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# Macro Determinants on Non-Performing Loans of Indonesia Commercial Banks (Credit Risk Scenario)

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**Abstract**
A stable financial system is significant for an economy. Commercial banks play a critical role in facilitating the flow of credit and boosting the productivity of businesses through investment funding. In addition to receiving deposits, commercial banks provide loans to customers, exposing them to credit risk in the form of non-performing loans (NPL). This study aims to analyze the determinants of NPL and stress-test macro variables in the Indonesian banking system. The findings of this study, which used a data panel (Stata 17) and the Monte Carlo Stressing test of the Value at Risk (VAR) approach by studying a sample of 43 Commercial Banks listed on the IDX from 2008.1 to 2023.4, are significant. The main findings are Non-Performing Loan lag -1 (NPLt-1), Loan Deposit Ratio (LDR), Interest rate (SBI) and inflation (INF), and the significance of Non-Performing Loan (NPL). The results of the NPL Stress Scenario based on the VaR approach with interest rate and inflation shock carried out are still much lower than based on the provisions of Bank Indonesia Regulation Number 06/10/PBI/2004 concerning the Health Level Assessment System for Commercial Banks, the NPL ratio is 5 percent. It can be concluded that the NPL condition of commercial banks in Indonesia from 2008 to 2023 is still below the specified limit to face serious credit problems. These significant findings can engage and interest the audience, particularly those involved in the Indonesian banking system and macro-prudential policies, and provide them with valuable insights.

*Keywords—Commercial Banks; Non-Performing Loan; Value at Risk*

**Abstrak**
Sistem keuangan yang sehat sangat penting bagi perekonomian suatu negara. Lembaga keuangan khususnya Bank Komersial tidak hanya memfasilitasi aliran kredit dalam perekonomian, tetapi juga meningkatkan produktivitas unit bisnis melalui pendanaan investasi. Selain menerima simpanan, bank umum juga memberikan pinjaman kepada nasabah sehingga menimbulkan resiko kredit dalam bentuk *Non-Performing Loan* (NPL). Penelitian ini bertujuan menganalisis factor penentu NPLserta melakukan *stress testing variable* makro pada sistem perbankan di Indonesia. Penelitian menggunakan pendekatan data panel (Stata 17) dan *Value at Risk* dengan *Monte Carlo Stress Test* pada 43 sampel Bank Umum yang terdaftar di Bursa Efek Indonesia selama periode 2008.1 hingga 2003.4. Berdasarkan hasil olah, *Non-Performing Loan* pada periode sebelumnya (NPL-1), *Loan to Deposit Ratio* (LDR), suku bunga (SBI) dan Inflasi (INF) berpengaruh signifikan terhadap *Non-Performing Loan* (NPL). Sementara itu, hasil skenario s*tress test* NPL berdasarkan pendekatan VaR dengan shock suku bunga dan inflasi menunjukkan kondisi yang masih lebih rendah dibandingkan denan ketentuan Bank Indonesia berdasarkan peraturan nomor 06/10/PBI/2004 tentang Sistem Penilaian Tingkat Kesehatan Bank Umum dengan rasio NPL sebesar 5 persen. Sehingga dapat disimpulkan kondisi NPL Bank Umum di Indonesia selama periode 2008 hingga 2023 masih berada dibawah batas yang ditentukan untuk menghadapi permasalahan kredit yang serius. Temuan ini diharapkan dapat menarik perhatian pembaca dan memberikan wawasan khususnya bagi pengambil keputusan dalam sistem perbankan Indonesia dan kebijakan makroprudensial.

Kata kunci—Bank Komersial; *Non-Performing Loan*; *Value at Risk*

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## I. INTRODUCTION

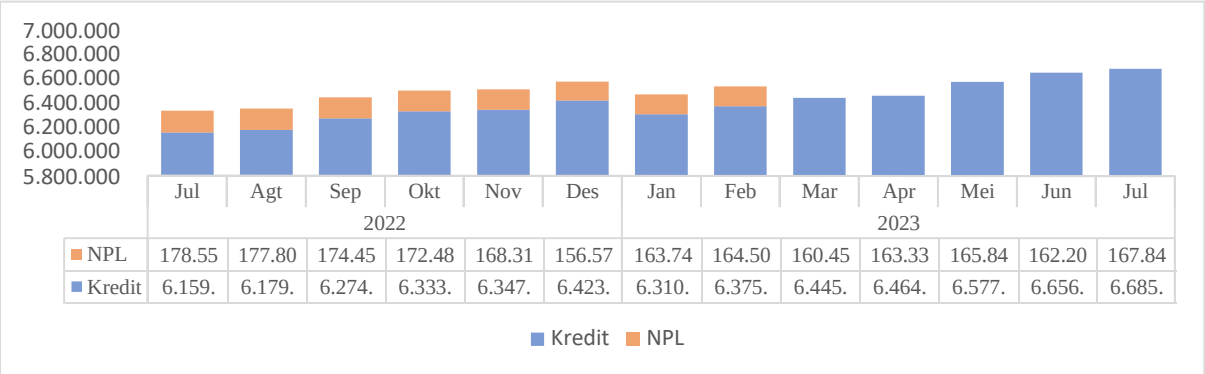
Sustainable economic growth integrates with economic growth, the environment, and social justice (Roseland, 2000; WCED, 1987; UNCED, 1992). Bank Indonesia establishes and implements macro-prudential policies to support sustainable economic growth. These policies encourage balanced, quality, and sustainable intermediation, mitigate and manage systemic risk, and increase economic and financial inclusion (BI Regulation No. 11 of 2023). The macro-prudential policy encompasses various tools to stabilize the entire financial system. It specifically focuses on identifying systemic risk and understanding how policies can impact the economic system as a whole (IMF, 2015). This study on the determinants of NPL and stress-testing of macro variables in the Indonesian banking system has the potential to improve the effectiveness of macro prudential policies significantly. The findings of this study can greatly inform and reassure the audience about the future of the Indonesian banking system, instilling confidence in the potential for a more stable and resilient financial system.

The global phenomenon of the 2008 crisis, which originated in the subprime mortgage market in the United States, had a systemic impact on the financial markets of both developed and developing countries. This impact extended to the emerging financial markets of subprime instruments, resulting in significant asset liquidation and large outflows. Consequently, there were sharp declines in equity markets, widening government bond spreads, exchange rate depreciation, and reduced bank lending in Asian markets (Diwa, 2010). Chung (2010) stated that the collapse of Lehman Brothers in the American financial system also caused a foreign exchange market crisis in Korea, where the country's actual economic conditions shrank rapidly. The Won plummeted against the dollar due to the exit of foreign investment funds and the deterioration of foreign currency lending conditions for domestic banks in Korea. This coincided with growing concerns about credit risk in the Korean financial markets.

The global financial crisis also affected banking conditions in Indonesia, leading to increased interest rates and banking liquidity by increasing deposit interest rates and lending interest rates on Conventional and Islamic banks. In addition, financial institutions, creditors, and investors in the US withdrew funds in forex, especially US dollars. Hence, the demand for dollars rose significantly, and depreciation occurred. Exchange rate fluctuations will also impact high price increases (inflation) (Hasbi, 2019).

A financial system is essential for an economy, and commercial banks play a pivotal role. They not only facilitate the flow of credit in the economy but also increase the productivity of business units through investment funding. As the main operating functions of commercial banks are accepting deposits and lending, they are exposed to credit risk in the form of bad debts, known as non-performing loans (NPLs). NPLs have received increasing international attention over the past few decades (Nikolopoulus & Tsalas. 2017; Anastasion, 2023). The increase in NPLs is claimed to be one of the main reasons for the decline in bank profitability. Suppose the ratio of non-performing loans or NPLs in the banking industry increases. In that case, it causes a slowdown in purchasing power and a decrease in income, which disrupts the debtor's ability to pay. In addition, high NPLs can adversely affect the bank's lending activities. So, it can be concluded that non-performing loans are usually used as an indicator to forecast bank failure (Bezt et al., 2017).

Based on data from the Financial Services Authority (OJK), the growth of loans and NPLs of commercial banks in Indonesia increased from 2022 to 2023, as shown in Figure 1.




| | Jul | Agt | Sep | Okt | Nov | Des | Jan | Feb | Mar | Apr | Mei | Jun | Jul |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2022 | | | | | | 2023 | | | | | | |
| NPL | 178.55 | 177.80 | 174.45 | 172.48 | 168.31 | 156.57 | 163.74 | 164.50 | 160.45 | 163.33 | 165.84 | 162.20 | 167.84 |
| Kredit | 6.159. | 6.179. | 6.274. | 6.333. | 6.347. | 6.423. | 6.310. | 6.375. | 6.445. | 6.464. | 6.577. | 6.656. | 6.685. |

Figure 1. Development of Loans and NPLs of Commercial Banks in Indonesia in 2022 - 2023
Source: OJK, data processed (2023)

The increase in NPLs above, according to OJK 2023, was due to credit restructuring policies due to the impact of the COVID-19 pandemic. Before the pandemic in 2019, the median NPL ratio of commercial banks was 2.6 percent, which means that the value of credit as financing disbursed by commercial banks that were bad or problematic was only 2.6 percent. However, during the COVID outbreak in 2022, the NPL ratio of commercial banks experienced an increasing trend beyond 3 percent. Therefore, OJK asks the financial services industry to conduct simulations to mitigate and know the impacts in the banking sector.

Based on several studies, most banking failures or crises are caused by non-performing loans (NPL) (Brownbridge, 1998); the 1997 Asian financial crisis (Li Yang, 2003) and the 2008 global financial crisis (Diwa, 2010) were caused by non-performing loans (NPL) (Brownbridge, 1998), for example: The 1997 Asian financial crisis and the 2008 global financial crisis (Diwa, 2010).

