

“The relationship between bank capitalization and socio-economic development: Evidence from European countries”

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THE RELATIONSHIP BETWEEN BANK CAPITALIZATION AND SOCIO-ECONOMIC DEVELOPMENT: EVIDENCE FROM EUROPEAN COUNTRIES

Abstract

Bank capitalization is a key factor in the banking system's resilience to economic shocks, as outlined in the Basel Accords on banking regulation. The paper aims to empirically evaluate the connection between bank capitalization and the socio-economic development level. The study uses World Bank data across 34 European countries of varying income levels (high, upper-middle, and lower-middle) for the years 2010, 2015, and 2020 as periods of financial and socio-economic turbulence. The study applies principal component analysis and correlation methods to identify relevant indicators. Countries were grouped using hierarchical clustering and K-means clustering methods. The results of the variance analysis revealed that only two indicators of bank capitalization – the share of non-performing loans and return on assets, and three socio-economic indicators – the Gini index, inflation, and unemployment, were statistically significant. As a result of both qualitative and quantitative changes between clusters, countries were reallocated from four clusters in 2010 and 2015 to three clusters by 2020: high-income countries, including Austria, Belgium, Denmark, Ireland, Iceland, Latvia, and others, consolidated into a single stable cluster (Cluster 3) in terms of both bank capitalization and socio-economic development. The primary drivers of inter-cluster movements were the positive dynamics of non-performing loans and bank assets, superior bank capitalization ratios, and improvements in inflation and unemployment levels. Based on the study's findings, a matrix of transformational sustainability among European countries has been developed. The analysis confirms a relationship between the components of the chain: "level of bank capitalization – level of socio-economic development".

Keywords

capitalization, bank, socio-economic development, clustering, return on equity, return on assets, inflation, unemployment

JEL Classification

G21, E24

INTRODUCTION

The sufficiency of capital in banking institutions is one of the key factors determining their resilience during periods of economic instability. Banks with higher capitalization levels demonstrate greater readiness to adapt in the face of structural shocks, ensuring the continuity of financial services and safeguarding the economy from significant imbalances. Moreover, the capitalization of banks significantly influences their ability to implement prudent lending policies, fostering investments that drive economic growth and innovation. An adequate level of capitalization also enhances the confidence of depositors and investors, creating conditions for redistributing accumulated funds into productive sectors of the economy. Additionally, capital acts as a buffer, protecting banks from potential financial losses and enabling them to continue funding even high-risk projects.

At the same time, socio-economic factors such as GDP dynamics, unemployment rates, and income inequality can significantly affect bank capitalization. Sustainable economic growth contributes to increased bank revenues by activating credit activity, potentially leading to higher capitalization levels. A favorable macroeconomic environment provides a foundation for the emergence of new financial institutions, expanding the banking sector, and attracting additional capital.

The state of the global banking system in recent years has been characterized by both significant socio-economic challenges and periods of increased capitalization level. Following the Asset Quality Review, the average Common Equity Tier 1 (CET1) ratio declined from 11.1% at the end of 2013 to 8.5% under the stress scenario by the end of 2016. During this period, 24 EU banks recorded a combined capital shortfall of EUR 24.2 billion (Wikipedia, 2014). As of June 2019, the average CET1 ratio in EU countries (fully loaded) stood at 14.3%, Tier 1 at 15.6%, and total capital at 18.9%, which is twice the level observed in December 2011 (EBF, 2019). In the first quarter of 2022, according to the European Central Bank, the lowest CET1 ratio was recorded in Greece (12.39%), while the highest was in Estonia (26.44%) (ECB, 2022).

At the same time, the following trends are observed on a global scale. According to the Global Banking Annual Review 2014, banks worldwide earned a record USD 1 trillion, maintaining a return on equity (ROE) of 9.5% for three consecutive years despite significant economic and political challenges. These included Russia's annexation of Crimea and the outbreak of armed conflict in Donbas, which led to EU and US sanctions, negatively impacted global financial markets, and were accompanied by a sharp decline in oil prices. In subsequent years, banks faced new difficulties primarily related to digital transformation. By 2020, banks in Japan and the United States lost between USD 1 billion and USD 45 billion in profits, depending on their level of adaptation to digital changes. However, due to mitigation measures, the decline in ROE was limited to just one percentage point, reducing it to 8% for US banks and 5% for Japanese banks. Banks in the United Kingdom and Europe experienced even greater losses. According to McKinsey (2016), serious digital challenges reduced their profits from USD 110 billion in 2016 to USD 50 billion in 2020, lowering ROE to a critical level of 1-2%, despite mitigation efforts.

The situation began to change in 2022. According to the Global Banking Annual Review 2023, by the end of the year, more than half of the world's banks still showed profitability below the cost of equity. At the same time, overall banking sector profitability reached its highest level in 14 years, with projected ROE ranging from 11.5% to 12.5%. This growth was mainly driven by a substantial increase in net income, made possible by rising interest rates after a prolonged period of low rates. Improved profitability accounted for 60% of the total growth in bank earnings. Currently, the global banking system maintains Tier 1 capital adequacy ratios within the range of 14-15% (Bhattacharyya et al., 2023).

Individual banks' capital formation is determined by internal factors (such as the specifics of operational activities, risk structures, and management systems) and external factors (including political, socio-cultural, and macroeconomic environments). External conditions can significantly influence the capitalization and resilience of banks (Andres & Arce, 2012). The level of capitalization is an important indicator of a bank's financial stability and resilience to economic shocks. Meanwhile, socio-economic development encompasses various dimensions, such as economic growth, employment, income distribution, and overall societal well-being.

While well-capitalized banks are generally considered more stable and adapted to long-term investments that contribute to socio-economic development, there is a gap in understanding the interrelationships between these categories. The issue of assessing the connection between bank capitalization and socio-economic development is particularly relevant in the global context, where countries have their macroeconomic environments, financial structures, and regulatory frameworks. Accordingly, it is necessary to identify possible interrelationships between these categories, as bank capitalization may affect socio-economic outcomes, and the socio-economic conditions may, in turn, affect bank capitalization strategies.

