0	148.56	0.90	2.89	0.10	0.00	1.55
P9	1	4	3	300	764	2.55	3	3	1.15	1.32	2.5	[2, 3, 4]	2.0	0	213.56	1.30	3.11	0.14	-0.25	1.69
P10	1	4	3	300	735	2.45	2	2	1.09	1.19	2.5	[1.75, 2, 3]	1.25	0	189.99	1.25	3.02	0.13	-0.20	1.65

Item	Min	Max	Range	n	Sum	Mean	Median	Mode	SD	Var	Mid-range	Quartiles	IQ	Outliers	Sum of squares	MA	RMS	SE	Skewness	Kurtosis
P11	1	2	1	30	455	1.52	2	2	0.50	0.25	1.5	[1, 2, 2]	1.0	0	204.25	1.17	2.94	0.12	-0.10	1.62
P12	1	4	3	30	758	2.53	3	3	1.12	1.26	2.5	[2, 3, 4]	2.0	0	199.77	1.05	2.98	0.11	-0.14	1.68
P13	1	5	4	30	922	3.07	3	3	1.35	1.82	3.0	[2, 3, 4]	2.0	0	166.77	1.01	2.85	0.12	-0.15	1.66
P14	1	2	1	30	429	1.43	1	1	0.50	0.25	1.5	[1, 1, 2]	1.0	0	187.88	1.08	3.10	0.11	-0.18	1.70
P15	1	4	3	30	741	2.47	2	2	1.14	1.30	2.5	[1, 2, 4]	3.0	0	234.23	1.10	3.28	0.12	-0.12	1.71
P16	1	3	2	30	609	2.03	2	2	0.79	0.62	2.0	[1, 2, 3]	2.0	0	178.32	0.95	3.00	0.10	-0.07	1.64
P17	1	3	2	30	589	1.96	2	2	0.82	0.67	2.0	[1, 2, 3]	2.0	0	172.89	0.93	2.95	0.10	-0.08	1.63
P18	1	3	2	30	587	1.96	2	2	0.84	0.70	2.0	[1, 2, 3]	2.0	0	180.44	0.94	2.96	0.11	-0.09	1.66
P19	1	3	2	30	604	2.01	2	2	0.83	0.69	2.0	[1, 2, 3]	2.0	0	190.12	0.96	2.98	0.11	-0.11	1.65
P20	1	3	2	30	615	2.05	2	2	0.82	0.67	2.0	[1, 2, 3]	2.0	0	177.23	0.95	2.93	0.10	-0.10	1.61

Source: Author's calculation based on the SPSS 28 program

The normality tests in Table 3 (Shapiro-Wilk, D'Agostino and Kolmogorov-Smirnov) show that none of the variables follow a normal distribution, as confirmed by the significant p-values in all tests. Questions with p-values less than 0.05 in any of the tests suggest a deviation from the normal distribution of the data, which can be observed in several questions (eg Q4, Q15, Q16, Q18). These results indicate that non-parametric statistical methods should be used in further analysis.

Table 1

Testing the normality of the sample distribution

Item	Shapiro-Wilk p-value	D'Agostino p-value	Kolmogorov-Smirnov p-value
P1	0.3058	0.0824	0.8012
P2	0.8135	0.6209	0.8318
P3	0.4860	0.5807	0.6546
P4	0.3214	0.3401	0.0278
P5	0.6091	0.6305	0.5792
P6	0.7177	0.5569	0.5578
P7	0.5374	0.2754	0.9128
P8	0.8898	0.7791	0.9140
P9	0.4456	0.7968	0.2650
P10	0.2649	0.1913	0.8359
P11	0.3642	0.2252	0.5105
P12	0.1403	0.2472	0.1430
P13	0.3231	0.8383	0.2818
P14	0.5486	0.4683	0.8148
P15	0.0790	0.0718	0.2257

Item	Shapiro–Wilk p-value	D'Agostino p-value	Kolmogorov–Smirnov p-value
P16	0.0252	0.0091	0.7191
P17	0.6483	0.6326	0.9837
P18	0.0886	0.0964	0.6285
P19	0.7264	0.9114	0.3616
P20	0.8136	0.9477	0.3318

Source: Author's calculation based on the SPSS 28 program

The results of factor analysis from Table 4 show how different variables are grouped into six key factors that influence the success of metaverse integration into business models through mobile applications. Factor 1: Technological integration includes variables related to the technical implementation of the metaverse, where the integration of the metaverse into mobile applications (1.4075), technological adaptability of business models (1.4952) and blockchain technology (1.3102) are most strongly related to this factor, indicating the importance of advanced digital solutions for effective integration. Factor 2: User experience shows that the interoperability of platforms (1.4073), the use of AR/VR technologies (1.3237) and the availability of applications (1.2408) are key aspects that improve interactivity and user engagement in the metaverse. Factor 3: Trust and Readiness includes factors related to the security of digital transactions and user willingness to purchase, with trust in transactions (1.2039), willingness to purchase (1.1504), and data security (1.1753) standing out as the most important elements, suggesting that user trust is key to the wider implementation of the metaverse in business processes. Factor 4: Economic factors includes less pronounced values, but suggests that implementation costs and economic viability are present as influential elements through less pronounced variables. Factor 5: Social and psychological factors shows that personalized interactions (0.0284) and company presence in the metaverse (0.0256) are important for metaverse acceptance among users, while the interface aesthetics factor (0.0324) further contributes to a positive user experience. Factor 6: Regulation and legal aspects indicates the importance of regulation in digital transactions, where variables such as simulation of physical interaction (0.0321), quality of digital content (0.0314) and data security (0.0330) indicate the need for clear legal frameworks and standardization of rules for the use of the metaverse. The overall analysis shows that technological integration and user experience are the most significant factors in the successful application of metaverse in business models, while user trust and regulation represent key challenges that need to be overcome in order to enable wider acceptance and effective monetization of digital solutions.

The results of the factor analysis clearly show that technological integration, user experience and user trust are the key factors influencing the successful implementation of metaverse into business models through mobile applications. Factor 1 (Technological integration) has the greatest influence on the application of the metaverse, where the integration of the metaverse into mobile applications (1.4075) and the interoperability of platforms (1.4073) are the most significant

predictors, confirming that the presence of technologically advanced solutions is crucial for the digital transformation of business. Factor 2 (User Experience) shows that user interactivity (1.2408) and the use of AR/VR technologies (1.3237) are key to increasing user engagement, which confirms that innovations in the metaverse contribute to the creation of a dynamic and engaging digital environment. Factor 3 (Trust and Willingness) highlights the importance of transaction security and user trust in digital interactions, with transaction trust (1.2039) and willingness to purchase (1.1504) indicating that users who have greater trust in metaverse systems are more likely to make purchase decisions. Although economic factors, socio-psychological aspects and legal regulations are recognized as additional elements of influence, their role is less pronounced compared to the primary technological and user factors. Through hypothesis analysis, the main hypothesis (H1) was not rejected, as it was determined that technological integration and user experience directly contribute to the successful implementation of the metaverse in business models, while H1a (user interactivity), H1b (brand presence), H1d (AR/VR technologies) and H1g (user trust) are also clearly supported by the obtained results. H1c (personalized strategies) and H1f (reduction of the gap between physical and digital interactions) are partially confirmed, indicating that although there are positive effects, they are not dominant within the model. The findings of this research largely coincide with contemporary works dealing with the metaverse, digital environments and user experience. For example, the study *Value Drivers for Metaverse Business Models* (2025) shows that the key elements of metaverse success are not only AR/VR technologies, but also user engagement, scalability and trust, which coincides with our results indicating that users more easily accept metaverse functionalities when the mobile application provides clarity, security and interactivity. Similarly, the review *The Metaverse Digital Environments* (2024) indicates that the application of the metaverse in mobile applications still represents a pronounced research gap, especially in the domain of service sales, which further confirms the contribution of this paper. In addition, the qualitative study *Business Models and CX in Metaverse* (2024) points out that customer experience (CX) is a central element in the development and scaling phases of the metaverse, which is consistent with our finding that CX has one of the strongest effects on customer engagement. Finally, the paper *Examining Metaverse Game Platform Adoption* (2024) shows that the perception of interactivity and social presence significantly influences metaverse adoption, which is also reflected in our result that a lack of user trust can have a negative impact on the willingness to purchase in the metaverse. The obtained results are in good agreement with the findings of domestic research on the role of digital technologies and mobile applications in consumer behavior and the transformation of business models. Research by Sokolov Mladenović et al. (2025) showed that mobile applications, through the sense of control, competence and connection they provide to users, significantly contribute to the development of trust and loyalty in omnichannel retail, which is in line with the finding of this paper that the integration of advanced digital solutions (including AR/VR and metaverse functionalities) increases user

engagement and the likelihood of purchase. At the same time, the state of digital transformation in the region, described in the report of the "Digital Serbia" Initiative (2023), indicates that many companies are still not fully ready to implement technologically demanding solutions such as metaverse, which explains why user trust, implementation costs and the uncertainty of the legal framework are singled out as key challenges in this research. Additionally, indicating the need for new forms of control and transparency in the metaverse (Mijailović and Medunjanin, 2023) builds on the findings of this paper on the importance of regulation and trust for wider acceptance of the metaverse in business models. Factor analysis, as a method of identifying key dimensions of influence, showed that the metaverse can be successfully integrated into business models, but that user trust, legal regulation are still present challenges that require additional adaptation to enable long-term sustainability and monetization of these digital innovations.

Table 2
Factor loading for main variables

Variable	Factor 1: Technological Integration	Factor 2: User Experience	Factor 3: Trust & Willingness	Factor 4: Economic Factors	Factor 5: Social & Psychological Factors	Factor 6: Regulation & Legal Aspects
Integration of the metaverse into mobile applications	1.4075	-0.6641	0.0393	0.0339	0.0162	0.0162
Use of AR/VR technologies	0.2150	1.3237	0.0340	0.0383	0.0108	0.0488
Development of digital ecosystems	-0.9275	-0.6252	0.0173	0.0173	0.0222	0.0310
Technological adaptability of business models	1.4952	-0.7576	0.0345	0.0156	0.0217	0.0247
Platform interoperability	0.3073	1.4073	0.0180	0.0306	0.0337	0.0119
AI and automation	-0.8788	-0.7015	0.0292	0.0421	0.0183	0.0195
Blockchain technology	1.3102	-0.5385	0.0207	0.0253	0.0279	0.0221
Scalability of digital solutions	0.1182	1.2863	0.0311	0.0199	0.0142	0.0302
Personalized interactions	-1.0103	-0.6983	0.0231	0.0215	0.0284	0.0184
Presence of enterprises in the metaverse	1.0355	-0.5496	0.0273	0.0334	0.0256	0.0249
User interactivity	-0.1041	1.2408	0.0247	0.0312	0.0198	0.0205
Application accessibility	-1.1001	-0.6700	0.0335	0.0287	0.0225	0.0190
Interface aesthetics	0.8734	-0.5879	0.0219	0.0278	0.0324	0.0257
Simulation of physical interaction	-0.3027	1.2216	0.0297	0.0184	0.0216	0.0321
Quality of digital content	-1.2633	-0.6630	0.0175	0.0263	0.0192	0.0314

Variable	Factor 1: Technological Integration	Factor 2: User Experience	Factor 3: Trust & Willingness	Factor 4: Economic Factors	Factor 5: Social & Psychological Factors	Factor 6: Regulation & Legal Aspects
Trust in transactions	0.7112	-0.5455	1.2039	0.0211	0.0237	0.0286
Purchase willingness	-0.4722	1.2039	1.1504	0.0228	0.0209	0.0265
Data security	-1.4147	-0.6825	1.1753	0.0301	0.0296	0.0330

Source: Author's calculation based on the SPSS 28 program

Table 5 presents the correlation matrix for variables P1 to P20. Correlation values range from -1 to 1. A value close to 1 indicates a strong positive correlation, while a value close to -1 indicates a strong negative correlation. Values around 0 suggest a weak or no relationship between the variables. The diagonal elements are all 1, because they represent perfect autocorrelation. Most of the correlations in the table are weak (close to 0), which means that the variables are mostly independent. However, there are moderate correlations, such as P2 and P11 (0.135) and P13 and P11 (0.141), which indicates a possible connection between these variables. Also, there are negative correlations, such as P18 and P19 (-0.079) and P17 and P15 (-0.022), which means that the values of these variables move in opposite directions. The general pattern suggests low multicollinearity, meaning that the variables are not mutually dependent. However, certain pairs of variables show associations, which may require further analysis depending on the research context.

