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Macroeconomic Determinants of Credit Risk on the Example of Non-performing Loans

Abstract

The primary goal of this article is to examine the principal macroeconomic factors influencing credit risk as assessed by the nonperforming loan ratio (hereinafter NPL ratio). Based on the results, the ratio of domestic credit to the private sector, Organization for Economic Cooperation and Development (OECD) membership with a negative correlation with NPLs while the unemployment rate and the ratio of public debt with a positive relation with NPLs were statistically significant. In addition, the correlation between the inflation rate and the depreciation of the home currency was proven.

The research examines the effects of the 2008 credit crunch, which triggered the financial crisis. The sample comprises 106 countries for the period 2009–2019. The real GDP growth, unemployment rate, public debt ratio, domestic credit to private sector ratio, currency depreciation, inflation rate, and interest rate were analysed as macroeconomic factors. A dummy variable representing OECD membership has been included in the analysis. The estimations were performed using the ordinary least squares (OLS) method.

This article contributes to the academic discourse on the panel data perspective with regard to non-performing loans, while the practical implications are beneficial for governments and international investors.

Keywords

credit risk | non-performing loans (NPLs) | macroeconomic factors

JEL Codes

G20, M21, E44

1. Introduction

The aim of this research study is to investigate the determinants of the non-performing loan ratio in 2019, which can be considered a proxy for the condition of the banking sector. While the factors with a material impact can be internal (bank-specific) or external in nature, this study focuses only on macroeconomic determinants, including real GDP growth, unemployment rate, public debt ratio, domestic credit to private sector ratio, currency depreciation, inflation rate, interest rate and a dummy variable representing OECD membership.

The analysis covers data points from 106 economies over the period from 2008 to 2019. The covered period was chosen to focus on the consequences of the global crisis caused by the subprime credit market crash. Due to extraordinary measures taken by governments and central banks, the year 2020 was therefore omitted on purpose. The NPL ratio, GDP growth, unemployment, inflation, and domestic credit to private sector ratio

were extracted from the World Bank database, whereas interest rates, public debt, and currency depreciation were taken from the International Monetary Fund (IMF) dataset.

The originality of the article resides in the author's concentration on panel data from countries around the globe, encompassing all continents, economies of varying sizes, and both developed and developing nations. The majority of scholars have explored the NPL ratio through the lens of time series. Panel-based studies have advantages compared to time-series analyses, and these benefits include (1) increasing degrees of freedom while reducing problems of data multicollinearity, (2) building more realistic behavioural models, (3) eliminating or limiting estimation bias, (4) obtaining more precise estimates of relationships and producing more accurate predictions, (5) providing information on the appropriate level of aggregation, and (6) simplifying cross-sectional or time series data (Hsiao, 2005, p. 12). However, there were a limited number of

panel studies that included countries from multiple continents and focused on the effects of the 2008 financial crisis. Moreover, participation in the OECD has not been considered a variable influencing NPLs.

Four sections comprise the remainder of the article: The Literature Review section begins the article, and is followed by the Methods section, which includes the variable definitions. The Results section contains descriptive statistics, a correlation matrix, and tests for normality, heteroscedasticity, collinearity, and endogeneity. The final section, Discussion and Conclusions, includes a discussion of the findings, study limitations, concluding remarks, and policy implications.

According to the IMF, a non-performing loan (NPL) is a loan when payments of interest and/or principal are past due by at least 90 days; interest payments equal to or greater than 90 days have been capitalized, refinanced, or delayed by agreement; or payments are less than 90 days overdue. Other circumstances, however, can also call into question whether payments will be made in full. Classification as a non-performing loan means that the debtor is in default, i.e., at risk of bankruptcy. If the debtor starts paying off liabilities again, the loan returns to the performing category. The NPL ratio, expressed as the ratio between the value of non-performing loans and the total loans in the bank, is the fundamental measure of credit risk. It is one of the most important measures affecting the bank's financial results (IMF, 2019, p. 59).

Consequently, the value of the NPL ratio can be viewed not only as a measure of credit risk, but also as an indicator of the overall state of the economy. Non-performing loans may determine the overall weakness of the banking system within a country (Giammanco, Gitto & Ofria, 2022, p. 2). Other studies prove that economic changes manifest themselves more quickly in the banking sector than in other sectors of the economy (Skikiewicz & Garczarczyk, 2018, p. 128). NPLs can be also used to mark the onset of a banking crisis (Reinhart & Rogoff, 2010, p. 41). A number of stakeholders, including the public as a user of banking services and as a potential investor in the banks' equity, the financial markets, the banks' management, shareholders, the banking supervisors, and in terms of ensuring the stability of the financial system and academic circles, regard information on the bank's loan quality as crucial.