1. LITERATURE REVIEW

The role of the central bank in bank capitalization is multifaceted, encompassing regulatory, supervisory, and stabilizing functions aimed at ensuring the resilience and stability of the banking sector. Espinosa et al. (2023) analyze how central banks, while striving to maintain economic stability, may unintentionally contribute to financial instability through their policies and interventions. Their study explores unintended consequences such as market distortions and moral hazard and highlights the challenges of balancing monetary policy objectives with financial system stability.

Messaoudi et al. (2023) demonstrate that central bank monetary policy significantly impacts Algeria's economic growth, with both short-term and long-term effects. Kamarudin et al. (2024) investigate how economic freedom, specifically regulatory efficiency and market openness, affects bank productivity across countries with varying income levels. They find that business freedom negatively affects bank output, while labor freedom positively influences productivity. Conversely, investment and financial freedoms under market openness have adverse effects on productivity. Wang and Lu (2024) examine how China's central bank policy of accepting green bonds as collateral promotes green finance by incentivizing financial institutions to lend more to environmentally friendly projects. Szüle (2023) suggests that traditional commercial banking activities – primarily credit and deposit margin income – are associated with lower systemic risk compared to more diversified operations. Nájnez Alonso et al. (2023) study credit unions' role in enhancing financial inclusion and local economic growth in Poland. Pietrucha and Maciejewski (2025) emphasize cash's ongoing importance for flexibility and security despite the rise of electronic payments. Waliszewski et al. (2024) explore the complementary role of LendTech and traditional banks in consumer financing during crises like COVID-19 and the war in Ukraine, helping to mitigate market shocks. The executive board's role is pivotal in managing bank capitalization. Steenbergen et al. (2023) find that a strong commercial focus and perceived unjustified board pay correlate with unethical behavior. Budhathoki and Khadka (2024) assess how dividend policies affect

microfinance share prices in Nepal, with Lestari et al. (2023) underscoring managerial effectiveness as a key factor in optimizing capital use and profitability. Fintech's transformative impact on bank capitalization is studied by Alabdullah (2023), who finds a positive link between fintech adoption, risk management, and profitability in Kuwait. Bouakkaz and Ferdjallah (2023) analyze equity crowdfunding development in Oman, and Yetongnon and Kasztelnik (2024) highlight how innovative leadership drives social impact and economic growth in Benin.

Socio-economic factors also shape bank capitalization globally. Aryal and Singh (2024) investigate credit risk factors in Nepalese commercial banks, finding limited impact of capital adequacy ratios. Morin (2024) critiques short-termism in corporate growth and societal well-being, suggesting regulatory strategies to mitigate its effects. Dahal et al. (2024) show that net interest margin and political stability positively impact profitability in developing Asia, while Shkodra et al. (2024) study non-performing loans' effect on profitability in the Western Balkans.

Bank consolidation in Europe, including mergers and acquisitions, significantly shapes capitalization by enhancing financial strength and operational efficiency. Vasylyeva et al. (2014a, 20114b) emphasize that implicit consolidation can affect systemic risk, necessitating careful monitoring and regulation. Kuzior et al. (2022) analyzes information trends related to cyberattacks on financial institutions to forecast future risks and inform strategies for countering cybercrime. Kravčáková Vozárova et al. (2023) explore how integration into the European Monetary Union influenced banking sector consolidation, suggesting EU membership may not be decisive in observed merger trends.

Buriak et al. (2015) propose a methodological approach to identify systemically important domestic banks in Ukraine, using an indicator-based assessment aligned with Basel Committee recommendations to enhance supervisory effectiveness. Waliszewski et al. (2024) also note the role of LendTech in Ukraine, complementing traditional banks, especially during crises, mitigating market shocks from limited loan supply.

Limited longitudinal research examines how the relationship between bank capitalization and socio-economic development evolves over time, especially during significant events such as financial crises or periods of economic recovery. Many studies focus only on macroeconomic indicators like GDP and unemployment, ignoring newer dimensions of socio-economic development, such as social inequity and inclusion.

In this regard, this paper aims to empirically assess the relationship between bank capitalization and the socio-economic development level in 34 European lower-middle-income, upper-middle-income, and high-income countries.

2. METHODOLOGY

The calculations are based on the World Bank statistics for 34 European countries for 2010–2020.

At the first stage of the research, it is necessary to form an array of input data, which includes statistical indicators of bank capitalization and socio-economic development of the countries under study (Albania, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark,

Estonia, Finland, France, Germany, Ireland, Iceland, Italy, Latvia, Luxembourg, Moldova, Lithuania, the Netherlands, Malta, Poland, Norway, Romania, Portugal, Serbia, Sweden, Slovenia, Slovakia, Switzerland, Spain, the United Kingdom, Ukraine) from 2010 to 2020. The selected years encompass periods of significant financial, political, and socio-economic challenges: 2009 marked the peak of the global financial crisis; 2015 was characterized by political instability in Ukraine, which impacted European and global markets; and 2020 was marked by the escalation of the COVID-19 pandemic. The source of all statistical indicators is the World Bank database. The array of input data is presented in Table 1.

At the second stage, the paper performs standard normalization of the input data, considering the standard deviation and average value. The study also considers the stimulants and de-stimulants of economic processes. In this case, there is only one de-stimulant, which negatively affects the capitalization of banks and the level of non-performing loans. For stimulants, whose increase is accompanied by an increase in the bank capitalization index, we can use formula (1):

$$\widehat{S}_{ij} = \frac{S_{ij}^s}{\max_j \{S_{ij}^s\}}, \quad (1)$$

Table 1. Input data

Source: Authors' compilation based on Stolz and Wedow (2011), World Bank (2020).

