Bootstrap DEA Analysis of Comparative Efficiencies of Islamic Banks: Across Nine South and Southeast Asian Countries

Abdus Samad
Utah Valley University

Using panel data (2011-2016), this paper applied the Bootstrap Data Envelope Analysis (DEA) and obtained overall technical efficiencies (TE), pure technical efficiencies (PTE), and scale efficiencies of the Islamic bank of the nine South and Southeast Asian countries The paper found the average TE, PTE, and SE were 77.3 percent, 81.2 percent, and 95.3 percent respectively. Comparison of efficiencies found: (i) the average TE of the Islamic banks of Malaysia was 81.9 percent and was the highest in the region; (ii) the average managerial efficiency (PTE 87.00) of the Islamic banks of Malaysia was the highest in the region except Brunei, Singapore, and Thailand; (iii) The average scale efficiency of Pakistan's Islamic banks was 96.8 percent and was the highest in the region except Singapore and Maldives.. The reason why the Islamic banks of Malaysia and Pakistan were most efficient in the region is because they were the first to introduce Islamic banks to operating side by side with the conventional banks in the region.

Keywords: Bootstrap DEA, technical efficiency comparison, Islamic banks, South and Southeast Asia

INTRODUCTION

This paper studied the bank efficiencies of the Islamic banks of nine South and Southeast Asia countries (SSEA): Indonesia, Malaysia, Brunei, Singapore, Maldives, Thailand, Bangladesh, Sri Lanka, and Pakistan deserve examination for several reasons.

The survey of literature, provided in Section 2, shows no evidence of the efficiency studies of the nine South and Southeast Asia (SSEA) countries Islamic banks. There are many Islamic banks operating in SSEA side by side and competing with conventional banks (interest-based banks). As Islamic Banks operation is the newest generation and the newest breed of financial institution, common sense view in the market that they are less efficient without proof. Financial markets want evidence to back the commonsense view, Islamic banks are less efficient, prevalent in the market. The accommodation of the commonsense cannot and should not continue for indefinite period. It deserves empirical evidence. The study of average technical efficiencies of the Islamic banks in the region is thus important and it deserves exploration.

Second, there is no evidence of comparative studies of efficiencies across Islamic banks in these regions. Although there are many Islamic banks competing with conventional banks in the SSEA region, and the Islamic banks of some countries were operating longer than those of other countries, yet their comparative level of technical efficiencies are unknown. We have no evidence of comparative efficiency levels across the Islamic banks of the region.

Third, as there is no efficiency studies, it is interesting to know whether the Islamic banks of pioneer countries, Malaysia, Bangladesh and Pakistan, were more efficient than the banks of trailer/follower

countries such as Indonesia, Sri Lanka, Thailand, and Singapore. Islamic banks of these trailer counties were of recent development. Banks of these countries are newcomers. Bankers, depositors, and the people of the region need to know how banks across these countries are performing in terms of various efficiencies.

Fourth, the study of efficiency is important for both the macroeconomics and the microeconomics point of view. Bank efficiency, from the macroeconomics point, is important for economic growth. The growth of banking and its efficiency is essential for economic development. Bank inefficiency and the subsequent failures have catastrophic impacts on economic growth and employment. The 2008-2009 global financial crisis caused by large scale bank failures in the U.S. testifies the claim.

Fifth, the study of efficiency is important from the microeconomics point of view. The inefficiency of banks both increases the cost of intermediation and affects the allocation of funds as well as the profitability of these banks resulting in bank failure (Samad, 2014). The increased efficiency in banks' deposit mobilization and loan advancement is key to successful entrepreneurs for enhancing the economic growth of a country (Schumpeter, 1911).

This study of efficiency and comparative efficiency using bootstrap DEA method is an important contribution to the banking literature, particularly on Islamic banking, in view of the absence of such studies across countries. This paper also contributes on estimate of overall bias-corrected technical efficiencies BC-TE), bias-corrected pure technical efficiencies (BC-PTE) and the scale efficiencies (SE) of the Islamic banks of the region and the comparative level of efficiency across countries.

This paper is organized as follows: a brief description of the characteristic features of the Islamic banks is outlined in section 2. Section 3 provides the survey of the literature. Data, methodology, and models are discussed in section 4. Section 5 provides empirical results. Conclusions are presented in Section 6.

KEY CHARACTERISTICS FEATURE OF ISLAMIC BANK

The Islamic bank is a different breed of the financial institution because of special characteristics and mode of operation.

The most distinguishing characteristics of the Islamic banks is the profit and loss sharing mode of operation. The key features of profit and loss sharing (PLS) are that (i) Both parties (bank and borrower) share the outcome of business venture (profit or loss); unlike conventional bank equity contracts where banks do not bear the risk of financing investments, Islamic banks share the risk of investment. That is, if there are losses, Islamic banks share the losses of investments (ii) Unlike conventional banks' equity contracts where banks enjoy the fixed rate of return from investments, even when there are losses for the project, there is no predetermined rate of returns on investments for Islamic banks. Justice requires that both partners of business must share the risk of the business. Thus, the key features of the Islamic banking and finance are, PLS, the avoiding of fixed interest, and Shariah based business conduct.

The other important characteristics is that the operation of Islamic banks are guised the Shariah rule. The shariah law of Islam prohibits the consumption and production of any harmful activity, such as wine, alcohol, and destructive weaponry. Since these are not permitted, Islamic banks do not finance the production and consumption of these kinds of businesses, irrespective of high profit prospects.

Another important characteristic is the avoidance of riba (usury) which is now interpreted as interest, although they are not the same. The Quran, the Divine book of Islam, without defining what "riba" is, strongly prohibits riba in business transactions. The Quran says: "… whereas Allah permitted trading and forbidden riba" (Quran: 2: 275). However, neither the Quran nor the Prophet of Islamic did define what riba is[1]. At present, riba is interpreted as interest. The present scholars of Shariah agreed that the predetermined fixed rate of return is not permitted in the business transactions of the Islamic bank and financing.

SURVEY OF LITERATURE

A survey of the efficiency studies of the Islamic banks can be classified in two broad categories: A. studies of the efficiency of the Islamic banks, and B. studies of the efficiency determinants of the banks,

Islamic banks in particular. As efficiencies are the main focus of this paper, the survey of literature will concentrate on studies of the efficiencies of Islamic banks.

El-gamal and Inanoglu (2004) estimated the comparative cost efficiency of the Turkish banks during the period 1990-2000 using the data envelopment analysis (DEA) method. They found that the Islamic banks were more efficient due to Islamic banks' asset-based financing mechanism.

