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Bank Health Ratio and Profitability of Commercial Banks in Indonesia: Optimal Strategies in Banking Intermediation Functions

Rasio Kesehatan Bank dan Profitabilitas Bank Umum di Indonesia: Strategi Optimal dalam Fungsi Intermediasi Perbankan

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ABSTRACT

The objective of this study is to examine and analyze the impact of commercial bank health on the profitability of commercial banks in Indonesia. The analysis in this study employs panel data regression techniques with a time series spanning from 2010 to 2023 and a cross-section of 105 commercial banks in Indonesia. The study's findings indicate that most bank health indicators have a positive and significant impact on profitability. Capital Adequacy Ratio (CAR), Net Interest Margin (NIM), Non-Performing Loan (NPL), Loan to Deposit Ratio (LDR), and Operating Expenses to Operating Income Ratio (BOPO) are all significant determinants of bank profitability. Future policies should prioritize dynamic capital requirements, advanced risk management systems, liquidity monitoring, and operational digitalization to enhance the resilience and competitiveness of banks in Indonesia.

Keywords*: Commercial banks, panel data regression, profitability*.

ABSTRAK

Tujuan dari penelitian ini adalah untuk menguji dan menganalisis pengaruh kesehatan bank umum terhadap profitabilitas bank umum di Indonesia. Analisis dalam penelitian ini menggunakan teknik regresi data panel dengan rentang waktu dari tahun 2010 hingga 2023 dan *cross-section* sebanyak 105 bank umum di Indonesia. Temuan penelitian menunjukkan bahwa sebagian besar indikator kesehatan bank memiliki pengaruh positif dan signifikan terhadap profitabilitas. *Capital Adequacy Ratio (CAR), Net Interest Margin (NIM), Non-Performing Loan (NPL), Loan to Deposit Ratio (LDR),* dan Rasio Biaya Operasional terhadap Pendapatan Operasional (BOPO) merupakan determinan signifikan dari profitabilitas bank. Kebijakan di masa depan perlu memprioritaskan persyaratan modal yang dinamis, sistem manajemen risiko yang lebih maju, pemantauan likuiditas, serta digitalisasi operasional untuk meningkatkan ketahanan dan daya saing perbankan di Indonesia.

Kata Kunci: Bank umum, regresi data panel, profitabilitas.

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INTRODUCTION

Banking is the backbone of a country's financial system. Its primary function as an intermediary institution that bridges surplus units (those with excess funds) and deficit units (those in need of funds) makes banks the key players in maintaining national economic stability and growth. In this context, bank health and profitability are two main indicators that reflect the efficiency, effectiveness, and sustainability of commercial banks' operations in Indonesia. Therefore, measuring bank health and profitability is not only an internal performance indicator but also reflects the extent to which banks can sustainably fulfill their role in supporting the national economy (Tangngisalu *et al*., 2020).

Banking health is crucial as it optimizes the intermediary function, ensures smooth and efficient payment transactions, and enhances the effectiveness of monetary policy. Additionally, bank health serves as a tool for regulatory authorities in establishing supervision strategies and priorities (Alazis, 2020). It is also of interest to all stakeholders, including owners, managers, and customers of banking services.

In the past decade, Indonesia's banking sector has shown a positive trend in asset growth and credit expansion. However, profitability has not always aligned with this expansion. Several banks have faced pressure due to high non-performing loans, low operational efficiency, interest rate volatility, and global uncertainty (Alazis, 2020). Therefore, understanding how bank health ratios affect profitability is crucial for developing effective business strategies and prudent regulatory policies.

Table 1. Indicators of Commercial Bank Health in Indonesia

Indicator	2019	2020	2021	2022	2023
Capital Adequacy Ratio (CAR)	23,21%	23,78%	24,21%	25,30%	24,77%
Operating Expenses to Operating Income (BOPO)	83,48%	84,72%	85,61%	88,79%	92,96%
Loan to Deposit Ratio (LDR)	94,25%	82,12%	80,83%	75,33%	76,60%
Net Interest Margin (NIM)	4,87%	4,65%	4,64%	4,30%	4,31%
Non-Performing Loan (NPL) Gross	2,53%	3,06%	3,00%	2,50%	2,19%

Source: OJK

Based on Table 1, which presents data on the financial indicators of commercial banks in Indonesia from 2019 to 2023, it can be analyzed that the condition of bank intermediation and operational efficiency experienced significant dynamics in line with national and global economic developments, including the impact of the COVID-19 pandemic. The Capital Adequacy Ratio (CAR) showed an increasing trend from 23.21 percent in 2019 to a peak of 25.30 percent in 2022, before slightly declining to 24.77 percent in 2023. The consistently high CAR, well above the regulatory minimum requirement of 8 percent, indicates that commercial banks in Indonesia possess strong capital buffers to absorb potential losses and maintain operational stability (OJK, 2022). This increase also reflects a conservative approach to credit expansion, especially during periods of uncertainty caused by the pandemic. Meanwhile, the BOPO ratio (Operating Expenses to Operating Income) showed a less favorable trend, rising from 83.48 percent in 2019 to 92.96 percent in 2023. This increase reflects a decline in operational efficiency, which could be due to rising operating costs or decreasing net interest income under economic pressure. A BOPO ratio consistently above 80percent indicates that banks continue to face major challenges in managing costs efficiently to generate optimal income (OJK, 2023).