Group	Indicator	Designation	Description	Unit of measurement
Bank capitalization level	Bank capital to assets ratio	BCAR	Indicates the level of capital coverage of the bank's active operations	%
	Nonperforming Loans level	NPL	Share of loans in default as a part of the bank's total loan portfolio	%
	Commercial bank branches per 1,000 adults	CBB	Assesses the extent to which individuals can physically reach the bank service	pcs/1.000 people
	Level of financial services depth	BDtGDP	Bank deposits to GDP ratio	%
	Bank's return on assets	ROA	This indicator reflects the bank's internal policy and the professionalism of its managers	%
	Bank regulatory capital level to risk-weighted assets	BRC	Regulatory capital adequacy ratio (solvency or Cooke's ratio) The regulatory value must be at least 8%, 12%, or 15% (depending on the bank's operating period)	%
	Return on equity	ROE	An indicator that characterizes the efficiency of using equity capital. It shows the return (rate of return) on the invested equity	%
	The cost-to-income ratio of banks	CIR	Characterizes the bank's operating profitability level	%

Table 1 (cont.). Input data

Group	Indicator	Designation	Description	Unit of measurement
Level of socio-economic development	Gross domestic product	GDP	The monetary value generated by resident economic units through their production of goods and services, both tangible and intangible	thousand USD
	Inflation rate (GDP deflator)	INFLATION	The ratio of the current period price index to the previous period price index in percentage terms	%
	Unemployment rate (% of total labor force)	UNEMPL	The proportion of the labor force (economically active working-age population) that is unemployed and actively seeking work	%
	Gini index	GINI	An indicator that shows income inequality in the population	units
	Growth in gross national income per capita	GNI	The rate of growth of the total value of goods and services received by a particular state over a specific period	%

where S_{ij} is the actual value of the i value for the j period. \widehat{S}_{ij} is the normalized i indicator for the j period.

The next formula (2) can be used for the de-stimulant indicators, the increase in which is accompanied by a decrease in the bank capitalization index:

$$\widehat{S}_{ij-} = \frac{\min_j \{S_{ij}^s\}}{S_{ij}^s}. \tag{2}$$

At the third stage, it is essential to identify statistically significant indicators of the bank capitalization level and the country's socio-economic development level. Its implementation requires additional optimization of the input array of information. The selection of indicators should be refined through correlation matrix analysis to eliminate redundant variables. If the corresponding value of the correlation matrix is greater than 0.7, the indicator has a high density of connections and is statistically significant. Thus, the bank capitalization indicator with a correlation value of more than 0.7 will be used for further calculations.

Factor analysis in Statistica, which is based on the principal component method, is also used to determine statistically significant indicators. The main goals of factor analysis are to decrease the number of variables (variable reduction) and to determine the structure of the relationships between variables. Reduction is achieved by identifying hidden common factors that explain the relationships between the observed features (vari-

ables) of an object, i.e., instead of the initial set of variables. It helps to analyze data on the selected factors, the number of which is much smaller than the starting number of related variables.

Factors identified in this way are called general factors because they affect all the attributes of an object. These factors are hypothetical and hidden. Next, the formula for the factor analysis model (3) is examined:

$$x_{ji} = a_{ji}f_{ji} + a_{j2}f_{2i} + \dots + a_{jr}f_{ri} + \dots + a_{jm}f_{mi} + d_{jji}, \tag{3}$$

where a_{jr} is the weighting coefficient of the i variable on the r common factor or the load of the j variable on the r common factor. f_{jr} is the r general factor value at the i research object. d_{ji} is the load or weighting coefficient of the j variable on the j characteristic factor; v_{ji} is the value of the j characteristic factor on the i research object.

At this stage, two hypotheses are proposed:

H1: The first factor will include indicators that strongly impact banks' capitalization levels.

H2: The first factor will include those variables that have a more substantial effect on the country's socio-economic development.

The study's final stage is the countries clustering by bank capitalization and socio-economic development, which combines different approaches (tree

clustering and K-means). As a result of the cluster analysis, the initial set of countries is divided into clusters or groups of similar objects. The process of agglomeration is shown in the form of dendrograms. With the help of tree clustering, dendrograms will be built to assess the optimal number of clusters visually. In the k-means method, an object belongs to the class with the minimum distance to it. A clustering algorithm is a function $X \rightarrow Y$ that maps any object $x \in X$ to the number of the cluster $y \in Y$. X is a country, and Y is a cluster. Clustering was carried out for 2010, 2015, and 2020 (periods of exacerbation of financial and socio-economic crises) with equal time intervals to avoid possible lags and obtain qualitative results on the movement of countries. At this stage, it is hypothesized that there is a link between the capitalization level and the socio-economic development of a country.

Thus, based on the transformational changes in the composition of the obtained clusters by country, the study empirically assesses the existence of the relationship between the bank capitalization level and a country's socio-economic development level.

3. RESULTS

Based on normalized input data, the following correlation matrix was obtained using correlation analysis, which reflects the density of relations between the banks' capitalization indicators (Table 2).

After analyzing the correlation matrix, a moderate direct relationship between return on equity (ROE) and return on assets (ROA) was indicated, which was 0.75. Additionally, statistically significant indicators were identified through factor analysis implemented in Statistica software, utilizing the principal component approach. The

Table 2. Correlation matrix

Indicator	<i>BCAR</i>	<i>NPL</i>	<i>CBB</i>	<i>BDtGDP</i>	<i>ROA</i>	<i>BRC</i>	<i>ROE</i>	<i>CIR</i>
<i>BCAR</i>	1.00	0.25	-0.06	-0.25	0.26	0.35	0.12	-0.13
<i>NPL</i>	0.25	1.00	0.02	-0.15	-0.16	-0.12	-0.26	-0.07
<i>CBB</i>	-0.06	0.02	1.00	0.50	-0.07	-0.20	-0.18	0.09
<i>BDtGDP</i>	-0.25	-0.15	0.50	1.00	-0.09	-0.02	-0.05	0.15
<i>ROA</i>	0.26	-0.16	-0.07	-0.09	1.00	0.35	0.75	-0.30
<i>BRC</i>	0.35	-0.12	-0.20	-0.02	0.35	1.00	0.25	-0.07
<i>ROE</i>	0.12	-0.26	-0.20	-0.05	0.75	0.25	1.00	-0.25
<i>CIR</i>	-0.13	-0.07	0.09	0.15	-0.30	-0.07	-0.25	1.00

two factors (cumulative % of total variance) together explain 61.31% of the total variance, with the first factor explaining 29.58% and the second explaining another 19.02%. This indicates that the variables included in the first factor (ROE, ROA) strongly impact bank capitalization. The eigenvalues of these two factors exceed one. Table 3 shows the results of the principal component analysis.

Table 3. Principal component analysis results

Source: Author's calculations.

