

CAPITAL ADEQUACY MEETS OPERATIONAL EFFICIENCY: A DUAL APPROACH TO ENHANCING PROFITABILITY

Sindik Widati^{1*}, Angga Deni Pratama², Dian Sulistyorini Wulandari³

^{1,2,3}Pelita Bangsa University, Indonesia

*Corresponding Author:

sindikwidati@pelitabangsa.ac.id

Abstract

This study aims to examine the effect of profitability on capital adequacy, with operational efficiency as a moderating variable in the banking sector. The data employed are secondary data from the annual financial reports of commercial banks listed from 2018 to 2023. A quantitative approach using panel data regression was used to test the relationships among variables. The results indicate that profitability has a positive and statistically significant effect on capital adequacy. However, operational efficiency does not significantly moderate this relationship. These findings suggest that while profitability plays a key role in capital planning, the moderating impact of operational efficiency is limited in the context of the sampled banks. This research provides insights for policymakers and bank managers on the strategic role of sustainable profitability in capital management, independent of internal operational enhancements.

Keywords: Capital Adequacy, Profitability, Operational Efficiency, Banking, Panel Regression

1. Introduction

The relationship between capital adequacy and profitability has become a pivotal topic in the post-crisis financial environment, especially in light of the ongoing adjustments banks must make to regulatory reforms and economic disruptions. Capital adequacy, typically measured by the Capital Adequacy Ratio (CAR), is crucial in ensuring that banks can withstand financial stress and fulfil their obligations to depositors and other stakeholders. It is a fundamental indicator of a bank's financial soundness and risk-bearing capacity (Su, 2021). However, the relationship between capital and profitability remains a complex one. While higher capital can enhance a bank's solvency and capacity to absorb losses, it can also restrict profit potential due to reduced leverage and increased compliance costs (Kashif et al., 2020). Thus, capital adequacy must be viewed not in isolation, but in the context of other internal performance drivers.

A growing body of research has highlighted operational efficiency as a critical factor that may moderate this relationship. Operational efficiency, measured through metrics such as the cost-to-income ratio or total operating expenses, reflects how well a bank uses its resources to generate income. Efficient banks are better positioned to leverage their capital structure in a profitable manner (Sinha & Sharma, 2020). For example, a bank with high capital reserves may still underperform if its operations are inefficient, while a leaner institution with streamlined processes might generate higher returns even with lower capital ratios. Therefore, analyzing operational efficiency as a moderating variable can offer nuanced insights into how capital adequacy translates into profitability across various operational contexts.

This research is especially urgent in light of the stricter regulatory environment under Basel III and its evolving iterations, which have significantly reshaped how banks manage their capital (Nguyen et al., 2022). For banks in emerging markets, where operational efficiency is often compromised by technological and structural limitations, understanding this dynamic is crucial. These institutions must balance capital compliance with profitability imperatives in an increasingly competitive financial ecosystem. Consequently, this study aims to examine the direct impact of capital adequacy on bank profitability while assessing how operational efficiency influences this relationship.

The findings of this study are expected to make theoretical and practical contributions. Theoretically, it enriches the existing literature by integrating a moderating perspective into the capital-profitability discourse. Practically, it may guide bank managers and policymakers in designing capital strategies that are aligned with operational capabilities to optimize performance outcomes in a tightly regulated environment.

2. Theoretical Background

The foundation of this study is grounded in several intersecting financial theories that address the roles of capital adequacy, profitability, and efficiency in the performance of banking institutions. One of the most relevant frameworks is the risk-return trade-off theory, which posits that institutions with higher capital buffers are better equipped to absorb risks, thereby providing stability and fostering trust. However, this increased safety can come at the cost of reduced returns on equity, especially when capital is idle or poorly utilized (Gupta et al., 2023).

The capital buffer theory further emphasizes that well-capitalized banks can engage more confidently in lending and investment activities without breaching regulatory limits, thereby potentially enhancing profitability. Yet, empirical evidence remains mixed. Some studies show a positive relationship between capital adequacy and profitability, while others suggest a negative or non-linear effect, largely depending on internal bank characteristics and external conditions (Wanjagi et al., 2024).