The financial system was profoundly affected by the 2008 financial crisis (Batrancea, 2021, p. 2). The

reduction of economic activity caused by the global crises lead to a decrease in liquidity across different sectors (Piosik, 2022, p. 339). Further, liquidity problems lead to increased levels of non-performing loans for banks. The 2008 financial crisis' implications have changed banks' principles of operation (Amuakwa-Mensah, Marbuah & Marbuah, 2017), (Kuzucu, 2019), (Tarchouna, Jarraya -& Bouri, 2017), (Yüksel, 2017). In result, the Basel Committee on Banking Supervision announced the third Basel Accord in November 2010 with the aim of enhancing the stability of the banking system as a reaction to the weaknesses in financial regulation that had been uncovered. According to Duffie, the reforms, particularly bank capital rules, have contributed significantly to the stability of the financial sector (Duffie, 2018, p. 2).

2. Literature Review

The topic of NPLs has been investigated by numerous authors. Two groups of factors influence the value of this indicator: internal (at the company level) and macroeconomic. Bank-specific determinants can be generally summarized as poor management; however, a lower-quality credit portfolio can sometimes be compensated for by a higher loan margin. Internal factors include an inefficient process of credit scoring, insufficient control of borrowers, and the absence of collateral (Podpiera & Weil, 2008), a high level of efficiency, bank size (Abid, Ouertani & Zouari-Ghorbel, 2014), and banks' low capitalization (Keeton & Morris, 1987).

Klein examined the banking sector in the countries of Central, Eastern, and Southeastern Europe from 1998 to 2011 in terms of macroeconomic factors. The level of non-performing loans rises with an increase in currency depreciation, the unemployment rate, and inflation, but NPLs exhibit negative correlation with real GDP growth (Klein, 2013).

Beck and the team who analysed a sample of 75 countries between 2006 and 2015 discovered that the following factors have a significant impact on NPL ratios: real GDP growth, share prices, the exchange rate, and the lending interest rate. In particular, changes in economic activity are the primary driver of the credit portfolio's quality. In addition, exchange rate depreciations may lead to a deterioration of banks' assets in nations with a high proportion of lending in foreign currencies, such as Swiss franc-denominated

credits in Poland, Hungary, and Croatia (Beck, Jakubik & Piloju, 2015).

Kjosevski and Petkovski assert that the NPLs in the Baltic States are subject to comparable macroeconomic determinants. Their empirical research indicates that the most influential macroeconomic determinants of NPL are changes in GDP, public debt, inflation, and unemployment. (Kjosevski & Petkovski, 2021).

Using the generalized method of moments, researchers covering banks in Southeastern European countries from 2003 to 2010 reached comparable conclusions. According to their studies, higher NPL values were correlated with lower economic growth, higher inflation, and higher interest rates (Curak, Pepur & Popovski, 2013).

The Polish banking sector was covered by Wdowiński, who used quarterly statistical data from 1997 to 2013. According to the study, the GDP growth rate, interest rates, unemployment rate, and exchange rate fluctuations are the primary macroeconomic determinants of the non-performing loan ratio in banks. The author claims that a deep recession would result in a material deterioration of credit portfolios both in the corporate and consumer segments (Wdowiński, 2014).

Petkovski conducted more recent evaluations of the Polish banking sector on a panel of 18 Polish banks using annual data from 2005 to 2018. The results indicate that GDP growth, domestic lending to the private sector, public debt, and unemployment have the largest influence on the value of non-performing loans (Petkovski, Kjosevski & Jovanovski, 2021).

Other authors also include public debt as a variable that degrades the quality of the loan portfolio. A model constructed using a sample of 85 banks in three southern European countries (Greece, Italy, and Spain) from 2004 to 2008 confirms that the NPL ratio is negatively correlated with GDP growth and positively correlated with unemployment and the real interest rate (Messai & Jouini, 2013).

Similar conclusions are confirmed in the Greek banking system. The authors demonstrate that value of nonperforming loans can be primarily attributed to macroeconomic variables including GDP growth, unemployment, interest rates, and public debt (Louzis, Vouldis & Metaxas, 2015).

