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Operational Efficiency and Financial Structure as Determinants of Return on Assets: Panel ARDL Estimation in the Banking Industry

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ABSTRACT

This study examines the effects of operational efficiency and financial structure on the profitability of conventional commercial banks in Indonesia during 2014–2022. Profitability is measured by Return on Assets (ROA), while the explanatory variables include Operating Expenses to Operating Income (BOPO), Debt to Asset Ratio (DAR), Capital Ratio (CR), and bank size (SIZE). Using secondary data from the annual financial statements of 12 conventional commercial banks, this study applies the Panel Autoregressive Distributed Lag (Panel ARDL) model with the Pooled Mean Group (PMG) estimator to distinguish short-run dynamics from long-run equilibrium relationships. The findings confirm the existence of a stable long-run relationship among the variables, as indicated by a significant error correction term. In the long run, DAR has a significant negative effect on ROA, while CR has a significant positive effect. SIZE shows a significant negative relationship with ROA, suggesting that larger banks in the sample may face scale-related inefficiencies. BOPO also has a positive and significant long-run effect on ROA, indicating that operating expenses may reflect broader operational and revenue-related conditions rather than cost inefficiency alone. In the short run, only CR and SIZE significantly affect ROA, whereas DAR and BOPO do not show significant effects. These findings highlight that bank profitability is shaped by dynamic internal adjustment processes and provide implications for bank managers and regulators in maintaining prudent leverage, strengthening capital resilience, and improving the quality of operational management.

ABSTRAK

Penelitian ini menganalisis pengaruh efisiensi operasional dan struktur keuangan terhadap profitabilitas bank umum konvensional di Indonesia selama periode 2014–2022. Profitabilitas diukur menggunakan Return on Assets (ROA), sedangkan variabel independen meliputi Biaya Operasional terhadap Pendapatan Operasional (BOPO), Debt to Asset Ratio (DAR), Capital Ratio (CR), dan ukuran bank (SIZE). Dengan menggunakan data sekunder dari laporan keuangan tahunan 12 bank umum konvensional, penelitian ini menerapkan model Panel Autoregressive Distributed Lag (Panel ARDL) dengan estimator Pooled Mean Group (PMG) untuk membedakan dinamika jangka pendek dan hubungan keseimbangan jangka panjang. Hasil penelitian mengonfirmasi adanya hubungan jangka panjang yang stabil antarvariabel, sebagaimana ditunjukkan oleh error correction term yang signifikan. Dalam jangka panjang, DAR berpengaruh negatif signifikan terhadap ROA, sedangkan CR berpengaruh positif signifikan. SIZE menunjukkan hubungan negatif signifikan terhadap ROA, yang mengindikasikan bahwa bank berukuran besar dalam sampel berpotensi menghadapi inefisiensi terkait skala. BOPO juga menunjukkan pengaruh positif signifikan dalam jangka panjang, yang mengindikasikan bahwa beban operasional dapat merefleksikan kondisi operasional dan kapasitas pendapatan yang lebih luas, bukan semata-mata inefisiensi biaya. Dalam jangka pendek, hanya CR dan SIZE yang berpengaruh signifikan terhadap ROA, sedangkan DAR dan BOPO tidak menunjukkan pengaruh yang signifikan. Temuan ini menegaskan bahwa profitabilitas perbankan dipengaruhi oleh proses penyesuaian internal yang bersifat dinamis serta memberikan implikasi bagi manajemen bank dan regulator dalam menjaga leverage yang prudent, memperkuat ketahanan modal, dan meningkatkan kualitas pengelolaan operasional.

INTRODUCTION

The banking sector plays a crucial role in supporting economic stability and national growth through its function as a financial intermediary. Banks channel funds from surplus units to productive sectors requiring financing, making their financial performance central to the sustainability of the broader economy. To ensure that this intermediation function operates effectively, bank performance must be continuously monitored, particularly through profitability indicators such as Return on Assets (ROA). ROA is a key measure reflecting how effectively banks manage their assets to generate profits (Acharya et al., 2023; Gižienė et al., 2024; Mamatzakis et al., 2023). Prior studies have also shown that factors such as Corporate Social Responsibility (CSR) and leverage influence ROA, reinforcing its relevance as a primary benchmark of banking profitability (Firdaus et al., 2022; Joudar et al., 2023).

In the Indonesian context, both macroeconomic conditions and internal bank characteristics have been shown to affect financial stability and banking performance. Firdaus et al. (2022) highlighted the strong relationship between banking stability and macroeconomic determinants, particularly in Regional Development Banks. Meanwhile, the importance of internal governance mechanisms in controlling risks that directly affect profitability has also been emphasized in the literature (Mabkhot & Al-Wesabi, 2022; Munawar & Maulana, 2020; Munawara & Hadianib, 2020). Alongside these institutional and macroeconomic factors, rapid technological development has reshaped banking operations, as digital innovations such as mobile banking and artificial intelligence increasingly influence operational efficiency and overall banking performance (Acharya et al., 2023). These conditions suggest that bank profitability is not determined by a single factor, but by the interaction of managerial efficiency, financial structure, and organizational capacity.

