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TOWARDS BANKING PERFORMANCE: A TWO-STEP CLUSTER ANALYSIS OF SOUTHEAST EUROPEAN COUNTRIES

Abstract

This study examines the performance of the banking sector in Southeast European countries using a two-step cluster analysis approach from 2017 to 2021. Based on the defined research objectives, this study employs key financial indicators, including the real interest rate, liquidity, credit risk, and the Herfindahl-Hirschman Index as a measure of market concentration. By applying the Schwarz-Bayesian Criterion, the optimal number of clusters was determined to be between 3 and 5. The results reveal significant differences in profitability, liquidity, and market structure among the analyzed countries. The most stable banking systems are found in Greece and Cyprus, while Serbia, Türkiye, and Montenegro face greater challenges in terms of credit risk and market concentration. Applied analysis enhances the competitiveness of banking systems through risk reduction and increased liquidity.

Key words: *Two-step cluster analysis, liquidity, credit risk, banking industry*

JEL classification: *G21, C38*

ЕВАЛУАЦИЈА ПЕРФОРМАНСИ БАНАКА: ДВОСТЕПЕНА КЛАСТЕР АНАЛИЗА ЗЕМАЉА ЈУГОИСТОЧНЕ ЕВРОПЕ

Апстракт

Ова студија анализира перформансе банкарског сектора у земљама југоисточне Европе применом двофазне кластер анализе у периоду од 2017. до 2021. године. Полазећи од постављених циљева истраживања, ова студија користи кључне финансијске показатеље, укључујући реалну каматну стопу, ликвидност, кредитни ризик и Herfindahl-Hirschman индекс као меру тржишне концентрације. Применом Schwarz-Bayesian критеријума, оптималан број кластера одређен је између 3 и 5. Резултати показују значајне разлике у профитабилности, ликвидности и структури тржишта међу анализираним земљама. Најстабилнији банкарски системи налазе се у Грчкој

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и Кипру, док се Србија, Турска и Црна Гора суочавају са већим изазовима у погледу кредитног ризика и тржишне концентрације. Примењена анализа побољшава конкурентност банкарског система кроз смањење ризика и повећање ликвидности.

Кључне речи: *двофазна кластер анализа, ликвидност, кредитни ризик, банкарска индустрија*

Introduction

The performance of the banking sector is a crucial factor influencing economic growth and financial stability. Banks play a fundamental role in mobilizing financial resources, transforming savings into investments, and supporting economic activities (Lutovac, 2024). Factors such as interest rates, market concentration, and liquidity risk significantly determine banks' profitability and long-term sustainability.

In Southeast Europe, the banking industry faces notable challenges, including a high proportion of non-performing loans (NPLs), liquidity fluctuations, and varying levels of market concentration (World Bank, 2017; Malenković, 2023). These challenges can hinder banks' ability to allocate financial resources and contribute to broader economic development in an efficient manner.

This study employs a two-step cluster analysis to identify key factors affecting banking performance during the period from 2017 to 2021. The methodology, widely used for classification, enables the grouping of countries into homogeneous clusters based on financial indicators (Kristóf et al., 2024). The analysis includes four primary indicators: the real interest rate, liquidity, credit risk, and the Herfindahl-Hirschman Index (HHI), which measures market concentration. Applying the Schwarz-Bayesian Criterion, the optimal number of clusters was determined to be between three and five (Tavsanli & Hamlaci, 2021).

The results reveal substantial differences among countries in terms of profitability and financial stability. Greece and Cyprus exhibit relatively stable banking sectors, with lower credit risk and higher profitability. In contrast, Serbia, Türkiye, and Montenegro show elevated credit risk levels and higher market concentration. These findings highlight the need for enhanced risk management and regulatory policies to support banking sector stability and competitiveness in the region (Horvat Marcikić et al., 2023).

Literature Review

The efficiency and performance of the banking sector in Southeast European countries have been extensively studied, particularly in relation to financial crises, macroeconomic determinants, and digitization. This review synthesizes key findings from existing studies, highlighting the various methodological approaches and perspectives employed. One notable contribution is by Ivanovska (2020), who conducted a cluster analysis of banking system indicators, demonstrating that North Macedonia's banking

sector is more closely aligned with other Balkan countries rather than EU member states. This result indicates that banking structures in the Western Balkans maintain distinct characteristics compared to more integrated European financial markets. Similarly, Skënderi (2023) compares the banking performance of Western Balkan countries during the Global Financial Crisis (2008) and the COVID-19 pandemic, shedding light on the resilience and adaptability of banking institutions in the region. The study highlights structural vulnerabilities and the role of crisis management policies in addressing these vulnerabilities.

