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Efficiency of the banking sector in Indonesia, conventional and Islamic: A stochastic frontier analysis

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Abstract

This study aims to compare the efficiency levels of conventional and Islamic banks in Indonesia and identify the main factors that influence their performance from January 2021 to June 2024. This study evaluates bank profit efficiency based on input and output variables derived from secondary data published by Bank Indonesia using the Stochastic Frontier Analysis (SFA) method. This analysis includes third-party funds, paid-in capital, placements in other banks, deposits in Bank Indonesia, and financing. The results show that conventional banks consistently demonstrate higher and more stable levels of efficiency, approaching the optimal value of 1 throughout the observation period. In contrast, Islamic banks exhibit more variability but show an increasing trend in efficiency, especially in 2024. The main performance drivers of Islamic banks include effective liquidity management through deposits and financing activities of Bank Indonesia, while paid-in capital and deposits significantly support efficiency in conventional banks. Third-party funds were found to have a negative impact on return on equity in both banking systems due to increased funding costs and operational risks. While conventional banks benefit from stable capital structures and interest-based operations, Islamic banks face structural limitations but have shown improvement in recent years. Each system has unique strengths and challenges, highlighting the need for tailored policy support to enhance efficiency and sustainability. Policymakers and regulators are encouraged to design targeted interventions to strengthen risk management, operational efficiency, and Sharia-compliant financing frameworks. For Islamic banks, optimizing third-party funds management and leveraging technology can enhance competitiveness. Meanwhile, conventional banks should integrate ethical practices to enhance long-term sustainability.

Keywords: Conventional banking, efficiency, Islamic bank, stochastic frontier analysis (SFA), third-party fund management.

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1. Introduction

The banking sector is an important part of the economy that mobilizes and allocates resources effectively and efficiently, hence serving as a foundation for economic development and financial stability [1, 2]. Financial institutions are involved as the primary sources of corporate financing to enhance access to finance and the sustainability of the markets [3]. Over the years, various reforms have been introduced across the world aimed at making banks stronger and contributing more to national economies [4, 5]. Shariah-compliant banks, being a distinctive part of the financial system, incorporate social welfare activities, such as the management of Zakat, Infaq, and ZIS, in parallel with their business activities. The effective mobilization of resources between depositors and borrowers efficiently utilizes available resources while ensuring stability during turbulent economic times [6].

Sustainable banking relies on the regulations and competitive behavior of the market, which include the deregulation of interest rates and competitive forces, among other interactions with stakeholders that guide operational practices [7, 8]. The growth of Sharia banks, which was initially underestimated, requires time and strategic efforts to elevate resource efficiency, hence enhancing the monetary transmitting mechanism, and effective overall financial systems. Such a performance is determined by a set of factors: internal level of NPF and OEF and external: the pandemic of Covid-19. Moreover, ratios such as Capital Adequacy Ratio (CAR) and Financing to Deposit Ratio (FDR) have a significant influence on their results in Indonesia [9].

Productivity is one of the critical performance measures in the banking industry and affects the transmission of monetary policy along with bank competitiveness. According to Ascarya and Yumanita [10], the efficiency of a bank is an indicator that has geared up the monetary policy transmission process with better results. These studies have analyzed inefficiencies in Sharia banks for the optimization of the input-output allocation, which has drawn scholarly attention to the rapid growth of the Sharia financial industry. However, the disparities among regions are noticed; some perform efficiently while others struggle due to less innovation and low operational capacity [11, 12]. Governance structures, for example, those in Malaysia, enhance resilience and efficiency at lower productivity levels [13].

Human, structural, and social capital efficiency are the key performance determinants of Sharia banks, and human capital efficiency is a negative performance determinant [14]. The external ownership, capital, and liquidity ratios are some of the most influential factors in performance, as well as regular performance appraisals to enhance resource allocation and failure prevention [15, 16]. Sharia banks are less efficient compared to conventional banks due to technological rather than structural inefficiencies [11, 17]. These issues are very significant for enhancing the continuous performance of Sharia banks within the competitive financial environment.

Efficiency improvements in banking systems, whether Sharia or conventional, can enhance profitability, service quality, and economic stability [18]. Inefficient intermediaries, however, pose risks, including taxpayer-funded bailouts in cases of significant losses. The efficiency of the banking sector in Indonesia rests on factors related to size, age, competition, inputs, output quality, ownership forms, and regulatory changes and management characteristics. Using techniques such as SFA, recent studies by researchers like Mohamad et al. [19] and Iqbal et al. [20] derived variances in resource utilization that ranked banks on their efficiency level relative to their best performers, given a certain sample.

