

MACROECONOMIC DETERMINANTS OF BANKING PROFITABILITY IN ROMANIA: EMPIRICAL EVIDENCE AND STRATEGIC IMPLICATIONS FOR AI ADOPTION

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Abstract: *This study examines the impact of key macroeconomic indicators on banking profitability in Romania, with the aim of establishing an empirical foundation for future research on the strategic adoption of artificial intelligence in the banking sector. Using annual data for the period 2010-2024, the analysis considers GDP growth, inflation rate and unemployment rate as determinants of profitability, measured through Return on Assets (ROA) and Return on Equity (ROE). The methodology employs multiple linear regression estimated in EViews, with HAC, robust standard errors to ensure coefficient reliability. The results indicate that the unemployment rate is the most significant macroeconomic factor negatively influencing profitability, while GDP growth and inflation show weak and statistically insignificant effects. These findings suggest that profitability in the Romanian banking sector is highly sensitive to labor market conditions, highlighting the need for enhanced credit risk prediction, portfolio monitoring and strategic decision-making tools. In this context, the research opens a relevant direction for integrating artificial intelligence models to improve forecasting accuracy, optimize asset management and strengthen institutional resilience under changing macroeconomic conditions. Furthermore, the study underscores that traditional profitability drivers, such as macroeconomic fluctuations, provide only a partial explanation of performance outcomes, reinforcing the importance of incorporating bank-specific indicators and advanced digital technologies in future analyses. By establishing a data-driven baseline of how external economic conditions affect profitability, the research creates a foundation for subsequent investigations into the role of AI-based risk assessment, default prediction and operational optimization tools, which may significantly enhance the ability of banks to anticipate economic stress, improve capital allocation and support more resilient financial strategies.*

Keywords: Banking Profitability; Multiple Linear Regression; Macroeconomic Indicators; Artificial Intelligence Models

JEL classification: G21; E44; C01

1. Introduction

The banking sector plays a fundamental role in supporting economic stability and development, acting as a key intermediary between savings and investment and influencing the efficiency of resource allocation in the economy.

The profitability of the banking sector represents a key indicator of financial stability and economic resilience. In Romania, the banking system has experienced multiple

structural transformations in recent years, shaped by global crises, inflationary pressures and fluctuations in economic growth. Understanding the factors that influence banking profitability is therefore essential for strengthening financial performance and ensuring sustainable development.

The main objective of this research is to empirically analyze the impact of key macroeconomic indicators, such as GDP growth rate, inflation rate and unemployment rate, on banking profitability in Romania, measured through financial performance indicators such as Return on Assets (ROA) and Return on Equity (ROE), using annual data for the period 2010-2024.

Moreover, the topic gains additional relevance in the context of the accelerating adoption of artificial intelligence (AI) technologies in banking. AI systems enhance decision-making processes in credit scoring, risk monitoring, fraud detection, pricing strategies and operational efficiency. However, the effectiveness of AI in supporting profitability ultimately depends on a clear understanding of the underlying macroeconomic variables that shape financial performance. Therefore, the findings of this study provide a necessary empirical foundation for future research exploring how AI-based tools may be integrated to improve profitability management, stress-testing, forecasting models and strategic planning within the Romanian banking sector.

This paper contributes to the existing literature by offering empirical evidence from a recent economic period and by outlining how AI-based analytical capabilities may support profitability optimization. The structure of the paper includes a brief review of relevant research, presentation of the methodological approach, discussion of empirical results and final conclusions with policy and strategic implications.

2. Literature Review

A recent study by Hussain and Zuhri (2025) examines the relationship between labor market conditions and banking profitability, focusing on the moderating effect of gross national income per capita. The authors find that rising unemployment significantly reduces both ROA and ROE, mainly due to higher credit risk and lower loan demand. Their findings highlight the importance of considering both macroeconomic conditions and structural financial characteristics when evaluating bank performance, reinforcing the need for more advanced tools, including AI-driven risk assessment models, to enhance resilience in fluctuating economic environments.

Spulbar and Birau (2019) emphasise that in transition banking systems the sustained profitability of banks depends not only on macro-economic stability but increasingly on their ability to anticipate and adapt to cyclical fluctuations. This insight underlines the importance of advanced analytical capabilities, such as artificial intelligence-driven forecasting and risk-assessment systems, as enablers of banking resilience in volatile macroeconomic environments.

