

Effects of NPL, NIM, and BOPO on ROA of Banks in the LQ45 Index

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Abstract

Bank profitability may fluctuate substantially as credit quality, interest margin generation, and operating efficiency change, making Return on Assets (ROA) an important but potentially unstable indicator of bank performance. This study examined the effects of Non-Performing Loans (NPL), Net Interest Margin (NIM), and Operating Expenses to Operating Income (Beban Operasional terhadap Pendapatan Operasional/BOPO) on the Return on Assets (ROA) of banks included in the LQ45 Index of the Indonesia Stock Exchange during 2018–2024. A quantitative approach was employed using secondary data from annual reports, with five banking companies and 35 balanced-panel observations selected through purposive sampling. Panel-data regression was estimated using EViews 12, and the Chow, Hausman, and Lagrange Multiplier tests were used to select the appropriate model. The random-effects model was selected. The results show that NPL has a negative but insignificant effect on ROA, while NIM has a positive significant effect and BOPO has a negative significant effect. NPL, NIM, and BOPO jointly had a significant effect on the ROA. This study was limited to five LQ45 banking companies and three internal financial ratios. The findings contribute empirical evidence on bank profitability during the pre-pandemic, pandemic, and post-pandemic periods and provide a basis for future studies to consider additional bank-specific and macroeconomic factors.

Keywords: Net Interest Margin, Non Performing Loan, Operating Expenses to Operating Income, Return on Assets, Random Effect Model

1. INTRODUCTION

Banking institutions play an important role in the financial system because they collect public funds and redistribute them through lending and other financial services. Therefore, bank profitability is an important indicator of the effectiveness of financial intermediation and the ability of management to convert assets into earnings. Return on Assets (ROA) is widely used to capture this capability because it relates profit generation to the assets managed by the bank. However, bank profitability is not constant, and changes in credit quality, interest margin generation, and operating efficiency can create fluctuations in ROA. Such fluctuations may indicate that banks face difficulties in maintaining consistent profitability and optimizing the use of their assets (Oktarini, Wijaya, Premayani, Yoga, & Suputra, 2026). From the perspective of signalling theory, changes in ROA may also provide different signals to external stakeholders regarding banks' financial conditions and prospects. In the capital market context, profitability information can also signal investors when evaluating company quality and prospects. ROA is significantly associated with stock underpricing among firms conducting initial public offerings in Indonesia, indicating the relevance of profitability information in market assessment (Gumilar & Hartikayanti, 2025). This problem is particularly relevant for banks whose profitability must be maintained despite changes in credit quality, interest margins, and operating efficiency. For the Liquidity 45 (LQ45) banking sample, this issue is distinctive because the study focuses on banks that are consistently represented in a selective and highly liquid market index, thus, changes in ROA are observed in institutions that play a prominent role in Indonesia capital market (Poseng, Fanggidae, & Tameno, 2026).

The banking sector experienced a particularly dynamic period during 2018–2024 because the observation window included normal conditions, the COVID-19 pandemic, and subsequent economic recovery. In the sample used in this study, the average ROA declined from 2.84% in 2018 to 1.50% in 2020, before recovering to 3.05% in 2023 and remaining relatively high at 2.92% by 2024. Over the same period, the average NPL increased from 2.21% in 2018 to 3.34% in 2020, while NIM declined from 5.74% to 4.75%, and BOPO increased from 69.99% to 81.93%. These patterns suggest that credit quality, interest-margin generation, and operating efficiency were important features of bank performance during this period.

However, existing evidence has not produced a uniform conclusion regarding the determinants of bank profitability. Credit risk and other bank-specific factors have been found to be relevant to profitability ([Saleh, & Abu, 2020](#); [Salike, & Ao, 2018](#)). Credit risk has also been shown to adversely affect profitability, with the strength of this relationship varying according to bank size ([Tran & Phan, 2020](#)). Non-performing loans have also been found to have a negative relationship with profitability ([Le, 2020](#)). Studies on bank profitability have further shown that funding structure, liquidity, bank size, and operating conditions can influence profitability in different ways ([Duan, & Niu, 2020](#); [Gržeta, Žiković, & Tomas, 2023](#); [Pak, 2020](#)). The evidence on net interest margins is likewise contextual, as funding liquidity and systemic importance have been found to affect NIM and ROA differently, while additional firm-level drivers can also influence profitability ([Ghose, & Maji, 2022](#); [López-Penabaz, Iglesias-Casal, & Silva, 2022](#); [Pak, 2020](#)). However, prior evidence is not uniform in terms of statistical significance or the magnitude of the relationship. Differences in bank size, business models, risk management capacities, measurements, and observation periods may produce different results even when the same profitability ratio is examined. This inconsistency is important for the present study because the 2018–2024 period covers a common shock as well as recovery, while the LQ45 sample represents a narrower group of relatively prominent and liquid banks, rather than the banking industry as a whole.

