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A SLACKS-BASED MEASURE OF EFFICIENCY IN DATA ENVELOPMENT ANALYSIS TO ASSESS EFFICIENCY OF INDONESIAN SHARIA BANKS

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HIGHLIGHT

- *A slacks-based measure of efficiency in DEA to assess efficiency of Indonesian sharia banks.*
- *Among twelve sharia banks under-investigated, four of them are considered as the most efficient.*

ABSTRACT

With the development of sharia banks, one of the effects that occurs is the existence of competition among sharia banks. The objective of this study is then to analyze the efficiency of sharia banks in Indonesia. Understanding the efficiency is important because if banks perform consistently with full efficiency, the less inputs they use, the larger output they achieve. The output is measured by total earning asset, while the inputs used are total deposit and total operating costs. A slacks-based measure of efficiency in data envelopment analysis is used to accomplish the objective of the research. Result shows that among twelve sharia banks under-investigated, four of them are considered as the most efficient.

KEYWORD

Data envelopment analysis, efficiency, Indonesia, sharia bank, slacks-based measure

A. INTRODUCTION

With the amendment of Undang-Undang Number 7 of 1992 into Undang-Undang Number 10 of 1998 about Indonesian banking which allows conventional banks to operate by applying sharia principles or conducting operations in sharia and conventional ways (dual banking system), the growth of Islamic banks has experienced a significant acceleration since the sharia unit can offer separate sharia banking products. The basic difference between these two types of banking lies in the returns and profit sharing provided by customers to financial institutions and/or financial institutions to the customers. In conventional banking, the distribution of profits is based on the principle of interest, while in sharia banking, the distribution of profits and losses are based on the principle of profit sharing.

With the development of sharia banks and the strength of conventional banks, one of the effects that occurs is the existence of competition both between conventional banks and sharia banks, as well as among sharia banks. The concern now is how the performance of these banks. Bank performance is important for stakeholders because they can evaluate the performance while still applying prudential principles, complying with regulations and implementing risk management. One of the important aspects in measuring bank performance is efficiency. Arafat (2006) stated that bank efficiency is considered to be very important at this time and in the future with increasingly fierce competition, problems that can arise due to lack of resources, and increasing standards of customer satisfaction. The objective of this study is then to analyze the efficiency of sharia banks in Indonesia. Understanding the efficiency, which is simply defined as the ratio of output to input (Cooper et al., 2006), is important because if banks perform consistently with full efficiency, the less inputs they use, the larger output they achieve.

This study uses DEA to assess the technical efficiency. It is a non-parametric approach that requires very few assumptions in estimating technical efficiency compared to the parametric approach such as the stochastic frontier analysis (SFA). In SFA, one has to define a functional form a priori and estimate the finite set of unknown parameters from the data. In addition, due to the use of maximum likelihood method, the distribution of inefficiency must be defined a priori. In DEA, we do not consider those issues. DEA has been widely used to assess technical efficiency of industrial sector, e.g., small and medium enterprise (Pramono et al., 2019; Sari et al., 2018), large and medium manufacturing industry (Ulkhaq, 2022; 2023; Ulkhaq & Pratiwi, 2022), and creative industry (Handayani et al., 2020).

A slacks-based measure of efficiency (SBM) in data envelopment analysis (DEA) (Tone, 2001) is used to accomplish the objective of this study. In contrast to

the constant returns-to-scale and variable returns-to-scale (VRS) DEA which are based on the proportional reduction (enlargement) of input (output) vectors, and which do not take into account of slacks, the SBM-DEA deals directly with input excess and output shortfalls (Tone, 2001). The SBM-DEA satisfied such properties as unit-invariance, monotone, translation invariant, and reference-set dependent

The rest of the paper is structured as follows. The following section shows the data used in this study, including inputs and output. The third section describes the empirical model of this study, i.e., the SBM-DEA. The fourth section shows the result of this study while the last section concludes.

B. DATA

The data used in this study consists of 12 Sharia Banks operated in Indonesia (10 national private banks and 2 local government banks). The data is taken from quarterly financial reports (December 2021) published by the Financial Services Authority (or Otoritas Jasa Keuangan/OJK in Bahasa Indonesia).