Khan (2022) examines the determinants of banking profitability in GCC economies using a panel of 59 banks over the period 2011–2017 and employing OLS, fixed-effects and random-effects estimations. The results indicate that both internal bank characteristics and macroeconomic conditions significantly shape profitability. Bank size, asset quality, asset management efficiency and GDP growth exert positive

effects on ROA, while ROE is enhanced by bank size, asset management and GDP growth, but negatively influenced by capital adequacy, asset quality, operational efficiency and financial risk. The study underscores the importance of effective portfolio management and supportive macroeconomic conditions in driving banking performance, while also suggesting the need for more advanced analytical tools to anticipate risks in a sector strongly dependent on economic cycles.

Popescu and Spulbar (2025) show that emerging technologies such as blockchain, digital financial assets, and artificial intelligence fundamentally transform financial analysis through advanced models for risk assessment and forecasting macroeconomic conditions. The authors emphasize that these tools enable a faster and more accurate interpretation of the relationship between economic variables and financial performance. In this context, the integration of AI becomes a strategic direction for the banking sector as well, supporting efforts to strengthen profitability and resilience.

Spulbar and Cărbune (2025) show that the integration of Open Banking and AI technologies stimulates financial innovation by enabling rapid access to standardized data and the development of more accurate predictive models. This combination enhances scoring, risk monitoring and service personalization, thereby increasing the operational efficiency of banks. The relevance for assessing banking profitability is significant, as these technologies enable a more efficient integration of macroeconomic and microeconomic data into the decision-making framework.

3. Research Methodology

The aim of this research is to examine the extent to which key macroeconomic factors influence banking profitability in Romania over the period 2010-2024. This interval reflects significant structural, financial and technological changes within the Romanian banking sector.

Bank profitability represents a central indicator of financial system performance and resilience. In this study, profitability is assessed using two complementary measures: Return on Assets (ROA), which captures the efficiency with which banks utilize their asset base to generate earnings and Return on Equity (ROE), which reflects the return delivered to shareholders.

The research focuses on three macroeconomic variables that reflect broader economic conditions: the GDP growth rate, the inflation rate and the unemployment rate, because they strongly influence credit demand, interest rate conditions and repayment capacity, ultimately shaping the risk levels and profitability of banks.

To empirically evaluate the relationship between banking profitability and the selected macroeconomic factors, the following hypotheses are formulated:

H1: GDP growth has a positive and statistically significant effect on banking profitability (ROA and ROE) in Romania.

H2: The inflation rate exerts a negative influence on banking profitability.

H3: The unemployment rate has a negative and statistically significant effect on banking profitability.

These hypotheses will be tested through econometric estimation techniques, allowing for a comparative interpretation of how macroeconomic conditions shape profitability from both an operational and shareholder return perspective.

The datasets used in this analysis were obtained from reputable international institutions, to ensure data accuracy and comparability. Specifically, data for ROA and ROE were sourced from the International Monetary Fund, while the macroeconomic indicators, GDP growth rate, inflation rate and unemployment rate were collected from Eurostat. All variables were measured on an annual basis to maintain consistency and allow coherent cross-variable comparison. All variables were measured on an annual basis to maintain consistency and allow coherent cross-variable comparison.

Descriptive statistics indicate moderate profitability in the Romanian banking sector, with a relatively stable ROA and a more volatile ROE, suggesting greater sensitivity of shareholder returns to financial cycle fluctuations. Macroeconomic conditions reflect modest economic growth, alternating inflationary pressures and a comparatively stable labor market.

To examine the influence of macroeconomic factors on profitability, two multiple linear regression models were estimated using the Ordinary Least Squares (OLS) method, with ROA and ROE serving as dependent variables. To address potential heteroskedasticity and autocorrelation in time-series data, Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors (Newey-West adjustment) were applied, improving the reliability of the coefficient estimates. Pearson correlation analysis was also used to assess the initial direction of variable relationships.