The research gap addressed in this study lies in the combination of three internal banking ratios, NPL, NIM, and BOPO, within a relatively selective LQ45 banking sample and a period that simultaneously captured pandemic disruption and recovery. This study also extends previous evidence by examining five banks that were consistently represented in the LQ45 sample used in the thesis, such as PT Bank Central Asia Tbk (BBCA), PT Bank Rakyat Indonesia (Persero) Tbk (BBRI), PT Bank Mandiri (Persero) Tbk (BMRI), PT Bank Negara Indonesia (Persero) Tbk (BBNI), and PT Bank Tabungan Negara (Persero) Tbk (BBTN). The objective was to analyze the partial and simultaneous effects of NPL, NIM, and BOPO on ROA during 2018–2024. Therefore, the research gap is not only the inconsistent findings across studies but also the limited evidence on whether NPL, NIM, and BOPO jointly explain profitability in a consistently represented LQ45 banking sample across pre-pandemic, pandemic, and recovery conditions.

2. LITERATURE REVIEW

2.1 Signalling Theory

Signalling theory explains how information disclosed by managers can reduce information asymmetry between internal decision-makers and external stakeholders. In banking, financial ratios published in annual reports can signal asset quality, profitability, income generation, and operating efficiency. A higher ROA may indicate more effective asset utilization, whereas a higher NPL or BOPO may indicate greater risk or lower efficiency. This perspective is consistent with the broader profitability literature, which emphasizes the role of bank-specific conditions in shaping the observed performance ([Almaskati, 2022](#); [Yuan, Gazi, Harymawan, Dhar, & Hossain, 2022](#)). It also provides a rationale for considering profitability ratios as information relevant to market participants ([Gumilar & Hartikayanti, 2025](#)).

2.2 Return on Assets

ROA represents a bank's ability to generate profits from the assets it manages. This is particularly relevant in the banking industry because banks operate with large pools of assets generated partly from third-party funds. Profitability has been shown to be influenced by a combination of credit risk, liquidity, capital, bank size, business structure, and macroeconomic conditions ([Gržeta, Žiković, & Tomas, 2023](#); [Radovanov, Milenković, Kalaš, & Horvat, 2023](#); [Saif-Alyousfi, 2022](#)). ROA has also been used as a measure of profitability in empirical research on Indonesian listed firms, reinforcing its relevance as an indicator of financial performance ([Musyaffa & Sastradiprajaja, 2025](#)). During periods of economic disruption, bank profitability may change as credit risk, loan growth, and operating conditions evolve ([Le, 2020](#); [Xiazi, & Shabir, 2022](#)). Profitability patterns may also differ across banking systems and macro-financial conditions, with bank-specific and market factors contributing to differences in profitability persistence and convergence ([Elekdag, Malik, & Mitra, 2020](#); [Killins, & Mollick, 2020](#); [Lamers, Present, & Vander, 2022](#)).

2.3 Non-Performing Loan and ROA

NPL measures the proportion of problematic loans relative to total loans and captures the credit quality. Higher NPLs can reduce interest income, increase provisioning needs, and constrain banks' ability to generate profits from productive assets. International evidence generally supports a negative association between credit risk and profitability, although the magnitude of the relationship varies across markets and bank characteristics ([Nguyen, 2025](#); [Saleh, & Abu, 2020](#); [Salike, & Ao, 2018](#); [Tran, & Phan, 2020](#)). The trade-off between loan growth, NPLs, and bank profitability has also been documented in India banking sector ([Gupta & Bansal, 2024](#)). Negative effects of NPL on ROA, together with the positive effects of NIM and negative effects of operating efficiency, have also been reported in banking research ([Joshi, 2024](#)). In the Indonesian context, Non-Performing Financing (NPF) has been found to negatively affects the profitability of Islamic banks, while Loan to Deposit Ratio (LDR), Capital Adequacy Ratio (CAR), and BOPO are significant determinants of NPL in conventional banks ([Abidi, & Sastradipraja, 2023](#); [Hartikayanti, & Wicaksana, 2020](#)). These mixed findings suggest that the effect of credit risk on profitability may not be mechanical in nature. A bank with stronger provisioning, collateral management, restructuring capacity, or diversified income sources may absorb part of the effect of rising NPL without an immediate proportional decline in ROA ([Priyanti & Dewi, 2026](#)). Conversely, banks with weaker risk management capacities may experience a stronger profitability effect ([Amalia, Rosalina, & Anggita, 2026](#)). Therefore, the expected negative relationship is theoretically clear, but its empirical strength can depend on bank- and period-specific conditions.