Sufian and Majid (2006) investigated the comparative efficiency of the foreign and domestic banks of Malaysia during 2001-2005. They found that banks' scale inefficiency dominated over the pure technical efficiency during the period. They also found that the foreign banks were more technically efficient than the domestic banks.

Kumar *et al* (2008) examined three efficiencies, technical efficiency, pure technical efficiency, and scale efficiency, of the 27 public sector banks of India for the year 2004. The empirical evidence of the paper showed that public sector banks were technically 88.5 percent efficient i.e., the inefficiency of the banks was 11.5 percent. Only 7 banks were technically efficient. The regression results of the paper found that the off-balance activities positively affected the Indian bank efficiency.

Samad (2013) investigated the efficiency of Islamic banks using the time-varying Stochastic Frontier function on the Islamic banks of 16 countries. Mean efficiencies between the pre-global financial crisisand the post-global crisis were estimated at 39 and 38 percent respectively and the difference was not statistically significant suggesting that the efficiencies of Islamic banks did not deteriorate during the global financial crisis.

Samad (2013) empirically estimated the technical efficiencies (TE) of Islamic banks of Bangladesh and compared these with conventional banks in deposit mobilizations and loan financing in 2010. TE was estimated applying the stochastic frontier production function. The paper found the mean TE of Islamic banks and conventional banks in loan financing was 59.6 percent and 62.8 percent respectively, and for deposits, the mean efficiency was 0.61 and 0.60 respectively. Parametric tests such as Satterthwaite-Welch t-test, ANOVA F-test, and Walch F-test, found no statistical evidence of significant differences between the TE of Islamic and conventional banks.

Samad (2017) estimated the loan and the deposit efficiencies of the Islamic banks of Malaysia during 2008-2012 applying the Data Envelopment Analysis (DEA) technique. The study found that the Islamic banks of Malaysia enjoyed the higher TE in deposit mobilizations than in the loan financings. The average technical efficiency of loan financing was 83 percent, 88 percent, 87 percent, 97 percent, and 94 percent in 2008, 2009, 2010, 2011, and 2013 respectively whereas the average technical efficiency in deposit mobilizations was 87 percent, 94 percent, 94 percent, 96 percent, 92percent, and 96 percent in 2008, 2009, 2010, 2011, and 2012 respectively. Whereas in loan financing, only four banks in 2008,two banks in 2009, three banks in 2010, and two banks in 2011-2012 were efficient in both technical efficiency and scale efficiency. On the other hand, in deposit mobilization, four banks in 2008 and 2009,five banks in 2010 and 2011, three banks in 2012, and five banks in 2013 were efficient in technical efficiency and scale efficiency. Most of the Islamic banks in Malaysia were operating below the optimum scale of production.

Applying both parametric method (SFA) and non-parametric frontier methods (DEA), Hassan (2006) Estimated various efficiencies, such as the cost, profit, allocative, technical, pure technical and scale efficiency of 43 Islamic banks in 21 countries from Middle East, Asia, Africa and Europe over the period 1995-2001. He found that Islamic banks were more cost inefficient than profit inefficient suggesting Islamic banks were more efficient in profit-making and in technical inefficiency. The technical efficiency dominated the scale efficiency. His findings confirmed the findings of Yudistira (2004). Yudistria examined the cross-country technical efficiency of 18 Islamic banks of GCC, East Asian, African and Middle Eastern countries during the period 1997-2000 and found that the overall technical inefficiency score of Islamic banks was on average just over 10%.

Sufian and Noor (2009) applied the panel DEA method and estimated the technical efficiencies of the MENA Islamic banks and the Asian Islamic banks and then compared their technical efficiency over the period 2001-2006. They found that the efficiency of the MENA Islamic banks was higher than thatof the Asian Islamic banks. Pure technical inefficiency was less prominent than the scale inefficiency. Scale inefficiency was the major source of inefficiency.

Using the DEA Noor and Ahmad (2012) investigated the efficiency of 78 Islamic banks operating in 25 countries in the world during the period 1992–2009 and found that the technical efficiency of the Islamic banks has increased during and after the global financial crisis period. The financial crisis of the period has decreased trust in the conventional banking system in favor of the Islamic banking system. They further found that the pure technical efficiency scores of the sampled Islamic banks werehigher than their scale efficiency scores which contradicted the findings of Sufian and Noor (2009) and Yudistira (2004).

Using the data of 25 Islamic banks in GCC countries for the period 2003-2009 and applying the DEA method, Srairi and Kouki (2012) found: (i) the overall technical inefficiency of GCC Islamic banks wasthe result of pure technical inefficiency (29.3%) rather than that of the scale inefficiency (17%); (ii) theoverall technical efficiencies of the Islamic banks increased during and after the global financial crisis.

Applying the DEA, Rahman and Rosman (2013) and Rosman et al. (2014) compared the technical efficiency levels of the Middle Eastern Islamic banks with those of their Asian counterparts during 2007-2009 and 2007-2010 and found the technical efficiency of the Middle Eastern Islamic banks declined, while the technical efficiency of the Asian Islamic banks increased.

Hassine and Limani (2014) examined 22 MENA Islamic banks during 2005-2009 and found that the pure technical inefficiency was the main source of Islamic banks' technical inefficiency.

Bahrini (2016) examined the technical efficiencies of the 33 MENA Islamic banks during and after the global financial crisis using the DEA and bootstrap DEA and found that the technical inefficiencies ofthe MENA Islamic banks were mainly attributed to pure technical inefficiencies (17.9%) rather than scale inefficiencies (9.1%).

To sum: This survey shows: (i) no evidence of studies on the efficiencies of the Islamic banks of the South and Southeast Asian countries, Indonesia, Malaysia, Brunei, Singapore, Maldives, Thailand, Bangladesh, Sri Lanka, and Pakistan as group; (ii) there is no evidence of comparative studies of efficiencies such as, the overall bias-corrected technical efficiencies BC-TE), bias-corrected pure technical efficiency (BC-PTE) and the scale efficiency—across the Islamic bank of the region. So, thisstudy is a pioneering work for this region and provides an important contribution in the efficiency literature of the Islamic banks.

DATA AND METHODOLOGY

Data

This paper uses the panel data for the period 2011-2016 in estimating the bootstrap DEA efficiency. Data of fixed capital, employee wages, bank deposit, gross loans, and earning assets for the period were obtained from Bank Scope data source. Values of variables for Malaysia, Indonesia, Brunei, Maldives, Thailand, Sri Lanka, Bangladesh, and Pakistan during 2014-2016 were expressed in constant U.S. dollar.

