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# Operational Efficiency and Leverage Effects in Driving Financial Performance: Firm Size Moderating in Indonesian Chemical Industry

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## ABSTRACT

**Manuscript type:** Research paper

**Introduction/Main Objectives:** Financial performance in Indonesia's chemical subsector fluctuated during 2020–2024. Therefore, this study examines the effects of operational efficiency (BOPO) and leverage (DER) on financial performance (ROA), with firm size as a moderating variable. **Novelty:** This paper adds novelty by testing firm size as a moderating variable in the relationships among operational efficiency (BOPO), leverage (DER), and financial performance (ROA), specifically in IDX-listed chemical subsector firms (2020–2024), thereby addressing gaps and inconsistent results in prior studies. **Research Methods:** A quantitative causal method with secondary data from annual reports/financial statements of 10 IDX-listed chemical subsector companies (2020–2024), selected using purposive sampling. Analysis uses multiple regression and Moderated Regression Analysis (MRA) in SPSS. **Finding/Results:** BOPO does not have a significant direct effect on ROA. DER significantly affects ROA with a negative direction. Firm size significantly moderates the BOPO–ROA relationship. Firm size does not moderate the relationship between DER and ROA. Leverage decisions are more consistently related to profitability in the chemical subsector, while the impact of operating efficiency on profitability depends on company scale (larger vs. smaller asset bases), indicating heterogeneous cost–performance dynamics across firm sizes. **Conclusion:** The study concludes that leverage (DER) influences ROA, while BOPO does not show a consistent direct effect. Firm size moderates the BOPO–ROA relationship but does not moderate the DER–ROA relationship.

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## 1. Introduction

The manufacturing sector in Indonesia constitutes a significant component of the country's economy. This sector contributes 20% or more of national GDP, underlining its importance for economic growth and structural transformation. The chemical subsector is especially important because it provides important materials for many other industries (Iskandar et al., 2020). The financial health of chemical companies is important not only to the companies themselves but also to the industry's overall stability. In reality, though, the financial performance of IDX-listed chemical subsector firms from 2020 to 2024 has exhibited considerable variation, showing that profitability doesn't always follow a company's operational capacity and financial structure.

This fluctuation is reflected in widely reported corporate outcomes. For example, PT Samator Indo Gas Tbk (AGII) recorded a net profit of Rp104.94 billion in 2024, but this figure declined by 3.6% from the prior period, suggesting potential pressure on profitability relative to assets (wartaekonomi, 2025). In contrast, PT Polychem Indonesia Tbk (ADMG) reported a substantial loss of Rp315.18 billion (associated with weakening sales), which directly implies negative profitability outcomes (Idxchannel, 2022).

The variation in profitability across firms suggests that financial performance is shaped not only by external market conditions, but also by internal factors related to how firms manage their operations and financing decisions. From the Resource-Based View, superior performance depends not simply on the resources a firm possesses, but on how effectively those resources are used to create value (Arbelo et al., 2024). In this regard, operational efficiency becomes relevant because it reflects how well a firm manages its internal resources in doing its everyday tasks. BOPO is therefore used as a proxy for operational efficiency, where a higher BOPO indicates that a larger share of operating income is absorbed by operating expenses, leaving less room for profit generation (Fietroh & Fitriyani, 2022). Alongside

operational efficiency, the financing structure is also closely related to profitability. The use of debt can support business activities by providing additional funds, but it also brings interest obligations and greater exposure to financial distress (Dsouza et al., 2025). DER is used to reflect the extent to which firms rely on borrowed funds to finance their operations. A higher DER indicates greater reliance on debt, which can raise expenses and, in turn, influence profitability (Fitriana & Nilwan, 2025; Hanif et al., 2025). More recent data demonstrates that there is not necessarily a straight relationship between leverage and profitability: moderate debt can support firm performance, while excessive debt tends to weaken it. In addition, ROA is used as the profitability measure because it captures the firm's ability to generate profit from its total assets and provides a broader picture of overall financial performance (Fajryanti & Zuhri, 2021).