2.4 Net Interest Margin and ROA

NIM reflects a bank's ability to generate net interest income from productive assets. A stronger NIM generally indicates that the bank can earn a wider net interest spread from its intermediation activities. Evidence from international banking research indicates that profitability and NIM can be shaped by funding liquidity, regulations, business models, and bank characteristics ([Ammar, & Boughrara, 2019](#); [Pak, 2020](#); [Savona, 2022](#)). NIM has been found to have a positive effect on ROA, while broader evidence indicates that bank profitability responds to operational and funding conditions ([Joshi, 2024](#)). The wider literature also indicates that technological and financial innovation can affect profitability and interest margin performance, which is relevant when interpreting bank profitability beyond traditional ratios ([Zheng, Rahman, Hossain, & Moudud-Ul-Huq, 2023](#)). However, this positive relationship is not expected to be identical across banks. A higher NIM can reflect stronger pricing and intermediation capacity, but it may also coexist with differences in funding costs, asset quality, loan composition, and competition ([Khasanova, 2025](#)). This helps explain why prior studies report different profitability responses to NIM across banking systems and periods, even when NIM remains an important income-generating channel.

2.5 BOPO Margin and ROA

BOPO measures operating efficiency by comparing operating expenses and operating income. A higher BOPO means that a greater share of operating income is absorbed by operating expenses, leaving less income to support profit. Consequently, an increase in BOPO is expected to be associated with a lower ROA because inefficient operations reduce the bank's ability to convert operating activity into earnings. International studies have identified operating efficiency as an important determinant of profitability ([Almaskati, 2022](#); [Joshi, 2024](#); [Rana, 2024](#)). However, the expected negative relationship is not assumed to be identical across banks. The magnitude can vary with branch structures, investment in technology, scale of operations, and management's ability to convert operating resources into income. Thus, operating efficiency should be interpreted as a channel whose contribution to profitability depends on the underlying operating model and the period observed.

Indonesian evidence also supports this expected negative relationship. Negative effects of operating efficiency measures on bank profitability have been reported, while broader evidence indicates that bank-specific operating structures and efficiency can explain differences in ROA ([Buchori, Imam, & Yaturrahmah, 2022](#); [Irawan, Damayanti, Pratama, Siagian, & Hanggraeni, 2025](#); [López-Penabad, Iglesias-Casal, & Silva, 2022](#)). From a signalling perspective, a high BOPO can provide a negative signal about the bank's efficiency and earnings capacity.

2.6 Research Gap

Previous studies provide substantial evidence that credit risk, interest-margin generation, and operating efficiency are related to bank profitability, however, the direction and significance of the relationships are not fully consistent. Differences can arise from the type of bank, observation period, sample size, economic conditions, and combination of explanatory variables used. The COVID-19 period is especially relevant because changes in credit quality, restructuring, monetary policy, and operating activities altered banking conditions. The present study addresses this gap by simultaneously examining NPL, NIM, and BOPO in five banking companies that were consistently included in the LQ45 Index during 2018–2024, such as BBCA, BBRI, BMRI, BBNI, and BBTN. Therefore, this study focuses on a selective, highly liquid banking sample and covers the pre-pandemic, pandemic, and recovery periods in one panel framework.

This study also contributes by combining evidence from internal bank ratios with a selective Indonesian capital market sample. The inclusion of the five studies further connects the article with relevant local research, such as [Abidi and Sastradipraja \(2023\)](#) on determinants of NPL, [Musyaffa and Sastradipraja \(2025\)](#) and [Gumilar and Hartikayanti \(2025\)](#) on profitability and ROA, [Hartikayanti and Wicaksana \(2020\)](#) on non-performing financing and bank profitability, [Romli, Jayanti, Lestari, and Adi \(2023\)](#) and on BI Rate and firm size in Indonesian listed banks. [Romli et al. \(2023\)](#) is particularly relevant for future model development because external monetary and bank characteristic variables may help explain profitability variation not captured by the three internal ratios used here.

2.7 Conceptual Framework and Hypotheses

Based on signalling theory and the literature reviewed above, this study assumes that NPL, NIM, and BOPO provide information about credit quality, interest-margin generation, and operating efficiency, respectively, and that these conditions are reflected in the ROA. NPL is expected to have a negative relationship with ROA because a worsening credit quality can reduce earnings. NIM is expected to have a positive relationship with ROA because stronger interest margin generation can increase income from productive assets. BOPO is expected to have a negative relationship with ROA because higher operating expenses relative to operating income reduce the efficiency and profitability.