Methodology

First, this paper applied the Bootstrap-DEA Method for obtaining bias corrected technical efficiency. In spite of the wide application, the DEA method suffers from serious shortcomings, according to Simarand Wilson (1998). (i) DEA method is deterministic. That is, the efficiency score obtained by the DEAdoes not allow for random error such as machine failure or power out etc. It thus overestimates the efficiency scores of the DMU and leads to biased efficiency (Simar and Wilson, 1998). (ii) The DEA methodology score does not provide a confidence interval. This paper, thus, employs the bootstrap- DEA approach introduced by Efron (1979). The main idea or objective of bootstrap is to simulate the data generating process (DGP) with repeated sampling. That is, it replicates repeated sampling from thedata. As the replicated data set approximates the original data, the sampling distributions of the samplemean and standard deviations generated from the repeated sampling are close to the original ones.

The bootstrap-DEA was first introduced by Simar and Wilson (1998) and it provides estimated efficiency scores of each DMU generated from numerously repeated sampling. The bootstrap-DEA, thus, provides the bias-corrected efficiency scores together with the confidence interval at α level. So, bootstrap-DEA efficiency scores are more accurate and have statistical properties which the DEA method efficiency scores lack.

Empirically, an estimate of the radial Debreu-Farrell output-based measure of technical efficiency can be calculated by solving a linear programming problem for each data point k (k=1, . . ., K):

$$\hat{F}_k^0(Y_k, X_k, Y, X|CRS) = \max_{\theta,z} \theta \quad (1)$$

$$\text{s.t.} \quad \sum_{k=1}^{K} Z_k Y_{km} \geq Y_{km}\theta_m, m = 1, \ldots, M$$
$$\sum_{k=1}^{K} Z_k X_{kn} \leq X_{kn}, n = 1, \ldots, N$$
$$Z_K \geq 0$$

where Y is K x M matrix of available outputs, X is K x N matrix of available inputs. CRS specifies constant returns to scale. For variables to scale (VRS) a convexity constraint $\sum_{k=1}^{K} z_k = 1$

θ Is a scalar and represents the efficiency score of each decision-making unit (DMU). The range of $\leq \theta \leq 1$, with a value of 1 indicating a point on the frontier and hence a technically efficient DMU; i.e., output the of the DMU cannot be increased without increasing inputs. A DMU is inefficient when the value of $\theta < 1$; that is, a given output can be produced by reducing inputs of the DMU.

Bias is calculated as follows:

$$\text{Bias}\left(\hat{\theta}_k\right) = \text{E}\left(\hat{\theta}_k\right) - \hat{\theta}_k$$
$$\text{Bias}\left(\hat{\theta}_k\right) = B^{-1}\sum_{k=1}^{K}\left(\hat{\theta}_k\right) \cdot -\hat{\theta}_k$$

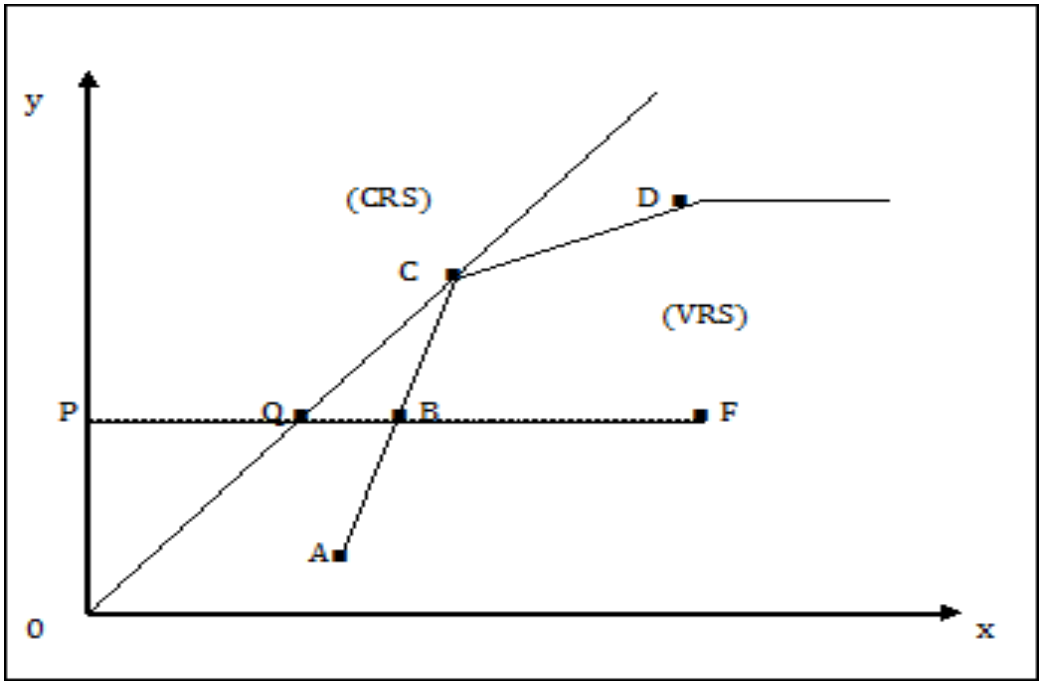
The bias-corrected efficiency score can be expressed as:

$$\tilde{\theta}_k = \hat{\theta}_k - \text{bias}\left(\hat{\theta}_k\right) = 2\hat{\theta}_k - B^{-1}\sum_{k=1}^{K}\left(\hat{\theta}_k\right)$$

The DEA is a linear programming technique, originally developed by Charnes et al. (1978), for constructing the best practice frontier from the observed inputs and outputs of all the sampled Decision-Making Units (DMUs). By comparing DMUs outside the frontier (inefficient DMUs) with those that lie on the frontier (efficient DMUs), this method can provide efficiency measures for each DMU (Coelli et al., 2005). The DEA has two versions. The DEA model proposed by Charnes, Cooper, and Rhodes (1978) is known as the CCR model. It measures the efficiency of the DMU under the assumption of constant returns to scale (CRS). As all DMUs do not operate under the CRS, Banker, Charnes, and Cooper (1984) proposed a DEA model called the BCC model. The BCC model assumes that DMUs operate under a variable return to scale (VRS) (increasing, constant or decreasing returns to scale.