Therefore, there is significant potential to enhance cost competence and productivity in both banking sectors to maintain a competitive advantage within the banking industry. By highlighting the potential synergy between Islamic and conventional banks within Indonesia's financial framework, this study aims to provide valuable insights for stakeholders in making better investment decisions while helping to define the roles of both Islamic and conventional banking, as well as reassessing their performance based on efficiency levels. Consequently, this research seeks to examine the productivity of Islamic and conventional banks in Indonesia and investigate the factors influencing their performance within the same context. Based on this premise, the study specifically analyzes the comparative productivity of Islamic and conventional banks in Indonesia from January 2021 to June 2024 using the stochastic frontier approach, aiming to identify the input and output variables that significantly affect the performance of both Islamic and conventional banks in the country.

2. Literature Review

2.1. Efficiency of Banking Sector in Indonesia, Conventional and Sharia Theory

The performance of Indonesia's banking sector, which covers both conventional and Sharia frameworks, is an important measure of the effectiveness of economic policies as well as banking performance [18]. Efficiency evaluation is done through both cost and profit efficiency using several methods such as the ratio method, regression analysis, and frontier techniques

like Data Envelopment Analysis (DEA) and the Stochastic Frontier Approach (SFA). Legal, regulatory, and contractual environments, property rights, and sensitivity to input-output prices determine bank efficiency [21]. According to Hadad [22], mixed foreign banks outperform others in Indonesia, but mergers do not always improve efficiency.

For Sharia banks, technical efficiency differs depending on the approach because full efficiency appears under the intermediation approach, whereas under the production approach, this is limited, according to Ascarya and Yumanita [10]. Sharia banks have efficient cost management; however, are strictly bound by principles of Sharia, where their operations are bounded compared to commercial banks, leading to a superior performance with financial indicators including CAR, LDR, and ROA, according to Novalina and Darmita [23] and Azeem [24]. External determinants, such as the COVID-19 pandemic, alongside internal elements like Non-Performing Financing (NPF), significantly affect the efficiency of Sharia banks [9]. Furthermore, social and ethical responsibilities serve to differentiate Sharia-compliant institutions, thereby enhancing customer loyalty [25].

2.2. Characteristics of Conventional and Sharia Banking Systems

Conventional and Sharia banking systems present fundamental differences in terms of business models, operating structures, and risk and profitability approaches. Conventional banks operate on an interest-based system, where profits are derived from the difference between loan and deposit interest rates. Sharia banks, on the other hand, implement the principle of profit-and-loss sharing, based on certain contracts such as mudharabah, musyarakah, and murabahah, which prevent usury and speculative transactions (gharar and maysir) [26].

The implementation of these Sharia principles generates significant differences in risk management and operational efficiency. Because they must comply with Sharia provisions, Sharia banks are limited in their ability to diversify their financial products and access conventional money market instruments. On the other hand, compliance with Islamic ethical principles creates a competitive advantage in attracting customers who prioritize moral values and sustainability [27].

In the context of efficiency, several empirical studies show mixed results. Research by Dewi [28] and Rahma [29] revealed that conventional banks tend to have greater stability in cost and profit efficiency thanks to more flexible capital structures and access to broader market-based instruments. However, research in the Middle East region shows that Islamic banks can achieve greater efficiency under certain economic conditions thanks to prudent risk management and real-sector financing [30]. In Indonesia, a study by Octrina and Priatmojo [9], which used the Stochastic Frontier Analysis (SFA) approach, concluded that while Islamic banks used to lag behind conventional banks in terms of efficiency, trends in recent years have shown a significant increase in efficiency. This is largely due to the digitalization of services, capital reinforcement, and Sharia-compliant product innovation.

Therefore, despite the structural challenges in Islamic banks' operations, the unique characteristics of this system provide room for competitive efficiency growth if supported by adaptive regulation, technology, and risk management.

2.3. Stochastic Frontier Analysis (SFA)

Typically, there are three fundamental approaches to the efficiency model of the financial sector [31], which also encompasses the banking sector: cost efficiency, standard profit efficiency, and alternative profit efficiency.

(1) Cost efficiency fundamentally evaluates the bank's expenses in relation to the operational costs of the most efficient bank, specifically one that generates identical output with the same technology. The cost efficiency ratio for a bank is defined as follows:

$$CEFF_n = \frac{\widehat{C}_{min}}{\widehat{C}_n} = \exp\frac{\left[\widehat{f_c}(w^n, y^n) + \log\left(\widehat{u}_{C_{min}}\right)\right]}{\left[\widehat{f_c}(w^n, y^n) + \log\left(\widehat{u}_{C_n}\right)\right]} = \frac{\widehat{u}_{C_{min}}}{\widehat{u}_{C_n}}$$

Where C_n is the actual cost of n banks? The cost-effectiveness factor (CEFF) represents the ratio of efficiently utilized costs or resources.

