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Exploring Proxies of Bank Profitability in Indonesia from 2012 to 2023

Vania Kusuma[1], Valentino Budhidharma[2]
[1,2]Faculty of Economy, Universitas Pelita Harapan, Jakarta

Article Info	ABSTRACT
Keywords: Bank Profitability Bank-Specific Variable Random Forest XGBoost	This study analyzes the factors affecting bank profitability in Indonesia during 2012–2023 using quarterly data from 50 banks listed on the Indonesia Stock Exchange. Bank profitability is calculated by Return on Assets (ROA) and Return on Equity (ROE), with explanatory variables including capital adequacy ratios (CAR) measured by total capital to total assets (TCTA) and total capital to risk weighted assets (TCRWA), equity ratios (EQTA), cost-to-income ratios (CIR), debt-to-equity ratios (DER), bank size (SIZE), and non-performing loans (NPL). Panel regression shows that CAR, EQTA, and DER are insignificant, while CIR, SIZE, and NPL negatively affect profitability. Machine learning techniques (Random Forest and XGBoost) confirm CIR, NPL, and SIZE as key factors. The findings highlight the importance of operational efficiency and credit risk management for improving bank profitability, offering insights for managers and policymakers.
This is an open access article under theCC BY-NClicense	**Corresponding Author:** Vania Kusuma Faculty of Economy, Universitas Pelita Harapan, Jakarta vaniakusuma@hotmail.com

INTRODUCTION

A bank is a mediator between the saver party that has capital funds and the borrower party that needs capital funds. Banks are essential in driving the economy through credit distribution, financial services, and fund management. The success of banks in carrying out this function depends on their profitability and operational efficiency, which are of primary concern to stakeholders, including investors, customers, and regulators. High bank profitability indicates the bank's capability to control assets effectively and make profits, which in turn strengthens public confidence in these financial institutions. According to Deutsche Bundesbank's (2018) report, the importance of bank profitability is closely tied to the security and the financial process operation. Bank profitability affects a bank capability to generate capital, which influences banks' lending behavior. When banks face weak profitability, their ability to generate and retain capital diminishes, potentially leading to more restrictive lending policies. This restriction can undermine the impact of accommodative monetary policy measures aimed at stimulating economic growth (Deutsche Bundesbank, 2018).

Many previous studies have employed ratios provided by banks in their financial reports to evaluate profitability. The simplest method to measure a bank's profitability is through return on assets (ROA), while another way to measure is using return on equity (ROE) (Kohlsheen et al., 2018). These two measures are indicators in assessing bank

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performance and financial resilience. Al-Sharkas and Al-Sharkas (2022) study measures bank profitability using Return on Assets (ROA) and Return on Equity (ROE), which represent annual net income divided by total assets, and net income divided by total equity, respectively (Al-Sharkas & Al-Sharkas, 2022).

Plenty of research has also been conducted to examine the variables influencing bank profitability. Almazari (2013) observed a dependency between CAR and profitability using nine banks in Saudi Arabia over the period of 2007 to 2011. The result shows that there is an impactful relationship between capital adequacy ratio, cost-income ratio, and bank size with profitability (Almazari, 2013). Lotto (2019) investigates the variables that affect the operational efficiency of 36 Tanzanian commercial banks from 2000 to 2017 which revealed that bank capital adequacy and liquidity are positively related to bank operational efficiency, and operational efficiency has a direct effect on bank profitability (Lotto, 2019). Al-Sharkas and Al-Sharkas (2022) studied the impact of capital adequacy ratios on bank profitability in 24 Jordanian Banks from the period 2008 to 2018. The study reveals that bank profitability has an important correlation with capital adequacy ratios (Al-Sharkas & Al-Sharkas, 2022).