The Loan to Deposit Ratio (LDR) consistently declined from 94.25percent in 2019 to 75.33 percent in 2022, with a slight increase to 76.60 percent in 2023. This trend

suggests that credit disbursement was relatively lower compared to the collection of third-party funds, which may reflect banks' cautious stance in extending credit amid economic uncertainty. However, an excessively low LDR also indicates that the funds collected have not been fully optimized to support the intermediary function (OJK, 2022). The Net Interest Margin (NIM) also declined from 4.87 percent in 2019 to 4.30 percent in 2022 and remained relatively stagnant at 4.31 percent in 2023. This downward trend implies a shrinking profit margin from intermediation activities, likely due to declining benchmark interest rates, asset quality pressures, and slowing credit growth. Although the NIM remains within a reasonable range, the downward trend points to challenges in maintaining profitability from interest income. Finally, the Non-Performing Loan (NPL) gross rose from 2.53 percent in 2019 to 3.06 percent in 2020 due to the initial impact of the pandemic but has steadily declined to 2.19 percent by 2023. This decline indicates an improvement in asset quality and borrowers' ability to meet credit obligations (OJK, 2023). It also reflects the effectiveness of credit restructuring policies and banks' credit risk management.

Overall, although Indonesia's commercial banks demonstrate resilience in terms of capital strength and improvement in asset quality, they still face persistent challenges in operational efficiency and the optimization of their intermediation role. Further analysis of Table 1 reveals several core issues. Despite the CAR consistently remaining at a very safe level and even increasing, it has not been accompanied by the optimal disbursement of credit, as reflected in the declining LDR, which has remained below 80 percent since 2021. This indicates that third-party funds collected have not been fully utilized for productive activities (OJK, 2021). On the other hand, the significant increase in BOPO to nearly 93 percent in 2023 highlights a concerning decline in operational efficiency, where high operational costs are not offset by proportional growth in operating income. Moreover, the declining NIM reflects the challenges banks face in generating net interest income amid falling interest rates and limited credit expansion. Although there has been an improvement in asset quality, as shown by the decreasing gross NPL, pressures on profitability and efficiency remain structural issues that need to be urgently addressed (Tangngisalu et al., 2020). Therefore, the main problem in the banking sector today lies in weak efficiency and the suboptimal intermediation function, even though capital strength and credit risk management have shown progress.

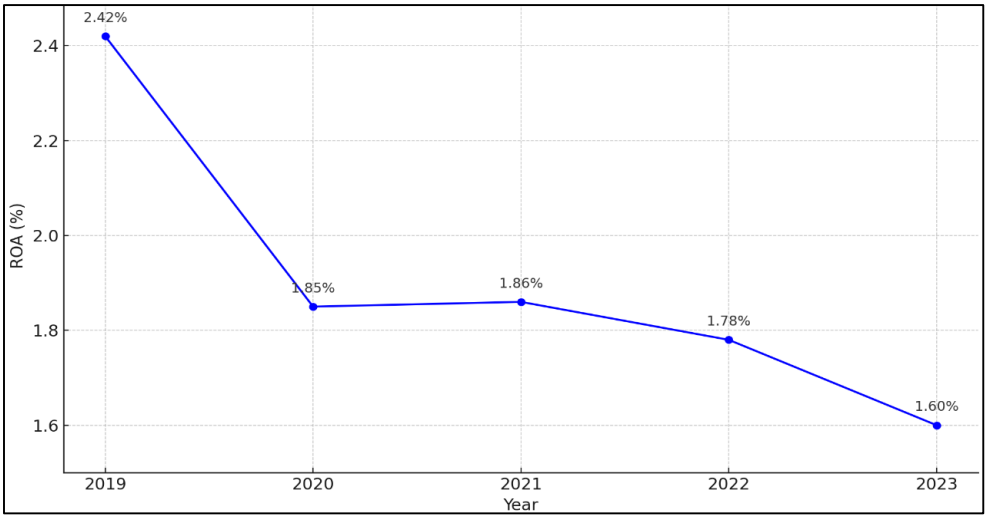

Figure 1. ROA in Indonesian Commercial Banks
Source: OJK

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Return on Assets (ROA) is a key indicator used to measure a bank's effectiveness in generating profits from its total assets. In the banking context, a high ROA reflects efficient asset utilization in producing income, while a declining ROA indicates pressure on the bank's profitability (Christaria & Kurnia, 2016). Figure 1 shows a consistent downward trend in the ROA of commercial banks in Indonesia from 2019 to 2023. In 2019, before the COVID-19 pandemic, ROA stood at a relatively high level of 2.42 percent, indicating stable and efficient profitability conditions. However, entering 2020, the direct impact of the pandemic became apparent, with ROA dropping significantly to 1.85 percent. This decline reflected growing operational pressure, an increase in non-performing loan (NPL) risks, and a slowdown in economic activity, all of which led to a reduction in profit margins. In 2021 and 2022, although there were modest improvements in macroeconomic conditions, ROA did not show a significant recovery. ROA rose slightly to 1.86% in 2021 but then dropped again to 1.78 percent in 2022. This suggests that the recovery in bank profitability was slow, despite the resumption of credit growth. The slow recovery was mainly due to declining operational efficiency and high intermediation costs (BOPO) (Astuti & Husna, 2018).