Ngọc Hà et al. (2014) conducted a study on macroeconomic factors and the ratio of non-performing loans in the banking system in Vietnam using a panel data regression model. The study also used the Value at Risk (VAR) approach to conduct macro stress testing to predict the level of non-performing loans and the expected losses that banks could suffer. It was found that the worst-case scenario for Vietnamese banks' minimum non-performing loan capital requirement to survive was 6 percent by the end of 2014. Quyen, P. D. (2012) researched the impact of macro variables on NPLs in commercial banks in Vietnam using the Vector autoregressive model. The historical data used to build macro scenarios are GDP growth, inflation, loans, and exchange rates. In his research, Shehata, KMF (2019) stated that the real GDP growth rate, loan interest rates, and unemployment rates significantly impacted the NPL ratio in commercial banks listed on the Egyptian Stock Exchange from 2010-2017. Furthermore, the NPL ratio in banks listed on the stock exchange is more sensitive than in banks not listed on the Egyptian Exchange.

Chi, Q & Li, W (2017) examined the impact of economic policy uncertainty on credit risk and bank lending in commercial banks in China from 2000 to 2014. The findings show a positive influence between economic policy uncertainty and the ratio of non-performing loans. Badar and Yasmin Javis (2013) examined the long-term and short-term dynamics between non-performing loans and macroeconomic variables in commercial banks in Pakistan. The variables used include inflation, exchange rates, interest rates, gross domestic product, and money supply. Empirical results show an influence between macroeconomic forces and non-performing loans in the long run. In short-term dynamics, the effect of inflation and exchange rates on non-performing loans is weak. Research conducted by Ahmed et al. (2021) found that credit growth, net interest margin, loan loss provision, and bank diversification significantly increase NPLs while operational efficiency, bank size, and ROA reduce NPLs. On the macro side, high interest rates, exchange rates, and political risk significantly increase NPLs, while GDP growth reduces NPLs.

Based on previous research conducted by Ahmed et al. (2021), Chi, Q & Li, W (2017), Ngọc Hà et al. (2014), Badar & Yasmin Javis (2013), Quyen, P. D. (2012), Shehata, KMF, (2019), Diwa (2010), this study aims: 1). to determining and examine what macroeconomic variables affect non-performing loans and, 2). to conduct a stressing test of macroeconomic variables on non-performing loans at commercial banks in Indonesia during the period 2008 to 2023. The contribution of this research provides policy recommendations related to factors affecting non-performing loans at commercial banks in Indonesia. It simulates the effect of macroeconomic variables, namely GDP and exchange rates, on the amount of NPL value required so that the adverse impact of the economy on non-performing loans does not harm the profitability and health of banks.

## II. LITERATURE REVIEW

Banks, as financial intermediaries, bridge the needs of customers who have funds and customers who need funds. Therefore, banks collect public funds in deposits and distribute them as credit. Based on Law No. 7 of 1992 concerning banking, as amended by Law No. 10 of 1998 Article 1 (paragraph 11), credit is the provision of money or bills that can be equated with it based on approval of a loan and borrowing agreement to pay off the debt after a certain period with interest. According to Taswan (2006), the purpose of credit provided will provide benefits for banks to maintain liquidity, for debtors to facilitate business, and for society to drive the economy. The elements contained in the provision of credit, according to Kasmir (2011), include Trust; that is, the credit given will be received in the future, Agreement; agreement between the giver and recipient of credit, Term consists of the agreed credit repayment period, Risk; the repayment period which causes the risk of uncollectible or loss of credit and, Service; profit on credit in the form of interest rates. Credit provided by banks includes investment credit, working capital credit, and consumer credit.

Based on POJK Number 18/PJOK.03/2016, credit risk is the risk arising from the failure of other parties to fulfill their obligations to the bank. This credit risk includes debtor failure, credit concentration risk, counterparty credit risk, and settlement risk. The ratio used by banks to measure the ability to manage the risk of debtors' failure to repay credit is called a non-performing loan. Following SE No.3/30 / DPNP dated 30 April 1997, NPL is the ratio of substandard, doubtful, and lousy quality loans to total loans where banks are expected to keep their NPLs below 5 percent. NPL values above 5% are considered high. This will interfere with the bank's lending and operational activities and cause losses to the bank. Therefore, the NPL ratio is critical because if the NPL value is high, banks must be able to provide more enormous reserves. The provision that must be formed to cover non-performing loans is regulated in OJK provisions of 50%, 75%, and 100% of the total loan amount, respectively. Therefore, the greater the provision, the negative impact it will have on the bank's capital adequacy, ultimately hampering bank asset growth.

Based on previous research, some factors that determine NPLs include Net Interest Margin (NIM). Net Interest Margin is a measure of the difference between interest income generated by banks or other financial institutions, where the value of interest paid to lenders is relative to the amount of the brand. The higher the NIM, the more influential the bank is in placing productive assets in the form of credit. The smaller the percentage of NIM, the more likely there will be a tendency for bad debts. The effect of NIM on NPL can be complex and has many meanings (Naili & Lahrichi, 2022). NIM is a net interest margin, which refers to income generated by banks and financial institutions and sources other than interest activities such as fees, commissions, and profits. Ozili (2019) and Adusei (2018) argue that NIM positively influences NPLs because if NIM is high, it will increase interest expense, so banks will increase interest margins to minimize losses from default risk. If NIM is higher, it shows that banks rely less on interest rate income, which means less sensitivity to interest rate fluctuations. So, it is hypothesized:

H1: Net Interest Margin (NIM) positively affects Non-Performing Loans (NPL).

Loan to Deposit ratio (LDR), according to BI Regulation No. 15/7/PBI/2013, is the ratio of loans granted to third parties in rupiah and foreign currencies, excluding loans to other banks, to third-party funds, which include demand deposits, savings, and deposits in rupiah and foreign currencies, excluding and between banks. Kasmir (2011) states that the Loan to Deposit Ratio is a ratio used to measure the composition of the amount of credit provided compared to the amount of public funds and capital used. The amount of LDR is determined by Bank Indonesia (BI) as the Central Bank in the form of the Macro-Prudential Intermediation Ratio (RIM) to keep banks healthy and able to carry out their functions properly, as stated in Bank Indonesia Regulation Number 24/16/PBI/2022. According to BI, banks' RIM value ranges from 80 - 92 percent, which can be implemented in Conventional Commercial Banks, Sharia Commercial Banks, and Sharia Business Units. If the third-party funds (LDR) are getting bigger, the higher the chance of NPLs and vice versa, Al Masud & Hossain (2020); Nurani, (2021); Astrini et al., (2018). This can happen if it is assumed that the bank can distribute credit effectively, so the number of bad debts will be small. In addition, the Loan Deposit Ratio (LDR) shows that banks have a significant ability to distribute credit compared to their deposits, which can result in greater credit risk for banks. Based on the research, hypothesized:

H2: The Loan-to-Deposit Ratio (LDR) positively affects Non-Performing Loans (NPL).

Based on Al Masud and Hossain's (2020) research, there is a negative and significant influence between GDP growth and NPLs, where banks with higher managerial efficiency and good asset utilization tend to have lower NPLs. This is in line with the findings of Ginting (2016), Ekanayake & Azeez (2015), and Messai & Jouini (2013) that macroeconomic conditions, especially gross domestic product, decrease on NPLs. This implies that economic improvements characterized by increased economic growth can reduce NPLs. Therefore, it is hypothesized:

H3: GDP growth (GDP growth) hurts Non-Performing Loan (NPL).

The effect of interest rates on NPLs is significant in determining the level of NPLs. Several studies conducted by Al Masud & Hossain (2020), Tanaskovic & Jandric (2015), and Buncic & Melecky (2012) state that an increase in interest rates causes an increase in NPLs. It is understood that an increase in interest rates will

Weaken the ability of borrowers to repay debts. In addition, actual interest rates are susceptible to lending problems in the banking system (Berge & Boye, 2007). Therefore, it is hypothesized that changes in interest rates can significantly affect the level of NPLs in a banking system. Which high interest rates can contribute to loan defaults so that it can be hypothesized:

H4: Interest rates (SBI) positively affect Non-Performing Loan (NPL).

The year-on-year change in the CPI represents inflation in quarter t. According to Nkusu (2011), inflation affects borrowers' debt servicing capacity through various channels. On the one hand, higher inflation can make debt repayment easier, either by reducing the actual value of outstanding loans or by being associated with lower unemployment, as indicated by the Phillips curve. Hence, the coefficient of this variable can be positive or negative. On the other hand, inflation can also weaken a borrower's ability to repay debt by reducing real income when wages are fixed. Al Masud and Hossain (2020) confirmed a positive influence between inflation and NPL. This implies that high inflation can weaken the ability of borrowers to repay their loans. So, it can be hypothesized:

H5: Inflation positively affects Non-Performing Loan (NPL).

The quarterly change in the IDR/USD exchange rate at time t. Exchange rate appreciation can have mixed impacts. It can weaken the competitiveness of export-oriented firms and adversely affect their ability to service their debt (Fofack, 2005). However, it can improve the debt servicing capacity of borrowers whose loans are denominated in foreign currency. Akinlo and Emmanuel (2014) found the exchange rate to be a determining factor for non-performing loans in Nigeria. The exchange rate has a positive influence on non-performing loans. Meanwhile, Buncic and Melecky (2012) found that changes in the exchange rate and control variables are not statistically significant on loans in their study on the macro-prudential stress test on credit risk. They explained that the statistical insignificance of the exchange rate is influenced by two conflicting effects of depreciation, namely the positive income effect and the negative balance effect. Thus, the impact of the exchange rate on NPL may vary.