The difference between the CCR and BCC models can be illustrated by the following figure:

FIGURE 1
CRS AND VRS EFFICIENCY FRONTIERS



(Coelli et al., 2005)

The line through the points Q and C represents the CRS efficiency frontier and the curve (ABCD) represents the VRS efficiency frontier. Each DMU that is on the frontier is technically efficient. For this reason, the particular DMU "F" is technically inefficient. When we refer to the CRS frontier, the distance FQ measures the technical inefficiency of the DMU "F". However, when we consider the VRS frontier, the technical inefficiency of the DMU "F" is only the distance FB. The difference between the CRS and the VRS frontiers is the distance QB which is a measure of scale inefficiency.

- The overall technical efficiency score (under the CRS frontier):TECRS = PQ/PF
- The pure technical efficiency score (under VRS frontier): TEVRS = PB/PF
- The scale efficiency score: SE = PQ/PB

From this, we can deduce that TECRS = TEVRS x SE which means that the overall technical efficiency (OTE) of a particular DMU is the product of two efficiencies: pure technical efficiency (PTE) and scale efficiency (SE).

Suppose that there are n DMUs to be evaluated. Each DMU_j, j =1, …., n uses m different inputs, noted *(i = 1, . . ., m)*, to produce s different outputs, noted *(r = 1, . . ., s)*. The technical efficiency score for a particular DMU, called DMUo, is determined by solving the following linear programming problem. The technical efficiency score θ for a particular DMU, called DMUo, is determined by solving the following linear programming problem:

$$\begin{aligned} &\theta^* = \text{Min } \theta \\ \text{s.t. } &\textstyle\sum_{j=1}^{n} \lambda_j x_{ij} \le \theta x_{io} && i = 1, \dots\dots, m; \\ &\textstyle\sum_{j=1}^{n} \lambda_j y_{rj} \ge y_{ro} && r = 1, \dots\dots, s; \\ &\lambda_j \ge 0 && j = 1, \dots\dots, n; \end{aligned} \qquad (1)$$

$\theta < 1$ Means that the evaluated DMU is technically inefficient. $\theta = 1$ Indicates a point on the frontier and hence a technically efficient DMU. In order to estimate the efficiency scores of all the DMUs in the sample, the above problem must be solved n times, once for each DMUj, $j = 1, n$ (Coelli et al., 2005).

Input-Output Controversy and Model Selection

In a firm's production, like coal mine, the inputs and outputs are easy to find. The output is the amount of coal and the inputs are labor and capital. However, in the multiproduct firms such as a bank which produces a series of services and uses a vector of inputs, deciding inputs and outputs are controversial. Which are the bank's inputs and which are the bank's outputs are a debatable issue for a long time.

Based on production approach (Benston, 1965), a bank is a producer of services for the bank account holders and it produces deposit accounts and loan services with labor and capital. In this sense, the number of deposit account or deposits can be used as output. Depositors' income which is equivalent to interest paid to depositors is an important factor for mobilizing total deposits.

Under the intermediation approach, first used by Sealey and Lindley (1977), the bank is a financial intermediary which collects deposits from the savers and channels funds to borrowers. It treats earning assets as outputs and deposits as inputs. In this sense, loans, investments in securities, and advances are the outputs of a bank and labor, capital, deposits, and expenses related to them are inputs of a bank

Based on Sealey and Lindley (1977), this paper estimates the following model using bootstrap DEA based on the assumption of Banker, Charnes, and Cooper[2] (1984):

Model 1:

$$loan_i = \beta_0 + \beta_1 \text{ Fixed capital} + \beta_2 salay + \beta_3 Deposit \quad (2)$$

where $loan_i$ = total loans + total earning assets. They are considered as output.
prem= bank fixed capital, salary= Salaries, and Depo = total deposits. They are considered as bank inputs used for producing outputs.

Descriptive statistics of inputs and output variables used for estimating technical efficiencies are provided in Table 1

TABLE 1
DESCRIPTIVE STATISTICS OF INPUTS AND OUTPUT VARIABLES FOR EFFICIENCY ESTIMATE

	Inputs for DEA Model			Output for DEA Model	
	WAGE	CAPITAL	DEPOSITS	LOANS	EARNASSET
Mean	27762.43	31248.35	2889310.	2427496.	3399466.
Median	11975.00	8458.000	1364184.	1260166.	1626164.
Maximum	190534.0	1028517.	23268496	18658282	25319612
Minimum	140.0000	4.000000	43.00000	225.0000	6140.000
Std. Dev.	39596.85	75097.63	3942223.	3334893.	4685625.
Skewness	2.221717	8.786129	2.274235	2.441312	2.259164
Kurtosis	7.407805	110.5465	9.119032	10.17270	8.797715
Jarque-Bera	465.1776	142005.6	695.1515	900.3146	646.0942
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	285	287	287	287	287

All values are in constant dollar

EMPIRICAL RESULTS

The estimated efficiency score of the overall bias-corrected technical efficiencies BC-TE), bias-corrected pure technical efficiency (BC-PTE) and the scale efficiency (SE) of the Islamic banks of nine countries in the region is presented in Table 3, Table 4, and Table 5.

TABLE 2
OVERALL STANDARD TECHNICAL (TE), BIAS-CORRECTED TECHNICAL EFFICIENCY (BCTE), BIASES, AND INTERVAL VALUE[1]DURING 2011-2016

Country	# of banks	TE	BC-TE	Bias	BCTELOWER	BCTEUPPER
Malaysia	17	0.875	0.819*	0.048	0.826	0.873
Indonesia	10	0.749	0.723*	0.013	0.709	0.745
Bangladesh	8	0.769	0.758*	0.043	0.699	0.765
Pakistan	6	0.814	0.786*	0.028	0.771	0.809
Brunei	1	0.761	0.754*	0.008	0.746	0.760
Singapore	1	0.936	0.800*	0.13	0.761	0.921
Thailand	1	0.767	0.751*	0.012	0.745	0.764
Sri Lanka	1	0.782	0.774*	0.014	0.758	0.780
Maldives	1	0.778	0.770*	0.007	0.759	0.775
All Banks average		**0.797**	**0.773***	**0.020**	**0.756**	**0.790**

1= BCTELOWER and BCTEUPPER represents the 95% confidence level lower-limit and upper-limit value of bias-corrected technical efficiencies. c*= Efficiency score significant at a 5 % level.