Gržeta et al. (2023) assisted a study to investigate the relationship of regulation on bank performance with bank size and other variables on 433 European banks in the 2006 to 2015 period. The findings imply that bigger banks have adeptly adjusted to the regulations that positively affect both efficiency and profitability. Conversely, because of the additional regulatory and administration burdens caused by the current regulatory scheme, small banks are experiencing difficulties with profitability and efficiency (Gržeta et al., 2023). Hersugondo et al. (2021) study the influence of bank size and bank age on banks' performance in 94 Indonesian banks from 2015 to 2019. It results that the bank size has an insignificant positive effect with bank performance, but bank age has a positive correlation with bank performance. It showed that the longer the bank was established, the higher the performance it had (Hersugondo et al., 2021).

Nugrahati et al (2018) managed a study to stipulate the perception of capital adequacy to bank profitability in Indonesian Islamic banks from 2012 to 2016 which resulted in capital adequacy level having a positive influence on profitability. The study shows that if the capital adequacy level (CAR) increases, the profitability obtained will increase (Nugrahanti et al., 2018). On the contrary, research by Hersugondo et al. (2021) also study the relationship of capital adequacy on banks' performance in Indonesia from 2015 to 2019 result that CAR has a significant negative relationship on bank profitability (Hersugondo et al., 2021).

The inconsistencies in previous findings about the impact of factors that determine bank profitability highlight the chance for further investigation into the specific drivers of profitability in the banking sector. This study will analyze the effect of the capital adequacy ratio, equity ratio, cost income ratio, debt ratio, bank size, and non-performing loans on bank profitability in Indonesia. This paper aims to devote a deeper understanding of the influence of those variables on the banking sector in Indonesia and to assist banks in developing strategies to increase profitability amidst increasingly complex regulatory demands.

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To achieve this, the study will not only employ statistical approaches but will also integrate machine learning techniques to come across complex schemes and interactions among the variables that may not be clear through conventional analysis. According to Qin (2022), Machine learning will increase the accuracy of company financial assessment while also saving a significant number of resources (Qin, 2022). Qin's (2022) study is also supported by Supsermpol et al. (2023) that state predictive models with machine learning offer insightful information that helps business to make better decisions, allocate resources, and improve long-term performance (Supsermpol et al., 2023). By leveraging machine learning, this study aims to provide more accurate predictions and insights into the factors that affect bank profitability, offering new contributions to the existing literature. This approach will enable a deeper appraisal of the determinants of bank profitability in Indonesia, supporting stakeholders in making data-driven decisions to enhance financial performance.

Literature Review

Bank Profitability

Since a well-capitalized and profitable banking sector can promote economic activity, effectively transmit monetary policy, and absorb possible financial shocks, profitability is a critical component of financial stability and efficient monetary policy transmission (Deutsche Bundesbank, 2018). According to Xu et al (2019), one important measure of financial stability is bank profitability where higher bank profitability contributes to financial stability by providing a buffer against risks, reducing the likelihood of defaults, and encouraging prudent risk management practices. Profitable banks are better positioned to maintain adequate capital ratio, absorb losses, and continue lending during economic downturns, which supports overall financial stability (Xu et al., 2019). Among the various metrics used to calculate bank profitability, return on asset (ROA) and return on equity (ROE) are the most common metrics. According to Marshall et al. (2023), a thorough evaluation of a business's profitability requires a comparison of net income and the utilized assets shown by ROA (Marshall et al., 2023). ROE, an alternative metric for bank profitability, evaluates how well a business generates revenue from shareholder capital. ROE is calculated by dividing net income by total equity (Brealey et al., 2014).

Determinants of Bank Profitability

The Capital Adequacy Ratio (CAR), which represents measurement of a bank's capital to its assets, is a crucial signal of its financial health (Al-Sharkas & Al-Sharkas, 2022). Basel III regulates the calculation of CAR, which is based on dividing the total of tier 1 and tier 2 capital by risk-weighted assets (RWA) (BIS, 2011). Hoenig (2013) argues that the Basel III framework, which uses a risk-weighted assets (RWA) approach to determine capital requirements, is a well-intentioned illusion that fails to address the real risks in the banking system. It has several weaknesses such as risk manipulation and limitations of risk assessment. Moreover, Hoenig supports calculating CAR based on total assets as a simpler and more transparent alternative approach because of simplicity and transparency, complexity reduction, and improving systemic stability (Hoenig, 2013). Total Capital to Total Assets (TCTA) is one measurement of CAR. Total capital is the total of capital tiers one and two, with capital tier two having a lesser ability to absorb losses and offer backup protection against losses (BIS, 2011). Total Capital to Risk-Weighted Assets (TCRWA) is the most widely utilized computation for the CAR by banks worldwide, particularly under the Basel III framework. This ratio is deemed suitable as it accounts for the bank's higher Tier 1 capital as well as its lower Tier 2 capital. Furthermore, by utilizing RWA, it ensures that the CAR is predicated on how risky the bank's assets are (BIS, 2011).

