

Interest Margin, Operational Efficiency, Liquidity, and Bank Profitability: Does Firm Size Matter?

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Abstract

Purpose: This study examines the effects of net interest margin (NIM), the operational efficiency (BOPO), and the loan to deposit ratio (LDR) on return on assets (ROA), and tests whether firm size significantly moderates these relationships among Indonesian conventional banks listed on the Indonesia Stock Exchange during 2020-2024.

Design/methodology/approach: The study uses a balanced panel of 25 conventional banks listed on the Indonesia Stock Exchange from 2020 to 2024, yielding 125 firm-year observations selected through purposive sampling. Fixed-effects panel regression and moderated regression analysis were estimated using EViews 12.

Findings: NIM does not significantly affect ROA, whereas BOPO has a significantly affect ROA and LDR has a significantly affect ROA. The interaction terms between firm size and NIM, BOPO, and LDR are all statistically insignificant. The baseline model explains 87.08% of the variation in ROA, while the moderated model explains 87.48%.

Practical implications: Bank managers should prioritize disciplined operating-cost control and prudent, productive lending rather than relying on asset growth alone to improve profitability.

Originality/value: The study evaluates firm size as a boundary condition for bank profitability during the pandemic and post-pandemic adjustment period across a broad sample of listed Indonesian conventional banks.

Paper type: Empirical research paper

Keywords: bank profitability, net interest margin, operational efficiency, liquidity, firm size.

1. Introduction

The Indonesian banking industry operated under unusually volatile conditions during 2020-2024. The initial economic disruption caused by the COVID-19 pandemic was followed by a recovery phase marked by global inflation, tighter monetary policy, and higher benchmark interest rates. Bank Indonesia reduced its policy rate to 3.50% in 2021 to support economic recovery Bank Indonesia (2021) and later raised it to 6.00% by 2024 to preserve stability Bank Indonesia (2024). These shifts affected banks through funding costs, loan pricing, liquidity management, and credit demand. At the same time, banks accelerated digital transformation, requiring substantial investment in technology and operating infrastructure.

Industry indicators reveal a profitability puzzle. Net interest margin declined from 4.80% in 2022 to 4.64% in 2023, while BOPO increased from 78.70% to 88.43%, indicating pressure on both interest margins and operating efficiency. In contrast, LDR rose from 78.98% in 2022 to 84.11% in 2023 and reached 89.05% in 2024. Despite weaker margins and higher operating costs, industry ROA increased from 2.45% in 2022 to 2.76% in 2023 before easing slightly to 2.72% in 2024. The divergent movement of these indicators suggests that bank profitability cannot be explained by a simple one-to-one relationship between a single financial ratio and ROA Otoritas Jasa Keuangan (2023).

ROA is a central measure of banking performance because it indicates how effectively management converts the asset base into net income. Three internal ratios are particularly relevant. NIM

captures the return generated from interest-earning assets after funding costs Lestari et al. (2021). BOPO measures the efficiency of bank operations by comparing operating expenses with operating income and LDR represents the extent to which deposits are transformed into loans Rosandy & Sha (2022). Higher NIM is generally expected to enhance profitability, whereas a higher BOPO reflect lower operational efficiency and is therefore expected to reduce profitability, and a higher LDR may improve profitability by increasing lending activities, provided that liquidity and credit risks are effectively managed.

Previous studies on the determinants of bank profitability have yielded inconsistent findings. Regarding NIM, Olivia et al. (2022) and Tantra et al. (2024) reported a significant positive effect on ROA, indicating that higher net interest margins contribute to greater bank profitability. In contrast, Antika et al. (2024) found that NIM had no significant effect on ROA. Similar inconsistencies have been observed for BOPO. Kesuma et al. (2025) and Setyaningsih et al. (2023) documented a significant negative effect of BOPO on ROA, suggesting that higher operating expenses relative to operating income reduce profitability.