The macroeconomic indicators listed above serve as independent variables in both models. The specification of the econometric models is presented in the following section:

Table 1: Selected variables

Acronym	Indicator	Unit
ROA	Return on Assets	Percentage (%)
ROE	Return on Equity	Percentage (%)
GDP_rate	Gross Domestic Product	Annual growth rate (%)
INF_rate	Inflation rate	Annual inflation rate (%)
UNEM_rate	Unemployment rate	Annual % of population in the labour force

Source: Author's contribution

For the implementation of the regression analysis, we employed EViews, a specialized econometric software widely used for time-series modeling and statistical evaluation in economic research. In this study, EViews was used to import and structure the dataset, generate descriptive statistics, compute the correlation matrix and estimate the two regression models with OLS. Additionally, EViews enabled the application of HAC standard errors (Newey-West) to ensure the robustness of the estimated coefficients. The reliability of the software in handling time-series data and delivering precise econometric outputs made it an appropriate choice for examining the relationship between macroeconomic conditions and banking profitability in Romania.

4. Findings

Table 2 summarizes the descriptive statistics for the variables used in the analysis: ROA, ROE, real GDP growth, inflation and unemployment over the period 2010-2024.

Table 2: Descriptive statistics

	GDP_RATE	INF_RATE	ROA	ROE	UNEM_RATE
Mean	2.666667	4.093333	0.773333	7.740000	6.973333
Median	3.200000	3.900000	1.200000	12.10000	6.100000
Maximum	8.200000	12.00000	1.800000	20.10000	9.100000
Minimum	-3.900000	-1.100000	-1.300000	-12.50000	4.900000
Std. Dev.	3.255910	3.502135	0.966929	9.779848	1.630279
Skewness	-0.681622	0.696413	-0.844059	-0.686001	0.205428
Kurtosis	3.088132	3.158653	2.375957	2.271984	1.283968
Jarque-Bera	1.166375	1.228210	2.024484	1.507748	1.945980
Probability	0.558117	0.541125	0.363403	0.470540	0.377951
Sum	40.00000	61.40000	11.60000	116.1000	104.6000
Sum Sq. Dev.	148.4133	171.7093	13.08933	1339.036	37.20933
Observations	15	15	15	15	15

Source: Author's contribution

The Romanian banking sector shows moderate profitability, with ROA averaging 0.77 percent and ROE averaging 7.74 percent. The considerably higher standard deviation of ROE relative to ROA indicates that shareholder returns were more volatile than asset-based returns, reflecting sensitivity to capital structure changes and financial cycle fluctuations.

The macroeconomic indicators show a modest average economic growth of 2.67 percent, alongside noticeable variation in inflation, which averaged 4.09 percent, reflecting alternating periods of price stability and inflationary pressure. The unemployment rate is comparatively stable, suggesting that labor market conditions fluctuated less sharply than output and prices.

The Skewness, Kurtosis and Jarque-Bera test results indicate that all variables are approximately normally distributed, supporting the application of linear regression methods without the need for variable transformation.

4.1. Regression Results for the ROA Model

The ROA regression model explains approximately 50 percent of the variation in bank profitability (Adjusted R-squared = 0.499) and the model is statistically significant overall (Prob(F-statistic) = 0.0189). Among the macroeconomic variables, the unemployment rate is the only significant determinant of ROA ($p = 0.0057$), with its negative coefficient indicating that higher unemployment reduces asset profitability of the banking sector by weakening credit performance. GDP growth and inflation show the expected coefficient signs but are not statistically significant,

suggesting a limited direct impact on ROA during the analyzed period. The model diagnostics confirm specification validity and robustness after applying HAC standard errors.

Table 3: Least Squares Panel

Dependent Variable: ROA

Method: Least Squares

Date: 11/07/25 Time: 21:15

Sample (adjusted): 2011 2024

Included observations: 14 after adjustments

HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 3.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.136168	0.935905	4.419431	0.0013
GDP_RATE_1	0.028982	0.038326	0.756197	0.4670
INF_RATE_1	-0.039967	0.055844	-0.715688	0.4906
UNEM_RATE_1	-0.453804	0.129660	-3.499959	0.0057
R-squared	0.614667	Mean dependent var 0.842857		
Adjusted R-squared	0.499067	S.D. dependent var 0.963738		
S.E. of regression	0.682101	Akaike info criterion 2.307678		
Sum squared resid	4.652618	Schwarz criterion 2.490266		
Log likelihood	-12.15375	Hannan-Quinn criter. 2.290777		
F-statistic	5.317199	Durbin-Watson stat 1.891364		
Prob(F-statistic)	0.018934	Wald F-statistic 4.780441		
Prob(Wald F-statistic)	0.025666			

Source: Author's contribution

The model explains approximately 61% of the variation in ROA ($R^2 = 0.61$), which indicates a moderate explanatory power suitable for annual macroeconomic data. The Durbin-Watson statistic (1.89) suggests no autocorrelation problems and the use of HAC-Newey West robust corrections ensures the reliability of coefficient inferences.