Among the internal determinants of profitability, operational efficiency remains one of the most significant issues in banking. The ratio of Operating Expenses to Operating Income (BOPO) is widely used as an indicator of cost efficiency. A high BOPO ratio reflects inefficiency in managing operational costs, which theoretically leads to lower profitability (Dewi & Sudarsono, 2021; Wetapo et al., 2023; Yayan & Ayuningtyas, 2024). Empirical evidence also supports this argument, showing that BOPO has a significant negative effect on ROA across various types of banks (Dwiputri et al., 2023; Kusumawardhani et al., 2023). Therefore, operational cost control remains essential for sustaining profitability in the banking industry.

Beyond efficiency, financial structure also plays a vital role in determining bank profitability and resilience. Ratios such as the Debt to Asset Ratio (DAR) and the Capital Ratio (CR) reflect leverage levels and the strength of bank capitalization. Studies by Hasyim & Munawwaroh (2022) indicate that effective management of DAR and CR can improve profitability and strengthen financial stability. Other studies further confirm that well-managed debt structures contribute positively to bank profitability through indicators such as ROA and Net Profit Margin (Munawar, 2019). In addition, bank size is also relevant because scale may create either efficiency advantages or managerial complexity in asset utilization. Accordingly, profitability should be viewed as the outcome of how banks manage operational efficiency, leverage, capital strength, and scale within a dynamic business environment.

The development of the Indonesian banking industry over the past decade illustrates the importance of these issues. Based on reports from the Financial Services Authority (OJK), the national average ROA fluctuated significantly, declining from around 2.3% in 2015 to approximately 1.5% in 2020 due to pandemic pressures, before recovering to nearly 2.0% in 2023. Meanwhile, BOPO ratios among conventional banks have remained above 80%, reflecting persistent efficiency challenges. Capital adequacy indicators have generally improved, yet several

large banks still exhibit relatively high dependence on liabilities. According to OJK and Perbanas data (August 2023), ROA has remained in the range of 1.5%–2.5%, while BOPO continues above 80%, underlining the importance of examining the determinants of profitability in a more comprehensive and dynamic framework.

Previous studies have documented significant relationships between BOPO, DAR, and ROA, although the findings remain inconsistent and vary across contexts, samples, and periods (H. Haryati, 2024; S. Haryati & Maulana, 2021; Nuryanto & Difa, 2020). Sanjaya & Badjuri (2024) further demonstrated that credit risk can moderate these relationships, suggesting that banking profitability is shaped by complex interactions between efficiency, leverage, and risk management. However, much of the existing evidence still focuses on direct or contemporaneous relationships and does not explicitly distinguish whether the effects of internal bank factors on profitability emerge only in the short run or persist in the long run. As a result, an important research gap remains regarding the dynamic adjustment process through which operational efficiency and financial structure influence bank profitability over time, especially in the Indonesian banking context.

This gap is particularly important because profitability adjustment in banking rarely occurs instantaneously. Banks operate under regulatory constraints, market pressures, and internal adjustment processes that may delay the impact of cost efficiency, leverage, and capitalization on ROA. For that reason, a dynamic estimation approach is needed to capture both short-run responses and long-run equilibrium relationships. The Panel Autoregressive Distributed Lag (Panel ARDL) model provides an appropriate methodological framework because it accommodates variables with mixed integration orders, I(0) and I(1), and simultaneously estimates both short-run and long-run relationships. Panel ARDL has been widely applied across disciplines and has produced robust causal insights in dynamic financial studies (Hossain, 2020; Qamruzzaman, 2022). This approach is particularly relevant for the banking sector, where profitability adjustments often occur gradually over time.

Therefore, this study aims to empirically examine the influence of Debt to Asset Ratio (DAR), Capital Ratio (CR), bank size (SIZE), and operational efficiency (BOPO) on Return on Assets (ROA) among 12 conventional commercial banks in Indonesia during 2014–2022 using the Panel ARDL model. By identifying both short-run and long-run effects, this study contributes to the banking profitability literature in two ways. First, it provides updated empirical evidence on how operational efficiency and financial structure shape ROA in Indonesian conventional commercial banks. Second, it clarifies whether these internal determinants affect profitability only contemporaneously or also through a longer-term adjustment process, thereby strengthening the understanding of profitability determinants within a dynamic banking framework.

LITERATURE

Theoretical Background: Firm Theory, Financial Performance, and Dynamic Profitability

This study is grounded in firm theory, financial performance theory, and the trade-off perspective to explain bank profitability. Firm theory emphasizes that firms are expected to allocate resources efficiently in order to maximize value, while financial performance theory views profitability as an outcome of how effectively management utilizes assets, capital, and operating resources. In banking, this logic implies that Return on Assets (ROA) reflects managerial effectiveness in transforming financial resources into earnings. Accordingly, internal bank-specific factors, particularly operational efficiency and financial structure, are central determinants of profitability (Qamruzzaman, 2022; Wongso & Mehzabin, 2023).

In addition, agency theory and the efficiency structure hypothesis provide a more specific explanation of bank profitability. Agency theory suggests that profitability depends on how effectively managers control costs, allocate assets, and balance liabilities in ways that are consistent with the interests of shareholders and institutional stability. In the banking context, this means that operational efficiency, capital management, and the use of financial resources are not purely technical matters, but also reflect managerial discipline and monitoring effectiveness. Meanwhile, the efficiency structure hypothesis explains that banks with superior cost control and resource allocation tend to achieve better financial performance, because efficiency enables them to transform inputs into earnings more effectively (Qamruzzaman, 2022; Wongso & Mehzabin, 2023).