Batrancea gave an alternative viewpoint on the question of interactions between macroeconomic variables and NPLs. Researchers view GDP growth as

a dependent variable explicable by the NPL ratio, bank capital to assets ratio, bank liquid reserves to assets ratio, interest rate spread, and inflation. The authors demonstrated, however, that bank capital-to-asset ratios were the primary drivers of economic development (Batrancea, Rathnaswamy & Batrancea, 2021).

3. Methods

The purpose of model validation is to ensure that a model is designed adequately to solve the problem it was planned to solve. In particular, it should provide accurate predictions. In order to achieve this, the author first developed a model using explanatory factors selected on the basis of the literature review. The second step focused on econometric analysis and tests including descriptive analysis, testing of specification, collinearity, endogeneity.

3.1. Definitions of variables

The explanatory factors listed in Table 1 have been selected on the basis of the literature review.

Additionally, the author decided to assign a dummy variable to OECD membership. Membership in the OECD would contribute to a more mature economy, i.e., more effective creditworthiness procedures and more stable economic activity. Consequently, the NPL should be reduced.

The NPL indicator in 2019 is the dependent variable. Because the quality and size of the loan portfolio are influenced by events from previous years, it was decided to use the average for the unemployment rate and the interest rate from 2009 to 2019. The index where the numerator is the value from 2019 and the denominator from 2008 was used for inflation, GDP, and currency depreciation expressed in special drawing rights (SDRs). As the nature of the banking sector development indicator and state debt ratio already incorporate events from prior years, it was determined that only 2019 data would be utilized. For details, please refer to Table 2.

Based on Table 2, the theoretical model is given as follows:

$$NPL_i = \beta_0 + \beta_1 INF_i + \beta_2 UN_i + \beta_3 DCTOPS_i + \beta_4 DEBT_i + \beta_5 GDP_i + \beta_6 IR_i + \beta_7 OECD_i + \beta_8 CurDep_i + \varepsilon_i$$

Where NPL_i is the NPL ratio for the country in 2019, β_0 represents the intercept, and INF_i represents the

Table 1. Description of the determinants and proxies of NPLs and a representative sample of their use in the literature

Variable	Expected impact on NPL	Basis of the NPL influence sign	Relevant literature
Inflation rate	+	The state of high inflation hinders running a business and reduces the ability of households to settle their liabilities.	Curak et al., 2013; Klein, 2013; Kjosevski & Petkovski, 2021
Unemployment rate	+	Unemployment reduces the ability of households to pay their liabilities.	Klein, 2013; Messai & Jouini, 2013; Wdowiński, 2014; Louzis et al., 2015; Kjosevski & Petkovski, 2021
Banking sector development	-	A large number of loans means greater availability of financing. In addition, the high value of loans means that banks are mature and can properly assess creditworthiness.	Keeton & Morris, 1987; Abid & Zouari, 2014; Petkovski et al., 2021
State debt	+	High state debt limits the availability of financing, which contributes to higher loan-servicing costs.	Louzis et al., 2015; Kjosevski & Petkovski, 2021
GDP growth rate	-	Lower GDP growth means limited ability to settle liabilities.	Messai & Jouini, 2013; Wdowiński, 2014; Beck et al., 2015; Louzis et al., 2015; Kjosevski & Petkovski, 2021
Interest rate	+/-	A high interest rate may limit lending, i.e., only those entities with high creditworthiness receive loans. On the other hand, the high cost of money may make it difficult to settle liabilities.	Curak et al., 2013; Messai & Jouini, 2013; Wdowiński, 2014; Beck et al., 2015
Currency depreciation	+	The depreciation of the domestic currency means an increase in loans in foreign currency. This is important in the case of loans with a significant value in a foreign currency.	Klein, 2013; Wdowiński, 2014; Beck et al., 2015

Source: Author's own research and design.

