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ASSESSING THE IMPACT OF LEVERAGE RATIO ON BANKING EFFICIENCY IN INDONESIA

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ABSTRACT

This study analyzes the significance of the leverage ratio on the efficiency of banking companies with the aim of assessing the readiness and suitability of banking companies in facing the implementation of Basel 4 or Basel 3.1. Data from 47 banking companies in Indonesia from the period 2008 to 2023 were used as material for this study. The data used in the research were analyzed using the Dynamic Stochastic Frontier (DSF) method. This method allows for more accurate efficiency analysis by avoiding assumptions of technology at different times. The researchers hypothesize that banking companies with a leverage ratio level higher than the minimum limit applied in BASEL have better efficiency, and the results of this study show corresponding results within the leverage ratio limit of 20%..

KEYWORDS *Bank Efficiency, Dynamic Stochastic Frontier, Leverage Ratio, BASEL.*

INTRODUCTION

Financial services refer to a type of service provided or offered by the financial institution industry. The financial services sector is one of the important sectors that serves as a pillar in a country's economy; the dynamics in the financial sector can serve as an indicator of the country's economic development. The Financial Services sector in Indonesia is divided into several sectors, namely the banking sector, the capital market, and the non-bank financial industry.

Banking is one of the very important financial service sectors in the economic development of Indonesia, and not only in Indonesia but also in many other industrial countries. Banking is crucial, especially in financing activities related to money (Permono, I.S, 2000). The role of banking is very significant, especially in facing the era of free markets and globalization, acting as an intermediary between the deficit and surplus sectors and as an agent of development. However, this responsibility still largely falls on government-owned banks (Dedy S, 2019). Banks

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function to attract funds from and distribute them to the public; therefore, banks must perform well in all their business activities (Muhlis et al., 2021).

Over the past five years, banking funds collected from third parties amounted to IDR 5,998.6 trillion in 2019 and increased to IDR 8,457.9 trillion in 2023, a 1.4 times increase. Compared to Indonesia's GDP in 2019, which was IDR 15,833.9 trillion, the funds managed by Indonesian banks contributed 38%. More than a third was in the hands of the banking sector. Bank deposits accounted for the largest portion of third-party funds collected, contributing 43% in 2019 and decreasing to 37% in 2023. Conversely, funds collected from demand deposits contributed only 24% in 2019 and increased to 31% in 2023. Meanwhile, the contribution from savings remained steady at 32% in both 2019 and 2023, unchanged (OJK, 2024).

The banking industry is the most regulated sector. This is logical because the funds collected from the public and developed through various forms of financing and investment must be accountable. If not, the impact would not only be the loss of funds but also economic disaster, which could devastate the country's economy. This reality underscores the importance of regulation and supervision for financial institutions, including banks.

One of the international regulations governing banking is Basel. Basel is formulated by the Basel Committee on Banking Supervision (BCBS), which is a committee under the Bank for International Settlements (BIS) that serves as a forum for cooperation related to banking supervision and setting banking regulatory standards. BCBS consists of 45 central banks and banking supervisory authorities from 29 countries, including Indonesia.

In 2017, BCBS developed Basel IV or Basel III.1, a series of banking reforms as a continuation of Basel I to Basel III. This regulation was initially planned to be implemented starting in January 2023 in the financial services sector, where they are required to increase oversight of significant capital. Bank Indonesia (BI) has applied Basel principles in its regulations and policies. On Tuesday, May 25, 2021, the Financial Services Authority (OJK) committed to implementing Basel IV in Indonesia's financial sector.

One principle emphasized in Basel IV is the implementation of the leverage ratio. The leverage ratio is a financial ratio used to measure how a bank utilizes debt in its capital structure relative to its equity. It reflects the level of leverage or the extent of debt usage in a company, expressed as a percentage. The calculation of leverage is the division of total debt, both long-term and short-term, by shareholder equity. Using debt for operational financing has different advantages and disadvantages compared to using equity. Its use for operational costs must be made carefully, considering all benefits and risks to avoid adversely affecting the bank's efficiency.

Efficiency refers to a bank's ability to use resources such as capital, labor, technology, and infrastructure effectively to increase revenue, reduce costs, and minimize risks. Banks in Indonesia need to operate efficiently for several reasons. First, efficiency helps increase market competitiveness by reducing operational costs and increasing productivity, allowing banks to offer more competitive products and services. Second, efficiency can improve customer satisfaction through fast and quality service, attracting new customers and increasing their loyalty. Third, operational efficiency directly impacts profitability through good cost management and resource maximization to increase profit margins.

In addition to these reasons, many other positive effects of efficiency on banks include better risk management through improved systems and procedures, allocation of more resources to technological innovation and product development, and ensuring compliance with regulations set by authorities such as OJK and Bank Indonesia, reducing the risk of sanctions due to violations. On a larger scale, operational efficiency contributes directly to the overall financial system's stability, enabling banks to empower the economy more effectively by providing low-cost credit and broader financial services. Overall, operational efficiency is essential for Indonesian banks to compete more effectively, function optimally, and contribute positively to Indonesia's economy.

Highly efficient banks can be indicated by their low-cost services, fast processes, and optimal results for shareholders. Therefore, one way to measure bank efficiency is by calculating the cost-to-income ratio. Additionally, many studies aim to analyze bank efficiency and performance using various frontier efficiency methods, such as stochastic frontier analysis (SFA), data envelopment analysis, and thick frontier analysis. Typically, these studies analyze the relationship between bank efficiency and bank ownership, mergers and acquisitions, or regulations/deregulations.