Previous research has yielded mixed results about how BOPO and DER affect profitability. In earlier studies by Jatmiko (2025), researchers found that BOPO affected overall ROA. According to this research's findings, the conclusion is consistent with the results of searches conducted by Destiani et al. (2023) and Fadhilah et al. (2025), unlike the research by Mandala et al. (2023) and Wijayanti & Nursiam (2024), which suggest that BOPO has no impact on ROA. The findings of Ramadanti et al. (2024) and Fietroh & Fitriyani (2022), which conclude that DER has a considerable influence on ROA, differ from those of other researchers. Several studies, including those conducted by Andiani et al. (2025) and Khoza (2025), have shown that DER has no impact on ROA.

The effects of operational efficiency and leverage on profitability may not be uniform across firms, as companies differ in their scale, resource capacity, and financial flexibility. Prior evidence shows that firm size can influence the relationship between financing decisions and profitability (Ahmed et al., 2023). In addition, larger firms generally have stronger resource bases, more established operating systems, and better access to external financing, which may cause the effects of efficiency and

leverage on profitability to vary across firms (Saif-alyousfi et al., 2025). Firm size is considered relevant because it may help explain why similar financial conditions do not always produce similar profitability outcomes. In this study, firm size denotes the magnitude of a company's operations and resources, typically shown by total assets or total sales (Ahmed et al., 2023).

This study aims to examine how operational efficiency and leverage relate to financial performance in chemical subsector firms listed on the Indonesia Stock Exchange, and to determine whether firm size helps explain differences in profitability across firms. The study becomes important because these firms operate under varying cost conditions, financing structures, and resource capacities, while their profitability during 2020–2024 has also shown noticeable variation. By focusing on these conditions, this study is expected to provide a clearer understanding of which factors are more likely to affect financial performance and why similar financial conditions may not always lead to similar profitability outcomes.

## 2. Literature Review

### 2.1 Resource-Based View (RBV)

The Resource-Based View (RBV) serves as the primary theoretical framework of this research. Penrose (1959) first proposed this concept, which was subsequently thoroughly explored by Barney (1991). This perspective emphasizes that firm performance is intricately linked to the resources and capabilities it possesses. In other words, differences in financial performance among firms, even within the same industry, cannot be explained only by external market conditions. They may also reflect differences in the quality of internal resources and in how those resources are managed. For that reason, operational efficiency becomes relevant in explaining variations in financial performance.

### 2.2 Trade-Off Theory

The Trade-off Theory was used as the supporting theory to explain the Leverage variable. Myers (2001) and Kraus & Litzenberger (1973) first

presented this idea, which holds that businesses weigh the benefits of the tax shelter provided by debt against the costs of financial distress.

### 2.3 Financial Performance (ROA)

Kasmir (2019) defines "financial performance" as the use of various financial analysis tools to evaluate a company's financial well-being and effectiveness. This allows for an assessment of the company's financial condition over a specified timeframe. This study employs the Return on Assets (ROA) metric as an indicator of financial success. According to Ilham et al. (2025), Return on assets (ROA) is an indicator that measures how efficiently a company generates profits relative to its total assets, taking financing costs into account.

### 2.4 Operational Efficiency

BOPO illustrates a company's capacity to effectively manage its operations by contrasting its operating expenses with its operating income (Lestari, 2023). A higher BOPO indicates low efficiency, since a larger portion of income is used to cover operating costs rather than to generate profit. From the perspective of the Resource-Based View, firm performance depends not only on the resources a firm possesses, but also on how effectively those resources are utilized to create value (Barney, 1991). In this sense, poor cost management may reduce the firm's capacity to convert its resources into profit, thereby weakening financial performance. This argument is also supported by empirical evidence showing that a higher cost-to-income ratio tends to reduce ROA because rising operating costs weaken profitability (Dsouza et al., 2022; Lalou et al., 2025).

