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EFFICIENCY MEASURES OF ISLAMIC BANKS USING DATA ENVELOPMENT ANALYSIS FRONTIER: EVIDENCE FROM MALAYSIA

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Abstract. *Efficiency in banking sector is extremely important for economic growth and financial sector development. It is a basis of profits, financial market funds and in productive investment. However, there is increasing concern that some commercial banks particularly Islamic banks are being inefficiently operated. Many researchers have compared the efficiency between Islamic banks and conventional banks, but very little literature focuses on the efficiency among Islamic banks alone. This study aims to propose efficiency measures of selected Islamic banks over the period of 2006 to 2015 in Malaysia using data envelopment analysis (DEA). The DEA was used to measure technical efficiency, pure technical efficiency and scale efficiency of a set of multiple inputs and multiple outputs of the five Islamic banks. With the objective function to maximize the efficiency, five linear programming problems were constructed based on multiple inputs and multiple outputs of the selected banks. The DEA results reveal that the BMMB is the least efficient bank among the five investigated Islamic banks. This paper contributes to the efficiency measures among Islamic banks in Malaysia where improvement to products and services of the banks could be suggested in the future.*

Keywords: Linear programming, Data envelopment analysis, Efficiency measures, Decision making, Islamic bank

1. **Introduction.** The concepts of efficiency and productivity have been procuring to high consideration in the different type of sectors. According to Cooper et al. [1], efficiency and productivity have comparable idea and identified with each other. In simple words, efficiency is a company's execution estimation. If the concepts of input and output are used, then efficiency is a distance between the quality of input and output or frontier [2]. Productivity is characterized by a proportion of output to input [3]. Thus, the ratios of efficiency are more comprehensive than productivity. Therefore, efficiency is the most vital viewpoint for any sort of businesses. Measuring efficiency is an important concept in most organizations including banking sectors. The purpose of measuring efficiency is to make use of the available inputs to the most extreme or to implement greater profit with lower investment [4]. Efficient banking system is believed to contribute to the development of capital and execution of financial strategy of a nation.

In Malaysian banking industry, banks are grouped into several types depending on their nature of businesses. Commercial banks are the largest group and the main players in the banking industry, where the banking system is separated into two, which are conventional banking and Islamic banking. Both of these banking systems are operated under different principles. Malaysia has been known as the first country to introduce a dual banking system. Islamic banks have been existing for more than 30 years in Malaysia. The

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conventional banks also offer Islamic banking products and services under the declaration of Islamic Banking Act 1983. Subsequently, this makes the conventional bank become more competitive in Malaysia [5]. There are twenty seven commercial banks, of which eight are domestic banks and nineteen are foreign banks. Out of these twenty seven banks, sixteen are Islamic banks, of which ten are domestic banks and six are foreign banks. The principle behind Islamic banking is the sharing of earn and loss. Under Islamic principle, collection and payment of interest by lenders and investors are prohibited. Islamic banking made its depositors with some ownership or possession rights. However, the organizational set-up of Islamic banking is similar to the conventional banking [6]. The similarity in organizational set-up would raise some doubts over the efficiency of Islamic banks compared to conventional banks.

Many studies have been embarked on comparing the efficiency between Islamic banks and conventional banks particularly in the countries where both systems are operated concurrently. [7], for example, conducted an empirical study to analyze the efficiency of full-fledged Islamic banks in Pakistan. They discovered that Islamic banks were less efficient in terms of total technical efficiency than conventional banks. Other studies, such as [8-12] also support the findings that Islamic banks are less efficient than the conventional banks. All this while, most of the studies compared the efficiency between Islamic banks and conventional banks in various countries. It seems that the relative efficiency among Islamic banks is given less attention. Unlike all these comparative related researches, the current paper aims to measure efficiency among selected Islamic banks in Malaysia using a non-parametric approach based on decision making units. In this paper, the data envelopment analysis (DEA) is applied to measuring efficiency of selected Islamic banks that are currently operated in Malaysia. Specifically, this paper aims to apply DEA in proposing measurement values of efficiencies of five selected Islamic banks in Malaysia. The DEA is a well-known method used in measuring the relative efficiencies of inputs and outputs in many sectors, including banking sectors. The next section provides a short review on bank efficiency. Methodology of the research is given in Section 3. Computations and results are presented in Section 4. Finally, Section 5 concludes this paper.

