ANALYSIS OF BANKING INDUSTRY PERFORMANCE EFFICIENCY IN INDONESIA USING PARAMETRIC AND NONPARAMETRIC METHODS

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ABSTRACT

This research aimed to measure the efficiency performance of the banking industry in Indonesia by using parametric and nonparametric methods, as measured by the stabilization of bank performance efficiency based on the time series from year to year and to identify which variables to the value of efficiency. The analytical method applied the parametric method with cross section approach of Stochastic Frontier Analysis (SFA) while for nonparametric method used intermediation approach from Data Development Analysis (DEA) CRS and VRS model. The data of this research was the financial statements of banks listed on the stock exchange for the period 2012-2016 with 29 databanks processed with the help of Stata 12. From the results of the analysis using the three measures of efficiency, it is known that the efficiency value with Cross Section Stochastic Frontier Analysis shows a stable and high efficient conditions for all banks. While nonparametric methods show different efficiency levels for each bank, which with DEA CRS model not all banks show an efficient performance, only 26,90% on average each year banks have efficient performance, and 99,31% of banks perform efficiently according to VRS model.

Keywords: *performance, efficiency, Stochastic Frontier Analysis (SFA), Data Development Analysis (DEA)*

INTRODUCTION

Performance appraisal is an important thing that must be conducted either by management, shareholder or employees that achieve company goals. Banking as an intermediary institution or as a supporter in the financing system (Republik Indonesia, 1998) needs to maintain prudence in managing and maintaining risks so that business processes can be run, on a sustainable basis and the national economy can be maintained properly. Therefore, performance assessment of financial condition becomes the most crucial and must be conducted so that unhealthy financial condition can be identified and detected earlier.

Efficiency is one of the performance parameters that underlie all the organizational performance, including banking. Muazaroh et al. (2012) define the efficiency as an organizational ability to maximize output by using certain inputs or using minimal inputs to produce output. This agrees with research described by Gordo in Muljawan et al. (2014) that efficiency is the ratio between input and output. This measure refers to technical or operational efficiency that reflects a company's ability to obtain optimal output from an input used, or vice versa, a company's ability to utilize at least an input to produce a certain amount of output. The more efficient the banking operations, the higher the income or profit of the banking and the more competitive.

In the assessment of the efficiency of banking performance, it can be done through the traditional approach and frontier approach. A traditional approach is an approach that uses Index

Number or Ratio, such as Return on Asset (ROA), Capital Adequacy Ratio (CAR), and Profitability Ratio. While the frontier approach is an approach based on the optimal company behavior that maximizes output or minimizes costs. The frontier approach itself is divided into two methods, namely parametric method and nonparametric method. The parametric method is a method the reckon in the random error and produces statistical inference. For this type of parametric approach, it consists of Stochastic Frontier Approach (SFA) and Distribution Free Approach (DFA). The difference between the two approaches is how to separate the inefficient size of each bank and the random error (Fries & Taci, 2004).

In this research, the parametric method used is the cross-section approach of SFA single equation model for data panel with pooled effect assumption which can be considered as cross-section data (no time). This formula follows the SFA form of equation (2) - (3) of Yekti et al. (2015) as follows where index i = 1, 2, … with n is the number of observation data.

$$\ln TC_i = a_0 + a_1 \ln P_{1i} + a_2 \ln P_{2i} + a_3 \ln Q_{1i} + a_4 \ln Q_{2i} + v_i - u_i \quad (1)$$

or

$$\ln TC_i = a_0 + a_1 \ln P_{1i} + a_2 \ln P_{2i} + a_3 \ln Q_{1i} + a_4 \ln Q_{2i} \text{ with } e_i = v_i - u_i \quad (2)$$

While to determine the cost efficiency ratio of a bank using cost frontier follow the form of CEFF model equation (2,3) from Rahmawati (2011) as follows:

$$\ln TC_i = a_0 + a_1 \ln P_{1i} + a_2 \ln P_{2i} + a_3 \ln Q_{1,i} + a_4 \ln Q_{2,i} + e_i$$

$$TC_i = \exp\left[a_0 + a_1 \ln P_{1i} + a_2 \ln P_{2i} + a_3 \ln Q_{1,i} + a_4 \ln Q_{2,i} + e_i\right]$$

$$TC_i = \exp\left[a_0 + a_1 \ln P_{1i} + a_2 \ln P_{2,i} + a_3 \ln Q_{1,i} + a_4 \ln Q_{2,i} + e_i\right]$$

Where is

$$\widehat{TC}_I = \exp\left[a_0 + a_1 \ln P_{1,i} + a_2 \ln P_{2,i} + a_3 \ln Q_{1,i} + a_4 \ln Q_{2,i} + e_i\right]$$

$\widehat{TC}_I$ = the alleged value of the SFA model to approximate the TCi value.

The formula of the i-frontier cost for i = 1, 2, ..., n with n is the number of observational data.

$$\mathbf{CEFF}_i = \frac{\widehat{\mathbf{TC}}_{min}}{\widehat{\mathbf{TC}}_i} = \frac{\exp\left[a_0 + a_1 \ln P_{1,i} + a_2 \ln P_{2,i} + a_3 \ln Q_{1,i} + a_4 \ln Q_{2,i} + e_{min}\right]}{\exp\left[a_0 + a_1 \ln P_{1,i} + a_2 \ln P_{2,i} + a_3 \ln Q_{1,i} + a_4 \ln Q_{2,i} + e_i\right]}$$

$$\text{CEFF}_i = \frac{\widehat{\text{TC}}_{min}}{\widehat{\text{TC}}_i} = \frac{\exp\left[a_0 + a_1 \ln P_{1,i} + a_2 \ln P_{2,i} + a_3 \ln Q_{1,i} + a_4 \ln Q_{2,i}\right].\exp[e_{min}]}{\exp\left[a_0 + a_1 \ln P_{1,i} + a_2 \ln P_{2,i} + a_3 \ln Q_{1,i} + a_4 \ln Q_{2,i}\right].\exp[e_i]}$$

$$\mathbf{CEFF}_i = \frac{\widehat{\mathbf{TC}}_{min}}{\widehat{\mathbf{TC}}_i} = \frac{\exp[e_{min}]}{\exp[e_i]} = \frac{c_{min}}{c_i}$$