The (TE) score shows the constant returns to scale efficiency obtained from the Data Envelope Analysis (DEA). The bias-corrected technical efficiency (BC-TE) scores were obtained by bootstrap DEA method. The BC-TE score are estimated at a 5 percent level of significance and are within the lower and upper bound of the confidence level.

Table 2, shows the average BC-TE of all Islamic banks in the region was 77.3 percent. This result suggests that the average technical inefficiency of all banks of the region was 22.7 percent.

Comparative results of the overall bias-corrected technical efficiencies (BC-TE) across banks of the region showed that the banks of Malaysian had the highest average BC_TE over all the Islamic banks in the region. The average BC-TE of Malaysian Islamic banks was 81.9 percent. This suggests that the average technical inefficiencies of the Malaysian Islamic banks were 18.1 percent.

The average overall BC-TE of the Islamic banks of Pakistan was the second. The average BC-TE of the Pakistan Islamic banks was 78.6 percent suggesting that the average inefficiency was 21.4 percent.

The average overall BC_TE of the Islamic banks of Indonesia, Bangladesh, Brunei, Thailand, Sri Lanka, and Maldives were below the regional average of 77.3 percent suggesting that the inefficiencies of the banks of these countries were higher than the regional average of 22.7 percent.

The average BC-TE of Islamic banks of Indonesia were the lowest in the region with the exception of Brunei, Thailand, Sri Lanka, and Maldives. The average BC-TE of the Indonesian Islamic banks was 72.3 percent.

TABLE 3
STANDARD PURE TECHNICAL EFFICIENCY (PTE), BIAS-CORRECTED PURE TECHNICAL EFFICIENCY (BCPTE), BIAS, AND INTERVAL VALUE1 DURING 2011-2016

Country	# of banks	PTE	BC-PTE	Bias	BCPTELOWER	BCPTEUPPER
Malaysia	17	0.904	0.870*	0.034	0.840	0.899
Indonesia	10	0.797	0.782*	0.014	0.769	0.793
Bangladesh	8	0.829	0.816*	0.013	0.803	0.826
Pakistan	6	0.837	0.807*	0.029	0.781	0.833
Brunei	1	0.868	0.855*	0.013	0.842	0.865
Singapore	1	0.957	0.864*	0.093	0.802	0.952
Thailand	1	0.866	0.855*	0.010	0.844	0.863
Sri Lanka	1	0.815	0.801*	0.014	0.790	0.812
Maldives	1	0.782	0.766*	0.017	0.749	0.779
All Banks average		**0.836**	**0.812***	**0.024**	**0.790**	**0.832**

1= BCTELOWER and BCTEUPPER represents the 95% confidence level lower-limit and upper-limit value of bias-corrected technical efficiencies. c*= Efficiency score significant at 5 % level.

Table 3 shows the average bias-corrected pure technical efficiency, also known as managerial efficiency, of all banks in the region was 81.2 percent. The average managerial efficiency (PTE) of the Islamic banks of Malaysia, excluding Brunei, Singapore, and Thailand, was higher than the average of the region. The average efficiency of the Malaysian Islamic banks was 87 percent compared to 81.2 percent of the region.

Although the average PTE of Brunei, Singapore, and Thailand Islamic banks was higher than the regional average of 81.2 percent, the result should be interpreted with caution. Because only one bank in each of these countries was in operation during 2013-2016 under this study.

The average estimation bias (BIAS) of all banks in the region was 0.02.

TABLE 4
AVERAGE SCALE EFFICIENCY (SE) SCORE OF SOUTHEAST ASIAN ISLAMIC BANKS DURING 2016-2011

Country	**Total observation**	**SE Score**	**Total CRS (Scale efficient)[1]**	**IRS**	**Total DRS**	**Total Banks**	**% scale efficient**
Malaysia	107	0.916	54		53	17	50.4
Indonesia	60	0.942	29		31	10	48.3
Bangladesh	52	0.932	13		39	8	44.2
Pakistan	38	0.968	21		17	6	55.2
Brunei	6	0.878			6	1	0
Singapore	3	0.978	3			1	100
Thailand	4	0.887			4	1	0
Sri Lanka	4	0.967	1		3	1	25.0
Maldives	3	0.994	3			1	100
Total	277		124		153	46	
All Banks average		0.953					45.6

1.number in the column represents the number of times during 2011-2016 the banks in the country were operating under the constant returns to scale (CRS), decreasing returns to scale (DRS), and increasing returns to scale (IRS). 2.

Table 4 shows, among countries of the Southeast Asia, the Islamic banks of Pakistan were more scale efficient during the period 2011-2016, excepting the banks of Singapore and Maldives. The average scale efficiency of the Islamic banks of Pakistan was 55.2 percent. Banks of Malaysia and Indonesia followed the efficiency of Pakistan. The average scale efficiency of the Islamic banks of Malaysia and Indonesia was 50.4 percent and 48.3 percent respectively.

The 100 percent scale efficiency of Singapore and Maldives Islamic banks should be interpreted cautiously because there is only one Islamic bank under this study in each of the countries. Secondly, the efficiency score represented the result of only three years (2013-2016).

Similarly, the 100 percent scale inefficiency of Brunei and Thailand Islamic banks should be interpreted cautiously because there was only one Islamic bank in these countries under this study. Secondly, the estimated inefficiency score was the result of only three years (2013-2016).

The higher scale efficiency of the Islamic banks of Pakistan and Malaysia, among the Islamic banks of the Southeast Asia, could be due to the reason they were the pioneers of Islamic banks. They were the first countries after Egypt to introduce Islamic bank. As these countries were the first to introduce Islamic banks to operate side by side with conventional banks, banks of these countries acquired and learned more operational, competitive and survival skill than the Islamic banks of other countries.

Results of comparative efficiencies: overall technical efficiency (BC-TE), managerial efficiency (BC-PTE), and Scale efficiency (SE) show that SE dominated other efficiencies. The average SE of all banks in the region was 95.3 percent suggesting that the scale inefficient was only 4.7 percent. The average managerial efficiency, BC-PTE, of all banks in the region was 81.2 percent suggesting the average inefficiency of bank management was 18.8 percent. The average technical efficiency (BC-TE) of all banks in the region was 77.3 percent i.e., inefficiency in resource allocation was 22.7 percent.

Results of comparative analysis of all three efficiencies: (BC-TE), (BC-PTE), and (SE) across all banks in the region showed that the average overall technical efficiency (BC-TE) and the management efficiency (BC-PTE) of the Malaysian Islamic banks were highest among the Islamic banks of the South and Southeast Asian countries. The average BC-TE and BC-PTE of Malaysian Islamic banks was

81.9 percent and 87.0 percent respectively. Pakistan was the second highest in BC-TE. The average overall BC-TE of the Islamic banks of Pakistan was 78.6 percent.