### H1: Operational Efficiency (BOPO) has a negative effect on Financial Performance

### 2.5 Leverage

The Debt-to-Equity Ratio (DER) is a metric used to assess how a company's total debt and total capital relate to one another (Fahmi, 2020). Through the lens of the Trade-Off Theory, the use of debt may result in the advantages of greater capital and the possibility of increased tax efficiency, however, it

also results in the incurrance of costs and risks, such as the possibility of financial troubles and the payment of interest expenditures, which could eventually make it harder for the company to make money off of its assets (Brusov & Filatova, 2023; Myers, 2001). Recent empirical evidence also shows that leverage is closely related to profitability. Nguyen et al. (2023) find that capital structure significantly affects firm profitability, while Nkansah (2025) reports that debt financing negatively affects ROA, a profitability measure.

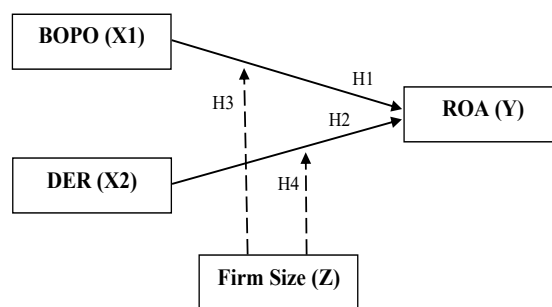
**H2: Leverage (DER) affects Financial Performance (ROA).**

**2.6 Firm Size**

As stated by Dina & Wahyuningtyas (2022), firm size can be used to measure a company's financial strength. According to Hardi et al. (2023), firm size is defined as the total assets (fixed, current, and other) held by the company. Firm size represents the scale of a firm's operations and the capacity of the resources it controls. Earlier evidence indicates that the relationship between capital structure and profitability is significantly influenced by company size (Ahmed et al., 2023). This becomes relevant in the present study because firms of different sizes do not operate under the same resource base, cost structure, or financing capacity. Larger firms tend to have more established operating systems and broader resources, which can influence how operational efficiency is translated into profitability. They also generally have better access to external funding and greater flexibility in managing debt-related risk (Saif-alyousfi et al., 2025).

**H3: Firm Size Moderates the Effect of BOPO on ROA.**

**H4: Firm Size Moderates the Effect of DER on ROA.**



**Figure 1.** Research Model

**3. Method, Data, and Analysis**

This study uses a quantitative, explanatory-causal research design to test causal relationships among operational efficiency, leverage, and financial performance, and to examine whether firm size moderates these relationships. Specifically, the model evaluates the effect of Operational Efficiency (BOPO) and Leverage (DER) on Financial Performance (ROA), with Firm Size as a moderating variable.

The research context includes publicly traded companies in the chemical subsector of the Indonesia Stock Exchange (IDX), examined over the period from 2020 to 2024. This study utilized secondary data from annual financial statements available on the official IDX website. The unit of analysis is the firm-year observation (company *i* in year *t*). The constructed dataset is a panel of firm-year records used to compute BOPO, DER, ROA, and Firm Size.

**Table 1.** Operational Variables

Variabel	Indicator	Reference
Efficiency Operational (BOPO)	$\frac{\text{Operating Expenses}}{\text{Operating Income}}$	(Hanif et al., 2025)
Leverage (DER)	$\frac{\text{Total Debt}}{\text{Total Equity}}$	(Fauziah et al., 2024)
Financial Performance (ROA)	$\frac{\text{Net Income}}{\text{Total Assets}}$	(Ilham et al., 2025)
Firm Size	Ln(Total Aset)	(Mardiyani et al., 2025)

Source: Processed data, 2026

The study initially identified 30 companies in the chemical subsector of the Indonesia Stock Exchange as the research population. This study applies purposive sampling, selecting firms that meet predefined criteria to ensure data completeness and comparability across 2020–2024. Purposive sampling is appropriate because the research requires firms with consistent reporting and available financial statement data across the full observation window (Sugiyono, 2016).