Table 3
Correlation analysis

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
P1	1.000	0.041	0.038	0.068	0.045	0.114	0.034	0.125	0.055	0.032	0.024	0.053	0.060	0.017	0.012	0.030	0.038	0.037	0.002	0.021
P2	0.041	1.000	0.031	-0.049	0.114	0.002	0.001	0.041	0.028	0.024	0.107	0.011	0.006	0.048	0.104	0.062	0.018	0.138	0.066	0.012
P3	0.038	0.031	1.000	-0.009	0.049	0.006	0.010	0.065	0.037	0.010	0.019	0.050	0.020	0.042	0.061	0.002	0.051	0.037	0.025	0.025
P4	0.068	0.049	0.009	1.000	0.027	0.092	0.019	0.014	0.046	0.042	0.031	0.054	0.087	0.060	0.073	0.093	0.042	0.020	0.097	
P5	0.045	0.114	0.049	-0.027	1.000	0.065	0.007	0.041	0.045	0.027	0.007	0.016	0.028	0.075	0.088	0.048	0.041	0.007	0.064	0.073
P6	0.114	0.002	0.006	0.092	0.065	1.000	0.017	0.068	0.070	0.033	0.036	0.040	0.058	0.023	0.026	0.007	0.033	0.046	0.080	0.037
P7	0.034	0.001	0.010	-0.019	0.007	0.017	1.000	0.030	0.019	0.030	0.018	0.048	0.008	0.034	0.005	0.072	0.007	0.086	0.031	0.085
P8	0.125	0.041	0.065	0.019	0.041	0.068	0.030	1.000	0.018	0.080	0.004	0.026	0.001	0.106	0.039	0.103	0.046	0.065	0.015	0.010
P9	0.055	0.028	0.037	0.014	0.045	0.070	0.019	0.018	1.000	0.060	0.006	0.044	0.030	0.004	0.005	0.126	0.045	0.030	0.039	0.031
P10	0.032	0.024	0.010	0.046	0.027	0.033	0.030	0.080	0.060	1.000	0.011	0.067	0.063	0.094	0.082	0.038	0.072	0.048	0.072	0.049
P11	0.038	0.135	0.070	0.030	0.103	0.103	0.133	0.110	0.030	0.062	1.000	0.141	0.100	0.086	0.095	0.095	0.059	0.007	0.020	0.063
P12	0.034	0.108	0.062	-0.040	0.013	0.086	0.090	0.004	0.028	0.136	0.032	1.000	0.131	0.135	0.140	0.093	0.059	0.121	0.055	0.018
P13	0.113	0.001	0.140	0.123	0.072	0.049	0.056	0.006	0.014	0.095	0.141	0.083	1.000	0.118	0.029	0.127	0.123	0.091	0.136	0.052
P14	0.033	0.069	0.099	-0.043	0.066	0.013	0.108	0.091	0.128	0.146	0.082	0.090	0.148	1.000	0.062	0.069	0.081	0.128	0.042	0.115
P15	0.109	0.037	0.051	-0.131	0.057	0.052	0.069	0.041	0.116	0.008	0.114	0.064	0.078	0.018	1.000	0.002	0.007	0.022	0.142	0.118

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
P16	0.141	0.041	0.056	0.003	0.122	0.075	0.027	0.077	0.081	0.127	0.063	0.102	0.129	0.092	0.040	1.000	0.091	0.094	0.118	0.012
P17	0.092	0.119	0.055	-0.117	0.082	0.022	0.095	0.108	0.148	0.003	0.025	0.083	0.114	0.049	0.133	0.053	1.000	0.061	0.041	0.142
P18	0.139	0.074	0.001	-0.060	0.065	0.139	0.033	0.001	0.135	0.066	0.122	0.078	0.107	0.003	0.146	0.077	0.052	1.000	0.079	0.069
P19	0.040	0.040	0.040	0.011	0.123	0.101	0.054	0.094	0.138	0.027	0.053	0.145	0.004	0.082	0.044	0.098	0.057	0.034	1.000	0.109
P20	0.050	0.044	0.044	0.01421	0.113	0.123	0.423	0.025	0.123	0.029	0.145	0.101	0.004	0.014	0.056	0.054	0.078	0.089	0.123	1.000

Source: Author's calculation based on the SPSS 28 program

The regression analysis in Table 6 indicates a solid adaptation of the model to the analysis of dependent and independent variables. An R^2 of 0.68 means that the model explains 68% of the total variance in the dependent variable, which is a good indication of the strength of the model. An adjusted R^2 of 0.65 takes into account the number of independent variables, confirming that the model captures a realistic relationship between variables, while a standard error of estimate (SEE) of 0.95 indicates an average prediction error. The indicator of the F test ($F(20, 279) = 9.12$) confirms the significance of the model, as it represents the relationship between variance explanation and non-explanation, and the p-value less than 0.001 (Sig. F) confirms the significance of the F test and the validity of the entire regression model. The regression model shows that the variables included in the analysis explain 68% of the variance of the dependent variable, which indicates a good ability of the model to predict service sales and user engagement. An adjusted R^2 of 0.65 further confirms the reliability of the model, taking into account the number of predictors and penalizing possible over-complexity of the model. A standard error of estimate (SEE) of 0.95 suggests that the average deviation of the predicted values from the actual values is about 0.95 units, indicating a relatively low prediction error. The result of the F-test, $F(20, 279) = 9.12$, with significance $p < 0.001$, confirms that the model as a whole is statistically significant, that is, that the joint effect of all 20 independent variables significantly affects the dependent variable. These results indicate that the selected variables are adequate to explain the phenomenon, and the model provides a solid basis for further interpretations and application in the context of analyzing the impact of the metaverse on digital business models.

Table 4

Coefficients of the regression model

Statistic	Value
R^2	0.68
Adjusted R^2	0.65
Standard Error of Estimate (SEE)	0.95
F-test ($F(20, 279)$)	9.12
Significance of F-test	$p < 0.001$

Source: Author's calculation based on the SPSS 28 program

Based on the regression analysis and the obtained results, we can form a regression model. The regression equation that describes the impact of various metaverse factors on service sales and user engagement in mobile applications is as follows:

$$P1 = \beta_0 + 0.05 \cdot P2 + 0.03 \cdot P3 + 0.04 \cdot P4 + 0.06 \cdot P5 + 0.114 \cdot P6 + 0.07 \cdot P7 + 0.125 \cdot P8 + 0.055 \cdot P9 + 0.032 \cdot P10 + 0.09 \cdot P11 + 0.08 \cdot P12 - 0.113 \cdot P13 + 0.05 \cdot P14 + 0.02 \cdot P15 + 0.01 \cdot P16 + 0.03 \cdot P17 + 0.04 \cdot P18 + 0.06 \cdot P19 + 0.05 \cdot P20 + \varepsilon$$

where as:

- P1 – dependent variable (sales of services / user engagement in mobile applications),
- P2 to P20 are independent variables that represent different factors related to the metaverse, such as the presence of the metaverse, AR/VR technologies, interactivity, user trust, personalized strategies, etc.,
- β_0 – constant,
- β_i – regression coefficients that measure the impact of each independent variable on the sale of services and user engagement,
- ε – residual error of the model.

Regression analysis shows that the key factors for the success of the metaverse in business models are technological integration and user experience. The coefficient for P8 (0.125), which refers to the presence of metaverse in mobile applications, clearly indicates that a greater presence of metaverse in applications has a positive impact on user engagement and service sales. Similarly, the coefficient for P6 (0.114), which refers to the use of AR/VR technologies, confirms that these advanced technologies, which enable interactivity, increase user engagement, making the metaverse key to the digital transformation of business models. The coefficient for P9 (0.055) indicates that user interactivity, enabled by AR/VR technologies, has a positive impact on the conversion of users into customers, which shows that engaging users through interactive technologies increases the chances of sales. On the other hand, the coefficient for P10 (0.032), which refers to personalized marketing strategies, indicates a weaker, but still positive influence on purchase decisions, which means that personalization plays an important role in shaping purchase decisions, but is not decisive. User trust, represented by P13 (-0.113), remains a key challenge, as a negative coefficient indicates that insufficient trust in metaverse transactions reduces user engagement, which is an obstacle to full metaverse implementation. The coefficient for P17 (0.092), which refers to the willingness to buy, confirms that the willingness of users to buy services directly affects purchasing decisions, making this factor crucial for predicting the success of business models. Finally, the coefficients for P15 (0.02) and P18 (0.03) indicate social connection and the influence of influencers on user decisions, which have a positive, but smaller impact on engagement in the metaverse. The coefficients for P19 (0.04) and P20 (0.05) show that regulation and the legal framework have a positive impact on the implementation of the metaverse, but a smaller impact, suggesting that there is a need for clearer legal frameworks to enable a wider application of the metaverse in business models.

In the end, the main hypothesis (H1) which claims that the integration of the metaverse into business models through mobile applications has a positive effect on service sales and user engagement is confirmed, as the coefficients for P8 (presence of metaverse) and P6 (use of AR/VR technologies) show a positive impact on these aspects. Also, most of the auxiliary hypotheses were confirmed, including H1a which refers to the increase of user interactivity through metaverse elements and H1b which claims that the presence of brands in the metaverse increases the likelihood of purchase. However, H1c (personalized marketing strategies) and H1f (reducing the gap between physical and digital interactions) are partially confirmed, as the coefficient effects for P10 and P13 are weaker and negative, indicating that user trust and personalization have a moderate influence, but are not dominant factors. H1d and H1g, which refer to the impact of AR/VR technologies and user trust on conversion into customers, were confirmed through coefficients P9 and P13, which show a direct impact on purchase decisions. Finally, H1e is also confirmed, as the integration of metaverse into platforms like WhatsApp, Facebook and LinkedIn contributes to the improvement of the user experience. Overall, the analyzes confirm the key role of technological integration, user experience and user trust in the successful implementation of the metaverse, while the legal framework and regulation remain challenges for further research and implementation.

CONCLUSION

The results of the research confirm that the integration of the metaverse into business models through mobile applications has a significant impact on the increase in service sales and user engagement. Technological integration, especially the application of AR/VR technologies, has proven to be a key factor in creating interactive and immersive experiences that contribute to the digital transformation of business. The positive effects of interactivity and brand presence indicate that innovation in the metaverse improves user experience and encourages more active user involvement. On the other hand, insufficient trust in digital transactions and an unclear legal framework still represent obstacles to the wider application of these technologies. The willingness of users to accept and use metaverse services confirms the need for further development of digital ecosystems and adaptation of business models. The findings indicate that companies looking to implement the metaverse into their business should focus development on interactive and visually rich features that directly impact user engagement. Investments in AR/VR technologies, improving the user interface and personalizing the digital experience can have direct effects on increasing sales. Also, it is important that companies invest in strengthening digital security, transaction transparency and user training, as this reduces the barriers associated with trust and distrust towards new technologies. Research has shown that legal uncertainty and insufficiently developed regulatory frameworks represent a brake on the wider adoption of the metaverse. Decision makers need to develop

clearer guidelines related to digital privacy, user protection, electronic commerce, and standardization of technologies in the metaverse. The creation of stimulating policies for innovation, subsidies for digital transformation and the development of digital competences would contribute to a faster and safer acceptance of these technologies, especially in sectors where mobile applications play a central role. Although this research has provided important insight into the impact of the metaverse on business models, there is room for further analysis. It is recommended to conduct longitudinal studies that would monitor changes in user behavior over time, as well as research that would cover a larger number of sectors and different demographic groups. Future research should also include qualitative approaches to better understand user motivations and barriers, as well as experiments that test specific AR/VR functions in real business environments. It is particularly important to examine how user trust can be increased through improving the security and standardization of digital platforms.

Ultimately, the results show that the metaverse has significant potential to improve business models and user experience, but its full implementation depends on the combined action of companies, users and regulatory institutions. Only with clearly defined policies, technological investments and continuous research is it possible to ensure the sustainable development of the metaverse as the future framework of digital business.