The nonparametric method can be divided into two approaches, namely Data Envelopment Analysis (DEA) using linear programming and assume there is no random error so that DEA approach produces more production frontier and Free Disposal Hull (FDH). In this research, the nonparametric method used is DEA approach. DEA is a method that measures the efficiency of DMUs by employing linear programming techniques to tightly envelop the input-output vector envelope. DEA allows multiple input-outputs to be considered at the same time without any assumption in the data distribution (Ji and Lee, 2010). In each case, efficiency is measured in a pattern of proportional change in input or output. A DEA model can be divided into two orientations, namely an input-oriented model that minimizes input when given at least the given output level, and an output-oriented model that maximizes output without requiring more observed input values.

It is described in Ji and Lee (2010) that the DEA model is also divided into two approaches from returns to scale by adding weight constraints. Where in the literature mentioned that DEA was originally proposed by Charnes, Cooper, and Rhodes (1978) to measure the efficiency of DMUs with constant returns to scale (CRS) showing that all DMUs operate on their optimal scale. After that Banker, Charnes, and Cooper (1984) introduced a measure of efficiency model with variable returns to scale (VRS) allowing breakdown efficiency in technical efficiency and scale efficiency within DEA.

The efficiency of observation B is defined as for $\theta_{B,input,CRS} = \overline{B_0B_1} / \overline{B_0B}$ the input-oriented DEA CRS model and represents the other one that can obtain the same output by reducing the input by the ratio $1-\theta_{B,input,CRS}$. The efficiency for the output-oriented DEA CRS model is defined as $\theta_{B,output,CRS} = \overline{B_3B} / \overline{B_3C}$ and represents the other one that can obtain the same input by increasing the output by the ratio $1-\theta_{B,output,CRS}$.

Based on the relative efficiency of the input-oriented VRS frontier is defined as $\theta_{B,input,VRS} = \overline{B_0B_2} / \overline{B_0B}$. All efficiency measures of DMU C are the same regardless of orientation due to frontiers.

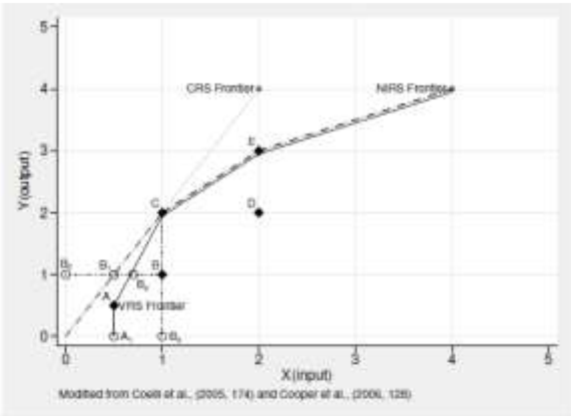

Figure 1 Concepts of Efficiency and *Returns to Scale*
(Source: Ji and Lee, 2010)

This may lead to inefficient CRS technical efficiency in scale efficiency and "pure" technical efficiency. In Figure 1, $\overline{B_2B}$ contribute to technical efficiency from point B by looking at the VRS model, and $\overline{B_1B}$ contribute to technical efficiency from point B by looking at the CRS model; then $\overline{B_1B}$ contribute to measuring scale efficiency. Application of DEA was initially introduced through the ratio form. For each firm, a ratio of all outputs and all inputs is obtained. The optimal weight is obtained by solving the following mathematical programming problems (Coelli et al., 2005):

$$\max_{u,v} \quad z = u'y_j / v'x_j$$

$$\text{subject to}: \quad u'y_j / v'x_j \le 1$$

$$u,v \ge 0$$

In practice, there is a problem in the formula part of the formula that has an infinite solution value. To avoid this, given constraint v'xj = 1. Thus, the formed input-oriented CRS efficiency is defined as (1).

$$\max_{u,v} \quad z = u'y_j \tag{1}$$

$$\begin{aligned} \textit{subject to}: \quad & v'x_j = 1 \\ & -v'X + u'Y \leq 0 \\ & u, v > 0 \end{aligned}$$

A group of observed DMUs is described by DMUj with j = 1, 2, ..., n. The variables xj and yj are the input vectors and the output vectors respectively. The row vectors u and v are the output multiplier and the input multiplier respectively. Form (1) is known as a form multiplier. The matrices X and Y are the input and output matrices, respectively. The purpose of input-oriented DEA is to minimize the actual input, relative to a given actual output, to limit (subject to) constraints that non-DMUs can operate across the set of possible production and constraints associated with non-negative weights. In practiced the most DEA programs are available using a dual form as depicted in (2) in which this model lowers the load calculation and is amount (1) (Ji and Lee, 2010).

$$\min_{\theta,\lambda} \quad \theta \tag{2}$$

$$\begin{aligned} \textit{subject to}: \quad & \theta x_j - X\lambda \geq 0 \\ & -y_j + Y\lambda \geq 0 \\ & \lambda > 0 \end{aligned}$$

where λ is a positive facet vector in Rk and θ is a real variable. The calculation procedure for (2) can be expressed as:

$$\min_{\theta} \quad \theta \tag{3}$$

$$\min_{\theta,s+,s-} \quad \sum -s^{+} - s^{-} \tag{4}$$

$$\begin{aligned} \textit{subject to}: \quad & \theta x_j - X\lambda - s^{-} = 0 \\ & Y\lambda + s^{+} = y_j \\ & \lambda > 0 \end{aligned}$$

where s +, s-, and λ are semipositive vectors in R^k and θ is a real variable. The Model DEA single-stage completes (3), while the two-stage DEA model completes (3) followed by (4) as aconsequences (Ji and Lee, 2010).