From the trade-off perspective, banks face a balancing problem between return enhancement and financial risk. Higher leverage may support asset expansion and intermediation capacity, but excessive dependence on liabilities can increase financial distress costs, risk exposure, and pressure on profitability. At the same time, stronger capitalization enhances resilience and supports business continuity. Therefore, bank profitability may be understood as the result of how efficiently banks manage costs, balance leverage and capital strength, and utilize their scale advantage in generating earnings (Abd-Elmageed, 2020).

The literature also shows that profitability outcomes in banking may be influenced by broader risk considerations, especially credit risk, which can interact with financial structure and performance (Sanjaya & Badjuri, 2024; Wongso & Mehzabin, 2023). However, in the present study, such factors are treated as contextual conditions rather than as the main explanatory variables. The focus is placed on internal determinants that are directly linked to managerial and balance-sheet decisions, namely operational efficiency, leverage, capital strength, and bank size.

Importantly, banking performance is not purely static. Profitability adjusts over time as banks respond to managerial decisions, regulatory constraints, and market dynamics. For this reason, the relationship between internal bank factors and ROA may differ between short-run adjustment and long-run equilibrium. This dynamic perspective provides the conceptual basis for using a modelling framework that can distinguish temporary responses from persistent effects, as commonly applied in banking performance research (Qamruzzaman, 2022).

Operational Efficiency and Profitability (BOPO → ROA)

Operational efficiency represents a bank's ability to control costs while generating operating income. In Indonesia, efficiency is commonly proxied by the Operating Expenses to Operating Income ratio (BOPO). A higher BOPO ratio generally indicates poorer cost efficiency, which theoretically reduces profitability because a larger proportion of income is absorbed by operating expenses (Nasution & Fakhri, 2024; Yayan & Ayuningtyas, 2024)

Empirical evidence largely supports this expectation, showing that BOPO has a significant negative effect on ROA across various types of banks (Dwiputri et al., 2023; Kusumawardhani et al., 2023). Nevertheless, the relationship may not always be uniform across banking contexts, because higher operating expenses may in some cases be associated with service expansion, digitalization, or other business strategies aimed at strengthening future income capacity. Even so, from the perspective of efficiency theory, banks with better cost control are generally expected to achieve higher profitability. Therefore, the following hypothesis is proposed:

H1: BOPO has a negative effect on ROA.

Leverage and Profitability (DAR → ROA)

Financial structure is central to banking resilience and profitability. The Debt to Asset Ratio (DAR) reflects the extent to which bank assets are financed by liabilities and therefore serves as an indicator of leverage. From the trade-off perspective, leverage may support banking operations and

asset growth, but excessive leverage increases financial burden and risk exposure, which can weaken profitability.

Prior evidence generally supports a negative relationship between leverage and ROA, although some studies report insignificant or context-dependent effects depending on the sample and observation period (Nuryanto & Difa, 2020). Other studies also emphasize that effective capital structure management is necessary to preserve profitability, particularly when banking risks intensify (S. Haryati & Maulana, 2021; Sanjaya & Badjuri, 2024). Accordingly, higher leverage is expected to reduce bank profitability. Therefore, the following hypothesis is proposed:

H2: DAR has a negative effect on ROA.

Capital Strength and Profitability (CR → ROA)

Bank capital functions as a buffer against losses and as a foundation for financial stability. The Capital Ratio (CR) captures the adequacy of capital available to absorb risks, maintain public confidence, and support operational continuity. In prudential banking, stronger capitalization is generally expected to strengthen profitability because it reduces vulnerability to shocks and improves the bank's capacity to sustain productive activities.

Recent studies provide evidence that CR is positively associated with ROA, supporting the argument that a robust capital base helps sustain both profitability and stability (Nezha et al., 2025; Olunja, 2025). Therefore, banks with stronger capital positions are expected to achieve better profitability. The following hypothesis is proposed:

H3: CR has a positive effect on ROA.

Bank Size and Profitability (SIZE → ROA)

Bank size may influence profitability through economies of scale. Larger banks may spread fixed costs more efficiently, access broader markets, diversify their services, and benefit from stronger organizational resources. From this perspective, bank size is expected to improve profitability.

However, empirical findings are not always consistent. Large size may also generate organizational complexity, higher overhead costs, and bureaucratic inefficiency that weaken the benefits of scale. Thus, the relationship between size and profitability may depend on how effectively large banks manage their expanded operations. Nevertheless, based on the economies of scale argument, this study expects bank size to have a positive effect on profitability in Indonesian conventional banks. Therefore, the following hypothesis is proposed:

H4: SIZE has a positive effect on ROA.

Summary of the Conceptual Model

Based on the theoretical and empirical arguments above, this study proposes that bank profitability (ROA) is shaped by four internal determinants: operational efficiency (BOPO), leverage structure (DAR), capital strength (CR), and bank size (SIZE). These variables represent managerial and balance-sheet factors that are directly linked to bank performance. Although other factors such as credit risk and macroeconomic conditions may also affect profitability, they are treated in this study as contextual boundaries rather than as core explanatory variables. Because the effects of these determinants may differ between short-run adjustment and long-run equilibrium, a dynamic modelling approach is required.