Banking industry efficiency is a popular performance parameter used for measurement. Efficiency measurements are often used to address difficulties in calculating performance metrics. Calculating a company's profitability is usually used to show good performance results, but this calculation sometimes does not meet the criteria for a healthy bank from Bank Indonesia's regulations. The Indonesian banking industry is heavily regulated by Bank Indonesia's regulations, which also serve as performance criteria for the Indonesian banking world. Regulations on the Capital Adequacy Ratio (CAR), Reserve Requirement, Legal Lending Limit, and the credibility of bank managers are examples of regulations that also serve as performance criteria in the Indonesian banking world. Banking industry efficiency can be measured using parametric methods, specifically Stochastic Frontier Analysis (SFA) and Distribution Free Analysis (DFA) (Hadad, 2003). This study will use parametric methods with the SFA approach to analyze the cost efficiency levels of banks listed on the Indonesia Stock Exchange. The assessment of banking cost efficiency is based on the value of costs incurred by a specific bank compared to the costs incurred by the best-practice banks.

This study aims to analyze the significance or correlation between the bank's leverage ratio and its efficiency performance. The leverage ratio can indicate a bank's ability to utilize its capital in generating income growth and profitability. This ratio also shows the economic position of a bank concerning its debt and capital. The calculation of the leverage ratio is obtained by dividing the bank's capital by its total consolidated assets. Capital includes common equity, reserves, retained earnings, and other securities minus goodwill.

A carefully conducted leverage ratio analysis can demonstrate a bank's ability to repay debt and manage funds, as well as indicate the bank's profitability. This analysis can also help determine whether a bank can withstand a financial crisis, the actual impact of which can only be understood when the crisis occurs. Previous studies have not provided a conclusive consensus regarding the effect of the leverage ratio on bank efficiency. Some studies have shown that the leverage ratio negatively affects the efficiency of banking companies, while other studies have shown the opposite. By using more data and different time frames, the researchers hypothesize that the leverage ratio can positively affect the efficiency of banks in Indonesia within certain limits.

Literature Review

This study uses the parametric frontier method to measure bank efficiency. In the parametric approach, to observe the relationship between costs, accurate information is needed for input prices and other exogenous variables. Knowledge of the precise functional form of the frontier and the structure of the one-sided error, if necessary, and a sufficiently large sample size are required to produce statistically valid conclusions. The non-parametric approach does not use the same information, so the amount of data needed, the assumptions required, and the smaller sample size can be used. However, statistical conclusions cannot be drawn using the non-parametric method (Hadad, 2003). In this approach, the assessment of cost efficiency is based on the value of a firm's costs compared to the best practice firms. In other words, cost efficiency is defined as the ratio between the minimum costs at which a firm can produce a certain amount of output and the actual costs incurred by the firm (Ansari, 2006).

One of these approaches is the Stochastic Frontier Analysis (SFA) approach, as described in the book by Aigner et al. (1977) and further elaborated in the book by Coelli et al. (2005). The SFA approach allows researchers to separate the efficiency component that can be measured from random errors in the data. In this approach, the cost or production model is combined with a stochastic term that represents inefficiency. SFA enables the determination of a bank's relative efficiency and also accounts for the uncertainty in these estimates. Therefore, this approach is a parametric method that has recently been frequently used in measuring efficiency, particularly in the context of production and costs. Efficiency analysis using this approach can provide deep insights into the efficiency of one bank compared to another.

Another approach within the parametric frontier methodology is Dynamic Stochastic Frontier (DSF). The DSF approach is an econometric approach that can be used to model bank efficiency over a long period. DSF combines elements from two main approaches: the Stochastic Frontier Model (SFM) and dynamic models. This approach is dynamic because it considers time variation in the data. The advantage of the DSF approach is its ability to capture the dynamics of the efficiency of an economic unit over time, providing better insights than a static model. In its application, this approach requires sufficient time series data to produce accurate results.

According to Huang et al. (1999), there are several reasons why this method can yield better results than the SFA method. The first reason is that the DSF method considers dynamics in data processing. Various dynamic considerations in the included variables allow for more biased and less stable efficiency estimates.

The second reason is that the DSF analysis can address heterogeneity between banks by considering individual factors such as technology used, production scale, and input quality. The third reason is that DSF analysis can explicitly consider uncertainty in the data, such as noise and measurement errors. This is related to the next reason, which is the ability of DSF to predict future efficiency. For these reasons, DSF analysis generally produces more stable efficiency estimates compared to SFA analysis, especially when data is limited.

This study will use the efficiency obtained from these two parametric frontier approaches to determine the significance of the leverage ratio. However, to achieve a more comprehensive and accurate analysis of the relationship between leverage ratio and bank efficiency, this study employs additional control variables based on existing banking theories. Based on the loan management theory, which explains that good loan management can also increase capital adequacy and optimize capital use, this study selects the Loan to Asset Ratio (LAR). Based on the Pecking Order theory regarding the order of preference in funding sources, this study selects bank size. Finally, based on the Trade-Off theory regarding the optimization of income and costs, this study selects Return on Assets (ROA) and Cost to Asset Ratio (CR). Each of these additional control variables has been proven to be significant to bank efficiency according to the majority of previous studies.

RESEARCH METHOD

The data used for this research includes secondary data, namely balance sheet and income statement reports for each quarter from banks in Indonesia whose data is publicly available, both those recognized nationally and those not included in such nominations. The researcher uses data from 47 banking companies listed under the supervision of the Financial Services Authority (OJK). Eikon Refinitiv was used in this study to obtain data from these 47 banks for the period 2008-2023. This study also uses data from related banks' financial reports to complement the data obtained from Refinitiv.

This study employs long-term analysis. Research by Berger et al. (1997) emphasizes the importance of using long-term studies in banking research. According to this research, long-term studies allow researchers to analyze changes in regulations, technology, and banking business strategies that influence bank efficiency over time. Studies by these authors generally use data over periods of 10 to 15 years. Therefore, this study also adopts a time frame between 10 to 15 years. Specifically, this study uses a 15-year period from 2008 to 2023. The year 2023 was chosen because it is the last year before this research was conducted, ensuring that bank data is available.