**Table 2.** Sampling Criteria

No	Sampling Criteria	Accepted	Rejected
1	The company is listed in the Chemicals sub-sector.	30	0
2	The company conducted an IPO before 2020.	21	9
3	Complete (Audited) Annual Financial Reports consecutively during the research period (2020-2024).	19	2
4	The company uses the Indonesian Rupiah/IDR currency.	12	7
5	The company has never experienced a loss during the research period.	10	2
6	The company has experienced a decline in profit.	10	0
Number of Samples = 10 X 5 years		<b>50</b>	

Source: Processed data, 2026

Based on the sampling procedure described in the draft, the final sample consists of 10 companies. With five years of observations (2020–2024), this yields 50 firm-year observations.

This research employed IBM SPSS Statistics version 27 for data analysis. The analysis techniques included, first, descriptive statistics to summarize each variable (minimum, maximum, mean, standard deviation) and to understand the distribution and variability across firm-year observations. Second, to ensure the findings from regression models were legitimate, traditional assumption tests were used. These tests examined normality, multicollinearity, heteroskedasticity, and autocorrelation. Third,

multiple linear regression, to test the direct effects of BOPO and DER on ROA, multiple regression was estimated as:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \epsilon \tag{1}$$

MRA was used to examine how Firm Size moderates the relationships between BOPO, DER, and ROA. The moderation models are specified as:

$$Y = \alpha + \beta_1 \text{BOPO} + \beta_2 \text{SIZE} + \beta_3 (\text{BOPO} \times \text{SIZE}) + \epsilon \tag{2}$$

$$Y = \alpha + \beta_1 \text{DER} + \beta_2 \text{SIZE} + \beta_3 (\text{DER} \times \text{SIZE}) + \epsilon \tag{3}$$

The moderating effect is supported when the interaction coefficient ( $\beta_3$ ) is statistically significant ( $p < 0.05$ ).

#### 4. Results and Discussion

##### 4.1 Descriptive Statistic

Descriptive statistics provide a summary of research data by displaying the minimum, maximum, mean, and standard deviation for each variable.

**Table 3.** Descriptive Statistics

	Min	Max	Mean	Std. Dev
BOPO_X1	0,786	0,981	0,9096	0,49858
DER_X2	0,046	4,561	0,6173	0,74418
ROA_Y	0,001	0,241	0,0485	0,41544
SIZE_Z	26,483	29,731	27,923	0,95803

Source: Processed data, 2026

BOPO (X1) ranges from 0.786 to 0.981 (mean 0.909, SD 0.049), indicating relatively low dispersion. DER (X2) shows a much wider range, from 0.046 to 4.561 (mean 0.617, SD 0.744), suggesting substantial variation in firms’ debt–equity structures across companies and years. ROA (Y) ranges from 0.001 to 0.241 (mean 0.048, SD 0.041), indicating noticeable differences in profitability across observations. Firm Size (Z) ranges from 26.483 to 29.731 (mean 27.922, SD 0.958), showing moderate variation in company scale, supporting its use as a moderating variable.

##### 4.2 Classical Assumption Tests

This classical assumption test uses four tests to assess the quality of the research data.

**4.2.1 Normality Test**

The purpose of the data normality test is to determine whether the residual, confounding, or regression variables follow a normal distribution. This study used the Kolmogorov-Smirnov (K-S) nonparametric test for assessing data normality, focusing on the asympSig (2-tailed) value. According to Ghozali (2021), the data are deemed normally distributed when the AsympSig (2-tailed) value is > 0.05.

**Table 4.** Normality Test

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		47
Normal Parameters <sup>a,b</sup>	Mean	0,0000000
	Std. Deviation	0,02044349
Most Extreme Differences	Absolute	0,086
	Positive	0,083
	Negative	-0,086
Test Statistic		0,086
Asymp. Sig. (2-tailed) <sup>c</sup>		.200 <sup>d</sup>
	Sig.	0,516
Monte Carlo Sig. (2-tailed) <sup>e</sup>	99% Lower Bound	0,503
	Confidence Interval	
	Upper Bound	0,529

Source: Processed data, 2026

According to Table 4, the value of the statistical test is 0.086, and the significance level for the overall variable is indicated as Asymp. Sig (2-tailed) at 0.200. Both of these values belong to the statistical test. This indicates that the residuals for each variable investigated in this study follow a normal distribution.