Output and input used in this study follow the study of Masrizal et al. (2022). The output is measured by total earning asset (in million rupiahs). It is the total sum of placement accounts with Bank Indonesia, placements with other banks, receivables (murabahah, salam, istishna', qardh, and multiservice), ijarah, and mudharabah, musyarakah, and other financings. Murabahah is a scheme used for short-term financing. Under this scheme, the seller discloses the real cost and profit of the products to the buyer. Negotiation of a profit margin is possible and installment payments are common (Dhumale and Sapcanin, 1999; Obaidullah, 2008). (Bai') salam is a scheme similar to forward contracts. Under this scheme, the seller and buyer agree to the future transaction where the buyer pays the full amount of the price and the seller promises to deliver the goods. Quality, quantity, price and time of delivery are determined at the time of the contract (Dhumale and Sapcanin, 1999). Istishna' is a type of sale transaction where the buyer places an order with the seller to manufacture certain asset and the sale is completed upon delivery of the asset to the buyer (Ayub, 2007). Qardh (al hasanah) is the only loan permissible under Islamic finance scheme. This scheme is a zero-return loan. However, administration and transaction costs are permissible (as long as there is no relationship between the maturity and amount of the loan) (Dhumale and Sapcanin, 1999). Ijarah is a (pure) lease transaction (Dhumale and Sapcanin, 1999; Obaidullah, 2008). In mudarabah contract, one party provides all the capital for the business which is called shahibul maal while the entrepreneurs or mudharib contribute effort and time to the project. The profits will be share in a fixed ratio and losses are borne by the financial institution (Dhumale and Sapcanin, 1999; Fianto et

al., 2018). In musharakah contract, profits are shared based on an agreement, whereas losses are shared based on equity participation (Chong and Liu, 2009; Dhumale and Sapcanin, 1999; Fianto et al., 2018).

The inputs used in this study are total deposit and total operating costs. Total deposit consists of total sum of wadiah savings accounts, mudharabah savings, and mudharabah deposits. Total operating costs consists of sum of personnel costs, advertising expenses, and other operational costs. Wadiah is trust or savings; the trusted party is not responsible for the loss unless the negligence stems from it (Ayub, 2007). The data of inputs and output used is shown in Table 1.

Table 1.

Data of inputs and output used (in million rupiahs)

Sharia bank (DMU)	Total earning asset	Total deposit	Total operating costs
PT Bank Muamalat Indonesia	24,945,246	46,871,375	1,248,231
PT Bank Victoria Syariah	858,781	1,230,445	34,572
PT Bank Jabar Banten Syariah	7,384,535	7,883,355	377,739
PT Bank Syariah Indonesia	193,074,867	233,251,358	8,542,492
PT Bank Mega Syariah	10,234,188	11,394,777	447,709
PT Bank Panin Dubai Syariah (Tbk)	10,078,411	7,796,461	195,656
PT Bank KB Bukopin Syariah	5,233,540	4,595,068	154,003
PT Bank BCA Syariah	7,400,747	7,677,861	212,486
PT Bank BTPN Syariah (Tbk)	11,519,289	10,993,547	1,686,155
PT Bank Aladin Syariah (Tbk)	1,158,299	1,038,184	156,319
PT Bank Aceh	20,171,538	24,018,009	1,346,241
PT Bank NTB Syariah	8,846,589	8,143,058	383,701

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In DEA, the influence of inputs on output cannot be investigated—whether the inputs significantly affect the output; thus, the selection of inputs only depends on the literature without knowing whether the selected inputs significantly influence the output. However, Ferrera et al. (2010, 2011) argued that inputs must fulfil the requirement of isotonicity (i.e., *ceteris paribus*, more input implies an equal or higher level of output); hence, the selected inputs should present a significant positive correlation with the output in addition to have theoretical support from previous work. Table 2 shows the correlation coefficients of all variables used. Notice that in Table 2, the output is strongly correlated with inputs.

Table 2.

Correlation coefficients of inputs and output

	Total earning asset	**Total deposit**	**Total operating costs**
Total earning asset	1		
Total deposit	0.99657013	1	
Total operating costs	0.98758628	0.98423903	1

C. EMPIRICAL MODEL

Efficiency refers to the ability of a decision-making unit, in this study, it is a sharia bank in Indonesia, to minimize input used in the production of a given output, or the ability to obtain maximum output from a given inputs (Cooper et al., 2006). Consequently, a decision-making unit (DMU)—in this study is the sharia bank—is fully technically efficient if it produces the maximum possible output from a fixed level of inputs (in an output orientation), or if it uses the minimum possible inputs to produce a given level of output (in an input orientation).