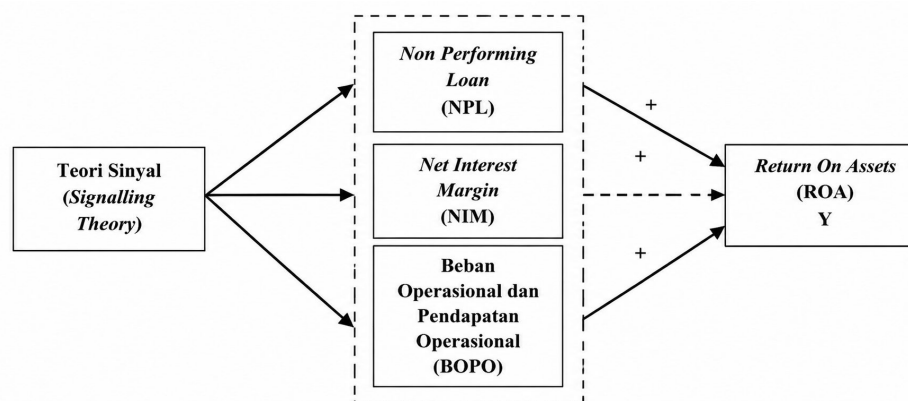


Figure 1. Conceptual framework of the study

Figure 1 shows the conceptual framework indicates the expected partial relationships between NPL, NIM, BOPO, and ROA. The empirical model simultaneously tests these relationships using panel data regression. The directional hypotheses are as follows:

H_1 : NPL, NIM, and BOPO simultaneously have a significant effect on ROA

H_2 : NPL has a negative effect on ROA

H_3 : NIM has a positive effect on ROA

H_4 : BOPO negatively affects ROA

3. RESEARCH METHODOLOGY

3.1 Data Collection Procedure

This study employed a quantitative explanatory approach using secondary data obtained from the annual reports and financial information of banks. The population consisted of banking companies included in the LQ45 Index of the Indonesia Stock Exchange at least once during the 2018–2024 observation period. Purposive sampling was used to select banks that remained consistently included in the LQ45 Index throughout the observation period and provided complete data for all the research variables.

Table 1. Sample selection procedure

Sample selection criteria	Observations
Banks included in the LQ45 Index at least once during 2018–2024	9
Banks not consistently included in LQ45 during 2018–2024	(4)
Final sample of consistently included banks	5
Annual observations per bank	7
Total balanced panel observations	35

Table 1 shows the sample selection process was conducted using predetermined criteria to ensure the consistency and availability of data during the observation period. The initial sample consisted of 9 banks included in the LQ45 Index at least once during 2018–2024. After excluding 4 banks that were not consistently included in the LQ45 Index, the final sample comprised 5 consistently included banks. With an observation period of 7 years per bank, the study generated a balanced panel dataset consisting of 35 annual observations.

Based on the established selection criteria, five companies were selected as the final research sample. The selected companies are banking institutions that were consistently included in the LQ45 Index during the 2018–2024 period, ensuring the availability and consistency of financial data for the analysis. The sample consists of PT Bank Central Asia Tbk (BBCA), PT Bank Rakyat Indonesia (Persero) Tbk (BBRI), PT Bank Mandiri (Persero) Tbk (BMRI), PT Bank Negara Indonesia (Persero) Tbk (BBNI), and PT Bank Tabungan Negara (Persero) Tbk (BBTN). These companies represent major banking institutions listed on the Indonesia Stock Exchange and provide a balanced panel dataset for examining the research variables.

3.2 Variable Measurement

The dependent variable was Return on Assets (ROA), while Non-Performing Loans (NPL), Net Interest Margin (NIM), and Operating Expenses to Operating Income (BOPO) were used as independent variables. All variables were measured as financial ratios obtained from the sampled banks' annual reports.

3.2.1 Return on Assets

Return on Assets (ROA) is a profitability indicator used to evaluate a bank's ability to generate profits from its total assets. This ratio reflects the effectiveness of management in utilizing available assets to produce earnings. A higher ROA indicates better asset utilization and stronger financial performance.

$$ROA = \frac{Profit\ before\ tax}{Average\ total\ assets} \times 100 \quad (1)$$

Formula 1 shows the percentage of profit generated from the average assets owned by the bank. Profit before tax represents the earnings obtained before deducting tax expenses, while Average Total Assets represents the average value of assets during the measurement period. A higher ROA value

indicates that the bank is more effective in utilizing its assets to generate profits and reflects better financial performance.