Conversely, Antika et al. (2024) reported no significant relationship between BOPO and ROA. Empirical evidence regarding LDR is likewise mixed. Tambunan (2020) found a significant positive effect of LDR on ROA, whereas Joysinta (2026) reported a negative effect. These contrasting findings suggest that lending expansion may enhance profitability through higher interest income but may also weaken profitability when accompanied by increased liquidity and credit risks.

The structure conduct performance (SCP) framework offers a relevant perspective for explaining these inconsistent findings. In this study, firm size reflects the structural capacity of a bank, while NIM, BOPO, and LDR represent managerial conduct in managing interest margins, operating efficiency, and financial intermediation. ROA, in turn, represents bank performance. Banks with larger asset bases may possess greater resources, broader funding access, stronger market positions, and more advanced risk-management capabilities. These characteristics may affect how financial and operational strategies are translated into profitability. However, previous studies have reported conflicting evidence regarding the moderating role of firm size in the relationships between NIM, BOPO, LDR, and ROA (Olivia et al. 2022; Wirawan & Wendy, 2025; Zamzam & Suryaningprang, 2024).

2. Literature Review and Hypotheses Development

Structure-conduct-performance theory

The structure conduct performance (SCP) framework, introduced by Mason (1939) and further developed by Bain, explains that firm performance results from structural conditions and managerial conduct. In banking, structural characteristics shape pricing power, cost structures, access to funding, technology investment, and risk-bearing capacity (Neuberger, 1997; Perloff et al., 2007). The framework also remains relevant for explaining competition and profitability in Indonesian banking Santoso et al. (2023). In this study, firm size, measured by the natural logarithm of total assets, represents structure; NIM, BOPO, and LDR represent conduct in managing interest margins, operational efficiency, and financial intermediation; and ROA represents performance. Accordingly, the SCP framework provides the theoretical basis for examining the effects of NIM, BOPO, and LDR on ROA and the moderating role of firm size.

Net interest margin on Return on Assets

Net interest margin (NIM) reflects a bank's ability to generate net interest income from its earning assets. A higher NIM increases the income available to cover operating costs, taxes, and credit-loss provisions, thereby potentially improving ROA. This expectation is supported by Olivia et al. (2022) and Tantra et al. (2024), who reported a significant positive relationship between NIM and bank profitability. However, Antika et al. (2024) found no significant effect of NIM on ROA, suggesting that higher interest margins may not translate into greater profitability when they are offset by higher funding costs, deteriorating asset quality, or larger impairment provisions. Based on this theoretical argument and the inconsistent empirical evidence, the following hypothesis can be formulated:

H₁: Net Interest Margin has a significant effect on Return on Assets

Operational Expenses on Return on Assets

The Operational Expenses (BOPO) is an inverse indicator of a bank's operational efficiency. A higher BOPO indicates that a greater proportion of operating income is absorbed by operating expenses, leaving less income available as profit and therefore potentially reducing ROA. This expectation is supported by Kesuma et al. (2025), Rosandy & Sha (2022), and Setyaningsih et al. (2023), who documented a significant negative effect of BOPO on ROA. However, Antika et al. (2024) found no significant effect of BOPO on ROA, suggesting that the profitability consequences of operational efficiency may vary across different banking conditions. Based on this theoretical reasoning and the inconsistent empirical evidence, the following hypothesis is proposed:

H2: Operational Expenses has a significant effect on Return on Assets

Loan to Deposit Ratio on Return on Assets

The loan-to-deposit ratio (LDR) reflects the extent to which deposits are allocated to loans. Within a prudent range, a higher LDR indicates more active financial intermediation and a larger portfolio of interest-earning loans, which may improve ROA. However, an excessively high LDR may create liquidity pressure and expose banks to greater credit risk. Therefore, the effect of LDR on profitability depends on the quality of lending and the effectiveness of risk management. Empirical findings remain inconsistent. Tambunan (2020) reported a positive effect of LDR on ROA, whereas Sunaryo (2020) documented a negative effect. In addition, Joysinta (2026) found that greater loan distribution did not significantly improve ROA. Based on this theoretical reasoning and the inconsistent empirical evidence, the following hypothesis is proposed:

