Measurement of Technical, Allocative, and Cost Efficiency of Islamic Banks in Bangladesh Using Data Envelopment Analysis

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Abstract:

The present paper is an attempt to measure the technical, allocative, and cost efficiency of Islamic banks operating in Bangladesh. The research is conducted by using of nonparametric technique DEA (Data Envelopment Analysis) as a mostly used tool for analysis of efficiency in banking. Two outputs and three inputs have been used for the purpose of the analysis according to the input-oriented approach. The authors have selected seven Islamic Banks listed in the Dhaka Stock Exchange for conducting the study and the secondary data for the same was related to the year 2006 to 2011. Through the study, EXIM Bank Limited was found to be most efficient Islamic bank with an average efficiency score of 0.9992 on the basis of the efficiencies to which they were put to test. ICB Islamic bank Limited was found to have the highest lack of efficiency among all the Islamic banks in Bangladesh.

Keywords: Overall Technical Efficiency, Pure Technical Efficiency, Scale Efficiency, Allocative Efficiency, Cost Efficiency, DEA, Islamic Banks, Bangladesh.

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1.0 Introduction

A good banking system not only acts as the heart of the economy, pumping the needed, finance to each and every organ of it, but also responsible for the overall development and health of it. It accepts the deposits from depositors and investors and channelizes the same to the needy individuals/businesses/ firms, etc. in the form of loans and advances. In this way the money is used for production, distribution and other allied activities which are responsible for generating surpluses for the economy and hence economic development take place. The banking system has a full control over the money circulation in a country. The better banking system is a source of better economy capable of fulfilling the needs of its people (Kuldip S. Chhikara and Deepak Bhatia, 2012).

Islam is the largest religion of Bangladesh, the Muslim population is approximately 148.6 million, which is the fourth largest Muslim population (after Indonesia, Pakistan, and India), constituting 90.4% of the total population as of 2010. Bangladesh established its first Islamic bank in 1983. At present there are seven full fledged Islamic Banks and nine conventional banks with banking branches are working on the basis of Islamic Shariah. The seven Islamic banks operating in Bangladesh include: Islami Bank Bangladesh Limited, Social Islami Bank Limited, Al-Arafah Islami Bank Limited, EXIM Bank Limited, First Security Islami Bank Limited, Shahjalal Islami Bank Limited, and ICB Islamic Bank Limited. Like any other conventional commercial banks, the Islamic banks produce loans and investments by mobilizing deposits. But the basic difference lies in their mode of operation i.e. their mode of operation is based on Shariah.

Due to Islamic banking expansion, an intensive competition among the Islamic banks has arisen by providing innovative Islamic products, and efficient management in resource allocation and saving money. It is a well-known fact that, an effective and efficient banking system is important for long-term growth and crucial for economic development (Gaddam, Al Khathlan, and Malik, 2009). Thus each bank tries to be unique than the others to achieve higher market share.

Now, it is pertinent to the study to measure the efficiency of Islamic banks operating in Bangladesh and to adjudge the positive or negative contribution made by them towards the economic development. For this purpose the Data Envelopment Analysis (DEA) is used to measure the efficiency of the selected Islamic banks.

In this paper the efficiency have been evaluated using data for the period 2006 to 2011. The remainder of the paper is organized as follows. Section 2 reviews the literature on performance efficiency studies in banking. Section 3 data and methodology used in the study. Section 4 discusses the empirical findings and section five concludes.

2.0 Literature Review

In a rapidly changing financial market worldwide, bank regulators, managers, and investors are concerned about how efficiently banks transform their expensive inputs into various financial products and services (Isik & Hassan, 2002).

There are a large number of studies in the literature concerning the banking sector using DEA. Most of the studies concentrate on the technical efficiency of the banks. Efficiency measurement indicates whether the banks have used a minimum number of inputs in order to produce a certain number of outputs or whether they can produce maximum output using a certain number of inputs (Fethi & Pasiouras, 2010).

Berger and Mester (1997) attempted to measure the efficiencies of the banks in the USA between 1990 and 1995 by using econometric efficiency frontier models. According to the findings of the study, while the average cost efficiencies of the American banks were at the level of 86%, their average profit efficiency scores were 47%. According to these results, the American banks were able to manage their cost efficiency well but they suffered from serious shortcomings regarding profit efficiency.