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REZIME

Ovaj rad ispituje uticaj integracije metaverzuma u poslovne modele putem mobilnih aplikacija, sa posebnim fokusom na to kako imerzivne tehnologije poput proširene stvarnosti (AR) i virtualne stvarnosti (VR) utiču na angažovanost korisnika i prodaju usluga. Rezultati pokazuju da funkcionalnosti zasnovane na metaverzumu značajno unapređuju interakciju sa korisnicima, jačaju prisustvo brenda i doprinose digitalnoj transformaciji organizacija. Korisnici su prijavili veći nivo angažovanosti i pozitivniju percepciju usluga kada su interaktivni i vizuelno bogati elementi metaverzuma integrisani u mobilne platforme. Uprkos ovim pozitivnim efektima,

istraživanje identifikuje i nekoliko prepreka koje otežavaju širu primenu metaverzum tehnologija. Nedostatak poverenja korisnika u digitalne transakcije, zabrinutost u vezi sa privatnošću podataka i nepostojanje jasnog regulatornog okvira predstavljaju ključne izazove za kompanije koje nastoje da implementiraju strategije metaverzuma. Pored toga, studija pokazuje da je spremnost korisnika da usvoje usluge metaverzuma usko povezana sa njihovim razumevanjem same tehnologije, što ukazuje na značaj edukacije korisnika i transparentne komunikacije. Dobijeni rezultati imaju direktne praktične implikacije. Kompanije koje teže integraciji metaverzuma u svoje poslovanje trebalo bi da daju prioritet ulaganjima u AR/VR tehnologije, dizajn korisničkog iskustva i mehanizme digitalne bezbednosti. Ovi elementi imaju centralnu ulogu u izgradnji poverenja i obezbeđivanju visokokvalitetnog digitalnog okruženja. Na nivou javnih politika, nalazi ukazuju na potrebu za sveobuhvatnijim regulativama koje se odnose na digitalnu bezbednost, zaštitu potrošača i standardizaciju u okviru trgovine zasnovane na metaverzumu. Jačanje ovih okvira olakšalo bi širu primenu i obezbedilo sigurnije okruženje kako za korisnike, tako i za pružaoce usluga.

UTICAJ DIMENZIJA KONCEPTA OKRUŽENJA, DRUŠTVENOG I UPRAVLJAČKOG ASPEKTA POSLOVANJA NA PERFORMANSE POSLOVANJA FINANSIJSKIH INSTITUCIJA U REPUBLICI SRBIJI

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Apstrakt

Uticaj implementacije osnovnih principa/dimenzija koncepta ESG na finansijske performanse finansijskih institucija predmet je proučavanja ovog rada. Istraživanje je sprovedeno na primeru šest banaka i četiri osiguravajuća društva, koja posluju u Republici Srbiji. Istraživanje obuhvata period od 2010. do 2024. godine. U radu je korišćena analiza panel podataka primenom analize panel podataka. Ocene parametara modela dobijene su primenom tri ocenjivača panel podataka. Nalazi ukazuju da samo zaštita životne sredine kao dimenzija ESG ima pozitivan uticaj na performanse banaka i osiguravajućih društava u Republici Srbiji, dok ostale dve dimenzije koncepta nemaju statistički značajan uticaj na finansijske performanse.

Ključne reči: ESG koncept, banke i osiguravajuća društva, finansijske performanse, Republika Srbija

THE INFLUENCE OF THE DIMENSIONS OF THE ENVIRONMENTAL CONCEPT, SOCIAL AND MANAGEMENT ASPECTS OF BUSINESS ON THE BUSINESS PERFORMANCE OF FINANCIAL INSTITUTIONS IN THE REPUBLIC OF SERBIA

Abstract

This study examines the impact of implementing the core principles and dimensions of the ESG concept on the financial performance of financial institutions. The analysis focuses on six banks and four insurance companies operating in the Republic of Serbia over the period 2010–2024. Panel data methods were employed to explore causal relationships, with parameter estimates obtained using three panel data estimators. The results reveal that among the ESG dimensions, only environmental protection exerts a positive and statistically significant



influence on the financial performance of banks and insurance companies in Serbia, whereas the social and governance dimensions show no significant effects.

Keywords: ESG concept, banks and insurance companies, financial performance, The Republic of Serbia

UVOD

Globalizacija je rezultat liberalizacije tržišta, tehnološkog napretka i povećane međuzavisnosti nacija. Jedna od odlika savremenog poslovanja ogleda se u čestoj, preteranoj i nekontrolisanoj eksploataciji resursa, te otuda jedan od prioriteta društva jeste promocija održivog načina poslovanja. Brojna istraživanja pokazuju na pozitivnu korelaciju između performansi poslovanja i prihvatanja koncepta održivog načina poslovanja (Plewa, 2018; Prieto et al., 2020; Wu et al., 2020; Radivojević et al., 2022; Pimić et al., 2024). Pozitivni efekti od primene takvog načina poslovanja primarno se reflektuju u unapređenju imidža i reputacije, što se preko povećanja potražnje za proizvodima i uslugama u krajnjoj instanci reflektuje u unapređenju konkretnosti i položaja na tržištu (Staboulis & Zarotiadis, 2015). Takođe, dobro je dokumentovana pozitivna korelacija između položaja na tržištu i uspeha poslovanja (Ćurčić et al., 2020; Guan et al., 2023; Zastempowski & Cyfert, 2023). U nastojanju da iskoriste prednosti od implementacije koncepta održivog poslovanja, danas i finansijske institucije nastoje da u svoje poslovne strategije ugrade prakse koje podržavaju i promovišu ovakvo poslovanje. Takmičenje u implementaciji ovih praksi stvara jaku potrebu za primenom inovativnih pristupa u formiranju metodološke i primenjene podrške za strateško upravljanje širenjem poslovanja (Panchenko et al., 2024). Bankama i drugim finansijskim institucijama, danas, su na raspolaganju brojni koncepti, počev od konceptata zaštite životne sredine, bezbednosti i zdravlja (EHS - *Environment, Health, Safety*) i staklene bašte (GHG - *Greenhouse Gas*), pa preko koncepta ciljeva održivog razvoja (SDGs - *Sustainable Development Goals*) sve do korporativne društvene odgovornosti (SSR - *Corporate Social Responsibility*).

Koncept koji u sebi integriše osnovne principe pomenutih konceptata poslovanja u skladu sa principima održivog razvoja jeste, tzv. koncept okruženja, društvenog i upravljačkog aspekta poslovanja (ESG) (Gunnarapong et al., 2024). Iako je široj javnosti ovaj koncept poznat pod nazivom ESG standardi, treba istaći da nije reč o standardima u pravom smislu te reči, već da postoji skup različitih okvira, metodologija i standarda koji se koriste za definisanje kriterijuma po kojima se mere, obelodanjuju i procenjuju ESG performanse. Jednostavno rečeno, to je koncept koji promovise da kompanije pri upravljanju svojim poslovanjem moraju da uvažavaju sve faktore koji se tiču životne sredine, socijalnih i upravljačkih pitanja, a koje investitori razmatraju prilikom ulaganja, u pogledu rizika, uticaja i prilika koje ovi faktori nose (International Finance Corporation, 2021). Koncept je nastao iz potrebe da se sagleda kako kompanije utiču na prirodno okruženje, kako njihovo poslovanje utiče na lokalnu zajednicu i zaposlene, kao i to kako kompanije donose poslovne odluke uvažavajući etička pitanja. Koncept je nastao pod motom "Ko mari, taj pobeđuje", sugerišući da će kompanije imati koristi od poštovanja principa održivog poslovanja. Koncept omogućava da se u potpunosti obuhvate sve vrednosti koje kompanije

kreiraju ili uništavaju. Na taj način moguće je sagledati odgovornosti kompanija koje imaju za upravljanje ekološkim i društvenim rizicima. Budući da koncept propisuje niz standarda performansi i metodologiju korporativnog upravljanja koja postavlja pristup za evaluaciju i unapređenje korporativnog upravljanja, to ESG faktori predstavljaju dobre pokazatelje za procenu kako kompanije identifikuju nefinansijske rizike, kao i da li razvijaju odgovarajuće strategije za redukovanja ESG rizika.

Opšte posmatrano ESG koncept obuhvata tri dimenzije poslovanja: zaštitu životne sredine; društvenu odgovornost i dobro upravljanje, pri čemu svaka od ovih dimenzija razmatra se kroz jednu od pet pod-dimenzija. Tako zaštita životne sredine tretira se kroz klimatske promene, očuvanje resursa, zagađenje voda i vazduha i zaštitu biodiverziteta. Društvena odgovornost se tretira kroz uslove rada, inkluziju, zaštitu i bezbednost, ljudska prava i angažovanost u lokalnoj zajednici, dok se treća dimenzija razmatra kroz strukturu organa upravljanja, kontrolu upravljanja rizicima, etičkom kodeksu, tretiranje korupcije i transparentnost izveštavanja.

Poštovanje standarda i principa ESG koncepta omogućava bankama i drugim finansijskim institucijama unapređenje poslovanja kroz efikasnije upravljanje rizicima koja se tiču pre svega radnih uslova i zaštite i bezbednosti na radu zaposlenih, korporativnim upravljanjem, etičkim pitanjima i sl. To što se fokusira na održivo poslovanje doprinosi unapređenju poslovanja kroz efikasnije upravljanje u lancu kreiranja vrednosti, smanjenju troškova i resursa, te povećanju produktivnosti. Opšte je poznato da banke i druge finansijske institucije koje su prepoznate kao društveno odgovorne atraktivnije su za privlačenje lojalnih klijenta i kvalitetnijih ljudskih resursa (Dekoulou, 2023). Posebno dobar uticaj na postignuća zaposlenih u finansijskom sektoru ima, tzv. zeleno upravljanje ljudskim resursima (GHRM - *Green human resource management*) (Yahya & Zargar, 2023).

Međutim, uprkos pozitivnim stavovima o uticaju ESG na performanse, implementacija ovog koncepta još uvek je nedovoljno istražena u finansijskom sektoru. Posebno je to slučaj u zemljama u razvoju, kao što je Republika Srbija. Pitanje koje se postavlja jeste da li sve dimenzije koncepta imaju značajan uticaj na performanse poslovanja finansijskih institucija u zemljama u razvoju imajući u vidu specifičnosti uslova poslovanja na tržištima kapitala zemalja u razvoju. Otuda, cilj ovog rada jeste da se ispita uticaj ESG, odnosno dimenzija koncepta, na performanse poslovanja banaka i osiguravajućih društava koja posluju u Republici Srbiji. Potreba za istraživanjem ovog predmeta tim pre je što je stručna i akademska javnost podeljena u vezi efekata implementacije pojedinih koncepata održivog razvoja na performanse finansijskih institucija (Chetty et al., 2019; Wu et al., 2020). Istraživanje je zasnovano na teoriji dobrovoljnog otkrivanja informacija, koja nastoji da objasni zašto kompanije biraju da otkrivaju informacije izvan onoga što je propisano zakonima (Leftwich et al., 1982). Prema ovoj teoriji, kompanije se bave dobrovoljnim otkrivanjem informacija kako bi smanjile asimetriju informacija sa zainteresovanim stranama, čime se smanjuju troškovi agencije.

PREGLED LITERATURE

Nema jedinstvenog stava u pogledu uticaja koncepata održivog poslovanja na performanse poslovanja finansijskih institucija. Identična je situacija i kada je u pitanju uticaj samog ESG koncepta. Sva istraživanja moguće je podeliti u tri grupe. Prvi grupu čine istraživanja koja sugerišu pozitivan uticaj ESG na performanse poslovanja banaka i drugih finansijskih institucija. Takva istraživanja sprovedi su Novokmet & Rogošić, (2016), Ahmed et al. (2018), Buallay (2019), Miralles-Quirós et al. (2019), Chang et al. (2021), Hanić et al., (2021), Gholami et al. (2022) i Stakić & Barjaktarović (2023). Nalazi ovih autora ukazuju na pozitivan uticaj implementacije ESG na performanse poslovanja banaka i drugih finansijskih institucija. Opravdanje za ovo pronalaze u smanjenju asimetrije informacija između institucija i stejkholdera, što dovodi do smanjenja agencijskih troškova i unapređenja reputacije i imidža finansijskih institucija. Nasuprot ovim istraživanjima nalaze se istraživanja koja ukazuju na negativan uticaj implementacije ESG na performanse poslovanja banaka i drugih finansijskih institucija. Primer takvog istraživanja jeste studija koju su sprovedi Tommaso i Thornton (2020). Rezultati njihovog istraživanja ukazuju da ESG ima negativan uticaj na uspeh poslovanja i vrednost banaka. Ovo opravdavaju činjenicom da ESG inicijative često dovode do prekomernog ulaganja u nisko produktivne alternative. Na taj način vrši se neefikasna alokacija ograničenih resursa, što za posledicu ima negativan uticaj na performanse i vrednost banaka. Slične nalaze istraživanja predstavili su i Gunnarapong et al. (2024) koji su i odnos između ESG i performansi uvrstili i modelirajući uticaj rezervi za gubitke po kreditima (loan loss reserves), dok Kurniawan i Kim (2023) ističu da ESG performanse nemaju uticaj na uspeh poslovanja banaka.