RESEARCH METHOD

Research Design and Approach

This study employs a quantitative research design with a causal explanatory approach to examine the influence of internal bank-specific factors on profitability. The study uses panel data

because the dataset combines cross-sectional observations from several conventional commercial banks with time-series observations over multiple years. This design is appropriate for identifying both differences across banks and changes in financial performance over time. Since the objective of the study is not only to estimate contemporaneous relationships but also to distinguish short-run adjustment from long-run equilibrium effects, a dynamic panel approach is adopted.

Population and Sample Selection

The population of this study consists of conventional commercial banks operating in Indonesia during the observation period. From an initial population of [insert total number of conventional commercial banks], the sample was selected using purposive sampling based on several criteria. First, the bank had to operate consistently as a conventional commercial bank throughout the study period. Second, the bank had to publish complete annual financial statements for all years of observation. Third, the financial statements had to contain complete data for all variables used in the model, namely Return on Assets (ROA), Operating Expenses to Operating Income (BOPO), Debt to Asset Ratio (DAR), Capital Ratio (CR), and bank size (SIZE), without missing values. After applying these criteria, 12 conventional commercial banks were retained as the final sample for the period 2014–2022.

This sampling process ensured a balanced panel structure, which is appropriate for dynamic estimation and allows consistent comparison across banks and years. However, the use of purposive sampling may limit the generalizability of the findings, since banks with incomplete reports or structural changes during the observation period were excluded from the analysis. Therefore, the results should be interpreted as evidence from a balanced panel of selected conventional commercial banks rather than from the entire banking industry in Indonesia.

Data Sources and Type

This study uses secondary data obtained from the annual financial reports of each sampled bank. The data were collected from official bank websites, publications issued by the Indonesian Financial Services Authority (OJK), and other official financial reporting sources. The dataset includes information from statements of financial position and income statements required to calculate the study variables. The observation period covers 2014 to 2022, which allows the analysis to capture dynamic changes in profitability and its determinants over time.

Research Variables and Measurement

The dependent variable in this study is Return on Assets (ROA), which measures a bank's ability to generate net income relative to its total assets and serves as an indicator of profitability. The independent variables consist of internal financial indicators commonly used in banking performance analysis. Debt to Asset Ratio (DAR) measures the extent to which bank assets are financed through liabilities and reflects leverage. Capital Ratio (CR) captures the strength of a bank's capital position and its capacity to absorb financial shocks. Bank Size (SIZE) is measured by the natural logarithm of total assets and represents differences in operational scale across banks. Operating Expenses to Operating Income (BOPO) is used as an indicator of operational efficiency, where a higher ratio reflects greater inefficiency in cost management.

Analytical Method: Panel ARDL Model

To examine both short-run and long-run relationships between internal banking factors and profitability, this study applies the Panel Autoregressive Distributed Lag (Panel ARDL) model. This method is appropriate because it allows the estimation of dynamic relationships when variables are integrated of order zero, I(0), and order one, I(1), provided that none of the variables is integrated of order two, I(2). In addition, the Panel ARDL framework enables simultaneous estimation of short-run dynamics and long-run equilibrium relationships within panel data settings.

The general Panel ARDL specification can be expressed as follows:

$$ROA_{it} = \alpha_i + \sum_{j=1}^{p} \lambda_{ij}\, ROA_{i,t-j} + \sum_{j=0}^{q_1} \delta_{1ij}\, BOPO_{i,t-j} + \sum_{j=0}^{q_2} \delta_{2ij}\, DAR_{i,t-j} + \sum_{j=0}^{q_3} \delta_{3ij}\, CR_{i,t-j} + \sum_{j=0}^{q_4} \delta_{4ij}\, SIZE_{i,t-j} + \varepsilon_{it}$$

where i denotes the bank, t denotes the year, α_i is the bank-specific intercept, p and q denote lag lengths, and ε_{it} is the error term.

For interpretation of dynamic adjustment, the Panel ARDL model can be re-parameterized into an error correction form as follows:

$$\Delta ROA_{it} = \phi_i(ROA_{i,t-1} - \theta_1 BOPO_{i,t-1} - \theta_2 DAR_{i,t-1} - \theta_3 CR_{i,t-1} - \theta_4 SIZE_{i,t-1}) + \sum_{j=1}^{p-1} \gamma_{ij}\, \Delta ROA_{i,t-j} + \sum_{j=0}^{q_1-1} \beta_{1ij}\, \Delta BOPO_{i,t-j} + \sum_{j=0}^{q_2-1} \beta_{2ij}\, \Delta DAR_{i,t-j} + \sum_{j=0}^{q_3-1} \beta_{3ij}\, \Delta CR_{i,t-j} + \sum_{j=0}^{q_4-1} \beta_{4ij}\, \Delta SIZE_{i,t-j} + \mu_{it}$$

In this specification, ϕ_i represents the error correction coefficient. A negative and statistically significant error correction term indicates that deviations from long-run equilibrium are corrected over time, thereby confirming the existence of a stable long-run relationship among the variables.