3.2.2 Non-Performing Loans

Non-Performing Loan (NPL) is a ratio that measures the proportion of problematic loans compared with the total loans provided by a bank. This ratio reflects the quality of credit management and indicates the level of credit risk faced by the bank. A higher NPL ratio indicates an increase in credit problems and potential losses from lending activities.

$$NPL = \frac{Non - performing loans}{Total loans} \times 100 \quad (2)$$

Formula 2 shows the percentage of loans that are classified as non-performing compared with the total loan portfolio. Non-performing loans refer to loans experiencing repayment difficulties, while total loans represent all credit facilities provided by the bank during the observation period. A higher NPL value indicates poorer credit quality and greater potential risks arising from lending activities.

3.2.3 Net Interest Margin

Net Interest Margin (NIM) is a ratio used to assess a bank's ability to generate net interest income from its productive assets. This indicator reflects the effectiveness of banking operations in managing interest-generating assets. A higher NIM indicates greater efficiency in generating income from productive assets.

$$NIM = \frac{Net interest income}{Average interest earning productive assets} \times 100 \quad (3)$$

Formula 3 the percentage of net interest income obtained from the average productive assets owned by the bank. Net interest income represents the difference between interest income and interest expenses, while average interest-earning productive assets refers to assets that generate interest income during the measurement period. A higher NIM value indicates that the bank has greater efficiency in managing productive assets to generate interest-based income.

3.2.4 Operating Expenses to Operating Income

BOPO is a ratio used to measure a bank's operational efficiency by comparing operating expenses with operating income. This ratio reflects how effectively a bank manages its operational costs to generate revenue. A lower BOPO ratio indicates higher operational efficiency because the bank requires fewer expenses to produce operating income.

$$BOPO = \frac{Operating expenses}{Operating income} \times 100 \quad (4)$$

Formula 4 shows the proportion of operating expenses required to generate operating income. Operating expenses represent costs incurred in conducting banking activities, while operating income represents revenue generated from the bank's operational activities. A lower BOPO value indicates higher operational efficiency because the bank is able to generate income with relatively lower operating costs.

3.3 Panel Data Model Analysis

The panel data model was estimated using EViews 12. Three candidate specifications were considered: the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). The Chow test was used to compare CEM and FEM, the Hausman test to compare FEM and REM, and the Lagrange Multiplier (LM) test to compare CEM and REM. The final model was determined based on the combined results of these specification tests. The model selection sequence was interpreted jointly rather than relying on a single test. The Chow test first determined whether bank-specific effects were needed relative to CEM, the Hausman test assessed whether those effects were better treated as fixed or random, and the LM test examined whether random effects were present relative to the pooled specification. In the final results, the Hausman probability of 0.0830 did not reject the null hypothesis at the 5% level, whereas the LM probability of 0.0020 indicated significant random effects relative to CEM. Together with Chow result favoring FEM over CEM, these results support the use of REM because the random-effects specification was preferred to FEM and pooled estimation after the sequential specification tests.

3.4 Classical Assumption Tests

Before hypothesis testing, the study examined residual normality using the Jarque–Bera statistic and multicollinearity using tolerance and the Variance Inflation Factor (VIF). Consistent with the final thesis methodology, the assumption checks were limited to normality and multicollinearity because the final specification used a Random Effect Model estimated through Generalized Least Squares. A residual was considered normally distributed when the Jarque–Bera probability exceeded 0.05, while multicollinearity was considered not problematic when the VIF values were below 10 and the tolerance values exceeded 0.10.

3.5 Hypothesis Testing

$$ROA_{it} = \alpha + \beta_1 NPL_{it} + \beta_2 NIM_{it} + \beta_3 BOPO_{it} + u_{it} \quad (5)$$

Formula 5 shows Return on Assets of bank i in year t , α is the constant, β_1 , β_2 , and β_3 are the regression coefficients of NPL, NIM, and BOPO, respectively, and represents the error term. The partial effects of each independent variable on ROA were evaluated using the estimated coefficient, t -statistic, and probability values at the 5% significance level. A probability value below 0.05 indicated a statistically significant effect, whereas a probability value equal to or above 0.05 indicated that the effect was not statistically significant. The direction of the relationship was determined from the sign of the estimated coefficient, with a positive coefficient indicating a positive relationship and a negative coefficient indicating a negative relationship between the variables.

The simultaneous effects of NPL, NIM, and BOPO on ROA were evaluated using the F -statistic. A probability value of the F -statistic below 0.05 indicates that the independent variables jointly had a statistically significant effect on ROA. In addition, the adjusted R -squared was used to assess the proportion of variation in ROA explained jointly by NPL, NIM, and BOPO after accounting for the number of explanatory variables in the model.

4. RESULTS AND DISCUSSION

4.1 Descriptive Result

The descriptive results indicate that the four ratios experienced different levels of variation across 35 observations. The discussion below further interprets the distribution and annual movement of each variable before the inferential analysis is conducted.