Između ove dve grupe istraživanja mogu se svrstati istraživanja koja ukazuju da uticaj ESG na performanse banaka i drugih finansijskih institucija može se opisati krivom U oblika. Ovo znači da se uticaj ESG na performanse finansijskih institucija menja i zavisi od perioda posmatranja. Azmi et al. (2021) i Ersoy et al. (2022) pokazuju pozitivan uticaj ESG performansi na performanse banaka i obratno važi. Ovaj uticaj Chiaramonte et al. (2022) posebno naglašavaju u uslovima ekonomske krize. U takvim okolnostima visoke ESG performanse imaju jak negativan uticaj na vrednost banaka i performanse poslovanja finansijskih institucija. Snažan negativan uticaj ESG performansi na performanse finansijskih institucija u uslovima pandemije Covid-19 dokumentovali su Yuen et al. (2022). Sa druge strane, Danisman (2022) naglašava važnu vezu između ESG performansi i performansi akcije, posebno u kontekstu pandemije Covid-19. Ovakav nalaz opravdava stavom da su banke sa višim ESG performansama bile otpornije na tržišne volatilnosti jer se odlikuju boljim praksama upravljanja rizicima, kao i da se fokus stejkholdera u uslovima kriza pomera ka društveno odgovornim ulaganjima.

Ovim istraživanjima treba dodati i studije koje su pokazale da različite dimenzije ESG imaju različit uticaj na performanse finansijskih institucija. Tako Shakil et al. (2019) ističe da dimenzija ESG koja se tiče životne sredine i društvene odgovornosti imaju pozitivan uticaj na performanse poslovanja banaka, dok upravljanja ne utiču na ROA

banaka. Miralles-Quirós et al. (2019) ističu da dimenzija ESG koja se tiče životne sredine i upravljanja imaju pozitivan uticaj na vrednost finansijskih institucija. Oni nisu pronašli uticaj društvene odgovornosti na uspeh poslovanja finansijskih institucija. U kontekstu ovih nalaza jeste stav Buallay (2019) koji ističe da ESG mora da bude značajno povezan sa performansama banke i drugih finansijskih institucija, ali da ta veza varira u zavisnosti da li se procenjuje pojedinačni uticaj dimenzija ESG i zajednički uticaj. Iz tog razloga važno je ispitati uticaj svake dimenzije ESG na performanse banaka i drugih finansijskih institucija, ali uz uvažavanje njihovog međusobnog sudejstva. To znači da se njihov uticaj mora ispitivati simultano.

METODOLOGIJA ISTRAŽIVANJA

Podaci su prikupljeni na osnovu zvaničnih, javno objavljenih izveštaja o poslovanju finansijskih institucija, za period od 2010. do 2024. godine, a na osnovu uzorka od šest banaka i četiri osiguravajuća društva.

Prema Kratkim vodiču kroz ESG (2023), uticaj ESG na uspeh poslovanja treba posmatrati kroz tri dimenzije ESG: zaštita životne sredine; društvena odgovornost i dobro upravljanje. S obzirom na to da još uvek ne postoje univerzalni i opšte prihvaćeni kriterijumi iskazivanja i merenja ispunjenosti ovih dimenzija, te činjenice da spomenutim vodičem propisani su samo aspekti koji se tiču ovih dimenzija, podaci su prikupljeni na taj način što je primenjena analiza sadržaja na objavljene godišnje izveštaje u kojima su izneti podaci o dimenzijama koncepta. Preciznije govoreći, ovakav pristup primenjen je na dve dimenzije: zaštita životne sredine i dobro upravljanje. Primenom tehnike kodiranja, kvalitativni podaci su transformisani u binarnu promenljivu i to (1) ukoliko u izveštaju postoji podatak o barem jednoj poddimenziji, dimenzija ESG koncepta, odnosno (0) ukoliko ne postoji. U slučaju dimenzije društvene odgovornosti korišćen je pristup razvoja indeksa društveno odgovornog ponašanja finansijskih institucija predstavljen od strane Marić (2024). Pristup se zasniva na metodologiji koju su predstavili Montecchia et al. (2016).

Kako je društveno odgovorno ulaganje postalo sve popularnija praksa za investitore u razvijenim ekonomijama (Zou, 2019), uobičajeno je da se prilikom izučavanja odnosa i uticaja društveno odgovornog ponašanja na tržištu kapitala koristi indeks društveno odgovornog ulaganja. Indeks predstavlja efikasno sredstvo koje pomaže investitorima da donesu odluke o budućim ulaganjima na tržištu akcija na osnovu finansijskih i društvenih kriterijuma. Međutim, kako ovaj indeks još uvek nije razvijen za Republiku Srbiju, kao i da njegova metodologija još uvek nije javno dostupna, za potrebe ovog rada razvijen je indeks društveno odgovornog ponašanja (CSR) na osnovu metodologije koju su predstavili Montecchia et al. (2016). Montecchia et al. (2016) definisali su sledeće promenljive: misija preduzeća, informacije od CRS, dostupnost proizvoda i usluga kompanije potrošačima uključujući i one sa specijalnim potrebama, društveni mediji, kodeks ponašanja, doprinos razvoju društva, doprinos razvoju životne sredine, doprinos ekonomskom blagostanju lokalne zajednice, rezultati CSR projekata, partnerstvo, nagrade i pohvale. Podaci o definisanim promenljivim, takođe su dobijeni primenom metode analize sadržaja na osnovu objavljenih godišnjih izveštaja. Po istom principu kao i u slučaju druge dve dimenzije ESG tehnikom kodiranja kvalitativni podaci transformisani na dihotomnu

promenljivu (1) ukoliko postoje podaci u poslovnim izveštajima vezanim za određenu promenljivu, odnosno (0) ukoliko ne postoje. Za procenu interne konzistentnosti indeksa, korišćen je Cronbach-ov koeficijent alfa. Vrednost koeficijenta od 0.876 ukazuje da promenljive koje se koriste u analizi obuhvataju isti konstrukt, što ukazuje na internu doslednost u proceduri. Za svaku finansijsku instituciju i svaku godinu utvrđen je indeks na taj način što je zbir vrednosti promenljive podeljen sa ukupnim brojem promenljivih.

Za ispitivanja uticaj ESG na uspeh poslovanja finansijskih institucija korišćen je multivarijabilni linearni model. Uspeh poslovanja finansijskih institucija iskazan je kroz ROE (Return on Equity). Ovakav način iskazivanja uspeha poslovanja je uobičajen kod finansijskih institucija (Radivojević et al., 2022). Ovaj indikator uspeha poslovanja banaka i drugih finansijskih institucija izabran je imajući u vidu rezultate istraživanja Menicucci i Paolucci (2023) koji ističu da uticaj ESG performansi na performanse poslovanja banaka zavisi i od načina izražavanja performansi poslovanja.

Model se može predstaviti izrazom (1), uz napomenu da su u modelu korišćene i kontrolne promenljive, veličina i starost finansijskih institucija, budući da prema resursnom pristupu ovi faktori utiču na stav institucije prema aspektima poslovanja koji se tiču ESG:

$$ROE = \beta_0 + \beta_1 Ecol + \beta_2 Empl + \beta_3 Gov + \beta_4 Size + \beta_5 Age + \varepsilon (1)$$

ROE - prinos na sopstvena sredstva, Ecol - dimenzija zaštite životne sredine, Empl - dimenzija društvene odgovornosti, Gov - dimenzija dobrog upravljanje, Size - veličina finansijske institucije, Age - starost finansijske institucije, ε - identično i nezavisno normalno distribuiran, slučajna greška.

Veličina finansijskih institucija iskazana je logaritmom vrednosti ukupne imovine finansijske institucije, dok je starost iskazana prirodnim logaritmom broja godina od osnivanja. Parametri modela (1) ocenjeni su primenom metode fiksnih efekata (FE), metode slučajnih efekata (RE) i metod najmanjih kvadrata za panel podatke (Pooled OLS). Izbor metode opredeljen je kvalitetom podataka, odnosno njihovim mogućnostima kooptiranja heterogenosti između jedinica posmatranja.

ANALIZA I DISKUSIJA DOBIJENIH REZULTATA

U tabeli 1 prikazani su rezultati deskriptivne statistike prikupljenih podataka. Kao što se može videti iz tabele 2 prosečna vrednosti ROE iznosi oko -0.006 što implicira da u proseku tokom perioda posmatranja, izabrane finansijske institucije su ostvarile negativan rezultat. Maksimalna vrednost, odnosno minimalna od -0.257 ukazuje na veliku varijabilnost u ovoj promenljivoj, što potvrđuje i vrednost standardne devijacije od oko 4.5%. Dalje analiza ukazuje da su izabrane finansijske institucije u osnovi ispunile principe poslovanja u skladu sa ESG konceptom, ali da nisu konzistentne u sprovođenju ovih praksi svake godine, jer po svakoj dimenziji minimalna vrednost iznosi nula. Visoke standardne devijacije u dimenzijama ESG ukazuju na značajne razlike u ekološkim i upravljačkim praksama, kao i u praksama upravljanja ljudskim resursima. Srednje vrednosti starosti i veličine finansijskih institucija kao i njihovih veličina ukazuju na raznovrsnost uzorka.

Tabela 1.

Deskriptivna statistika, testovi stacionarnosti i Breusch-Pagan LM test za cross-section dependence

	<i>ROE</i>	<i>Ecol</i>	<i>Empty</i>	<i>Gov</i>	<i>AGE</i>	<i>Size</i>
Srednja vrednost	-0.006	0.500	0.587	0.631	2.877	24.492
St. Dev.	0.045	0.502	0.494	0.484	0.384	1.500
Kurtosis	9.687	-2.027	-1.899	-1.723	0.435	-1.370
Skewness	-1.533	0.000	-0.356	-0.548	0.462	0.177
Minimum	-0.257	0	0	0	2.197	22.259
Maximum	0.121	1	1	1	3.951	27.060
Broj	150	150	150	149	150	150
$\chi^2_{45} = 42.45 (0.581)$						
BP LM						
ADF Size	Inverse chi-square(30) = 14.151 p -vrednost 0.993					
ADF Ecol	Inverse chi-square(30) = 37.007 p -vrednost 0.176					
LLC	-7.458* (0.000)	-0.247* (0.402)	-16.126* (0.000)	-10.907* (0.000)	-13.902* (0.000)	-0.368* (0.356)
		- 13.082** (0.000)				-11.842** (0.000)

*Napomena: * Vrednosti Z testa. ** Vrednost LLC testa nakon diferencijacije*

Izvor: Autori

Prvi korak u radu sa panel podacima jeste testiranje *cross-section dependence*. Za tu svrhu u radu je korišćen Breusch-Pagan LM test za *cross-section dependence* (BP LM), jer je u ovom slučaju vremenska dimenzija veća od broja finansijskih institucija ($T > N$). Vrednost testa iznosi 42.45 sa p-vrednost (0.581), što ukazuje na nepostojanje zavisnosti. Prema Radivojević i Jovović (2017) značajan korak u radu sa panel podacima podrazumeva analizu stacionarnosti podataka, to je za potrebe ovog rada izvršeno testiranje prisustva jediničnog korena primenom ADF testa. Usled zastarelosti ovog testa izvršeno je dodatno ispitivanje stacionarnosti primenom Levin-Lin-Chu pooled ADF (LLC). Rezultati testiranja pokazali su da su sve serije podataka stacionare, osim veličine institucija i dimenzije ESG koja se tiče životne sredine (tabela 2). Iz tog razloga na ove dve serije podataka primenjena je diferencijacija. Nakon ove diferencijacije i ove dve serije postale su stacionarne. Treći korak u radu sa panel podacima podrazumeva ispitivanje stepena korelacije između izabranih promenljivih. Isti su prikazani u tabeli 3. Rezultati pokazuju da nema značajne snažne korelacije, što sugerise da se u istraživanje mogu zadržati sve promenljive. Uprkos ovoj konstataciji zbog nešto veće vrednosti koeficijenta korelacije između promenljive *Empty* i *Ecol*, kao i između *Ecol* i *Gov* u nastavku izvršeno je ispitivanje multikolinearnosti primenom test faktora inflacije varijanse (VIF). Rezultati VIF testa

prikazani su takođe u tabeli 2. Kao što se vidi vrednosti VIF kreću se od 1.109 do 2.323, što ukazuje da sve promenljive mogu da se koriste u nastavku istraživanja.