Steps of Empirical Analysis

The empirical analysis was conducted in several stages.

1. Panel Unit Root Test
   The stationarity of the variables was examined to ensure that none of the series was integrated of order two, I(2), because such a condition would invalidate the use of the Panel ARDL model. The unit root tests were conducted using Levin–Lin–Chu (LLC), Im–Pesaran–Shin (IPS), Fisher-type ADF, and PP-Fisher tests. Based on these procedures, each variable was classified as stationary at level, I(0), or stationary after first differencing, I(1).
2. Optimal Lag Length Selection
   Before estimating the Panel ARDL model, the optimal lag structure was determined by comparing several alternative lag specifications using information criteria, namely the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and Hannan–Quinn Criterion (HQC). The preferred lag order was selected based on the most parsimonious and statistically appropriate specification according to these criteria.
3. Estimation of Dynamic Panel ARDL Models
   The Panel ARDL model was estimated using three alternative estimators: Pooled Mean Group (PMG), Mean Group (MG), and Dynamic Fixed Effects (DFE). The PMG estimator allows short-run coefficients and adjustment speeds to vary across banks while constraining long-run coefficients to be homogeneous. The MG estimator allows all coefficients to vary across cross-sectional units, whereas the DFE estimator imposes greater homogeneity on both long-run and short-run parameters except for the intercept.
   To determine the most appropriate estimator, the Hausman test was employed. If the Hausman test does not reject the null hypothesis, the PMG estimator is considered efficient and consistent relative to the MG estimator and is therefore preferred for long-run interpretation.
4. Long-Run Relationship and Error Correction Mechanism
   The existence of a long-run relationship among ROA, BOPO, DAR, CR, and SIZE was assessed through the error correction representation of the Panel ARDL model. A negative and

statistically significant error correction term indicates that deviations from long-run equilibrium are corrected over time, thereby confirming cointegration among the variables. The magnitude of the coefficient reflects the speed of adjustment from short-run disequilibrium to long-run equilibrium.

5. Interpretation of Short-Run and Long-Run Coefficients
   After estimating the preferred Panel ARDL specification, the long-run coefficients were interpreted to explain the equilibrium relationship between profitability and its determinants, while the short-run coefficients captured the immediate dynamic responses of ROA to changes in BOPO, DAR, CR, and SIZE. This distinction is central to the objective of the study, which is to identify whether internal banking factors affect profitability only temporarily or persistently over time.

Analytical Tools

All statistical analyses were conducted using EViews software, which supports panel data estimation, unit root testing, dynamic panel ARDL modelling, PMG/MG/DFE estimators, and error correction representation.

RESULT and DISCUSSION

Results

Panel Unit Root (Stationarity) Test Results

Testing for stationarity is an essential first step in dynamic panel estimation to ensure that the variables do not contain unit roots and to avoid spurious regression results. In this study, panel unit root tests were conducted using four procedures, namely Levin, Lin and Chu (LLC), Im, Pesaran and Shin (IPS), ADF-Fisher, and PP-Fisher. The tests were performed at both the level and first-difference forms in order to determine the order of integration of each variable.

Table 1. *Panel Unit Root Test Results*

Panel A. Stationarity at Level

Variable	LLC Prob.	IPS Prob.	ADF-Fisher Prob.	PP-Fisher Prob.	Conclusion
ROA	0.0001	0.0002	0.0003	0.0000	Stationary at level, I(0)
SIZE	0.0000	0.0000	0.0001	0.0000	Stationary at level, I(0)
BOPO	0.0032	0.0021	0.0040	0.0013	Stationary at level, I(0)

Panel B. Stationarity at First Difference

Variable	LLC Prob.	IPS Prob.	ADF-Fisher Prob.	PP-Fisher Prob.	Conclusion
DAR	0.0345	0.0487	0.0120	0.0157	Stationary at first difference, I(1)
CR	0.0210	0.0184	0.0095	0.0102	Stationary at first difference, I(1)

Source: Research Output (2025)

Table 1 shows that the variables are integrated at mixed orders, namely I(0) and I(1). Panel A indicates that ROA, SIZE, and BOPO are stationary at level and are therefore classified as integrated of order zero. Panel B shows that DAR and CR become stationary after first differencing, indicating that these variables are integrated of order one. Since none of the variables is integrated of order two, I(2), the dataset satisfies the requirement for applying the Panel ARDL model. These results confirm that the selected variables are appropriate for dynamic analysis involving both short-run and long-run relationships.

Optimal Lag Length Selection

Before estimating the Panel ARDL model, the optimal lag structure was determined by comparing several alternative lag specifications using the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and Hannan–Quinn Criterion (HQC). This procedure was carried out to ensure that the dynamic model adequately captured the relationship between profitability and the selected internal banking variables while maintaining a parsimonious specification.

The selected lag structure was then retained for the main estimation of the Panel ARDL model. This step is important because an appropriate lag specification improves the reliability of both the short-run and long-run estimates and helps avoid over-parameterization in dynamic panel analysis.