(2) Standard profit efficiency fundamentally assesses how effectively the banking sector in Indonesia operates, encompassing both conventional and Sharia banking. It evaluates the banks' capability to produce maximum profits at a specific price level of output and compares this with banks that achieve the highest profit levels within the sample, known as best practices. Regarding the cost efficiency perspective, the natural logarithm function of standard profit is defined as follows:

$$\log \pi = f(w, y) + \log u + \log v$$

Then standard profit efficiency for banks becomes:

$$\pi_{std} EFF_n = \frac{\widehat{\pi}_n}{\widehat{\pi}_{max}} = \exp\frac{\left[\widehat{f_n}(w^n, y^n) + \log\left(\widehat{u}_{\pi_n}\right)\right]}{\left[\widehat{f_n}(w^n, y^n) + \log\left(\widehat{u}_{\pi_{max}}\right)\right]} = \frac{\widehat{u}_{\pi_n}}{\widehat{u}_{\pi_{max}}}$$

Where is $\widehat{\pi}_n$ Standard utility effectiveness is the proportion of bank utility in the case of bank Z compared to the utility of the best-performing bank. Choice utility effectiveness is often associated with imperfect advertising competition, where banks have a dominant position in deciding on revenue costs but not on input costs. In these different types of markets, the most important difference between the two models (standard utility productivity and choice utility effectiveness) is that the

exogenous variable is taken into account in achieving the highest utility, i.e., the amount of revenue. In this approach, the bank maximizes utility by choosing revenue costs (p), the sum of inputs (x), for a predetermined sum of revenue (y), and input costs (r). The inverse utility of comparison work is called indirect utility because a work is made up of choices that can be composed as follows:

$$Max\ \pi\ =\ P \times Q\ =\ (p,r)(y,-x)$$

In line with that, the alternative profit function is:

$$Log\ \pi\ =\ f\ (w,y)\ +\ log\ u\ +\ log\ v$$

Then, alternative profit efficiency can be written as follows:

$$\pi_{Alt}EFF_n = \frac{\widehat{\pi}_n}{\widehat{\pi}_{max}} = \exp\frac{\left[\widehat{f_n}(w^n,y^n) + \log\left(\widehat{u}_{\pi_n}\right)\right]}{\left[\widehat{f_n}(w^n,y^n) + \log\left(\widehat{u}_{\pi_{max}}\right)\right]} = \frac{\widehat{u}_{\pi_n}}{\widehat{u}_{\pi_{max}}}$$

There are two methodologies for evaluating ability when employing the parametric stochastic frontier analysis (SFA) and the dispersion-free approach (DFA). The SFA technique was introduced by Aigner et al. [32]. This approach models the advantages of banks by differentiating within the effective frontier, which is influenced by random shocks and inefficiencies. The conventional stochastic frontier analysis typically relies on the log assumption in its formulation:

$$log\ \pi_i\ =\ f\ (log\ X_i\ , logY_i)\ +\ e_i$$

Where:

π_i : Total profit of bank i
X_i : Input at period i
Y_i : Output at period i
e_i : error

e_i consists of 2 functions:

e_i : $u_i + v_i$

Where:

u_i : Controllable error factors
v_i : Random factor errors that cannot be controlled.

In the framework of choice utility maximization, a bank optimizes its utility by selecting revenue cost (y) and total inputs (X), with total revenue (Y) and input cost (r) being predetermined. Several methodologies are used to determine input and revenue factors in banks, such as the Intermediary Approach, User-Cost Approach, and Value-Added Approach. The Intermediary Approach considers the bank as an intermediary institution that focuses on input and revenue factors associated with its role. The User-Cost Approach is cost-related and focuses on the operational impact on the costs of account management based on the holding of funds. The Value-Added Approach emphasizes input and revenue factors to maximize the value-creation objectives of the bank.

Ascarya and Yumanita [10] highlight the wilderness approach as widely adopted because it uses a measurable framework that eliminates variations in input costs and other exogenous factors affecting performance. The Stochastic Wilderness model allows for analyzing technical inefficiency within the production function system. Hadad [22] notes that parametric and non-parametric approaches yield similar results when applied to the same unit and production process, ensuring consistent findings across methodologies.