H3: Loan to Deposit Ratio has a significant effect on Return on Assets

The Moderating role of Firm size

Firm size may influence how banks translate financial and operational decisions into profitability. Larger banks generally have broader funding access, more diversified income sources, stronger information systems, wider operational networks, and greater capacity to absorb risk. These structural advantages may affect how interest-margin management, operational efficiency, and lending activities contribute to ROA. Olivia et al. (2022) found that bank size strengthened the relationship between NIM and ROA and mitigated the negative relationship between BOPO and ROA, although it did not moderate the relationship between LDR and ROA. Similarly, Zamzam & Suryaningprang (2024) reported significant moderating effects of firm size on the NIM on ROA and BOPO on ROA relationships. By contrast, Wirawan & Wendy (2025) found that firm size did not significantly moderate the relationship between NIM and ROA. These inconsistent findings indicate that the moderating role of firm size may depend on bank characteristics, the study period, and the financial conditions examined. Accordingly, the following hypotheses are proposed:

H4: Firm Size moderates the relationship between Net Interest Margin and Return on Assets.

H5: Firm Size moderates the relationship between Operational Expenses and Return on Assets.

H6: Firm Size moderates the relationship between Loan to Deposit Ratio and Return on Assets.

3. Research Method

Research Design, Population, and Sample

This study employs a quantitative explanatory design using secondary financial data from conventional banks listed on the Indonesia Stock Exchange during 2020–2024. Purposive sampling was applied to the population of 42 banks by excluding banks with incomplete financial statements, regional development banks, and banks that reported losses during the observation period. The final sample consists of 25 banks, producing a balanced panel of 125 firm-year observations. The data were collected from audited annual reports and financial statements published by the sampled banks and the Indonesia Stock Exchange.

The operational definitions and measurements of all variables are presented in **Table 1**.

Table 1. Operational Definition of Variables

Variable	Variable Type	Formula	Scale
Return On Asset (ROA)	Dependent	$\frac{\text{Net income}}{\text{Total asset}}$	Ratio
Net Interest Margin (NIM)	Independent	$\frac{\text{Interest Income} - \text{interest expense}}{\text{Total Earning asset}}$	Ratio
Operational Expenses (BOPO)	Independent	$\frac{\text{Operational cost}}{\text{Operational incomes}}$	Ratio
Loan To Deposit Ratio (LDR)	Independent	$\frac{\text{Total loans}}{\text{Total deposits}}$	Ratio
FIRMSIZE	Moderator	Ln Total asset	Natural Logs

Source(s): Authors' own creation

Data analysis

The analysis was conducted using EViews 12. Descriptive statistics were used to summarize the data. Panel-data model selection was performed using the Chow test to compare the common effects and fixed effects models, followed by the Hausman test to compare the fixed effects and random effects models. The fixed effects model was selected for both Equation (1) and Equation (2). Residual normality, multicollinearity, and heteroskedasticity were also assessed before hypothesis testing.

Equation 1

$$\text{ROA} = \alpha + \beta_1 \text{NIM} + \beta_2 \text{BOPO} + \beta_3 \text{LDR} + \beta_4 \text{FZ} + \varepsilon$$

Equation 2

$$\text{ROA} = \alpha + \beta_1 \text{NIM} + \beta_2 \text{BOPO} + \beta_3 \text{LDR} + \beta_4 \text{FZ} + \beta_5 \text{LnNIM} * \text{FZ} + \beta_6 \text{LnBOPO} * \text{FZ} + \beta_7 \text{LnLDR} * \text{FZ} + \varepsilon$$