Operational efficiency adds another dimension to this discussion. According to the theory of resource-based view (RBV), firms that utilize their internal resources, such as technology, human capital, and operational systems, efficiently can achieve a sustained competitive advantage. In banking, this means converting inputs (capital and assets) into profitable outcomes with minimal waste. Efficient banks are more likely to maximize the benefits of capital adequacy by translating available capital into income-generating activities at lower costs (Mehzabin et al., 2023).

From a moderating perspective, operational efficiency can either amplify or dampen the effect of capital adequacy on profitability. For instance, a highly efficient bank can utilize even a modest capital base to achieve high returns, whereas a poorly managed institution may struggle to convert high capital reserves into profits. This perspective is supported by findings showing that efficiency metrics such as the cost-to-income ratio significantly influence how capital adequacy impacts return measures (Kadek, 2022).

The integration of these perspectives leads to the formulation of the following hypotheses:

H1: Capital adequacy has a significant positive effect on bank profitability.

H2: Operational efficiency moderates the relationship between capital adequacy and profitability, strengthening the effect in more efficient banks.

This theoretical framework provides the conceptual foundation for analyzing how capital adequacy interacts with operational efficiency to influence profitability, offering a comprehensive view of bank performance dynamics in contemporary financial systems.

3. Methods

This study adopts a quantitative explanatory research design to investigate the relationship between capital adequacy and profitability in the banking sector, with operational efficiency acting as a moderating variable. The explanatory approach is suitable for testing causal relationships among variables using statistical methods (Ahiabor & Ayentimi, 2021). The focus is on determining whether variations in capital adequacy can predict profitability, and how this effect is influenced by the level of operational efficiency within banks.

The population of this study comprises all commercial banks operating within a selected emerging market economy, specifically those listed on the national stock exchange between the years 2018 to 2023. The sampling technique used is purposive sampling, targeting banks that have consistently published audited annual reports and disclosed financial ratios during the observation period. This approach ensures data completeness and comparability across institutions (Widyatmoko & Risman, 2024). The final sample includes approximately 25–30 banks that met the inclusion criteria.

Data collection is conducted through secondary sources, primarily derived from the banks' published annual reports, financial statements, and regulatory disclosures available through official stock exchange databases and central bank records. This method ensures reliability and objectivity, as the data are verified by external auditors and regulators.

To ensure conceptual clarity and empirical precision, the operational definitions of the variables are as follows:

- 1) Capital Adequacy (Independent Variable): Measured using the Capital Adequacy Ratio (CAR), which is the ratio of a bank's capital to its risk-weighted assets. It is a key indicator of a bank's capacity to absorb losses and comply with regulatory standards (Nguyen dkk., 2022).
- 2) Profitability (Dependent Variable): Measured using Return on Assets (ROA) and Return on Equity (ROE), representing the efficiency of banks in generating income relative to their assets and shareholder equity.
- 3) Operational Efficiency (Moderator Variable): Assessed through the Cost-to-Income Ratio, which reflects the proportion of operating expenses to operating income. A lower ratio indicates higher efficiency in operations (Mehzabin dkk., 2023).

The data analysis is carried out using moderated regression analysis (MRA), implemented in EVIEWS software. MRA is used to assess not only the direct effect of capital adequacy on profitability but also the interaction effect of operational efficiency on this relationship. To validate the results, statistical tests such as multicollinearity diagnostics, heteroscedasticity tests, and F-tests for overall model significance are also conducted (Kadek, 2022).

This methodological framework ensures that the study rigorously tests the formulated hypotheses and provides robust, generalizable findings on how internal operational factors influence the financial resilience and performance of banks in a regulated environment.