H6: The exchange rate has a positive/negative effect on non-performing loans (NPLs).

Literature Gap

This research aims to examine the macroeconomic determinants of NPL and determine macro stress testing in Indonesia's banking system. The analysis approach refers to previous research by Ngoc Ha et al. (2014),which used NPLt-1, GDP, Interest rate, Inflation, and Exchange rate as independent variables that will influenceNPL. Meanwhile, research conducted by Naili and Lahrichi (2022) states that the smaller the Net Interest Margin(NIM) percentage, the more likely there will be bad credit. Hence, the researchers included the NIM variable. Meanwhile, in their research, Al Masud and Hossain (2020) used the Loan Deposit Ratio (LDR) variable, whichis assumed to affect NPL positively. Based on the research above, the independent variables used in this researchare NIM, LDR, GDP growth, SBI, Inflation (INF), and Exchange rate (ER) as variables that influence NPL in commercial banks in Indonesia.

## III. RESEARCH METHODOLOGY

The analytical method includes two testing stages: First, the determining factors of NPL are defined using a panel regression model. Second, macro stress testing should be carried out using the VaR (Value at Risk) method, a method used to measure the risk of loss of a portfolio. This method is prevalent in risk management, especially in developed countries. VaR is rarely applied in Indonesia, especially when determining the influence of risk management in the banking sector using a macroeconomic approach. Therefore, to determine the VaR stress testing method, the Monte-Carlo method approach is used, which is more similar to variance-covariance, where the parameters of a distribution are not measured but are assumed to carry out stress testing for credit risk in the banking system of commercial banks in Indonesia.

Based on the previous research above, the first stage will analyze the NPL equation using panel data on Commercial banks listed on the IDX from 2008 to 2023 using the following equation.

$$\boldsymbol{NPL_{i,t}} = Q_0 + Q_1\,\boldsymbol{NPL_{i,t-1}} + Q_2\,\boldsymbol{NIM_{i,t}} + Q_3\,\boldsymbol{LDR_{i,t}} + Q_4\boldsymbol{gGDP_{i,t}} + Q_5\,\boldsymbol{SBI_{i,t}} + Q_6\,\boldsymbol{INF_{i,t}} + Q_7\,\boldsymbol{ER_{i,t}} + s_{i,t}$$

*whi*ch one:
$NPL_{i,t} = Non\ Performing\ Loan$
$NPL_{i,t-1} = Provious\ years\ Non\ Performing\ Loan$
$NIM_{i,t}$ = Net Interest Margin
$LDR_{i,t}$ = Loan-to-deposit ratio
$gGDP_{i,t} = growth\ gross\ domestic\ product$
$SBI_{i,t}$ = SBI interest rate
$INF_{i,t} = Inflasi$
$ER_{i,t}$ = Exchange rate
$\beta_n = coeficient$
$\varepsilon_{i,t}$ = error term

Based on the equation above, the operational description of this research is presented in Table 1 .below.

Table 1. operational description of this research

| Variable | Defines Operational | Parameter | Scale |
|---|---|---|---|
| **Dependent** | | | |
| *Non-Performing Loan (NPL)* | The non-performing loan ratioof bank I at time t. This ratio ismeasured by the amount of substandard commercial bank credit to the total credit lent to customers. SE BI No 6/23/DPNP 2004 | $\text{NPL} = \frac{\text{Non-Current Credit}}{\text{Total credit issued}} \text{ x100\%}$ | Ratio |
| **Independent** | | | |
| *Net Interest Margin (NIM)* | The ratio between net interestincome and productive assets | $\text{NIM} \frac{Net\ Interest\ Incone}{\text{Average produktive assets}} \text{ x 100\%}$ | Ratio |
| *Loan to Deposit Ratio(LDR)* | The ratio between total credit granted to total third party fundsfrom time to time t SE BI No 3/30/DPNP 2001 | $\text{LDR} = \frac{\text{Total Credit}}{\text{Third-Party Fund}} \text{ x100\%}$ | Ratio |
| GDP growth (*Gross Domestic Product*) | The GDP growth rate over timet bi.go.id | $\text{GDP growth} = \frac{GDPt - GDPt-1}{GDPt-1} * 100$ | Percent |
| SBI | The SBI interest rate is the sizeof the investment return from securities issued by BI to Investors. Bi.go.id | Auction results from commercial banks andmoney market brokers registered with BI. | Ratio |
| INF (*Inflation)* | Changes in CPI over time,which represents inflation bi.go.id | $\text{INF} = \frac{\text{January s/d December}}{12} \text{ x100\%}$ | Percent |
| ER (*Exchange rate*) | Annual change in the Rp/USD exchange rate at time t. Exchange rate appreciation or depreciation can have varying impacts. Bi.go.id | | Rp/USD |

The data used is quarterly banking data from the first quarter of 2008 to the fourth quarter of 2023. Sample data based on existing criteria comes from 43 conventional banks listed on the IDX, i.e., BPD Banten, jtrust, Bank of India, MNC Inter, Raya Indo, KB Bukopin, Victoria, Neo Commerce, China Construction, BTN, BNI, Sinarmas, QNB, Mandiri, Artha Graha, BPD Jatim, IBK Indo, Maybank, Permata, Pan Indo, CIMB Niaga, Ganesha, Jago, Mayapada, Mestika Dharma, Danamon, Amar, Multiarta Sentosa, BRI, Mega, Bumi Arta, Ina Perdana, Capital Indo, Oke, OCBC NISP, BPD Jabar, BCA, Maspion, Krom Bank, Woori Saudara, National Nobu, BTPN (https://www.idxchannel.com/market-news/ list-of-bank-issuers-on-the-indonesian-stock-exchange-2023). Data sources also come from the Financial Services Authority (OJK), financial reports on each bank's website, and Bank Indonesia, which has 2751 observations.

After conducting panel data regression, based on the approach used by Ngoc Ha et al. (2014), the next step is to carry out macro stress testing with the stage of analyzing the sensitivity of non-performing loans to economic variables and secondly, developing a macro stress testing framework for credit risk in a commercial bank. The second stage of the research is conducting macro stress testing using the Value at Risk (VaR) approach.

The VaR approach is one of the most important and widely used statistical approaches to measure the worst potential losses in assessing bank capital adequacy based on NPL predictions over a certain period. The VAR approach includes three steps: Step 1: Build macroeconomic scenarios. Sensitivity analysis is applied to perform stress testing using the VaR approach. Specifically, one macro variable is given an artificial shock while the other variables are obtained stochastically in each stress scenario. Step 2: Predict the bank's NPL ratio using the scenarios that have been prepared. Using panel regression results, the predicted values of macroeconomic variables are substituted to obtain the NPL level. Because the baseline and stress scenarios contain stochastic macroeconomic indicators, NPL predictions using this approach must be stochastic and not deterministic as in the conventional approach. In general, calculate the estimated NPL value with the following two equations:

$$NPL_t = \beta_0 + \beta_1 NPL_{t-1} + \beta_z(Zt)$$

$Z \sim N(\mu_z, \sigma_z)$

Where Zt is a vector of customarily distributed economic variables at time t.
The 3 step is measuring stress scenarios based on predicted shock interest rate and inflation values in the forecast period, which have been obtained stochastically based on historical data's average and standard deviation.
In the VaR approach, Stochastic Loss Given Default (LGD) measures the VaR of the bank's expected loss or capital adequacy ratio. According to Greg & Rogers (2002) in Ngoc Ha et al. (2014) research, it is assumed that LGD follows a beta distribution between 0 and 1. Therefore, the VaR approach is more dynamic and stochastic for predicting NPL levels in stress scenarios than conventional approaches.

## IV. RESULT/FINDING

Descriptive statistical calculations from existing data for each variable are presented in Table 2 below.

Table 2.Descriptive statistical calculations

| | NPL | NIM | LDR | gGDP | SBI | INFLASI | ER |
|---|---|---|---|---|---|---|---|
| Mean | 3.455109 | 5.495210 | 86.42687 | 4.856129 | 5.967742 | 4.720323 | 1.237258 |
| Median | 2.710000 | 5.070000 | 84.35500 | 5.090000 | 6.000000 | 4.135000 | 1.325000 |
| Maximum | 81.60000 | 90.45000 | 748.4100 | 6.500000 | 9.250000 | 12.14000 | 1.640000 |
| Minimum | 0.000000 | -6.250000 | 0.000000 | -2.070000 | 3.500000 | 1.330000 | 0.860000 |
| Std. Dev. | 4.320347 | 3.643804 | 42.00079 | 1.861600 | 1.532524 | 2.418707 | 0.232083 |
| Skewness | 6.451177 | 5.915891 | 5.440137 | -2.556501 | 0.189971 | 1.035115 | -0.298155 |
| Kurtosis | 73.19030 | 116.5763 | 71.15784 | 9.411606 | 2.496749 | 3.791336 | 1.584822 |
| Jarque-Bera | 565763.9 | 1448478. | 529186.7 | 7470.519 | 44.16871 | 545.6486 | 261.9696 |
| Probability | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| Sum | 9211.320 | 14650.23 | 230414.0 | 12946.44 | 15910.00 | 12584.38 | 3298.530 |
| Sum Sq. Dev. | 49743.29 | 35384.03 | 4701236. | 9235.706 | 6259.101 | 15590.64 | 143.5441 |
| Observations | 2666 | 2666 | 2666 | 2666 | 2666 | 2666 | 2666 |

Sources: data processed (Stata 17 software)

In Table 2. above, it can be seen that the average value of the NPL variable is 3.454983 or 3.45%, with the lowest NPL value being 0.000000 or 0.00%, and the highest NPL value being 81.60000 or 81.60% with the distribution (standard deviation) NPL of 4.321153 or 4.32%. Based on the mean analysis of NPLs, it shows that commercial banks in the last decade (2008Q1-2023Q4) had good credit management performance because they were still able to maintain NPLs below the 5% requirement as determined by the OJK as the banking regulator and supervisor. Some banks still need to meet the 5% NPL limit, indicating the maximum NPL value reaching 81.60%. The NPLs of the 43 commercial banks listed on the IDX during the 2008 – 2023 period can be seen in Figre 2 below.