This study sets the time frame from 2008 to 2023. The year 2008 was chosen as the starting point because of the global economic crisis that occurred that year. BASEL III was developed in response to the 2008 global financial crisis. This event resulted in many banks experiencing a decline in efficiency due to decreased profitability, increased operational costs, changes in business strategies, and reduced investor confidence. Consequently, Indonesian banks faced an increase in non-performing loans, a decline in credit demand, and financial market volatility. Since 2008 marked a period where banks experienced low efficiency, starting from that year, these banks have continuously struggled to improve their efficiency, making it interesting to analyze their progress. The period from 2008 to 2023 also saw the issuance of many new banking regulations that affected changes in the banking industry in Indonesia, making the growth of bank efficiency during this period increasingly interesting to explore.

The banks selected as samples for this study are those listed on the Indonesia Stock Exchange (IDX) since 2018. There is a requirement for the company's age to go public on the Indonesia Stock Exchange (IDX), which is regulated in the Financial Services Authority Regulation (POJK) No. 1/POJK.04/2020 regarding the Issuance of Equity Securities and Listing of Securities on the Stock Exchange. This regulation states that a company must have a minimum of 3 years of operational history in the same core business field before it can go public on the IDX. In accordance with this regulation, the banking companies whose data are used have been operating for at least the minimum duration required for long-term analysis, which is 10 years before 2023. Although the DSF method has the ability to handle imbalances in panel data, this time frame selection was made to minimize panel data imbalance. The banks in this study are also a mix of various banks with different criteria, representing the overall banking sector in Indonesia.

This study consists of two stages. In the first stage, it applies the Dynamic Stochastic Frontier (DSF) and Stochastic Frontier Analysis (SFA) approaches to analyze the efficiency of banks in Indonesia. In the second stage, this study uses multiple regression methods to determine the significance of the leverage ratio on bank efficiency obtained from the first stage.

In the first stage, the approach used is the intermediation approach by Sealey and Lindley (1977), which is widely used in studies on banking performance. According to this approach, banks are viewed as financial intermediaries that gather funds/collect deposits and other funds and transform them into loans and other income-generating assets using capital and labor. The intermediation approach views deposits as inputs that are treated as outputs in the production and value-added approach. The intermediation approach considers all types of loans as inputs and production and value-added as outputs.

This study follows the research by Almanidis et al. (2019). The model used in that research is a multi-input and multi-output translog stochastic output distance frontier. The researcher uses data with first-degree homogeneity on output and adds relevant error conditions, namely symmetric error $\varepsilon_{i,t}$ and one-sided inefficiency $u_{i,t} \geq 0$. By defining the output distance function, the model used for this study is:

$$y^*_{1,i,t} = \sum_{m=2}^{M} \boldsymbol{\alpha_m} \left(\boldsymbol{k_{i,t}}\right) y^*_{m,i,t} + \sum_{j=1}^{J} \boldsymbol{\beta_j} \left(\boldsymbol{k_{i,t}}\right) x^*_{j,i,t} + \frac{1}{2} \sum_{m=2}^{M} \sum_{n=2}^{N} \boldsymbol{\alpha_{mn}} \left(\boldsymbol{k_{i,t}}\right) y^*_{m,i,t}\ y^*_{n,i,t} + \frac{1}{2} \sum_{j=1}^{J} \sum_{l=1}^{L} \boldsymbol{\beta_{jl}} \left(\boldsymbol{k_{i,t}}\right) x^*_{j,i,t}\ x^*_{l,i,t} + \sum_{j=1}^{J} \sum_{m=2}^{M} \boldsymbol{\delta_{jm}} \left(\boldsymbol{k_{i,t}}\right) x^*_{j,i,t}\ y^*_{m,i,t} + \mu_{\boldsymbol{i,t}} + \boldsymbol{\varepsilon_{i,t}} \quad (1)$$

Where $y^*_{m,i,t}$ is the m[th] output variabel dan $x^*_{j,i,t}$ is j[th] the input variable for bank i at time t. $\alpha(\boldsymbol{k_{i,t}})$, $\beta(\boldsymbol{k_{i,t}})$, and $\delta(\boldsymbol{k_{i,t}})$ are specific parameters to describe transient production technology . $(\boldsymbol{k_{i,t}})$ is the variable that determines the classification group of bank i at time t.. $y^*_{1,i,t}$ is the natural logarithm of $Y_{1,i,t}$ or $y^*_{1,i,t}$ = ln $Y_{1,i,t}$. $y^*_{m,i,,t}$ = ln ($Y_{m,i,t}/Y_{1,i,t}$), $x_{j,i,t}$ = ln $X_{j,i,t}$ dan $x_{1j,i,t}$ = ln $X_{1j,i,t}$.. $\mu_{i,t} = \alpha_{0t}$ ($k_{i,t}$) + $u_{i,t}$ is the intersection of bank i at time t. $\boldsymbol{\varepsilon_{i,t}}$ represents the inefficiency of the bank.

The sum of the absolute values of the partial input ($\sum_j |\partial \ln D_{i,t}/\partial \ln X_{j,i,t}| \geq 0$) provides an indication of scale elasticity in the context of the output distance function specification. A bank will show whether returns to scale are increasing, constant, or decreasing over a certain period based on whether this measure is greater than, equal to, or less than one.

Using the same inputs as Almanidis et al. (2019), the inputs used in this study include: Non-Interest Deposits (X1), which are all funds deposited in the bank that do not earn interest for the owner. Other Deposits (X2), which are the total of interest-bearing deposits and other deposits. Full-Time Employees (X3), which is the total number of people working for the bank with full-time status. Capital (X4), which is the total amount of funds available to the bank after deducting liabilities and assets. Total Short-Term Borrowings (X5), which is the total amount of loans or debts that must be repaid by the bank in the short term (usually within one year or less).