The DEA CRS model assumption is appropriate when all firms operate at optimal scales, but imperfect competition (government regulation or financial constraints) may cause a company not to run at an optimum scale. Thus, the DEA CRS model needs to consider also the condition of variable returns to scale (VRS). By using the CRS provisions when all firms are not running at optimal scales, the results in technical efficiency measures (TE) disrupt scale efficiencies (SE). The use of the VRS provision allows the calculation of TE to overcome the SE effect. The linear programming problem of CRS can be easily modified in calculating the VRS form by adding convexity constraint to (2), as to obtain the following linear programming VRS problems (Coelli et al., 2005).

$$\min_{\theta,\lambda} \quad \theta \tag{5}$$

$$\begin{aligned} \textit{subject to}: \quad & \theta x_j - X\lambda \geq 0 \\ & -y_j + Y\lambda \geq 0 \\ & I1'\lambda = 1 \\ & \lambda > 0 \end{aligned}$$

To calculate scale efficiencies (SE), the ratios of technical efficiencies (TE) CRS and technical efficiencies (TE) VRS are used; SE = TECRS / TEVRS. The DEA model is output-oriented in contrast to the DEA input orientation. The following are given the following linear programming problems (Coelli et al., 2005).

- DEA CRS is output-oriented

$$\min_{\phi,\lambda} \quad \phi \tag{6}$$

$$\begin{aligned} \textit{subject to}: \quad & x_j - X\lambda \geq 0 \\ & -\phi y_j + Y\lambda \geq 0 \\ & \lambda > 0 \end{aligned}$$

- DEA VRS output-oriented

$$\min_{\phi,\lambda} \quad \phi \tag{7}$$

$$\begin{aligned} \textit{subject to}: \quad & x_j - X\lambda \geq 0 \\ & -\phi y_j + Y\lambda \geq 0 \\ & I1'\lambda = 1 \\ & \lambda > 0 \end{aligned}$$

Research to measure the efficiency of bank performance has been done by many researchers. Ferrier and Lovell (1990) analyzed the efficiency rates of 575 banks in the US using the SFA and DEA methods, which found that the level of bank efficiency in the US with the DEA method was higher than that of SFA. Hasan and Hunter (1996) have examined the efficiency issue of Japanese multinational banks in the United States, which the results found that the mean SFA efficiency was higher than that of the average TFA efficiency. Fiorentino, Karmann, and Koetter (2006) have conducted cost-efficiency studies on 34.192 universal banks in Germany using the Stochastic Frontier Approach and Data Envelopment Analysis methods, which from the results of his research indicate that the average cost efficiency level substantially higher by SFA compared to DEA. Yassine and Soumia (2016) have examined the effect of certain bank-specific factors; profitability, bank size, and ownership status on differences in efficiency by using a parametric and nonparametric approach to banks in Algeria, whose research results indicate a relative consistency between two approaches and more frontier methods.

In Indonesia, Rahmi (2008) in her research on Sharia Business Unit in Indonesia in 2005-2007 period using SFA and DEA technique concluded that by using DEA which have high-efficiency level is SBU BTN and BPD DKI, while by using SFA the most efficient SBUs are BPD JABAR and DKI. Hartono (2009) has used the Stochastic Frontier Approach (SFA) technique in his study concluded that there is a high level of efficiency for banks listed on the stock exchange during the period 2004-2009, especially groups of Non-Foreign Exchange Banks and banks with small capitalization. According to Siregar, Mariana, and Umanto (2015) researched commercial banks in Indonesia for the period 2009-2013 with the technique of Data Development Analysis (DEA) concluded that the average of commercial banks listed on the Stock Exchange during the period 2009-2013 efficient. However, for that period the Non-Foreign Exchange BUSN group has a higher efficiency level than the other groups.

The difference in efficiency level results is shown by using two different approaches that have been applied to US banks and banks in Germany using criteria from Bauer et al. (1998). It includes efficiency level, efficiency rating, identification of extreme performers, time consistency, and the correlations consistent with the accounting indicators used make the basis for the authors to conduct the same research on the overall bank in Indonesia whether efficiency measures produce consistent results on efficiency levels, efficiency ratings, extreme performers and time consistency. Because measuring the consistency of efficiency over time and does not vary from year to year, knowing the extreme bank performers, as well as the efficiency rating, is very important, it is used as a baseline to determine a policy for policy developers in this case Bank Indonesia and the Financial Services Authority.

Based on the results of previous research studies, it is known that there are many studies on the efficiency of both methods. However, to analyze the stabilization of bank's performance efficiency by using parametric SFA and nonparametric DEA method still does not exist. Differences in the use of bank samples, time periods, input and output specifications and different methods as the second reason for the authors to analyze three measures of efficiency using the same bank sample, same period, the same input and output specifications that applied to three different efficiency measures. Concerning these issues, the purposes of this research are to determine the level of bank efficiency measured using three measures of efficiency, to know the factors that influence the efficiency of bank performance during the observation period, and to measure the consistency of bank efficiency in Indonesia by using two comparison methods SFA and DEA. Where in this study, it test the efficiency results developed from four Bauer et al. (1998) criteria to be able to determine the performance of the bank in terms of efficiency, efficiency rating, identification of extreme performers, and time consistency.

