PARAMETRIC STOCHASTIC FRONTIER APPROACH TO MEASURE EFFICIENCY PRE-AND-POST-MERGER BANK SYARIAH INDONESIA

Mella Katrina Sari✉, Saniman Widodo, Suryani Sri Lestari, Mustika Widowati, Siti Hasanah
Politeknik Negeri Semarang, Indonesia
✉mellakatrina92@gmail.com

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ABSTRACT

This research analyses the efficiency of pre-and-post-merger Bank Syariah Indonesia (BSI). This research used a descriptive quantitative analysis method. The population in this research is Islamic banks, which were merged into BSI. The sampling technique was carried out using saturated samples, resulting in the merged of three Islamic Banks, namely Bank Syariah Mandiri (BSM), Bank Negara Indonesia Syariah (BNIS), Bank Rakyat Indonesia Syariah (BRIS), to become BSI. The data used is secondary data in the form of quarterly financial reports for 2019-2022. The research focused on input variables such as total fixed assets, third-party funds, operating costs, and financing. The data analysis techniques used to measure the efficiency of Islamic banks are the Econometric Model (Single Equation Model), Stochastic Frontier Analysis (SFA), and Independent Sample t-test. The result showed that pre-merger, the total fixed asset, total third-party funds, and operating cost as the input variables of the three Islamic Banks were optimal for generating financing. Therefore, the total assets, total third-party funds, and operating costs produced a more optimal impact on the distribution of total financing. It is shown that BSI, both pre-and-post-merger, has generally been efficient in its operational activities. The results of this research complement the theory related to the efficiency level of Islamic banks in terms of the amount of financing as measured by fixed assets, total third-party funds, and operational costs. Practically, the results of this research can be a reference for banks, especially Islamic banks, that will carry out mergers to measure their efficiency level.

Keywords: merger, Islamic banks, efficiency, stochastic frontier approach.

INTRODUCTION

Indonesia has a dual banking system, as stipulated in law number 10 of 1998, concerning banking, which allows for implementing a dual banking system where banks simultaneously carry out interest-based and noninterest-based banking activities. Then, in 2008, law number 21 of 2008 concerning Islamic banking was enacted, which generally regulates the existence of Islamic banking in Indonesia, divided into three types: Islamic Microcredit Banks (BPRS), Islamic Commercial Banks (BUS), and Islamic Business Units (UUS). Currently, the growth of Islamic banks in Indonesia is accelerating, as evidenced by the merger of the three BUSs in Indonesia, BSM, BRIS, and BNIS, into BSI (Hendrawan et al. 2023). Government regulation number 28 of 1999 states that a merger is the merging of two or more banks while maintaining the existence of one bank and dissolving the others without prior liquidation. Indonesians say that the merger policy carried out by Indonesian Islamic Banks is a form of effort to increase market penetration in Indonesia because Islamic banking shows a positive trend (Fiqri et al. 2021). Mergers can lead to efficiency changes through market power,

economies of scale, and economies of scope, indicating the availability of services for small customers and payment system efficiency (Berger 1998).

As the first merger of Islamic banks in Indonesia, BSI needs to be supported by effective performance measurement, one of which is efficiency. Efficiency measurement can be observed in both the input and output of the operational bank's activities. By understanding the banks' efficiency level, especially in BSI, we can assess the banks to optimize all their resources and provide more significant benefits to society. A bank is considered efficient if it can achieve optimal profits, obtain maximum funds, and improve service quality. The more efficient a bank is, the better its performance (Lestari and Purnomo 2001). If an Islamic bank can deliver good performance, it can enhance the trust of both customers and investors. Therefore, the function of Islamic Banks as intermediary institutions will run smoothly because the trust of customers and investors is a crucial factor, particularly for Islamic banks in performing their intermediary functions.

The increase in company performance efficiency after a merger using data from the US indicates a positive correlation with post-merger performance improvement. Therefore, it is concluded that a merger can enhance company performance efficiency (Cui and Leung 2020). In the research conducted by Musah, Abdulai, and Baffour (2020), on the effects of bank mergers in Ghana between 2009 and 2018, it is mentioned that the mergers resulted in the banks in Gana having a negative performance compared to before the mergers. Technical efficiency is the production process that produces a specific output by limiting resource consumption and generating efficient production functions. A company is considered technically efficient if it can produce output with a specific input to achieve maximum output or if it can produce output to achieve maximum output with minimum input (Rahmi and Putri 2019).

The purpose of measuring efficiency is to achieve a profit for the bank. Efficiency itself is one of the performance parameters that theoretically underpins the company's entire performance (Rabbaniyah and Afandi 2019). One of the methods used to estimate the efficiency score of Islamic banks is through the SFA. The advantages of using the SFA method in analyzing efficiency are (1) the presence of a disturbance term representing disturbances, measurement errors, and exogenous shocks beyond control, (2) the Environmental variables are easier to handle, allowing hypothesis testing using statistics, and easier identification of outliers. The efficiency value calculated using the SFA method in percentage form indicates that as it approaches 100%, a bank is acting more efficiently (Coelli et al. 2005).