2.4. Hypothesis

Based on the theory and literature review explained above, the hypothesis in this research is as follows:

$H_0 =$ Input variables and output variables do not affect the efficiency of Sharia banks

$H_1 =$ Input variables and output variables influence the efficiency of Sharia banks.

3. Research Methods

This request seeks a clear quantitative assessment intended to evaluate the performance of Sharia banks in Indonesia, along with investigating the factors that influence the productivity of these banks in the country. This investigation employs two sorts of investigation plans, counting (i) expressive and (ii) correlational investigations. This investigates employment auxiliary information related to this inquiry about Sharia Managing an account information issued by Bank Indonesia for the January 2021- June 2024 period. The information utilized is paid-in capital, labor costs, arrangements with the Central Bank, situations with other banks, and financing offices.

3.1. Data Analysis Techniques

In this research, the Stochastic Frontier Analysis (SFA) method is employed to assess the profit efficiency of Sharia banks through an alternative approach that involves calculating the deviation of the estimated profit function from the marginal profit. This method was selected due to the nature of the banking market in Indonesia, which is characterized as an imperfectly competitive market rather than a perfectly competitive one. In this study, the input and revenue factors play a crucial role in determining the value creation approach, hence, these factors will be defined as follows:

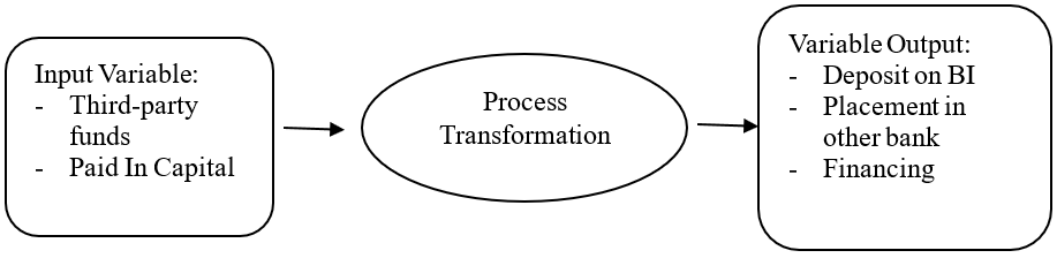

Figure 1.
Theoretical Framework.

In an alternative method for assessing profit efficiency, the bank seeks to maximize its profits by determining the output price (y) and the input quantity (X), while the output quantity (Y) and the input price (r) are predetermined. The conventional formulation of the stochastic profit frontier typically takes on the following general logarithmic form:

$$Log\ \pi_i = f(log\ X_i, logY_i) + e_i$$

With variable input and yield, the SFA condition can be composed:

$$log\ \pi = \beta_0 + \beta_1 logX_1 + \beta_2 logX_2 + \beta_3 logY_1 + \beta_4 logY_2 + \beta_5 logY_3$$

Meanwhile, to calculate the efficiency of using alternative profit efficiency, it can be written as follows:

$$\pi_{Alt} EFF_n = \frac{\widehat{\pi}_n}{\widehat{\pi}_{max}} = \exp \frac{\left[\widehat{f_n}(w^n, y^n) + \log(\widehat{u}_{\pi_n})\right]}{\left[\widehat{f_n}(w^n, y^n) + \log(\widehat{u}_{\pi_{max}})\right]} = \frac{\widehat{u}_{\pi_n}}{\widehat{u}_{\pi_{max}}}$$

This question builds upon the research conducted by Rozzani and Rahman [33], who examined the efficiency of Shariah banks and Schedule banks in Malaysia using Stochastic Frontier Analysis (SFA). Their study identified good efficiency as the dependent variable while considering three returns and two inputs. The input variables included labor input, inventory input, and physical capital input. Conversely, the output components consisted of loans and assets. Additionally, Gumilar and Komariah [34] incorporated liveliness input, such as the number of stores and paid-up capital, along with output measures such as current accounts at Bank Indonesia, current accounts at other banks, loans, and dependence on indicators like BOPO/ROA. The dependent variable employed in this research is the positive efficiency rating derived from the SFA analysis. To streamline the results, aligning with positive operational conditions, all positive variables (π), input variables, and output variables are transformed into a logarithmic format.

3.2. Ordinary Least Squares (OLS) Test

The investigation employs the regression analysis method. The classical assumption test is used, which consists of three tests: the normality test, the multicollinearity test, and the heteroscedasticity test.

4. Results and Discussion

Input variables such as third-party funds and paid-in capital reflect the main costs incurred by banks for operations and funding, so they are relevant for evaluating cost efficiency. Therefore, the selection of input and output variables in this study is based on the relevance and linkage of these variables to the efficiency of the bank in generating profits. Meanwhile, output variables such as Deposit on BI, Placement in Other Banks, and Financing reflect the output or products produced by the bank in its business activities. These variables include the main financial dimensions used in previous studies.