METHODS

This research is a quantitative research using parametric research method with cross section approach of Stochastic Frontier Approach (SFA) and non-parametric Data Envelopment Analysis (DEA) model of constant returns to scale (CRS). It is with assumption when all companies operate at optimum scale and model variable returns to scale (VRS) when the company operates on an abnormal scale due to imperfect competition (government regulation or financial constraints). The data used in this study is secondary data in the form of bank financial statements for the period of the observation year 2012-2016 with the following criteria: (1) Samples used are banks that have to go public in Indonesia; (2) Banks used are banks that have been listed on the Jakarta Stock Exchange (BEJ) within the period of the observation year 2012-2016 and not delisting during the observation period to avoid bias in the results of research; (3) The sample banks have no loss and have complete financial report during the observation period and has been audited by audit firm; (4) The sample banks have published their financial statements. Based on the criteria for determining the sample above, it selected to be observed were 29 banks, consisting of 14 BUSN foreign exchange, two non-foreign exchange banks, four state-owned banks, two joint venture banks and seven regional development banks. Where to take the sample is done by purposive sampling.

According to Hadad et al. (2003) in Purwanto (2011), there are three commonly used approaches in both parametric Stochastic Frontier Analysis (SFA) and non-parametric Data Envelopment Analysis (DEA) methods. It defines the relationship between input and output in a financial activity financial institutions (banks), namely; (1) Asset approach describes the main function of the financial institution as the lender of the loan, in this approach the output is actually defined into the asset form; (2) Production Approach, in this approach, consider financial institutions as deposit accounts and lenders so in this approach the output is defined as the amount of labor, capital expenditure on fixed assets, and other materials; (3) Intermediation Approach, in this approach consider the financial institution as an intermediary, change and transfer the financial assets of the surplus unit to the deficit unit. In this case, the institutional inputs such as labor costs, capital, and interest financing on the deposit. While the output is measured in the form of credit loans and financial investment.

This research uses intermediation approach, where banks have a function to collect and channel funds from people who surplus funds to the people who need funds (deficit). According to Berger and Humphrey (1997) in Purwanto (2011) stated that the intermediation approach is the most appropriate approach to evaluate the financial performance of financial institutions in general due to the characteristics of financial institutions as financial intermediation. The independent variable in this research is the total operational cost (TC), where TC = (Total interest expense + Expense of estimated loss of commitment and contingency + Total other operating expenses + Provision allowance expense + Amortization expense + Non-operational expense). To be able to generate some output (Oi) the bank asks for input (ii) by minimizing operational costs (TC).

The dependent variable consists of three input variables and three output variables. The first input variable is the total savings (I_1). Deposits are public deposit funds to banks used by banks for economic activities with the assurance that banks will return the funds intact to the public. The forms of deposits include demand deposits, deposits, certificates of deposit, savings, and or other similar forms. The second input variable is the total fixed asset (I_2). It is as a proxy of the size of the bank because the asset has economic value in the future. The higher the value of bank assets, the bank's ability to guarantee risks for productive assets and financing or credit becomes higher. The third input variable is the labor load (I_3). The burden of manpower absorbs the greatest burden in the bank's operational expenses because in the workforce it includes salaries, benefits, employee development. The output variables in this research include total credit (O_1) that is total loan given either to party related to the bank or not related to the bank. Because of the total credit is the main product of the bank as an intermediary institution. The second output variable is securities (O_2), and the third output variable is non-credit operating income (O_3).

The analytical model used to determine the efficiency scores with the Stochastic Frontier Approach (SFA) approach is to use the cross-section of the Stochastic Frontier Approach (SFA) single equation model for the data panel with pooled effect assumptions which can be considered as cross-(no time), with the following formula:

$$1nTC_{it} = \beta_{Ot} + \beta_1 1nO_{1it} + \beta_2 1nO_{2it} + \beta_3 1nO_{3it}\ \beta_4 1nI_{1it} + \beta_5 1nI_{2i}t + \beta_6 1nI_{3it} + \varepsilon it \ldots\ldots\ldots \quad (1)$$

where:

TC = Total cost incurred by the bank.
O_1 = Total Loans disbursed by the bank, either to parties related to the bank or not.
O_2 = Securities owned by the bank.
O_3 = Non-Credit Operating Income
I_1 = Savings Fund Interest Expense
I_2 = Depreciation Expense on Fixed Assets
I_3 = Burden of Labor

According to Coelli (1996) in Hartono (2009), the value of inefficiency in the cost function ranged from 1 to up. While the analytical model used to determine efficiency scores with DEA uses an output-oriented DEA model with Constant Return to Scale (CRS). It is introduced first by Charnes, Cooper, and Rhodes (1978) and variable returns to scale (VRS) assuming when all firms do not running-on an optimum scale, results in measures of technical efficiencies (TE) disrupt scale efficiencies (SE). The use of the VRS provision allows the calculation of TE to overcome the SE effect.

The researchers have tested the stabilization of bank performance efficiency in Indonesia by observing the stability of bank performance over time as a recommendation for policymakers to organize and set appropriate rules or strategies that face global competition. To that end, the researchers classify stabilization efficiency into bank performance in Table 1.