Table 2. *Summary of Lag Length Selection Procedure*

Criterion	Function in Model Selection	Decision in This Study
Akaike Information Criterion (AIC)	Evaluates model fit with penalty for complexity	Used in lag selection
Schwarz Information Criterion (SIC)	Selects more parsimonious lag structure	Used in lag selection
Hannan–Quinn Criterion (HQC)	Balances fit and parsimony	Used in lag selection
Final lag specification	Selected from the comparison of alternative lag structures	Retained for Panel ARDL estimation

Model Selection: PMG, MG, and DFE

To determine the most appropriate dynamic panel estimator, the model was estimated using the Pooled Mean Group (PMG), Mean Group (MG), and Dynamic Fixed Effects (DFE) estimators. These estimators were considered because each provides a different assumption regarding the homogeneity and heterogeneity of coefficients across cross-sectional units. The PMG estimator allows short-run dynamics to differ across banks while constraining long-run coefficients to be homogeneous. By contrast, the MG estimator allows both long-run and short-run coefficients to vary across banks, whereas the DFE estimator imposes stronger homogeneity assumptions across the panel.

Based on the model comparison procedure, the PMG estimator was retained as the main estimator for this study. Accordingly, the long-run and short-run interpretations reported in the following analysis are based on the PMG estimates. The use of PMG is consistent with the objective of this study, namely to identify common long-run relationships in banking profitability while still allowing for adjustment differences across banks in the short run.

Table 3. *Summary of Estimator Comparison and Final Model Selection*

Estimator	Main Assumption	Role in This Study	Final Use
Pooled Mean Group (PMG)	Homogeneous long-run coefficients, heterogeneous short-run dynamics	Main estimator candidate	Selected for interpretation
Mean Group (MG)	Heterogeneous long-run and short-run coefficients	Used for comparison	Not selected as main estimator
Dynamic Fixed Effects (DFE)	Greater homogeneity across the panel	Used for comparison	Not selected as main estimator

Long-Run Estimation Results (PMG Panel ARDL)

After confirming the integration properties of the variables, the long-run coefficients were estimated using the Pooled Mean Group (PMG) estimator within the Panel ARDL framework. This estimation provides evidence on the equilibrium relationship between profitability and the selected internal banking variables.

Table 4. *Long-Run Coefficients (Panel ARDL – PMG Estimator)*

Variable	Coefficient	Std. Error	t-Statistic	Probability	Effect
DAR	-0.017167	0.001054	-16.29455	0.0000	Negative
CR	0.026265	0.002256	11.64633	0.0000	Positive
SIZE	-0.004209	0.000357	-11.77285	0.0000	Negative
BOPO	0.026553	0.002112	12.49287	0.0000	Positive

Source: Research Output (2025)

Table 4 presents the long-run coefficients of the Panel ARDL model. The results indicate that all explanatory variables have statistically significant long-run effects on ROA at the 5 percent significance level. DAR has a negative coefficient, indicating that higher leverage is associated with lower profitability in the long run. CR has a positive coefficient, suggesting that stronger capitalization contributes positively to bank profitability. SIZE has a negative and significant coefficient, implying that larger banks in the sample tend to exhibit lower ROA in long-run equilibrium. BOPO also has a positive and significant coefficient, indicating a positive long-run association between BOPO and ROA.

Overall, the long-run findings confirm that leverage structure, capital strength, bank size, and BOPO are all relevant determinants of profitability in Indonesian conventional commercial banks. In terms of hypothesis testing, the estimated long-run coefficients support H2 and H3, while H1 and H4 are not supported.

Short-Run Dynamics and Error Correction Mechanism

In addition to the long-run coefficients, the Panel ARDL model also provides short-run estimates and an error correction term, which together describe the adjustment process toward long-run equilibrium.

Table 5. *Short-Run Coefficients (Panel ARDL)*

Variable	Coefficient	Std. Error	t-Statistic	Probability	Significance
COINTEQ(-1)	-0.852519	0.136447	-6.247980	0.0000	Significant
ΔDAR	-0.008309	0.009381	-0.885744	0.3778	Not Significant
ΔCR	0.002256	0.000702	3.212400	0.0027	Significant
ΔSIZE	-0.003142	0.000685	-4.997772	0.0000	Significant
ΔBOPO	0.016789	0.013914	1.206623	0.2330	Not Significant

Source: Research Output (2025)

Table 5 presents the short-run estimation results of the Panel ARDL model. The coefficient of the error correction term, COINTEQ(-1), is negative and statistically significant, confirming the existence of a stable long-run relationship among ROA, DAR, CR, SIZE, and BOPO. The magnitude of the coefficient indicates that approximately 85.25 percent of deviations from long-run equilibrium are corrected within one period, suggesting a relatively rapid adjustment process.

With respect to the short-run coefficients, changes in CR have a positive and statistically significant effect on ROA. Changes in SIZE also have a negative and significant effect on ROA. By contrast, changes in DAR and BOPO do not show statistically significant short-run effects. These results suggest that, in the short run, profitability adjustment is more immediately associated with

changes in capital strength and bank size, while leverage and BOPO do not exert significant short-run effects.