4. Results and Discussion

4.1 Panel Data Regression Results

Table 1. Descriptive Statistics

	Capital Adequacy	Profitability	Operational Efficiency
Mean	33.46849	1.411947	79.46667
Median	26.51417	0.982367	84.68000
Maximum	106.1038	4.731816	111.7000
Minimum	10.78070	0.038596	23.77000
Std. Dev	17.90788	1.234454	18.71355
Skewness	1.901360	1.075763	-1.194111
Kurtosis	6.976229	3.118251	4.046904
Jarque-Bara	105.9488	16.25066	23.79865
Probability	0.000000	0.000296	0.000007
Sum	2811.353	118.6035	6675.200
Sum Sq. Dev.	26617.46	126.4818	29066.35

Source: Proceed Data, 2025

The descriptive statistics in Table 1 provide a preliminary overview of the distributional characteristics of the three main variables: capital adequacy, profitability, and operational efficiency. Capital adequacy, measured through capital ratios, shows a high mean value of 33.47, indicating a generally strong capitalization among the banks in the sample. However, the maximum value of 106.10 suggests a significant disparity across institutions, while the standard deviation of 17.91 confirms high variability. The skewness value of 1.90 and kurtosis of 6.98 indicate a right-skewed and leptokurtic distribution, meaning a few banks maintain exceptionally high capital levels. The Jarque-Bera statistic is significant ($p < 0.01$), suggesting that the distribution is not normal.

Profitability, captured by metrics such as ROA, reflects more moderate variation. The mean value of 1.41 indicates relatively low but consistent earnings performance across the panel, which is typical in emerging markets or conservative banking systems. The skewness of 1.08 again suggests a right-skewed distribution, with most banks earning below average and a few achieving high returns. The standard deviation of 1.23 further confirms some dispersion in profit levels, and the Jarque-Bera probability (0.000296) supports the presence of non-normality. This variation in profitability could be influenced by external economic conditions or internal management practices.

In contrast, operational efficiency—measured using the cost-to-income ratio, displays a mean of 79.47, indicating that on average, 79% of income is spent on operating costs, which is relatively high. The distribution is negatively skewed (-1.19), indicating that more banks fall on the higher end of inefficiency, with fewer banks achieving exceptional efficiency. The maximum value of 111.70 and the minimum of 23.77 also reveal a wide range in operational performance. The kurtosis (4.05) and the significant Jarque-Bera statistic ($p < 0.01$) again confirm deviation from normality. These findings suggest that inefficiency is a common challenge in the sample, potentially acting as a limiting factor in the profitability derived from capital adequacy.

Table 2. Chow Test Results

Effects Test	Statistic	d.f	Prob.
Cross-section F	7.228157	(20.61)	0.0000
Cross-section Chi-square	102.049871	20	0.0000

Source: Proceed Data, 2025

Table 2 presents the results of the Chow Test, which is used to determine whether a pooled OLS model or a fixed effects model is more appropriate for the panel data analysis. The results indicate a Cross-section F-statistic of 7.228 and a Chi-square value of 102.05, both with highly significant p-values of 0.0000. These findings reject the null hypothesis that the coefficients are the same across cross-sections, thus confirming the presence of significant individual (bank-level) effects. Therefore, the fixed effects model is statistically preferred over the pooled regression model for this dataset, as it better captures the unobserved heterogeneity among the banks.

Table 3. Hausman Test Results

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	4.791629	2	0.0911

Source: Proceed Data, 2025

Table 3 presents the results of the Hausman Test, which is used to choose between a fixed effects model and a random effects model in panel data analysis. The test yields a Chi-square statistic of 4.792 with 2 degrees of freedom and a p-value of 0.0911. Since the p-value is greater than the standard 5% significance level, we fail to reject the null hypothesis, indicating that there is no significant difference between the fixed and random effects estimators. Therefore, the random effects model is deemed more appropriate for this study, as it assumes that the individual-specific effects are uncorrelated with the independent variables, allowing for more efficient estimation.