Table 1 Stabilization of Bank Performance Efficiency

Efficiency Condition	Performance Bank
Stable Inefficiency (SI)	Worst
Stable Low Efficiency (SLE)	Bad
Stable Intermediate Efficiency (SIE)	Fair
Stable High Efficiency (SHE)	Good
Unstable Efficiency Increase (UEI)	Good
Unstable Efficiency Decrease (UED)	Bad

RESULTS AND DISCUSSIONS

From the number of observation data to 29 banks listed on the Jakarta Stock Exchange in 2012-2016 for 145 observations generated descriptions of each research variables in Table 2.

Table 2 Descriptive Statistics of the Aggregate Data
(29 banks 5 years; 2012-2016)

Variable	Mean	Std.Dev	Min	Max
Dependent				
Total Operating Cost (TC)	0,08334	0,02988	0,01466	0,26579
Independent				
Input				
Deposit (I_1)	0,03560	0,01613	0,00149	0,07464
Fixed Assets (I_2)	0,00966	0,00396	0,00061	0,02039
Labor (I_3)	0,01975	0,00890	0,00192	0,02039
Output				
Loan (O_1)	0,65372	0,07991	0,39383	0,79834
Securities (O_2)	0,09097	0,06865	0,00041	0,33631
Non-Credit Operating Income (O_3)	0,01923	0,01811	0,00258	0,14249

Total operational cost (TC) in 2012 - 2016 from 29 bank companies shows an average value of 0,08334. It means that the total operational cost incurred by the bank is 8,33% of total assets with a minimum value of 1,47 % and maximum 26,58%. Inputs that are obtained by banks in the period 2012 - 2016 in the form of deposits cost of funds (I_1) of 3,56%, (I_2) of 0,97%, depreciation expenses of fixed assets and labor expenses (I_3) of 1,98% (O_1) of 65,37%, securities (O_2) of 9,10%, and non-credit operating income (O_3) of 1,92% of the total assets of the bank.

By using SFA method, the efficiency level of each bank in Indonesia can be measured. The efficiency level is analyzed from the cost function model between total cost (TC) as dependent variable with independent variable; interest expense of deposit fund (I1), depreciation expense of fixed asset (I2), labor burden (I3), total loan disbursed by bank (O1), bank-owned securities (O2), and non-credit operating income (O3) that is transformed into natural logarithms (ln) into translog models rather than linear models. The SFA for the cross-section model (frontier) is estimated based on a pattern of production function approaching a balanced efficiency of 1 from below (less than or equal to 1). In addition, a likelihood-ratio test of sigma_u = 0 is used to test whether the sample data can be worked with SFA for the cross-section (frontier) or SFA model for the panel model (xtfrontier). If the result of P-value (Prob> = chibar2) > α with α = 0,05, then the data sample is suitable to be done with SFA for the cross-section model (frontier). From the result of STATA output, obtained P-value equal to 1,000 (P-value > 0,05), so the test is concluded that the data sample that is suitable to be done with SFA for cross-section model (frontier).

Furthermore, multicollinearity test to determine whether in a regression model there is intercorrelation between independent variables or not. Multicollinearity test is done by deflecting the value of correlation coefficient between free variable. If the value of the correlation coefficient shows the number of 0,75 both negative and positive, it can be concluded the existence of multicollinear here is the result of the correlation between free variable. This result indicates that the correlation between variables is relatively low. This indicates the absence of multicollinear problems in the model. Table 3 shows the correlation between independent variable, while Figure 2 shows the cost efficiency level for each bank by using the SFA method.

Table 3 Correlation between Independent Variable

Var	lnI_1	lnI_2	lnI_3	lnO_1	lnO_2	lnO_3
lnI_1	1,000					
lnI_2	-0,213	1,000				
lnI_3	0,199	0,190	1,000			
lnO_1	0,255	-0,079	0,286	1,000		
lnO_2	-0,039	-0,101	-0,265	-0,634	1,000	
lnO_3	0,283	0,044	0,294	0,214	-0,041	1,000

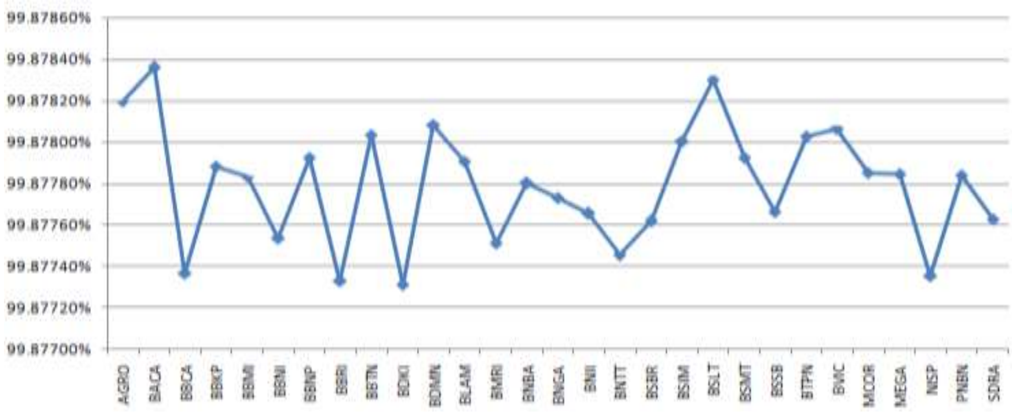

Figure 2 The Cost Efficiency Level for Each Bank by the SFA Method

After examining the problem of multicollinearity and cost efficiency prediction, the next step is to answer the hypothesis test of the problem. The hypothesis for the simultaneous test of regression coefficient with Wald test (Chi-Square test).
H_0: There is no concurrent or joint effect of lnI_1, lnI_2, lnI_3, lnO_1, lnO_2, and lnO_3 to lnTC.
H_1: There are concurrent or joint effects of lnI_1, lnI_2, lnI_3, lnO_1, lnO_2, and lnO_3 to lnTC.