4. Result and Discussion

Descriptive statistics

Descriptive statistics were used in this research to determine a number of data (n) as variables used to show the results of the highest value (maximum), the lowest value (minimum), the average value (mean), and the standard deviation of each variable. The statistics for each variable studied are as follows:

Table 2. Descriptive statistics

Variable	Mean	Median	Std. dev.	Minimum	Maximum
ROA (%)	1.357	1.160	1.005	0.020	4.140
NIM (%)	5.147	4.800	2.450	0.250	19.490
BOPO (%)	72.141	69.750	16.472	26.850	122.840
LDR (%)	95.544	85.040	55.898	29.670	527.910
Firm size (ln assets)	18.323	18.768	1.835	14.181	21.610

Source(s): Authors' calculations from the EViews 12 output; ratio statistics rescaled into percentage points

Table 2 shows that Return on Assets (ROA) has a mean value of 1.357% and a standard deviation of 1.005%. The observed values range from 0.020% to 4.140%, reflecting considerable variation in profitability among conventional banks during the 2020–2024 observation period. This finding suggests that the sampled banks differed in their ability to utilize total assets to generate profits, indicating heterogeneous financial performance across the banking sector.

Net Interest Margin (NIM) records a mean value of 5.147% and a standard deviation of 2.450%, with values ranging from 0.250% to 19.490%. These results indicate variation in the banks' ability to generate net interest income from earning assets. The relatively wide range of NIM values reflects differences in interest-margin management and lending strategies adopted by the sampled banks during the observation period.

The operating expenses to operating income ratio (BOPO) has a mean value of 72.141% and a standard deviation of 16.472%, with values ranging from 26.850% to 122.840%. These results indicate differences in operational efficiency among the sampled banks. Higher BOPO values indicate that a greater proportion of operating income is absorbed by operating expenses, whereas lower values reflect more efficient cost management.

The Loan to Deposit Ratio (LDR) has a mean value of 95.544% and a standard deviation of 55.898%. The observed values range from 29.670% to 527.910%, indicating substantial variation in liquidity management and lending activities across the sampled banks. This variation suggests that banks adopted different approaches to utilizing third-party funds to support their lending operations throughout the study period.

Firm size has a mean value of 18.323 and a standard deviation of 1.835, with values ranging from 14.181 to 21.610. Firm size is measured using the natural logarithm of total assets. Its distribution indicates that the sample includes banks with diverse asset scales, reflecting differences in organizational capacity and resource availability. This variation provides an appropriate basis for examining the moderating role of firm size in the relationships between NIM, BOPO, LDR, and ROA.

Model selection and diagnostic tests

For the baseline model or equation 1, the Chow test is significant ($p < 0.000$) and the Hausman test is also significant ($p = 0.0200$), indicating that bank-specific fixed effects should be used. The moderated model or equation 2 produces the same conclusion: the Chow test is significant ($p < 0.000$) and the Hausman test yields $p = 0.0002$. Confirming that the Fixed Effects Model is the most appropriate estimation method.

The baseline residuals satisfy the Jarque-Bera normality test ($p = 0.0875$), and the moderated residuals also appear normally distributed ($p = 0.4876$). Pairwise correlations remain below 0.90, and the Glejser tests show probability values above 0.05. The models therefore show no material multicollinearity or heteroskedasticity problem under the criteria applied in this study.

Equation 1 fixed-effects results

Table 3. Fixed-effects regression results

Variable	Coefficient	Std. error	t-statistic	Probability
Constant	-206.8955	399.0083	-0.5185	0.6053
NIM	-0.018047	0.030888	-0.5843	0.5604
BOPO	-0.021288	0.005599	-3.8023	0.0003
LDR	0.004990	0.001293	3.8585	0.0002
Firm size	0.002498	0.002130	1.1728	0.2438
R-squared	0.870859			
Adjusted R-squared	0.833193			
F-statistic	23.12047			0.0000

Source(s): Authors' calculations from EViews 12 output

Equation (1) is statistically significant, as indicated by a Prob(F-statistic) value of 0.0000, which is below the 0.05 significance level. The R-squared value of 0.870859 indicates that NIM, BOPO, LDR, and firm size explain 87.09% of the variation in ROA.