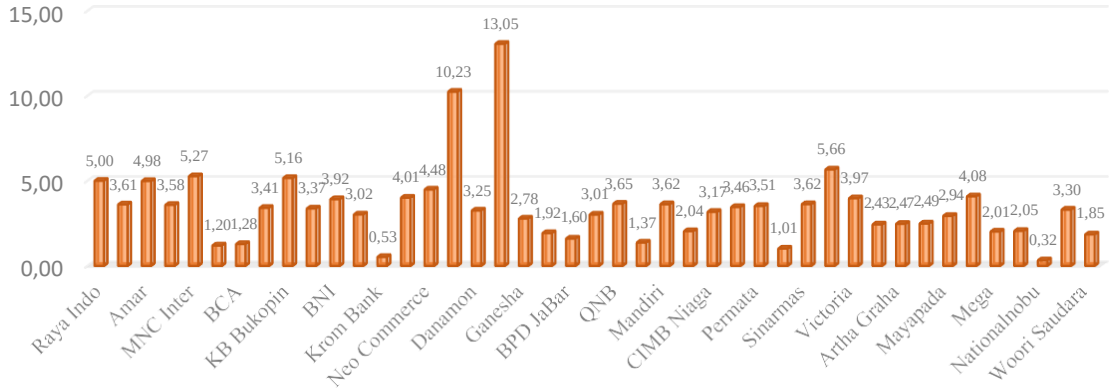



Figure 2 .Non-Performing Loans 43 Commercial Banks listed on the IDX, Period 2008 – 2023 (data processed)

The average value of the NIM variable is 5.495210 or 5.49%, with the lowest value of NIM being -6.250000 or -6.25% and the highest value of NIM being 90.45000 or 90.45% with a standard deviation of NIM of 3.189467 or 3. .19%. Based on the mean analysis of NIM, it shows that the interest income ratio in the last decade (2008Q1-2023Q4) has not had good credit management performance because it has not been able to maintain NIM above the 6% requirement as determined by the OJK as the banking regulator and supervisor. Some banks meet the NIM limit of more than 6%, indicating a maximum NIM value of 90.45%. The development of NIM for the 43 Commercial Banks listed on the IDX is as follows.

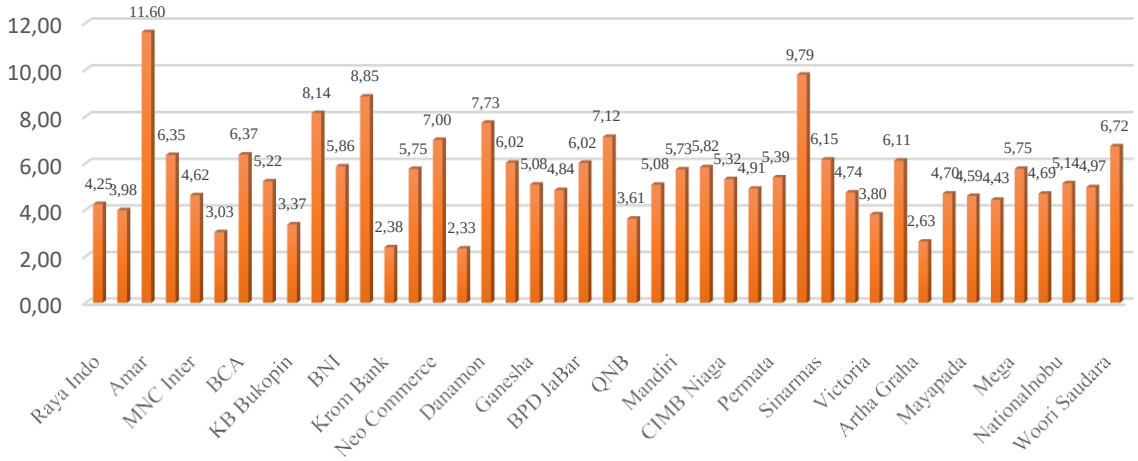



Figure 3.Net Interest Margin 43 Commercial Banks listed on the IDX, Period 2008 – 2023, (data processed)

In the LDR variable, the average value is 86.42687 or 86.43%, with the lowest LDR value being 0.000000 or 0% and the highest LDR value being 748.4100 or 748.41% with a distribution (standard deviation) of LDR of 42.00079 or 42 %. Based on the mean analysis of LDR, it shows that commercial banks in the last.

Decade (2008Q1-2023Q4) has good capital standards to limit risk-taking because they have maintainedan LDR of 78%-94% as determined by the OJK as the banking regulator and supervisor. Some banks meet the LDR limit of less than 78% -94%, indicating a minimum LDR value of 0%. Figure 4. shows the development of the LDR of 43 Commercial banks in Indonesia from 2008 to 2023.

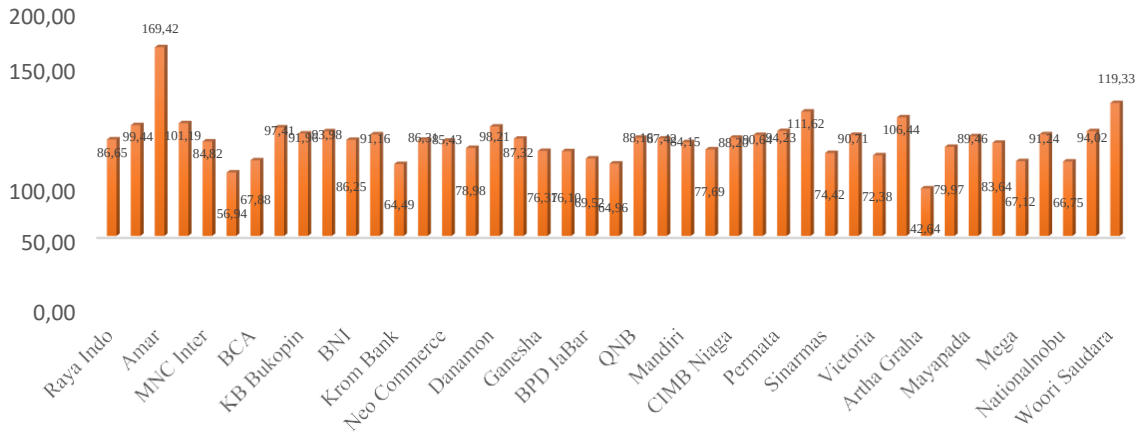



Figure 4. Loan to Deposit Ratio 43 Commercial Banks listed on the IDX, Period 2008 – 2023 (data processed)

The average value of the GDP Growth variable is 4.856129 or 4.86%, with the lowest value of GDP Growth being -2.070000 or -2.07% and the highest value of GDP Growth being 6.500000 or 6.5% with the distribution (standard deviation) small GDP growth of 1.861600 or 1.86%. A standard deviation reflects that Indonesia's GDP growth in the last decade has tended to be stable from year to year. Indonesia's GDP growth is still positive until the first quarter of 2020, which means the economy continues to contract yearly, to be expected. However, in the second quarter of 2020, Indonesia's GDP growth was negative until the first quarter of 2021. However, until last year, Indonesia's GDP growth returned positive, reflecting a stable economy.

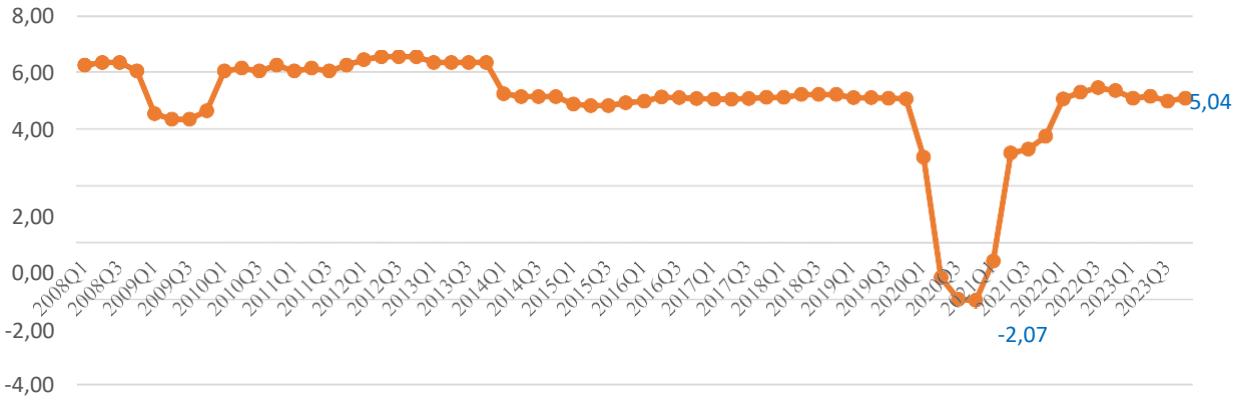



Figure 5. Indonesia GDP Growth, Period 2008 – 2023 (data processed)

Furthermore, the average value of the SBI variable is 5.967742 or 5.97%, with the lowest SBI value being 3.500000 or 3.5% and the highest SBI value being 9.250000 or 9.25%, with a standard deviation of SBI amounting to 1.532524 or 1.53%. SBI has averaged 5.97% in the last decade, with movements ranging from a minimum of 3.5% in 2021 to a maximum of 9.25% in 2008. The movement in interest rates from 2008 to 2023 can be seen in Figure 6. below.