This test is expected to have a simultaneous or joint effect of predictor variables on response variables based on concurrent tests of regression coefficients. This test is satisfied when the value of P-value (Sig.) $\leq \alpha$ with α is set at 5%. From the result of output, it can get the result of statistical test of Chi-Square test (Wald chi2 (6)) 141,90 and P-value (Prob> chi2) 0,0000 so that the test can be concluded that there are simultaneous or joint effect of lnI_1, lnI_2, lnI_3, lnO_1, lnO_2, and lnO_3 to lnTC (due to P-value <0,05). There is the hypothesis to test individual regression coefficients with z test.

H_0: There is no partial or individual influence lnI_1, lnI_2, lnI_3, lnO_1, lnO_2, and lnO_3 to lnTC.
H_1: There are partial or individual influences lnI_1, lnI_2, lnI_3, lnO_1, lnO_2, and lnO_3 to lnTC.

This test is conducted to determine whether there is the significant influence of each predictor variable to the response variable. This test shows a significant influence when the value of P-value (Sig.) $\leq \alpha$ where α equal to 5%.

Table 4 The Result of the z Test for the Significance of Stochastic Frontier Model Coefficient

Independent Variable	Coeff.	Std. Error	Statistic z	P-value
lnI1	0,08429	0,02845	2,96	0,003*
lnI2	-0,06637	0,04022	-1,65	0,099
lnI3	0,47448	0,04860	9,76	0,000*
lnO1	-0,14358	0,17404	-0,82	0,409
lnO2	0,07435	0,02471	3,01	0,003*
lnO3	-0,05361	0,03644	-1,47	0,141
constanta	-0,72907	0,36833	-1,98	0,048

*Significant to a significant level (α) of 5%

From the above equation and the value of P-value (Sig.) for each variable in Table 4, it is known that the input variable of deposit interest expense (I_1), labor (I_3), and securities output variable (O_2) have a significant influence on total cost, ie smaller than the 0,05 trust level. This means that any increase or decrease in the value of variables I_1, I_3 and O_2 of 1 unit will affect the increase or decrease in total cost of the coefficient of each variable. The Stochastic Frontier Model by involving all variables for all banks formulates below.

$$\mathbf{lnTC} = -0{,}729067 + 0{,}08429\ \mathbf{lnI_1} - 0{,}06637\ \mathbf{lnI_2} + 0{,}47448\ \mathbf{lnI_3} - 0{,}14358\ \mathbf{lnO_1} + 0{,}07435\ \mathbf{lnO_2} - 0{,}05361\ \mathbf{lnO_3} + \boldsymbol{e}$$

The coefficient of determination (R2) is obtained at 0,49459593 which means that the lnTC diversity capable of being described in lnI1, lnI2, lnI3, lnO1, lnO2, and lnO3 is 49.46% together with the remaining 50,54% explained by error (e) or other variables not included in the Stochastic Frontier Model. Based on the results of cost efficiency output with the SFA cross-section model, Cost Efficiency in 2012 - 2016 from bank companies shows the average value of all banks. This shows that the cost efficiency is close to the value 1 so it is concluded that the cost efficiency level for all banks has a very good efficiency level and is expressed as high efficiency as shown in Table 5.

Table 5 Category Efficiency per Grouping

Score Efficiency (%)	Level Efficiency
96-100	High Efficiency
86-95	Intermediate Efficiency
66-85	Low Efficiency
<65	Inefficiency

Source: secondary data is processed

According to the analysis with DEA CRS model, it is known that on average every year 73,10% banks in Indonesia have inefficient performance. Whereas according to the DEA VRS model, it is only 3,45% only Banks in Indonesia that inefficient performance of the Regional Development Bank Lampung (BLAM) and it only happened in 2012, the rest is efficient. It is shown in Figure 3.

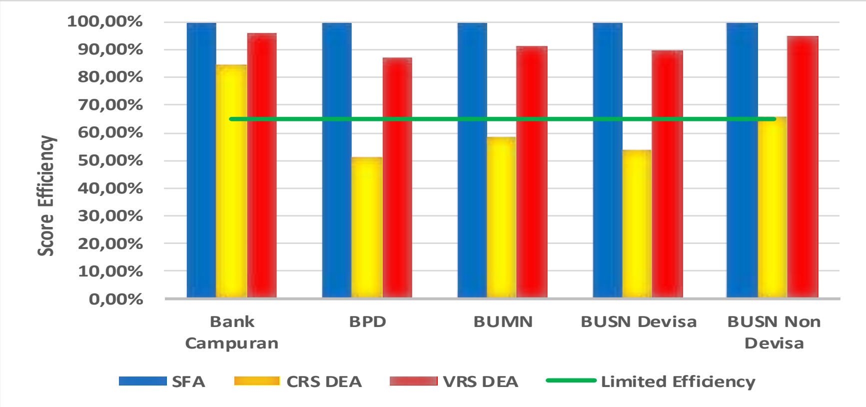

Figure 3 The Average Score Efficiency per Group of Banks in Indonesia Period 2012-2016

The three measures of efficiency, Mixed Banks and Non-Foreign Exchange National Private Banks show better levels of operational efficiency compared to the Group of State Owned Enterprises (BUMN), BPD, and Private Foreign Exchange Banks (BUSN Foreign Exchange).

From the average of each year 73,10% of banks in Indonesia are inefficient 40,69% are banks of Foreign Exchange BUSN group, 13,79% BPD, 16,34% BUMN, and the remaining 3,45% Bank Mixed and Non -Foreign Exchange BUSN. BUSN Foreign exchange has the worst performance in 2013 where all BUSN banks have inefficient performance, while state-owned banks have a performance where all state-owned banks are inefficient in 2012 and 2015. Table 6 shows a list of inefficient banks during the 2012-2016 observation period according to DEA CRS Model.

