

THE EFFECT OF CAPITAL ADEQUACY RATIO, LOAN TO DEPOSIT RATIO, EXCHANGE RATE, AND GROSS DOMESTIC PRODUCT ON NON-PERFORMING LOANS WITH INFLATION AS A MODERATING VARIABLE IN NATIONAL PRIVATE BANKS IN INDONESIA

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Abstract

This study investigates the influence of Capital Adequacy Ratio (CAR), Loan to Deposit Ratio (LDR), exchange rate, and Gross Domestic Product (GDP) on Non-Performing Loans (NPL) with inflation as a moderating variable in national private banks in Indonesia. Using a quantitative explanatory approach, this research employs balanced panel data from 38 national private banks over the period 2019–2023. The analytical technique applied is panel data regression using the Random Effect Model (REM), complemented by Moderated Regression Analysis (MRA) to examine the moderating role of inflation. The results reveal that CAR and LDR have a positive and significant effect on NPL, while the exchange rate has a negative and significant effect. GDP is found to have no significant direct effect on NPL. Furthermore, inflation does not moderate the relationship between CAR, LDR, and the exchange rate on NPL, but it significantly moderates the relationship between GDP and NPL. These findings suggest that internal banking factors play a more dominant role in determining credit risk compared to macroeconomic factors. The study provides important implications for bank management and regulators in strengthening credit risk management and maintaining financial system stability, particularly in periods of economic uncertainty.

Keywords: Non-Performing Loans, Capital Adequacy Ratio, Loan to Deposit Ratio, Exchange Rate, Gross Domestic Product, Inflation, Panel Data Regression

INTRODUCTION

The banking sector plays a vital role in economic development by functioning as a financial intermediary that channels funds from surplus units to deficit units. Through this intermediation process, banks support investment, consumption, and overall economic growth. However, the sustainability of banking operations is highly dependent on the quality of their credit portfolios. One of the most widely used indicators to assess credit quality and banking stability is the Non-Performing Loan (NPL) ratio, which reflects the proportion of loans that are classified as substandard, doubtful, or loss. A high NPL ratio indicates deteriorating credit quality and poses serious risks to bank profitability, liquidity, and solvency.

In developing economies such as Indonesia, the dynamics of NPLs are shaped by a combination of internal banking conditions and external macroeconomic factors. From the internal perspective, the Capital Adequacy Ratio (CAR) measures a bank's ability to absorb potential losses arising from risky assets, while the Loan to Deposit Ratio (LDR) reflects the extent of credit expansion relative to funds collected from depositors. Excessive credit growth without adequate capital support and prudent risk management may increase the likelihood of loan defaults.

From the external perspective, macroeconomic variables such as exchange rates and economic growth, commonly proxied by Gross Domestic Product (GDP), significantly influence borrowers' repayment capacity. Exchange rate fluctuations, particularly depreciation of the domestic currency, can increase the debt burden of borrowers with foreign currency exposure. Meanwhile, economic slowdowns reduce income and business performance, thereby weakening borrowers' ability to service debt obligations.

The period 2019–2023 was characterized by heightened economic uncertainty due to the COVID-19 pandemic, global inflationary pressures, and exchange rate volatility. These conditions created substantial challenges for the Indonesian banking sector, particularly in maintaining credit quality. Although numerous studies have examined the determinants of NPLs, empirical findings remain inconsistent, especially regarding the role of inflation. Inflation is commonly treated as an independent variable, yet its interaction with other macroeconomic and bank-specific factors has not been sufficiently explored.

Therefore, this study aims to analyze the effects of CAR, LDR, exchange rate, and GDP on NPLs in national private banks in Indonesia, while explicitly examining inflation as a moderating variable. By employing a panel data regression approach with the Random Effect Model, this research seeks to provide robust empirical evidence that contributes to the banking and financial risk management literature. The findings are expected to serve as a reference for bank management and policymakers in designing more effective strategies to mitigate credit risk and enhance financial system resilience.

REVIEW OF LITERATURE

Non-Performing Loans (NPLs) have long been a key indicator in assessing credit risk and the stability of the banking sector, particularly in developing countries. The high level of NPLs not only reflects the weak quality of the bank's credit portfolio, but also has the potential to create systemic risks that could disrupt the stability of the financial system as a

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whole. Therefore, identifying factors that influence NPL is a major concern in banking and finance literature. Various previous studies have shown that NPL dynamics are influenced by a combination of internal bank factors and broader macroeconomic conditions (Louzis et al., 2012; Klein, 2013).