Table 2. Result of descriptive statistics

Variables	Mean	Std. Dev.	Minimum	Maximum
NPL	2.6097	0.9156	0.9700	4.7800
NIM	5.1817	1.1249	2.8600	7.4500
BOPO	70.1429	14.4360	41.7000	98.1200

Variables	Mean	Std. Dev.	Minimum	Maximum
ROA	2.4949	1.1348	0.1300	4.0300

Table 2 shows NPL recorded a mean of 2.6097% with a standard deviation of 0.9156 pp. The ratio ranged from 0.9700% for BMRI in 2024 to 4.7800% for BBTN in 2019, indicating differences in credit quality across banks and observation years. The sample-wide average NPL increased from 2.21% in 2018 to 3.34% in 2020, before declining gradually to 2.17% by 2024. The decline after the pandemic indicates an improvement in the quality of the loan portfolio within the selected banks. Descriptively, the movement of NPL was characterized by deterioration during the pandemic, followed by gradual normalization in the recovery period. Overall, the mean NPL across the full 2018–2024 observation period was 2.6097%.

The NIM had a mean of 5.1817% with a standard deviation of 1.1249 percentage points. The minimum value of 2.8600% was recorded by BBTN in 2024, while the maximum value of 7.4500% was recorded by BBRI in 2018, indicating differences in interest margin generation across the sample. The annual average NIM declined from 5.74% in 2018 to 4.75% in 2020, and subsequently recovered, reaching 4.85% in 2024. This pattern shows that the recovery in interest-margin generation was gradual and did not immediately return to its pre-pandemic position. The descriptive movement is consistent with changing conditions of credit demand, funding costs, and intermediation activity over the observation period, without establishing a causal effect on ROA. Overall, the mean NIM across the entire 2018–2024 observation period was 5.1817%.

BOPO recorded the largest dispersion among the independent variables, with a mean of 70.1429% and a standard deviation of 14.4360 percentage points. The minimum value of 41.7000% occurred at BBKA in 2024, while the maximum value of 98.1200% occurred at BBTN in 2019, indicating substantial differences in operating efficiency across observations. The sample-wide average BOPO increased from 69.99% in 2018 to 81.93% in 2020, and then declined progressively to 64.90% in 2024. The improvement in BOPO after the pandemic suggests that operating efficiency strengthened as banking activities normalized. The descriptive pattern is particularly relevant because a lower BOPO indicates that a smaller proportion of operating income is absorbed by operating expenses. Overall, the mean BOPO across the 2018–2024 observation period was 70.1429%.

ROA had a mean of 2.4949% with a standard deviation of 1.1348 percentage points. The minimum value of 0.1300% was recorded by BBTN in 2019, while the maximum value of 4.0300% was recorded by BMRI in 2023, indicating considerable differences in profitability across banks and over time. The annual average ROA declined from 2.84% in 2018 to 1.50% in 2020, then recovered to 3.05% in 2023, before slightly decreasing to 2.92% in 2024. The descriptive movement indicates that profitability improved substantially after the pandemic. However, the pattern also demonstrates that bank profitability is sensitive to changes in credit quality, interest margin generation, and operating efficiency during the observation period. These descriptive observations provide an economic context for the subsequent regression results, while the direction and significance of the relationships are determined only through panel data estimation. Overall, the mean ROA across the full observation period of 2018–2024 was 2.4949%.

4.2 Panel Data Model Selection

To determine the most appropriate estimation technique for the panel data regression, three statistical tests were conducted Chow, Hausman, and Lagrange Multiplier tests. A summary of these model selection tests is presented in Table 3.

Table 3. Panel model selection

Test	Statistic / Criterion	Prob.	Selected Model
Chow	Cross-section $F=9.7315$	0.0001	FEM over CEM
Hausman	Chi-square=6.6759	0.0830	REM over FEM
Lagrange Multiplier	Breusch–Pagan cross-section=9.5379	0.0020	REM over CEM

The Chow test rejected the common-effect specification and favored the Fixed Effect Model (FEM). The Hausman test produced a probability of 0.0830, above 0.05, therefore, the null hypothesis was not rejected, and the Random Effect Model (REM) was preferred to the FEM. The Lagrange Multiplier Test (LM) test produced a cross-section probability of 0.0020, indicating significant random effects relative to the Common Effect Model (CEM). Therefore, the REM was selected as the final estimation model.

4.3 Classical Assumption Test

To ensure that the estimated panel regression model was robust and free from statistical bias, several classical assumption tests were performed, including normality and multicollinearity tests. The results of these diagnostics are summarized in Table 4.