Table 6 List of Inefficiency Bank Period 2012-2016 by DEA CRS Model

Group Bank	2012	2013	2014	2015	2016
BUSN Devisa	BDMN	BBNP	BBCA	BBCA	
	BNBA	BDMN	BBMI	BBKP	
	BNII	BNBA	BBNP	BBMI	
	BNGA	BNGA	BDMN	BBNP	
	BPKP	BNII	BNBA	BDMN	
	BSIM	BPKP	BNGA	BNBA	
	MEGA	BSIM	BNII	BNGA	
	SDRA	MEGA	BPKP	BNII	
			BSIM	BSIM	
			MEGA	MEGA	
			NISP	NISP	
			PNBN	PNBN	
				SDRA	
BUSN Non Devisa	BTPN	BTPN	BTPN	BTPN	BTPN
BUMN	BBNI	BBNI	BBNI	BBNI	BBRI
	BBRI	BBTN	BBTN	BBRI	BBTN
	BBTN	BMRI	BMRI	BBTN	BMRI
	BMRI			BMRI	
BPD	BDKI	BLAM	BLAM	BDKI	BDKI
	BLAM	BSLT	BSLT	BLAM	BLAM
	BNTT	BSMT	BSMT	BNTT	BSMT
	BSLT			BSMT	
	BSMT			BSSB	

Table 6 List of Inefficiency Bank Period 2012-2016 by DEA CRS Model (Continued)

Group Bank	2012	2013	2014	2015	2016
BPD	BSSM				
Mixed Bank	MCOR		MCOR	MCOR	MCOR

Based on the results of the analysis process with the three measures of efficiency can also be known bank ratings with the lowest and highest efficiency each year as shown in Table 7.

Table 7 The Highest and Lowest Bank Ranked According to
Value the Efficiency of The Period 2012-2016

Model-rank	2012	2013	2014	2015	2016
SFA					
Highest	BACA	AGRO BACA	BNII	BSLT	BACA
Lowest	BBCA	BNII	BDKI BBRI SDRA	BBRI BDKI	BBCA BBRI BDKI
DEA CRS					
Highest	AGRO BACA BBNP BSBR BVIC	AGROS SDRA	SDRA	AGRO BACA BSLT BVIC	BACA BVIC PNBN
Lowest	BNBA		BDMN	BDMN	BDMN
DEA VRS					
Highest	AGRO BACA BBNP BSBR BVIC	AGRO BDKI BVIC PNBN SDRA	AGRO MCOR SDRA	AGRO BACA BBTN BSLT BVIC	BACA BSLT BVIC MEGA PNBN
Lowest	BLAM	BMRI	BDMN	BDMN	BBNI

The rating of the bank with the highest efficiency value is dominated by banks from the Foreign Exchange BUSN group while the lowest rank is dominated by the group of foreign exchange BUSN banks and BUMN. The result of DEA VRS analysis process, it is known that AGRO bank for the fourth consecutive year ranked highest for efficiency value that is from the 2012-2014 period, while based on the result of analysis process with DEA CRS only 2012, 2013, and 2015 ARGO bank reach the highest rank. In contrast to SFA, the ARGO bank is the highest in 2013 alone. Likewise, with BACA banks with three efficiency measures in 2012 and 2016 is the highest for efficiency. However, in 2013 only the SFA method alone, BACA is ranked highest while with DEA and DEA VRS DEA method just occurred in 2015. With DEA CRS and DEA VRS BVIC banks are highest in 2012, 2013, 2015 and 2016.

The lowest ranked bank is achieved by BDMN in 2013-2016 with DEA CRS and DEA VRS methods. State-owned banks are among the lowest in the period 2012-2016, namely BBNI, BBRI, and BMRI. Bank BMRI achieves the lowest rank by DEA VRS method in 2013, while BBNI in 2016. While Bank BBRI reaches the lowest rank three years in a row according to SFA method, that is from 2013-2016.

Table 8 Condition of Bank Performance Period 2012-2016

No	Bank	Condition			Performance Bank		
		SFA	DEA CRS	DEA VRS	SFA	DEA CRS	DEA VRS
1	AGRO	SH	UDE	UDE	Good	Bad	Bad
2	BACA	SHE	UIE	UIE	Good	Good	Good
3	BBCA	SHE	UDE	UDE	Good	Bad	Bad
4	BBKP	SHE	SI	SIE	Good	Worst	Fair
5	BBNI	SHE	SI	SLE	Good	Worst	Bad
6	BBNP	SHE	UDE	UDE	Good	Bad	bad
7	BBMI	SHE	UDE	SIE	Good	Bad	Fair
8	BBRI	SHE	UDE	UEI	Good	Bad	Good
9	BBTN	SHE	SI	UDE	Good	Worst	Bad
10	BDKI	SHE	UDE	UDE	Good	Bad	Bad
11	BDMN	SHE	SI	SLE	Good	Worst	Bad
12	BLAM	SHE	SI	UEI	Good	Worst	Good
13	BMRI	SHE	SI	SLE	Good	Worst	Bad
14	BNBA	SHE	SI	UDE	Good	Worst	Bad
15	BNGA	SHE	SI	UEI	Good	Worst	Good
16	BNII	SHE	SI	UDE	Good	Worst	Bad
17	BNTT	SHE	SI	UEI	Good	Worst	Good
18	BSBR	SHE	SLE	UDE	Good	Bad	Bad
19	BSIM	SHE	SI	UDE	Good	Worst	Bad
20	BSLT	SHE	UEI	UEI	Good	Good	Good
21	BSMT	SHE	SI	UDE	Good	Worst	Bad
22	BSSB	SHE	SI	SIE	Good	Worst	Fair
23	BTPN	SHE	SI	UEI	Good	Worst	Good
24	BVIC	SHE	UEI	UEI	Good	Good	Good
25	MCOR	SH	UED	UED	Good	Bad	Bad
26	MEGA	SHE	SI	UEI	Good	Worst	Good
27	NISP	SHE	UEI	SIE	Good	Good	Fair
28	PNBN	SHE	UEI	UEI	Good	Good	Good
29	SDRA	SHE	UED	UEI	Good	Bad	Good