Tabela 2.

Matrica korelacije

	ROE	Ecol	Emplay	Gov	AGE	Size		VIF
ROE	1						ROE	1.731
Ecol	0.133	1					Ecol	2.011
Emplay	0.013	-0.406	1				Emplay	2.323
Gov	0.088	0.315	-0.184	1			Gov	2.317
AGE	-0.084	0.019	-0.16	0.135	1		AGE	1.109
Size	0.146	0.092	0.022	0.179	0.13	1	Size	1.217

Napomena: Svi koeficijenti korelacije statistički su značajni za nivo poverenja od 0.05

Izvor: Autori

Ocene parametara modela (1) date su u tabeli 3.

Tabela 3.

Ocene parametara modela (1)

Model 1: Fiksnih efekata, upotreba 140 opservacija				
10 jedinica posmatranja				
Zavisna promenljiva: ROE				
	<i>Koeficijent</i>	<i>Std. greška</i>	<i>t-racio</i>	<i>p-vrednost</i>
Kons.	0.093	0.012	7.750	0.000
Size	0.024	0.008	3.000	0.003
AGE	-0.021	0.011	-1.909	0.058
Ecol	0.019	0.008	2.375	0.019
Emplay	-0.003	0.046	-0.065	0.948
Gov	-0.002	0.058	-0.034	0.972
F(5, 125) = 4.064, sa p-vrednost 0.002				
LSDV R-squared 0.73				
Model 1: Slučajnih efekata				
	<i>Koeficijent</i>	<i>Std. greška</i>	<i>t-racio</i>	<i>p-vrednost</i>
const	0.083	0.014	5.929	0.000
Size	0.032	0.007	4.571	0.000
AGE	-0.036	0.013	-2.769	0.001
Ecol	0.021	0.01	2.100	0.035
Emplay	-0.006	0.037	-0.162	0.871

Gov	-0.003	0.038	-0.079	0.937
$\chi^2 (5) = 11.6298$ sa p-vrednost 0.040 $\text{corr}(y, \hat{y})^2 = 0.67$				
Pooled OLS				
	<i>Koeficijent</i>	<i>Std. greška</i>	<i>t-racio</i>	<i>p-vrednost</i>
const	0.089	0.013	6.846	0.000
Size	0.026	0.007	3.714	0.000
AGE	-0.034	0.011	-3.091	0.002
Ecol	0.022	0.006	3.667	0.000
Empty	-0.004	0.038	-0.105	0.916
Gov	-0.002	0.067	-0.030	0.976
$R^2 - 0.67$ $F(5, 134) = 3.901$, sa p-vrednost 0.003				

Napomena: F test, χ^2 test, kao i koeficijent determinacije (R^2) ukazuju na validnost izabranih ocenjivača.

Izvor: Autori

Na osnovu vrednosti dobijenih ocena parametara modela odnosno njihovih p vrednosti mogu se izvesti sledeći zaključci:

1. Zaštita životne sredine kao dimenzija ESG ima pozitivan uticaj na performanse banaka i osiguravajućih društava u Republici Srbiji. Ovakav nalaz u skladu je sa rezultatima istraživanja Buallay (2019) i Shakil et al. (2019). Opravdanje za ovo može se naći u činjenici da ulaganje ovih institucija u ekološke inicijative doprinosi smanjenju potencijalnih rizika povezanim sa zakonskim regulativama, sa jedne strane, ali povećanja imidža i reputacije institucije. Povećanje svesti društva u Republici Srbiji po pitanjima preterane eksploatacije ograničenih resursa, zaštite životne sredine utiče da ovaj aspekt održivog poslovanja ima uticaj na to da klijenti favorizuju institucije koje vode računa o ovim pitanjima.

2. Društvena odgovornost kao dimenzija ESG nema statistički značajan uticaj na performanse banaka i osiguravajućih društava u Republici Srbiji. Ovakav nalaz suprotan je očekivanjima, pre svega iz razloga što institucije veliku pažnju poslednjih godina poklanjaju društveno odgovornom ponašanju prema lokalnoj zajednici. Pojedina istraživanja (Radivojević et al., 2022) pokazuju pozitivan uticaj ovakvog ponašanja na reputaciju banaka. Međutim, ovakav nalaz može se opravdati činjenicom da prilikom definisanja ove dimenzije uključeni su i aspekti koji se tiču i aspekata društvene odgovornosti koja se ne odnosi samo na akcije povezane sa lokalnom zajednicom, već pre svega za aspekte koji se tiču uslova rada, bezbednosti i zdravlja na radu i sl. Kako uslovi rada po ovim aspektima u Republici Srbiji još uvek nisu na željenom nivou, plus uticaj socijalističkog nasleđa na odnos zaposlenih prema radu i menadžmentu imali su veći uticaj na to da ova dimenzija ESG nema statistički značajan uticaj. Nalaz je u skladu sa rezultatima istraživanja Miralles-Quirós et al.

(2019). Radivojević et al. (2025) ističe da socijalističko nasleđe i model samoupravljanja utiču na radnike da imaju specifičan stav u pogledu njihovog tretmana kada su sprečeni da rade stalno ili privremeno. Otuda se opravdanje za ovakav nalaz može tražiti i u ovoj činjenici. Mada je ovo u suprotnostima sa nalazima Dai et al (2025) koji ističu da socijalističko nasleđe doprinosi većoj društvenoj odgovornosti kompanije.

3. Rezultati, takođe, pokazuju da ni upravljanje nema značajan uticaj na performanse poslovanja, što je u skladu sa nalazima Shakil et al. (2019). Ovo može biti pre svega posledica nedostatka inovativnih načina organizovanja i strukture upravljanja u ovim institucijama ili činjenice da se još uvek ne osećaju efekti od inovativnih načina organizovanja posla i upravljanja. Tesno skopčano sa ovim jeste nedostatak jasnih i preciznih smernica i standarda za primer dobrih upravljačkih praksi. Kada regulativa nije dovoljno razvijena ili se ne sprovodi dosledno, tada se upravljanje smatra manje značajnim u poređenju sa ostalim aspektima poslovanja koji direktno utiču na profitabilnost, te mu se ne posvećuje dovoljno pažnje. Usmerenost na ostvarivanje kratkoročnih ciljeva i brzinu ostvarivanja profita, umesto na dugoročno strateško planiranje, takođe utiče na uticaj ove dimenzije ESG na performanse poslovanja. U takvom okruženju, investiranje u upravljanje i odgovornost često može biti percipirano kao trošak, što može ograničiti njegov pozitivan uticaj na performanse.

4. Veličina banke i osiguravajućeg društva ima značajan uticaj na performanse poslovanja. Ovo je u skladu sa resursnim pristupom. Veće institucije često imaju prednost u ekonomiji obima, što im omogućava smanjenje troškova i povećanje efikasnosti. Međutim, prevelike institucije mogu se suočiti sa izazovima u upravljanju i birokratijom, što može smanjiti njihovu sposobnost da brzo i efikasno donose odluke. U ovom kontekstu, optimalna veličina može doprineti boljim performansama.

5. Uticaj starosti finansijskih institucija na njihove performanse u suprotnosti je sa očekivanjem prema resursnom pristupu. Prema ovom pristupu, zbog većeg iskustva i stabilnosti poslovanja, veličina bi trebalo da ima pozitivan uticaj na rezultate poslovanja. Međutim, nalazi u ovom radu ukazuju na suprotno, da mlađe finansijske institucije ostvaruju bolje performanse. Opravdanje za ovo može se naći u tome da su mlađe institucije možda agilnije, te da su manje opterećene nasleđem.

ZAKLJUČAK

Predmet proučavanja ovog rada jeste uticaj ESG koncepta na uspeh poslovanja finansijskih institucija u Republici Srbiji, sa akcentom na banke i osiguravajuća društva. Rezultati istraživanja ukazuju na složenost i različite aspekte ovog uticaja, te na važnost svake od dimenzija ESG u kontekstu lokalnog tržišta. Najznačajniji nalazi pokazuju da dimenzija zaštite životne sredine pozitivno utiče na performanse poslovanja, što ukazuje na sve veću svest o važnosti ekoloških inicijativa u očima potrošača i strateških partnera. Investicije u ekološke projekte ne samo da minimiziraju rizike povezane sa zakonodavstvom, već i poboljšavaju imidž i reputaciju institucija, što je u današnjem konkurentnom bankarskom okruženju

ključno. S druge strane, društvena odgovornost i upravljanje su pokazali da nema statistički značajnog uticaja na performanse. Ovo može biti rezultat nedovoljnog razvoja upravljačkih struktura i nedostatka ulaganja u društveno odgovorne prakse koje bi se mogle odraziti na uspeh. Odsustvo pozitivnog uticaja upravljanja na performanse može biti posledica nedostajućih jasnih smernica i standarda, što otežava ovim institucijama da usvajaju i primenjuju dobru upravljačku praksu. Kratkoročna opredeljenost za profit može odvratiti pažnju od razvoja strategija koje podrazumevaju efikasno upravljanje i društvenu odgovornost. Veličina i starost finansijskih institucija pokazuju se kao značajni faktori u uticaju na performanse. Veće institucije, uz moguće prednosti ekonomije obima, ali i izazove upravljanja, mogu uticati na profitabilnost.

Na osnovu dobijenih nalaza može se odgovoriti na istraživačko pitanje od koga se pošlo u radu, a to je da dimenzije ESG nemaju isti značaj na finansijske performanse finansijskih institucija. U kontekstu ovog nalaza budućim istraživačima ostaje da ispituju razloge zašto društvena odgovornost i upravljački aspekti kao dimenzije ESG koncepta nemaju statistički značajan uticaj.

Kao i svako istraživanje ove vrste i ovo istraživanje ima niz ograničenja koja se moraju uzeti u obzir prilikom interpretacije rezultata istraživanja i prihvatanja zaključaka. Prvo ograničenje odnosi se na metodologiju prikupljanja podataka. Naime, primena pristupa kodiranja (binarne varijable) u smislu da li finansijska institucija pominje ili ne u svojim izveštajima aktivnosti vezane za dimenzije koncepta, ne znači nužno da ona ostvaruje stvarni učinak, odnosno da postiže zadovoljavajući učinak, već znači da je transparentna u objavljivanju svojih aktivnosti. Ovakav pristup podacima može da ima uticaj na uticaj (znak uticaja) dimenzija ESG koncepta na finansijske performanse. Drugo, prilikom definisanja CSR kao dimenzije ESG koncepta nisu uključeni aspekti koji se odnose na akcije povezane sa lokalnom zajednicom, već aspekti koji se tiču uslova rada, bezbednosti i zdravlja na radu, što se odražava na statističku značajnost ove dimenzije. Treće, primena tehnike analize sadržaja, odnosno kodiranje kvalitativnih podataka na dihotomne promenljive smanjuje i raznovrsnost i preciznost podataka, čime se ignoriše stepen i intenzitet sprovedenih aktivnosti. Na ovaj način potencijalno se gube neki delovi informacija. Na kraju treba istaći i relativno mali uzorak, što može uticati na reprezentativnost i generalizaciju rezultata za celokupni sektor finansijskih institucija u Republici Srbiji.