Table 2. Data specification and symbols

Variable	Symbol
<i>Non-performing loan ratio in 2019</i>	NPL
<i>Natural logarithm of non-performing loan ratio in 2019</i>	ln_NPL
<i>Inflation rate is expressed as an index in 2019, where the base year is 2008</i>	INF
<i>Unemployment rate is expressed as the average unemployment rate in 2009-2019</i>	UN
<i>Banking sector development indicator as a relation between total loans granted to the private sector and GDP in 2019</i>	DCTOPS
<i>State debt as a ratio of public debt to GDP in 2019</i>	DEBT
<i>GDP growth rate as a relation of the value of GDP expressed in constant prices to the national currency in 2019 to 2008</i>	GDP
<i>Interest rate as the average interest rate on loans granted in 2009-2019</i>	IR
<i>OECD membership (dummy variable)</i>	OECD
<i>Currency depreciation as a ratio of the value of the currency expressed in SDRs in 2019 in relation to 2008</i>	CurDep

Source: Designed by the author

index in 2019, with 2008 as the base year. UN_i is the average unemployment rate from 2009 to 2019; $DCTOPS_i$ represents the banking sector development indicator as a ratio of total loans given to the private sector and GDP in 2019; and $DEBT_i$ represents state debt as a ratio of public debt to GDP in 2019. $CurDep_i$ reflects currency depreciation as a ratio of the value of the currency represented in SDRs in 2019 relative to 2008, while $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$, and β_8 designate relevant coefficient terms. The value of ε_i represents a random variable.

4. Results

4.1. Descriptive statistics

Table 3 provides descriptive statistics for both dependent and independent variables.

NPL, inflation, unemployment rate, banking development index, state debt, GDP growth rate, inflation rate, OECD, and currency depreciation had mean values of 6.44, 1.60, 8.37, 61.40, 53.6, 1.24, 10.16, 0.28, and 1.31, respectively, as shown in Table 3. The price change index ranged from a low of 1.00 (Brunei) to a maximum of 6.19 (Belarus), with a standard deviation of 0.50. The lowest unemployment rate was recorded in Thailand (0.71%), and the highest was in Kosovo (30.65%). The standard deviation of the unemployment rate was 6.21. Afghanistan had the lowest level of banking sector development (3.23), while Hong Kong had the highest level (236.75). The

standard deviation of the variables was 42.32. The state debt variable recorded a maximum of 194.11 for Greece and a minimum of 2.58 for Brunei, with a standard deviation of 31.36. The standard deviation of the GDP index is 0.23, with China recording the greatest value of 2.16 and Greece recording the lowest value of 0.79. Madagascar had the highest interest rates (54.48%), while the United Kingdom had the lowest (0.52%). The interest rate standard deviation amounted to 7.43. The home currency in Belarus declined the greatest (8.58), while the Seychelles rupee was the strongest with an index of 0.76. The standard deviation for currency depreciation was 0.90.

In this analysis, there are 106 observations. In terms of loan portfolio quality, Ukraine is in the worst situation in 2019, followed by Greece and Cyprus, with NPL percentages of 47%, 39%, and 31%, respectively. Macao, South Korea, and Micronesia are the nations with the lowest NPL rates, with NPL ratios of 0.2%, 0.4%, and 0.4%, respectively (Table 4). NPL had a standard deviation of 6.92.

All variables were right-skewed and leptokurtic in terms of skewness and curtosis. The Jarque Bera test revealed that none of the eight variables had normal distributions. Except for the dependent variable, it might not be an issue for the independent variables. To check missing distribution normality, the author additionally employed the Ramsey Regression Equation Specification Error Test (RESET test), which was designed to identify improper functional forms in linear regression (Sapra, 2005). The test outcomes are displayed below (Table 5).

Table 3. Descriptive statistics of variables

	NPL	INF	UN	DCTOPS	DEBT	GDP	IR	CurDep
Mean	6.44	1.60	8.37	61.40	53.60	1.24	10.16	1.31
Maximum	46.82	6.19	31.65	236.75	194.11	2.16	54.48	8.58
Minimum	0.20	1.00	0.71	3.23	2.58	0.79	0.52	0.76
Standard deviation	6.92	0.71	6.21	42.32	31.36	0.23	7.43	0.90
Skewness	3.38	3.92	1.55	1.37	1.40	0.89	2.78	6.20
Kurtosis	15.23	20.04	2.09	2.38	3.28	1.54	12.94	44.56
Jarque-Bera test	1.119.70	1.868	57.70	53.63	75.08	22.27	799.40	8,610.70
JB Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	106	106	106	106	106	106	106	106