The outputs used in this study include: Gross Loan (Y1), which is the total of short-term and long-term loans, both to individuals, organizations, and other banks. Due to data limitations, loans are not separated into personal loans, corporate loans, and real estate loans, but are combined into gross loans. Instead, this study uses an additional output, securities (Y2), which are financial investments held by the bank including stocks, bonds, and other financial instruments owned by the bank for investment or trading purposes.

The existing data is processed by excluding observations with null values and obvious errors. After this elimination process, the data obtained consists of 47 banks and 2,156 observations from 2008 to 2023.

In the second stage of this study, the input variables will be compared with the efficiency obtained from the efficiency analysis in the first stage. In the second stage, this study uses the multiple linear regression method. This method is used to model the relationship between one dependent variable or output variable and six independent variables or input variables. The main purpose of this method is to predict the value of the output variable based on the values of the input variables and to understand the significance and direction of the relationships between these variables. In the second stage of this study, multiple linear regression uses the following mathematical linear equation model:

$$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6 + \epsilon \qquad (2)$$

Where Y is the output variable (dependent variable) and X_1-X_6 are the input variables (independent variables). β_0 is the intercept value (constant). β_1-β_6 are the regression coefficients that indicate the average change in the output variable for each unit change in the input variables, assuming the other variables remain constant. ϵ is the error term representing other variables not included in the model and other random factors.

The regression coefficients (β) are estimated using the Ordinary Least Squares (OLS) method. The OLS method aims to minimize the sum of the squares of the differences between the actual values and the values predicted by the model (residuals).

$$Minimize \sum_{i=1}^{m} \left(Y_i - \hat{Y}_i\right)^2$$

Where m is the number of observations, Y_i is the true value, and $\hat{Y}_i$ is the value predicted by the model.

This study focuses primarily on the significance of the leverage ratio on bank efficiency. Therefore, the leverage ratio is the main input in this research. Other input variables are selected based on banking theories to support the main variable, such that the input variables in the second stage of this study include: BASEL Leverage Ratio or Tier 1 Capital Ratio (X_1), which is the proportion of core capital (Tier 1 capital) to total bank exposure, covering assets on the balance sheet and off-balance sheet exposure. Debt to Equity Ratio (X_2), which is the proportion of debt to total bank equity. Loan to Asset Ratio (X_3), which is the proportion of loans to bank assets. Size (X_4), or bank size reflected by the value of bank assets. Return on Asset (X_5), which is the proportion of earnings to bank assets. Cost to Asset Ratio (X_6), which is the proportion of bank operational costs to operational earnings.

This study focuses on the significance of independent variables on bank efficiency. Therefore, the output variable or dependent variable used in this second stage is bank efficiency (Y), which was previously calculated through DSF analysis and SFA in the first stage of this research.

RESULT AND DISCUSSION

Table 1 Bank Efficiency and Ratios

variable	Mean	Std. Dev.	Max	Min
TE-DSFM	52.2663%	25.2243%	96.9304%	0.0003%
TE-SFA	45.1347%	21.1970%	95.7626%	0.0023%
Tier 1 Capital Ratio	15.9193%	10.1168%	94.3890%	2.2699%
DER	683.0073%	336.2779%	4305.4594%	5.9446%
LAR	62.0570%	11.9745%	87.7661%	7.0696%
size	17.3507	1.75358	21.4999	13.4070
ROA	0.2037%	0.7567%	2.7518%	-11.4021%
CR	0.9734%	0.7567%	6.8793%	-2.6820%

Table 1 presents descriptive statistics for various bank metrics, including mean, median, standard deviation, minimum, and maximum values. For technical efficiency obtained using the Dynamic Stochastic Frontier (DSF) method, the average value reaches 52.2663% with a standard deviation of 25.2243 percentage points, a maximum value of 96.9304%, and a minimum value of 0.0003%. The error coefficient obtained is 17.8137%. Similar results are observed for technical efficiency obtained using the Stochastic Frontier Analysis (SFA) method, with an average value reaching 45.1347%, a standard deviation of 21.1970 percentage points, a maximum value of 95.7626%, and a minimum value of 0.0023%.

The leverage ratio (Tier 1 Capital Ratio), calculated by dividing total capital by total assets, has an average value of 15.9193%, a standard deviation of 10.1168%, a maximum value of 94.3890%, and a minimum value of 2.2699%. The Debt to Equity Ratio, obtained by dividing total liabilities by total equity, has a much higher average value of 680.0073% with a standard deviation of 336.2779%. The maximum value reaches 4,305.4594%, while the minimum value is 5.9446%.

The Loan to Asset Ratio, obtained by dividing total gross loans by total bank assets, has an average value of 62.0570%, a standard deviation of 11.9745%, a maximum value of 87.7661%, and a minimum value of 7.0696%. Bank size, measured by the natural logarithm of assets, has an average value of 17.3508 with a standard deviation of 1.7536. The maximum value is 21.4999, and the minimum value is 13.4071.

The Return on Assets, obtained by dividing net profit by total bank assets, has an average value of 0.2037% with a standard deviation of 0.7567%. The maximum value reaches 2.7518%, while a negative value of -11.4021% indicates that the bank experienced a loss in that period. Finally, the Cost to Asset Ratio, obtained by dividing operational costs by bank operational income, has an average value of 0.9734% with a standard deviation of 0.7567%. The maximum value is 6.8793%, and negative values, such as -2.682%, are likely caused by accounting adjustments like receipt of subsidies or grants related to operational costs.