Index	Factor 1	Factor 2
<i>BCAR</i>	-0.485	0.381
<i>NPL</i>	-0.143	-0.749
<i>CBB</i>	0.428	-0.469
<i>BDtGDP</i>	0.377	0.692
<i>ROA</i>	0.794	0.318
<i>BRC</i>	-0.585	-0.080
<i>ROE</i>	0.740	0.397
<i>CIR</i>	0.463	0.076
Total variance	2.337	1.519
Total variance percentage	0.292	0.189

The hypothesis that the first factor includes those variables that have a more substantial effect on the bank capitalization level is confirmed. The relevant indicators are the following variables: ROA (0.794), ROE (0.740), and NPL (-0.749). These indicators demonstrated strong factor loadings exceeding the 0.7 threshold, indicating robust relationships with their respective factors. Thus, these indicators can be used in clustering countries by the bank capitalization level.

The study also determines statistically significant indices of the country's socio-economic development by building a correlation matrix (Table 4).

A moderate inverse connection is observed between the inflation rate (INFLATION) and unemployment (UNEMPL) -0.42. The principal com-

Table 4. Correlation matrix of socio-economic development indicators

Indicator	GDP	INFLATION	UNEMPL	GINI	GNI
GDP	1.000	-0.237	0.251	-0.090	-0.081
INFLATION	-0.237	1.000	-0.421	-0.190	0.061
UNEMPL	0.251	-0.421	1.000	0.273	-0.110
GINI	-0.090	-0.190	0.273	1.000	-0.012
GNI	-0.081	0.061	-0.110	-0.012	1.000

ponents method was used to identify the most significant socio-economic development factors. The hypothesis was that the first factor would include indicators that strongly impact the phenomenon under study – the country's socio-economic development. The two selected factors together account for approximately 70% of the total variance, specifically 66.62%. The first factor alone accounts for 34.52%, while the second contributes 22.1%. These results suggest that the variables grouped under the first factor (INFLATION and UNEMPL) have a significant influence on the socioeconomic development of a country. Both factors have eigenvalues greater than one, confirming their relevance. The subsequent stage of the analysis involves determining the factor loadings (Table 5).

Table 5. Principal component method outcomes

Source: Author's calculations.

Index	Factor 1	Factor 2
GDP	-0.491	0.660
INFLATION	0.755	0.017
UNEMPL	-0.808	-0.074
GINI	-0.448	-0.743
GNI	0.244	-0.333
Total variance	1.726	1.105
Percentage of total variance	0.345	0.221

The hypothesis that the first factor comprises indicators that substantially impact the country's socio-economic development is confirmed. As can be seen from the second column (Table 7), the cells with the factor loadings of those variables that have a statistically significant impact within the first factor are marked in grey. Such variables include the following: INFLATION (0.755) and UNEMPL (-0.808). It is worth noting that all of the above indicators have factor loadings of more than 0.7 by module. In the second selected factor, the Gini index has a statistically significant impact, according to the value of the factor load of -0.743. Thus, these indicators of socio-economic development are significant and can be used to cluster countries.

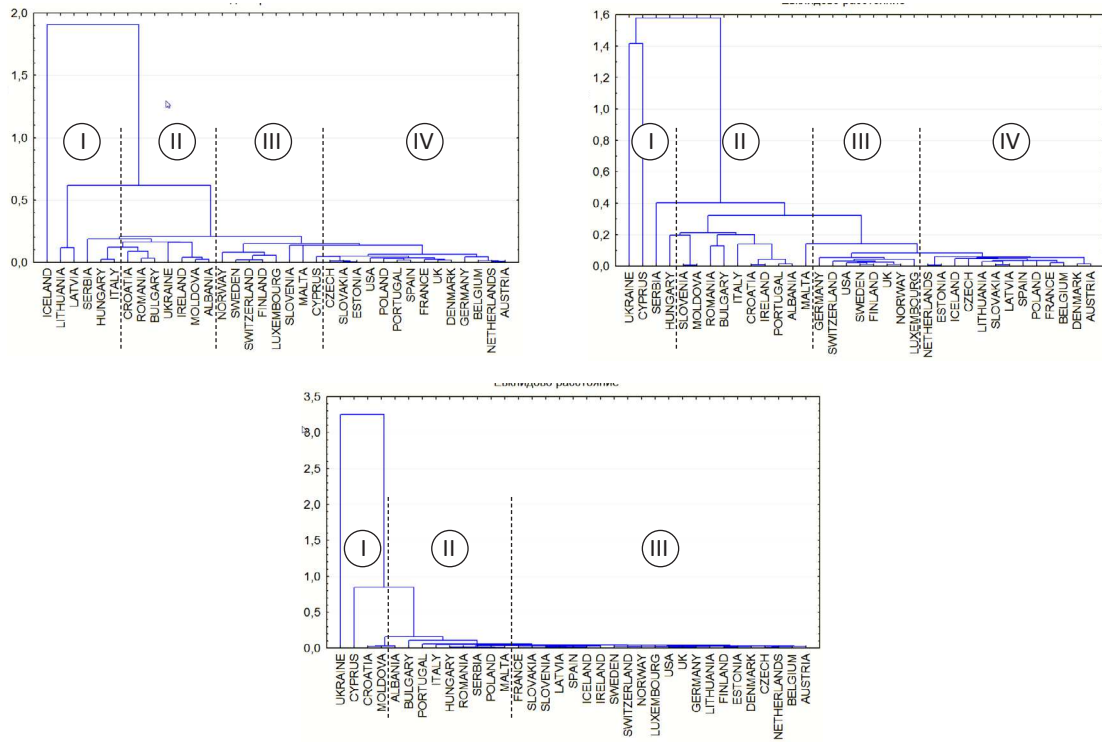
The final stage is to cluster countries by bank capitalization and socio-economic development level, which combines different approaches (tree clustering and K-means). Since the sample includes 34 countries that differ in terms of income, we will check their redistribution in the context of the level of bank capitalization based on the return on assets, return on equity, NPLs, and the socio-economic development level based on inflation, unemployment, and the Gini index.

Using hierarchical clustering (tree clustering), the key clusters of the distribution of countries by bank capitalization and socio-economic development were identified among the countries studied in 2010, 2015, and 2020. The results are presented in vertical dendrograms (Figure 1).