Source: Designed by the author in R software

Table 4. Top 10 of the highest and lowest NPL ratios in 2019

Country	NPL as assets %	Country	NPL as assets %
Ukraine	46.8	Macao	0.2
Greece	39.4	South Korea	0.4
Cyprus	30.5	Micronesia	0.4
Angola	17.7	Hong Kong	0.7
Burundi	17.7	Luxembourg	0.8
Iraq	14.1	Australia	0.9
Moldova	13.1	Norway	1.0
Italy	12.9	United Kingdom	1.0
Albania	12.8	United States	1.1
Vanuatu	12.7	Singapore	1.2

Source: Designed by the author based on World Bank and IMF data

Table 5. Ramsey's RESET test results

RESET	5.3029
df1	2
df2	95
<i>p</i> value	0.0065

Source: Designed by the author based on R software results

Table 6. Correlation matrix

	In NPL	INF	UN	DCTOPS	DEBT	GDP	IR	OECD	CurDep
In NPL	1								
INF	0.30	1							
UN	0.25	-0.20	1						
DCTOPS	-0.54	-0.35	-0.08	1					
DEBT	0.33	0.02	0.14	0.08	1				
GDP	-0.11	-0.05	-0.13	0.00	-0.26	1			
IR	0.27	0.41	-0.11	-0.47	-0.04	-0.02	1		
OECD	-0.28	-0.32	-0.01	0.34	0.13	-0.27	-0.48	1	
CurDep	0.28	0.91	-0.07	-0.28	0.08	-0.10	0.27	-0.16	1

Source: Designed by the author in R software

With a statistic of 5.3029 and a *p*-value of 0.007 (Table 5), Ramsey's RESET test indicates that the linearity assumption is invalid. Consequently, the variable NPL was replaced by its natural logarithm. On the basis of this replacement, a new modified model is presented (change of dependent variable from NPL to natural logarithm of NPL and elimination of currency depreciation variable) as follows:

$$\ln NPL_i = \beta_0 + \beta_1 INF_i + \beta_2 UN_i + \beta_3 DCTOPS_i + \beta_4 DEBT_i + \beta_5 GDP_i + \beta_6 IR_i + \beta_7 OECD_i + \varepsilon_i$$

4.2. Correlation matrix

Table 6 presents the correlation matrix between explained variables and explanatory variables.

According to Table 6, there is a 0.91 correlation between the rate of inflation and currency depreciation. To prevent the model's multicollinearity problem, the choice was made to eliminate variable currency depreciation from the analysis. Other factors did not demonstrate a significant correlation, as their values were less than 0.80.

4.3. Regression analysis

Consider the following models, which are distinguished by the dependent variables chosen: model (a) considers all variables, whereas models (b), (c), and (d) remove the inflation rate, GDP, and all variables, respectively.

Model (e) does not take the inflation rate, GDP, or interest rate into account.

The estimated results for the aforementioned models are presented in Table 7.

Several statistical tests, including the Ramsey Regression Equation Specification Error Test (RESET test), the Shapiro Test, and the Jarque Bera Test, can be used to evaluate the distribution's normality assumption. The preceding tests were performed

on the ln NPL variable, and the results are provided above (Table 7).

With a statistic of 1.2344 and a p-value of 0.2956, Ramsey's RESET test indicates that the linear model has been defined appropriately. In addition, the linearity assumption is not violated by the Shapiro test findings with W equal to 0.9841 and a p-value of 0.2376. The Jarque Bera Test demonstrates the same, with an X-squared equal to 3.0718 and a p-value of 0.215.

Table 7. Regression statistics for the assessment of non-performing loans

Variable	Model (a)	Model (b)	Model (c)	Model (d)	Model (e)
INF	0.1624 (0.1526)	0.1499 (0.1783)	0.1690 (0.1328)	n/a	n/a
UN	0.0268* (0.0258)	0.0279* (0.0187)	0.0277* (0.0190)	0.0227 (0.0520)	0.0243* (0.0318)
DCTOPS	-0.0110*** (0.0000)	-0.0106*** (0.0000)	-0.0110*** (0.0000)	-0.0116*** (0.0000)	-0.0114*** (0.0000)
DEBT	0.0105*** (0.0000)	0.0104*** (0.0000)	0.01071*** (0.0000)	0.0107*** (0.0000)	0.0110*** (0.0000)
GDP	-0.1737 (0.5958)	-0.1430 (0.6577)	n/a	-0.2259 (0.4903)	n/a
IR	-0.0075 (0.5274)	n/a	-0.0066 (0.5744)	-0.0045 (0.7007)	n/a
OECD	-0.3360 (0.0789)	-0.2906 (0.0992)	-0.3035 (0.0921)	-0.3856* (0.0419)	-0.3268* (0.0468)
p-value:	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Residual standard error	0.7050	0.7028	0.7024	0.7088	0.7037
White test p-value:	0.3654	0.3014	0.406	0.3185	0.2484
Goldfeld-Quandt test p-value:	0.9114	0.8307	0.9144	0.8789	0.8730
Multiple R-squared	0.4922	0.4901	0.4907	0.4814	0.4785
Adjusted R-squared	0.4559	0.4592	0.4598	0.45	0.4578
AIC	236.3774	234.8116	234.6833	236.6023	233.1925
BIC	260.3484	256.1191	255.9909	257.9098	249.1731
RESET	1.2344 (0.2956)				
Shapiro	0.9841(0.2376)				
Jarque Bera	3.0718 (0.2153)				
Observations	106	106	106	106	106