The equity ratio (EQTA) gives an overview of a bank's capital structure and leverage by comparing total equity to its total assets. A greater equity ratio implies a less leveraged capital structure and a more cautious approach to funding, implying that the bank depends more on stock than on borrowed money. For regulators, investors, and other stakeholders concerned with the financial health of banks, this can improve the bank's capacity to resist financial shocks and take in losses, making it a crucial step (Admati et al., 2013). EQTA is used to measure the portion of a bank's assets that are financed by equity and indicates the bank's ability to absorb losses and maintain solvency during distress (Al-Sharkas & Al-Sharkas, 2022).

Ayinuola and Gumel (2023) explain that the cost to income ratio (CIR) compares operating costs, which include staff wages, administrative expenses, and other costs—against income in order to determine how efficient a bank's operations are. A lower CIR indicates increased efficiency, implying that the bank is generating money at a lower rate, which contributes to higher profitability. On the other hand, a larger CIR indicates inefficiency, as operating expenses reduce profits and lower total profitability. The CIR is proportion of a bank's costs to its earnings, and hence experts usually hold that poor productivity and efficiency correlate with high CIR (Ayinuola & Gumel, 2023).

The debt-to-equity (DER) ratio is a leverage ratio which illustrates the composition of the capital structure toward debt or equity financing by calculating the total weight of debt and other financial liabilities in relation to total shareholder equity (CFI, 2024). A higher debt-to-equity ratio can lead to increased profitability due to the tax benefits of debt and the lower cost of borrowing compared to equity financing (Modigliani & Miller, 1958). However, Myers (1977) argues that while debt provides tax benefits, the associated costs from altered investment decisions and potential financial distress lead firms to limit their borrowing, resulting in an optimal, rather than maximal, debt-to-equity ratio (Myers, 1976).

Banks are usually categorized into different size groups to help in analyzing how banks of different sizes perform under different economic conditions and regulatory environments (Regehr & Sengupta, 2016). In 2023, Gržeta et al. managed research on European banks and discovered that large banks can more quickly adapt to established banking regulations and have a positive effect on bank profitability. Meanwhile, small banks are struggling with profitability and efficiency because they are burdened with administrative processes and regulations (Gržeta et al., 2023). According to Al-Sharkas and Al-Sharkas (2022), bank size is measured as the natural logarithm of total assets to account for the imbalance in the distribution of assets across banks (Al-Sharkas & Al-Sharkas, 2022).

Non-performing loans represent a significant risk to banks because they indicate the likelihood of losses from defaults. High levels of NPLs are usually associated with expanded credit risk, requiring banks to reserve larger provisions for potential loan losses, which directly reduces profitability. NPL ratios serve as an index of a bank's credit risk management effectiveness and overall financial health (Prawira & Wiryono, 2020). NPL can be composed by dividing non-performing loans to total loans (Al-Sharkas & Al-Sharkas, 2022).