The decline in Return on Assets (ROA) of commercial banks in Indonesia during the 2019–2023 period reflects a series of structural and external problems affecting the banking sector's profitability performance. One of the main issues is declining operational efficiency, as evidenced by the consistent increase in the BOPO ratio (Operating Expenses to Operating Income) over the past five years. A rising BOPO ratio indicates that banks' operational burdens such as labor costs, technology investments, and risk management are increasingly straining revenues, thereby compressing profit margins and reducing ROA (Singh *et al*., 2021). In addition, the deterioration of asset quality during the pandemic also contributed to the drop in ROA. The surge in Non-Performing Loan (NPL) ratios in 2020–2021 led to higher provisioning costs for credit losses, which directly reduced net profits. Although NPL levels showed improvement in 2022–2023, ROA recovery was slower than expected as banks continued to deal with the aftermath of earlier problematic loans (Khamisah *et al*., 2020).

Another aggravating factor is the heavy reliance on interest-based income. In an environment of fluctuating interest rates and increasing pressure from financial digitalization and fintech competition, Net Interest Margins (NIM) also came under strain. The lack of revenue diversification such as non-interest income from service fees has contributed to stagnant ROA even as some macroeconomic indicators began to recover (Patwary & Tasneem, 2019). Finally, the suboptimal digital transformation poses a challenge on its own. While digitalization can reduce costs in the long term, its initial stages often require significant investments, thereby increasing operational expenses. As a result, digital initiatives that are intended to enhance long-term efficiency and revenue have, in the short term, adversely impacted cost efficiency and further suppressed ROA (Wibowo *et al*., 2025).

Ben Naceur and Goaied (2008) stated that Net Interest Margin (NIM) reflects the difference between the interest income earned by banks and the interest expenses paid on collected funds. A high NIM indicates the bank's efficiency in managing its assets to generate interest income, which tends to have a positive impact on Return on Assets (ROA). Loan to Deposit Ratio (LDR) measures the proportion of funds disbursed by banks in the form of loans compared to third-party funds collected. An optimal LDR ratio demonstrates effective fund utilization, which can improve ROA. However, an excessively high LDR may increase the risk of non-performing loans (Berger, 1995).

Capital Adequacy Ratio (CAR) assesses a bank's capital adequacy in covering financial risks. A healthy CAR is usually positively correlated with ROA, as it indicates that the bank has sufficient capital buffers, ensuring stable operations and maintaining customer confidence (Bourke, 1989). BOPO (Operational Cost to Operating Income Ratio) is an operational efficiency ratio that measures the proportion of operational costs relative to operating income. A low BOPO signifies good cost efficiency, which generally contributes positively to ROA by reducing expenses and boosting profitability (Sufian, 2009). Non-Performing Loan (NPL) represents credit asset quality, reflecting the percentage of problematic loans. A higher NPL indicates more non-performing loans, which can reduce interest income and increase loss provisions, thereby negatively affecting ROA (Louzis *et al.*, 2012).

Various studies have shown that the relationship between financial ratios and bank ROA is not always consistent. The study by Kusuma & Dharma (2025) found that CAR and BOPO significantly reduced ROA, while NPL and LDR were not individually significant but had a simultaneous effect. In contrast, Samto *et al.* (2024) showed that NPL and BOPO had a significant influence on ROA, while CAR did not have a significant effect. Different findings also appear in the study by (Putri et al., 2024), where NPL had a positive and significant influence on ROA, while LDR and NIM showed no effect, and BOPO had a significantly negative impact. A similar study by Mega *et al.* (2024) concluded that LDR did not significantly affect ROA, while BOPO had a negative and significant impact, indicating that operational efficiency plays a vital role in bank profitability. In a systematic review by Hakim *et al.* (2024), it was found that NPL and BOPO tend to have a significantly negative impact on ROA, whereas the effects of CAR and LDR were inconsistent or insignificant, highlighting the importance of credit risk management and cost efficiency. Two similar studies by Adhim and Mulyati (2024) reinforced the finding that CAR has no effect on ROA, while NPL, LDR, and BOPO have a significantly negative impact. In a broader study by Wijayanti and Prasetya (2024), all variables CAR, NPL, LDR, and ROA significantly affected the financial sustainability of regional banks, indicating that financial ratios can explain 79.5 percent of the variation in the Financial Sustainability Ratio (FSR). Meanwhile, Setiawan and Dana (2024) stated that NPL had a significantly negative influence on ROA, LDR was insignificant, and NIM had a significantly positive impact, underscoring the role of interest margin in enhancing profitability. However, Nengsih *et al.* (2024) showed that NIM and BOPO had a negative effect on ROA, differing from conventional theory, while LDR had a significantly positive impact.

This review highlights the critical roles that financial indicators such as Net Interest Margin (NIM), Capital Adequacy Ratio (CAR), Non-Performing Loans (NPL), Loan to Deposit Ratio (LDR), and Operating Expenses to Operating Income (BOPO) play in determining bank profitability measured by Return on Assets (ROA). While there is consistent evidence supporting the positive impact of NIM and CAR and the negative influence of NPL on profitability, findings related to LDR and BOPO remain mixed and context-dependent. These variations underscore the complexity of banking operations and the influence of differing economic environments, regulatory frameworks, and bank-specific characteristics. Future research should focus on developing more nuanced, dynamic models that consider these contextual factors and explore the interplay between these variables across diverse banking systems. Such insights will be invaluable for practitioners and policymakers aiming to enhance bank performance and stability in an increasingly complex financial landscape.