4.1. Estimation Result of Efficiency Level of Islamic and Conventional Banking

Based on the Stochastic Frontier Analysis (SFA) model, this study analyzes banking efficiency in Indonesia by comparing conventional and Sharia banks. The estimation result of the profit efficiency of each Sharia bank is as follows:

Table 1.
Efficiency Level of Sharia Banks January 2021 - June 2024

Month	2021	2022	2023	2024
January	1	0.8953	0.8968	0.9544
February	0.9895	0.9536	0.9044	0.9607
March	1	0.9682	0.8815	0.9481
April	0.9659	0.9539	0.8668	0.9654
May	0.9491	0.9445	0.9030	0.9912
June	0.9079	1	1	0.9898
July	0.9137	0.9872	0.9473	-
August	0.9258	0.9283	0.9950	-
September	0.9394	0.9975	0.9712	-
October	0.9208	0.9886	0.9647	-
November	0.8503	0.9709	1	-
December	0.8509	0.9266	0.9497	-

Based on Table 1, from January 2021 to June 2024, the efficiency levels of Sharia banks varied significantly, ranging from 85% to 100%. In 2021, efficiency peaked at 100% in January and March but declined to 85% in November and December, possibly due to seasonal factors or market changes. In 2022, efficiency recovered, reaching 100% in June and September, with the lowest at 90% in January, indicating improved risk management and operational adjustments. In 2023, peak efficiency of 100% was achieved in June, August, and November, while the lowest dropped to 87% in April, likely influenced by external factors such as global economic uncertainty. By mid-2024, efficiency showed greater consistency, with a high of 99% in May and June and a low of 95% in January and March, reflecting improved stability over time despite ongoing challenges. Meanwhile, the estimation results for conventional banks are as follows:

Table 2.
Efficiency Level of Conventional Banks January 2021 - June 2024.

Month	2021	2022	2023	2024
January	1	0.9914	0.9936	0.9944
February	1	0.9905	0.9935	0.9947
March	0.9947	0.9900	0.9948	0.9948
April	0.9941	0.9917	0.9946	0.9939
May	1	0.9933	0.9942	1
June	1	1	0.9946	0.9946
July	1	0.9947	0.9937	-
August	1	1	0.9944	-
September	1	1	1	-
October	0.9938	1	1	-
November	0.9933	0.9946	1	-
December	0.9919	1	1	-

Based on the data provided, from January 2021 to June 2024, the efficiency levels of conventional banks remained highly stable, ranging between 99% and 100% with minimal fluctuations. Efficiency reached 100% in several months each year, such as January, February, May, and others in 2021, June and December in 2022, and the last four months of 2023, while the lowest efficiency of 99% occurred in the remaining months. In 2024, up to June, the highest efficiency was recorded at 100% in May, with other months at 99%. This consistent performance reflects strong operational efficiency, effective risk management, and favorable market conditions, highlighting conventional banks' ability to maintain stability as a benchmark for others. This analysis indicates that conventional banks have an advantage in maintaining their operational efficiency, which can be a benchmark for other banks to optimize their performance.

4.2. Classical Assumption Test of Sharia Banks and Conventional Banks

4.2.1. Normality Test

The normality test aims to ensure that the residuals in the multiple linear regression model are normally distributed. This is an important assumption for the regression analysis results to be valid and interpretable. The normality test also helps ensure that the modeling of the relationship between variables can be applied properly.

Table 3.
Shapiro-Wilk tests for normality test results.

Variable	Obs.	W	V	z	Prob>z
Sharia Bank	41	0.88448	4.654	3.241	0.0006
Conventional Bank	41	0.97147	1.149	0.293	0.3847

According to the data processing, a normality test is conducted using the Shapiro-Wilk method, which stipulates that the data is deemed valid when the Shapiro-Wilk test value exceeds the significance level (α) of 5%. The results of the analysis indicate that the data are not normally distributed if the Shapiro-Wilk test value falls below α. Conversely, if the obtained value is higher than α, then the data satisfy the criteria for the normality test in multiple regression and are regarded as normally distributed. Based on the information presented in the table, the data in this study are found to be normally distributed.

4.2.2. Multicollinearity Test

The multicollinearity test aims to ensure that the independent variables in multiple linear regression do not have a very strong relationship with each other, which can distort the coefficient estimates. The model is considered multicollinearity-free if the Tolerance value > 0.1 and the Variance Inflation Factor (VIF) value < 10.