One of the most common applications of Two-Step Cluster Analysis in banking is the identification of distinct customer profiles, enabling banks to understand consumer needs better and optimize their services. Schiopu (2010) employed Two-Step Cluster Analysis to identify three customer profiles, which helps banks to manage their client base more efficiently. This analysis enables the segmentation of clients based on their financial habits, facilitating targeted advertising and the development of banking products. Kovács et al. (2021) applied TwoStep Cluster Analysis to identify investment patterns of potential retail banking customers. Their analysis revealed three main groups of investors, each with distinct risk preferences and preferred types of financial products. These findings are beneficial for banking marketing strategies. Tavsanli and Hamlaci (2021) used a two-step cluster analysis to segment Turkish banks based on their financial strength. The analysis identified three distinct groups, with the largest group comprising banks that performed below average. This approach provides regulatory bodies and investors with insights into the risk levels of individual banks. Harmatiy et al. (2021) applied cluster analysis to study the development of banking institutions, showing that banks can be grouped based on their ability to adapt to market changes. This study highlights the usefulness of cluster analysis in predicting future trends in the banking sector, as also supported by Vranjanac and Rađenović (2022) and Rađenović et al. (2022). By applying comparative clustering approaches within a macroeconomic analysis framework, this study provides a valuable methodological parallel for the application of Two-Step Cluster Analysis in research on banking sector performance.

Efficiency and productivity within the Southeast European banking sector have also been examined by Varesi (2015), who analyzed the macroeconomic and bank-specific determinants influencing performance. This research aligns with later studies on banking profitability, which employ a panel data approach to investigate the key drivers of profitability in commercial banks. Similar findings are presented by Nurboja (2017), who examines the cost efficiency of banks in Southeast Europe and points to the existence of a significant "efficiency gap" between banks operating in European Union member states and those that are still candidates or remain outside the EU. Although this study does not use a two-step cluster analysis, it provides valuable insights into financial stability. Kalaš et al. (2020) conducted a survey of banks in Central and Southeastern Europe covering the period from 2008 to 2015. In their research, they applied a two-step model, wherein the first model analyzed return on assets as the dependent variable, while the second model focused on return on equity. On the other hand, the independent variables included gross domestic product, inflation rate, and real interest rate. The results of the panel analysis indicate a significant impact of gross domestic product and inflation on bank profitability indicators in the analyzed countries. Agoraki (2019) further examines how specific banking, industry, and macroeconomic factors influence the net interest margin,

showing that a stronger capital position, effective cost control, and reduced credit risk lead to narrower margins, while institutional weaknesses and regulatory inconsistencies increase cost pressure and widen the net interest margin (NIM) (Todorović et al., 2024) Examined the impact of various macroeconomic and banking variables on the NIM of banks in selected countries of Southeast Europe during the period from 2012 to 2021. Their research focuses on countries with similar socio-economic characteristics and types of financial systems, which enables the identification of common determinants of NIM. The paper uses regression methods with ordinary least squares (OLS). They concluded that key variables demonstrated the expected influence on the NIM movement, where increases in the exchange rate, the real interest rate, the degree of concentration, and the size of the banking sector are accompanied by an increase in the net interest margin of banks (Colić et al., 2024; Todorović et al., 2024).

Methodology Framework for Two-Step Cluster Analysis of the Southeast European Countries (2017-2021)