DISCUSSION

Interpretation of Panel ARDL Findings

This study employed the Panel ARDL approach to examine the short-run and long-run determinants of profitability among 12 conventional commercial banks in Indonesia. The results confirm the existence of a stable long-run equilibrium relationship between operational efficiency, financial structure, bank characteristics, and Return on Assets (ROA), as indicated by the negative and statistically significant error correction term. This finding suggests that bank profitability is not determined only by contemporaneous financial conditions, but also by a gradual adjustment process through which short-run deviations converge toward long-run equilibrium. The significant Error Correction Term (ECT) coefficient of -0.8525 indicates that approximately 85 percent of short-run disequilibrium is corrected within one period. This reflects a relatively rapid adjustment mechanism in the Indonesian banking industry. In practical terms, shocks affecting profitability do not persist indefinitely, as banks tend to adjust their financial and operational positions in order to return to long-run equilibrium. This result also supports the relevance of using a dynamic model, since the determinants of profitability operate through both immediate and persistent channels rather than through a purely static relationship.

Long-Run Effects of Internal Banking Variables on ROA

Effect of Debt to Asset Ratio (DAR)

The long-run estimation shows that DAR has a negative and statistically significant effect on ROA. This indicates that higher leverage reduces bank profitability in the long-run equilibrium. The finding suggests that excessive dependence on liabilities increases financial obligations and funding pressure, which in turn weakens profitability. In the banking context, leverage may support intermediation and asset expansion, but when liabilities become too dominant, the associated financial burden can offset these benefits and reduce returns on assets. This result is consistent with the trade-off perspective emphasized by (Abd-Elmageed, 2020) which explains that firms, including banks, face a balance between return enhancement and financial risk. The finding is also in line with (Nuryanto & Difa, 2020), who show that higher leverage tends to weaken profitability, and with (Tahu, 2023) who argues that leverage structure plays an important role in shaping firm performance. In the Indonesian banking context, this result implies that prudent liability management remains essential to sustaining profitability over time. By contrast, DAR does not show a significant short-run effect, suggesting that the impact of leverage is more structural and becomes more visible over a longer adjustment horizon than through immediate changes in profitability. Therefore, Hypothesis H2 is supported.

Effect of Capital Ratio (CR)

Capital Ratio (CR) has a positive and statistically significant effect on ROA in the long run, and it also remains significant in the short run. This indicates that stronger capitalization contributes to profitability both immediately and persistently. A stronger capital position improves a bank's capacity to absorb risk, maintain public confidence, and support business continuity, all of which are important for sustaining profitability. This finding is consistent with (Nezha et al., 2025) who emphasize that stronger capital supports both banking stability and profitability. It also accords with (Olunja, 2025) who finds that adequate capitalization strengthens financial sustainability by

improving shock absorption and operational continuity. In the Indonesian banking context, this result highlights that capital is not merely a prudential requirement, but also an important driver of performance. Banks with stronger capital buffers appear to be better positioned to maintain profitability under changing business conditions. Therefore, Hypothesis H3 is supported: CR positively affects ROA.

Effect of Bank Size (SIZE)

The results reveal that bank size has a negative and statistically significant effect on ROA in both the long run and the short run. This finding does not support the conventional economies-of-scale argument, which predicts that larger banks should be more profitable because they can spread fixed costs, access broader markets, and utilize superior resources. Instead, the evidence suggests that in the sampled banks, larger asset scale is associated with lower profitability. One plausible interpretation is that larger banks may face diseconomies of scale, including greater organizational complexity, higher administrative costs, and less efficient asset allocation. In this case, expansion in size does not automatically translate into better profitability unless it is accompanied by stronger governance and more effective managerial control. This interpretation is consistent with (Wongso & Mehzabin, 2023) who argue that firm size does not necessarily guarantee efficiency or profitability when expansion is not matched by sound internal management. Thus, the Indonesian banking evidence suggests that scale alone is insufficient to improve profitability. Therefore, Hypothesis H4 is rejected: SIZE does not positively affect ROA; instead, it shows a negative impact.

Effect of Operational Efficiency (BOPO)

An important empirical result of this study is the positive and statistically significant long-run relationship between BOPO and ROA. This finding is not consistent with the initial hypothesis and differs from the conventional efficiency argument, which generally predicts that a higher BOPO ratio should reduce profitability because it reflects weaker cost efficiency. However, the result suggests that in the sampled Indonesian conventional banks, a higher BOPO ratio may not solely capture inefficiency. A more cautious interpretation is that higher operating expenses may, in some banks, be associated with business expansion, service development, digital investment, compliance strengthening, or other strategic expenditures that support income generation over time. Under such conditions, banks with larger operating expenses may still maintain profitability when those costs are accompanied by sufficiently strong revenue capacity. Thus, BOPO in this sample may partly reflect business intensity and operational expansion rather than pure cost inefficiency alone. This interpretation is particularly relevant in the Indonesian banking context, where banks may increase operational spending to strengthen service networks, upgrade digital infrastructure, or improve competitiveness in a changing financial environment. Accordingly, the positive long-run coefficient should not be interpreted as evidence that inefficiency improves profitability, but rather as an indication that the BOPO ratio may capture more complex operational conditions in the sample. In the short run, changes in BOPO are not statistically significant, indicating that fluctuations in operating efficiency do not immediately translate into profitability changes. Therefore, Hypothesis H1 is rejected.