Table 4.
Multicollinearity Test Results.

Variable	Sharia Bank		Conventional Bank	
	VIF	1/VIF	VIF	1/VIF
Paid-In Capital	5.18	0.1930	1.42	0.70
Deposit on BI	4.01	0.2496	1.20	0.83
Placement in another bank	2.24	0.4470	1.34	0.74
D. Financing	11.87	0.0842	2.08	0.48
third-party funds	11.28	0.0886	2.06	0.48
Mean VIF	6.91		1.62	

Table 4 presents the findings of the multicollinearity test conducted on the Shariah and conventional banking models within Indonesia. The data reveal that the variance inflation factor (VIF) values for all variables, such as paid-up capital, deposits in Bank Indonesia (BI), placements in other banks, financing, and third-party funding, are below the threshold of 10 for both Islamic and conventional banks. This suggests that there are no indications of multicollinearity present in the data, allowing us to regard the independent variables utilized in the model as independent from one another.

4.2.3. Autocorrelation Test

The autocorrelation test is used to detect the presence of correlation between residuals in a regression model, which violates the assumption of independence. One commonly used method is the Durbin-Watson Test, which helps determine whether positive or negative autocorrelation is present. This test is important in research because autocorrelation can lead to inaccurate parameter estimates, thus affecting the validity of the analysis results.

Table 5.
Autocorrelation Test Results

Sharia Bank	Conventional Bank
Durbin-Watson d-statistic (6,41) = 1,03	Durbin-Watson d-statistic (6,41) = 0.62

Table 5 shows the results of the autocorrelation test using Durbin-Watson for Sharia and conventional banking models in Indonesia. Based on this test, autocorrelation is detected if the Durbin-Watson value is outside the range $-2 < DW < 2$. In Sharia banks, the Durbin-Watson value is 1.03, while in conventional banks it is 0.62. Both values are within the specified range, so it can be concluded that there are no autocorrelation symptoms in both research models.

4.2.4. Heteroscedasticity Test

The heteroscedasticity test aims to ensure that the variance of the residuals is constant across the values of the predictor variables, which is an important assumption in multiple linear regression. In this study, this test helps validate the regression model so that the estimation results are unbiased and the interpretation is accurate.

Table 6.
Heteroscedasticity Test Results

Bank	Chi-Squared (χ^2)	p-value	Conclusion
Sharia Bank	6.68	0.0097	Heteroscedasticity detected (reject Ho)
Conventional Bank	0.06	0.8056	No heteroscedasticity (accept Ho)

Table 6 presents the findings from the heteroskedasticity test conducted using the Breusch-Pagan method for both Islamic and conventional banking models in Indonesia. The criteria for decision-making are as follows: a significance value (p-value) greater than 0. 05 implies the absence of heteroskedasticity, whereas a p-value less than 0. 05 signals the presence of heteroskedasticity. In the Shariah banking model, the prob > chi² value is 0. 0097 (< 0.05), suggesting a heteroskedasticity issue within the data. Conversely, in the conventional banking model, the prob > chi² value is 0. 8056 (>0. 05), indicating that there is no heteroskedasticity problem in the data.

4.3. Multiple Linear Regression

This analysis is applied through multiple regression methods to see how some independent variables influence ROA as the dependent variable, describing a bank's profitability ratio of net profit on its total assets. ROA would thereby exhibit just how effectively a bank deploys all its assets toward generating net income. In essence, the independent variables covered in the study include: paid-up capital, deposits with BI, Other banks, and financing together with third-party funds. According to the processed data, the findings from the multiple linear regression in this study are:

Table 7.
Results of Multiple Linear Regression for Sharia Banks

Variable	Coefficient	Std. Error	t-value	p-value	95% Confidence Interval
third-party funds	-1.923089	0.80819948	-2.38	0.023	-3.563812 to 0.2823663
Paid-In Capital	-0.5553852	0.4068665	-1.37	0.181	-1.381368 to 0.27005976
Deposit on BI	0.3293163	0.1181936	2.79	0.009	0.893705 to 0.5692621
Placement in another bank	0.1062715	0.0495641	2.14	0.039	0.005651 to 0.2068921
financing	0.9875227	0.4778534	2.07	0.046	0.0174288 to 1.957617
cons	3.393682	3.225354	1.05	0.300	-3.154136 to 9.9415

Note: *p < 0.05
Number of Observations: 41
F(5, 35) : 3.48
Prob > F: 0.0118
R-squared: 0.3144
Root MSE: 0.11947