The previous studies, some of which were carried out by Auliani and Perwithosuci (2023), researched the efficiency of 11 samples of Islamic Banks, consisting of 6 BUS and 5 UUS, the average technical efficiency of Islamic Banks in Indonesia using input-oriented (total assets and third-party funds) shows fully efficient. Rabbaniyah and Afandi (2019), with the SFA method, showed efficiency in both types of banks from 2010 to 2016, with the highest efficiency values in 2015, reaching 0,9981 for BUS Devisa and 0,9998 for BUS Non-Devisa. Meanwhile, the highest average efficiency values for 2010-2016 were 0,9366 for foreign exchange banks and 0,9395 for non-financial exchange. Dumilah (2018), determining the varibles in this research using SFA showed that one cooperative

compared to the other three cooperatives was the mos efficinet BMT Cooperative in each year when measured relatived agints others, namely BMT Mekar Dakwah with 97,26%. Karimah, Novianti, and Effendi (2016), who researched using DEA and SFA methods, show that BUS in Indonesia could operate more efficiently. Kusumo and Karim (2014) analysis of Islamic banking efficiency using SFA with input and output variables is third-party funds, paid-up capital, placements in Bank Indonesia, placements in other banks and financing provided shows that the efficiency of Islamic banks from 2010 to 2013, experienced an average annual efficiency of 94,37%, this shows that BUS have been optimal and efficient in managing their operational activities.

Wang, Le, and Nguyen (2019) apply SFA and DEA in measuring banks' cost efficiency in lending activities, and the results of this research are indicated that bank loans fund to have a significantly negative effect on bank efficiency. Another research conducted by Aliyah, Hamid, and Al Arif (2023) examining the determinants of the efficiency of Islamic banks in Indonesia using the DEA method shows that third-party funds do not significantly affect financing distribution. The research conducted by Rodoni et al. (2020) on the efficiency and stability of Islamic banking in ASEAN using the SFA method shows no significant difference between the efficiency levels of Islamic banks in ASEAN. Several previous studies have conducted analyses related to efficiency using DEA. However, in addition to using the DEA approach, another approach that can be used is the parametric SFA method. The advantages of using this method include incorporating disturbances that represent problems, minimizing measurement errors, and facilitating the identification of outliers (Afandi, Suhel, and Syathiri 2023). The novelty of this research is that it analyzes the efficiency of BSI pre-and post-merger using parametric SFA that adopts the intermediation function of Islamic banks through input and output variables. Therefore, this research aims to analyze efficiency before and after the BSI merger using parametric SFA. The findings of this research are expected to enable the management of BSI to adopt appropriate strategies to maintain the company's efficiency effectively.

LITERATURE REVIEW

Islamic Banking Efficiency

Islamic finance is currently the main focus in the financial industry due to the significant benefits it offers (Diallo and Gundogdu 2021). Islamic banks are a rapidly growing industry (Bitar, Hassan, and Walker 2017). The banking industry plays a crucial role in efficiency in Islamic banking, one of the parameters used to measure performance (Muttaqin, Rini, and Fatriansyah 2020). The Islamic financial industry worldwide has experienced significant growth since 25 years ago compared to conventional banks. The growth is increasing, leading to debates on the policies that have been implemented (Majeed and Zainab 2021).

Indonesia recognizes a dual banking system, which is conventional and Islamic banks. In general, both types of banks have the same function of collecting funds from the public and then channeling them back to the public in the form of credit or financing. One of the differences between the two is that the Islamic banks operate on the principles and laws of Islam in their daily operations.

As a result, Islamic banks do not use interest-based calculation systems like conventional banks; instead, they use profit-sharing systems or other calculating systems that have been predetermined between the Islamic bank and calculations like banks in general (Kristiyanto 2022). Islamic banks in Indonesia are not the leading indicators in the development of the Islamic financial economy in Indonesia. This can be seen from the rapid development of Islamic banks in Indonesia (Octrina and Priatmojo 2023).

In the bank sector, efficiency level is the primary measure to evaluate performance. The bank that achieves optimal efficiency can maximize profit and reduce the risk of losses. Efficiency is relevant in addressing challenges such as effective resource allocation, proper use of technology, and efficient cost management (Akbar 2019; Tri and Nguyen 2020). Efficiency is one of the benchmarks in measuring performance, which theoretically underpins the entire performance within an organization. The desired performance measure is the ability to produce maximum output with the available input. The assessment of cost efficiency is based on the company's cost compared to the best-practicing firm (Kusumo and Karim 2014). Three concepts in measuring the efficiency of financial institutions: (1) cost efficiency to calculate how close costs incurred by a bank are to good operations, costs are used to produce the same output under the same conditions, (2) efficiency in obtaining profits is a standard for measuring how close a bank is to maximizing profits from its operational processes, (3) alternative profit efficiency is measured by how close a bank is to obtaining maximum profits based on its output level compared to its output costs (Berger and Mester 1997).

Efficiency can be achieved through three approaches (Muharam 2007) : (1) Ratio approach, efficiency is measured by calculating the ratio of output to input. High efficiency is evaluated when maximum output is achieved with minimum input. However, this approach has a limitation: when many inputs and outputs are calculated, it may result in vague assumptions. (2) Regression approach, efficiency using the regression approach is measured by employing a model of a particular output level as a function of various specific inputs. Then, an estimation of the relationship is generated, which can be used to produce the output level resulting from a specific input level. A bank is considered efficient if it produces more output than the estimated output. The limitation of this approach lies in its inability to accommodate multiple outputs. In a regression equation, only one output indicator can be included, so if multiple outputs are combined into one indicator, the resulting information becomes less detailed. (3) Frontier approach, efficiency is measured using the frontier approach, which has two types: parametric and non-parametric. The parametric frontier approach employs a model by setting certain conditions about population parameters in the research. In contrast, the non-parametric frontier approach does not set specific population conditions.