Implications of the Findings

The findings of this study have several important implications. Theoretically, they reinforce the view that bank profitability is shaped by internal financial and operational determinants, but that these determinants do not operate uniformly across time horizons. The distinction between short-run and long-run effects confirms that profitability adjustment in banking is dynamic rather than instantaneous. This supports the relevance of a dynamic analytical framework in explaining profitability behavior in the banking industry. From a managerial perspective, the results suggest

that banks need to pay close attention to leverage discipline, capital strength, cost management, and growth strategy. Excessive leverage should be avoided because it weakens profitability in the long run. Strong capital buffers should be maintained because they support profitability both in the short run and in the long run. Meanwhile, asset expansion should not be pursued without adequate managerial control, since larger size may create complexity that reduces profitability. The positive long-run BOPO coefficient also indicates that operating costs should be assessed carefully, because higher expenses may reflect productive strategic spending as well as inefficiency.

The findings also provide practical implications for regulators, particularly the Financial Services Authority (OJK). Profitability supervision should not rely only on ROA as a headline indicator, but should also consider leverage composition, capital resilience, and the quality of operational spending. OJK may encourage banks to maintain prudent leverage levels, strengthen capital positions, and improve efficiency reporting so that productive operating expenditures can be distinguished from purely inefficient costs. This is especially important for larger banks, where growth in asset scale may create diseconomies unless accompanied by stronger governance, internal control, and cost discipline. Methodologically, this study shows that the Panel ARDL framework is useful for distinguishing long-run equilibrium effects from short-run fluctuations in banking profitability. This approach is particularly valuable for banking studies because financial performance often adjusts gradually rather than instantaneously. By capturing both dimensions, Panel ARDL offers a more comprehensive understanding of how internal banking factors influence profitability over time.

CONCLUSSION and IMPLICATION

Conclusion

This study examined the determinants of profitability among 12 conventional commercial banks in Indonesia during 2014–2022 by applying the Panel Autoregressive Distributed Lag (Panel ARDL) approach. The use of this model made it possible to distinguish between short-run dynamics and long-run equilibrium relationships in the effects of operational efficiency, leverage, capital strength, and bank size on Return on Assets (ROA).

The empirical results confirm the existence of a stable long-run relationship among the variables, as indicated by the negative and statistically significant error correction term. This finding shows that deviations from profitability equilibrium are corrected relatively quickly, which implies that bank profitability in Indonesia follows a dynamic adjustment process rather than a purely static pattern.

In the long run, the Debt to Asset Ratio (DAR) has a negative and significant effect on ROA, indicating that higher leverage tends to reduce profitability. This suggests that excessive reliance on liabilities weakens long-term profitability through greater financial burden and risk exposure. By contrast, the Capital Ratio (CR) shows a positive and significant effect on ROA, demonstrating that stronger capitalization supports profitability and enhances financial resilience. These findings confirm that financial structure remains an important determinant of bank performance in the Indonesian banking sector.

The results also show that bank size (SIZE) has a negative and significant effect on ROA in both the long run and the short run. This suggests that larger banks in the sample may face diseconomies of scale, greater operational complexity, or less efficient asset utilization. Therefore, expansion in asset scale does not automatically improve profitability unless it is accompanied by effective governance, managerial discipline, and stronger operational control.

A notable finding of this study is the positive and significant long-run relationship between BOPO and ROA. This result does not support the conventional expectation that a higher BOPO ratio necessarily reduces profitability. Instead, it suggests that, in the sampled banks, higher operating expenses may also reflect business expansion, service development, digital investment, or other strategic expenditures associated with revenue generation. Accordingly, BOPO should be interpreted carefully, since it may capture broader operational conditions rather than pure cost inefficiency alone.

In the short run, only changes in Capital Ratio and bank size significantly affect ROA, while changes in DAR and BOPO do not have significant immediate effects. This indicates that profitability adjustments in banking are influenced more strongly by structural and persistent factors than by short-term fluctuations in leverage and operating efficiency.

Overall, this study contributes to the literature in two ways. Empirically, it provides updated evidence on the internal determinants of profitability in Indonesian conventional commercial banks. Methodologically, it demonstrates that the Panel ARDL framework is useful for distinguishing short-run responses from long-run equilibrium effects in banking profitability analysis. The findings also imply that bank managers should maintain prudent leverage levels, strengthen capital buffers, and ensure that growth in scale is accompanied by effective governance and cost discipline. For regulators, especially OJK, the results suggest that profitability supervision should consider not only ROA, but also leverage composition, capital resilience, and the quality of operational spending.

This study is limited to internal bank-specific variables and does not explicitly include other relevant determinants such as credit risk, macroeconomic conditions, or market structure. Therefore, the findings should be interpreted within the scope of internal profitability drivers. Future research is encouraged to extend the model by incorporating variables such as non-performing loans, inflation, GDP growth, interest rates, or banking market concentration in order to provide a more comprehensive explanation of profitability dynamics in the Indonesian banking industry.

In addition, this study utilized GPT-based artificial intelligence tools to assist in language refinement and improve the clarity of writing. The use of GPT was limited to editorial support and did not influence the research design, data collection, analysis, or interpretation of results. All substantive components of the study, including theoretical development and empirical findings, were conducted and validated by the authors to ensure the integrity and originality of the research.

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