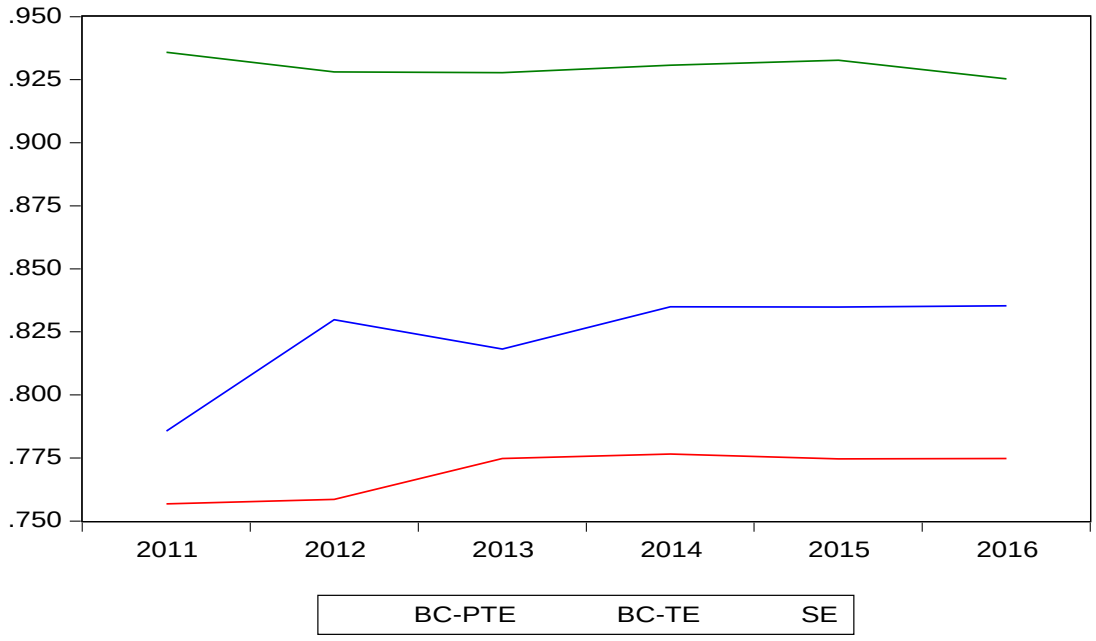
In terms of scale efficiency (SE), the Islamic banks of Pakistan were more scale efficient than the Islamic banks of all countries under study in the region. Whereas the scale efficiency of Pakistan's Islamic banks was 55 percent during 2011-2016, the scale efficiency of Malaysian Islamic banks was 50 percent during the same period. Thus, the scale efficiency of Malaysian Islamic banks ranked second in the region.

The growth of the three types of bank efficiencies—BC-TE, BC-PTE, and SE—is presented in Figure 2. Figure 2 shows that bank technical efficiencies (BC-TE) increases from 2011 to 2013 and remains stable in the region i.e. South and Southeast Asia during 2013-2016.

Bank managerial efficiency, BC-PTE, fluctuated over from 2011 to 2013 and then remains stable. The scale efficiency of banks in the South and Southeast Asia, under study, remained stable until 2015.

In general, all three efficiencies: BC-TE, BC-PTE, and SE, remained relatively stable. This stability of efficiencies could be explained by the stability of economic growth of these countries. The per capita GDP of these countries were stable.

FIGURE 2
COMPARATIVE GROWTH OF PURE TECHNICAL EFFICIENCY, TECHNICAL EFFICIENCY, AND SCALE EFFICIENCIED DURING 2011-2016



Comparative Efficiencies of Islamic Banks Across Countries

Comparative growth trend of all three efficiencies: the overall bias-corrected technical efficiencies BC-TE), bias-corrected pure technical efficiency (BC-PTE), and the scale efficiency (SE) of the Islamic banks across countries in the region is presented in Figure 3, Figure 4, and Figure 5.

The growth of the overall technical efficiency (BC-TE) of the Islamic banks of Malaysia, Indonesia, Brunei, Singapore, Thailand, Maldives, Sri Lanka, Bangladesh, and Pakistan is presented Sri Lanka, Bangladesh, and Pakistan are presented in Figure 4.

Figure 3 shows the fluctuation of BC-TE of Islamic banks across the countries. However, Islamic banks of Malaysia and Bangladesh shows the growth of overall BC-TE since 2014 until 2016. On the other hand, Pakistan and Thailand shows a declining growth of BC-TE since 2014. Only the Islamic banks of Singapore were 100 percent efficient. However, this result of Singapore banks should interpreted carefully because there was only one Islamic bank in Singapore under this study.

The growth of the managerial efficiency (BC-PTE) of the Islamic banks Malaysia, Indonesia, Brunei, Singapore, Thailand, Maldives, Sri Lanka, Bangladesh, and Pakistan are presented in Figure 4.

Figure 4 shows that the average managerial efficiency, BC-PTE, of Islamic banks across the countries remain unstable. However, the managerial efficiency of the Islamic banks of Malaysia and Bangladesh shows an increasing trend from 2014 to 2016. On the other hand, Pakistan and Thailand shows a declining trend of BC-PTE since 2014. Only Singapore Islamic banks showed that their managerial efficiency was 100 percent. This result of Singapore banks should interpreted carefully because there was only one Islamic bank in Singapore under this study.

The trend of the scale efficiency (SE) of the Islamic banks of Malaysia, Indonesia, Brunei, Singapore, Thailand, Maldives, Sri Lanka, Bangladesh, and Pakistan is presented in Figure 5.