Table 4. Classical assumption test results

Diagnostic test	Statistic / Result	Decision
Jarque–Bera	1.082528, Prob.=0.582012	Residuals normally distributed
VIF – NPL	3.219	No problematic multicollinearity
VIF – NIM	1.433	No problematic multicollinearity
VIF – BOPO	3.775	No problematic multicollinearity
Tolerance	All values >0.10	No problematic multicollinearity

The Jarque–Bera probability of 0.582012 exceeded 0.05, indicating that the residuals were normally distributed. The Variance Inflation Factor (VIF values for NPL, NIM, and BOPO were also below 10, and the corresponding tolerance values exceeded 0.10, indicating that multicollinearity was not a serious concern. The diagnostic results supported the continuation of the final REM estimation.

4.4 Regression Results and Hypothesis Testing

To examine the effect of independent variables on the dependent variable and test the research hypotheses, panel data regression analysis was conducted using the random effects model.

Table 5. Random effect model estimation

Variables	Coefficient	Std. Error	t-Statistic	Prob.
C	5.335509	0.664362	8.031030	0.0000
NPL	-0.165816	0.085918	-1.929918	0.0628
NIM	0.320826	0.082557	3.886132	0.0005
BOPO	-0.058029	0.006974	-8.320515	0.0000

Table 5 show that the constant coefficient is positive and statistically significant with a coefficient value of 5.335509 and a probability value of 0.0000, indicating the baseline level of ROA when all independent variables are assumed to be zero. NPL has a negative coefficient of -0.165816 with a probability value of 0.0628, indicating a negative but statistically insignificant effect on ROA. Meanwhile, NIM has a positive and significant effect on ROA with a coefficient of 0.320826 and a probability value of 0.0005, whereas BOPO has a negative and significant effect on ROA with a coefficient of -0.058029 and a probability value of 0.0000, indicating that higher operational costs reduce bank profitability. The estimated model was:

$$ROA = 5.335509 - 0.165816NPL + 0.320826NIM - 0.058029BOPO \quad (6)$$

Formula 6 shows the equation indicates that the constant value of 5.335509 represents the estimated ROA level when all independent variables (NPL, NIM, and BOPO) are assumed to be zero. The NPL coefficient of -0.165816 indicates that an increase in non-performing loans tends to reduce ROA, while the NIM coefficient of 0.320826 shows that higher net interest margins contribute to increased bank profitability. Meanwhile, the BOPO coefficient of -0.058029 indicates that higher operational expenses relative to operating income negatively affect ROA, suggesting that operational

inefficiency reduces bank profitability. The model produced an adjusted R-squared of 0.867247, indicating that 86.72% of the variation in ROA was jointly explained by NPL, NIM, and BOPO in the sample. The F-statistic was 75.03825 with a probability of 0.0000, indicating that the three explanatory variables jointly affected the ROA.

Table 6. Summary of hypothesis testing

Hypothesis	Expected Direction	Result	Decision
H_1 : Joint effect	Significant	Prob(F)=0.0000	Supported
H_2 : NPL $\rightarrow$ ROA	Negative	$p=0.0628$, coefficient negative	Not supported
H_3 : NIM $\rightarrow$ ROA	Positive	$p=0.0005$, coefficient positive	Supported
H_4 : BOPO $\rightarrow$ ROA	Negative	$p=0.0000$, coefficient negative	Supported

Table 6 shows the independent variables collectively have a significant effect on Return on Assets (ROA), as demonstrated by the F -test probability value of 0.0000, supporting H_1 . Partially, NPL has a negative effect on ROA but is statistically insignificant with a p-value of 0.0628, resulting in H_2 being not supported. Meanwhile, NIM shows a positive and significant effect on ROA ($p=0.0005$), and BOPO has a negative and significant effect on ROA ($p=0.0000$), confirming that H_3 and H_4 are supported.

4.5 Discussions

4.5.1 Effect of NPL on ROA

NPL had a negative coefficient of -0.165816, but its probability value of 0.0628 was above 0.05. Thus, NPL did not have a statistically significant partial effect on ROA at the 5% level, although the direction was consistent with the expectation that deteriorating credit quality tends to reduce profitability. The descriptive pattern also showed that the NPL rose to 3.34% in 2020 and subsequently declined to 2.17% in 2024, while the ROA recovered substantially after 2020. This pattern is consistent with a negative direction, but the statistical result indicates that NPL variation alone is insufficient to explain ROA differences in the selected LQ45 banks.