2. **Related Research.** Bank efficiency has a substantial position in financial markets development. This section provides a brief review of the past research related to bank efficiency and productivity. A considerable amount of literature has been published on bank efficiency. [13] investigated the efficiency and productivity of banking system of seven central and east European countries from 2004 to 2008. In this research, the average efficiency of banks grew in the period of research. Ahmad et al. [10] conducted a research that measures and ranks the relative efficiency of the commercial banks and domestic Islamic subsidiaries by using DEA. This research emphasizes the scale efficiency, technical efficiency and pure technical efficiency. The result showed the technical inefficiency is due to pure technical inefficiency for the selected banks in 2008. On the other hand, the technical inefficiency depends on the scale inefficiency in 2009 and 2010.

[14] conducted a research about assessing the effect of local market conditions on efficiency of small mutual-cooperative banks' (BCCs) from 2006 to 2011. Firstly, the efficiency was evaluated by applying stochastic frontier. Then, the individual and environmental factors were regressed after the efficiency. The individual and environmental factors are intended to gage the structure of the BCCs reference market. Although the efficiency decreased over time, the results showed that BCCs have performed better than other bank in the present crisis. Moreover, BCC efficiency increases with demand density and market concentration and decreases as the number of bank branches in local market increases. [15] collected some cross-country evidence in the relationship between mergers and acquisition (M&A), and bank efficiency. The empirical analyses show that the link between

M&A and bank efficiency is weak. [16] analyzed the performance measurement of Indian banks using multi criteria decision making techniques. They investigated the efficiency of Nationalized Indian Banks using analytic hierarchy process (AHP) and DEA approach. In another related research, an efficiency assessment of Malaysia dual banking system was conducted using the dynamic slacks based model (DSBM) [17]. More precisely, a two-stage approach of DSBM was used first to assess the relative efficiency of Malaysia commercial banks a rating system. Monte Carlo Markov chain method was applied in the second stage to generalized linear mixed models. The model was then combined with DSBM as part of an effort to produce a model for banking performance assessment with effective predictive ability. The results indicate higher inefficiency levels and slacks among Islamic banks in Malaysia.

3. Methodology.

This section is divided into three subsections where the data, the evaluation model and also variables used in this study are described in three subsections.

3.1. Data.

In this research, the data were collected from annual reports of the banks. This information was retrieved from the official websites of the selected banks. This research is only interested in measuring the bank efficiency for ten years. Therefore, secondary data from 2006 to 2015 of bank's annual reports were collected. Five Islamic Banks were selected in this study. The banks are Affin Islamic Bank Berhad (AIBB), Bank Islam Malaysia Berhad (BIMB), Bank Muamalat Malaysia Berhad (BMMB), Hong Leong Islamic Bank Berhad (HLIBB) and RHB Islamic Bank Berhad (RHBIBB).

3.2. Evaluation model.

The data envelopment analysis (DEA) is a non-parametric method where linear programming (LP) is used for measuring relative efficiency of decision making units (DMUs). The DMUs consume a variety of multiple inputs and produce a variety of multiple outputs [18]. The DEA basic efficiency measure is the ratio of total outputs to total inputs.

$$Efficiency = \frac{output}{input}$$

In the case where there is one input and one output, then the output-input ratio exhibits efficiency. For the case of multiple inputs and multiple outputs, the multiplications with weights of inputs and outputs are suggested.

$$Efficiency = \frac{weighted\ sum\ of\ outputs}{weighted\ sum\ of\ inputs}$$

The DEA assigns one as efficient score and a score with less than one is considered as inefficient.