NIM has a t-statistic of -0.584278 , which is lower in absolute value than the critical t-value of 1.97993 , and a probability value of 0.5604 , which exceeds 0.05 . Therefore, NIM has no significant effect on ROA, and H1 is not supported. BOPO has a t-statistic of -3.802330 , whose absolute value exceeds 1.97993 , and a probability value of 0.0003 . Thus, BOPO has a significant negative effect on ROA, supporting H2. LDR has a t-statistic of 3.858549 , which exceeds 1.97993 , and a probability value of 0.0002 . Therefore, LDR has a significant positive effect on ROA, supporting H3. Firm size has a t-statistic of 1.172796 and a probability value of 0.2438 , indicating no significant direct effect on ROA.

Equation 2 Moderated regression results

Table 4. Moderated fixed-effects regression results

Variable	Coefficient	Std. error	t-statistic	Probability
Constant	-342.0658	440.4118	-0.7767	0.4393
NIM	0.046788	0.050391	0.9285	0.3556
BOPO	-0.040039	0.025346	-1.5797	0.1176
LDR	0.003771	0.002667	1.4139	0.1607
Firm size	0.001917	0.002367	0.8099	0.4200
ln(NIM) x firm size	105.7429	184.8395	0.5721	0.5686
ln(BOPO) x firm size	27.77580	41.20160	0.6741	0.5019
ln(LDR) x firm size	-49.59986	29.46662	-1.6833	0.0957
R-squared	0.874852			
Adjusted R-squared	0.833136			
F-statistic	20.97160			0.0000

Source(s): Authors' calculations from EViews 12 output

Equation (2) is statistically significant, as indicated by a Prob(F-statistic) value of 0.0000 , which is below the 0.05 significance level. The R-squared value of 0.874852 indicates that NIM, BOPO, LDR, firm size, and their interaction terms explain 87.49% of the variation in ROA.

The interaction between NIM and firm size has a t-statistic of 0.572080 , which is lower than the critical t-value of 1.97993 , and a probability value of 0.5686 , which exceeds 0.05 . Therefore, firm size does not significantly moderate the relationship between NIM and ROA, and H4 is not supported. The interaction between BOPO and firm size has a t-statistic of 0.674144 , which is also lower than 1.97993 , and a probability value of 0.5019 . Thus, firm size does not significantly moderate the relationship between BOPO and ROA, and H5 is not supported. The interaction between LDR and firm size has a t-statistic of -1.683256 . Its absolute value of 1.683256 is lower than the critical t-value of 1.97993 , while its probability value of 0.0957 exceeds 0.05 . Therefore, firm size does not significantly moderate the relationship between LDR and ROA, and H6 is not supported. Although the R-squared value increased from 0.870859 in Equation (1) to 0.874852 in Equation (2).

Discussion

Net interest margin on Return on Assets

The results show that NIM has no significant effect on ROA. This indicates that a wider interest margin did not automatically translate into higher profitability among the sampled banks. One possible explanation is that the benefits of higher interest income may have been offset by funding costs, operating expenses, or credit-loss provisions. From the SCP perspective, interest-margin management represents managerial conduct, but this conduct alone may be insufficient to improve performance.

This finding is consistent with Antika et al. (2024), who also reported no significant effect of NIM on ROA, but differs from Olivia et al. (2022) and Tantra et al. (2024), who found a significant positive effect. These differences suggest that the relationship between NIM and profitability may

depend on the economic environment and banks' financial conditions. Therefore, managers should combine interest-margin strategies with effective cost, funding, and asset management. Therefore, H1 is not supported.