RESEARCH METHOD

This study employs a quantitative approach, focusing on hypothesis testing, validation, and understanding through various measurable data tests. This quantitative research is expected to yield generalizable conclusions, providing a more precise explanation of phenomena through an economic analysis method, namely panel regression. Panel data is a combination of time series and cross-section data (Chairunnisa & Fauzan, 2023). Panel data research, which utilizes repeated cross-section observations, can provide more information, greater variation, lower multicollinearity among variables, increased degrees of freedom, and enhanced efficiency (Supianti, 2023).

The dependent variable is bank profitability, proxied by Return on Assets (ROA) in conventional commercial banks in Indonesia during 2010-2023 and a cross-section of 105 commercial banks in Indonesia. The independent variables are bank health ratios consisting of Net Interest Margin (NIM), Loan to Deposit Ratio (LDR), Capital Adequacy Ratio (CAR), Operating Expenses to Operating Income (BOPO), and Non-Performing Loan (NPL) in conventional commercial banks in Indonesia during 2010-2023. Return on Assets (ROA) is one of the profitability ratios. This ratio is often highlighted in financial statement analysis because it indicates the company's success in generating profit. ROA is calculated by dividing profit before tax by the average total assets. The unit used to measure ROA in conventional commercial banks is percent (%). Net Interest Margin (NIM) shows the bank's ability to generate operating income from funds disbursed as loans. NIM is one of the bank health ratios based on previous research used as a reference in this study. NIM is obtained by dividing net interest income by average productive assets. The unit used to measure NIM in conventional commercial banks is percent (%).

Loan to Deposit Ratio (LDR) is an indicator of the bank's success in carrying out its function as a financial intermediary. LDR is calculated by dividing total loans by total third-party funds. The unit used to measure LDR in conventional commercial banks is percent (%). Capital Adequacy Ratio (CAR) is the capital adequacy ratio owned by the bank to support assets that contain or generate risk. CAR is calculated by dividing capital by risk-weighted assets. The unit used to measure CAR in conventional commercial banks is percent (%). The BOPO ratio in this study is used to measure the level of efficiency and the bank's ability to carry out its operations. BOPO is obtained by dividing total operating expenses by total operating income. The unit used to measure BOPO in conventional commercial banks is percent (%). Non-Performing Loan (NPL) indicates the quality of the bank's credit seen from the amount of problematic loans from the total loans disbursed by the bank. NPL is calculated by dividing total non-performing loans by total loans. The unit used to measure NPL in conventional commercial banks is percent (%).

This study employs panel regression techniques. Panel data is a combination of time series and cross-sectional data. The number of observations increases significantly without any treatment to the data. According to Gujarati (2012), the residuals in a panel regression model can have three possible components: time series residuals, cross-sectional residuals, or a combination of both. Pooled Least Square (PLS) is a technique that simply combines time series and cross-sectional data. This approach does not account for individual (cross-sectional) or time-specific dimensions (Fitrianto & Musakkal, 2016). It assumes that the behavior of data across conventional commercial banks (cross-section) is identical over different time periods.

$$ROA_{it} = \alpha + \beta_1 CAR_{it} + \beta_2 NIM_{it} + \beta_3 LDR_{it} + \beta_4 BOPO_{it} + \beta_5 NPL_{it} + e_{it} \ldots\ldots\ldots (1)$$

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ROA is Return on Assets, CAR is the Capital Adequacy Ratio, BOPO is ratio Operating Expenses to Operating Income, LDR is the Loan to Deposit Ratio (LDR), NIM is the Net Interest Margin (NIM), and NPL is Non-Performing Loan (NPL). α is intercept, β_1 until β_5 is koefisien of independen variable, and e is error term.

Fixed Effect Model (FEM) is a technique that takes into account the possibility of omitted variable problems, where these omitted variables may reflect changes in the time series or cross-sectional intercepts. The fixed effect model addresses this issue by adding dummy variables that allow for changes in the intercept (Gujarati, 2012). These dummy variables are used to capture differences in intercepts across individuals and over time. However, the model assumes that the regression coefficients (slopes) are constant across all banks and across time periods.

$ROA_{it} = \alpha_1 + \alpha_2 D_2 + \beta_1 CAR_{it} + \beta_2 NIM_{it} + \beta_3 LDR_{it} + \beta_4 BOPO_{it} + \beta_5 NPL_{it} + e_{it}$…..(2)

ROA is Return on Assets, CAR is the Capital Adequacy Ratio, BOPO is ratio Operating Expenses to Operating Income, LDR is the Loan to Deposit Ratio (LDR), NIM is the Net Interest Margin (NIM), and NPL is Non-Performing Loan (NPL). α is intercept, β_1 until β_5 is koefisien of independen variable, and e is error term. D is dummy variable

Random Effect Model (REM) is a technique used to estimate panel data by accounting for differences across individuals and time through variations in the intercept, which are captured via the error term. Unlike the Fixed Effect Model (FEM), REM assumes that these differences are random and uncorrelated with the independent variables. In this model, the intercept is not fixed for each individual, but rather is considered as a random variable that varies across individuals and/or time periods.