This finding is consistent with evidence that credit risk does not always translate one-for-one into contemporaneous profitability because banks can absorb part of the effect through provisioning, restructuring, collateral, and other income sources. This is also consistent with the contextual nature of bank credit risk documented in international studies ([Nguyen, 2025](#); [Tran, & Phan, 2020](#); [Saleh, & Abu, 2020](#)). In contrast, [Hartikayanti and Wicaksana \(2020\)](#) found that NPF has a negative and significant effect on profitability in Indonesian Islamic commercial banks. [Abidi and Sastradipraja \(2023\)](#) further show that internal banking conditions, such as LDR, CAR, and BOPO, significantly affect NPL in conventional banks. This difference suggests that the profitability response to credit quality may depend on the bank type, observation period, and broader operating environment. Therefore, the results do not support H_2 at the 5% significance level.

4.5.2 Effect of NIM on ROA

NIM had a positive coefficient of 0.320826 and a probability value of 0.0005, indicating a positive and significant partial effect on the ROA. This result suggests that banks that generate a stronger net interest margin from productive assets tend to achieve higher profitability, ceteris paribus. The descriptive evidence also showed that the NIM declined during 2020 and then recovered in the following years, broadly accompanying the recovery in ROA. This finding is consistent with the role of interest income generation in bank profitability, as well as with previous evidence identifying net interest margin as an important channel of bank profitability ([Joshi, 2024](#); [\(Pak, 2020\)](#); [Saif-Alyousfi, 2022](#)). Therefore, H_3 was supported.

4.5.3 Effect of BOPO on ROA

BOPO had a coefficient of -0.058029 with a probability value of 0.0000, indicating a negative and significant partial effect on the ROA. This result indicates that an increase in the operating expense-to-operating income ratio is associated with lower profitability. The annual pattern strongly supports the economic interpretation BOPO rose to 81.93% in 2020 when ROA fell to 1.50%, and

then declined as ROA recovered. This finding is consistent with international evidence showing that operating efficiency is an important determinant of banks ([Almaskati, 2022](#); [Joshi, 2024](#); [Rana, 2024](#)). It also reinforces the thesis-level evidence that higher operating costs relative to operating income reduce banks' capacity to convert operating activity into profit. H_4 was supported.

4.5.4 Simultaneous Effect of NPL, NIM, and BOPO on ROA

The F-statistic of 75.03825 with a probability of 0.0000 indicates that NPL, NIM, and BOPO jointly affect ROA. The adjusted R-squared of 86.72% further indicates substantial explanatory power within the selected sample, although 13.28% of ROA variation remains attributable to factors outside the model. This result is consistent with the broader bank profitability literature, which emphasizes that profitability is a multi-dimensional outcome influenced by credit risk, operating efficiency, margins, liquidity, capital, size, and external conditions ([Radovanov, Milenković, Kalaš, & Horvat, 2023](#); [Saif-Alyousfi, 2022](#); [Yuan, Gazi, Harymawan, Dhar, & Hossain, 2022](#)). The joint result supports H_1 and suggests that assessing bank profitability through a single ratio overlooks the interaction of multiple dimensions of bank performance.

5. CONCLUSIONS

5.1 Conclusion

The study concludes that NPL, NIM, and BOPO jointly affect ROA among the five banking companies consistently represented in the LQ45 sample from 2018 to 2024. Partially, NPL showed a negative but insignificant relationship with ROA, whereas NIM had a positive significant relationship, and BOPO had a negative significant relationship. Theoretically, the findings support the signalling perspective by indicating that financial ratios related to credit quality, margin generation, and operating efficiency contain information relevant to bank profitability. Empirically, this study contributes evidence from a selective LQ45 banking sample covering pre-pandemic, pandemic, and recovery conditions, with NIM and BOPO emerging as the more direct profitability channels in the model.

5.2 Research Limitations

The study was limited to five banking companies represented in the LQ45 sample and three internal financial ratios. The 2018–2024 period also contained a major structural shock in the form of the COVID-19 pandemic, which may have affected banking relationship stability. The analysis did not include broader macroeconomic variables or other bank-specific variables that could explain the remaining ROA variation.

5.3 Suggestions and Directions for Future Research

Future research should expand the sample to a broader population of listed banking firms and extend the observation period. Additional variables, such as CAR, LDR, bank size, the BI Rate, inflation, and other macroeconomic measures, could also be considered. showed that the BI Rate and firm size were relevant to the basic lending rate of Indonesian listed banks, supporting their consideration as potential explanatory factors in future banking profitability models. Future studies may also examine whether the effects of NPL, NIM, and BOPO differ across the pre-, during, and post-pandemic sub-periods or across bank size groups.

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AUTHOR CONTRIBUTIONS

BENK contributed to the conceptualization, methodology development, data collection, formal analysis, investigation, visualization, and writing of the original draft. US contributed to supervision, validation, methodological review, and writing—review and editing. Both authors contributed to the interpretation of the findings, reviewed the manuscript critically, and approved the final version of the manuscript.

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