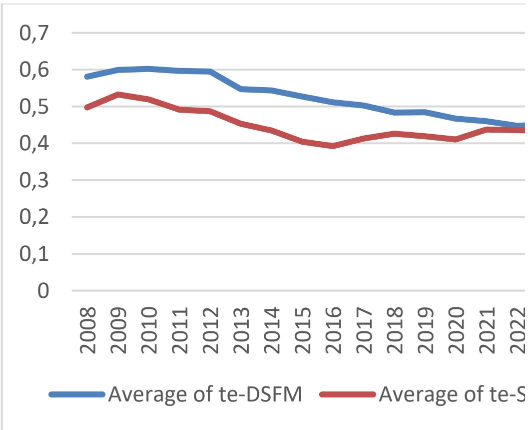

Figure 1 Development of Bank Efficiency

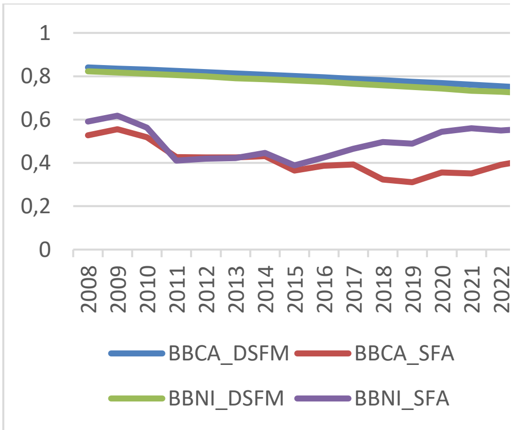

Figure 2 Development of BBCA and BBNI Efficiency

Figure 1 shows the comparison of the average technical efficiency of Indonesian bank firms calculated using the Dynamic Stochastic Frontier (DSF) and Stochastic Frontier Analysis (SFA) methods. Although both methods show a downward trend in average technical efficiency over the past 15 years, it can be seen that the average technical efficiency calculated using the DSF method is consistently higher and more stable compared to the average technical efficiency calculated using the SFA method.

This is also reflected in the individual technical efficiency of each firm in Figure 2. In this study, the efficiency analysis results calculated using the DSF method tend to be higher and more stable compared to the SFA method. This is in line with the findings of Huang et al. (1999) who suggest that the DSF method is superior for analyzing technical efficiency due to its ability to:

Table 2 Regression Results for Determinants of Bank Efficiency (DSF)

te_dynamic	Coeff icient	Std. err.	t	P>|t|
Tier 1 Capital	-0.2960	0.0565	-5.23	0
DER	0.02491	0.0016	15.42	0
LAR	-0.6589	0.0322	-20.42	0
size	0.0708	0.0022	31.22	0
ROA	2.9382	0.5124	5.73	0
CR	-2.7377	0.6054	-4.52	0
constant	-0.4004	0.0496	-8.07	0

Table 3 Regression Results for Determinants of Bank Efficiency (SFA)

te_frontier2	Coefficient	Std. err.	t	P>|t|
Tier 1 Capital	-0.2652	0.0607	-4.37	0
DER	0.0184	0.0017	10.62	0
LAR	-0.2696	0.0346	-7.79	0
size	0.0076	0.0024	3.13	0.002
ROA	1.1929	0.5499	-2.17	0.03
CR	-8.2533	0.6496	-12.7	0
constant	0.4856	0.0532	9.13	0

Multiple regression analysis was conducted using leverage ratio, debt-to-equity ratio (DER), loan-to-asset ratio (LAR), bank size, return on assets (ROA), and cost to asset ratio (CR) as independent variables and bank efficiency as the dependent variable. The results showed a P-value of 0.00, an R-squared value of 0.5388, and an adjusted R-squared value of 0.5375. The P-value tests the statistical significance of each coefficient. A P-value less than 0.05 allows us to reject the null hypothesis that all regression coefficients are equal to zero. This indicates that the model as a whole is statistically significant and that at least one independent variable is related to bank efficiency.

R-squared is the coefficient of determination that measures the proportion of variation in the output variable explained by the model. In this model, the R-squared value explains 0.5388 or 53.88% of the variation in bank efficiency. Adjusted R-squared is the adjusted coefficient of determination that considers the number of input variables in the model. In this model, its value is 0.5375 or 53.75%.

Homoscedasticity testing using residual plot against fitted values shows a linear relationship within the spread boundaries with a negative direction. Normality testing shows a P value of 0.00, indicating no violation of the normality assumption even though the distribution of random data does not form a pattern.

Multicollinearity testing using Variance Inflation Factor (VIF) shows an average of 1.50, indicating that on average, each input variable does not experience multicollinearity with each other. The VIF values of each input variable are also less than 10, proving that there is no multicollinearity in each input in this research model.

The model and inputs used in this study have passed the basic assumptions testing of multiple regression, thus meeting the requirements for testing their significance on bank efficiency.

Significance of Leverage Ratio on Efficiency

Leverage ratio is one of the most important financial analysis tools for measuring a company's ability to meet its debt obligations. This ratio indicates how much of a company's assets are financed by debt compared to equity from the bank itself. A high leverage ratio indicates that a bank is riskier because it relies heavily on debt to fund its operations. If there is a decline in profitability, the bank may have difficulty repaying its debts. However, banks with high leverage ratios are attractive to investors seeking high potential returns with greater risk.

While there is potential for harm to banks, many studies have found that companies with an optimal leverage ratio can increase their company value. However, excessive leverage can decrease a company's value in the Indonesian capital market. Research by Maulidiani et al., (2018) found that the optimal leverage ratio range is 30% to 50%. Companies with a leverage ratio below 30% are unprofitable because a lack of funds limits the company's ability to finance its growth. While companies with a leverage ratio above 50% bear the company's financial risk and can decrease the company's value.