The parametric frontier approach can be measured using Stochastic Frontier Analysis (SFA) and Distribution Free Analysis (DFA). SFA is used to estimate the production frontier and measure production efficiency. This SFA model is an advancement of the deterministic frontier model developed by Aigner and Chu (1968). Efficiency values using the SFA approach range between 0 and 1. When efficiency is at 1, the bank is highly efficient, or if it approaches 1. It is

considered efficient. If it shows 0, the bank is less efficient. Efficiency is comparing output and input or the amount produced from one input (Permono and Darmawan 2000). A company is considered efficient if it uses fewer units than other companies to produce the same output or uses the same input but produces a larger output. Measuring efficiency can be done with a parametric approach, namely stochastic frontier analysis, which is better and more advantageous than DEA analysis (Hussein 2001).

Framework and Hypothesis Development

The research will analyze the efficiency of BSI pre-and-post-merger by looking at input and output variables (Figure 1). Bank Syariah Mandiri, Bank Negara Indonesia Syariah and Bank Rakyat Indonesia Syariah merged on January 27, 2021, and this research will observe the efficiency conditions of these three Islamic banks before the merger, from January 2019 until December 2020. Bank Syariah Indonesia, which has undergone the merger, will be observed from January 2021 until December 2022. The input variables used in this research are total fixed assets, third-party funds and operating costs. Meanwhile, the output variable used is total financing. The values of the input and output variables are calculated using the SFA to determine the efficiency pre-and-post-merger.

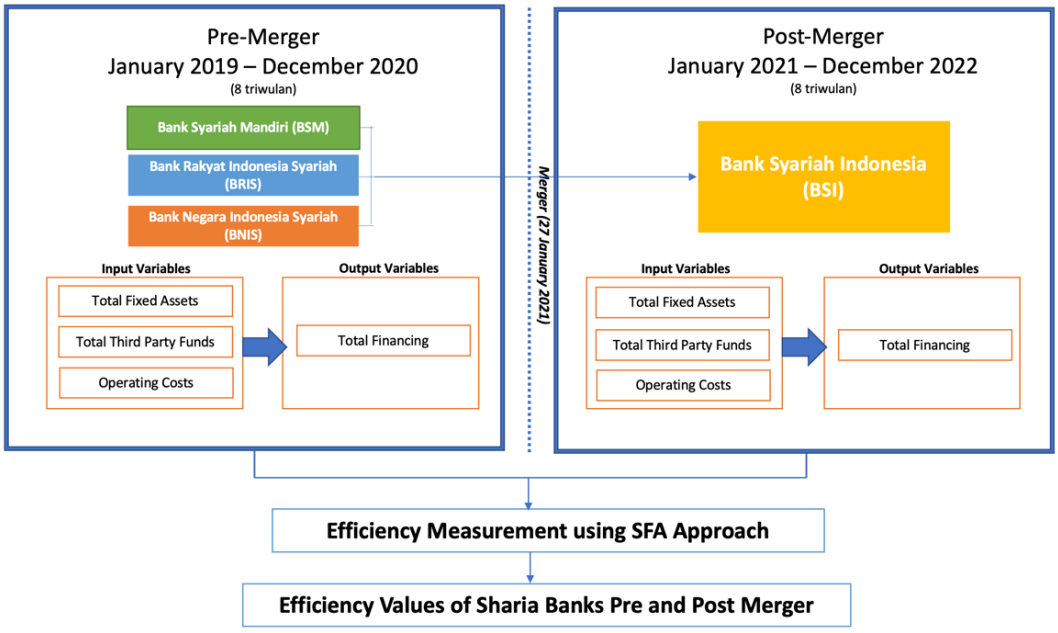

Figure 1 Research Framework
Source: secondary data (processed, 2023)

Previous research results Kusumo and Karim (2014); Karimah, Novianti, and Effendi (2016); Dumilah (2018); Rabbaniyah and Afandi (2019); Wang, Le, and Nguyen (2019); Nasution (2020); Rodoni et al. (2020); Afandi, Suhel, and Syathiri (2023); Auliani and Perwithosuci (2023), indicate that the efficiency of companies measured using stochastic frontier analysis shows a good level of efficiency, in line with the theory proposed by Aigner and Chu in 1968 that the efficiency value using good Stochastic Frontier Analysis is between 0 and 1. The

hypothesis in this research is as follows: H_1: There is a difference in efficiency values between Islamic banks pre-and-post-merger using the parametric SFA in the BSI.

METHOD

In this research used descriptive quantitative analysis method. Descriptive analysis is conducted to explore and clarify the existence of a social phenomenon by describing several variables related to the issue and the research unit. The population in this research is Islamic banks, which were merged into BSI. The sampling techniques is conducted through saturated sample, resulting in three Islamic banks that are merging, namely BSM, BNIS, and BRIS, becoming the merged bank is BSI. The data used is secondary data in the form of quarterly financial reports for 2019-2022. Data processing tools use Frontier 4.1 and SPSS 26 software. This research measures the efficiency of Islamic banks pre-and-post-merger using two variables: input and output variables. The input variables in this research are related to the inputs in the operational processes of Islamic banks. The output variables represent the results of the operational production of these Islamic banks. Tabel 1 is a description of the variables used in the SFA model.