**4.2.2 Multicollinearity Test**

The goal of multicollinearity testing is to determine whether the variables are independent. To determine whether a regression model exhibits multicollinearity, we examine the tolerance and Variance Inflation Factor (VIF) (Lestari, 2023). Ghozali (2021) states that a regression model is deemed free of multicollinearity when Tolerance ≥ 0.1 and VIF ≤ 10.

**Table 5.** Multicollinearity Test

Model	Coefficients <sup>a</sup>	
	Tolerance	VIF
1 (Constant)		
Efficiency	0,771	1,297
Operational		
Leverage	0,235	4,251
Firm Size	0,217	4,616

a. Dependent Variable: Financial Performance

Source: Processed data, 2026

The tolerance value for the Operational Efficiency (BOPO) variable is 0.771, which exceeds the threshold of 0.10. On the other hand, the VIF is 1.297, which is lower than the critical value of 10. In contrast, the value of the VIF is still below 10, while the value of tolerance for the Leverage (DER) variable is 0.235, which is greater than 0.10. Considering the moderating variable of Company Size, the tolerance value of 0.217 is greater than 0.10, whereas the VIF value of 4.616 remains less than 10. These tolerance and VIF values show that the independent variables in the regression model do not exhibit multicollinearity. As a result, this model is appropriate for predicting financial performance from 2020 to 2024.

**4.2.3 Heteroscedasticity Test**

The Heteroscedasticity Test is designed to determine whether the regression model exhibits heteroscedasticity across the available observations. Homoscedasticity is a qualitative characteristic of a well-constructed regression model. This study used the Glejser test to determine whether homoscedasticity was present.

Table 6 shows the test outcomes, indicating that the significance values for each independent variable are greater than 0.05. Another variable that demonstrates a significant value is the Company Size variable, which has a value of 0.579. The Operational Efficiency (BOPO) variable has a significant value of 0.802, while the Leverage (DER) variable has a significant value of 0.145. Because of this, it is possible to conclude that the regression model used in this investigation does not exhibit

heteroscedasticity. As a result, it is suitable for predicting BOPO and DER in relation to ROA, with Company Size serving as a moderating variable.

**Table 6.** Heteroscedasticity Test

Coefficients <sup>a</sup>		
Model	t	Sig.
1 (Constant)	0,614	0,542
Efficiency Operational	-0.252	0,802
Leverage	1,486	0,145
Firm Size	-0,559	0,579

a. Dependent Variable: Financial Performance

Source: Processed data, 2026

**4.2.4 Autocorrelation Test**

In the context of a linear regression model, the autocorrelation test is used to determine if the disturbance errors (residuals) at time t and those at time t-1 (the preceding period) are correlated. This research utilized the Durbin-Watson test, also known as the DW test, in order to identify instances of autocorrelation.

**Table 7.** Autocorrelation Test

Model Summary <sup>b</sup>					
Model	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	Std. Error	D-W
1	.505 <sub>a</sub>	0,255	0,203	0,021145	1,947

a. Predictors: (Constant), Leverage, Efficiency Operational, Firm Size

b. Dependent Variable: Financial Performance

Source: Processed data, 2026

Based on the information shown in Table 7, the Durbin-Watson (DW) test gives a value of 1.947. With a significance level of 5%, N equal to 47, and K equal to 4, this value will be compared to the Durbin-Watson statistic. The lower limit (dL) will be set at 1.3535, and the upper limit will be established at 1.7203. For the purpose of this comparison, the significance level will be set at 5%.

From the calculated value and the Durbin-Watson table 12, it can be seen that the criteria  $dL < dU < dW < 4-dU < 4-dL$ , namely  $1.3535 < 1.7203 < 1.947 < 2.2797 < 2.6465$ , are met. Therefore, it is possible to draw the conclusion that there is neither

a positive nor a negative correlation, nor any evidence of autocorrelation.