From the analysis of Sharia banks, the following results were shown about regression: independent variables have a significant impact on return on equity with an F-statistic value of 3.48 and a probability value of 0.0118 and R-squared of 0.3144, meaning that 31.44% of ROE variations are explained by the model. Third-party funds lower ROA-ratio -1.92, P = 0.023-presumably as a result of the high costs of raising such funds, whereas deposits at BI and placements in other banks increase the ROA coefficients are 0.33 and 0.11, correspondingly with the P = 0.009 and 0.039 as a manifestation of effective liquidity management. Financing also significantly affects ROA (coefficient 0.99, P = 0.046), which shows that financing is the main source of income for banks, and paid-up capital has no significant effect (P = 0.181).

Table 8.
Results of Multiple Linear Regression for Conventional Banks

Variable	Coefficient	Std. Error	t-value	p-value	95% Confidence Interval
third-party funds	-19.10439	9.561129	-2.00	0.054	-38.51451 to 0.305737
Paid-In Capital	2.510837	0.9652914	2.60	0.014	0.5511908 to 4.470482
Deposit on BI	1.947065	0.6555351	2.97	0.005	0.6162584 to 3.277873
Placement in another bank	-1.344056	0.9415586	-1.43	0.162	-3.255522 to 0.5674096
financing	12.41422	12.03636	1.03	0.309	-12.02088 to 36.84933
cons	-38.92358	17.19746	-2.26	0.030	-73.83628 to -4.010868

Note: *p < 0.05
Number of Observations: 41
F(5, 35) : 5.68
Prob > F: 0.0006
R-squared: 0.4480
Root MSE: 0.459

The regression analysis for the conventional banking system, based on 41 observations, has resulted in a significant model with an F-statistic of 5.68 and P = 0.0006. The R-squared stands at 0.4480, which means that the independent variables explain 44.80% of the variations in ROA. Paid-in capital positively and significantly affects return on equity, as it carries a coefficient of 2.51 at P = 0.014, indicating that for every 1% rise in capital, profitability increases by 2.51%. Bank Indonesia deposits have a positive and significant effect on return on equity with a coefficient of 1.95, P = 0.005, reflecting effective liquidity management. Third-party funds negatively affect ROA due to high funding costs, with a coefficient of -19.10, P = 0.054, while placements in other banks and financing do not show any statistically significant effects.

4.4. Discussion

This paper measures and compares the efficiency levels of Islamic and conventional banking in Indonesia using the Stochastic Frontier Analysis (SFA) technique. It indicates that during the period covering January 2021 to June 2024, conventional banking consistently maintains high efficiency, where most of the time it registers almost or approximately a value of 1. However, Sharia banking presents a more varied case, with the highest efficiency recorded at 1 in a few months, one of which is June 2023, while the lowest is recorded at 0.8503 in November 2021. This does prove that operational efficiencies are more stable in conventional banks, while showing a rising trend of efficiency, especially in 2024, suggesting that there may be more vibrant competition forthcoming.

The findings support the existing literature on differences between the two systems. Conventional banks enjoy flexible capital structures and revenue models based on interest, which enhances stability in revenue [24]. In contrast, Sharia banks are restricted by compliance with Sharia law and tend to have higher risks from risk-sharing models, although they exhibit cost management better than conventional banks [24]. Additionally, studies by Adawiyah et al. [30] emphasize that managing operational costs and third-party funds is critical for efficiency, as evidenced by Middle Eastern Sharia banks outperforming their Southeast Asian counterparts. Despite these challenges, Sharia banks attract market segments valuing ethical investments and social responsibility, supporting long-term sustainability [25]. Also, ROA favors regression analysis of the efficiency differences in the two models, proving that the efficient utilization of assets is very necessary for profitability.

For both Shariah banks and conventional banks, the variable of third-party funding significantly negatively impacts return on equity. Funding from third parties reduces the ROE of Shariah and conventional banks on challenges introduced

by such funding. Third-party funding is vital in keeping banks liquid, but when the amount of money given is higher, the operating costs become more expensive, and profitability falls. In this regard, Dewi [28] demonstrates that relatively high operational costs greatly reduce financial performance in rural banks. Furthermore, poor risk management can exacerbate operational and liquidity risks, further reducing asset management efficiency and overall profitability [29]. The presence of non-performing loans (NPLs) compounds these issues, as banks struggle to convert external funds into productive assets, thereby weakening operational efficiency and adversely affecting ROE [35].