Table 1 .Description of Model Variables

Variables	Notation	Definition
Input	P1: Total Fixed Assets P2: Total Third Party Funds P3: Operating Cost	Total Fixed Assets Total Third Party Funds Total operating cost incurred by the company
Output	Total Financing	Murabaha Financing, Musharakah Financing, Lease Financing and others

Source: Dumilah (2018)

The model analysis used in this research are: (1) Econometric Model (Single Equation Model) is an econometric model used to test equations individually. $\text{Ln}(Q_1) = \beta_0 + \beta_1 \text{LnP}_{1,i} + \beta_2 \text{LnP}_{2,i} + \beta_3 \text{LnP}_{3,i} + V_i - U_i$, with $ei = v_i - u_i$ where index i = 1,2,3, …, N with being number of observation data. Q1 = Total Financing, P1 = Total Fixed Assets, P2 = Total Third-Party Funds, P3 = Operational Cost, Ui = Controllable Random Factor (Inefficiency), Vi = Uncontrollable Random Factor (Random Noise). From this model, the hypothesis will be determined regarding whether there is an influence between input and output variables using a two-tailed with $\alpha = 0{,}5$.

(2) Stochastic Frontier Analysis (SFA) determines the efficiency level over time. The efficiency values generated range from 0 to 1. If the value approaches 1, the bank becomes more efficient; conversely, if it approaches 0, it is considered inefficient. This SFA method uses controlled errors or "U" to obtain efficiency values. Production function analysis using SFA is performed using a time-varying model parameter. Therefore, the production function has a general (log) form: $\text{Ln}(Q_1) = \beta_0 + \beta_1 \text{Ln}(P_1) + \beta_2 \text{Ln}(P_2) + \beta_3 \text{Ln}(P_3) + \ldots + \beta_n \text{In}(P_n) + E_n$. Input Variables: P1 = Total Fixed Assets, P2 = Total Third-Party Funds, P3 = Operational Cost; Output

Variables: Q1 = Total Financing; En represents the error term obtained from Vi-Ui where: Ui = Controllable random factor (inefficiency), Vi = Uncontrollable random factor (random noise).

(3) Independent Sample t-test data processing in this research uses a statistical technique: a test of differences between two averages (independent sample t-test). Some conditions must be met in parametric statistics before conducting an independent sample t-test. The t ratio is calculated by finding the difference between the mean of the two groups divided by the standard deviation of the difference between the mean of sample group 1 and group 2. To calculate the difference test, it is calculated using the following formula:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s^2}{N_1} + \frac{s^2}{N_2}}}$$

Descriptions:

$\bar{x}_1 - \bar{x}_2$ = Mean Efficiency Scores of Islamic banks pre-and-post-merger

$S\bar{x}_1 - \bar{x}_2$ = Standard deviation of mean efficiency scores of Islamic banks pre-and-post-merger

S^2 = Population Variance

N_1, N_2 = Number of subjects in the pre-and-post-merger bank groups.

Assumptions for the use of an independent sample t-test, according to Santoso (2014), are as follows: (a) Both samples are not paired. Hypothesis testing should be done using paired sample t-tests if the samples are paired. (b) The number of data points in each sample is less than 30. If there are 30 data points or more, it is recommended to use the Z-test. (c) The data used in this test is quantitative data on interval or ratio scale. (d) The data in both samples are normally distributed. The purpose of the mean difference test is to verify or reject a hypothesis that has been made. The significance level used is 95%.

RESULTS AND DISCUSSIONS

Econometric Model (Single Equation Model) Results

The following are the results of maximum likelihood estimation (MLE) processed using Frontier 4.1. Software.

Table 2 The Results on BSI (Pre-Merger)

	Coefficient	*t-ratio*
Constant	-0.200000	2.0100
Total Fixed Assets	-0.433680	4.3250
Total Third-Party Funds	0.100000	2.2500
Operational Costs	0.173472	2.1173
Sigma-squared	0.147195	1.4795
Gamma	-0.500000	5.0021

Source: secondary data (processed, 2023)

Table 2 shows the results of the BSI pre-merger's maximum likelihood estimation (MLE). The coefficient of the constant is -0.2000, total fixed assets are -0,433680, total third-party funds are 0.1000, and operational cost is 0.173472.

With a constant t-ratio of 2.0100, total fixed assets were at 4.3250, total third-party funds were at 2.2500, and operational costs were at 2.1173. The results of the test conducted on BSI post-merger are in Table 3.

Table 3 The Results on BSI (Post-Merger)

	Coefficient	T-ratio
Constant	0.100000	1.2000
Total Fixed Assets	0.542101	4.4213
Total Third-Party Funds	0.100000	2.8000
Operational Costs	0.566000	2.5603
Sigma-squared	0.115951	1.1595
Gamma	0.500000	5.0000

Source: secondary data (processed, 2023)

Table 3 shows the maximum likelihood estimation (MLE) results of BSI pre-merger. The coefficient of the constant is -0.2000, total fixed assets are -0,433680, total third-party funds are 0.1000, and operational cost is 0.173472. With a constant t-ratio of 2.0100, total fixed assets were at 4.3250, total third-party funds were at 2.2500, and operational costs were at 2.1173.

Stochastic Frontier Analysis (SFA) Results

The following are the results of the Stochastic Frontier Analysis processed using Frontier 4.1. Software.