Operational Expenses on Return on Assets

The results show that BOPO has a significant negative effect on ROA. This means that profitability decreases when a greater proportion of operating income is absorbed by operating expenses. The finding supports the SCP framework, in which managerial conduct in controlling operating costs directly influences bank performance.

This result is consistent with Kesuma et al. (2025), Olivia et al. (2022), and Setyaningsih et al. (2023). However, these findings do not imply that banks should reduce all operating expenses. Investments in technology, compliance, and risk management may remain necessary, but they should contribute to higher revenue or greater efficiency. The relevant objective is productive expenditure rather than indiscriminate cost cutting. Accordingly, H2 is supported.

Loan to Deposit Ratio on Return on Assets

The results show that LDR has a significant positive effect on ROA. This suggests that greater lending intensity was associated with higher profitability among the sampled banks. From the SCP perspective, effective financial intermediation represents managerial conduct that can improve performance when deposits are allocated to productive lending activities.

The finding is consistent with Tambunan (2020), but differs from Sunaryo (2020), who reported a negative effect, and Joysinta (2026), who found no significant relationship. These differences indicate that the profitability effect of lending may depend on credit quality and liquidity management. From a managerial perspective, banks should expand lending prudently while maintaining sound credit assessment, stable funding, and adequate liquidity. Accordingly, H3 is supported.

The Moderating role of Firmsize

The results show that firm size does not significantly moderate the relationships between NIM, BOPO, and LDR and ROA. Within the SCP framework, firm size represents the structural dimension of banking operations. However, the findings indicate that larger asset size alone was insufficient to change how interest-margin management, operational efficiency, and lending activities affected profitability.

The findings are partially consistent with previous studies. For the NIM on ROA the result are consistent with Wirawan and Wendy (2025), but differs from Olivia et al. (2022) and Zamzam and Suryaningprang (2024), who reported significant moderation effects of Firmsize. These differences may be related to variations in samples, periods, and banking conditions. Asset scale may provide resources and market access, but it does not guarantee efficient operations or profitable lending. Therefore, banks should not rely only on asset growth but should also improve operational efficiency and financial management.

From a managerial perspective, expanding a bank's asset base alone is unlikely to improve profitability or strengthen the effectiveness of its financial strategies. Growth in firm size should be accompanied by improvements in operational efficiency, funding management, lending quality, and managerial capabilities. These findings suggest that Firm Size should not be viewed as a universal mechanism for strengthening or weakening the relationship between financial performance indicators and profitability. In the sampled conventional banks during 2020–2024, effective financial management appeared to be more important than asset size alone. Therefore, H4–H6 are not supported.

5. Conclusion

This study examines the effects of NIM, BOPO, and LDR on ROA and evaluates firm size as a moderator in 25 Indonesian conventional banks listed during 2020–2024. The evidence shows that NIM does not have a significant direct effect on ROA. BOPO has a significant negative effect, confirming that operating efficiency is a central determinant of profitability. LDR has a significant effect, indicating that productive credit intermediation supported profitability during the observation period. Firm size neither has a significant direct effect nor significantly moderates any of the three operating relationships.

The managerial implication is straightforward. Banks should not assume that asset growth will compensate for inefficient operations or weak lending quality. Profitability is more likely to improve when management controls operating costs, aligns technology and expansion expenditure with measurable income benefits, maintains stable funding, and expands lending within prudent risk limits. For regulators and investors, the results imply that bank scale should be evaluated together with efficiency and credit-allocation quality rather than used as a stand-alone indicator of resilience or profitability.

The study is subject to several limitations. The sample includes only profitable listed conventional banks and excludes regional development banks, so the conclusions may not apply to loss-making, unlisted, or regional institutions. The five-year period captures an unusual economic cycle, and the model focuses on internal financial ratios. Future research may extend the time horizon, include non-performing loans, capital adequacy, or compare conventional and Islamic banks. Alternative moderation specifications and robustness tests may also clarify whether the role of bank size changes across business models or economic regimes.

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