Based on time series sampling as shown in Table 8, the stabilization efficiency with SFA cross-section indicates that all banks listed on the Jakarta stock exchanges perform at stable high-efficiency conditions. This means that all bank companies in Indonesia have a high efficient and good performance. Meanwhile, according to the non-parametric method of DEA both CRS and VRS, some banks show unstable performance. DEA CRS notes that 13 banks in Indonesia listed on the Jakarta stock exchange have an unstable performance. Of the 13 unstable banks, eight banks show a decrease in efficiency or poor performance, such as AGRO, BBCA, BBNP, BBMI, BBRI, BDKI, MCOR, and SDRA bank. While five banks show an increase in efficiency level or have good performance, such as BACA, BSLT, BVIC, NISP, and PNBN. Among the banks with stable performance, one bank is in stable condition of low efficiency or has poor performance that is BSBR bank, while 14 other banks are in stable condition inefficient or have very bad performance like BBKP, BBNI, BDMN, BLAM, BMRI, BNBA, BNGA, BNII, BNTT, BSMT, BSLT, BSSB, BTPN, and MEGA.

DEA VRS identifies seven banks from 29 banks listed on the Jakarta stock exchange with stable performance with efficiency and performance appraisal that varied, while the remaining 22 banks are in unstable condition. Of the seven banks that have stable performance, four of them are in the stable condition of middle efficiency or good enough performance, such as BBKP, BBMI, BSSB, and NISP. While the three banks stable low efficiency or have poor performance, such as BBNI, BDMN, and BMRI. The 22 unstable banks consisted of 11 banks in unstable conditions, where the bank's efficiency level decreases or shows poor performance, such as AGRO, BBCA, BBNP, BBTN, BDKI, BNBA, BNII, BSBR, BSIM, BSMT and MCOR. The rest of the 11 banks are in an unstable condition, where the efficiency of the bank has improved or shows good performance, such as READ, BBRI, BLAM, BNGA, BNTT, BSLT, BTPN, BVIC, MEGA, PNBN and SDRA.

From the comparison of the two DEA CRS and DEA VRS models, it can be concluded that there are different efficiency conditions in some banks, including BBKP, BBNI, BDMN, BMRI, BNII, BSSB, AGRO, BBCA, BBMI, BBNP, BBRI, BDKI, MCOR, and SDRA. According to the DEA CRS model, the condition of these banks is stable and declining to inefficient. Whereas according to the DEA VRS model some of the banks above are stable and declining in performance, yet, still in the efficient condition only change level only. This reinforces the statement from Ji and Lee (2010) that CRS technical efficiency is not efficient in scale efficiency and "pure" technical efficiency. So, the efficiency conditions of some banks with DEA VRS conditions are efficient, but with DEA CRS can be inefficient. While the difference in efficiency values of SFA and DEA is due to differences in determining the efficiency level which for the SFA parametric method of determining the efficiency level reckon the approach of random error while DEA does not reckon the existence of random error, but rather the output and input approaches determine DMU.

CONCLUSIONS

Based on the results of the analysis, it can be drawn some conclusions as (1) Total operating expenses are incurred by banks during the period 2012-2016 average 8,33% of total assets with a minimum value of 1,47% and a maximum of 26,58%. (2) The amount of bank operational expenses during the period 2012-2016 is strongly influenced by the decrease or increase of interest expense of deposit fund equal to 8,5%, labor cost equal to 47,45%, and securities equal to 7,43%. (3) There is a difference in the level of bank efficiency with the three measures of efficiency, where all banks with parametric approach cross section SFA show a very efficient performance with high-efficiency level approaching 100%, while with nonparametric DEA approach, not all banks show efficient performance, only 26. An average 90% on average per year is a bank that has efficient performance according to CRS model and 99,31% according to VRS model. (4) Based on the efficiency rating, a fairly a stable Bank is ranked the highest efficiency during the period 2012-2016 are AGRO, BACA and BVIC banks, while BDMN and BBRI banks are the lowest for efficiency during 2012-2016. (5) DEA method CRS identifies banks that perform poorly and very poorly during the period 2012-2016, Bank AGRO, BBCA, BBNI, BBMI, BBRI, BDKI, MCOR, SDRA BBKP, BBNI, BDMN, BLAM, BMRI, BNBA, BNG, BNII, BNTT, BSMT, BSLT, BSSB, BTPN, and MEGA. While banks that have good performance during the period 2012-2016 are banks BACA, BSLT, BVIC, NISP, and PNBN. (6) The DEA VRS method of familiarizing banks that perform poorly during the period 2012-2016 is bank AGRO, BBCA, BBNP, BBTN, BDKI, BNBA, BNII, BSBR, BSIM, BSMT, BBNI, BMRI, BDMN, and MCOR. While banks that perform well during the period 2012-2016 are banks BACA, BSLT, BVIC, BBKP, BBMI, BSSB, NISP, and PNBN.

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