Table 4 The Results of SFA on BSI (Pre-Merger)

Bank Year / Quarterly	Efficiency	Bank Year / Quarterly	Efficiency
BNI Syariah 2019/QI	0,9122	BRI Syariah 2020/QI	0,8992
BNI Syariah 2019/QII	0,9315	BRI Syariah 2020/QII	0,9022
BNI Syariah 2019/QIII	0,9425	BRI Syariah 2020/QII	0,9180
BNI Syariah 2019/QIV	0,9560	BRI Syariah 2020/QIV	0,9456
BNI Syariah 2020/QI	0,9240	BSM 2019/QI	0,9878
BNI Syariah 2020/QII	0,9581	BSM 2019/QII	0,9987
BNI Syariah 2020/QIII	0,9691	BSM 2019/QIII	0,9852
BNI Syariah 2020/QIV	0,9790	BSM 2019/QIV	0,9677
BRI Syariah 2019/QI	0,8220	BSM 2020/QI	0,9521
BRI Syariah 2019/QII	0,8371	BSM 2020/QII	0,9423
BRI Syariah 2019/QIII	0,8578	BSM 2020/QIII	0,9642
BRI Syariah 2019/QIV	0,8878	BSM 2020/QIV	0,9878

Source: secondary data (processed, 2023)

Table 4 shows the efficiency analysis results using Stochastic Frontier on pre-merger BSI (BNIS, BRIS, and BSM) each quarter from 2019 to 2020.

Table 5 The Results of SFA on BSI (Post-Merger)

Bank Year / Quarterly	Efficiency	Bank Year / Quarterly	Efficiency
BSI 2021/QI	0,9366	BSI 2022/QI	0,9342
BSI 2021/QII	0,9564	BSI 2022/QII	0,9548
BSI 2021/QIII	0,9667	BSI 2022/QIII	0,9672
BSI 2021/QIV	0,9998	BSI 2022/QIV	0,9787

Source: secondary data (processed, 2023)

Table 5 shows the efficiency analysis results using Stochastic Frontier on post-merger BSI each quarter from 2021 to 2022.

Independent Sample T-test Results

This test is conducted to determine whether there is a difference between BSI pre-and-post-merger; in this research, an Independent Sample t-test was used to use the SPSS 26 version software. The results of the independent sample t-test are in Table 6 and Table 7.

Tabel 6 The Results of Independent Sample T-test

	Group	N	Mean	Std. Deviation	Std. Error Mean
Efficiency Value	Pre-Merger	24	0.934496	0.0477756	0.0097521
	Post-Merger	8	0.961800	0.0215729	0.0076272

Source: secondary data (processed, 2023)

Table 6 shows the results of the independent sample t-test, indicating that the efficiency values of pre-and-post-merger are different. The number of data (N) in the pre-merger is 24, and the post-merger is 8. Meanwhile, the mean efficiency value in the pre-merger is 0.934496, the standard deviation is 0.477756, and the standard error is a mean value of 0,0097521. The mean efficiency value in the post-merger is 0.961800, with a standard deviation of 0.0215729 and a standard error with a mean value of 0.0076272. Therefore, there is a difference in the average efficiency value of BSI pre-and-post-merger.

Table 7 The Results of Independent Sample T-test

	N	Sig	T	Sig. (2-tailed)	Mean Difference
Efficiency Value	4.273	0.047	-1.551	0.131	-0.027304
			-2.205	0.036	-0.027304

Source:Data processed (2023)

Table 7 shows that the sig Levene's t-test for equality of variances is 0,131 > 0,05, which means that the variance of the data between BSI pre-and-post-merger is homogenous or the same. Therefore, it can be said that the output table of independent samples t-test above follows the "equal variances assumed" table. Meanwhile, in the "independent samples t-test" output table in the "equal variance assumed" section, the sig (2-tailed) value is 0,036 < 0,05, so based on the decision-making basis in the independent sample t-test, it can be said that there is a significant difference between the efficiency of BSI pre-and-post-merger (H_1 is accepted). Furthermore, it is said from the Table 7 that the "mean difference" is -0,027304, which means that the difference between the pre-and-post-merger 0,961800 - 0,934496 = 0,027304 and the difference range is -0,0632 to 0,0086 (95% confidence interval of the difference lower upper).

Econometric Model (Single Equation Model)

The discussion of this research is an analysis of efficiency value before the merger of BSI consisting of three BUSs (BSM, BNIS, and BRIS) from 2019 to

2020 using quarterly date (1 year = 4 quarters) using the SFA method referring to the equation from the results on BSI (pre-merger): LnQ1 = -0,2000 – 0,4336 LnP1 + 0,1000 LnP2 + 0,1734 LnP3 + 0,1471 – 0,5000. From the equation, a frontier model in the form of a trans log that is not a linear model is generated, so all variables in this research are converted to natural logarithm form. Maximum likelihood estimation (MLE) determines the maximum performance of the three BUS before and after the merger in disbursing total financing. Maximum likelihood estimation (MLE) is obtained from estimation using ordinary least squares (OLS), and the estimation is conducted to determine the stochastic frontier function using maximum likelihood estimation (MLE). The regression equation model shows that the constant value is 0,2000, indicating that if the input variables are considered constant, the three BUSs (BSM, BNIS, and BRIS) will disburse their financing at a certain level of 0,8000 from the total input.