Yudistira (2004) examined the efficiency of the Islamic banking system with 18 Islamic banks over 3 years by using DEA and found that banks could be scored between zero and one, "with a completely efficient bank having an efficiency score of one. In DEA the most efficient bank (with a score of one) does not necessarily generate the maximum level of output from the given inputs"

Samad (2004) measured the performance of the Islamic banking sector in contrast to that of the Western system in Bahrain and showed that there were no significant differences between the Islamic & the Western banking system in Bahrain with regard to profitability and deposit risk.

According to the results of his study, the Islamic banks had shown higher equity ratios than Western banks. The finding suggested that Islamic banks in the study exercised more caution when making loans than their Western counterparts did.

Johnes, Izzeldin, and Pappas (2009) measured the efficiency of Islamic versus Western banks through the Cooperation Council of the Arab States within the Gulf of GCC area and found that leaders of Islamic banks were less cost efficient but more revenue and profit efficient than Western banks.

Kamaruddin et al., (2008) investigated profit and cost efficiency of Islamic banks and Islamic windows at commercial (non-Islamic) banks by using DEA showed that the Islamic banks achieved technical efficiency through using technology such as ATMs, Internet banking, smart cards, and wireless banking. For cost efficiency, the Islamic banks used about 30% of their resources to produce outputs. Islamic windows and foreign Islamic banks operated more efficiently on the cost side than the profit side.

In a recent study, Samad (2009) measured inefficiencies in Bangladesh banking industry using stochastic frontier production function. Samad (2009) showed that the technical efficiency in Bangladesh banking industry lies between 12.7% and 94.7% and that the industry average efficiency is around 69.5%. Samad (2009) used a cross sectional data for the year 2000 involving 44 commercial banks.

Wadud and Yasmeen (2004) measured technical efficiency of Bangladeshi banks using DEA techniques. Using data for nine commercial banks in 2001, they estimated the industry

average technical efficiency, pure technical efficiency and scale efficiency as 73%, 90.6% and 81.7%, respectively. They found that while a majority of the private banks in Bangladesh are purely technically efficient, they tend to operate with high scale efficiency. Very recently, WahidaYasmeen (2011) examines technical efficiency and productivity growth of various banks in Bangladesh by using DEA. The results show significant variation in technical efficiency and PTE across various banks. Efficiency differences were also observed among public, private and specialized banks.

This paper adopts a more complete approach compared to the previous studies. Firstly this paper analyses efficiency of the Islamic banks operating in Bangladesh using data in a longitudinal context from 2006 to 2012. Secondly, the paper provides the dynamics of pure technical efficiency, overall technical efficiency, scale efficiency, allocative efficiency, and economic efficiency of the Islamic banks. Thirdly, the study includes the Islamic banks operating in Bangladesh.

3.0 Objective of the study

1. To measure the overall technical efficiency, pure technical efficiency, scale efficiency, allocative efficiency, and cost efficiency of the Islamic banks in Bangladesh.

2. To assess the ranking of the selected banks under study.

3. To give viable suggestions to improve the efficiency of the banks.

4.0 Data and Methodology

4.1 Data

As the study is about measuring the technical, allocative and cost efficiency of Islamic banks, the population included all the Islamic banks operating in Bangladesh. At present there are seven Islamic banks in Bangladesh and all the banks have been selected for the purpose of the study. The study is based on secondary data; for the purpose of the analysis the data were extracted from the published annual reports of the selected banks. The data on the selected input and output variables for the year 2006 to 2011 has been taken into consideration for measuring the efficiency of Islamic banks in Bangladesh.

For analyzing the efficiency of the banks, the DEA (Data Envelopment Analysis) method has been used. DEA is a mathematical linear programming approach based on the technical efficiency concept, it can be used to measure and analyze TE of different entities: productive and non productive, public and private, profit and nonprofit seeking firms. It is a non-parametric approach that calculates efficiency level by doing linear program for each unit in the sample.

The DEA measures the efficiency of the decision-making unit by the comparison with best producer in the sample to derive compared efficiency. DEA submits subjective measure of operational efficiency to the number of homogeneous entities compared with each other, with a number of sample's units which form together a performance frontier curve that envelops all observations. That's why, this approach is called Data Envelopment Analysis. Consequently, decision-making units (DMUs) which lie on the curve are efficient in distributing their inputs

and producing their outputs, while DMUs which do not lie on the curve are considered to have lack of efficiency.