Let us consider a set of n *DMUs*, in which x_{ij} $(i = 1, 2, \ldots, m)$ and y_{rj} $(r = 1, 2, \ldots, s)$ are inputs and outputs of DMU_j $(j = 1, 2, \ldots, n)$. The standard form of DEA model for assessing DMU_p is written as:

$$\begin{aligned} \max \theta &= \sum_{r=1}^{s} v_r y_{r0}, \\ \text{s.t. } &\sum_{i=1}^{m} u_i x_{i0} = 1 \\ &\sum_{i=1}^{s} u_i x_{ij} \geq \sum_{r=1}^{m} v_r y_{rj} \leq 0, \quad \forall_j \\ &u_r, v_i \geq 0 \quad \forall_r i \end{aligned}$$

where u_i is the weight associated to the i^{th} input and v_r is the weight associated to the r^{th} output. The target DMU (DMU_0) is technically efficient if and only if $\theta = 1$.

It can be seen that the DMU_0 tries to find out its weight vector, in order to maximize its weighted output subjected to with the constraints. Each DMU utilizes m inputs to produce s outputs. The relative technical efficiency (TE), ρ_0 for DMU_0 is defined as $\rho_0 = \frac{1}{\theta_0}$.

For analysis under the assumption of pure technical efficiency (PTE), an additional convexity constraint is imposed on λ_k such that $\sum_{k=1}^{N} \lambda_k = 1$.

The ratio of TE and PTE efficiency is the scale efficiency (SE) and it is written as, $SE = \frac{TE}{PTE}$. The three efficiency measures TE, PTE and SE are used to measure the efficiency of the selected Islamic banks in Malaysia.

Prior to using this evaluation model, multiple inputs and multiple outputs (variables) are identified.

3.3. **Multiple inputs and multiple output.** The variables used in this study are selected based on the research of Wheelock and Wilson [19] and Tahir and Haron [20]. There are three inputs and three outputs selected to be inserted to the evaluation model. Table 1 presents the input/output variables and its brief descriptions.

Table 1. Input and output variables

Input/ Output	**Variable**	**Description**
Input	Deposit from customers (u_1)	Customer deposit is money paid to an organization by a customer, for which the organization has not yet given products or administrations in return.
	Personnel expenses (u_2)	Value of use identified with work force including compensation, advantages, trainings, and payroll taxes caused by the association amid the reporting period.
	Total assets (u_3)	Whole of all present and non-current resources and must be equivalent to the entire aggregate liabilities and stockholders' value joined.
Output	Earnings per share (v_1)	Portion of an organization's benefit distributed to each exceptional offer of basic stock. Earnings per share fill in as an indicator of an organization's benefit.
	Net profit and financing (v_2)	Quantity of offers dollars staying after all operating costs, premium, charges and favored stock profits have been deducted from an organization's total revenue.
	Advances and other loans (v_3)	Bank loans are made at enthusiasm, which means borrowers have to pay a specific rate. Most advances, likewise have a development date, by which time the borrower must have compensated the advance.

These variables are the main structure of the LP problem of DEA.

4. **Computations and Results.** In this section, the analysis is made according to the proposed steps. The efficiencies are measured according to the proposed steps. The computations are made as follows.

Step 4.1: **Data Collection**. The related data of this study were obtained from the Annual Reports of the investigated banks for ten years. The input variables are deposit from customers, personnel expenses and total assets, while the output variables are earning per share, net profit and financing, advances and other loans.

Step 4.2: **Construct Objective Function and Constraints**. The constraints of DEA Frontier are constructed. For the purpose of description on the procedural computation, data of the AIBB are used as an example. The linear programming (LP) model is formulated as follows.

The LP for DMUs A (AIBB):

$$< A > \max \theta = 0.914v_1 + 49743400v_2 + 4377965800v_3$$

Subject to $910175000u_1 + 6662709000u_2 + 46685900u_3 = 1$

$$910175000u_1 + 6662709000u_2 + 46685900u_3$$

$$\geq 0.194v_1 + 49743400v_2 + 4377965800v_3$$

$$32540382000u_1 + 28972793000u_2 + 318101900u_3$$

$$\geq 0.187v_1 + 48780600v_2 + 17454127440v_3$$

$$17672916000u_1 + 15577753000u_2 + 146906000u_3$$

$$\geq 0.108v_1 + 93629200v_2 + 8190666000v_3$$

$$14077121000u_1 + 14666164000u_2 + 157593000u_3$$

$$\geq 0.202v_1 + 132090200v_2 + 13188629000v_3$$

$$20775630000u_1 + 14666164000u_2 + 533867000u_3$$

$$\geq 0.173v_1 + 132090200v_2 + 13188629000v_3$$

Similarly, data of four other banks are employed to construct four other LP models for different DMUs.