In the input variable, total assets or approximated by (lnP1) has a regression coefficient of -0,433680, indicating that if total Fixed Assets increase by 1%, total financing will decrease by 0.433689% or 0.44%. This indicates that the Islamic Banks that are undergoing a merger are not optimal in managing their existing assets, which can result in inefficiencies because, before the merger, the composition of total assets from each bank was not balanced, BSM at 51,2%, BNIS 25,0%, and BRIS at 17,4%. The second input variable is total third-party funds or, approximated by (lnP2), has a regression coefficient of 0.1000, indicating that if total third-party funds increase by 1%, total third-party funds will increase by 0.1%. This indicates that BUSs increase in third-party funds does not impact financing distribution, showing that the three BUSs have efficiently managed their third-party funds. Meanwhile, in the third input variable, operational costs approximated by lnP3 have a coefficient of 0,1734, indicating that if operational costs increase by 1%, total financing will increase by 0,1734%. It can be concluded that the total financing distributed by BUS that will undergo a merger (BSM, BNIS, and BRIS) is not affected by an increase in operational costs incurred by BSI pre-merger. Therefore, the three BUSs that will undergo a merger have been quite good at managing operational costs, and the BUSs are efficient.

The results on BSI (post-merger), the regression equation model is LnQ1 = 0,100000 + 0,542101 LnP1 + 0,10000 LnP2 + 0,566000 LnP3 + 0,11595 + 0,50000. The regression equation model shows that the constant value is 0,100, indicating that BSI will channel its financing at a certain level of 0,9000 of the total input. The first input variable is total fixed assets or approximated by (LnP1); the regression coefficient is 0,542101, indicating that if total assets increase by 1%, total financing will increase by 0,542101% or 0,54%. This shows that BSI has been quite good in managing its assets, and it can be concluded that BSI is efficient post-merger. Next, the input variable of total third-party funds (LnP2) has a regression coefficient of 0,100000, indicating that if total third-party funds increase by 1%, total financing will increase by 0,1%. This indicates that BSI is already optimal in managing third-party funds and shows that BSI is efficient. As the third input variable, operational costs approximated by LnP3 have a regression coefficient of 0,5660, indicating that if operational costs increase by 1%, total financing will increase by 0,566%. This shows that the total financing distributed by BSI after the merger is not affected by the operational costs incurred. Therefore, BSI has been quite good at managing operational costs, indicating that

BSI is quite efficient. This is in line with the research results conducted by Dumilah (2018); Rabbaniyah and Afandi (2019); Auliani and Perwithosuci (2023), which indicate that operational costs do not affect the total financing to be provided by the debtors, indicating that BSI has been efficient in carrying out in operational activities.

Stochastic Frontier Analysis (SFA)

The results of SFA show the efficiency results of the three BUSs pre-merger (BNIS, BRIS, and BSM), as seen from quarterly data from 2019 to 2020. Each bank shows that the highest efficiency value is BSM at 0,9987. Meanwhile, the lowest efficiency value is BRIS at 0,8220. The results of SFA show from the efficiency results of the BSI post-merger as seen from quarterly data in 2021-2022; the highest efficiency value is 0.9998, and the lowest efficiency value is 0,9342. Therefore, by using the SFA method, it can be proven that with the merger, BSI becomes more efficient in its operational management because the results approach the number 1, according to Muharam (2007), which explains that the efficiency values using the SFA approach range between 0 and 1. A bank that has efficiency values approaching 1 can manage its good operations. This is also supported by research by Rabbaniyah and Afandi (2019); Nasution (2020); Rodoni et al. (2020); Wang, Le, and Nguyen (2019); Ulkhaq (2021).

Independent Sample T-test

The results show a difference in efficiency values between BSI pre-and-post-merger using the parametric SFA. The merger of three BUSs (BSM, BNIS, and BRIS) has proven to be more efficient in terms of total assets, total third-party funds, and operational costs, which can optimize the amount of financing the bank distributes. This can be seen from the model applied in this research, which is conducted through the specification of the Cobb-Douglas function, where all observations are required to be below the frontier using data from several company samples. Efficiency values using the SFA range from 0 to 1. When efficiency is at 1, the bank is very efficient; if it is close to 1, it is already efficient, and if it is at 0, the bank is less efficient. The result of this research shows that the efficiency level is close to 1 and less than 0; this is supported by previous research by Kusumo and Karim (2014); Apriyana, Hasanah, and Siregar (2015); Karimah, Novianti, and Effendi (2016); Dumilah (2018); Rabbaniyah and Afandi (2019); Wang, Le, and Nguyen (2019); Afandi, Suhel, and Syathiri (2023); Auliani and Perwithosuci (2023).

CONCLUSIONS

Based on the research conducted on BSI, both pre-and-post-mergers generally have efficiently conducted their operational activities. The results show that the input variables in this research use total assets, total third-party funds, and operational costs, while the output variable uses financing distribution. The pre-merger of BSI from 2019 to 2020 shows that the highest efficiency value is BSM. Meanwhile, merging the three BUSs into BSI shows that BSI is becoming more efficient in operational processes. The output test results in this research also show a difference in efficiency values between pre-and-post-merger BSI using

Parametric SFA. The merger of three BUSs (BSM, BNIS, BRIS) has proven to be more efficient regarding total assets, total third-party funds, and operational costs, which can optimize the amount of financing the bank distributes.

The results of this research complement the theory related to the efficiency level of Islamic banks in terms of the amount of financing as measured by fixed assets, total third-party funds, and operational costs. Practically, the results of this research can be a reference for banks, especially Islamic banks, that will carry out mergers to measure their efficiency level. The limitations of this research are that the samples taken are still relatively small because it only examines one bank (BSI) with the phenomenon of a merger, and the input and output components in this research still need to be expanded. Hence, there are still many variables that can increase the efficiency of Islamic Banks that are not included in this research; the analysis technique in this research is also simple, only measuring the cost efficiency of BSI using SFA. Suggestions for future research are as follows: It is hoped that other production input variables will be included, and future research is expected to add different research objects and more extended observation periods to produce more optimal outputs.