Thus, in 2010 and 2015, we distinguish 4 clusters of countries with various bank capitalization levels and socio-economic development levels. In 2020, it is expected that there will be three clusters. The K-means clustering method enables granular analysis of cluster composition and quantifies the relative contribution of each indicator to group formation. Since the construction of clusters by both the bank capitalization level and the socio-economic development level is based on three criteria, it is important to define which of them has the most significant impact when grouping countries. The analysis of variance allows us to perform this test (Table 6).

Since the p -values of NPL and ROA for 2010, 2015, and 2020 are less than 0.05, these indicators play a significant role in clustering countries by bank capitalization. ROE has a p -value greater than 0.05, so this indicator is not statistically significant in the modelling, which is explained by the relative stability of ROE compared to ROA, which is subject to volatility in terms of assets and profits, and the share of non-performing loans, which is characterized by fluctuations. The p -values of UNEMPL and GINI in 2010, 2015, and 2020 are

By level of bank capitalization



By level of socio-economic development

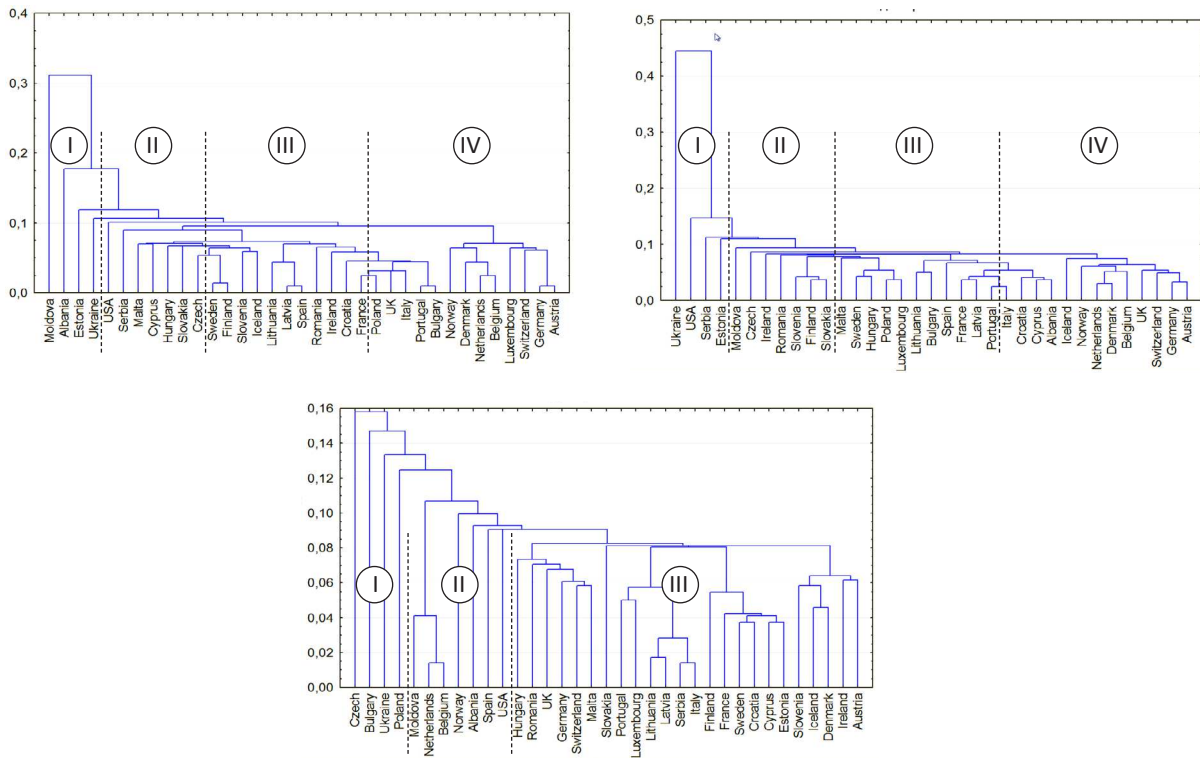


Figure 1. Dendrograms of clustering of the studied countries by bank capitalization levels and levels of socio-economic development in 2010, 2015, and 2020 using the Ward method

Table 6. Results of analysis of variance for 2010, 2015, and 2020

Indicators		Criteria			
		Between-group variance	Within-group variance	F-test	p-level
2010					
Level of bank capitalization	NPL	25.65324	3.595963	76.094	0.000000
	ROA	0.002790	0.000394	76.060	0.000000
	ROE	0.000120	0.005962	0.215	0.884923
Level of socio-economic development	INFLATION	0.172490	0.040864	43.617	0.000000
	UNEMPL	0.529266	0.140688	38.873	0.000000
	GINI	0.226990	0.096507	24.304	0.000000
2015					
Level of bank capitalization	NPL	43.64746	2.617440	177.873	0.000000
	ROA	0.004750	0.000280	176.792	0.000000
	ROE	0.000150	0.003190	0.515	0.674480
Level of socio-economic development	INFLATION	0.046384	0.228005	2.102	0.120156
	UNEMPL	0.594716	0.074038	83.003	0.000000
	GINI	0.216284	0.142876	15.642	0.000002
2020					
Level of bank capitalization	NPL	22.61298	1.329980	280.539	0.000000
	ROA	0.002460	0.000140	282.212	0.000000
	ROE	0.000360	0.002050	2.926	0.067610
Level of socio-economic development	INFLATION	0.001861	0.039127	0.491	0.690706
	UNEMPL	0.547531	0.138858	40.745	0.000000
	GINI	0.235662	0.120436	20.219	0.000000

less than 0.05, meaning these variables play a significant role in clustering countries by socio-economic development. Table 7 shows the qualitative composition of the clusters as of 2010, 2015, and 2020.

An analysis of the average values criteria in 2010 shows that Cluster 1 is represented by countries with high NPLs (above the average of 7.7%) and

close to average ROA (around 0.6%), Clusters 2 and 3 consist of countries with close to or below average NPLs and close to average ROA, and Cluster 4 has high NPLs and close to average ROA (see Figure 2). Thus, Clusters 2 and 3, which had below-average NPLs and ROAs close to the average, were the most resilient to the crisis regarding bank capitalization in 2010.

Table 7. Composition of the obtained clusters by the banks' capitalization level and level of socio-economic development in 2010, 2015, and 2020

Source: Based on World Bank (2021).