Step 4.3: **Solve the LP Problem**. Step 4.2 are solved using DEA Frontier software to obtain the TE. An excerpt of the results is shown in Figure 1.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	**Inputs**		**Outputs**												
2	TA		EPS												
3	DFC		NP												
4	PE		LFA												
5															
6			Input-Oriented												
7			CRS	Sum of			Optimal Lambdas								
8	DMU No.	DMU Name	Efficiency	lambdas	RTS		with Benchmarks								
9	A	AIBB	1.00000	1.000	Constant		1.000	AIBB							
10	B	BIMB	1.00000	1.000	Constant		1.000	BIMB							
11	C	BMMB	0.74298	0.619	Increasing		0.035	BIMB		0.020	HLIBB		0.564	RHBIBB	
12	D	HLIBB	1.00000	1.000	Constant		1.000	HLIBB							
13	E	RHBIBB	1.00000	1.000	Constant		1.000	RHBIBB							
14															
15															

FIGURE 1. A snapshot of the results

The results obtained are summarized in Table 2.

TABLE 2. Technical efficiency

Islamic Bank	TE
AIBB	1.00000
BIMB	1.00000
BMMB	0.74298
HLIBB	1.00000
RHBIBB	1.00000

Step 4.4: **Iteration**. Computation in Step 4.3 is iterated to measure PTE. The results obtained for PTE are shown in Table 3.

TABLE 3. Pure technical efficiency

Islamic Bank	PTE
AIBB	1.00000
BIMB	1.00000
BMMB	0.80276
HLIBB	1.00000
RHBIBB	1.00000

Step 4.5: **Compute SE**. By using the efficiency results in Table 1 and Table 2, the SE is calculated using the ratio of TE and PTE. The ratio results are summarized in Table 4.

TABLE 4. Scale efficiency

Islamic Bank	SE
AIBB	1.00000
BIMB	1.00000
BMMB	0.92554
HLIBB	1.00000
RHBIBB	1.00000

Step 4.6: **Ranking the Efficiency**. Finally, the efficiency measures are ranked. Table 5 presents the ranking of bank efficiency.

TABLE 5. Ranking of efficiency

Islamic Bank	Ranking
AIBB	1
BIMB	1
BMMB	2
HLIBB	1
RHBIBB	1

It is shown that the AIBB, BIMB, HLIBB and RHBIBB are ranked as the first while BMMB is ranked as the second. Out of five Islamic banks, the BMMB fails to achieve the maximum efficiency. One of the possible explanations is that the BMMB has the least mean earning per share (RM0.108) and also the least mean net profit (RM93,629,200) despite the second high mean deposit from customers (RM15,577,752,800).

5. **Conclusion.** It is known that efficiency is a measure that can reflect the maximum output as a result of the given inputs. The purpose of this study was to establish the efficiency measures among the selected Islamic banks in Malaysia. This study investigated the efficiency of Islamic banks during the period of 2006-2015 using a non-parametric approach DEA method. This approach used a set of decision making units which later are used as multiple inputs and multiple outputs. The efficiency measures of the selected Islamic banks based on three efficiency measures were obtained. The efficiency measures have given a better understanding pertaining to the efficiency of five Islamic banks in Malaysia. In this investigation, it is found that the BMMB is the least efficient banks compared to four other Islamic banks. One of the limitations from this investigation is the selected time frame of the investigation. The results were obtained after considering 10 years data retrieved from the annual reports of respective banks. This work contributes to existing knowledge in efficiency of Islamic banks by suggesting the banks that really

achieve the efficiency level. It is good if this time frame is extended with more years taken into consideration, so that larger inputs and output data could be captured. Another point that could be explored in future research is the number of banks. All Islamic banks that are currently operating in Malaysia should be included as a comprehensive case study.

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