FIGURE 3
GROWTH OF ISLAMIC BANKS' OVERALL TECHNICAL EFFICIENCY (BC-TE) ACROSS COUNTRIES

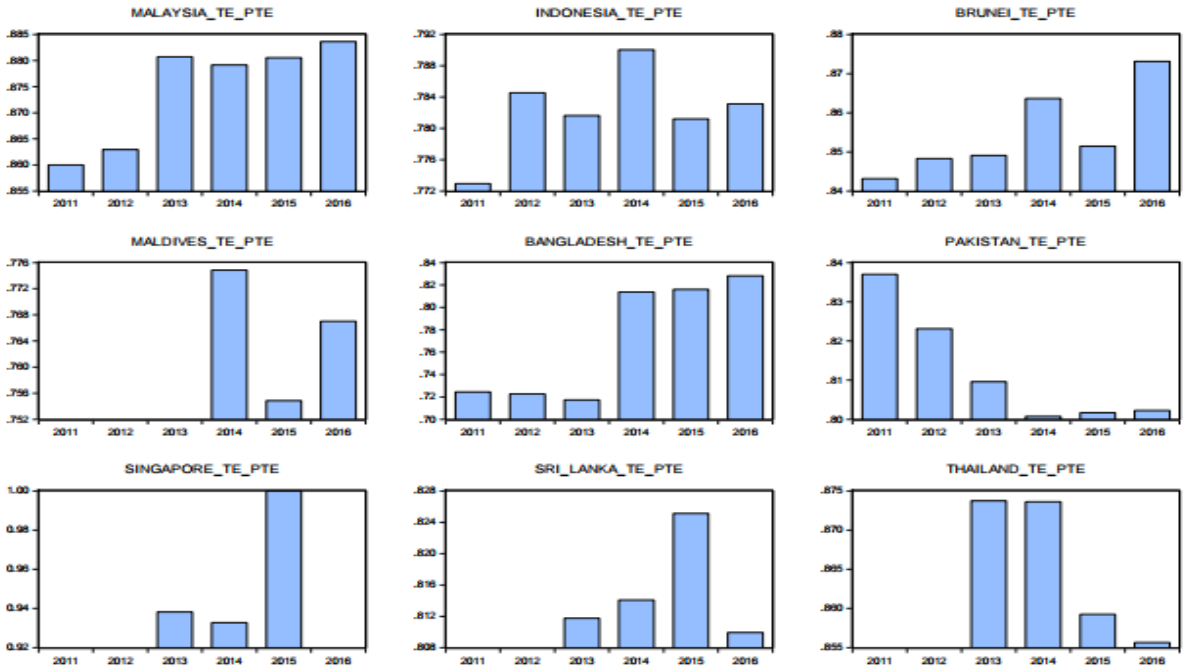
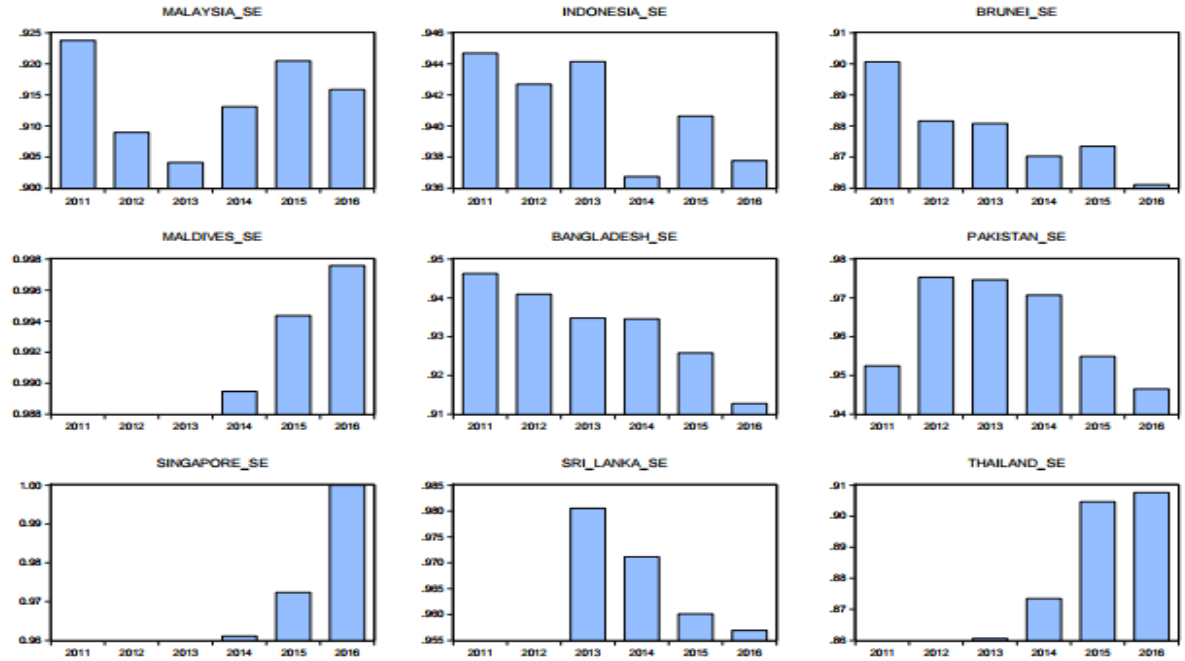


FIGURE 4
GROWTH OF ISLAMIC BANKS' MANAGERIAL EFFICIENCY (BC-PTE) ACROSS COUNTRIES



CONCLUSIONS

This paper estimated and compared efficiencies of the Islamic banks of nine South and Southeast Asian countries: Indonesia, Malaysia, Brunei, Singapore, Maldives, Thailand, Bangladesh, Sri Lanka, and Pakistan.

In estimating bank efficiencies, this paper used the panel data of 2011-2016 and applied the Bootstrap Data Envelope Analysis (DEA) for its obvious advantage over the DEA method and obtained overall technical efficiencies (TE), pure technical efficiencies (PTE), and scale efficiencies of the Islamic bank of the nine South and Southeast Asian countries. The following are important findings of this paper:

(i) Results of the Bootstrap DEA estimates found that the average overall TE of the region was 77.3 percent indicating the average inefficiencies of the banks were 22.7 percent. The finding of the result suggests that the Islamic banks misused their resources on average 22.7 percent.

(ii) Results of the Bootstrap DEA estimates found that the average PTE of the Islamic banks of the region was 81.2 percent suggesting that the banks' average managerial inefficiencies were 19.8 percent.

(iii) The Bootstrap DEA estimate found that the average SE of the Islamic banks of the region was 95.3 percent suggesting the banks' average scale inefficiencies were 4.7 percent.

(iv) A comparison among three efficiencies, TE, PTE, and SE, the paper finds that scale efficiencies (SE) of the Islamic bank's efficiencies dominate over the TE and PTE during this period (2011-2016).

Cross country comparison of efficiency of TE, PTE, and SE among the Islamic banks reveal the following results:

(v) the Islamic banks of Malaysia were relatively more efficient in both TE and PTE. The average TE and PTE of the Malaysian Islamic banks was 81.9 percent and 87.0 percent respectively and was higher than the regional average of 77.3 percent and 81.2 percent respectively.