Cluster 1	Cluster 2	Cluster 3	Cluster 4
2010			
By level of bank capitalization			
5 countries	8 countries	7 countries	14 countries
Iceland (HI*), Serbia (UMI**), Ukraine (LMI***), Latvia (HI), Lithuania (HI)	Hungary (HI), Italy (HI), Croatia (HI), Romania (HI), Bulgaria (UMI), Ireland (HI), Moldova (UMI), Albania (UMI)	Slovenia (HI), Finland (HI), Switzerland (HI), Norway (HI), Sweden (HI), Luxembourg (HI), Malta (HI)	Cyprus (HI), Czech (HI), Slovakia (HI), Estonia (HI), Germany (HI), Poland (HI), Portugal (HI), Spain (HI), Austria (HI), Belgium (HI), France (HI), UK (HI), Denmark (HI), Netherlands (HI)
By level of socio-economic development			
4 countries	6 countries	9 countries	15 countries
Moldova (UMI), Albania (UMI), Estonia (HI), Ukraine (LMI)	Serbia (UMI), Malta (HI), Cyprus (HI), Hungary (HI), Slovenia (HI), Czech (HI)	Slovenia (HI), Finland (HI), Sweden (HI), Iceland (HI), Lithuania (HI), Latvia (HI), Spain (HI), Romania (HI), Ireland (HI)	France (HI), Poland (HI), UK (HI), Italy (HI), Portugal (HI), Bulgaria (UMI), Norway (HI), Denmark (HI), Netherlands (HI), Belgium (HI), Luxembourg (HI), Switzerland (HI), Germany (HI), Austria (HI), Slovakia (HI)

Table 7 (cont.). Composition of the obtained clusters by the banks' capitalization level and level of socio-economic development in 2010, 2015, and 2020

Cluster 1	Cluster 2	Cluster 3	Cluster 4
2015			
By level of bank capitalization			
3 countries	9 countries	10 countries	12 countries
Cyprus (HI), Ukraine (LMI), Serbia (UMI)	Albania (UMI), Bulgaria (UMI), Ireland (HI), Italy (HI), Portugal (HI), Romania (HI), Hungary (HI), Croatia (HI), Moldova (UMI)	Malta (HI), Slovenia (HI), Netherlands (HI), Germany (HI), Switzerland (HI), Sweden (HI), Finland (HI), Luxembourg (HI), Norway (HI), UK (HI)	Austria (HI), Iceland (HI), Belgium (HI), Denmark (HI), Estonia (HI), France (HI), Czech (HI), Slovakia (HI), Lithuania, Latvia, Spain (HI), Poland (HI)
By level of socio-economic development			
3 countries	7 countries	12 countries	12 countries
Ukraine (LMI), Serbia (UMI), Estonia (HI)	Moldova (UMI), Czech (HI), Ireland (HI), Romania (HI), Slovenia (HI), Finland (HI), Slovakia (HI)	Malta (HI), Sweden (HI), Hungary (HI), Poland (HI), Luxembourg (HI), Lithuania (HI), Bulgaria (UMI), Spain (HI), France (HI), Latvia (HI), Portugal (HI), Italy (HI)	Croatia (HI), Cyprus (HI), Albania (UMI), Iceland (HI), Norway (HI), Netherlands (HI), Denmark (HI), Belgium (HI), UK (HI), Switzerland (HI), Germany (HI), Austria (HI)
2020			
By level of bank capitalization			
Cluster 1	Cluster 2	Cluster 3	
4 countries	7 countries	23 countries	
Ukraine (LMI), Cyprus (HI), Moldova (UMI), Croatia (HI)	Albania (UMI), Bulgaria (UMI), Serbia (UMI), Romania (HI), Hungary (HI), Portugal (HI), Italy (HI)	Austria (HI), Belgium (HI), Denmark (HI), Estonia (HI), Ireland (HI), Iceland (HI), Spain (HI), Latvia (HI), Lithuania (HI), Luxembourg (HI), Malta (HI), Netherlands (HI), Germany (HI), Norway (HI), UK (HI), Poland (HI), Slovakia (HI), Slovenia (HI), Finland (HI), France (HI), Czech (HI), Switzerland (HI), Sweden (HI)	
By level of socio-economic development			
5 countries	5 countries	24 countries	
Czech (HI), Bulgaria (UMI), Ukraine (LMI), Poland (HI), Moldova (UMI)	Netherlands (HI), Belgium (HI), Norway (HI), Albania (UMI), Spain (HI)	Austria (HI), Denmark (HI), Estonia (HI), Ireland (HI), Iceland (HI), Latvia (HI), Lithuania (HI), Luxembourg (HI), Malta (HI), Germany (HI), UK (HI), Slovakia (HI), Slovenia (HI), Finland (HI), France (HI), Switzerland (HI), Sweden (HI), Romania (HI), Portugal (HI), Serbia (HI), Italy (HI), Croatia (HI), Cyprus (HI), Ireland (HI)	

Note: * HI – high-income countries; ** UMI – upper-middle-income countries; *** LMI – lower-middle-income countries.

After the 2014 crisis, the trend changed. In 2015, Cluster 1 included countries with high NPLs and close to average ROAs, Cluster 2 included countries with above-average NPLs and close to average ROAs, and Clusters 3 and 4 included countries with below-average NPLs and ROAs. Accordingly, Clusters 3 and 4 were the most resilient to the crisis regarding bank capitalization in 2015.

As you can see, in 2020, the countries were mainly redistributed into three clusters. It is noticeable that the structure of the clusters is somewhat different from what it was in 2010 and 2020. Cluster 3 included countries with below-average NPLs and close to average return on assets, reflecting the resilience of the constituent countries in the crisis. This cluster included countries with high-income levels, a characteristic of a country's socio-economic development.

Analysis of the average values of the criteria of socio-economic development of countries in 2010 shows that Cluster 1 is represented by countries with high inflation (above the average of 2.4%), unemployment (above the average of 3.6%), and the indicator of uneven distribution of income – Gini index (above the average of 30.9), Clusters 2 and 3, respectively, consist of countries with close to or below average inflation, unemployment, and Gini index, while Cluster 4 consists of countries with above-average inflation and close to average unemployment and Gini index. Thus, Clusters 3 and 4, including high-income countries, are resistant in terms of socio-economic development.