The Capital Adequacy Ratio (CAR) represents the buffer available to absorb potential losses arising from credit risk. Theoretically, higher CAR should reduce NPLs by strengthening banks' resilience. Empirical evidence, however, remains mixed. Some studies find a negative relationship between CAR and NPLs (Berger & DeYoung, 1997; Ahmad & Bashir, 2013), while others report a positive or insignificant effect, suggesting that well-capitalized banks may engage in riskier lending behavior.

The Loan to Deposit Ratio (LDR) reflects the aggressiveness of banks in extending credit relative to deposits. A high LDR is often associated with increased liquidity risk and weaker credit screening, leading to higher NPLs. Numerous studies document a positive relationship between LDR and NPLs, particularly during periods of economic instability (Makri et al., 2014; Abid et al., 2014).

Macroeconomic conditions play a crucial role in shaping credit risk. Exchange rate depreciation increases repayment burdens for borrowers with foreign currency exposure, thereby raising default risk. Empirical studies generally find that exchange rate volatility significantly affects NPLs, especially in open economies (Nkusu, 2011; Beck et al., 2015). Economic growth, as measured by GDP, is typically associated with lower NPLs due to improved income and business performance. However, the impact of GDP on NPLs may vary depending on sectoral growth distribution and time lags.

Inflation influences credit risk through changes in purchasing power, real interest rates, and operational costs. While high inflation can weaken borrowers' repayment capacity, moderate inflation may reduce the real value of debt. The mixed empirical findings suggest that inflation may play a moderating role rather than a direct determinant of NPLs. However, limited studies explicitly examine inflation as a moderating variable, particularly in the context of Indonesian banking.

RESEARCH METHOD

This study adopts a quantitative explanatory research design to examine the causal relationships between bank-specific factors, macroeconomic variables, and Non-Performing Loans (NPLs). Panel data regression is employed to capture both cross-sectional and time-series variations.

Data and Sample

The dataset consists of annual data from 38 national private banks in Indonesia over the period 2019–2023, resulting in 190 observations. Bank-specific data were obtained from published financial statements and the Financial Services Authority (OJK), while macroeconomic data were sourced from Bank Indonesia and the Central Statistics Agency (BPS).

Variable Measurement

- Dependent Variable: Non-Performing Loans (NPL), measured as the ratio of non-performing loans to total loans.

- Independent Variables: Capital Adequacy Ratio (CAR), Loan to Deposit Ratio (LDR), exchange rate (ER), and Gross Domestic Product (GDP).
- Moderating Variable: Inflation.

Model Specification

The baseline panel regression model is specified as:

$$NPL_{it} = \beta_0 + \beta_1 CAR_{it} + \beta_2 LDR_{it} + \beta_3 ER_t + \beta_4 GDP_t + \epsilon_{it}$$
 To test the moderating effect of inflation, interaction terms are added to the model.

Estimation Technique

Model selection is conducted using the Chow Test, Hausman Test, and Lagrange Multiplier Test. Based on these tests, the Random Effect Model (REM) is selected. Classical assumption tests, including multicollinearity, heteroscedasticity, and normality tests, are performed to ensure model validity.

Table 1.
Statistical Analysis Results

Variable	Key Characteristics
CAR	High variability with wide range; right-skewed and leptokurtic distribution
LDR	Significant variation across banks; presence of extreme values
ER	High volatility indicated by large dispersion and strong skewness
GDP	Fluctuating economic growth with moderate dispersion
Normality	Jarque–Bera test indicates non-normal distribution for all variables
Observations	190 panel observations, sufficient for regression analysis

Summarizes the descriptive characteristics of the research variables. The results indicate considerable variability across bank-specific and macroeconomic variables, reflecting heterogeneity among banks and economic conditions during the study period. All variables exhibit right-skewed and leptokurtic distributions, suggesting the presence of extreme values. The Jarque–Bera test confirms non-normal data distribution; however, the number of observations is sufficient to support panel data regression analysis.