This study uses SBM-DEA to assess efficiency. DEA is a non-parametric approach that requires very few assumptions in estimating technical efficiency compared to the parametric approach such as the stochastic frontier analysis (SFA). In SFA, one has to define a functional form a priori and estimate the finite set of unknown parameters from the data. In addition, due to the use of maximum likelihood method, the distribution of inefficiency must be defined a priori. In DEA, we do not consider those issues.

In contrast to the constant returns-to-scale and variable returns-to-scale DEA which are based on the proportional reduction (enlargement) of input (output)

vectors, and which do not take into account of slacks, the SBM-DEA deals directly with input excess and output shortfalls (Tone, 2001). The SBM-DEA satisfied such properties as unit-invariance (i.e., the measure is invariant with respect to the units of data), monotone (i.e., the measure is monotone decreasing in each slack in input and output), and translation invariant (i.e., the measure is invariant under parallel translation of the coordinate system applied, see Ali and Seiford, 1990; Pastor, 1996). In addition, it is reference-set dependent, indicating that the measure is determined only by its reference-set and is not affected by statistics over the whole data set.

Let M be the number of inputs and N be the number of DMUs, (in this study, M = 2 and N = 12). In order to estimate efficiency of a DMU, the following fractional programming is formulated

$$\begin{aligned} &\text{Min} && \rho = \frac{1-\frac{1}{M}\sum_{i=1}^{M}\frac{\bar{s_i}}{x_{io}}}{1+\frac{s^+}{y_o}} \\ &\textit{Subject to} && \boldsymbol{x}_o = \mathbf{X}\,\boldsymbol{\lambda} + \mathbf{s}^- \\ & && y_o = \mathbf{Y}\,\boldsymbol{\lambda} - s^+ \\ & && \boldsymbol{\lambda} \geq \mathbf{0},\ \mathbf{s}^- \geq \mathbf{0},\ s^+ \geq 0, \end{aligned} \qquad (1)$$

where $1 \geq \rho > 0$ is such an index that satisfies the properties of unit invariant and monotone; $\mathbf{X}$ represents the $M \times N$ input matrix; $\mathbf{Y}$ is the $1 \times N$ output vector; $\boldsymbol{\lambda}$ is $N \times 1$ vector of constants; $\boldsymbol{x}_o$ and y_o are inputs and output of DMU under consideration; $\mathbf{s}^-$ and s^+ indicate the input excess and output shortfall, respectively, called slacks.

Model (1) can be transformed into a linear programming using the Charnes-Cooper transformation (see Charnes and Cooper, 1962; Charnes et al., 1978) as follows. Let us multiply a scalar variable $t(>0)$ to both the denominator and the numerator of Model (1). This causes no change in ρ. We adjust t so that the denominator becomes 1 with the objective is to minimize the numerator as follows

$$\begin{aligned} &\text{Min} && \tau = t - \frac{1}{M}\sum_{i=1}^{M}\frac{t\bar{s_i}}{x_{io}} \\ &\textit{Subject to} && 1 = t + \frac{ts^+}{y_o} \\ & && \boldsymbol{x}_o = \mathbf{X}\,\boldsymbol{\lambda} + \mathbf{s}^- \\ & && y_o = \mathbf{Y}\,\boldsymbol{\lambda} - s^+ \\ & && \boldsymbol{\lambda} \geq \mathbf{0},\ \mathbf{s}^- \geq \mathbf{0},\ s^+ \geq 0,\ t > 0. \end{aligned} \qquad (2)$$

Model (2) is a nonlinear programming problem since it contains the nonlinear terms ts^+. However, we can transform it into a linear programming as follows. Let us define $\boldsymbol{S}^- = t\boldsymbol{s}^-$, $S^+ = ts^+$, and $\boldsymbol{\Lambda} = t\lambda$. Then Model (2) becomes:

$$
\begin{aligned}
&\text{Min} && \tau = t - \frac{1}{M}\sum_{i=1}^{M}\frac{S_i^-}{x_{io}} \\
&\textit{Subject to} && 1 = t + \frac{S^+}{y_o} \\
& && t\boldsymbol{x}_o = \mathbf{X}\boldsymbol{\Lambda} + \boldsymbol{S}^- \\
& && t\boldsymbol{y}_o = \mathbf{Y}\boldsymbol{\Lambda} - S^+ \\
& && \boldsymbol{\Lambda} \geq \mathbf{0}, \boldsymbol{S}^- \geq \mathbf{0}, S^+ \geq 0, t > 0. \qquad (3)
\end{aligned}
$$