REFERENCES

Afandi, Akhmad, Suhel Suhel, and Ahmad Syathiri. 2023. "Analisis Efisiensi Bank Umum Syariah Di Indonesia (Studi Kasus Metode Stokastik Frontier)." *Ekonomi, Keuangan, Investasi Dan Syariah (EKUITAS)* 4 (3): 869–76. https://doi.org/10.47065/ekuitas.v4i3.2756.

Aigner, D. J., and S. F. Chu. 1968. "On Estimating the Industry Production Function." *American Economic Review* 58 (4): 826–39. https://www.jstor.org/stable/1815535.

Akbar, Taufiq. 2019. *Kajian Kinerja Profitabilitas Bank Pada Perspektif Bank Umum Berdasarkan Kegiatan Usaha (BUKU): Studi Empiris Pada Momen Penurunan Profitabilitas Bank-Bank Di Indonesia*. Cirebon: Uwais Inspirasi Indonesia.

Aliyah, Hikmatul, Abdul Hamid, and Mohammad Nur Rianto Al Arif. 2023. "Determinant of Efficiency in the Indonesian Islamic Banks." *Signifikan: Jurnal Ilmu Ekonomi* 12 (1): 161–74. https://doi.org/10.15408/sjie.v12i1.30376.

Apriyana, Alfin, Heni Hasanah, and Hermanto Siregar. 2015. "Faktor-Faktor Yang Memengaruhi Efisiensi Biaya Perbankan Di Kawasan ASEAN-5." *Jurnal Manajemen Teknologi* 14 (3): 321–33. https://doi.org/10.12695/jmt.2015.14.3.6.

Auliani, Adristi Prily, and Winny Perwithosuci. 2023. "Efisiensi Teknis Bank Syariah Di Indonesia Selama Pandemi Covid-19: Pendekatan Data Envelopment Analysis." *Cakrawala Repositori IMWI* 6 (1): 174–85. https://doi.org/10.52851/cakrawala.v6i1.159.

Berger, Allen N. 1998. "The Efficiency Effects of Bank Mergers and Acquisition: A Preliminary Look at the 1990s Data." In *Bank Mergers & Acquisitions*, 79–111. Boston: Springer. https://doi.org/10.1007/978-1-4757-2799-9_5.

Berger, Allen N., and Loretta J. Mester. 1997. "Inside the Black Box: What

Explains Differences in the Efficiencies of Financial Institutions?" *Journal of Banking & Finance* 21 (7): 895–947. https://doi.org/10.1016/S0378-4266(97)00010-1.

Bitar, Mohammad, M. Kabir Hassan, and Thomas Walker. 2017. "Political Systems and the Financial Soundness of Islamic Banks." *Journal of Financial Stability* 31 (August): 18–44. https://doi.org/10.1016/j.jfs.2017.06.002.

Coelli, Timothy J., Dodla Sai Prasada Rao, Christopher J. O'Donnell, and George Edward Battese. 2005. *An Introduction to Efficiency and Productivity Analysis*. 2nd ed. New York: Springer Science. https://books.google.co.id/books?id=V2Rpu8M6RhwC.

Cui, Huijie, and Sidney Chi-Moon Leung. 2020. "The Long-Run Performance of Acquiring Firms in Mergers and Acquisitions: Does Managerial Ability Matter?" *Journal of Contemporary Accounting & Economics* 16 (1): 100185. https://doi.org/10.1016/j.jcae.2020.100185.

Diallo, Amadou Thierno, and Ahmet Suayb Gundogdu. 2021. *Sustainable Development and Infrastructure*. Palgrave Studies in Islamic Banking, Finance, and Economics. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-67094-8.

Dumilah, Ratna. 2018. "Analisis Efisiensi Biaya Dengan Pendekatan Stochastic Frontier Approach (SFA)." *JURNAL SeMaRaK* 1 (2): 49–60. https://doi.org/10.32493/smk.v1i2.1802.

Fiqri, Alfany Arga Alil, Minerva Maharani Azzahra, Khansa Dzakiyah Branitasandini, and Laila Masruro Pimada. 2021. "Peluang Dan Tantangan Merger Bank Syariah Milik Negara Di Indonesia Pada Masa Pandemi Covid-19." *El Dinar* 9 (1): 1–18. https://doi.org/10.18860/ed.v9i1.11315.

Hendrawan, Surya, Nur Hendrasto, Muhammad Fahri Farid, and Desmy Riani. 2023. "Job Satisfaction Of Bank Syariah Indonesia Employees Post-Merger." *JPS (Jurnal Perbankan Syariah)* 4 (2): 213–30. https://doi.org/10.46367/jps.v4i2.1398.

Hussein, Khaled A. 2001. *Operational Efficiency in Islamic Banking: The Sudanese Experience*. Islamic Research and Training Institute, Islamic Development Bank.

Karimah, Siti, Tanti Novianti, and Jaenal Effendi. 2016. "Kajian Efisiensi Bank Umum Syariah Di Indonesia." *Al-Muzara'ah* 4 (1): 33–43. https://doi.org/10.29244/jam.4.1.33-43.

Kristiyanto, Sony. 2022. "Efisiensi Perbankan Buku 4 Sebelum Masa Pandemi." In *SENMAKOMBIS: Seminar Nasional Mahasiswa Ekonomi Dan Bisnis Dewantara*, 13–22. Jombang: STIE PGRI Dewantara. https://ejournal.stiedewantara.ac.id/index.php/SENMAKOMBIS/article/view/960.