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SUMMARY

Excessive and uncontrolled resource exploitation has negatively impacted society and the community, prompting companies to adopt the principle of sustainable behavior in their operations. Financial institutions are not exempt from this demand. One of the concepts that integrates the requirements of environmental preservation, social responsibility, and good governance is the ESG concept. Despite the general belief that the implementation of this concept contributes to positive business results, this relationship has not yet been thoroughly studied in the financial sector. This is especially true in developing countries, such as the Republic of Serbia. The question arises whether all dimensions of the concept have a significant impact on the performance of financial institutions, considering the specific conditions of their business environment. Therefore, the aim of this paper is to examine the influence of ESG, or its dimensions, on the operational performance of banks and insurance companies operating in the Republic of Serbia. The research was conducted on a sample of six banks and four insurance companies. Data were collected for the period from 2021 to 2024. The study indicates that only environmental protection as a dimension of ESG has a positive impact on the performance of banks and insurance companies, while the other two dimensions of the concept do not have a statistically significant effect on financial performance.

MARKET RISK ASSESSMENT USING ANALYTICAL METHOD DURING THE GLOBAL FINANCIAL CRISIS: A CASE STUDY OF THE TRADING PORTFOLIO ON THE BELGRADE STOCK EXCHANGE

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Abstract

This research analyzes the market risk of a portfolio containing continuously traded stocks on the Belgrade Stock Exchange during the global financial crisis of 2008–2009. Utilizing the Value-at-Risk (VaR) model through an analytical approach, it examines potential losses at varying confidence intervals. The method's effectiveness is evaluated based on the failure rate, identifying the confidence level at which the model proves reliable under the specified conditions. The analysis contributes to a better understanding of how traditional risk assessment tools perform in emerging markets during periods of heightened volatility. Additionally, it highlights the importance of model calibration and backtesting in capturing extreme market movements.

Keywords: market risk, Value-at-risk (VaR) model, analytical method, financial market

PROCENA TRŽIŠNOG RIZIKA KORIŠĆENJEM ANALITIČKE METODE TOKOM FINANSIJSKE KRIZE 2008–2009. GODINE

Apstrakt

Ovo istraživanje analizira tržišni rizik portfolia koji sadrži akcije kojima se kontinuirano trguje na Beogradskoj berzi, tokom globalne finansijske krize 2008–2009. godine. Koristeći model Value-at-Risk (VaR) kroz analitički pristup, ispituju se potencijalni gubici na različitim intervalima poverenja. Efikasnost metoda procenjuje se na osnovu stope neuspeha, identifikujući nivo pouzdanosti na kojem se model pokazao pouzdanim u zadatim uslovima. Analiza doprinosi boljem razumevanju načina na koji tradicionalni alati za procenu rizika funkcionišu na tržištima u razvoju tokom perioda povećane volatilnosti. Pored toga, naglašava se značaj kalibracije modela i provere tačnosti u uslovima ekstremnih tržišnih kretanja.

Ključne riječi: tržišni rizik, vrednost izloženog riziku (VaR) model, analitička metoda, finansijsko tržište



INTRODUCTION

In 2007, the United States was hit by a financial crisis originating in the mortgage market, which soon escalated into a global economic downturn. A huge number of debtors were unable to repay their loans, and US banking giants, which had great expectations in terms of earnings arising from these loans, found themselves facing bankruptcy. However, the crisis did not stop with the mortgage market, and in 2008 it spread on the market of stocks and bonds, the prices of which decreased drastically. In September 2008, several large investment banks that had bad mortgage securities in their balance sheets went bankrupt. After September 2008, the crisis deepened and spread across the EU, Russia and other countries, causing panic in the financial and banking markets. The stock market crisis and banking crisis are illustrated by the indicators that show a drastic decline in bank loans and the value of shares and bonds on the stock market that, together with a decline in inflow of net foreign capital, reflected on the decline in economic activity and investors' confidence to invest in the economy. Stock exchange and banking crisis spread to the real economy in many countries and caused a recession.

This paper explores the market risk assessment on the Serbian stock market during the 2008–2009 period, focusing particularly on Value-at-Risk (VaR) modeling. The period under review was notably shaped by the global financial crisis, which had profound impacts on emerging markets like Serbia. The Serbian market, heavily influenced by the global downturn, witnessed extreme market volatility during this period, thus emphasizing the importance of accurately quantifying risk in such turbulent times.

The analytical VaR model used in this research aims to measure potential market risk by calculating the maximum expected loss over a given time horizon at a specific confidence level, while also testing the model's accuracy through backtesting.

Value-at-Risk has become a critical tool in risk management for financial institutions, especially in volatile environments like the one observed in 2008-2009. Various approaches have been developed over time to estimate VaR, including historical simulation, variance-covariance, and models based on time-series data such as GARCH (Generalized Autoregressive Conditional Heteroskedasticity). These models offer different strengths and weaknesses in predicting risk, particularly under conditions of heavy-tailed distributions or market turbulence.

By comparing these methodologies, we aim to provide an in-depth assessment of the applicability and reliability of the VaR model in capturing risk during a major financial crisis. Previous works, including Obadović et al. (2016), offer insight into risk assessment in similar market conditions, contributing to the broader understanding of how risk can be measured and mitigated during extreme economic events.

In the evolving landscape of financial risk management, accurately quantifying potential losses is paramount. Value-at-Risk (VaR) has emerged as a cornerstone metric, offering a statistical estimate of the maximum expected loss over a specified time horizon at a given confidence level (Jorion, 2001). Its widespread adoption across financial institutions underscores its utility in risk assessment and regulatory compliance (Allen, Boudoukh, & Saunders, 2004).

The analytical, or variance-covariance, approach to VaR estimation is renowned for its computational efficiency and straightforward implementation. By assuming normally distributed returns and linear relationships among portfolio assets, this method facilitates rapid risk assessments (Alexander, 2008). However, its reliance on these assumptions can lead to underestimation of risk, especially during periods of market turbulence characterized by non-linear behaviors and fat-tailed distributions (Crouhy, Mark, & Galai, 2001; Shaik, 2022).

Alternative methodologies, such as historical simulation, Monte Carlo simulation, and GARCH-based models, have been developed to address these limitations. These approaches offer enhanced flexibility in modeling complex market dynamics but often at the expense of increased computational demands (Alexander & Baptista, 2004; Wang & Su, 2022). Recent literature also explores the integration of environmental, social, and governance (ESG) factors into VaR models, reflecting the growing emphasis on sustainable finance (Gao & Li, 2023).

Despite the advancements in alternative models, the analytical VaR approach remains a fundamental tool in risk management, serving as a benchmark for evaluating more complex models and providing quick insights into potential exposures (Dowd, 2005). This paper aims to delve into the analytical VaR model's framework, assess its applicability in contemporary financial contexts, and explore its integration with emerging risk factors.

Analytical VaR method

The analytical VaR model, also known as the variance-covariance method, estimates potential losses by assuming that asset returns are normally distributed and that the portfolio's composition remains static over the risk horizon. This method calculates VaR using the portfolio's mean return, standard deviation, and a z-score corresponding to the desired confidence level (Hull, 2012).

It sets the maximum loss that might hit over a chosen horizon at a preset confidence level. In short, VaR states how much the portfolio could lose with a given probability—say 95 % or 99 %. A one-day 5 % VaR of \$1 million means the portfolio has a 95 % probability of not losing more than \$1 million tomorrow, while a one-day 5 % VaR of −\$1 million means the portfolio has a 95 % probability of gaining at least \$1 million tomorrow (Crouhy 2001). Financial firms compute VaR through techniques such as historical simulation, the analytical method, and Monte Carlo simulation.

The methodology employed here is identical to that used in the previously published study by Obadović and Obadović (2009), ensuring full comparability of results. The analytical method assumes that market variables follow a normal probability distribution. This assumption allows for the application of statistical tools, such as the Gaussian (Normal) distribution function:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2} \quad (1)$$

where: x – independent variable, $\pi \approx 3,14159$, $e \approx 2,71828$, μ - mean (expected) distribution value and σ - standard deviation.

The normal distribution can also be depicted as a bell-shaped curve. Its essential feature is symmetry, and it is fully specified by only two parameters: μ (mean) and σ (standard deviation). Once these are fixed, the normal distribution is fully determined and is denoted as $N(\mu, \sigma^2)$. The distribution $N(0,1)$ is named the standard normal distribution. This standard form is obtained by rescaling every observation so that its deviation from the mean is expressed in standard-deviation units. The standardized distance of a random variable x_i from the mean is denoted by z and is computed with the formula:

$$z = \frac{x_i - \mu}{\sigma} \quad (2)$$

where $-\infty < z < +\infty$. Applying this formula to each observation yields its corresponding z_i value. For every z_i one can find the probability that the random variable x_i lies below or above that standardized value. The probability that z_i is less than a chosen value y is written:

$$P(z_i < y). \quad (3)$$

When the chance that z_i is smaller than 0.5 is required, we write:

$$P(z_i < 0,5). \quad (4)$$

This probability is obtained by evaluating the definite integral of the normal distribution function. Ready-made probabilities for every possible y values are provided in standard normal tables.

Because VaR is routinely computed at fixed confidence levels such as 90 %, 95 %, 99 % and 99.5 %, the z_i values that match these probabilities are already set.

By relying on the normal distribution, the variance-covariance method derives VaR as the product of the portfolio's standard deviation of value changes by a corresponding z_i value associated with the desired confidence level.

VaR depends only on the chosen confidence level (z), the portfolio's standard deviation (σ), and its current value (V). After the standard deviation of value changes is known, VaR is obtained from:

Table 1
Confidence levels and VaR

Confidence levels	VaR
90%	$-1,28 * \sigma * V$
95%	$-1,65 * \sigma * V$
99%	$-2,33 * \sigma * V$
99,5%	$-2,58 * \sigma * V$

The hardest part of the approach is estimating the standard deviation of the change in portfolio value. After that figure is in hand, VaR is simply the product of standard deviation σ , the specific value of parameter z and portfolio value V .

The standard deviation σ itself is extracted from the covariance matrix built from the assets' historical returns over the past n days. The calculation follows this formula:

$$\sigma = \sqrt{wVw^T}, \quad (5)$$

where $w = (w_1, w_2, \dots, w_n)$ represents the weighted portfolio vector (nominal amounts invested into each asset), and V is covariance matrix, based on the daily returns of the assets. In this example, an equal amount (4.35%) of the initial portfolio value is allocated to each asset. The covariance matrix V is structured as follows:

$$\begin{bmatrix} Var(R_1) & Covar(R_1, R_2) & \dots\dots Covar(R_1, R_n) \\ Covar(R_2, R_1) & Var(R_2) & \dots\dots Covar(R_2, R_n) \\ \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \\ Covar(R_n, R_1) & Covar(R_n, R_2) & \dots\dots Var(R_n) \end{bmatrix}, \quad (6)$$

where $Var(R_n)$ represents variance of the return rate of asset n , and $Covar(R_n, R_m)$ represents the covariance between the return rates of assets n and m , and it satisfies $Covar(R_n, R_m) = Covar(R_m, R_n)$. Next, the standard deviation of the portfolio is obtained as the square root of its variance:

$$\sigma = \sqrt{\sigma^2}, \quad (7)$$

where:

$$\sigma^2 = [w_1, w_2, \dots, w_n] \begin{bmatrix} Var(R_1) & Covar(R_1, R_2) & \dots & Covar(R_1, R_n) \\ Covar(R_2, R_1) & Var(R_2) & \dots & Covar(R_2, R_n) \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ Covar(R_n, R_1) & Covar(R_n, R_2) & \dots & Var(R_n) \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ \cdot \\ \cdot \\ \cdot \\ w_n \end{bmatrix}. \quad (8)$$

The volatility needed to build the covariance matrix is computed using the equally weighted historical method:

$$\sigma = \sqrt{\frac{1}{T} \sum_{t=1}^T (r_t - r_m)^2}, \quad (9)$$

where r_t represents individual asset return rates and r_m is the mean return rate of the asset. T is the number of observed daily return rates.

While this model offers simplicity and speed, its assumptions may not hold in real-world markets. Empirical studies have shown that financial returns often exhibit skewness and kurtosis, deviating from normality (Ding, Granger, & Engle, 1993). Moreover, during periods of financial stress, asset correlations can increase, leading to higher portfolio risk than estimated by the analytical model (Ziković & Aktan, 2009).

To enhance the analytical model's robustness, researchers have proposed incorporating alternative distributions, such as the t-distribution, to better capture fat tails (Chen, Liu, & Zhang, 2023). Additionally, adjustments for time-varying volatility through models like GARCH can provide more accurate risk estimates (Wang & Su, 2022).