After the 2014 crisis, the trend changed, and in 2015, Cluster 4 began to include countries with above-average unemployment and closer-to-average inflation and Gini indexes. In 2015, Clusters 3

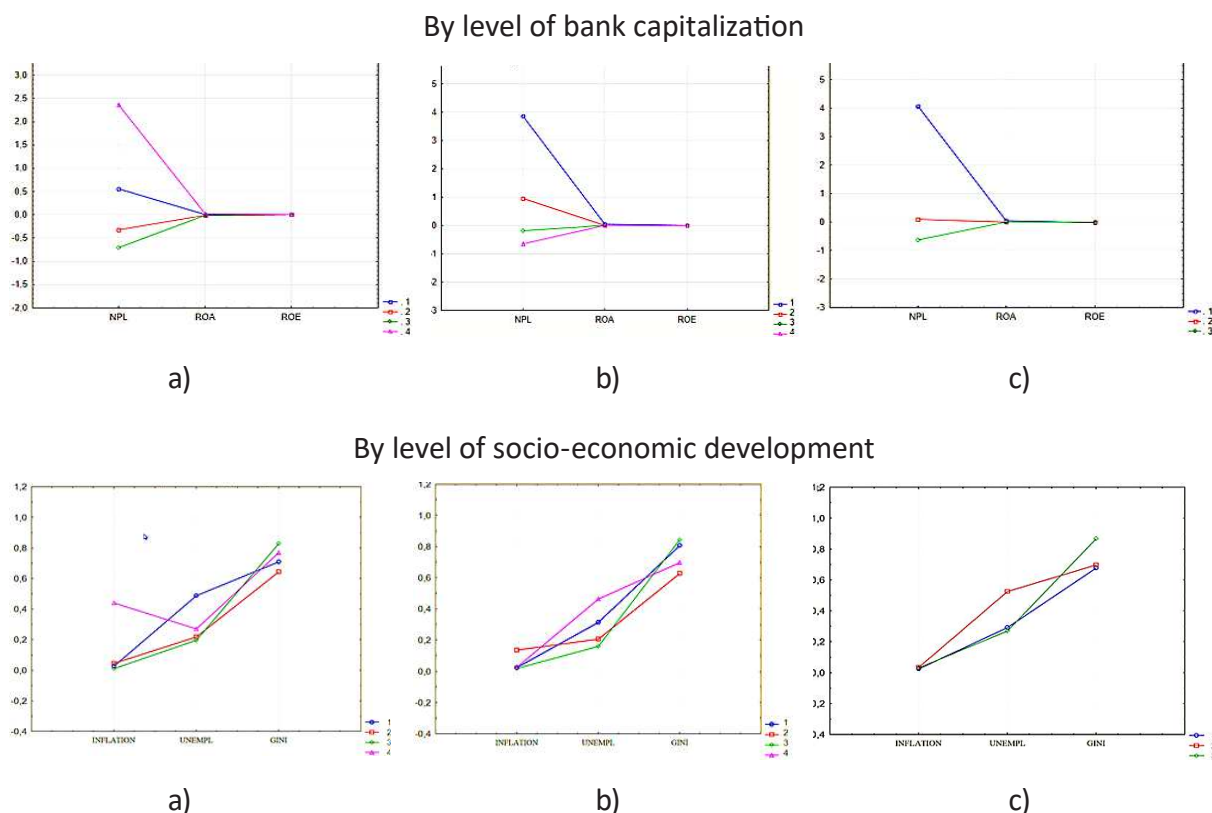


Figure 2. Chart of average values of factor indicators for clusters by bank capitalization and level of socio-economic development in 2010 (a), 2015 (b), and 2020 (c)

and 4 remained resilient to the crisis. In the wake of the COVID-19 pandemic, the countries were redistributed in 2020 into three possible clusters. Cluster 1 includes countries with above-average inflation, unemployment, and the Gini index; Cluster 2 includes countries with significantly higher than average unemployment and close to the average inflation and Gini index; and Cluster 3 includes countries with close to average inflation and unemployment and above-average Gini indices. Accordingly, Cluster 3, which included countries with high and upper-middle incomes, was resilient in 2020.

An analysis of the qualitative composition of the clusters by bank capitalization reveals several transformations. In 2010, Cluster 1 included countries with high levels of NPLs, including Serbia* (high-income country), Ukraine*** (lower middle-income country), and Cyprus*. From 2010 to 2015, there was significant volatility in the composition of the clusters: Iceland*, Latvia*, and Lithuania* moved from Cluster 1 (above-average NPLs) to Cluster 4 (below-average NPLs). In 2020,

compared to 2015, Moldova* (upper middle-income)** and Croatia*, which were in Clusters 3 and 2, respectively, joined Cluster 1, which included countries with high NPLs, and Serbia** moved to Cluster 2. The vast majority of high-income countries in the third and fourth clusters in 2010 and 2015 merged into the third cluster in 2020. The main reasons for these moves were the positive dynamics of NPLs and bank assets.

In contrast, an analysis of the qualitative composition of country clusters by level of socio-economic development confirms significant volatility in the key indicators that underpin clustering. The most significant redistribution is observed between upper-middle-income countries in Clusters 1 and 4 in 2010 and 2015. Moldova*, which was in Cluster 1, characterized by high unemployment, moved to Cluster 2 with close to average inflation, unemployment, and Gini index values in 2015. Albania** moved from Cluster 1 in 2010 to Cluster 4, which is characterized by high unemployment. There was also a transformation in the composition of Cluster 4, which included high-income countries.

France, Poland, Italy, Portugal, and Luxembourg moved from Cluster 4 (above-average inflation) to Cluster 3. The United Kingdom, Denmark, the Netherlands, Belgium, Switzerland, Germany, and Austria were in Cluster 4 in 2010 and 2015. In 2020, they moved to Cluster 3, characterized by resilient inflation, unemployment, and the Gini index. It is worth noting that the highest volatility in times of economic turbulence is observed in upper-middle-income countries: Bulgaria, Albania, Moldova, and Serbia.