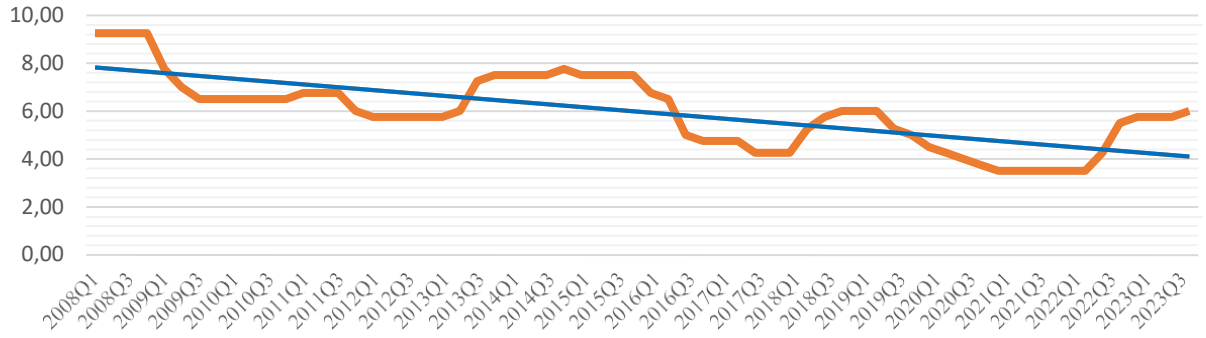



Figure 6. Indonesia SBI rate, Period 2008 – 2023 (data processed)

The average value of the Inflation variable in Indonesia is 4.720323 or 4.72%, with the lowest value of Inflation being 1.330000 or 1.33% and the highest value of Inflation being 12.14000 or 12.14% with a spread (standard deviation) of Inflation amounting to 2.418707 or 2.42%. Inflation in Indonesia in the last decade has had the highest value above 10% or has exceeded single-digit inflation and is outside the Government's inflation target, which means that the Government has not controlled inflation well for three quarters in 2008, namely during the monetary crisis.

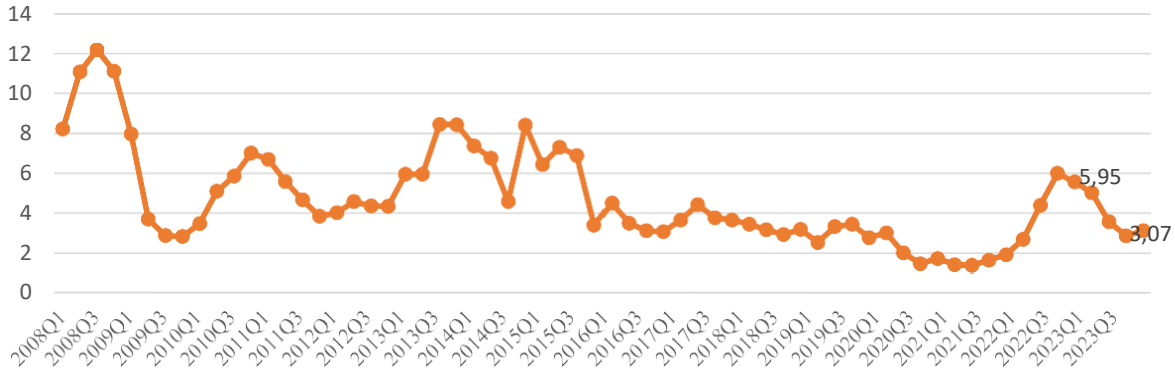



Figure 7. Indonesia Inflation rate, Period 2008 – 2023 (data processed)

Finally, the average value of the exchange rate variable in Indonesia is 12374.43, with the lowest value of the exchange rate being 8640,000 and the highest value of the exchange rate being 16448.84 with a spread (standard.

Regression Model Selection

The selection of the regression model is between the three-panel data models, namely the expected effect (CEM), fixed effect (FEM), and random effect (REM) methods. To get the best model, the Chow test is carried out first, followed by the Haussmann test, and then the Lagrange Multiplier test, as shown in Table 3.

Table 3 .Estimation Model Determination Result

| Test Type | Result | Conclusion |
|---|---|---|
| Chow test | *p-value cross section c-square (*F-statistic) α0,0000 < 0,10, so H0 rejected, and Ha accepted | FEM is better than CEM |
| Hausman Test | p-*value cross-section random* (Chi square-stat)α 0,0000 < 0,10, so H0 rejected, and Ha accepted | FEM is better than REM |
| Lagrange Multiplier Test | *p-value cross-section Breusch Pagan* (F-stat) α 0,0000 < 0,10, so H0 rejected dan Ha accepted | FEM is better than REM |

Sources: data processed (Software Stata 17)

Thus, in this research, the selected regression model is the fixed effect model, as shown in Table 4. following.

Table 4 Panel Data Regression (Fixed Effect Model)

Fixed-effects (within) regression — Number of obs = 2,751
Group variable: ID — Number of groups = 43

R-squared:
Within = 0.4587
Between = 0.9843
Overall = 0.5797

Obs per group:
min = 63
avg = 64.0
max = 64

Corr(u_i, Xb) = 0.4793 — F(7,2701) = 326.95; Prob > F = 0.0000

| NPL | Coefficient | Std. err. | t | P>\|t\| | [95% conf. | interval] |
|---|---|---|---|---|---|---|
| NPL_L1 | .6540511 | .0142912 | | 45.77 | .6260282 | .6820739 |
| | | | | 0.000 | | |
| NIM | .0295998 | .0192323 | 1.54 | 0.124 | -.0081117 | .0673114 |
| LDR | .0082564 | .0015281 | 5.40 | 0.000 | .0052601 | .0112527 |
| GDP | -.035673 | .0347783 | | -1.03 | -.1038677 | .0325218 |
| | | | | 0.305 | | |
| SBI | .133981 | .060402 | 2.22 | 0.027 | .0155421 | .2524199 |
| INF | -.0625501 | .0373479 | | -1.67 | -.1357834 | .0106833 |
| | | | | 0.094 | | |
| ER | -.0000128 | .0000278 | | -0.46 | -.0000673 | .0000418 |
| | | | | 0.646 | | |
| _cons | .1358987 | .553992 | 0.25 | 0.806 | -.9503925 | 1.22219 |
| sigma_u | .79600886 | | | | | |
| sigma_e | 2.7062808 | | | | | |
| rho | .07962592 | (fraction of variance due to u_i) | | | | |

F test that all u_i=0: F(42, 2701) = 4.02 — Prob > F = 0.0000

Sources: data process (Software Stata 17)
Note: *significance with alpha 0.10;

The following is the panel data regression equation.

$NPL_{i,t}$= 0.1358987 + 0.6540511$NPL_{i,t-1}$ + 0.0295998$NIM_{i,t}$ + 0.0082564$LDR_{i,t}$ – 0.035673g$GDP_{i,t}$ + 0.133981$SBI_{i,t}$ – 0.0625501$INFI_{i,t}$ – 0.0000128$ER_{i,t}$ + $e_{i,t}$

F Test and Coefficient of Determination.

The F-Test results show that the model's p-value Prob F-statistic is 0.000000, more diminutive than 0.10. Thus, Ho in the F-Test is rejected, and Ha is accepted. Hence, NPL_L1, NIM, LDR, GDP Growth, SBI, Inflation, and Exchange Rate significantly influence NPL. The coefficient of determination (Adjusted $R^2$) shows that NPL_L1, NIM, LDR, GDP Growth, SBI, Inflation, and Exchange Rate contribute 0.5797 or 57.97% to NPL. Variables outside this research influence the remaining 42.03%.

t-test

The t-test results show that the model has a p-value t-statistic for the independent variable NPLt-1, which is 0.0000, more diminutive than 0.10, so Ho in the t-test is rejected, and Ha is accepted. Thus, NPLt-1 has a significant influence on NPLs. The NPLt-1 coefficient is 0.6540511, indicating the direction of a positive impact on NPL, meaning that changes in NPLt-1 are in the same direction as changes in NPL; if NPLt-1 increases, then NPL will increase and vice versa.

The independent variable NIM, the model has a p-value t-statistic of 0.124, more significant than 0.10, so Ho in the t-test is accepted, and Ha is rejected. Thus, NIM has little influence on NPL. The NIM coefficient is 0.0295998, indicating a positive impact on NPL, meaning that changes in NIM are in the same direction as changes in NPL; if NIM increases, then NPL will increase and vice versa.

The t-test for variable LDR is 0.000, which is smaller than 0.10. If Ho in the t-test is rejected, Ha is accepted. Thus, LDR has a significant influence on NPL. The LDR coefficient is 0.0082564, indicating a positive direction of influence on NPL, meaning that changes in LDR are in the same direction as changes in NPL. If LDR increases,

then NPL will increase, and vice versa.

The t-test for variable GDP growth is 0.305, more significant than 0.10, so Ho is accepted, and Ha is rejected. Thus, GDP Growth does not significantly influence NPL. The GDP Growth coefficient is -0.035673, indicating a negative influence on NPL, meaning that changes in GDP growth are in the same direction as changes in NPL. If GDP growth increases, then NPL will decrease, and vice versa.

The t-test results for the independent variable SBI show that the model has a p-value t-statistic of 0.027, more diminutive than 0.10. Thus, Ho in the t-test is rejected, and Ha is accepted. Therefore, SBI has a significant influence on NPL. The SBI coefficient is 0.133981, indicating a positive impact on NPL. This means that changes in SBI are in the same direction as changes in NPL. If SBI increases, then NPL will increase, and vice versa.