Conceptual Framework

This section describes the conceptual framework that connects the independent variables (TCTA, TCRWA, EQTA, CIR, DER, SIZE, and NPL) with the dependent variables (ROA and ROE) based on previous literature review:

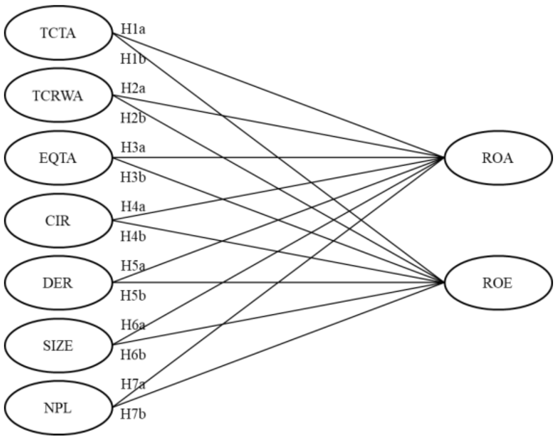

Figure 1. Conceptual Framework

Developed hypotheses in this study are as follows:
H1a= TCTA is negatively significant to ROA.
H1b= TCTA is negatively significant to ROE.
H2a= TCRWA is negatively significant to ROA.
H2b= TCRWA is negatively significant to ROE.
H3a= EQTA is positively significant to ROA.
H3b= EQTA is positively significant to ROE.
H4a= CIR is negatively significant to ROA.
H4b= CIR is negatively significant to ROE.
H5a= DER is positively significant to ROA.
H5b= DER is positively significant to ROE.
H6a= SIZE is positively significant to ROA.
H6b= SIZE is positively significant to ROE.
H7a= NPL is negatively significant to ROA.
H7b= NPL is negatively significant to ROE.

RESEARCH METHOD

The study employed quarterly financial data from 50 banks that are indexed on the Indonesia Stock Exchange (IDX). The dataset spans from the first quarter of 2012 to the fourth quarter of 2023. All public companies that have been listed on the IDX since 1973 make up the population of this study, and the sample was selected based on the availability of data relevant to the research variables. The source of the information is Capital IQ Pro.

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The data is winsorized at the 1% level to avoid the impact of outliers (Klein & Weill, 2018). The software used for data processing in this study is R Studio.

This study performs Chow-Test, Hausman-Test, and Langrage Multiplier Test to choose the suitable panel model for this study between the Pooled OLS (CEM), the fixed effects (FEM), and the random effects (REM). Diagnostic tests are used to validate the assumptions underlying various econometric models, ensuring that the chosen model is suitable for the data and that the results are reliable. This study performs Autocorrelation test, Heteroskedasticity test, and Cross-Sectional Dependence test to validate the models. In addition to regression methods, Variable importance measurement is crucial for understanding which independent variables most significantly influence the bank profitability. This measurement may result in the creation of a more precise and comprehensive model to the study. Measuring variable importance is essential for improving model interpretability, optimizing model performance, and making informed decisions based on the most impactful variables. Machine learning techniques like Random Forests and XGBoost are performed to offer advanced ways to measure variable importance.

RESEARCH RESULT

Descriptive Statistics

This subchapter presents the descriptive statistics of the variables used in the study to provide a general overview of the dataset. Statistical data from the variables used in this study can be seen in the following table:

Table 1. Descriptive Statistics

Variable	Observations	Mean	Median	Standard Deviation	Minimum	Maximum
ROA	2,150	0.79%	0.98%	2.73%	-13.49%	8.98%
ROE	2,161	5.25%	6.48%	15.23%	-79.48%	32.49%
TCTA	1,927	16.89%	14.32%	10.33%	6.79%	72.60%
TCRWA	2,042	27.11%	20.36%	25.53%	10.26%	197.77%
EQTA	1,959	17.28%	14.60%	10.76%	6.27%	74.52%
CIR	1,827	66.83%	58.43%	34.28%	26.41%	249.72%
DER	1,939	0.33%	0.19%	0.42%	0.00%	1.94%
SIZE	2,262	14.48	14.22	1.87	10.77	18.52
NPL	1,847	3.19%	2.79%	2.32%	0.00%	14.51%

Source: Primary Data Processed

Panel Model Selection

In this section of the research, the results of the panel model selection test are presented to determine the fittest panel model in this study. To determine whether the FEM is more suitable for the data than a CEM, the Chow test is used. The result can be seen in the following table:

Table 2. Chow Test

Chow-Test	ROA - TCTA	ROA - TCRWA	ROE - TCTA	ROE - TCRWA
P-Value	0.000	0.000	0.000	0.000

Source: Proceed by R-Studio

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In all four cases, the p-values are significantly less than α = 5%, which leads to the rejection of the null hypothesis (H0). This indicates that the FEM is fit for all models. The significant effects suggest that the influence of the independent variables on ROA and ROE varies across the entities, supporting the use of the fixed effects model over the CEM.