Table 2.
Panel Data Regression Model Selection

Test	Probability Value	Decision	Selected Model
Chow Test	0.0000 (< 0.05)	FEM preferred to CEM	FEM
Hausman Test	0.0894 (> 0.05)	REM preferred to FEM	REM

LM Test	0.0000 (< 0.05)	REM preferred to CEM	REM
Final Model	—	Consistent results	Random Effect Model (REM)

Presents the panel data model selection results. The Chow Test indicates that the Fixed Effect Model is preferable to the Common Effect Model, while the Hausman and Lagrange Multiplier tests support the use of the Random Effect Model. Accordingly, the Random Effect Model is selected as the most appropriate estimation method, as it captures interbank heterogeneity efficiently.

RESULTS AND DISCUSSION

Descriptive statistics reveal substantial variability across all variables, indicating heterogeneity among banks and macroeconomic fluctuations during the observation period. The presence of skewness and kurtosis values exceeding normal thresholds suggests non-normal data distribution; therefore, outlier treatment was applied to improve estimation robustness.

Panel Data Regression Results

The Random Effect Model estimation indicates that the Capital Adequacy Ratio (CAR) and Loan-to-Deposit Ratio (LDR) have a positive and statistically significant effect on Non-Performing Loans (NPLs), implying that higher capitalization and aggressive lending practices are associated with increased credit risk. The exchange rate exhibits a negative and significant effect on NPLs, suggesting that currency appreciation improves borrowers' repayment capacity. Meanwhile, Gross Domestic Product (GDP) shows a negative but statistically insignificant effect, indicating that economic growth does not directly reduce credit risk in the short term.

Moderating Effect of Inflation

The Moderated Regression Analysis demonstrates that inflation does not moderate the relationship between CAR, LDR, and the exchange rate on NPLs. However, inflation significantly moderates the relationship between GDP and NPLs, indicating that the impact of economic growth on credit risk depends on prevailing inflationary conditions.

Discussion

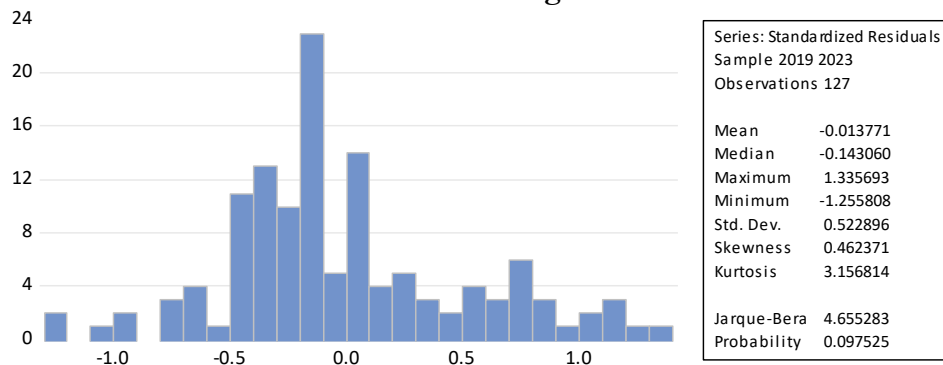
Overall, the findings support banking risk management theory, emphasizing the dominant role of internal bank-specific factors in determining credit risk. The insignificant direct effect of GDP may reflect time lags in economic transmission and uneven sectoral growth distribution. These results underscore the importance of prudent credit expansion policies and the implementation of robust risk management frameworks to maintain banking stability.

Classical Assumption Tests

The residual histogram indicates that standardized residuals are symmetrically distributed around zero. The Jarque–Bera test yields a probability value greater than the 5 percent significance level, confirming that the residuals are normally distributed and that the normality assumption is satisfied.

Multicollinearity test results show that the highest correlation coefficient among independent variables is below the accepted threshold of 0.80, indicating no multicollinearity issues in the model. Furthermore, the heteroscedasticity test reveals that residuals are randomly distributed with constant variance, suggesting that the regression model does not suffer from heteroscedasticity problems.

Figure 1.
Residual Histogram



The histogram of standardized residuals exhibits a distribution that closely approximates normality, with residuals concentrated around zero and a relatively symmetrical spread on both sides. The skewness value of 0.462 indicates a slight right skew, while the kurtosis value of 3.156 suggests a degree of peakedness comparable to a normal distribution. Furthermore, the Jarque–Bera test yields a statistic of 4.655 with a probability value of 0.097, exceeding the 5 percent significance level. These results confirm that the residuals are normally distributed, indicating that the normality assumption of the panel data regression model is satisfied.