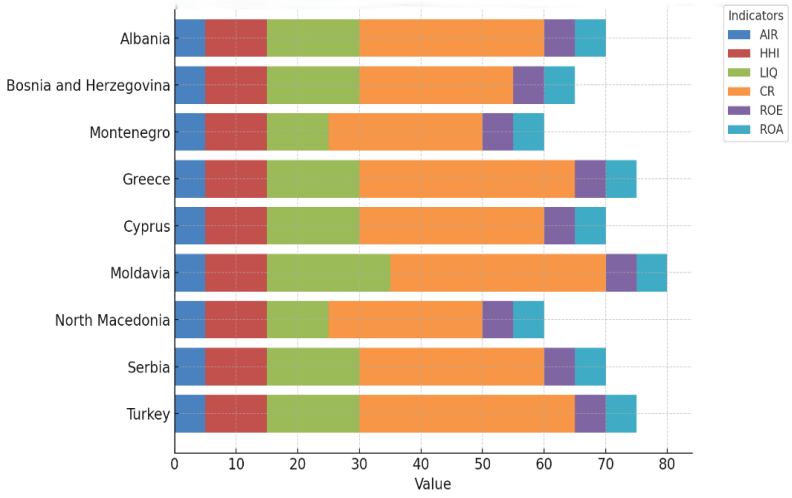
The Two-Step Cluster Methodology effectively handles large datasets with mixed types of variables. By integrating hierarchical clustering with k-means clustering, this method is efficient in grouping data points into homogeneous clusters. In the first step, the method begins by using hierarchical clustering to create pre-clusters. This process divides the data into smaller clusters without assigning them to a definitive final group yet, as previously applied by Popović et al. (2025). This is a crucial step because it helps manage the complexity of large datasets and provides a preliminary understanding of the underlying structure. Hierarchical clustering efficiently handles large volumes of data, particularly when working with both categorical and continuous data. The method is capable of utilizing multiple distance measures, making it flexible in handling various data types. It provides a structure that enables the algorithm to identify potential clusters based on the similarity of data points. The two-step process ensures handling large datasets with thousands of data points. The algorithm performs a pre-clustering phase, where it groups similar observations into sub-clusters using a distance measure, such as Euclidean distance or correlation-based similarity. By combining the strengths of hierarchical clustering and k-means, the method enables the achievement of stable and well-defined clusters.

Performing a two-step cluster analysis to classify the Southeast European Countries based on their financial characteristics in this study focuses on four key indicators from 2017 to 2021:

- Real Interest Rate (RIR): The nominal interest rate adjusted for inflation, representing the cost of borrowing in the economy.
- LiqLiquidity (LIQ): Measures the ratio of liquid assets to total assets or the ratio of liquid liabilities to GDP, assessing the financial system's ability to meet short-term obligations.
- Credit Risk (CR): Reflected in indicators such as the Non-Performing Loan (NPL) ratio, evaluating the risk of defaults in the banking system.
- HerFindahl-Hirschman Index (HHI): Market concentration in the banking sector, indicating the level of competition or monopolistic tendencies.

Descriptive statistics were calculated by computing the yearly average for each indicator to capture the overall trend over the five years (2017-2021). This ensures that the analysis reflects the general financial environment in the region, avoiding any distortion from year-to-year volatility (Figure 1).

Figure 1: Average Annual Values of Key Banking Sector Indicators in the Region (2017–2021)



Source: Authors' calculation

Research Results and Discussion

The dataset provided presents the Schwarz Bayesian Criterion (BIC) values for different numbers of clusters ranging from 1 to 10. The BIC is a statistical measure used for model selection, particularly in clustering. The model with the lowest BIC score is typically preferred, as it strikes the best balance between fitting the data and maintaining simplicity. According to the provided dataset, the BIC values and associated changes indicate that the optimal number of clusters lies between 2 and 5 (Table 1). After this point, the additional clusters show diminishing improvements in terms of BIC, suggesting that adding more clusters may introduce complexity without substantial gains in model quality. Therefore, increasing the number of clusters yields only marginal improvements, as evidenced by the minor changes in BIC and the stable distance measure ratios. While increasing the number of clusters might improve the model's fit, the BIC penalizes excessive complexity, helping to avoid overfitting. Therefore, in terms of model selection, it would be scientifically reasonable to focus on 3 to 5 clusters as the optimal solution, as this offers a balance between simplicity and a good model fit.

Table 1: BIC Scores and Optimal Cluster Range Determination

Number of Clusters	Schwarz's Bayesian Criterion (BIC)	BIC Change	Ratio of BIC Changes	Ratio of Distance Measures
1	132.92			
2	155.39	22.47	1.00	1.44
3	185.83	30.44	1.35	1.77
4	224.08	38.25	1.70	1.07
5	263.01	38.93	1.73	1.60
6	305.50	42.48	1.89	1.38
7	349.59	44.09	1.96	1.01
8	393.73	44.14	1.96	1.21
9	438.62	44.89	1.99	1.01
10	483.54	44.92	1.99	.