Thus, the analysis of the qualitative composition of country clusters by the level of bank capitalization and the level of economic development confirmed the existence of a link between these economic processes. An analysis of changes in the average values of clustering indicators in 2010 and 2015 shows a significant redistribution of countries in Clusters 1 and 4 by NPLs, inflation, and unemployment levels. Table 8 shows the matrix of transformational resilience of European countries by the bank capitalization level and socio-economic development.

In 2010 and 2015, Slovenia and the Czech Republic, which are high-income countries, were in Cluster 2 by the socio-economic development level. Thus, based on the analysis of the matrix of coincidence of countries by clusters, it is worth noting the existence of a direct relation between the bank capitalization level and the countries' socio-economic development, which is confirmed by the quantitative and qualitative empirical assessment of the composition of clusters and their volatility. Accordingly, the hypothesis of a relationship between the level of bank capitalization and the level of socio-economic development is confirmed.

4. DISCUSSION

The findings of this study offer significant insights into the connection between the level of bank capitalization and the socio-economic development of European countries. By applying advanced statistical methods, such as factor analysis and clustering, the research has illuminated patterns and trends that align with and build upon prior literature while revealing new dynamics worthy of further exploration.

The findings align with studies such as those by Buriak et al. (2015), who emphasized the importance of regulatory frameworks in mitigating systemic risks through robust capitalization, and Aryal and Singh (2024), who noted the indirect effects of macroeconomic variables on financial stability. This study confirms that NPL and ROA are significant and exhibit dynamic interrelations with socio-economic indicators across different income-level countries. These results reinforce Espinosa et al.'s (2023) observations about the unintended consequences of central bank interventions, which must consider the broader socio-economic landscape.

The cluster analysis provides a nuanced understanding of how countries with varying income and economic resilience have responded to financial and economic shocks over time. For instance, in 2010, countries in Cluster 1 exhibited high NPL levels and modest ROA values, indicative of heightened systemic risk and weaker financial buffers. By contrast, Clusters 3 and 4 comprised high-income countries with lower NPL levels and stable ROA, underscoring their resilience to economic shocks. This supports the findings of Szüle

Table 8. Matrix of transformational resilience of European countries in 2010, 2015, and 2020

Source: Based on World Bank (2020).

Cluster number	Countries	
	By level of bank capitalization	By level of socio-economic development
1	Ukraine***	Ukraine***
2	Hungary*, Romania*, Italy*, Albania**	Slovenia*, Czech* (2010, 2015)
3	Slovenia*, Finland*, Switzerland*, Norway*, Luxembourg*, Sweden*, Malta*	Sweden*, Luxembourg*, Malta*
4 (2010, 2015)	Austria*, Czech*, Slovakia*, Estonia*, Poland*, Denmark*, France*, Spain*, Belgium*	UK*, Norway*, Netherlands*, Denmark*, Belgium*, Austria*, Switzerland*, Germany*

Note: * HI – high-income countries; ** UMI – upper-middle-income countries; *** LMI – lower-middle-income countries.

(2023) and Nández Alonso et al. (2023) on the stabilizing role of traditional banking activities in high-income economies.

The transition of countries such as Iceland, Latvia, and Lithuania from Cluster 1 to Cluster 4 between 2010 and 2015 illustrates the effectiveness of targeted reforms and improved banking practices in enhancing financial resilience. This mirrors the trends observed by Kravčáková Vozárová et al. (2023), who documented similar transformations following strategic consolidations within the European banking sector.

By 2020, consolidating countries into three clusters reflects a more homogenized response to systemic challenges, particularly among high-income nations. The positive shifts in NPL levels and ROA values observed in these clusters resonate with Dahal et al. (2024) findings that macroeconomic stability enhances banking sector performance. Furthermore, as demonstrated in the concordance matrix, the alignment between socio-economic and capitalization clusters validates the interconnectedness posited by Steenbergen et al. (2023).

The research findings reinforce the critical role of socioeconomic factors in shaping banking stability. Countries with higher income inequality and unemployment rates tended to cluster, reflecting their shared vulnerabilities. This outcome aligns with Morin (2024), who argued that socioeconom-

ic disparities could undermine financial stability and long-term growth. Additionally, the resilience of high-income countries with moderate inflation and unemployment rates highlights the importance of maintaining balanced socio-economic policies to support financial systems.

Meanwhile, for middle-income countries, targeted interventions to address unemployment and income inequality are essential to improve socio-economic development and bank capitalization. These strategies align with the policy recommendations of Alabdullah (2023) and Wang and Lu (2024) on fostering economic stability through financial innovation and inclusivity.

While this study provides a comprehensive analysis, it is not without limitations. The reliance on secondary data from 34 European countries may overlook unique regional or institutional factors influencing the relationship between bank capitalization and socio-economic development. Additionally, the study's focus on the period from 2010 to 2020 limits its ability to capture longer-term trends or the full impact of recent crises, such as the COVID-19 pandemic. Future research could expand the scope to include more diverse geographical regions, incorporate qualitative data, and explore the influence of emerging factors, such as digital transformation and environmental sustainability, on banking and socio-economic dynamics.

CONCLUSION

The study, the main objective of which was to empirically evaluate the connection between bank capitalization and a country's socio-economic development based on European countries' data, has led to many conclusions.

Based on the use of one of the factor analysis tools, namely the principal components method, statistically significant indicators of the level of bank capitalization were identified: return on assets, return on equity, and the level of non-performing loans, and indicators of the level of socio-economic development: inflation, unemployment, and the Gini index. The most relevant indicators were used to cluster countries by the bank capitalization level and socio-economic development.

The clustering method, including the Ward method and k-means, identifies groups of countries with similar levels of bank capitalization and socio-economic development in 2010, 2015, and 2020. In 2020, most high-income countries were grouped into a single cluster with an average return on assets (about 0.6%) and low NPLs (less than 7.7%). At the same time, countries with close to average levels of inflation (2.4%), unemployment (3.6%), and the Gini index (30.9) remained stable to economic turbulence.

Based on the empirical comparison of quantitative and qualitative volatilities between the clusters in the context of the countries under study, the existence of a link between the elements of the chain “level of bank capitalization - level of socio-economic development” was determined. Thus, the hypothesis of a link between these blocks was confirmed. Banks can use the results obtained in developing resource policies and general strategies for managing banking activities, as well as at the level of public administration of banking systems and in formulating a country’s socio-economic policy.

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