Note: Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

Source: Designed by the author based on R software results

With a p-value less than 0.001, all models are statistically significant. The residual standard errors ranged from 0.7024 for model (c) to 0.7088 for model (d). According to the outcomes of both the White and Goldfeld-Quandt tests, the p-value for heteroscedasticity is not less than 0.05 in any circumstance. The null hypothesis is not rejected, and there is insufficient evidence to conclude that heteroscedasticity is present in the regression models.

According to Akaike's Information Criterion (AIC), model (e) is the best fit for the data because it received the lowest score, 233.1925, while model (d) received the worst score, 236.6023. Similar conclusions can be drawn from the Bayesian information criterion (BIC) since model (e) received the lowest score (249.1731) and model (a) had the greatest score (260.3484).

Almost 46% (45.59 precisely) of the \ln NPL in 2019 was explained by the independent variables, as demonstrated by model (a). The results indicate that the unemployment rate, the banking sector development index, and the public debt are significant. The increase of 0.03 percentage points in the unemployment rate resulted in a 1% increase in the NPL ratio. The positive association is also evident for the public debt, as the NPL ratio increases by 1% for every 0.01 percentage point increase in the public debt to GDP ratio. The ratio of non-performing loans decreases by 1% when the value of loans provided grows faster than the GDP by 0.01 percentage point.

The models (b) and (c) indicate the same conclusion regarding relevant independent factors, as the unemployment rate and public debt have a positive impact on \ln _NPL, with the estimators amounting to 0.03 and 0.01, respectively. The DCTOP's influence is negative (DCTOPS growth triggers NPL decrease) with an estimator value of -0.01. The adjusted R squared for the model excluding interest rate (b) was 0.4592, which is similar to the value recorded for the model without inflation (c) rate, which was 0.4598.

Forty five percent of the variations in \ln _NPL were caused by changes in macroeconomic factors, according to Model (d), which does not include inflation. While DCTOPS and debt have identical estimation values of -0.01 and 0.01 as in previous models, respectively, the OECD has replaced the unemployment rate on the list of significant factors with a p-value of less than 0.05. Membership in the OECD has a detrimental impact on the NPL. When a country belongs to the OECD, the value of the NPL indicator decreases by 0.39%.

Model (e), which excludes the impact of inflation, GDP growth, and interest rate, is characterized by an adjusted R square value of 0.4785, which means 47.85% of the variance in \ln _NPL can be explained by changes in the unemployment rate, DCTOPS, debt, and OECD membership collectively. All independent variables are statistically significant. The impact of all factors is the same as in previously mentioned models, as an increase in the unemployment rate and public debt ratio would trigger NPL growth. The banking sector development index, proxied by the relation between total loans granted to the private sector and GDP in 2019, and OECD membership are negatively correlated with the NPL ratio.

Based on the above, DCTOPS and debt ratio were statistically significant in all tested models, while unemployment was relevant in 4 out of 5. The OECD membership turned out to be statistically significant in 2 out of 5 models (d and e). Inflation rates, GDP changes, or interest rates were not considered relevant in any model.

4.4. Collinearity testing

One of the fundamental assumptions of the method of ordinary least squares (OLS) is that the explanatory variables must be independent. As a result of association testing, the currency depreciation variable has already been omitted from this study. In the scientific literature, the variance inflator factor (VIF) test is commonly used to confirm the absence of collinearity (Garcia et al., 2016). The results of the VIF test are shown in Table 8.