Table 4. Lagrange Multiplier Test Results

	Test Hypothesis		
	Cross-Section	Time	Both
Breusch-Pagan	39.78465 (0.0000)	0.016944 (0.8964)	39.80159 (0.0000)

Source: Proceed Data, 2025

Table 4 displays the results of the Lagrange Multiplier (LM) Test, used to decide between the random effects model and the pooled OLS model in panel data regression. The Breusch-Pagan test reports a statistically significant result for the cross-section component (39.78, $p = 0.0000$) and the combined effect (39.80, $p = 0.0000$), indicating the presence of significant variance across entities (banks). However, the time-specific component is insignificant (0.017, $p = 0.8964$), suggesting that time effects do not contribute meaningfully to model variation. These results confirm that the random effects model is superior to pooled OLS, as it captures cross-sectional heterogeneity more effectively while time effects remain negligible.

4.2 The Effect of Profitability on Capital Adequacy

Table 5. Panel Least Squares

Variable	Coefficient	Std Error	t-Statistics	Prob.
C	27.90979	4.449153	6.273058	0.0000
X1	3.936900	2.070894	1.901063	0.0008

Source: Proceed Data, 2025

Table 5 presents the Panel Least Squares regression results analyzing the effect of profitability (X1) on capital adequacy. The coefficient for profitability is 3.9369, indicating that for every one-unit increase in profitability, capital adequacy increases by approximately 3.94 units. This relationship is statistically significant, with a t-statistic of 2.07 and a p-value of 0.0008, which is well below the 5% significance threshold. The constant term (intercept) is also significant at the 1% level, with a value of 27.91 and a

p-value of 0.0000, suggesting that even in the absence of profitability, banks maintain a base level of capital adequacy. Overall, these results confirm a positive and significant effect of profitability on capital adequacy within the sampled banking institutions.

4.3 Operational Efficiency Moderates the Effect of Profitability on Capital Adequacy

Table 8. Panel Least Squares 1

Variable	Coefficient	Std Error	t-Statistics	Prob.
C	27.14284	22.98995	1.180640	0.2412
X1	4.053172	3.336125	1.214934	0.2279
Z	0.007585	0.237277	0.031968	0.9746

Source: Proceed Data, 2025

Table 9. Panel Least Squares 2

Variable	Coefficient	Std Error	t-Statistics	Prob.
C	30.02431	24.02849	1.249529	0.2151
X1	1.568875	6.817699	0.230118	0.8186
Z	-0.034738	0.255920	-0.135738	0.8924
X1Z	0.042286	0.101781	0.415461	0.6789

Source: Proceed Data, 2025

Tables 8 and 9 present the results of the moderation analysis using Panel Least Squares regression to examine whether operational efficiency (Z) moderates the relationship between profitability (X1) and capital adequacy. In Table 8, which tests the model without the interaction term, the coefficients for both profitability (4.05) and operational efficiency (0.0076) are statistically insignificant with p-values of 0.2279 and 0.9746, respectively. This suggests that neither variable has a direct, standalone influence on capital adequacy in this context. Although the constant term (C) is positive and reasonably large (27.14), its p-value (0.2412) also indicates a lack of statistical significance. Thus, the initial model fails to establish meaningful direct effects between the variables.

In Table 9, the interaction term (X1Z) is introduced to test moderation explicitly. However, the interaction effect also proves statistically insignificant with a coefficient of 0.0423 and a p-value of 0.6789. Additionally, neither profitability ($p = 0.8186$) nor operational efficiency ($p = 0.8924$) shows a significant individual effect. While the intercept (30.02) remains positive, its p-value of 0.2151 again denotes non-significance. These results suggest that operational efficiency does not significantly moderate the effect of profitability on capital adequacy within the sampled banking institutions. The overall findings imply that other factors may better explain the variance in capital adequacy, and further model refinement or inclusion of alternative moderators may be necessary.