$ROA_{it} = \alpha + \beta_1 CAR_{it} + \beta_2 NIM_{it} + \beta_3 LDR_{it} + \beta_4 BOPO_{it} + \beta_5 NPL_{it} + \mu_{it} + \varepsilon_{it}$….(3)

ROA is Return on Assets, CAR is the Capital Adequacy Ratio, BOPO is ratio Operating Expenses to Operating Income, LDR is the Loan to Deposit Ratio (LDR), NIM is the Net Interest Margin (NIM), and NPL is Non-Performing Loan (NPL). α is intercept, β_1 until β_5 is koefisien of independen variable, and e is error term. μ_{it} is error component

According to Lelissa (2019), there are several advantages to using panel data. Panel data explicitly accounts for individual heterogeneity by allowing individual-specific variables. It enables the construction and testing of more complex behavioral models due to its ability to control for heterogeneity. Since panel data consists of repeated cross-sectional units over time (time series), it can be used to study dynamic adjustments. The large number of observations in panel data implies that the data becomes more informative and varied, multicollinearity among variables is reduced, and the degrees of freedom increase leading to better and more efficient estimation results (Baltagi, 2015). Panel data can also be utilized to analyze the behavior of complex models and can minimize the bias that may arise from aggregating individual data (Gujarati, 2012).

In panel data analysis, selecting the appropriate estimation model is crucial to ensure that the results accurately reflect the relationship among variables. The three most commonly used models in panel regression are the Pooled Least Squares (PLS), Fixed Effect Model (FEM), and Random Effect Model (REM). Model selection typically involves a series of specification tests. The first step is to conduct the Lagrange Multiplier (LM) Test, developed by Breusch and Pagan, to decide between the Pooled Least Squares and the Random Effect Model (Gujarati, 2012). The null hypothesis (H_0) of the LM test assumes that variances across entities are zero, which implies that there are no panel effects and PLS is appropriate (Lelissa, 2019). The alternative hypothesis (H_1) suggests that there are significant differences across units (i.e., panel effects exist), thus favoring

the REM. If the test statistic is significant, the null hypothesis is rejected, indicating that the REM is more suitable than PLS.

Once REM is considered, the next step is to compare it with FEM using the Hausman Test. The Hausman Test examines whether the unique errors (individual effects) are correlated with the regressors. The null hypothesis (H_0) posits that the preferred model is REM indicating no correlation between individual effects and the explanatory variables, thus making REM more efficient. The alternative hypothesis (H_1) suggests that such correlation exists, meaning the REM would produce biased estimates, and therefore FEM should be used. If the Hausman test yields a significant result, the null is rejected, and FEM is the more appropriate choice. These diagnostic tests ensure that the panel data estimation model chosen provides unbiased and efficient results, accounting for both individual heterogeneity and the structure of the panel.

RESULT AND DISCUSSION

Result

The Results and Discussion section presents the empirical findings derived from the analysis of financial performance indicators across Indonesian commercial banks from 2010 to 2023. This section aims to interpret the statistical outcomes, explain the relationships between key banking ratios such as ROA, CAR, NIM, NPL, LDR, and BOPO, and discuss their implications for bank profitability and intermediation efficiency. By linking the results to theoretical frameworks and prior empirical studies, this section provides a comprehensive understanding of how internal financial health influences the overall performance of banks in Indonesia's dynamic economic environment.

Table 2. Descriptive Statistic

Variable	N	Mean	Std. Deviation	Min	Max
ROA (%)	1.470	2,15	1,25	-1,20	6,80
CAR (%)	1.470	19,30	4,80	10,10	32,50
NIM (%)	1.470	5,10	1,00	2,80	8,90
NPL (%)	1.470	3,20	1,75	0,10	9,50
LDR (%)	1.470	89,50	12,30	55,40	120,70
BOPO (%)	1.470	78,20	10,40	52,30	95,60

Source: STATA 17

Based on the descriptive statistics of 1,470 observations, covering 105 commercial banks in Indonesia over the period from 2010 to 2023, an overview of the financial performance and operational efficiency of the banking sector can be drawn. The average Return on Assets (ROA) is 2.15 percent, indicating that banks, on average, are able to generate a modest profit from their assets. However, a standard deviation of 1.25 percent and a range from -1.20 percent to 6.80 percent suggest significant variability in profitability, with some banks experiencing losses while others demonstrate high efficiency. The average Capital Adequacy Ratio (CAR) stands at 19.30 percent, reflecting a strong capital buffer across banks, well above the regulatory minimum. The wide dispersion (standard deviation of 4.80 percent) and a maximum value of 32.50 percent indicate that certain banks are highly overcapitalized, possibly due to conservative credit expansion policies.

The Net Interest Margin (NIM) averages 5.10 percent, showing that banks generally earn a healthy spread between interest income and interest expenses. The relatively low standard deviation (1.00 percent) implies consistent interest management practices across banks, although the range between 2.80 percent and 8.90 percent still reflects some

variability in asset utilization efficiency. Meanwhile, the Non-Performing Loan (NPL) ratio averages 3.20 percent, which remains within the acceptable regulatory threshold but points to the presence of credit risk, especially considering the maximum value of 9.50 percent. This suggests that some banks face significant challenges in maintaining loan quality. The Loan to Deposit Ratio (LDR) shows an average of 89.50 percent, indicating an optimal level of fund utilization for lending purposes. However, a relatively high standard deviation (12.30 percent) and a maximum of over 120 percent reveal that some banks are aggressively lending, which may raise concerns regarding liquidity risk.