The estimated regression equation for the ROA model is expressed as follows:

$$ROA = \beta_0 + \beta_1(GDP_RATE_{t-1}) + \beta_2(INF_RATE_{t-1}) + \beta_3(UNEM_RATE_{t-1}) + \epsilon$$

Substituting the estimated coefficients:

$$ROA = 4.136168 + 0.028982 \cdot GDP_RATE_{t-1} - 0.039967 \cdot INF_RATE_{t-1} - 0.453804 \cdot UNEM_RATE_{t-1}$$

The negative coefficient of unemployment indicates that weaker labor market conditions reduce asset profitability. The positive GDP coefficient suggests that economic expansion enhances bank performance, although the effect is not statistically strong. Inflation demonstrates no significant influence on ROA, which may suggest efficient interest margin adjustments by banks.

Table 4 – Correlation matrix

	ROA	INF_RATE	GDP_RATE	UNEM_RATE
ROA	1.000000	0.232181	0.231800	-0.839666
INF_RATE	0.232181	1.000000	-0.083711	-0.299787
GDP_RATE	0.231800	-0.083711	1.000000	-0.295150
UNEM_RATE	-0.839666	-0.299787	-0.295150	1.000000

Source: Author's contribution

The correlation matrix provides initial evidence regarding the relationships between banking profitability and the macroeconomic variables included in the study. ROA exhibits a strong negative correlation with the unemployment rate (-0.84), indicating that higher unemployment is associated with lower bank profitability. This relationship aligns with economic expectations, as deteriorating labor market conditions reduce repayment capacity of households and diminish credit activity. ROA shows a weak positive correlation with both GDP growth (0.23) and inflation (0.23). The weak correlation between inflation and ROA may reflect the ability of the banks to adjust interest margins to offset price fluctuations. The macroeconomic variables are only moderately correlated with each other and no values indicate problematic multicollinearity, which supports the suitability of including these variables in the regression model.

4.2. Regression Results for the ROE Model

The regression results indicate that among the macroeconomic variables included in the model, the unemployment rate is the only statistically significant determinant of ROE at the 5% level. The estimated coefficient for unemployment rate is negative and statistically significant (-4.4096 , $p = 0.0110$), implying that an increase in unemployment by one percentage point leads to a substantial decrease in bank profitability. This supports the notion that adverse economic conditions weaken credit demand and elevate credit risk, ultimately reducing banking sector performance.

Table 5: Least Squares Panel

Dependent Variable: ROE

Method: Least Squares

Date: 11/07/25 Time: 23:59

Sample (adjusted): 2011 2024

Included observations: 14 after adjustments

HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 3.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	39.42386	10.39350	3.793128	0.0035
GDP_RATE_1	0.341821	0.381100	0.896931	0.3908
INF_RATE_1	-0.181146	0.604699	-0.299564	0.7706
UNEM_RATE_1	-4.409552	1.416694	-3.112564	0.0110

R-squared	0.592721	Mean dependent var	8.414286
Adjusted R-squared	0.470537	S.D. dependent var	9.780503
S.E. of regression	7.116704	Akaike info criterion	6.997723
Sum squared resid	506.4747	Schwarz criterion	7.180311
Log likelihood	-44.98406	Hannan-Quinn criter.	6.980821
F-statistic	4.851064	Durbin-Watson stat	1.746826
Prob(F-statistic)	0.024634	Wald F-statistic	3.959724
Prob(Wald F-statistic)	0.042430		

Source: Author's contribution

The coefficient associated with GDP growth is positive, suggesting that economic expansion tends to improve profitability. However, the effect is not statistically significant, meaning that economic growth does not exert a consistent or strong influence on ROE during the examined period.

Similarly, the inflation rate displays a negative but statistically insignificant effect, indicating that inflation variability does not meaningfully contribute to changes in banking profitability under the observed economic conditions.