4.4 Discussion

4.4.1 The Effect of Profitability on Capital Adequacy

The results of this study reveal that profitability has a positive and statistically significant effect on capital adequacy among commercial banks. This finding aligns with financial theory suggesting that retained earnings—often the product of strong profitability—serve as an internal source of capital, thereby enhancing banks' ability to meet regulatory capital requirements. Empirical evidence from several recent studies supports this relationship. For example, (Su, 2021) found that increases in return on assets (ROA) positively influence capital adequacy ratios in Vietnamese banks,

emphasizing that efficient profit generation enhances a bank's capital reserves. Similarly, Kanakriyah et al., (2025) demonstrated a strong association between earnings quality and capital structure, particularly in emerging markets, where retained profits are critical to fulfilling capital adequacy mandates due to limited access to external financing.

The positive linkage also resonates with broader international findings. Aliyu et al., (2020) reported that profitability was a key determinant of capital adequacy for Nigerian deposit money banks, suggesting that sustainable earnings provide financial resilience and regulatory compliance. Moreover, in the Asia-Pacific context, Gupta et al., (2023) observed that profitability significantly boosts capital buffers, particularly when banks follow sound risk management and asset quality practices. These consistent findings across regions and methodologies reinforce the conclusion that profitability is not just an outcome but a contributor to capital strength, supporting the view that regulators and bank managers should focus on sustainable profit strategies as part of capital planning frameworks.

Operational Efficiency Moderates the Effect of Profitability on Capital Adequacy

The results of this study show that operational efficiency does not significantly moderate the effect of profitability on capital adequacy in the sampled commercial banks. Despite the theoretical rationale that efficient operations can enhance the impact of profitability by reducing costs and improving capital retention, the statistical evidence, particularly the insignificance of the interaction term (profitability $\times$ efficiency), suggests otherwise. This is consistent with the findings of (Yahya & Setyono, 2024), who concluded that operational efficiency failed to strengthen the link between financial performance and capital adequacy in Islamic banking. Similarly, Manurung & Usman, (2020) observed that, although operational efficiency positively influences profitability and capital metrics individually, its role as a moderating factor remains limited in empirical tests. These results highlight that the internal performance improvements driven by operational efficiency may not always be sufficient to alter the capital structure response to profitability changes, especially in highly regulated financial environments.

Furthermore, the lack of significant moderation may stem from institutional and structural factors such as banking regulations, ownership structure, or limited flexibility in adjusting operational models. For example, Kirimi et al., (2022) found that bank size and institutional features often override internal efficiencies in determining financial resilience. In some developing markets, operational costs are heavily influenced by legacy systems, labor intensity, or branch networks, which are difficult to adjust quickly. In these contexts, the strategic benefits of profitability in enhancing capital buffers may operate independently of short-term efficiency gains. Therefore, while operational efficiency remains crucial for cost management and performance optimization, this study supports the notion that its moderating role between profitability and capital adequacy is context-specific and not universally applicable.

5. Conclusion

This study aimed to examine the effect of profitability on capital adequacy and to explore whether operational efficiency moderates this relationship in commercial banks. Using panel data regression analysis on a sample of banks from 2018 to 2023, the results reveal that profitability has a positive and statistically significant effect on capital adequacy, confirming that higher earnings performance strengthens a bank's ability to

maintain regulatory capital buffers. This aligns with financial theory, suggesting that profitable banks are better positioned to retain earnings and reinvest them into capital, thereby enhancing financial stability.

However, the findings regarding the moderating role of operational efficiency were not statistically significant. Neither the direct effect of operational efficiency nor its interaction with profitability showed a meaningful influence on capital adequacy. This suggests that, within the studied sample, operational efficiency alone does not enhance or weaken the impact of profitability on a bank's capital structure. These results imply that while profitability is a key driver of capital adequacy, other internal or external factors, such as risk management practices, regulatory constraints, or macroeconomic conditions, may play more influential roles than operational efficiency in this dynamic. Overall, the study provides valuable insight into the capital behavior of banks, emphasizing the importance of sustained profitability, but also signaling the need for broader models to capture the complexity of capital adequacy determinants.

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