Serbian Portfolio: Sample Dataset and Primary Value-at-Risk Assessment Results

The paper generates one-day Value-at-Risk estimates at four standard confidence thresholds (90 %, 95 %, 99 % and 99.5 %), for a Serbian equity portfolio composed of 23 continuously quoted companies on the Belgrade Stock Exchange during the two-year period following the global financial crisis (01.01.2008–31.12.2009).

Share-price series were downloaded from the Belgrade Stock Exchange official portal (www.belex.rs) and the ticker symbols and full corporate names that compose the portfolio are listed in Table 2. The sample employed here is a 23-company subset drawn from the original 27 firms examined in Obadović & Obadović (2009), rendering the results sufficiently comparable with the earlier study.

Table 2

Ticker symbols and names of the companies included in the portfolio

Symbol	Company name
1. SJPT	<i>Soja protein a.d. Bečej</i>
2. DNVG	<i>Dunav Grocka a.d. Grocka</i>
3. FITO	<i>Galenika Fitofarmacija a.d. Zemun</i>
4. IMLK	<i>Imlek a.d. Beograd</i>
5. NPRD	<i>Napred GP a.d. N. Beograd</i>
6. TLKB	<i>Telefonkabl a.d. Beograd</i>
7. TGAS	<i>Messer Tehnogas a.d. Beograd</i>
8. PUUE	<i>Putevi a.d. Užice</i>
9. CCNB	<i>Čačanska banka a.d. Čačak</i>
10. ALFA	<i>Alfa plam a.d. Vranje</i>
11. ENHL	<i>Energoprojekt holding a.d. Beograd</i>
12. MTLK	<i>Metalac a.d. Gornji Milanovac</i>
13. BMBI	<i>Bambi Banat a.d. Beograd</i>
14. PLNM	<i>Planum GP a.d. Beograd</i>
15. PTLK	<i>Pupin Telecom a.d. Zemun</i>
16. RMBG	<i>Ratko Mitrović a.d. Beograd</i>
17. TIGR	<i>Tigar a.d. Pirot</i>
18. BNNI	<i>Banini a.d. Kikinda</i>
19. RDJZ	<i>Radijator a.d. Zrenjanin</i>
20. AIKB	<i>AIK banka a.d. Niš</i>
21. PRGS	<i>Progres a.d. Beograd</i>
22. UNBN	<i>Univerzal banka a.d. Beograd</i>
23. KMBN	<i>Komercijalna banka a.d. Beograd</i>

Source: www.belex.rs

The portfolio-formation and tracking procedure replicates the one in Obadović & Obadović (2009), except that the present study employs a reduced set of 23 companies

instead of the original 27. An initial investment of RSD 10 million is still allocated equally across the 23 firms (RSD 434,782.61 per company), the number of shares bought in each firm is held constant throughout the observation period, and all changes in portfolio value are driven solely by market-price movements, thereby preserving full comparability with the earlier study. The amount allocated to each company is obtained by dividing the total investment by the number of firms in the portfolio:

$$10,000,000 / 23 = 434,782.61 \text{ dinars.} \quad (10)$$

Let $p_{1,1}, p_{1,2}, \dots, p_{1,23}$ denote the share prices on 1 January 2008 and $q_1, q_2, \dots, q_{23}$ the number of shares bought in each firm. Equal cash allocation implies:

$$p_{1,1} q_1 = p_{1,2} q_2 = \dots = p_{1,23} q_{23} = 434,782.609 \text{ dinars,} \quad (11)$$

so the quantity purchased in each company is:

$$q_n = 434,782.609 / p_{n,n}. \quad (12)$$

This quantity is held constant throughout the sample period; only market-price movements and their effect on portfolio value are recorded.

After prices change to $p_{2,1}, p_{2,2}, \dots, p_{2,23}$ the next day, the portfolio is worth RSD 9,911,450.35. The relative change is:

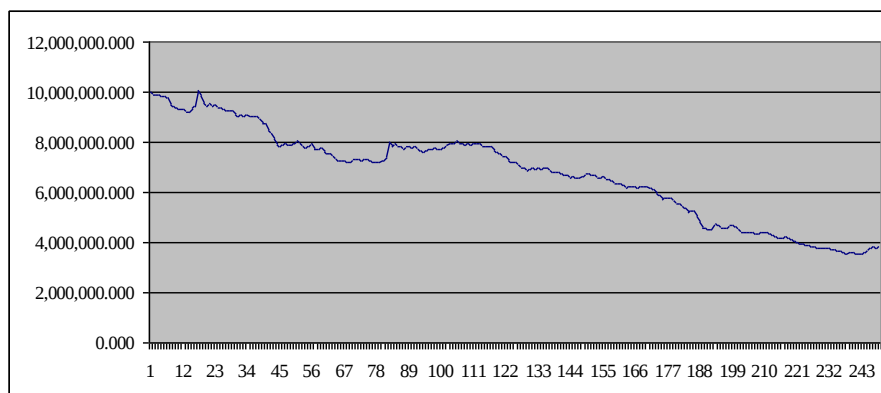
$$(9,911,450.35 - 10,000,000) / 10,000,000 = -0.00886 = -0.886 \%,$$

i.e. a loss of 0.886 %.

One year (249 trading days) later, the portfolio was worth RSD 3,804,795.13, a shortfall of RSD 6,195,204.87 relative to the starting capital, resulting in a negative return of 61.95%. The chart below illustrates how the portfolio's value evolved throughout 2008.

Image 1

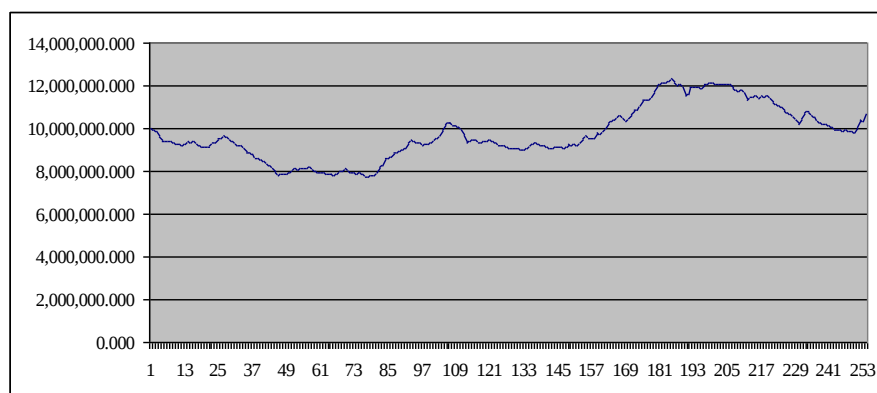
Visual overview of portfolio value movements during 2008



At the start of 2009 an investment of RSD 10,000,000 was placed in the portfolio, and after 254 trading days the position ended the year at RSD 10,738,961.11, a gain of 7.39 percent. The chart below tracks the portfolio's value throughout 2009.

Image 2

Visual overview of portfolio value movements during 2009.



Using the standard analytical approach we computed one-day Value at Risk at the 90%, 95%, 99%, and 99.5% confidence levels, and the outcomes are reported in Table 3 and displayed in Figures 3 and 4.

Table 3

One-day VaR estimates obtained with the delta-normal approach across multiple confidence levels

VaR	31.12.2009	31.12.2008
$VaR_{99.5\%}(23)$	2.9989%	4.1609%
$VaR_{99\%}(23)$	2.7020%	3.7912%
$VaR_{95\%}(23)$	1.8909%	2.7815%
$VaR_{90\%}(23)$	1.4585%	2.2432%

Source: Authors' calculation.

From Table 3, it is evident that on 31/12/2008, at a 99.5% confidence level, the maximum estimated one-day loss was 4.1609% of the portfolio value. Scaling the one-day result to a 250-day horizon in the usual way ($\text{loss} \times \sqrt{250}$) gives a maximum projected decline of 65.79 percent, underscoring a very high risk exposure.

The figure that follows shows the portfolio returns and the analytically derived VaR figures for the 23-stock portfolio during 2008.

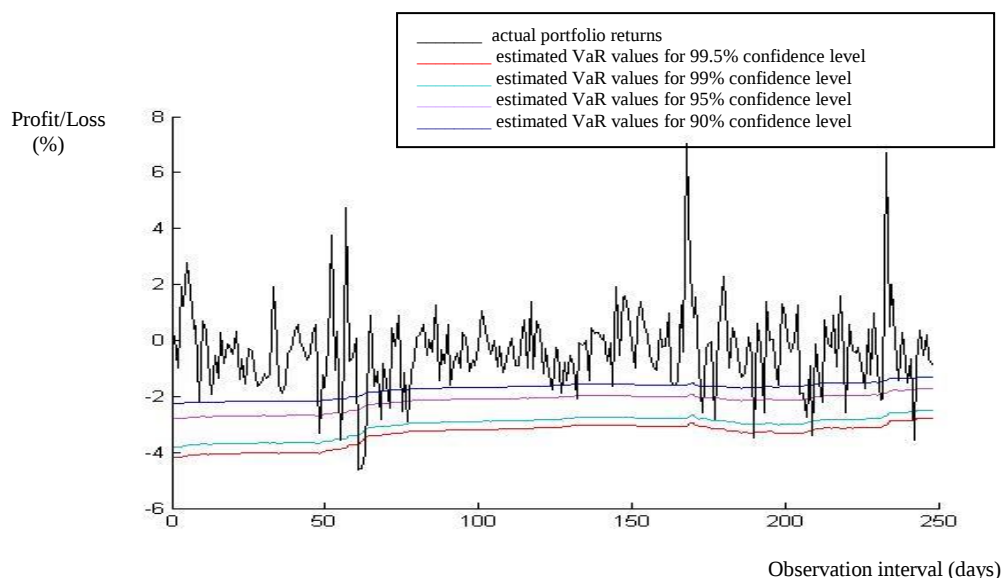
Image 3*2008 portfolio returns and analytical VaR chart*

Image 3 plots 248 consecutive daily VaR forecasts (shown in color) at four confidence levels for the 23-share portfolio throughout 2008.

The black line tracks the corresponding 248 realised daily portfolio returns, providing a direct visual benchmark for the VaR estimates.

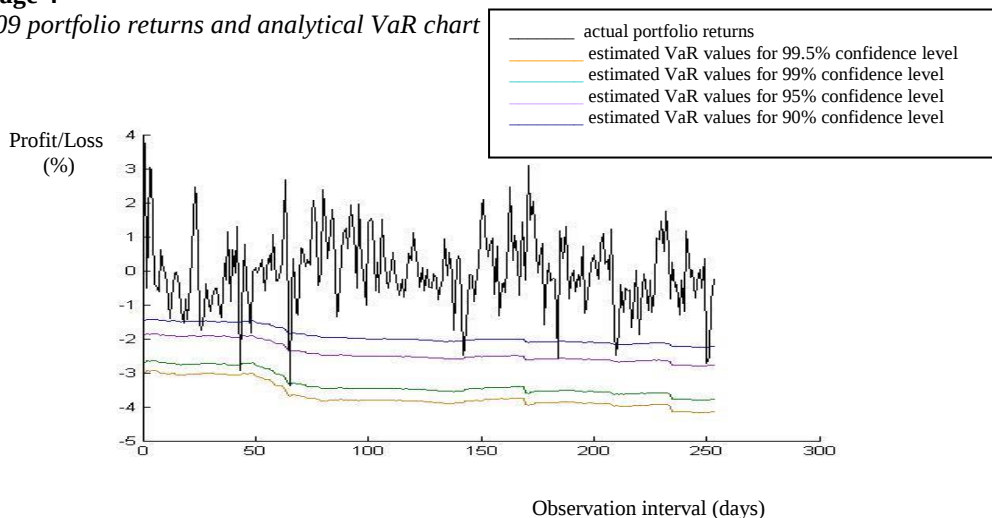
Image 4*2009 portfolio returns and analytical VaR chart*

Image 4 plots 248 consecutive daily VaR forecasts (shown in color) at four confidence levels for the 23-share portfolio throughout 2009.

The black line tracks the corresponding 248 realised daily portfolio returns, providing a direct visual benchmark for the VaR estimates.

VERIFICATION OF MODEL ACCURACY

Estimated VaR (Value at Risk) values should not be taken at face value. As previously shown, there were instances where portfolio returns exceeded the estimated VaR values on certain days. Therefore, it is essential to verify the model's accuracy.