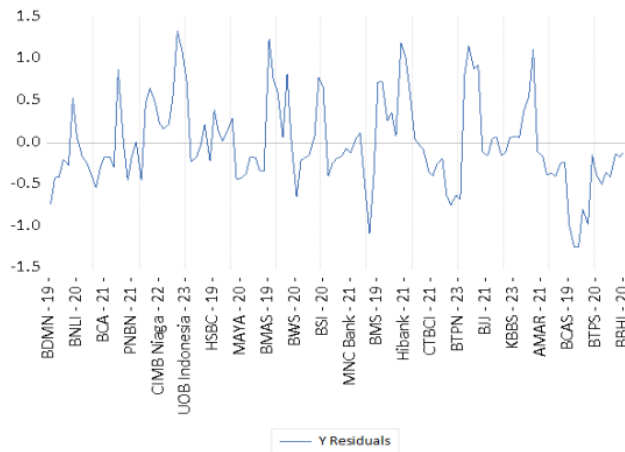
Table 3.
Multicollinearity Test

	X1	X2	X3	X4
CAR	1	0.6324	0.0158	-0.0384
Long Distance Relationship	0.6324	1	-0.0103	-0.0327
ER	0.0158	-0.0103	1	0.1145
GDP	-0.0384	-0.0327	0.1145	1

Based on the multicollinearity test results, the highest correlation coefficient is observed between the Capital Adequacy Ratio (CAR) and Loan-to-Deposit Ratio (LDR) variables, with a value of 0.6324, which remains below the commonly accepted threshold of

0.80. Correlations among the remaining independent variables are relatively low. Therefore, it can be concluded that the regression model does not suffer from multicollinearity issues.

Figure 2.
Heteroscedasticity Test (Glejser Method)



The residual plot demonstrates that residual values fluctuate randomly around the zero line without forming any discernible pattern, such as upward, downward, or systematic wave movements. This indicates that the average residual is close to zero and that residual variance remains relatively constant throughout the observation period. Consequently, there is no visual evidence of heteroscedasticity, and the classical assumption regarding homoscedastic residuals is fulfilled. The regression model can thus be considered reliable in explaining the relationship between the independent and dependent variables.

Table 4.
Panel Data Regression Estimation (Random Effect Model)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.594446	1.077466	2.407916	0.0175
CAR	0.009265	0.004225	2.192935	0.0302
Long Distance Relationship	0.005418	0.001265	4.284607	0.0000
ER	-0.000160	7.34E-05	-2.182717	0.0310
GDP	-0.019080	0.014585	-1.308169	0.1933

The Random Effect Model estimation results indicate that CAR and LDR have positive and statistically significant effects on Non-Performing Loans (NPLs), suggesting that higher capitalization and more aggressive lending practices are associated with increased credit risk. The exchange rate exhibits a negative and significant effect on NPLs, implying that currency appreciation enhances borrowers' repayment capacity. In contrast, Gross Domestic Product (GDP) shows a negative but statistically insignificant effect, indicating that economic growth does not directly reduce credit risk during the study period.

The estimated regression equation is expressed as follows:

$$\text{NPL} = 2.594446 + 0.009265 \text{ CAR} + 0.005418 \text{ LDR} - 0.000160 \text{ ER} - 0.019080 \text{ GDP}$$

Table 5
Panel Data Regression Estimation Results with Inflation as the Independent Variable (Random Effect Model)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.713931	0.670507	4.047583	0.0001
CAR (X1)	0.015654	0.003950	3.963512	0.0001
LDR (X2)	0.004156	0.001440	2.885091	0.0048
ER (X3)	-0.000165	4.66E-05	-3.544246	0.0006
GDP (X4)	-0.038839	0.025438	-1.526790	0.1299
MODERATED INFLATION (Z)	0.015137	0.023976	0.631357	0.5292

The results of panel data regression estimation using *the Random Effect Model* as shown in the output above, obtained the following regression equation:

$$\text{NPL} = 2.7139 + 0.0157 \text{ CAR} + 0.0042 \text{ LDR} - 0.0001 \text{ ER} - 0.0388 \text{ GDP} + 0.0151 \text{ Inflation}$$