The FEM and the REM are compared to see which is better suit for the data using the Hausman Test. The result can be seen in the following table:

Table 3. Hausman Test

Hausman-Test	ROA - TCTA	ROA - TCRWA	ROE - TCTA	ROE - TCRWA
P-Value	0.000	0.000	0.000	0.000

Source: Proceed by R-Studio

In all cases, the p-values are significantly less than α = 5%, leading to the rejection of the null hypothesis (H0). This indicates that the FEM is fit for all dependent and CAR measurements. The significant effects suggest that the influence of the independent variables on ROA and ROE varies across the entities, supporting the use of the FEM over the REM.

Diagnosis Test

In this section of the research, the results of the diagnostic tests are shown to validate the assumptions underlying various econometric models, ensuring that the chosen model is fit for the data and that the results are reliable. To determine whether the panel data model indicates autocorrelation issue, Wooldridge test is used. The result can be seen in the following table:

Table 4. Autocorrelation Test

Autocorrelation	ROA - TCTA	ROA - TCRWA	ROE - TCTA	ROE - TCRWA
P-Value	0.039	0.052	0.007	0.005

Source: Proceed by R-Studio

In ROA – TCTA, ROE – TCTA, and ROE – TCRWA, the p-values are less than 0.05, leading to the rejection of the null hypothesis (H0) of no autocorrelation. This indicates the presence of serial correlation for all three models. The significant p-value suggests that the residuals in the models are not independent but rather correlated over time or across entities. Meanwhile ROA – TCRWA has p-value larger than 0.05 that indicates there is no significant evidence of autocorrelation in the residuals of the fixed effect model.

To determine whether the panel data model indicates heteroskedasticity issue, Breusch-Pagan test is used. The result can be seen in the following table:

Table 5. Heteroskedasticity Test

Heteroskedasticity	ROA - TCTA	ROA - TCRWA	ROE - TCTA	ROE - TCRWA
P-Value	0.000	0.000	0.000	0.000

Source: Proceed by R-Studio

For all cases, the p-values are significantly less than 0.05, leading to the rejection of the null hypothesis (H0). This indicates the presence of heteroscedasticity in the regression models. The significant Breusch-Pagan test statistics indicates that the variance of the error terms is not fixed.

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To determine whether the panel data model indicates cross-sectional dependence issue, Pesaran test is used. The result can be seen in the following table:

Table 6. Cross Sectional Dependence Test

Cross Sectional Dependence	ROA - TCTA	ROA - TCRWA	ROE - TCTA	ROE - TCRWA
P-Value	0.000	0.000	0.000	0.000

Source: Proceed by R-Studio

In all cases, the p-values from the Pesaran CD test are significantly less than 0.05, leading to the rejection of the null hypothesis (H0). This indicates the existence of cross-sectional dependence on the panel data models. The significant test statistics suggest that the residuals across different cross-sectional units are correlated, which violates the assumption of independence across entities.

Regression Analysis

To address violation with the assumptions of the panel data, such as autocorrelation, heteroskedasticity, and cross-sectional dependence test, Driscoll-Kraay Standard Errors regression is used. The table below shows the comparative analysis of various financial indicators across four models of panel data regression:

Table 7. Panel Regression

Independent variables	ROA				ROE			
	TCTA		TCRWA		TCTA		TCRWA	
	Coef,	P	Coef,	P	Coef,	P	Coef,	P
TCTA	-0.046	0.408			-0.309	0.359		
TCRWA			0.014	0.325			0.032	0.562
EQTA	0.075	0.181	0.002	0.939	0.277	0.432	-0.093	0.491
CIR	-0.025	0.000*	-0.026	0.000*	-0.139	0.000*	-0.141	0.000*
DER	-0.211	0.553	-0.311	0.317	-1.769	0.417	-2.238	0.248
SIZE	-0.618	0.000*	-0.627	0.000*	-3.727	0.000*	-3.777	0.000*
NPL	-0.379	0.000*	-0.358	0.000*	-2.489	0.000*	-2.413	0.000*
F-Statistics	25.376		18.097		26.373		21.319	
Adj. R-Squared	0.2296		0.2320		0.2536		0.2537	
Prob>F	0.000		0.000		0.000		0.000	

Source: Proceed by R-Studio

Variable Importance Analysis

In addition to regression methods, this section performs Random Forests and XGBoost models as machine learning techniques to offer advanced ways to measure variable importance. Below are the important variables of Random Forest for ROA and ROE models:

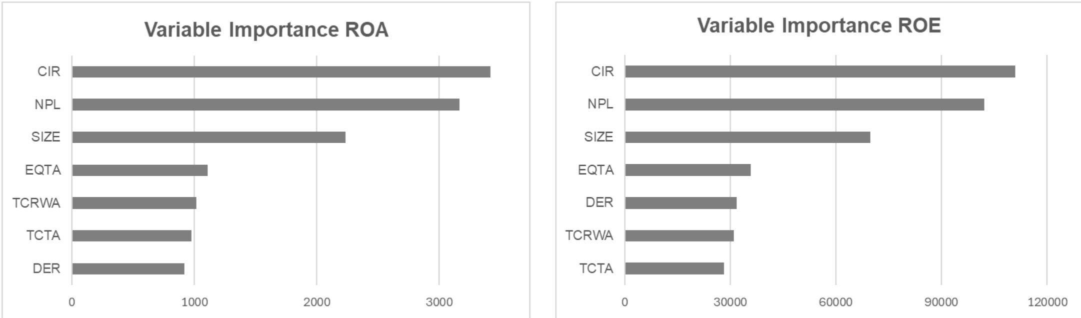

Figure 2. Random Forest Variable Importance
Source: Proceed by R-Studio

Based on the Random Forest figure, ROA model the variable importance order is CIR, NPL, SIZE, EQTA, CCRWA, CCTA, TCRWA, TCTA, and DER. Meanwhile for ROE models the variable importance order is CIR, NPL, SIZE, EQTA, CCRWA, DER, TCRWA, TCTA, and CCTA. In both ROA and ROE models, CIR, NPL, and SIZE are the top three variables that have the most influence on bank profitability.

Meanwhile, below are the important variables of XGBoost for ROA and ROE models:

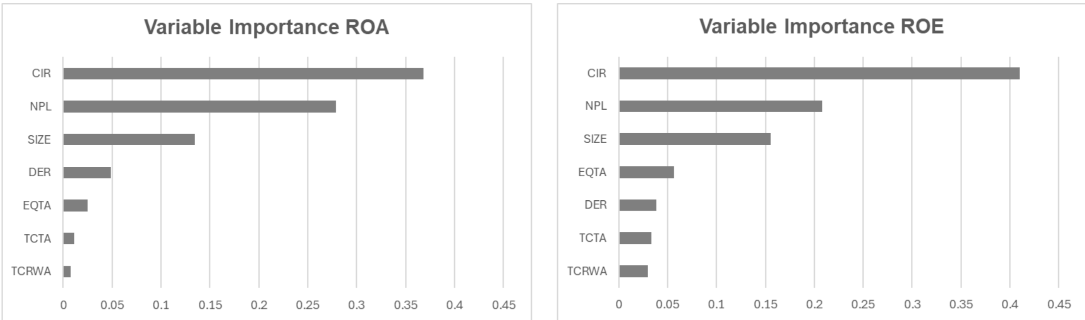

Figure 3. XGBoost Variable Importance
Source: Proceed by R-Studio

Based on the XGBoost figure, ROA model the variable importance order is CIR, NPL, SIZE, CCTA, DER, CCRWA, EQTA, TCTA, and TCRWA. Meanwhile for ROE models the variable importance order is CIR, NPL, SIZE, EQTA, CCRWA, DER, TCTA, TCRWA, and CCTA. In both ROA and ROE models, CIR, NPL, and SIZE are the top three variables that have the most influence on bank profitability.