(vi) The average overall bias-corrected technical efficiency (BC-TE) of the Islamic banks of Indonesia, Bangladesh, Brunei, Thailand, Sri Lanka, and Maldives were below the regional average of 77.3 percent suggesting that the inefficiencies of the banks of these countries were higher than the regional average of 22.7 percent

(vii) An examination of the bar graphs shows that there is an increasing trend of average growth of BC-TE and BC-PTE of the Islamic banks of Malaysia and Bangladesh from 2014 to 2016.

(viii) The comparative scale efficiency results showed that the Islamic banks of Pakistan were more scale efficient among the Islamic banks in the region, with the exception of the Islamic bank of Singapore. The average SE of the Pakistan's Islamic bank was 96.8 percent compared to region average of 95.3 percent.

(ix) Only the Islamic banks of Singapore revealed 100 percent efficiency in all fields of technical efficiencies: TE, PTE, and SE. However, this result should be interpreted cautiously. Because this is the result of just one bank. There was only one Islamic bank operating in Singapore during 2013-2016.

(x) The Islamic banks of Malaysia and Pakistan exceled the banks of the other countries. The reason may be that Pakistan was one of the pioneers in the region to introduce the Islamic banks to operate side by side with conventional banks.

ENDNOTES

1. [Umar b. al-Khattab said, "There are three things: If God's Messenger had explained them clearly, it would have been dearer to me than the world and what it contains: (These are) kalalah, riba, and khilafah." (Sunan Ibn Majah, Book of Inheritance, Vol. 4, #2727;
2. Banker, Charnes, and Cooper (1984) estimated the technical efficiency based on the assumption that firms normally operate under the variable returns to scale instead of the constant returns to scale assumed by Charnes, Cooper, and Rhodes (1978)

REFERENCES

Bahrini, R. (2016). Technical efficiency Analysis of MENA Islamic banks during and after theglobal financial crisis. *Journal of Islamic Banking and Finance*, *4*(2), 15–24.

Bahrini, R. (2017). Efficiency Analysis of Islamic Banks in the Middle East and North AfricaRegion, Bootstrap DEA Approach. *International Journal of Financial Studies*, *5*(7), 1–13.

Banker, R.D., Charnes, A., & Cooper, W.W. (1984). Some models for the estimation of technical and scale inefficiencies in data envelopment analysis. *Management Science*, *30*, 1078–1092.

Benston, G.J. (1965). Branch Banking and Economies of scale. *Journal of Finance*, *20*(2), 312–331.

Charnes, A., Cooper, W.W., & Rhodes, E. (1978). Measuring the efficiency of decision-making units. *European Journal of Operational Research*, *2*, 429–441.

Coelli, T.J., Prasad Rao, D.S., O'Donnell, C.J., & Battese, G.E. (2005). *An introduction to efficiency and productivity analysis* (2nd Ed.). New York, NY: Springer.

Efron, B. (1979). Bootstrap methods: Another look at the Jackknife. *Annals of Statistics*, *7*, 1–26.

El-gamal, M., & Inanoglu. (2004). Islamic banking in Turkey: Boon or Bane for the financial Sector. *Proceedings of the firth Harvard University forum on Islamic Finance*. Cambridge: Center for Middle Eastern Studies, Harvard University.

Hassan, M.K. (2006). The X-efficiency in Islamic banks. *Islamic Economic Studies*, *13*, 49–78.

Hassine, B.M., & Limani, R. (2014). The impact of bank characteristics on the efficiency: Evidence from MENA Islamic banks. *Journal of Applied Finance and Banking*, *4*, 237–253

Kumar, S., & Gulati, G. (2008). An Examination of Technical, Pure Technical, and Scale Efficiencies in Indian Public Sector Banks using Data Development Analysis. *Urasian Journal of Business and Economics*, *1*(2), 33–69.

Noor, M.A.N.M., & Ahmad, N.H.B. (2012). The determinants of Islamic banks' efficiency changes: Empirical evidence from the world banking sectors. *Global Business Review*, *13*, 179–200.

Rahman, A.R.A., & Rosman, R. (2013). Efficiency of Islamic banks: A comparative analysis of MENA and Asian countries. *Journal of Economic Cooperation & Development*, *34*, 63–92.

Rosman, R., Wahab, N.A., & Zainol, Z. (2014). Efficiency of Islamic banks during the financial crisis: An analysis of Middle Eastern and Asian countries. *Pacific-Basin Finance Journal*, *28*, 76–90.

Samad, A. (2013). Are Islamic Banks Immune from Global Financial Crisis: Evidences from 16-Cross-Country Islamic Banks. *Global Journal of Management and Business Research*, *13-C*(8), 1–6.

Samad, A. (2016). Technical Efficiency of Islamic Banks versus Domestic Banks: Evidence from Bangladesh. *International Journal of Business and Finance*, *10*(2), 31–40. Retrieved from http://ssrn.com/abstract=2752712

Samad, A. (2017). Which Efficiency Dominates Production, Deposit vs Loan: Evidence from Islamic Banks, Malaysia During 2008-2012 (Accepted). *Journal of Business Studies Quarterly*.

Sealy, C.W., Jr., & Lindley, J.T. (1977). Inputs, outputs and a theory of production and cost at depository financial institutions. *The Journal of Finance*, *32*, 1251–1266.

Simar, L., & Wilson, P.W. (1998). Sensitivity analysis of efficiency scores: How to bootstrap in nonparametric frontier models. *Management Science*, *44*, 49–61.

Srairi, S.A., & Kouki, I. (2012). Efficiency and stock market performance of Islamic banks in GCC Countries. *ISRA International Journal of Islamic Finance*, *4*, 89–116.

Sufian, F., & Abdul Majid, M.Z. (2006). Bank ownership, Characteristics and Performance: A Comparative analysis of Domestic and Foreign Islamic Banks in Malaysia. *Journal of King Abdul Aziz University –Islamic Economics*, *21*(2), 3–38.

Sufian, F., & Noor, M.A.N.M. (2009). The determinants of Islamic bank's efficiency changes: Empirical evidence from MENA and Asian banking sectors. *International Journal of Islamic and Middle Eastern Finance and Management*, *2*, 120–138.

Yudistira, D. (2004). Efficiency in Islamic banking: An empirical analysis of eighteen banks. *Islamic Economic Studies*, *12*(1), 1–19.