The simplest approach to verify accuracy is to calculate the failure rate, which measures how often the actual loss surpasses the estimated VaR value within a given dataset. Let N represent the number of exceedances (instances when losses exceed VaR). At a given confidence level, if N is significantly smaller or larger than expected, it indicates potential inaccuracies in the model.

The table below displays the number of exceedances (N) for various confidence levels in the years 2008 and 2009:

Table 4

Frequency of actual losses exceeding VaR estimates for a portfolio of 23 shares (2008–2009, analytical method)

Delta normal method	2009 T=253	2008 T=248
p=0.005	N = 0	N = 6
p=0.01	N = 2	N = 6
p=0.05	N = 2	N = 21
p=0.1	N = 11	N = 29

Source: Authors' calculation.

where T – the total number of VaR predictions, and N – the number of days actual losses exceeded VaR estimates.

The failure rate (N/T) is then compared to the left-tail probability (e.g., $p = 0.01$) used for VaR estimation. If these values align, the model is considered accurate. If significant deviations exist, the model should be rejected.

To keep the test transparent, we adopt the 95 % confidence level, roughly two standard deviations under normality, as the cut-off for model acceptance. Kupiec (1995) frames this decision with a likelihood ratio (LR) test whose acceptable region is defined as follows:

$$LR = -2\ln [(1 - p)^{T-N} p^N] + 2\ln [(1 - (N/T))^{T-N} (N/T)^N].$$

The LR statistic is asymptotically $\chi^2(1)$ distribution under the null hypothesis that p equals the true exceedance probability.

For example, with $T = 250$ observations and $p = 0.10$, the expected number of exceedances would be:

$$N = pT = 0.1 \times 250 = 25.$$

The null hypothesis is retained provided N lies inside the 95 percent confidence interval $15 < N < 35$. Values $N \geq 35$ indicate the model understates risk, whereas $N \leq 15$ imply it is excessively conservative.

The table below outlines the acceptable regions for model verification at a 5% significance level ($\alpha = 0.05$):

Table 5

Acceptable regions for model verification at a 5% significance level

Delta normal method	2009 T=253	2008 T=248
p=0.005	$0 < N < 4$	$0 < N < 4$
p=0.01	$0 < N < 7$	$0 < N < 7$
p=0.05	$5 < N < 20$	$5 < N < 20$
p=0.1	$15 < N < 36$	$15 < N < 35$

Source: Authors' calculation.

The final verification, based on Kupiec's Likelihood Ratio test, determines whether the model is acceptable or rejected at different confidence levels:

Table 6

Model verification results using kupiec's likelihood ratio test

Delta normal method	2009 T=253	2008 T=248
p=0.005	accepted	rejected
p=0.01	accepted	accepted
p=0.05	rejected	rejected
p=0.1	rejected	accepted

Source: Authors' calculation.

CONCLUSION

Value-at-Risk projections give managers an early view of the downside a portfolio may face within a fixed horizon. Among the many techniques discussed in the literature, we rely on the simple variance–covariance approach, producing one-day VaR figures at 90 %, 95 %, 99 % and 99.5 % confidence levels for an equally weighted basket of twenty-three liquid Serbian stocks recorded daily on the Belgrade Stock Exchange from 1 January 2008 through 31 December 2009. To verify the model's

accuracy, a 5% significance level ($\alpha = 0.05$) was employed. The results revealed the following findings:

- **In 2009**, the analytical VaR method overestimated risk at lower confidence levels (90% and 95%).
- **In 2008**, no clear pattern emerged across different confidence levels. At higher confidence levels (99.5% and 95%), the method underestimated risk, while it performed acceptably at lower confidence levels.

These results underscore the sensitivity of the analytical VaR method to extreme market conditions, such as those experienced during the 2008 financial crisis. The model's limitations become especially evident when return distributions deviate from normality, which is a fundamental assumption of the analytical approach. While the analytical method is computationally efficient and easy to interpret, its reliability may be compromised during periods of high volatility or market stress.

The analytical VaR model remains a valuable tool in financial risk management due to its simplicity and effectiveness. Its ease of implementation makes it particularly useful for preliminary risk assessments and regulatory reporting. However, the model's reliance on assumptions, such as normal distribution and static correlations, can limit its accuracy in volatile market conditions.

Enhancements to the model, including the adoption of alternative distributions and the integration of volatility modeling techniques like GARCH, show promise in addressing the limitations of the basic VaR method (Alexander & Baptista, 2004; Wang & Su, 2022). Moreover, the inclusion of environmental, social, and governance (ESG) factors in VaR assessments reflects the evolving nature of risk considerations in modern finance (Gao & Li, 2023).

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REZIME

Ovo istraživanje bavi se procenom tržišnog rizika portfolija sastavljenog od akcija kojima se kontinuirano trguje na Beogradskoj berzi u periodu globalne finansijske krize 2008–2009. godine, koji je bio obeležen izraženom nestabilnošću, povećanom volatilnošću i značajnim padovima tržišnih vrednosti. Cilj rada je da se ispita primenljivost i pouzdanost analitičke metode Value-at-Risk (VaR) u uslovima ekstremnih tržišnih kretanja, sa posebnim fokusom na tržište u razvoju. U istraživanju se koristi analitički VaR model, koji polazi od pretpostavke normalne raspodele prinosa, kako bi se procenili potencijalni maksimalni gubici portfolija za različite

nivoa poverenja i vremenske horizonte. Dobijeni rezultati se zatim upoređuju sa stvarnim ostvarenjima gubitaka, pri čemu se efikasnost modela ocenjuje primenom backtesting procedure, odnosno analizom stope neuspeha (failure rate). Na taj način identifikuje se nivo poverenja na kojem analitički VaR model pokazuje najveći stepen pouzdanosti u posmatranom periodu. Rezultati istraživanja ukazuju na ograničenja tradicionalnih modela za procenu rizika u periodima finansijskih kriza, kada dolazi do odstupanja od standardnih statističkih pretpostavki. Ipak, analiza pokazuje da pravilna kalibracija modela i kontinuirana provera njegove tačnosti mogu značajno unaprediti kvalitet procene tržišnog rizika. Rad doprinosi boljem razumevanju ponašanja analitičkih metoda za merenje rizika na tržištima u razvoju i pruža korisne smernice za njihovu primenu u uslovima povećane neizvesnosti i sistemskih šokova.

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Tabela 1

Vrijednosti pseudokorelacijskih koeficijenata determinacije u izolovanom modelu predikcije percepcije kvaliteta nogometa

Model	-2 Log likelihood	Coxov & Snellov R ²	Nagelkerkeov R ²
1	37,039	0,071	0,129

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Više autora: Jovetić, S. i Janković, N. (2011). Značaj naučno-tehnološkog razvoja za društveno-ekonomski razvoj zemlje: statističko-ekonometrijski model. U: *Tehnologija, kultura i razvoj: tematski zbornik radova XVIII naučnog skupa međunarodnog značaja "Tehnologija, kultura i razvoj"* (str. 142-151). Beograd: Udruženje "Tehnologija i društvo".

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Na kraju teksta neophodno je dati rezime (SUMMARY) članka na engleskom jeziku u dužini do jedne stranice, ukoliko rad nije na engleskom jeziku. Ukoliko je rad na engleskom jeziku, rezime napisati na bosanskom ili srpskom jeziku.

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The institution where the author is affiliated (10 point, normal, centred and upper and lower case)

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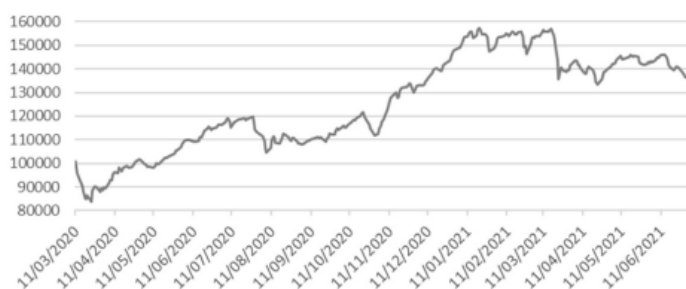
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Figure 1

Turkish Stock Market Trend XU100



Source: Authors' calculations

Table 1

Values of Pseudo-correlation Determination Coefficients in the Isolated Model of Predicting Perception of Football Quality

Model	-2 Log likelihood	Coxov & Snellov R ²	Nagelkerkeov R ²
1	37,039	0,071	0,129

Source: Redžepagić, B., Plojović, Š., & Ujkanović, E. (2013). Opportunities of transitional potential of BH sports and its more successful connection with the overall tourism offer of Bosnia and Herzegovina. *Economic Challenges*, 2(4), 15-36. <https://doi.org/10.5937/EkoIzavov1304015R>

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For three or more authors, use 'et al.' after the first author's surname indicating additional authors.

When quoting sources with embedded quotes, include them in the quote, but you don't need to cite embedded quotes on your reference page (only the source you are citing).

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Example of a narrative citation

The general citation style is:

Author (year) "quote" (p. #).

Single author: Meta (2015) says, "each of these funding sources has its own characteristics, advantages, and disadvantages that should be considered when choosing between them" (p. 19)

Two authors: Kalač and Jokić (2017) highlight that "a certain number of the most successful entrepreneurs use part of their achieved financial surpluses for various humanitarian and socially beneficial purposes..." (p. 73).

Three or more authors: Plojović et al. (2022) argue, "Resources (human, material, financial) are needed to achieve the goal. For example, if we talk about software and mention human resources, they are closely related to the complexity of the project" (p. 3).

Example of a parenthetical citation

The general citation style is:

"Quote" (Author, year, p. #)

Single author: "each of these funding sources has its own characteristics, advantages, and disadvantages that should be considered when choosing between them." (Meta, 2015, p. 19)

Two authors: "a certain number of the most successful entrepreneurs use part of their achieved financial surpluses for various humanitarian and socially beneficial purposes..." (Kalač & Jokić, 2017, p. 73).

Three or more authors: "Resources (human, material, financial) are needed to achieve the goal. For example, if we talk about software and mention human

resources, they are closely related to the complexity of the project.” (Plojović et al., 2022, p. 3).

Paraphrasing and summarizing

Paraphrasing is when you put a passage or idea from another work into your own words.

A paraphrased passage is generally shorter and more concise than the original.

You can cite your data as part of the sentence (narrative citation) or at the end in parentheses (parenthetical citation).

Summarizing is very similar to paraphrasing in that it also involves conveying someone else's ideas in your own words to condense the material.

A summary includes only the main points and/or ideas of a longer passage or entire work.

For two authors, use 'and' in narrative citations and the ampersand '&' for parenthetical citations.

For three or more authors, use 'et al.' after the first author's surname to indicate there are additional authors.

Include only the author/year from the article you are summarizing. You do not need to include page numbers or section identification.

If citing multiple works in parentheses, arrange the citations in alphabetical order separated by semicolons.

Example of narrative paraphrasing

The general citation style is:

Author (year) summary.

Single author: Meta (2015) emphasizes that investing only makes economic sense if it can achieve effects.

Two authors: Kalač and Jokić (2017) state that the problem does not arise if the lease period is identical or approximately identical to the economic and technological lifespan of the leased item.

Three or more authors: Plojović et al. (2022) emphasize that communication is the way ideas are transmitted from one subject to another.

Example of parenthetical paraphrasing

The general citation style is:

Summary (Author, year)

Single author: Investing only makes economic sense if it can achieve effects (Meta, 2015).

Two authors: The problem does not arise if the lease period is identical or approximately identical to the economic and technological lifespan of the leased item (Kalač & Jokić, 2017).

Three or more authors: Communication is the way ideas are transmitted from one subject to another. (Plojović et al., 2022).

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A numbered list of sources and literatura (formatted in Times New Roman font, 10-point, normal, justified, upper and lower case) should be provided at the end of the paper as follows:

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Single author: Saračević, M. (2012). *Tools for Interactive Mathematics Teaching and E-Learning: A Handbook for Mathematics, Informatics, Technical and Informatics Education, Physics, Chemistry Teachers, and Primary School Teachers*. Novi Pazar: University of Novi Pazar.

Multiple authors: Plojović, Š., Bušatlić, S., & Bećirović, S. (2022). *Project Management: (with Examples from the IT Industry)*. Novi Pazar: University of Novi Pazar.

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