Table 6.
Panel Data Regression Estimation with Inflation Interaction Variable as a Moderating Variable (Random Effect Model)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.664773	0.659897	4.038165	0.0001
CAR X1	0.015012	0.003916	3.833481	0.0002
LDR X2	0.004317	0.001424	3.030993	0.0031
ER X3	-0.000162	4.59E-05	-3.540533	0.0006
GDP X4	-0.040006	0.025176	-1.589056	0.1152
Z MODERATED INFLATION	0.040888	0.029573	1.382581	0.1699
X1Z	-1.94E-06	2.69E-06	-0.723208	0.4713
X2Z	-1.50E-06	2.55E-06	-0.588411	0.5576
X3Z	-2.07E-07	8.69E-07	-0.237701	0.8126
X4Z	-0.003146	0.001434	-2.193500	0.0306

Based on the results of panel data regression estimation using *the Random Effect Model* as shown in the output above, the following regression equation is obtained:

$$\text{NPL} = 2.664773 + 0.015012 \text{ CAR} + 0.004317 \text{ LDR} - 0.000162 \text{ ER} - 0.040006 \text{ GDP} + 0.040888 \text{ Inflation} - 1.94\text{E}-06 (\text{CAR}\times\text{Inflation}) - 1.50\text{E}-06 (\text{LDR}\times\text{Inflation}) - 2.07\text{E}-07 (\text{ER}\times\text{Inflation}) - 0.003146 (\text{GDP}\times\text{Inflation})$$

Based on the Random Effect Model estimation, the regression results indicate that CAR and LDR have positive and significant effects on Non-Performing Loans (NPLs), while the exchange rate exerts a negative and significant influence. Gross Domestic Product (GDP) shows a negative but statistically insignificant effect on NPLs. The interaction analysis further reveals that inflation does not moderate the effects of CAR, LDR, and the exchange rate on NPLs, but significantly moderates the relationship between GDP and NPLs.

These findings are consistent with banking risk management theory, which emphasizes the dominant role of internal bank-specific factors in shaping credit risk. The positive impact of CAR suggests that higher capital levels may encourage greater credit expansion, including to higher-risk segments, if not accompanied by effective risk controls. Similarly, the positive effect of LDR reflects increased credit risk associated with aggressive lending behavior.

The negative effect of the exchange rate indicates that currency appreciation improves borrowers' repayment capacity, thereby reducing credit risk. In contrast, the insignificant effect of GDP implies the presence of time lags and uneven sectoral growth, limiting the short-term impact of economic growth on credit quality. Overall, the results confirm that internal banking factors, particularly CAR and LDR, play a more decisive role in influencing NPLs than macroeconomic variables, highlighting the importance of prudent credit expansion and robust risk management to maintain banking stability.

Discussion

The findings of this study are consistent with banking risk management theory, which emphasizes the critical role of capital adequacy and credit distribution in influencing non-performing loans. The positive effect of CAR on NPLs indicates that higher capital levels may encourage greater credit expansion, including lending to higher-risk segments, if not accompanied by stringent risk management practices. Similarly, the positive effect of LDR reflects the increased liquidity and credit risk associated with aggressive lending behavior.

The negative and significant effect of the exchange rate suggests that currency appreciation contributes to improved debt-servicing capacity, particularly for firms reliant on imported inputs or foreign-currency obligations. Meanwhile, the insignificant effect of GDP implies the presence of time lags and uneven sectoral growth distribution, which may limit the short-term impact of economic growth on credit quality.

Overall, the results confirm that internal bank-specific factors, particularly CAR and LDR, exert a more dominant influence on NPLs than macroeconomic variables. These findings highlight the importance of prudent credit expansion, effective risk management, and continuous monitoring of macroeconomic conditions to maintain banking stability.

CONCLUSION

This study demonstrates that the application of panel data regression using the Random Effects Model provides a comprehensive understanding of the determinants of Non-Performing Loans in banking. Internal banking variables play a dominant role in shaping credit risk, while macroeconomic variables serve as complementary factors. The fulfillment of classical assumptions strengthens the reliability of the estimation results and supports their use in policy formulation.

Despite its contributions, this study is subject to limitations related to variable scope and methodological approach. Future research is encouraged to incorporate broader macroeconomic indicators and adopt advanced analytical techniques, such as hybrid econometric and machine learning models, to enhance predictive accuracy and deepen insights into credit risk dynamics.

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