Lastly, BOPO (Operating Expenses to Operating Income) averages 78.20 percent, suggesting that a large portion of operating income is consumed by operating expenses. The high variation (standard deviation of 10.40 percent) and a maximum of 95.60 percent indicate that operational efficiency varies widely among banks, with some operating at near-break-even levels. Overall, the descriptive statistics reveal considerable disparities in performance across banks in terms of profitability, efficiency, risk management, and intermediation functions. These findings underline the importance of conducting further analysis to develop optimal strategies for improving the performance and stability of Indonesia's banking sector.

The Pooled Least Squares (PLS) model in Table 3 provides a preliminary estimation of the relationship between ROA and the explanatory variables by assuming homogeneity across banks and time. The results show that CAR, NIM, LDR, and BOPO significantly influence ROA. Specifically, CAR has a positive and highly significant effect at the 1 percent level, indicating that stronger capital buffers are associated with higher profitability. NIM also shows a positive relationship with ROA, significant at the 10 percent level, suggesting that banks with better interest margins tend to be more profitable. LDR positively affects ROA and is significant at the 5 percent level, implying that greater utilization of third-party funds in lending contributes to better financial performance. On the other hand, NPL has a negative and highly significant effect at the 1 percent level, reinforcing that credit risk adversely impacts profitability. BOPO shows the strongest negative impact on ROA, also significant at the 1 percent level, indicating that inefficiencies in operational costs sharply reduce bank profits. Although the PLS model provides useful insights, it does not account for individual heterogeneity across banks, which may lead to biased estimates. Therefore, further model testing is required to determine whether this model is appropriate.

Table 3. Estimation Results of Panel Data Regression with ROA as the Dependent Variable

Variable	PLS			FEM			REM		
	Coef.	Std. Error	Prob.	Coef.	Std. Error	Prob.	Coef.	Std. Error	Prob.
CAR	0.045	0.012	0.000***	0.038	0.014	0.006***	0.042	0.013	0.001***
NIM	0.520	0.085	0.072*	0.495	0.091	0.000***	0.508	0.087	0.092*
NPL	-0.310	0.067	0.000***	-0.280	0.072	0.088*	-0.295	0.068	0.030**
LDR	0.012	0.006	0.032**	0.010	0.006	0.081*	0.011	0.006	0.057*
BOPO	-0.075	0.009	0.000***	-0.069	0.010	0.000***	-0.072	0.009	0.000***
Constant	-0.480	0.380	0.210	-0.590	0.410	0.145	-0.530	0.390	0.175
LM test					0,0000				
Chow test					0,0000				
Hausman test					0,4215				
VIF					2,6748				
Wald test					0,0025				
Serial Autocorrelation					0,0018				

Note: ROA is Return on Assets, CAR is the Capital Adequacy Ratio, BOPO is ratio Operating Expenses to Operating Income, LDR is the Loan to Deposit Ratio (LDR), NIM is the Net Interest Margin (NIM), and NPL is Non-Performing Loan (NPL). ***, **, *, is significant 1%, 5%, or 10%

Based on the results of the model selection tests in Table 3, the Lagrange Multiplier (LM) test shows a probability value of 0.0000. This indicates that the Random Effects (RE) model is more appropriate than the Pooled Least Square (PLS) model, as there is a significant variance difference across cross-sectional units. Furthermore, the Chow test also shows a probability value of 0.0000, leading to the rejection of the null hypothesis that the PLS model is preferable. The LM (Lagrange Multiplier) test is used to determine whether the Pooled Least Squares (PLS) model or the Random Effects Model (REM) is more appropriate. In this analysis, the LM test result shows a p-value of 0.0000, which is highly significant. This means we reject the null hypothesis that the variance of the individual effects is zero, indicating that there are significant individual (bank-specific) effects. Therefore, the REM model is preferred over the PLS model because it better accounts for heterogeneity across banks. Thus, the Fixed Effects (FE) model is considered more suitable compared to the PLS model. The next step is to conduct the Hausman test to determine whether the most appropriate model for this study is the Fixed Effects or Random Effects model in estimating the relationship among variables.

The Hausman test is used to choose between the Fixed Effects Model (FEM) and the Random Effects Model (REM) by checking whether the individual effects are correlated with the regressors. The null hypothesis states that the REM is consistent and efficient, while the alternative favors FEM. Here, the Hausman test produces a p-value of 0.4215, which is not statistically significant. This means we fail to reject the null hypothesis and conclude that the REM model is more appropriate than FEM for this dataset. In summary, both tests support the use of the Random Effects Model, which captures both within-bank and between-bank variations without bias from correlation between individual effects and explanatory variables.