Source: Authors' calculation

Descriptive statistics among the analyzed clusters predict the conditions in the cluster environment by comparing them according to the indicators mentioned earlier. Cluster 1 seems to have a very low ROE (-2.86) and ROA (-0.24), indicating poor profitability or efficiency in generating returns from equity and assets. The liquidity and current ratio are high, indicating good short-term financial health and the ability to meet obligations; however, the negative profitability signals underlying issues. Cluster 1 may require some intervention or strategic changes, as its negative profitability measures (ROE and ROA) are concerning, despite having excellent short-term financial metrics (liquidity and current ratio). Cluster 2 has a positive ROE (8.96) and ROA (1.34), indicating that it's more profitable and efficient than Cluster 1. However, the liquidity (35.63) and current ratio (5.88) are lower compared to Cluster 1, indicating relatively fewer cash or assets available to cover short-term liabilities. The HHI index (0.03) suggests low market concentration, which may reflect effective competition—cluster 2 lies in between, showing decent profitability but weaker liquidity than Clusters 1 and 3. Cluster 3 stands out with very high RIR (3.16) and high ROE (13.34), signaling excellent return generation from investments and equity. The ROA (1.88) is also strong, showing efficient asset utilization. The liquidity (34.78) and current ratio (6.51) are slightly higher than those of Cluster 2, indicating a strong financial position, with a good balance between profitability and economic stability. Cluster 3 appears to be the most financially healthy, with high returns and good liquidity.

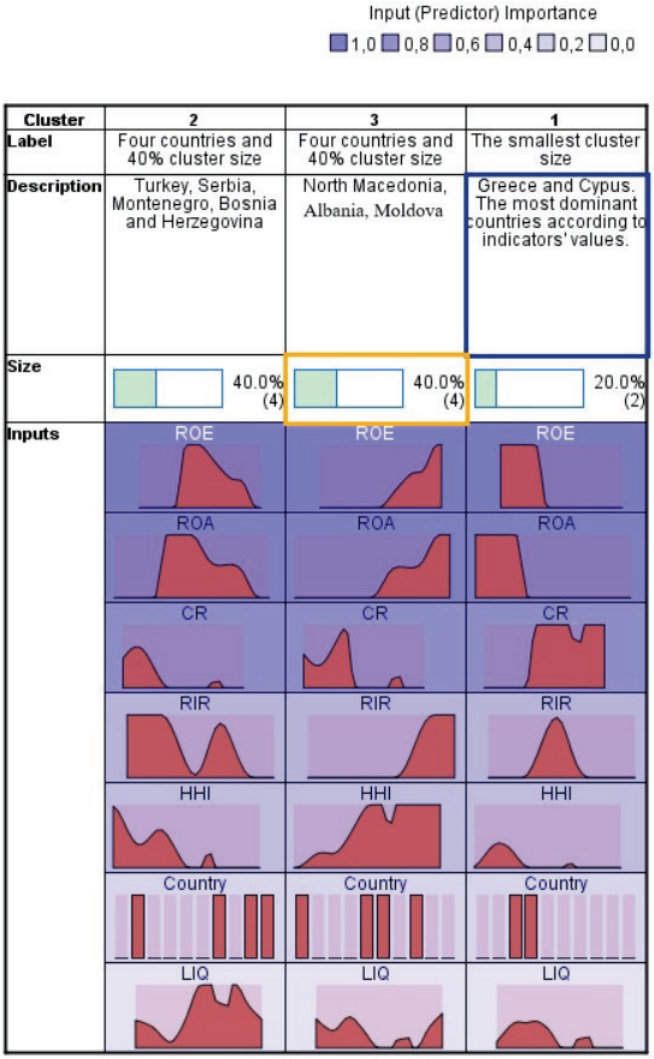
Table 2: Mean Values of Key Banking Sector Indicators by Cluster

MEAN		RIR	HHI	LIQ	CR	ROE	ROA
Cluster	1	.19	.03	31.29	25.21	-2.86	-.24
	2	-.32	.03	35.63	5.88	8.96	1.34
	3	3.16	.11	34.78	6.51	13.34	1.88