For variable Inflation, the t-test shows that the model has a t-statistic p-value of 0.094, which is smaller than 0.10, so Ho for the t-test is accepted, and Ha is accepted. Thus, inflation does not have a significant influence on NPL. The Inflation Coefficient is -0.0625501, indicating a negative direction of influence on NPL, meaning that changes in inflation are in the same direction as changes in NPL; if inflation increases, then NPL will decrease and vice versa.

Finally, the results of the t-test show that the model has a p-value t-statistic for the independent variable Exchange Rate, which is 0.646, which is greater than 0.10, so Ho in the t-test is accepted, and Ha is rejected; thus, the Exchange Rate does not have a significant influence on NPL. The Exchange Rate coefficient is 0.0000128, indicating a positive impact on NPL, meaning that changes in the Exchange Rate are in the same direction as changes in NPL; if the Exchange Rate increases, then NPL will decrease and vice versa.

Correlation Coefficient and Multicollinearity

Table 5. presents the Pearson correlation for a pair of variables. The test results show that all independent variables are significantly related to NPL at a critical value of at least 10%. The automatic regression parameter, NPL at one period lag, was found to have a solid and positive relationship with NPL, while other variables also had a positive relationship. Only the exchange rate variable has a negative relationship. Table 5. shows that the absolute value of the correlation coefficient between the independent variables varies from -0.54 to 0.80. This correlation coefficient indicates that there is no multicollinearity issue between these variables.

Table 5. *Pearson Correlation*

| Correlation<br>Probability | NPL | NPL_L1 | NIM | LDR | GGDP | SBI | INFLASI | ER |
|---|---|---|---|---|---|---|---|---|
| NPL | 1.000000<br>---------- | | | | | | | |
| NPL_L1 | 0.762898<br>0.0000 | 1.000000<br>----- | | | | | | |
| NIM | 0.062715<br>0.0012 | 0.040073<br>0.0386 | 1.000000<br>----- | | | | | |
| LDR | 0.163991<br>0.0000 | 0.124124<br>0.0000 | 0.450110<br>0.0000 | 1.000000<br>----- | | | | |
| GGDP | -0.013066<br>0.5002 | -0.019964<br>0.3029 | 0.188740<br>0.0000 | 0.038109<br>0.0492 | 1.000000<br>----- | | | |
| SBI | 0.071734<br>0.0002 | 0.054850<br>0.0046 | 0.355686<br>0.0000 | 0.199647<br>0.0000 | 0.494360<br>0.0000 | 1.000000<br>----- | | |
| INFLASI | 0.074482<br>0.0001 | 0.082567<br>0.0000 | 0.366807<br>0.0000 | 0.224286<br>0.0000 | 0.512396<br>0.0000 | 0.804014<br>0.0000 | 1.000000<br>----- | |
| ER | -0.047771<br>0.0136 | -0.056196<br>0.0037 | -0.254410<br>0.0000 | -0.006188<br>0.7495 | -0.494993<br>0.0000 | -0.549084<br>0.0000 | -0.457554<br>0.0000 | 1.000000<br>----- |

Sources: data processed (Software Stata 17)

Based on the initial regression results, the p-value was consistently significant and better; therefore, the author chose to keep NIM and SBI in the model. A redundant variable (Wald) test is conducted to find the most appropriate model for the next forecasting stage.

Redundant Variable Test

The Pooled OLS model presents four independent variables that have statistically significant coefficients with NPL, including NPL_t-1, NIM, LDR, GDP, SBI, Inflation (INF), and Exchange Rate (ER). NIM, GDP, and ER variables do not have a significant relationship with NPL. In addition, researchers are interested in finding the most appropriate model for forecasting purposes for the next stage.

The NIM, gGDP, and ER variables based on initial processing are not significant, as mentioned in the regression results in Table 6. so these variables are excluded from the regression model. Apart from not having a considerable coefficient with NPL, this raises concerns if the regression model has excessive variables. The inflation variable is not excluded because the coefficient value has a relationship according to the theory. Therefore, the redundancy test (Wald test) is used to test the estimates of the NIM, GDP, and ER variables after testing. As a result, lagging NPLt-1, LDR, Inflation (INF), and SBI remain in the model where the F-statistic increases to 571.11 from 326.95 in the previous model.

Table 6 . Data Panel Regression after removing variable NIM, gGDP, and ER

```
Fixed-effects (within) regression               Number of obs      =      2,751
Group variable: ID                              Number of groups   =         43

R-squared:                                      Obs per group:
     Within  = 0.4579                                         min =         63
     Between = 0.9880                                         avg =       64.0
     Overall = 0.5805                                         max =         64

                                                F(4,2704)          =     571.11
Corr(u_i, Xb) = 0.4886                          Prob > F           =     0.0000

------------------------------------------------------------------------------
         NPL | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      NPL_L1 |   .6559246   .0142173    46.14   0.000     .6280468    .6838024
         LDR |   .0090879   .0014131     6.43   0.000     .0063169    .0118588
         SBI |   .1433252   .0569626     2.52   0.012     .0316307    .2550198
         INF |  -.0624811   .0360665    -1.73   0.083    -.1332019    .0082396
       _cons |  -.1684229   .2536179    -0.66   0.507    -.6657275    .3288817
-------------+----------------------------------------------------------------
     sigma_u |  .78032703
     sigma_e |  2.7065951
         rho |  .07674146   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(42, 2704) = 3.94                     Prob > F = 0.0000
```

Sources: data processed (Software STATA 17)
Note: *significance with alpha 0.10.

Below is the panel data regression equation after removing the NIM, growth GDP, and ER variables.

$NPL_{i,t} = -0.1684229 + 0.6559246NPL_{i1} + 0.0090879LDR_{i,t} + 0.1433252SBI_{i,t} - 0.0624811INFI_{i,t} + ei_{,t}$

Constant Test

The numbers in the constant test are calculated to see Non-Performing Loans in the 43 commercial banks that are the research sample if the panel data regression results are a Fixed Effect Model. Based on the results of the sum of the individual effect and intercept in the panel data regression model by removing the NIM, growth, and ER variables in the regression model, it is known that the five commercial banks that have the highest NPL values are BTPN with an intercept value of 0.151456162, Nationalnobu: 0.123817324, Woori Brother: 0.116789424, Krom Bank: 0.110420108 and Maspion bank: 0.087759716. Meanwhile, the five commercial banks that have the lowest NPL values are BPD Banten: -0.599445396, Jtrust: -0.441645097, Bank of India: - 0.158059266, MNC Inter: -0.1440531, and Raya Indo: -0.127566553.

Macro Stress Testing Using the Monte Carlo Value at Risk (Var) Method Approach

The VaR (Value at Risk) method is prevalent in risk management and became widely known in 1994 when JP Morgan created a risk metrics system (VaR-based) www.jpmorgan.com. VaR has three approaches: The Historical Simulations Method, the -Covariance Method, and the Monte Carlo Simulation method (Best, 1998). This research uses the Monte Carlo method because it is a relatively simple VAR measurement method with the advantage of accuracy. Therefore, the method also aims to introduce the Monte-Carlo method for carrying out credit risk stress testing in the banking system of commercial banks in Indonesia. The framework for the VaR approach based on Wong et al. (2006) is as follows.

Step 1: Develop a macroeconomic scenario

As previously mentioned, the Inflation and SBI variables were obtained to build macro scenarios. For the base scenario, the inflation and SBI values in the forecast period have been obtained stochastically based on historical data's average and standard deviation (see Table 2).

For the stress scenario, the effects of artificial shocks, including inflation and SBI shocks, are used to test the bank's resilience in unfavorable conditions. Because the data was obtained in 2008, the baseline scenario captured the alarming situation of the global financial crisis from 2007 to 2008. In each stress scenario, one of the two variables, Inflation and SBI, will experience a shock, and the other will experience a shock. Randomly, as in the baseline. The two stress scenarios are defined as follows:

- Stress scenario with decreasing inflation shock: Indonesia's y-o-y inflation rate fluctuates at 5.58%, 5.58%, 5.07%, 3.81%, 3.73%, 3.27% for each of the six quarters consecutively starting from 2022: Q3.

- Stress scenario with increasing SBI shock: BI Interest Rate fluctuates by 4.04%, 5.21%, 5.70%, 5.75%, 5.75%, and 5.96%, respectively, for six consecutive quarters starting from 2022: Q3.

Step 2: Predict the bank's NPL ratio using the prepared scenario

This section applies the Monte-Carlo simulation to perform stress testing using the VaR approach. NPL estimates in the baseline and stress scenarios will be measured using macroeconomic variables, namely the inflation rate and SBI interest rates (according to inflation targeting policy), which can influence the Indonesian economy using the following equation:

a) Baseline scenario
   NPLi, t = -0.1684229 + 0.6559246NPLt-1 + 0.0090879LDRi, t + 0.1433252SBIi, t - 0.0624811INFi, t
   SBI ~ N (5.967742, 1.532524)
   INF ~ N (4.720323, 2.418707)
   The results in Table 4.1 are used to calculate constant values and correlation parameters. In this scenario, the SBI interest and inflation rates are usually distributed. For simplicity, they are assumed to be normally distributed.

b) Stress scenario with an increase in the SBI shock interest rate

c) NPLi, t = -0.1684229 + 0.6559246NPLt-1 + 0.0090879LDRi, t + 0.1433252SBIi, t - 0.0624811INFi, t
   SBI ~ N (5.967742, 1.532524)
   In this scenario, the inflation variable is stochastic, while the SBI interest rate variable experiences shocks with artificial values mentioned in the first step of this approach. The reverse method will be applied for the second stress scenario.

d) Stress scenario with a decrease in the shock inflation rate

e) NPLi, t = -0.1684229 + 0.6559246NPLt-1 + 0.0090879LDRi, t + 0.1433252SBIi, t - 0.0624811INFi, t
   INF ~ N (4.720323, 2.418707)

Table 7. presents the results of each baseline, stress scenario, and corresponding NPL of a hypothetical bank (assuming the bank's NPL equals 2.56% in the 4th quarter of 2023). After running some simulations, the following average estimated NPL level for 2023 quarter four is obtained: around 2.56% in the baseline scenario and around 1.78% in the stress scenario. The expected NPL level is still below the stress scenario in the VaR approach, which is much lower than the conventional approach, which is determined where the maximum NPL is below 5%. This is because both the macro variables SBI interest rate and inflation rate (sensitivity analysis) experience shocks in the first approach, compared to the two variables SBI interest rate and inflation rate (scenario analysis) in the latter approach.