An optimal solution is $(\tau^*, t^*, \boldsymbol{\Lambda}^*, \boldsymbol{S}^{-*}, S^{+*})$. Then we have an optimal solution of Model 1 as defined by: $\rho^* = \tau^*$, $\boldsymbol{\lambda}^* = \boldsymbol{\Lambda}^*/t$, $\mathbf{s}^{-*} = \boldsymbol{S}^{-*}/t$, $\mathbf{s}^{+*} = \boldsymbol{S}^{+*}/t$. A DMU is called SBM-efficient is $\rho^* = 1$; otherwise, the corresponding DMU is considered as inefficient. The methodology is completely deterministic, in the sense that it attributes all the deviation from the frontier to inefficiency; there is no random error estimated.
The assumption of VRS is used, as this assumption is relevant to be applied in the Indonesian economy which is characterized by many distortions.

D. RESULT

The result of the SBM-DEA is shown in Table 3. There are 4 sharia banks which have $\rho^* = 1$, indicating the most efficient DMUs. They are PT Bank Victoria Syariah, PT Bank Syariah Indonesia, PT Bank Panin Dubai Syariah (Tbk), and PT Bank Aladin Syariah (Tbk). The other sharia banks are considered as inefficient since their efficiency scores are less than one. We also provide rank for each DMU.

PT Bank Syariah Indonesia which is located at the frontier has the highest value of total earning asset among others. Note that the high value of output does not guarantee the efficiency score will be 1 (one). The second to the fourth highest output values belong to PT Bank Muamalat Indonesia, PT Bank Aceh, PT Bank BTPN Syariah (Tbk), and PT Bank Mega Syariah, respectively. However, those banks have efficiency scores less than 1, meaning that all of them are inefficient. It is of interest viewing banks having two lowest output values (PT Bank Aladin Syariah (Tbk) and PT Bank Victoria Syariah) are located at the frontier. This indicates that to be the most efficient one, DMU does not have to have the highest output value, it also must have low values of inputs.

Table 3 also shows the reference set for each DMU for the sake of benchmarking. For instance, the reference set for PT Bank Muamalat Indonesia is {4, 6}, which is PT Bank Syariah Indonesia and PT Bank Panin Dubai Syariah (Tbk); and the values of λ are $\lambda_4 = 0.081$ and $\lambda_6 = 0.919$. They show the proportions

contributed by PT Bank Panin Dubai Syariah (Tbk) and PT Bank Syariah Indonesia to the point used to evaluate PT Bank Muamalat Indonesia. Hence, PT Bank Muamalat Indonesia is inefficient. Note that the reference set for the efficient DMUs is themselves.

Table 3.

Data of inputs and output used (in million rupiahs)

No	Sharia bank (DMU)	Efficiency	Rank	Reference set
1	PT Bank Muamalat Indonesia	0.629	9	$\lambda_4 = 0.081$ $\lambda_6 = 0.919$
2	PT Bank Victoria Syariah	1.000	1	$\lambda_2 = 1.000$
3	PT Bank Jabar Banten Syariah	0.552	11	$\lambda_6 = 1.000$
4	PT Bank Syariah Indonesia	1.000	1	$\lambda_4 = 1.000$
5	PT Bank Mega Syariah	0.577	10	$\lambda_4 = 0.00085$ $\lambda_6 = 0.99915$
6	PT Bank Panin Dubai Syariah (Tbk)	1.000	1	$\lambda_6 = 1.000$
7	PT Bank KB Bukopin Syariah	0.825	5	$\lambda_2 = 0.488$ $\lambda_6 = 0.512$
8	PT Bank BCA Syariah	0.712	6	$\lambda_2 = 0.018$ $\lambda_6 = 0.982$
9	PT Bank BTPN Syariah (Tbk)	0.513	12	$\lambda_4 = 0.0078$ $\lambda_6 = 0.992$
10	PT Bank Aladin Syariah (Tbk)	1.000	1	$\lambda_{10} = 1.000$
11	PT Bank Aceh	0.665	7	$\lambda_4 = 0.055$ $\lambda_6 = 0.945$
12	PT Bank NTB Syariah	0.644	8	$\lambda_6 = 1.000$

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E. CONCLUSION

This study aims to measure the efficiency of sharia banks in Indonesia. SBM-DEA with VRS approach is used to accomplish the objective of the study. Result shows that among twelve sharia banks under-investigated, four of them are considered as the most efficient, located at the frontier (see Table 3). The rank for each DMU is also provided.

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