Kusumo, Willyanto Kartiko, and Abdul Karim. 2014. "Analisis Efisiensi Perbankan Syariah Dengan Metode Stochastik Frontier Approach (SFA): Studi Kasus Pada Bank Umum Syariah, Unit Usaha Syariah Dan Layanan Syariah (Office Chanelling) Di Indonesia." *SOLUSI* 13 (2): 123–51. https://doi.org/10.26623/slsi.v12i2.1601.

Lestari, Etty Puji, and Budi Purnomo. 2001. "Efisiensi Teknik Perbankan Di Indonesia Tahun 1995-1999: Aplikasi Data Enverlopment Analysis."

Universitas Gadjah Mada. https://etd.repository.ugm.ac.id/penelitian/detail/7510.

Majeed, Muhammad Tariq, and Abida Zainab. 2021. "A Comparative Analysis of Financial Performance of Islamic Banks Vis-à-Vis Conventional Banks: Evidence from Pakistan." *ISRA International Journal of Islamic Finance* 13 (3): 331–46. https://doi.org/10.1108/IJIF-08-2018-0093.

Muharam, Harjum. 2007. "Analisis Perbandingan Efisiensi Bank Syariah Di Indonesia Dengan Metode Data Envelopment Analysis (Periode Tahun 2005)." *Jurnal Ekonomi Dan Bisnis Islam* 2 (3): 80–166. http://eprints.undip.ac.id/38915/.

Musah, Alhassan, Mohammed Abdulai, and Hilda Baffour. 2020. "The Effect of Mergers and Acquisitions on Bank Performance in Ghana." *Asian Journal of Economics and Empirical Research* 7 (1): 36–45. https://doi.org/10.20448/journal.501.2020.71.36.45.

Muttaqin, Ibnu, Rini Rini, and Alif Ilham Akbar Fatriansyah. 2020. "Efisiensi Bank Umum Syariah Di Indonesia Dengan Pendekatan Three Stages Frontier Analysis." *Jurnal Akuntansi Dan Keuangan Islam* 8 (2): 115–29. https://doi.org/10.35836/jakis.v8i2.119.

Nasution, Zubaidah. 2020. "Profit Efficiency Development of Islamic Banking Using the Stochastic Frontier Approach." *Jurnal Ekonomi & Keuangan Islam* 6 (1): 55–63. https://doi.org/10.20885/jeki.vol6.iss1.art6.

Octrina, Fajra, and Hariadi Eka Priatmojo. 2023. "Islamic Bank Efficiency: An Efficiency Method with SFA." *Jurnal Perspektif Pembiayaan Dan Pembangunan Daerah* 10 (6): 379–94. https://doi.org/10.22437/ppd.v10i6.18250.

Permono, Iswardono S., and Darmawan Darmawan. 2000. "Analisis Efisiensi Industri Perbankan Di Indonesia (Studi Kasus Bank-Bank Devisa Di Indonesia Tahun 1991-1996)." *Journal of Indonesian Economy and Business* 15 (1): 1–13. https://journal.ugm.ac.id/jieb/article/view/39324.

Rabbaniyah, Lathiefah, and Akhsyim Afandi. 2019. "Analisis Efisiensi Perbankan Syariah Di Indonesia Metode Stochastic Frontier Analysis." In *Proceeding of Conference on Islamic Management, Accounting, and Economics*, 200–211. Yogyakarta: Universitas Islam Indonesia, Yogyakarta. https://journal.uii.ac.id/CIMAE/article/view/13149/9468.

Rahmi, Hanifah, and Dewi Zaini Putri. 2019. "Analisis Efisiensi Perbankan Syariah Selama Krisis Global Di Indonesia." *Jurnal Kajian Ekonomi Dan Pembangunan* 1 (2): 321–30. https://doi.org/10.24036/jkep.v1i2.6174.

Rodoni, Ahmad, Aisyah Raisa Medina, Bahrul Yaman, and Sopyan Sopyan. 2020. "Efficiency And Stability Of Islamic Banking In ASEAN." *Al-Iqtishad: Jurnal Ilmu Ekonomi Syariah* 12 (1). https://journal.uinjkt.ac.id/index.php/iqtishad/article/view/16187.

Santoso, Santoso. 2014. *Statistik Parametrik Edisi Revisi*. Jakarta: Elex Media Komputindo.

Tri, Ta Minh, and Phuong Anh Nguyen. 2020. "Effect Of Bank Merger On Efficiency Using Stochastic Frontier Analysis: The Case Of Vietnam." *Journal of Critical Reviews* 7 (16): 320–29. https://www.researchgate.net/publication/344013713.

Ulkhaq, M. Mujiya. 2021. "Metode Stochastic Frontier Analysis Untuk Mengukur

Efisiensi Di Sektor Pendidikan." *Sainteknol: Jurnal Sains Dan Teknologi* 19 (2): 65–73. https://journal.unnes.ac.id/nju/sainteknol/article/view/33553.

Wang, Lai-Wang, Ke-Duc Le, and Thi-Duong Nguyen. 2019. "Applying SFA and DEA in Measuring Bank's Cost Efficiency in Relation to Lending Activities: The Case of Vietnamese Commercial Banks." *International Journal of Scientific and Research Publications* 9 (10): 70–83. https://www.researchgate.net/publication/337106462.