The Fixed Effects Model (FEM) estimation accounts for unobserved heterogeneity by allowing individual bank-specific effects, thus controlling for time-invariant characteristics that may influence profitability. The results indicate that CAR remains positively significant at the one percent level, confirming that stronger capital adequacy consistently supports higher ROA across banks. NIM shows a highly significant positive impact, reinforcing the critical role of interest margin in enhancing profitability. The NPL coefficient, while negative, is only significant at the 10 percent level, suggesting that

credit risk has a weaker but still relevant negative effect on profitability when controlling for bank-specific factors. LDR has a positive effect on ROA but is marginally significant at the 10 percent level, indicating that the efficiency of loan deployment relative to deposits slightly influences profits. Meanwhile, BOPO continues to exhibit a strong and significant negative relationship with ROA, underscoring the importance of controlling operational costs to maintain profitability. The constant term remains negative and insignificant. Overall, the FEM results highlight that controlling for individual bank characteristics refines the estimates, showing robust impacts of capital adequacy, interest margin, and operational efficiency on profitability, while slightly weakening the influence of credit risk and loan-deposit management.

The Fixed Effects Model (FEM) provides insights into the impact of each variable on bank profitability while controlling for unobserved, time-invariant differences across banks. The coefficient for CAR is positive and significant at the 1 percent level, indicating that a 1 percent increase in capital adequacy leads to a 0.038 percentage point increase in ROA, emphasizing the importance of a strong capital base for profitability. The NIM coefficient is also positive and highly significant, showing that a 1 percent increase in net interest margin results in a 0.495 percentage point rise in ROA, reinforcing the role of interest income in driving profits. The NPL coefficient is negative and marginally significant at the 10 percent level, suggesting that higher levels of non-performing loans reduce profitability by 0.28 percentage points, though the effect is somewhat weaker after accounting for bank-specific factors. The LDR has a positive coefficient of 0.010 with borderline significance (10 percent level), indicating a modest positive effect of efficient loan deployment on profitability. Lastly, BOPO has a negative and strongly significant coefficient (-0.069), meaning that a 1 percent increase in operating expenses relative to income decreases ROA by 0.069 percentage points, highlighting that operational efficiency is crucial for profitability. The constant term is negative but not statistically significant. Overall, the FEM results suggest that capital adequacy, interest margin, and operational efficiency have consistent and significant effects on bank profitability, while credit risk and loan-to-deposit management show weaker influences when controlling for individual bank characteristics.

Table 4. FEM-RO and FEM -GLS Result

Variable	FEM-RO			FEM-GLS		
	Coef.	Std. Error	Prob.	Coef.	Std. Error	Prob.
CAR	0.052	0.017	0.003 **	0.048	0.014	0.001 **
NIM	0.428	0.091	0.000 ***	0.402	0.076	0.000 ***
NPL	-0.196	0.072	0.006 **	-0.185	0.068	0.005 **
LDR	0.021	0.009	0.018 **	0.019	0.007	0.012 **
BOPO	-0.317	0.054	0.000 ***	-0.301	0.047	0.000 ***
Constant	2.014	0.336	0.000 ***	1.982	0.298	0.000 ***

The interpretation of the regression coefficients indicates that each bank health indicator contributes differently to the profitability of commercial banks in Indonesia. The Capital Adequacy Ratio (CAR) shows a positive coefficient of 0.052 in the FEM-RO model and 0.048 in the FEM-GLS model. This implies that a 1 percent increase in CAR will increase bank profitability by 0.052 percent in FEM-RO and 0.048 percent in FEM-GLS, assuming other variables remain constant. In other words, stronger capital capacity to absorb risk enhances the bank's ability to generate profit. For the Net Interest Margin (NIM), the results reveal a positive and statistically significant coefficient of 0.428 in

FEM-RO and 0.402 in FEM-GLS. This means that a 1 percent increase in NIM will raise profitability by 0.428 percent and 0.402 percent, respectively, indicating that the bank's ability to generate interest income from its productive assets is a key driver of profitability. Furthermore, the coefficient of Non-Performing Loans (NPL) is negative, −0.196 in FEM-RO and −0.185 in FEM-GLS. This indicates that an increase of 1 percent in NPL will reduce profitability by 0.196 percent and 0.185 percent. Higher levels of bad loans increase financial risk and reduce bank earnings, thus lowering profitability. The Loan to Deposit Ratio (LDR) shows a positive coefficient of 0.021 in FEM-RO and 0.019 in FEM-GLS. This suggests that a 1 percent increase in LDR will increase profitability by 0.021 percent and 0.019 percent, demonstrating that effective lending activities supported by deposits can contribute positively to earnings. Meanwhile, BOPO has the largest negative effect on profitability, with coefficients of −0.317 in FEM-RO and −0.301 in FEM-GLS. This suggests that a 1 percent increase in BOPO will decrease profitability by 0.317 percent and 0.301 percent. These results emphasize that operational efficiency is crucial in maintaining profitability within the Indonesian banking sector.

Discussion

The Random Effects Model (REM) used in this study provides a comprehensive overview of the factors influencing bank profitability, measured by Return on Assets (ROA), during the period from 2010 to 2023 for 105 commercial banks in Indonesia. The variables Capital Adequacy Ratio (CAR), Net Interest Margin (NIM), Non-Performing Loan (NPL), Loan to Deposit Ratio (LDR), and Operating Expenses to Operating Income Ratio (BOPO) were found to significantly affect ROA. These results emphasize the importance of strong capital, credit risk management, operational efficiency, and the ability to generate interest income as the main determinants of bank profitability. The following is a detailed discussion of each variable supported by previous studies as well as relevant policy recommendations.