According to O'Brien, the problem of multicollinearity is deemed irrelevant if the VIF does not exceed a universally acknowledged threshold. In the case of the model, the derived values are far below the threshold of 10, hence the model is exempt from this issue (O'Brien, 2007).

4.5. Endogeneity testing

Endogeneity may be caused by omitted factors, simultaneity, or measurement mistake (Roberts & Whited, 2013, p. 8). As the unemployment rate can be influenced by variables such as GDP growth, interest rates, and others, the author decided to evaluate this variable for endogeneity using the Wu-Hausman test (Hausman, 1978).

Table 8. VIF testing results

	INF	UN	DCTOPS	DEBT	GDP	IR	OECD
vif(a)	1.3699	1.1468	1.4102	1.1042	1.2153	1.6610	1.5495
vif(b)	1.3278	1.1215	1.2615	1.1038	1.1885	X	1.3277
vif(c)	1.3531	1.1194	1.4102	1.0576	X	1.6245	1.3884
vif(d)	1.0817	1.3429	1.0971	X	1.2004	1.6100	1.4983
vif(e)	1.0280	1.1399	1.0400	X	X	X	1.1428

Source: Designed by the author in R software

The statistic of 0.137 and a p-value > 0.71 (Table 9) do not reject the null hypothesis, so the instruments are not related to the errors of the linear model.

In conclusion, the tests performed, including heteroscedasticity, collinearity, and endogeneity, confirmed the validity of the econometric models.

5. Discussion and Conclusions

The findings reveal that macroeconomic variables, including the unemployment rate, banking system development, public state debt, and OECD membership debt, have a substantial effect on the ratio of non-performing loans.

The results validate the hypothesis that unemployment affects households' ability to pay their loans resulting in a worsening of the loan portfolio of the entire economy. This work concurs with the findings of earlier studies on the NPL being correlated with the unemployment rate (Klein, 2013), (Louzis et al., 2015), (Messai & Jouini, 2013), (Wdowiński, 2014).

The significance of the introduction of the banking sector development index proxied by the relation between total loans granted to the private sector (generally, the size of bank assets) indicates that banking system maturity leads to accurate creditworthiness assessment. Banks in developed systems are also generally more risk averse as (Abid, Ouertani & Zouari, 2014), (Petkovski et al., 2021), (Keeton & Morris, 1987). However, this study does agree with the work of both Pesola and Nkusu, who claimed that high levels of debt make borrowers much more vulnerable to shocks, which may directly negatively influence their income and, therefore, their ability to service their obligations (Pesola, 2005), (Nkusu, 2011).

Table 9. Wu-Hausman test results

	df	df2	statistic	p-value
Wu-Hausman	1	97.00	0.137	0.71

Source: Designed by the author in R software

Furthermore, high state debt limits the availability of financing and may result in asset allocation inefficiencies that manifest as higher NPLs. This phenomenon is highly visible in Greece, which places second in the NPL's highest ranking and is characterized by the highest public ratio. This study confirms the conclusions reached by Louzis, who covered the Greek banking system (Louzis et al., 2015).

In contrast, the inflation rate, GDP growth rate, interest rate, and national currency depreciation are not significant in the constructed model. The lack of significance of GDP change and interest rates in the panel data model does not necessarily mean that those measures have no influence on the NPL ratio. Researchers demonstrated their significance when employing models based on time series. In practice, expansive lending policies fuelled by low interest rates lead to an increase in the value of loans, followed by a rise in GDP. Consequently, after an increase in interest rates, borrowers' ability to repay may diminish, resulting in a rise in the nonperforming loan ratio.

The study does not take into account the country's geographical location and deliberately ends in 2019 in order to focus on the effects of the 2008 financial crisis and not on extraordinary actions implemented by governments and central banks in response to worldwide pandemics. The inclusion of the aforementioned would be an advantageous addition to the subject.

The practical implications are advantageous for governments, supervisory agencies, regulators, and international investors, who can either influence the NPL ratio through the implementation of pertinent economic policies or make informed business decisions. From the perspective of international investors, there may be an expectation of higher returns to account for the anticipated non-performing loans in indebted nations. In terms of economic policy, however, a study reveals that established banking systems have higher portfolio quality. In addition, effective public debt management contributes to a sustainable development policy. By facilitating sustainable growth and reducing administrative impediments, authorities can improve the economy's operation.

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