Table 7. NPL predictions from 2022: Q3 to 2023: Q4 under the baseline scenario and stress scenario using Monte Carlo simulation (% and Rupiah/$)

| Period | Baseline | | | | Stress Scenario 1: SBI Shock | | | | Stress Scenario 2: INF shock | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INF | SBI | LDR | NPL | INF Shock | SBI | LDR | NPL | INF | SBI Shock | LDR | NPL |
| 2022: Q3 | 5.95 | 4.25 | 82.05 | 3.16 | 5.58 | -1.33 | 76.47 | 1.57 | 0.67827 | 4.04 | 78.01 | -0.88 |
| 2022: Q4 | 5.51 | 5.50 | 84.27 | 2.83 | 5.58 | -0.08 | 78.69 | 1.51 | 0.94481 | 5.21 | 79.06 | -2.38 |
| 2023: Q1 | 4.97 | 5.75 | 96.04 | 2.90 | 5.07 | 0.68 | 90.97 | 1.57 | 1.14780 | 5.70 | 90.34 | -2.80 |
| 2023: Q2 | 3.52 | 5.75 | 98.31 | 3.00 | 3.81 | 1.94 | 94.50 | 1.79 | 1.63352 | 5.75 | 92.56 | -2.75 |
| 2023: Q3 | 3.82 | 5.75 | 83.41 | 3.00 | 3.73 | 2.02 | 79.68 | 1.80 | 1.50524 | 5.75 | 77.66 | -2.75 |
| 2023: Q4 | 3.07 | 6.00 | 87.37 | 2.56 | 3.27 | 2.73 | 84.10 | 1.78 | 1.94024 | 5.96 | 81.41 | -3.40 |

Sources: Data Processed

## V. DISCUSSION

*The effect of NIM on NPL*

NIM is assumed to have a positive effect on NPL. This follows research conducted by Ozili (2019) and Adusei (2018). However, in contrast to Naili and Lahrichi (2022), the influence of NIM on NPL can be complex. Based on the results of panel data processing for 43 commercial banks in Indonesia, NIM does not significantly affect NPL. Suppose you look at the developments shown in Figure 8. NIM and NPL for several periods before and moved down together in 2008: Q2. In 2008, there was a decline in credit expansion when the global financial crisis occurred because many business actors went bankrupt and could not deal with their business. In 2009: Q4, both NPL and NIM increased again until 2011: Q1 and fluctuated until 2023.

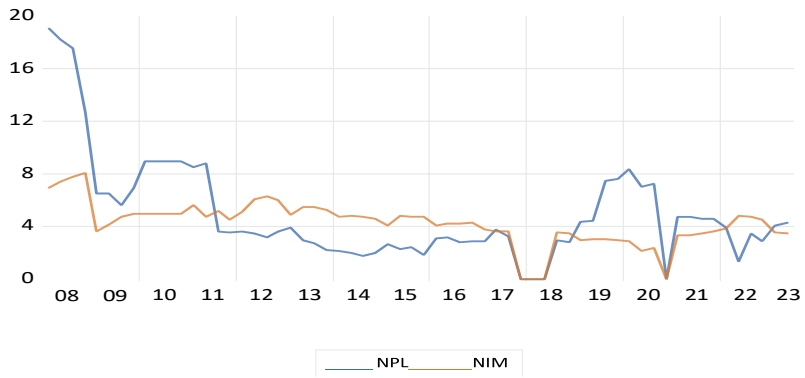



Figure 8. Influence of the NIM variable with NPL (data processed)The

*Effect of LDR on NPL*

LDR is assumed to have a positive effect on NPL for several different moving periods. Empirically, in Figure 9, LDR fell drastically in 2008: Q2, while NPL was insignificant and tended to fluctuate stably. This differs from the LDR, which experienced a drastic decline in 2017: Q2 and 2020: Q2. This happened due to the 2008 global crisis and the emergence of the Covid-19 pandemic. Based on panel data processing on commercial banksin Indonesia in Table 6, the LDR coefficient value of 0.0090879 shows a positive and significant influence on NPL. This means that changes in LDR are in the same direction as changes in NPL. If LDR increases, NPL will increase, and vice versa. The processed data hypothesis is based on research conducted by Al Masud and Hossain(2020), Nurani (2021), and Astrini et al. (2018).

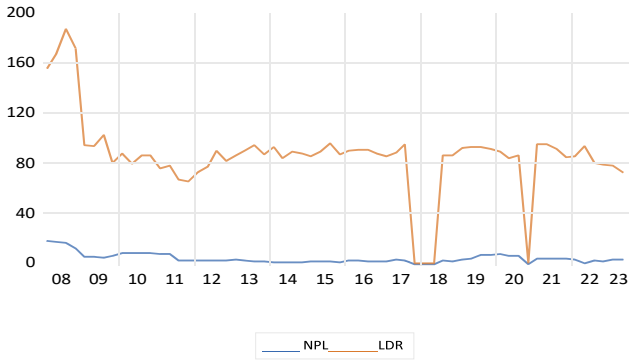



Figure 9. Influence of the LDR variable with NPL (data processed data)

*The Effect of GDP Growth on NPL*

The effect of GDP growth on NPL is to the hypothesis and previous research conducted by Al Masud and Hossain (2020), Ginting (2016), Ekanayake & Azeez (2015), Messai & Jouini (2013) and Akinlo & Emmanuel (2014). The negative influence of GDP growth on NPL is that when GDP growth increases, it shows that the economy is healthy and developing, which causes increased employment levels, higher income levels, and overall economic improvement. As a result, borrowers become better able to pay off their debts, thereby reducing the NPL level. On the other hand, if the economy experiences a crisis, consumption will increase due to an increase in the price of goods and scarcity, thereby reducing the savings rate (according to Keynes' theory). So, if economic growth improves, the businesses carried out by the community will run well, and the community will be able to pay for credit, thereby reducing the number of loan problems. During periods of economic growth, banks may be willing to lend money to stimulate further economic activity and contribute to lower NPLs

Figure 10. NPL is assumed to be negatively related to GDP growth in the initial period, moving together downwards even though only NPL decreased significantly in 2019: Q1. NPL experienced a drastic decline until it was below GDP growth starting in 2011: Q1 until 2019: Q4. The decline in GDP growth was quite drastic when the COVID-19 pandemic caused the Indonesian economy to weaken. NPL also received the impact by falling drastically in 2020: Q2. The decline in NPL occurred due to the 2008 global crisis and the emergence of the Covid-19 pandemic.

On the other hand, contrary to previous research, the findings of Tanaskovic and Jandric (2015) state that GDP growth has a positive effect on NPL. This condition can occur during an economic crisis or a period of slow GDP growth; borrowers may face financial difficulties, which causes borrowers to face difficulties in paying the return of the loan, increasing NPL. Therefore, the positive influence between GDP growth and the NPL ratio can be attributed to the economy's overall health and the ability of individuals and businesses to meet their financial obligations. Based on the results of panel data processing on 43 commercial banks in Indonesia, GDP growth is insignificant to NPL.

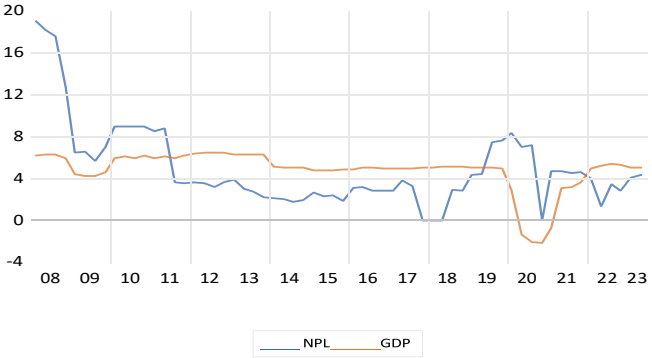



Figure10 .The influence of the GDP growth variable on NPL (processed data)

*The influence of variable SBI interest rates on NPL*

A positive influence exists between the SBI interest rate and non-performing loans (NPL). A higher real interest rate will create difficulties for borrowers to fulfill their financial obligations, increasing defaults (Messai

and Jouini (2013). This is based on research conducted by Al Masud and Hossain (2020), which found a significant favorable influence between actual interest rates and NPLs. These findings support the idea that higher interest rates can contribute to non-paying loans. Research conducted by Tanaskovic and Jandric (2015), The effect of interest rates on non-performing loans (NPLs) in an economy There is a strong impact between interest rates and NPL where an increase in interest rates causes an increase in the NPL ratio. Buncic and Melecky (2012) found that the NPL ratio tends to increase when economic growth decreases, and actual interest rates are also susceptible to loan problems (Berge & Boye, 2007).