Overall, the model explains approximately 59% of the variation in ROE (R-squared = 0.5927), reflecting a moderate explanatory power. The Durbin-Watson statistic of 1.75 suggests no presence of significant autocorrelation in the residuals. The Wald F-statistic ($p = 0.0424$) confirms that the model is statistically significant as a whole. The estimated regression equation for the ROE model is expressed as follows:

$$ROE_t = C + \beta_1 \cdot GDP_RATE_{t-1} + \beta_2 \cdot INF_RATE_{t-1} + \beta_3 \cdot UNEM_RATE_{t-1} + \epsilon_t$$

Substituting the estimated coefficients:

$$ROE_t = 39.42 + 0.34 \cdot GDP_RATE_{t-1} - 0.18 \cdot INF_RATE_{t-1} - 4.41 \cdot UNEM_RATE_{t-1} + \epsilon_t$$

The results suggest that among the selected macroeconomic variables, the unemployment rate plays the most influential role in determining banking sector profitability in Romania during the period 2010-2024. Higher unemployment significantly reduces the return on equity, while GDP growth and inflation do not demonstrate statistically meaningful effects. These findings highlight the sensitivity of the banking sector to labor market conditions and underline the importance of macroeconomic stability in sustaining financial performance.

Table 6 – Correlation matrix

	ROE	GDP_RATE_1	INF_RATE_1	UNEM_RATE_1
ROE	1.000000	0.379697	0.128803	-0.757724
GDP_RATE_1	0.379697	1.000000	-0.064793	-0.351837
INF_RATE_1	0.128803	-0.064793	1.000000	-0.276252
UNEM_RATE_1	-0.757724	-0.351837	-0.276252	1.000000

Source: Author's contribution

The correlation analysis reveals several notable relationships. First, the return on equity (ROE) exhibits a strong negative correlation with the unemployment rate (UNEM_RATE_1), with a coefficient of -0.7577 . This finding suggests that an

increase in unemployment is associated with a significant decrease in banking sector profitability. Economically, this is intuitive: when labor market conditions deteriorate, households tend to reduce consumption and borrowing capacity, leading to lower lending volumes and potentially higher credit risk, which negatively affects bank performance.

ROE is found to have a moderate positive correlation with GDP growth (GDP_RATE_1), with a coefficient of 0.3797. This indicates that periods of economic expansion are generally associated with higher profitability in the banking system. However, the correlation is not strong enough to suggest a stable or direct dependence, which is confirmed later in the regression results.

Meanwhile, the correlation between ROE and the inflation rate (INF_RATE_1) is positive but weak (0.1288), suggesting that inflation has only a limited influence on the profitability of banks during the analyzed period. Similarly, the correlations among the independent macroeconomic variables are moderate to weak, indicating an absence of multicollinearity issues that could distort the regression estimates.

The results show that H1 is only partially supported, as GDP growth has a positive but weak influence on banking profitability, without representing a major determinant. H2 is not confirmed, since the inflation rate has no significant impact on ROA or ROE, suggesting that banks effectively adjust interest margins. In contrast, H3 is strongly supported: the unemployment rate has a robust and statistically significant negative effect. This confirms that labor market conditions are the primary macroeconomic factor shaping banking profitability in Romania.

5. Conclusion

The empirical evidence indicates that banking profitability in Romania is shaped primarily by labor market conditions, with both ROA and ROE declining as unemployment rises. This underlines the sensitivity of credit performance to periods of economic stress and emphasizes the importance of timely risk assessment. GDP growth contributes moderately to profitability, while inflation shows no significant effect, suggesting that traditional macroeconomic drivers alone do not fully explain profitability dynamics. These results highlight the need for banks to strengthen credit risk management and provisioning policies, particularly in response to labor market fluctuations. In this context, the strategic adoption of artificial intelligence becomes increasingly relevant, as AI-based credit scoring, default prediction models and automated portfolio monitoring can enhance early risk detection and support more resilient decision-making.

The findings of this study differ from part of the literature that identifies, for example, GDP growth as a strong determinant of banking profitability, as our results show only a weak and statistically insignificant relationship. This divergence may be linked to structural and regulatory characteristics specific to the Romanian banking sector and to the limitations of using a small annual dataset. These aspects suggest that macroeconomic variables alone do not fully explain profitability dynamics. Future research should therefore include bank-specific indicators, such as the net interest margin, cost-to-income ratio, loan-to-deposit ratio, non-performing loans ratio and capital adequacy ratio, to provide a more comprehensive understanding of

profitability drivers. Incorporating these variables would also support the assessment of how AI-based analytical tools can enhance risk management and operational efficiency in banking.

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