**Table 8.** Durbin-Watson Test Bound

N	K=4	
	dL	dU
47	1,3535	1,7203

Source: Processed data, 2026

**4.3 Multiple Linear Regression Analysis**

In order to assess how the independent variables affect the dependent variable, we implemented multiple regression analysis. When it comes to the multiple regression analysis that investigates BOPO and DER on ROA, the following results pertain to the investigation.

**Table 9.** Multiple Linear Regression Analysis

Coefficients <sup>a</sup>			
Model	Unstandardized Coefficients		Standardized Coefficients
	B	Std. Error	Beta
1 (Constant)	0,161	0,059	
Efficiency Operational	-0,120	0,064	-0,255
Leverage	-0,020	0,008	-0,347

a. Dependent Variable: Financial Performance

Source: Processed data, 2026

The equation for linear regression that is presented here is derived from the results of the multiple linear regression analysis that is displayed in Table 9:

$$ROA = 0,161 - 0,120BOPO - 0,020DER + \epsilon \quad (4)$$

An comprehension of the regression equation that was presented earlier can be found in the following manner:

- a. The value of the constant (0.161) indicates that the financial performance of the company is 0.161 when BOPO and DER are both equal to 0.
- b. The coefficient of BOPO is -0.120, which indicates that a decrease in financial performance of 0.120 is resulting from an

increase of one unit in BOPO, provided that all other factors remain unchanged.

- c. The coefficient of DER is -0.020, which indicates that a decrease of 0.020 in financial performance occurs when there is an increase of one unit in DER. This is the case whenever all other factors remain unchanged.

**4.4 Determination Coefficient Analysis**

Shows how strongly financial performance (dependent) can be explained by operational efficiency and leverage (independent) in the model. Evaluation criteria according to Ghozali (2021) :

**Table 10.** Determination Coefficient Analysis

Model Summary <sup>b</sup>				
Model	R	R Square	Adjusted Square	R
1	.423 <sup>a</sup>	0,179	0,142	

a. Predictors: (Constant), *Leverage*, Efficiency Operational

b. Dependent Variable: Financial Performance

Source: Processed data, 2026

The data in Table 10 indicate that the ROA variable's R-square (R2) is 0.179, while the adjusted R-square is 0.142. The findings suggest that the variables in the research model, specifically BOPO and DER, account for up to 17.9% of the variation in ROA. Within this model, it is highly probable that the remaining 82.1% of the variation can be attributed to external factors not accounted for.

**4.5 Hypothesis Testing Results (t-test)**

This test employs a t-test to evaluate the hypothesis by analyzing the partial impact of the independent variable on the dependent variable. It does this by comparing the significance value derived from the processed data to the criteria established beforehand.

SPSS output provides regression coefficient values, t-calculated values, and significance values (p-values) for the t-test. Hypothesis decisions are based on p-values: if  $p < 0.05$  ( $\alpha = 5\%$ ), then the

hypothesis is accepted; if  $p \geq 0.05$ , then hypothesis are rejected.

**Table 11.** Hypothesis Testing Results (t-test)

Coefficients <sup>a</sup>		
Model	T	Sig.
1 (Constant)	2,747	0,009
Efficiency Operational	-1,867	0,069
<i>Leverage</i>	-2,536	0,015

a. Dependent Variable: Financial Performance

Source: Processed data, 2026

Given that the value of the BOPO variable, which is 0.069, is greater than the threshold of 0.05, the findings that are presented in Table 11 indicate that the variable is worthy of consideration. Because the p-value  $> 0.05$ , (H1) is rejected. Therefore, it is proven that operational efficiency (BOPO) has no effect on ROA. The value of the DER variable is 0.015, which is low enough to be considered below the threshold of 0.05. Because the p-value  $< 0.05$ , (H2) is accepted. Leverage affects return on assets (ROA) and is quantified by the Debt-to-Equity Ratio (DER). This has been shown.

**4.6 Moderated Regression Analysis (MRA)**

To determine whether Firm Size (Z) can influence (either amplify or reduce) the impact of independent variables on dependent variables, researchers use a technique known as moderated regression analysis (MRA). Using MRA, this study investigated two aspects: (1) how the size of the firm influences the relationship between BOPO (X1) and ROA (Y), and (2) how the size of the firm influences the relationship between DER (X2) and ROA (Y).