In the results from the significance testing of the Tier 1 Capital Ratio on bank efficiency analyzed using the DSF method, the t-test produced a p-value smaller than α (the chosen significance level of 0.05), with a very small value of 0.00. This indicates that the leverage ratio is a statistically significant variable. This means that the related input has a significant influence on the output. However, the coefficient of the Tier 1 Capital Ratio is -0.29603. A negative coefficient indicates that the relationship between the leverage ratio and bank efficiency is negative. This means that for every 1 unit increase in the Tier 1 Capital Ratio, bank efficiency decreases by 0.29603.

In the results from the significance testing of the leverage ratio on bank efficiency analyzed using the SFA method, the t-test also produced a p-value smaller than α (the chosen significance level of 0.05), with a very small value of 0.00. This indicates that the leverage ratio is a statistically significant variable. This means that the related input has a significant influence on the output. The coefficient of the Tier 1 Capital Ratio is -0.2652815. A negative coefficient indicates that the relationship between the leverage ratio and bank efficiency is negative. This means that for every 1 unit increase in the Tier 1 Capital Ratio, bank efficiency decreases by 0.2652815.

To further explore the significance, this study uses scatter plot graphs to help visualize the relationship between these variables and efficiency as obtained through both DSF and SFA analyses.

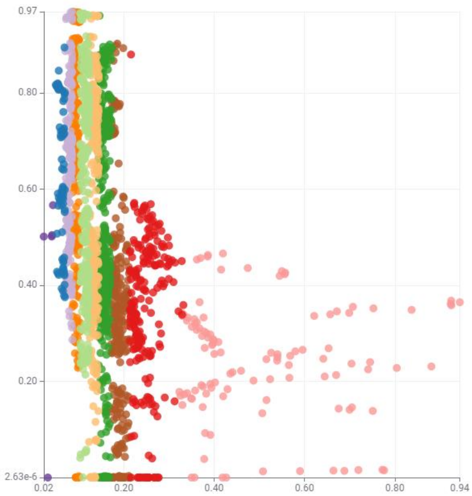

Figure 4 DSF Efficiency/ Tier 1 Capital Ratio

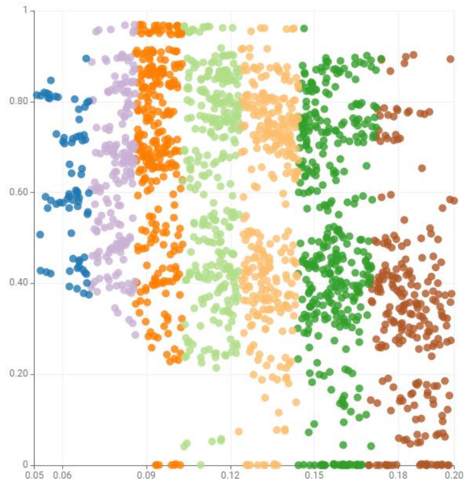

Figure 5 DSF Efficiency/ Tier 1 Capital Ratio (zoomed)

Figure 4 and Figure 5 depict the distribution of bank efficiency analyzed using the DSF method (vertical axis) at various levels of the leverage ratio (horizontal axis). In using scatter plot analysis, a clear and directional pattern on the scatter plot graph indicates a significant relationship between input and output, demonstrating the significance of the input. Overall, the scatter plot graph shows a negative relationship between bank efficiency and the Tier 1 Capital Ratio. This means that a higher leverage ratio tends to lower bank efficiency. This can be seen from the data trend, which decreases from right to left.

By examining the scatter plot graph more deeply, it was found that although bank efficiency and the Tier 1 Capital Ratio have a negative relationship, this relationship does not apply at leverage ratio levels below 5% because the maximum efficiency value increases before and after the 5% mark. The leverage ratio reaches around 14%, where the maximum efficiency value begins to decline. The decline continues drastically at a leverage ratio value of 20%. When looking at the minimum efficiency value, banks have the highest minimum efficiency value at a leverage ratio of 5%, and this trend continues to decline in the leverage ratio range of 12% to 20%.

These observations indicate that banks can achieve a relatively high efficiency range within the Tier 1 Capital Ratio range of 5% to 12%. The scatter plot graph shows that banks can attain the highest maximum efficiency value within the Tier 1 Capital Ratio range of 8% to 14% and can still achieve a high maximum efficiency value up to a Tier 1 Capital Ratio of 20%, but with the offsetting risk of the lowest minimum efficiency.

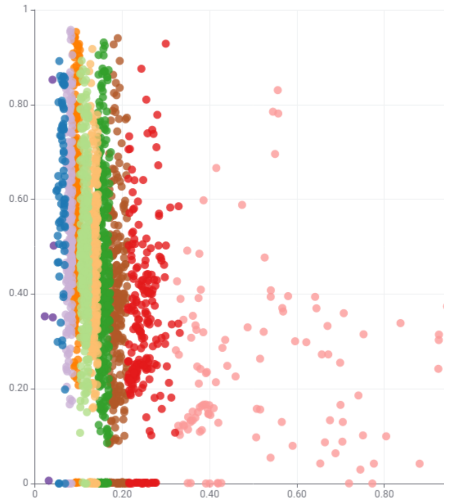

Figure 6 SFA Efficiency/ Tier 1 Capital Ratio

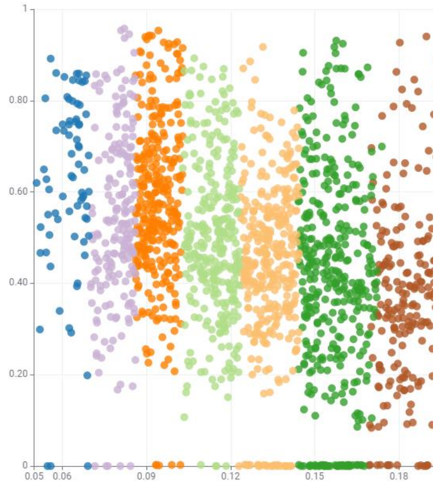

Figure 7 SFA Efficiency/ Tier 1 Capital Ratio (zoomed)

Figure 6 and Figure 7 depict the distribution of bank efficiency analyzed using the SFA method (vertical axis) at various levels of the leverage ratio (horizontal axis). The scatter plot distribution resembles that of the scatter plot distribution of bank efficiency analyzed using the DSF method at various Tier 1 Capital Ratio levels. Overall, this scatter plot also shows a negative relationship between bank efficiency and the Tier 1 Capital Ratio, meaning that a higher Tier 1 Capital Ratio tends to lower bank efficiency. This can be seen from the data trend, which decreases from right to left. However, the distribution on this graph shows a more uneven spread with both maximum and minimum efficiency trends being lower.