Source: Authors' calculation

Based on the two-step cluster analysis, the first cluster consists of Greece and Cyprus, which exhibit dominant characteristics according to the financial indicators considered: Credit Risk, Interest Rate, Herfindahl-Hirschman Index (HHI), Liquidity, Return on Investment (ROI), and Return on Assets (ROA). These two countries seem to stand out for having more favorable values across these indicators, suggesting a robust financial environment compared to the other countries in the second cluster. Both Greece and Cyprus exhibit relatively lower credit risk levels, which may be indicative of a more stable or efficient banking system, a lower likelihood of defaults, or more sound lending practices (Figure 2). Their interest rates, while higher compared to countries in the second cluster, may be reflective of the countries' economic conditions, but are still relatively manageable within a European context. The second cluster consists of Serbia, Türkiye, and Montenegro, where the financial indicators—such as Credit Risk, Interest Rate, HHI, Liquidity, ROI, and ROA—are not as strong as those of Greece and Cyprus. The relatively poor performance on these indicators may indicate several challenges that these countries face in maintaining financial stability and fostering strong economic growth. The higher credit risk levels in Serbia, Türkiye, and Montenegro suggest that their financial systems may be more vulnerable to defaults, potentially due to weaker lending standards, economic instability, or external shocks. The higher interest rates observed may reflect this elevated credit risk, making it more expensive for borrowers to access credit. The higher concentration of banking systems in these countries, as indicated by a higher HHI, may suggest monopolistic tendencies or a smaller number of players in the market. This reduces the competitive pressure on financial institutions, potentially leading to inefficiencies, higher costs for consumers, and reduced innovation. From the third cluster, Moldova faces significant economic challenges, including poverty, agricultural reliance, and political instability. Its financial system is still underdeveloped. Likely to fall into the second cluster, exhibiting high credit risk, low liquidity, and underperforming ROI/ROA indicators. Albania has experienced strong economic growth, particularly in the tourism and foreign investment sectors. However, its financial sector is still underdeveloped, and access to credit remains limited. North Macedonia has demonstrated stable economic growth, although challenges such as high unemployment and low income levels persist. Its financial system is improving, but still has room for growth.

Figure 2: Distribution of Key Banking Sector Indicators Across Clusters



Source: Authors' calculation

Conclusion

Economic instability, often driven by inflation, political uncertainty, or external shocks, is a critical factor that exacerbates credit risk, liquidity concerns, and market concentration in these countries. High levels of inflation, currency volatility, and geopolitical risks can undermine investor confidence, reduce consumer spending, and ultimately weaken financial institutions. Policymakers need to focus on creating a stable macroeconomic environment by controlling inflation, managing public debt, and fostering fiscal discipline. Central

banks should implement measures to stabilize currency volatility and mitigate inflationary pressures, such as raising interest rates when necessary or utilizing foreign currency reserves to intervene in the market (Marjanović & Marković, 2019). In summary, Greece and Cyprus are performing better in terms of financial stability, efficiency, and market competition compared to Serbia, Türkiye, and Montenegro. All three countries—Moldova, Albania, and North Macedonia—share a common need to focus on improving their financial systems, increasing access to credit, and attracting investment. Structural reforms aimed at increasing competitiveness, transparency, and financial diversification will be essential in helping these economies improve and potentially transition toward a stronger financial position, similar to Greece and Cyprus. The recommendations for these countries focus on maintaining their strengths in liquidity, market competition, and profitability, while also exploring new areas for investment and innovation. On the other hand, Serbia, Türkiye, and Montenegro need to address several financial challenges, particularly related to credit risk, market concentration, and liquidity. Policymakers and financial regulators should prioritize improving risk management practices, reducing economic instability, and promoting a more competitive banking environment. By focusing on these strategies, both clusters could experience improved financial health, stronger economic growth, and more favorable investment conditions. For instance, countries in clusters with higher credit risk may need to prioritize NPL reduction and strengthen regulatory frameworks, while countries with low liquidity may benefit from liquidity-enhancing policies. Financial institutions in these countries need to improve their credit scoring systems and adopt more sophisticated risk management tools. By incorporating better data analytics, credit institutions can more effectively evaluate the creditworthiness of borrowers, thereby reducing the likelihood of defaults. Central banks and financial regulators should introduce stricter regulations around loan provisioning, ensuring that financial institutions maintain appropriate reserves to cover potential loan losses. Implementing rules on loan-to-value ratios and debt-service-to-income ratios can also help to prevent excessive risk-taking. Policymakers should create an environment that encourages new entrants into the banking sector. This could be achieved by relaxing some regulatory barriers that may be preventing smaller banks or fintech companies from entering the market. Encouraging competition through the introduction of digital banking and fintech innovation could reduce concentration and promote financial inclusion. Acknowledge potential limitations of the analysis, such as data quality or availability, the subjectivity in defining financial indicators, or the choice of clustering algorithm. Further research proposes exploring how external factors, such as political stability, regulatory reforms, or macroeconomic shocks, influence the clusters over time.

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