**Table 12.** Moderated Regression Analysis (MRA)

Variables	t	Sig.
X <sub>1</sub> *Z	2,698	0,010
X <sub>2</sub> *Z	-0,838	0,407

Source: Processed data, 2026

X<sub>1</sub>\*Z, which is the product of BOPO and firm size, has a significant value (B = 0.144;  $p = 0.010 < 0.05$ ).

This indicates that firm size affects the relationship between operational efficiency and financial performance. Consequently, this provides support for the validity of the third hypothesis (H3). Furthermore, it is worth noting that the coefficient  $X_2 \cdot Z$  does not demonstrate statistical significance ( $B = -0.009$ ;  $p = 0.407 > 0.05$ ). This implies that the impact of leverage on financial performance is not affected by firm size. Consequently, the second hypothesis (H4) is rejected.

#### **The Effect of Operational Efficiency on Financial Performance**

In the chemical subsector, differences in production scale, cost structure, and operating revenue composition may cause the BOPO effect on profitability to vary across firms. As a result, an increase in operating costs relative to operating income does not always translate into the same degree of decline in ROA. This condition is consistent with the Resource-Based View that firms within the same industry may possess different operational systems, managerial capabilities, process controls, and strategic flexibility, causing the same efficiency indicator to produce different performance outcomes.

This interpretation is supported by prior empirical evidence. Mandala et al. (2023) found that BOPO did not significantly affect ROA, indicating that operational efficiency was not always a stable predictor of profitability. This finding aligns with the present study, which also shows that BOPO does not have a significant effect on ROA. However, Handoyo et al. (2023) reported that operational efficiency had a positive and significant effect on manufacturing performance, suggesting that efficiency improvements can strengthen firm performance when they are effectively translated into productive outcomes. Taken together, these findings indicate that the relationship between operational efficiency and financial performance is context-dependent. In the chemical subsector, BOPO remains economically relevant, but its effect on ROA appears to depend more on firm-specific conditions than on a uniform efficiency–profitability pattern.

#### **The Effect of Leverage on Financial Performance**

In the chemical subsector, greater reliance on debt may place direct pressure on profitability when additional financing is not followed by a proportional increase in returns generated from assets. This indicates that leverage can weaken financial performance when interest obligations and financial risk become more dominant than the benefit of additional capital. Such a result is consistent with Trade-Off Theory, which explains that debt may create benefits up to a certain level, but excessive debt can reduce firm performance because of higher fixed obligations and the risk of financial distress.

Previous empirical data supports this interpretation. Ahmed et al. (2024) found that the debt-to-equity ratio, along with other debt measures, negatively and significantly affected ROA, indicating that higher debt levels tended to reduce firms' asset-based profitability. Similarly, Nkansah (2025) reported that short-term debt, long-term debt, and total debt negatively affected ROA, indicating that a higher debt burden tends to suppress asset-based profitability, Mardiyani et al. (2025) also found that DER significantly affected ROA, confirming that capital structure decisions play an important role in shaping financial performance. This evidence strengthens the present study's result that greater reliance on debt places stronger pressure on financial performance rather than improving it. In the chemical subsector, the cost side of debt was more dominant than its financing benefit, so higher DER tended to place greater pressure on ROA rather than improve it.

#### **The Moderating Effect of Firm Size on Operational Efficiency**

The moderating results show that company size has a strong effect on how operational efficiency affects financial performance. This means that the impact of BOPO on ROA depends on company scale, so the same level of operating efficiency does not necessarily yield the same profitability across firms. In the chemical subsector, this finding suggests that the profitability consequences of efficiency are shaped by the scale at which firms operate, rather

than by efficiency alone. Larger firms tend to have more established operating routines, broader resource buffers, and more formalized control systems, while smaller firms are generally more sensitive to changes in operating cost efficiency. Therefore, firm size serves as a boundary condition that shapes how strongly BOPO translates into ROA, rather than merely serving as an additional explanatory variable.