By examining the scatter plot graph more deeply, it was found that although bank efficiency and the Tier 1 Capital Ratio have a negative relationship, this relationship does not apply at Tier 1 Capital Ratio levels below 5% because the maximum efficiency value increases before and after the 5% mark until the Tier 1 Capital Ratio reaches around 10%, where the maximum efficiency value fluctuates. This fluctuation stops and declines drastically at a Tier 1 Capital Ratio of 20%. Unlike the previous graph, in this graph, there are still a few banks that can achieve relatively high maximum efficiency up to a Tier 1 Capital Ratio of 57%. When looking at the minimum efficiency value, banks have the highest minimum efficiency value at a leverage ratio of 5%, and this trend continues to decline up to a Tier 1 Capital Ratio of 70%. However, at almost every Tier 1 Capital Ratio value, there are banks with very low efficiency values, even reaching 0%.

This scatter plot also shows that banks can achieve a relatively high efficiency range within the Tier 1 Capital Ratio range of 5% to 10%. The scatter plot shows that banks can still attain the highest maximum efficiency within the Tier 1 Capital Ratio range of 8% to 9% and can still achieve a high maximum efficiency up to a Tier 1 Capital Ratio of 20%, with some outlier cases achieving relatively high maximum efficiency up to a leverage ratio of 57%. However, it should be noted once again that the overall efficiency trend continues to decline.

This study shows that the Tier 1 Capital Ratio significantly affects bank efficiency. The Tier 1 Capital Ratio can have a positive impact within the 5% to 15% range, but overall, it has a negative impact on bank efficiency.

1. Significance of Debt to Equity Ratio on Bank Efficiency

Testing the Debt to Equity Ratio using the regression method showed a significant effect on bank efficiency, as evidenced by the t-test results. The t-test yielded a p-value smaller than α (the chosen significance level of 0.05), with a very small value, close to 0. This indicates that the Debt to Equity Ratio is a statistically significant variable affecting bank efficiency in both the DSF efficiency model and the SFA efficiency model.

The coefficient of the DER on bank efficiency calculated using the DSF method is 0.0249. The coefficient of the DER on bank efficiency calculated using the SFA method is 0.0184. This indicates that for every 1 unit increase in DER, bank efficiency increases by 0.0249 using the DSF method and by 0.0184 using the SFA method. This means that DER has a smaller significance compared to the leverage ratio on bank efficiency.

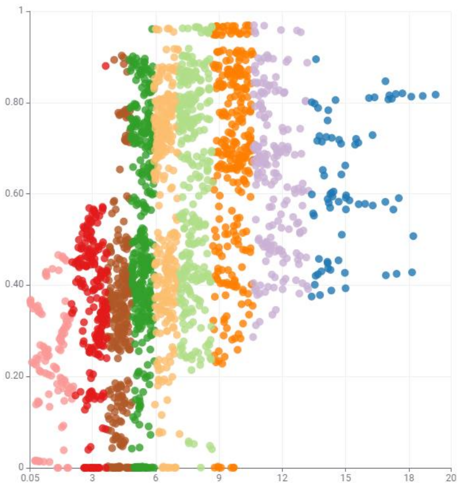

Figure 8 DSF/DER Efficiency

The distribution of the Debt to Equity Ratio against bank efficiency on the scatter plot shows a clear and directional pattern. This indicates that the Debt to Equity Ratio has a significant relationship as an input for bank efficiency. Unlike the leverage ratio, which has a negative relationship with bank efficiency, overall, the scatter plot shows a positive relationship between bank efficiency and the Debt to Equity Ratio. This means that a higher Debt to Equity Ratio tends to increase bank efficiency. This can be seen from the data trend, which increases from right to left.

By examining the scatter plot more deeply, it was found that because bank efficiency and the Debt to Equity Ratio have a positive relationship, the maximum efficiency value continues to rise from a Debt to Equity Ratio of 5% until reaching its peak around a Debt to Equity Ratio of 600%. The maximum efficiency value remains stable until the Debt to Equity Ratio reaches around 1200% before starting to decline. The decline from the maximum efficiency value then levels off at a Debt to Equity Ratio of around 1600% and remains relatively stable until a Debt to Equity Ratio of 1900%.

The minimum value of bank efficiency also increases. Within the Debt to Equity Ratio range of 6% to 9%, the minimum efficiency value begins to rise. On the scatter plot, the minimum efficiency value continues to increase up to a Debt to Equity Ratio of 2000% and keeps increasing, although the trend begins to level off.

This study shows that the DER has a significant impact on bank efficiency. Overall, the DER positively affects bank efficiency, consistent with the findings of Agustian, A. (2017), and Athanasoglou et al. (2008). However, this study shows that the optimal DER range is between 600% and 1200%.

Significance of Loan to Asset Ratio on Bank Efficiency

Testing the Loan to Asset Ratio using the regression method showed a significant effect on bank efficiency, as evidenced by the t-test results. The t-test yielded a p-value smaller than α (the chosen significance level of 0.05), with a very small value, close to 0. This indicates that the Loan to Asset Ratio is a statistically significant variable affecting bank efficiency in both the DSF efficiency model and the SFA efficiency model.