Results and Discussion

Key findings from descriptive statistics reveal that ROA and ROE exhibit left-skewed distributions, with median values exceeding their means, indicating that most banks perform better than the average while a few significantly underperform. Variability is evident, as reflected by high standard deviations and wide ranges between minimum and maximum values, underscoring differences in efficiency and profitability across banks. Notably, ROA ranges from -13.49% to 8.89%, and ROE ranges from -79.48% to 32.49%, highlighting operational challenges and exceptional performance among banks. Additional ratios such as CAR, EQTA, CIR, and NPL show significant variability and skewness. CIR, with a mean of 66.83%, highlights operational efficiency disparities, while NPL averages 3.19%, signaling moderate credit risk with some banks showing strong asset quality and others struggling with high default rates. DER and SIZE show relatively modest variability, reflecting consistent leverage and size structures among banks. These findings provide insights into the financial health, operational efficiency, and risk management practices of Indonesian banks.

The panel model selection tests confirm that the Fixed Effects Model (FEM) is the best fit for the data, as evidenced by the Chow and Hausman tests, where all p-values are significantly below 0.05, rejecting the null hypothesis in favor of FEM over the Common Effects Model (CEM) and Random Effects Model (REM). The diagnostic tests reveal key econometric issues: the Wooldridge test indicates the presence of autocorrelation in three out of four models, while the Breusch-Pagan test confirms heteroskedasticity across all models. Additionally, the Pesaran test detects cross-sectional dependence in all cases, suggesting correlation among residuals across entities. These findings highlight the necessity of addressing model assumptions to ensure the robustness of the analysis.

The regression analysis confirms that all four models are statistically significant, with Prob>F values below 0.05, validating their reliability in explaining bank profitability. However, the adjusted R-squared values remain relatively low, indicating that additional factors beyond the independent variables influence ROA and ROE. The results show that capital adequacy ratios (TCTA and TCRWA) and equity ratio (EQTA) have no significant impact on profitability, aligning with the notion that banks prioritize stability over direct profitability optimization. In contrast, cost efficiency (CIR), non-performing loans (NPL), and bank size (SIZE) significantly and negatively affect ROA and ROE, highlighting the importance of operational efficiency, risk management, and scale management. These findings support Agency Theory and Diseconomies of Scale Theory, emphasizing that cost control, credit risk management, and strategic growth planning are crucial for sustaining profitability.

The variable importance analysis using Random Forest and XGBoost confirms that CIR, NPL, and SIZE are the three most influential factors affecting bank profitability in both ROA and ROE models. Scenario testing for model improvement shows that the original ROA-TCRWA model has the highest adjusted R-squared (0.2320), indicating the best explanatory power for ROA. For ROE, the highest adjusted R-squared (0.2542) is achieved when CAR variables (TCTA and TCRWA) are excluded, reinforcing their insignificance in explaining bank profitability. These findings highlight the distinct characteristics of ROA and ROE, where ROE is more sensitive to past performance via retained earnings, while ROA remains more stable.

CONCLUSION

This study finds that bank profitability in Indonesia is primarily influenced by operational efficiency (CIR), credit risk (NPL), and bank size (SIZE), while capital adequacy (CAR), equity ratio (EQTA), and debt to equity ratio (DER) have no significant impact. The negative effects of CIR, SIZE, and NPL highlight the need for banks to control costs, optimize operations, and strengthen credit risk management. Machine learning analysis further confirms CIR, NPL, and SIZE as the most critical factors. The ROA-TCRWA model offers the best explanatory power for ROA, while ROE models excluding CAR perform better. These findings suggest that banks should focus on efficiency, risk management, and sustainable resource allocation to enhance long-term profitability.

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