This interpretation is supported by prior empirical evidence. Vinori & Jaya (2025) found that firm size moderated the effect of OEI on ROA, with the impact of operational efficiency becoming mitigated in larger firms, indicating that company scale changes how efficiency affects profitability. Likewise, Rachman et al. (2023) reported that bank size moderated the relationship between BOPO and profitability, showing that the profitability impact of efficiency was not uniform across firms of different sizes.

#### **The Moderating Effect of Firm Size on Leverage**

The moderation test indicates that business size does not significantly influence the relationship between leverage and financial performance. This indicates that the relationship between DER and ROA tends to remain relatively stable across firms, regardless of size. In other words, differences in company size were not strong enough to alter the association between leverage and profitability in the sampled chemical firms. This result implies that firm size did not act as a decisive boundary condition in the leverage–profitability relationship, so the effect of DER on ROA was broadly similar across the sample.

This result is closest to the findings of Rachman et al. (2023), who found that bank size moderated BOPO, NPL, and CAR, but did not moderate DER in explaining profitability. Their evidence suggests that not all financial relationships become stronger or weaker when firm size is introduced, and that leverage may remain relatively stable across firm scales. However, other studies reported different patterns. Ahmed et al. (2023) found that firm size significantly improved the influence of capital

structure choices on profitability. Similarly, Mardiyani et al. (2025) reported that company size strengthened the effect of DER on ROA, while Dsouza et al. (2025) showed that larger firms were better able to sustain elevated leverage without detrimental performance impacts, while smaller firms gained more from preserving reduced debt levels. Compared with those studies, the present finding suggests that, in the chemical subsector, firm size was not a sufficiently decisive moderator to alter the leverage–profitability relationship.

#### **5. Conclusion**

This research aimed to analyze the relationships among operational efficiency, leverage, and financial performance in chemical subsector companies listed on the Indonesia Stock Exchange between 2020 and 2024, while also evaluating how business size alters these correlations. The results show that leverage is linked to profitability, meaning that higher reliance on debt tends to be associated with weaker financial performance. Operational efficiency, as measured in this study, does not show a stable direct relationship with profitability across the sample. Firm size, however, meaningfully affects how operational efficiency relates to profitability, suggesting that efficiency translates into performance differently in larger firms than in smaller ones. The firm's size does not affect the relationship between leverage and profitability, suggesting that the performance implications of debt are broadly similar across firm scale.

Beyond its theoretical contributions, this study also offers important practical implications. Drawing on evidence from the chemical industry helps explain why earlier research on the relationship between efficiency and profitability has often produced seemingly inconsistent findings. From a theoretical standpoint, the study reinforces the view that a firm's financing structure plays a crucial role in shaping its overall performance. It also shows that the link between efficiency and performance is not universally applicable, but instead depends on specific firm characteristics. One of the most important findings is that firm size moderates the

relationship between operational efficiency and profitability within this subsector. This result highlights why companies operating in relatively similar industry conditions may still achieve different outcomes. Given that excessive leverage may reduce profitability, the findings suggest that managers should be prudent in making debt-related decisions. In addition, efficiency strategies should be adjusted to the firm's scale, since similar changes in cost structure may yield different profitability outcomes across companies of different sizes.

Several limitations need to be taken into account when analyzing these results. First, the study is confined to a single subsector and a specific period of observation, which may restrict the degree to which the findings can be extrapolated to other sectors or varying economic environments. Second, the analysis employs accounting-based indicators to measure efficiency, leverage, performance, and firm size. This should not be understood as a data error, but rather as a limitation arising from the selected proxies and the inherent constraints of secondary financial statement data, which may not fully reflect operational complexity, competitive strategy, or managerial capability. Third, the regression model may not entirely capture unobserved firm-specific factors that affect profitability, such as product composition, pricing power, or variations in risk management practices. These issues represent methodological constraints rather than flaws in the analysis itself.

Future studies may improve the robustness and validity of the findings by broadening the sample across industries, extending the observation period, incorporating additional control variables, and applying panel-data techniques better suited to capturing firm-level differences over time.

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