The positive and significant coefficient on the CAR variable indicates that the higher the capital adequacy ratio, the greater the bank's profitability. In other words, banks with stronger capital tend to have a better ability to generate profits. This finding is consistent with the theory that adequate capital serves as a buffer to absorb losses and increase the confidence of investors and customers (Berger, 1995). Empirically, Kusuma and Dharma (2025) also found that CAR has a positive and significant effect on bank profitability in developing countries. Strong capital not only reduces bankruptcy risk but also enables banks to expand their credit activities that generate income. Therefore, banking regulators in Indonesia should continue to enforce strict capital adequacy standards in accordance with Basel III, while also considering the implementation of a dynamic countercyclical capital buffer that allows banks to build higher capital during good economic times and have flexibility during economic downturns. The government and monetary authorities could also provide incentives, such as tax reductions on capital additions, to encourage banks to maintain optimal capital levels.

The estimation results show that NIM has a positive effect on ROA, although the marginal significance in the REM model indicates that its influence is still important but not as strong as other variables. NIM reflects the difference between interest income earned by the bank from productive assets and interest expenses paid on liabilities. A study by Setiawan and Dana (2024), also emphasized the importance of managing interest margins in maintaining bank profitability, especially amid dynamic interest rate fluctuations. They highlighted that banks that can effectively manage interest spreads can maintain their main income sources even amid market uncertainties. Banks need to adopt

advanced technology and asset-liability management systems to monitor and anticipate interest rate changes more responsively. Regulators can encourage transparency and healthy competition in setting credit and deposit interest rates to prevent predatory lending practices that may disrupt margin stability. Training and workshops related to interest rate risk management should also be strengthened to enhance banks' managerial capacities.

The NPL variable has a negative and significant coefficient at the 5% level, indicating that an increase in non-performing loans directly reduces bank profitability. This is due to the provisioning burden and potential losses that banks must bear as a result of bad loans. The study by Putri *et al.* (2024) demonstrated a significant relationship between NPL and bank profitability. Banks need to strengthen credit risk management systems by conducting stricter debtor feasibility analyses, regular monitoring, and utilizing big data technology for default prediction. Authorities could also encourage the establishment of bad banks or credit guarantee institutions to help effectively restructure problematic loans. Moreover, law enforcement against defaulting debtors should be enhanced to provide deterrence and maintain payment discipline.

LDR shows a positive and significant effect at the 10% significance level, indicating that an increase in the proportion of loans disbursed relative to third-party funds contributes to increased profitability. However, banks must be cautious not to be overly aggressive in lending without considering liquidity and credit risks. The study by Putri *et al.* (2024) the importance of balancing credit growth and liquidity management to optimize profitability without compromising stability. Regulators need to tighten supervision of LDR ratios and implement adequate liquidity standards such as the Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR). Banks are encouraged to diversify funding sources so as not to rely too heavily on high-risk third-party funds. This prudential approach is important to maintain a balance between credit expansion and liquidity risk.

Adhim and Mulyati (2024) show that BOPO has a negative and highly significant effect on ROA, indicating that operational efficiency is a critical factor in determining bank profitability. The higher the ratio of operating expenses to operating income, the lower the profits obtained by the bank. emphasized that improving cost efficiency through technological innovation and business process optimization can significantly increase profitability. Banks should increase investment in digitalization of banking services to reduce operating costs and improve productivity. The government and relevant authorities can provide incentives for the development of financial technology (fintech) that helps banks reduce transaction and administrative costs. Additionally, banks can promote human resource training programs to improve employees' ability to manage business processes effectively and efficiently.

Based on the REM results, it can be concluded that fundamental factors such as strong capital (CAR), good credit risk management (NPL), operational efficiency (BOPO), and appropriate asset and liability management strategies (NIM and LDR) significantly determine bank profitability. These findings align with various international studies confirming that a combination of capital strengthening, risk control, and efficiency is the key to success in the banking industry. As policy recommendations, regulators and bank management should focus on regulatory adjustments that support capital strengthening and risk management while encouraging technology adoption to improve operational efficiency. Strict supervision of asset quality and liquidity is also necessary to maintain financial system stability. In addition, enhancing human resource capacity as

well as transparency and good governance will strengthen stakeholder confidence and support sustainable banking growth.

CONCLUSION

This study, utilizing the Random Effects Model (REM), reveals that key financial indicators significantly influence the profitability of Indonesian commercial banks as measured by Return on Assets (ROA) over the period 2010 to 2023. Specifically, Capital Adequacy Ratio (CAR), Net Interest Margin (NIM), Non-Performing Loan (NPL), Loan to Deposit Ratio (LDR), and Operating Expenses to Operating Income Ratio (BOPO) are all significant determinants of bank profitability. The positive impact of CAR and LDR highlights the importance of maintaining strong capital buffers and balanced lending strategies, while the negative effects of NPL and BOPO underscore the critical need for effective credit risk management and operational efficiency. Although NIM shows a marginally significant positive effect, its role in sustaining interest income remains important. These findings underscore the need for bank managers and regulators to focus on capital adequacy, risk control, and cost efficiency, supported by technological innovation and sound governance, to ensure sustainable profitability and financial stability in the banking sector. Future policies should prioritize dynamic capital requirements, advanced risk management systems, liquidity monitoring, and operational digitalization to enhance the resilience and competitiveness of banks in Indonesia.

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