Despite these threats, under efficient management, the third-party funds would positively impact the performance of a bank. Efficient utilization of such funds enhances liquidity and encourages profitable asset expansion, i.e., increased ROE. It would thus act as a strength if banks had efficiency in operations, effective risk management, and NPL curtailment. This pertains to the role of efficiency in asset and operational management towards the maximization of profitability.

Deposits in BI and financing activities have a positive and significant effect on ROA for Islamic banks, which is a sign of sturdy resource management competencies. BI deposits offer stable liquidity, where the bank can carry its profitability financing operations directly, leading to complementing its ROA [36]. Moreover, these deposits facilitate the diversification of portfolios, including Shariah financing models that are evidenced to increase profitability significantly [26, 27]. Smart management of BI deposits reduces the level of operating costs (BOPO), one of the key components of increasing profitability [37]. In other words, BI deposits not only optimize liquidity management but also drive up the strategic ROA increment, resulting in sustainable growth.

It is very important for Islamic banks to efficiently manage their deposits in Bank Indonesia (BI) in feasible operations that comply with Sharia. Managing their deposits in BI would allow an Islamic bank to positively control its business development, particularly in resource allocation for high-yield Sharia-compliant options in financing; e.g., mudharabah financing, which is profit- and efficiency-inducing [27, 38]. However, the high dependence on BI funds and special finance is at risk due to relatively ineffective liquidity management and high non-performing finance (NPF) that potentially erodes profitability due to poor control [26]. The ability to balance resource allocation with the principle of Sharia compliance is one of the determining factors in achieving a higher ROA in Islamic banking.

In conventional banking, paid-up capital and BI deposits significantly affect ROA. It shows the importance of a capital structure in influencing financial performance. Higher paid-up capital enhances financial stability and allows for a larger buffer against losses and further lending, thus directly increasing interest income and ROA [39]. Further, higher capital facilitates investment in technologies and business processes that lower expenses and widen net interest margins, elevating profitability [40]. A robust capital base also enhances the reputation of a bank, leading to higher deposits and customers, and further elevating profitability [41]. In less regulated markets, capital sufficiency has an even more significant impact on financial performance [40].

Paid-in capital and deposits at Bank Indonesia (BI) significantly impact banking efficiency by enhancing financial stability and operational capacity. Paid-in capital acts as a buffer against losses, enables resilience during economic shocks, and supports compliance with regulatory standards through improved capital adequacy ratios [42, 43]. Deposits serve as the key source of finance, enabling efficient management of liquidity, loan disbursal, and cost economies, which minimize average costs and enhance efficiency [44]. However, these factors are not the only determinants, and other variables like labor cost and interest rate have a significant impact on banking performance in general, thus indicating that efficiency in the sector requires a comprehensive approach [44].

5. Conclusion

This study illustrates a significant gap in efficiency between conventional banking and Shariah banking in Indonesia, starting from January 2021 to June 2024. Conventional banks demonstrate consistently high and steady efficiency levels, supported by their flexible capital structures and interest-based operational frameworks. On the other hand, Shariah-compliant banking faces challenges in the quest for efficiency due to the restrictions of Shariah compliance. However, a significant upward trajectory in their efficiency was recorded in 2024, presenting the potential for increased competitive dynamics. These factors include paid-up capital, third-party funds, BI deposits, and financing activities, which exert substantial influence on ROA for both banking forms. For the Shariah banks, BI deposits and financing contribute positively to returns by efficiently managing liquidity and possessing a diversified portfolio of Shariah-compliant financing; third-party funds conventionally impact return on equity negatively by raising non-performing financing risks and operating expenses.

Conventional banks enjoy solid capital structures that further establish financial stability, increase market status, and improve operational efficiency. Islamic banks, on the other hand, apply ethical investment policies and a sense of social consciousness practice that draws specific market segments. These aspects highlight that both banking types have certain advantages and face specific problems that require special approaches to fully exploit the potential of financial performance.

6. Recommendation

To improve efficiency and profitability, Islamic banks need to strengthen their risk and operational management, particularly in managing third-party funds and financing. This includes optimizing the allocation of resources to Sharia-based financing with high potential returns, such as mudharabah. Regulators are also advised to support the development of technology and infrastructure that help Islamic banks improve operational efficiency, as well as provide incentives for the implementation of Sharia principles in fund management and financing.

Conventional banks can continue to utilize their strong capital advantage to improve efficiency through investments in technology and process innovation. However, to ensure sustainability, conventional banks also need to consider enhancing social responsibility and ethical investment practices, which can be a competitive advantage amidst the increasing market

awareness of sustainability values. The results also underscore the need for a multifaceted policy approach covering capital, risk, and operational efficiency aspects to support the overall performance of the banking sector.

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