Figure 11. NPL is assumed to be positively related to the SBI interest rate in the initial period, moving together in 2008: Q3, although only NPL decreased drastically until 2009: Q1. In 2019, Q2 NPL experienced an increase, while SBI looked relatively stable and was above NPL in 2011. From 2018 to 2020, NPL experienced an increase but fell drastically in 2020 Q1, caused by COVID-19, which caused the Indonesian economy to suffer. 2020 experienced deflation or a drastic decline because economic development in Indonesia had an unstable movement. This situation occurred during the COVID-19 pandemic regarding the monthly interest rates on Bank Indonesia Certificates collectively and individually.

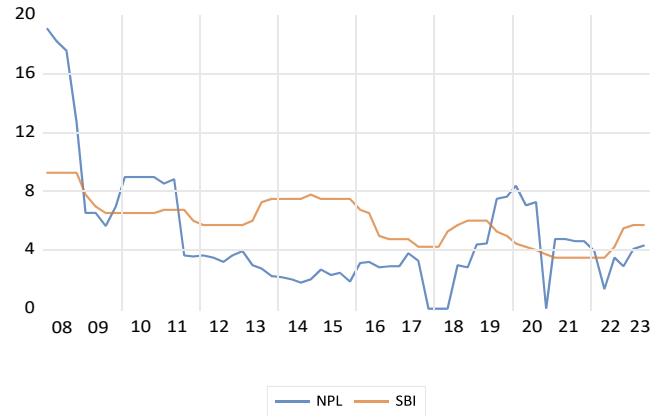



Figure 11. The influence of the SBI interest rate variable on NPL (data processed data)

*The influence of the inflation variable on NPL*

Based on the processing results, inflation and NPL have a negative influence. Based on the results of panel data processing, inflation hurts NPL at 43 commercial banks in Indonesia. The results of this research are based on Nkusu (2011), who states that increasing inflation can weaken the borrower's ability to repay their loans. Meanwhile, Ekanayake and Azeez's (2015) research showed that inflation positively influenced non-performing loans in Sri Lanka between 1999 and 2012. Figure 12. shows that NPL decreased drastically from 2008Q1 to 2009: Q2. Meanwhile, inflation increased in 2008: Q1 and fell drastically until 2009: Q2. Inflation experienced a fluctuating movement, rising above the NPL until 2015. Meanwhile, the NPL experienced an increase in 2017: Q2 to 2020 and fell again during the Covid-19 pandemic in 2020: Q1. Inflation was also impacted by COVID-19, which caused the Indonesian economy to be sluggish from 2020: Q2 to 2022: Q4.

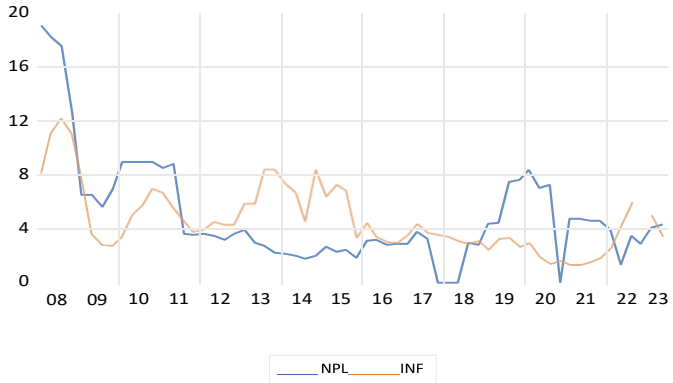



Figure 12. Influence of Inflation Variables on NPL (processed data)

*The influence of the variable Exchange Rate on NPL*

The exchange rate is the price of a country's currency against other countries. Changes in exchange rates are very vulnerable to external credit problems and the fall of exchange rates due to panic by market participants. The effect of exchange rates on non-performing loans will impact economic activity, especially for producers who use imported raw materials. If the exchange rate depreciates, the price of imported raw materials will increase and burden production costs, impacting business profits and producer income. Furthermore, producers as debtors will be affected by bank loan repayments. In contrast, Buncic and Melecky (2012) explained the insignificance of the effect of a depreciated exchange rate. According to him, the exchange rate factor and other control variables do not significantly influence NPLs when considering banking policy and macro-prudential supervision. Empirically, chart 5.6. The IDR/USD exchange rate fluctuated due to a weakening during the 2008 global crisis: Q3. Rising inflation in 2014-2015 caused the exchange rate to weaken until 2016. Significant changes occurred again in 2019: 4 due to the COVID-19 pandemic, and until 2023, the IDR/USD exchange rate continued to weaken. Meanwhile, the NPL is below the exchange rate due to different ratios.

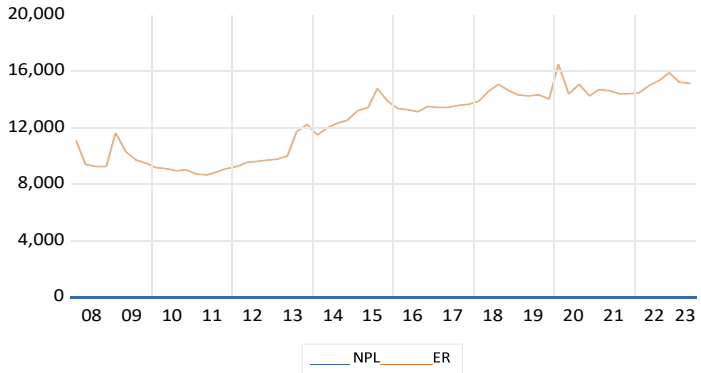



Figure 13. Effect of Exchange Rates on NPL (processed data)

*Stress Scenario*.

The stress test process, using a Monte Carlo simulation approach, aims to evaluate how banks perform in bad conditions so that it can help identify potential vulnerabilities and risks in banking operations. The variable shocks to the SBI interest rate and inflation rate, which are part of monetary policy to maintain inflation targeting, are used to assess bank resilience in adverse conditions that significantly affect NPL. The shocks are expected to determine how the bank's financial stability will be impacted in various stress scenarios.

The results of processing the VaR approach from 43 commercial banks in Indonesia show that the resulting NPL level predictions are slightly different between the initial and the stress scenarios due to the shocks that occur, as presented in Table 7. In the baseline scenario, the NPL level is 2.56% in Q4 2023. Meanwhile, in the SBI Shock scenario, the NPL value in the same quarter is below 2 percent (1.78%). The NPL stress testing results during the research period were still below the value required by Bank Indonesia in Circular Letter No.3/30/DPNPdated 30 April 1997, in which banks were expected to be able to maintain their NPL below 5 percent (see Figure 14). In contrast to the SBI interest rate shock, the inflation shock causes the NPL to become negative. This findingdiffers from previous research conducted by Ngoc Ha et al. (2014), where the minimum capital requirement for non-performing loans at commercial banks in Vietnam is 6 percent.

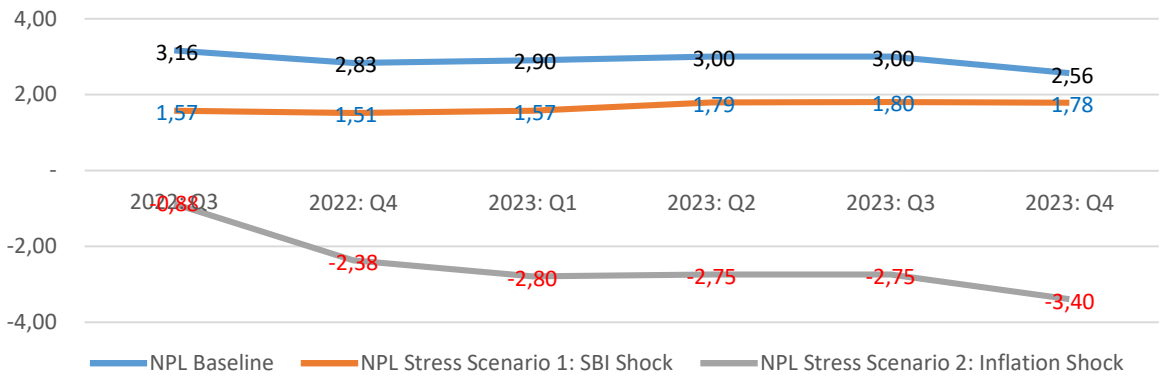



Figure 14. Stress Scenario (data processed)

## VI. CONCLUSION AND RECOMMENDATION

This research focuses on the factors that determine non-performing loans at 43 commercial banks in Indonesia. Panel data regression is used to study macroeconomic factors that specifically influence non-performing loans. Based on the regression results, the previous year's Non-Performing Loan variables, Loan Deposit ratio, interest rate on Indonesian bank certificates, and inflation significantly influence non-performing loans in Indonesia. Meanwhile, the net interest margin, GDP growth, and exchange rate variables insignificantly influence non-performing loans in Indonesia during the observation period.

The stress testing test using Bank Indonesia's interest rate variables and inflation as shock variables for targeting monetary policy shows that the shock that occurred significantly affected non-performing loans, with the NPL value still at the figure set by Bank Indonesia. To maintain the banking sector's stability, banking authoritiesmust continue to carry out adequate supervision to reduce the risk of non-performing credit ratios in the bankingindustry if economic uncertainty occurs in the future. Partially, banks always pay attention to accuracy in analyzing the suitability of prospective debtors so that the loans disbursed are suitable, on target, and effective. Itwill also study the factors that influence NPL to ensure that the credit used is as intended, considering the big problem of credit misuse.

### Limitation and Future Research

This study includes macroeconomic variables as determinants of NPLs, limited to 2008 quarter 1 to 2023 quarter 2. Therefore, for further research, several bank-specific factors such as profitability, liquidity measures, and NPL determinants are considered not only for commercial banks but also for the banking sector based on the Core Capital Bank Group (KMBI) according to POJK No. 12/POJK.03/2021.

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