The coefficient of the LAR on bank efficiency calculated using the DSF method is -0.6589. The coefficient of the LAR on bank efficiency calculated using the SFA method is -0.2696. This indicates that for every 1 unit increase in LAR, bank efficiency decreases by 0.6589 using the DSF method and by 0.2696 using the SFA method. The significantly negative LAR coefficient values align with previous studies, such as those by (Van Nguyen et al., 2022).

Significance of Bank Size on Bank Efficiency

Testing the size of the bank using the regression method showed a significant effect on bank efficiency, as evidenced by the t-test results. The t-test yielded a p-value smaller than α (the chosen significance level of 0.05), with a very small value, close to 0. This indicates that bank size is a statistically significant variable affecting bank efficiency in both the DSF efficiency model and the SFA efficiency model.

The coefficient of bank size on bank efficiency calculated using the DSF method is 0.0708. The coefficient of bank size on bank efficiency calculated using the SFA method is 0.0076. This indicates that for every 1 unit increase in bank size, bank efficiency increases by 0.0708 using the DSF method and by 0.0076 using the SFA method.

The scatter plot graph also shows a positive trend between bank size and bank efficiency (DSF). Starting from a company size range of 13 to 19, the scatter plot distribution continues to increase and peaks in the range of 19 to 20. However, there is a decline thereafter. The scatter plot also shows a group of banks with the highest efficiency in the bank size range of 15 to 17, but efficiency decreases thereafter.

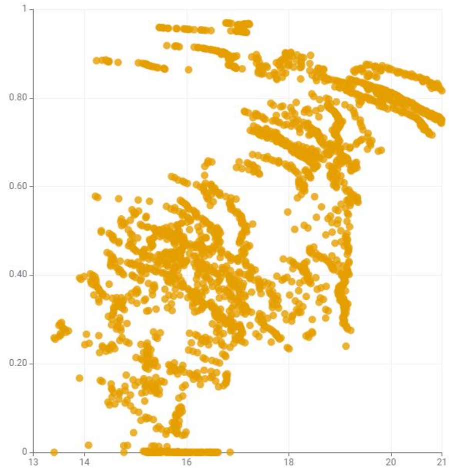

Figure 9 DSF Efficiency/ Size

This study shows that bank size has a significant impact on bank efficiency. Overall, bank size positively affects bank efficiency, consistent with the findings of Almanidis et al. (2019), Hasan et al. (2016), and Beck et al. (2000). However, this study shows that the optimal bank size is in the range of 19 to 20. Banks with a size greater than 20 may have a negative relationship with bank efficiency.

Significance of Return on Assets on Bank Efficiency

Testing the Return on Assets using the regression method showed a significant effect on bank efficiency analyzed using the DSF method, as evidenced by the t-test results. The t-test yielded a p-value smaller than α (the chosen significance level of 0.05), with a very small value, close to 0. For testing efficiency analyzed using the SFA method, the p-value obtained was 0.03. This value is relatively larger but still smaller than the 0.05 threshold. This indicates that Return on Assets is a statistically significant variable affecting bank efficiency in both the DSF and SFA efficiency models.

The coefficient of ROA on bank efficiency calculated using the DSF method is 2.938. This indicates that for every 1 unit increase in ROA, bank efficiency increases by 2.938 using the DSF method. Meanwhile, the coefficient of ROA on bank efficiency calculated using the SFA method is 1.1929. This indicates that for every 1 unit increase in ROA, bank efficiency changes by 1.1929. This shows a significantly positive relationship between ROA and bank efficiency. Therefore, the results of this study are consistent with the research by (Muhlis et al., 2021).

Significance of Cost to Asset Ratio on Bank Efficiency

Testing the Cost to Asset Ratio using the regression method showed a significant effect on bank efficiency, as evidenced by the t-test results. The t-test yielded a p-value smaller than α (the chosen significance level of 0.05), with a value of 0.00 in testing efficiency using both the DSF and SFA methods. This indicates that the Cost to Asset Ratio is a statistically significant variable affecting bank efficiency in both the DSF and SFA efficiency models.

The coefficient of CR on bank efficiency calculated using the DSF method is -2.737757. This indicates that for every 1 unit increase in CR, bank efficiency decreases by 2.737757 using the DSF method. Meanwhile, the coefficient of CR on bank efficiency calculated using the SFA method is -8.2534. This indicates that for every 1 unit increase in CR, bank efficiency decreases by 8.2534. This shows a significantly negative relationship between CR and bank efficiency. Therefore, the results of this study are consistent with the research by Sari et al. (2020) and Khan et al. (2018).

CONCLUSION

This study was conducted with the aim of analyzing the efficiency of banks in Indonesia and the significance of the leverage ratio in preparation for the implementation of BASEL IV. In this research, testing was carried out using a two-stage analysis. The first stage involved testing using the stochastic frontier estimation method (SFA) and Dynamic Stochastic Frontier (DSF) to assess the efficiency levels of banking companies. The results of the study indicate that, on average, banks in Indonesia have not yet achieved maximum cost efficiency, as reflected in the average efficient score of 52.2663%.

In the second stage, testing was conducted to analyze the factors of ratios that have significance on the efficiency of banking companies using multiple regression methods with several tests such as linearity, multicollinearity, and scatter plots. The results of regression and multicollinearity show that Tier 1 Capital Ratio and Debt to Equity Ratio have a significant impact on bank efficiency. Tier 1 Capital Ratio has a negative effect on efficiency, meaning that an increase in Tier 1 Capital Ratio leads to a decrease in bank efficiency. Meanwhile, Debt to Equity Ratio has a positive relationship with bank efficiency, so an increase in DER will also increase bank efficiency. However, using scatter plots, both leverage ratio and Debt to Equity Ratio also have significant distribution patterns regarding the level of bank efficiency. Both have ranges where their effects contradict the overall impact.

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