4.2 Modeling Efficiency

The results on technical efficiency, scale efficiency, cost efficiency and allocative efficiency (according to Coelli, 1996) have been presented in this research.

The technical efficiency gives information about management and their ability to organize activities in their bank and also to find the best way to transform inputs into outputs. Full technically efficient bank makes the maximum amount of outputs from given level of resources.

If the technical efficiency analysis is made assuming the Constant Return to Scale (CRS), this kind of efficiency is considered as "Overall Technical Efficiency" (OTE). In the case of CRS we are starting with assumption of optimal level of its capacities. On the other hand, if the bank is below or above the optimum level, then we are starting with the assumption of Variable Return to Scale (VRS) (Banker et al., 1984). According to this, in DEA analysis OTE will be decomposed into Pure Technical Efficiency (PTE) and the Scale efficiency (SE). Scale Efficiency (SE) = Overall Technical Efficiency (OTE)/Pure Technical Efficiency (PTE). The PTE gives information not only about efficiency configuration of inputs/outputs, but also quality of setting of capacities of the operations that bank realizes. The SE provides information about managerial ability in deciding about optimal amount of resources use, or activities that will result with efficient banking operations. If the analysis is conducted on VRS assumption, there will be two possible results: Decreasing Return to Scale (DRS), or Increasing Return to Scale (IRS). If the bank is in the "IRS", it means that the bank has some unused capacities and that management can increase bank efficiency by increasing the activity level and vice versa for the "DRS". For measuring Cost Efficiency (CE), information about input prices is needed. Therefore, a bank is cost efficient if it has minimum costs of inputs for a given level of output. Finally, the Allocative Efficiency (AE) measures how bank allocates its resources to realize the level and mix of outputs that maximize revenue (Leibenstein, 1966).

This study uses the input-oriented intermediation approach with different return to scale which Coelli (1996) presented as a mathematical problem, computing the ratio of all outputs over all inputs such as $u'y_i/v'x_i(1)$

Where, y_i and x_i are output and input respectively, while the symbol 'u' is the Mx1 vector of output weights and 'v' is the Kx1 vector of input weights. According to (Coelli, 1996), mathematical formulation of the model for the constant return to scale is:

$$\max u,v(u'y_i/v'x_i i)$$

$$\text{st} \quad u'y_j/v'x_j \leq 1, \qquad j= 1,2,\ldots..,N$$

$$u, v \geq 0.$$

One problem with this particular ratio formulation is that it has an infinite number of solutions, so it is necessary to impose a constraint v'xi= 1, and then the model gets the following form (Coelli T.A., 1996):

$$\max \mu,v(\mu'y_i),$$

$$\text{st} \quad v'x_i = 1$$

$$\mu'y_j - v'x_j \leq 0, \qquad j= 1,2,\ldots,N$$

$$\mu,v \geq 0.$$

By using the duality in linear programming, it is possible to derive the final formulation of the model (Coelli, 1996):

$$\min_{\theta\lambda} \theta,$$

$$\text{st} \quad - y_i + Y\lambda \geq 0,$$

$$\theta x_i - Y\lambda \geq 0,$$

$$\lambda \geq 0$$

Where 'è' is a scalar of the efficiency scores that satisfies the condition è = 1. If it is equal to 1, it indicates full technical efficiency. The 'ë' is an Nx1 vector of constants. But for the variable return to scale it is necessary to introduce the convexity constraint N1'ë = 1 as follows (Coelli, 1996):

$$\min_{\theta\lambda} \theta,$$

$$\text{st} \quad - y_i + Y\lambda \geq 0,$$

$$\theta x_i - X\lambda \geq 0,$$

$$N1\lambda = 1$$

$$\lambda \geq 0$$

where, N1 is an Nx1 vector of ones. For allocative and cost efficiency it is necessary to conduct the cost DEA (Coelli, T. A., 1996):

$$\min_{\lambda,xi} w_i' x_i^*,$$

$$\text{st} \quad -y_i + Y\lambda \geq 0,$$

$$x_i^* - X\lambda \geq 0,$$

$$N1'\lambda = 1$$

$$\lambda \geq 0$$

Where, 'w_i' is a vector of input prices for the i-th DMU and x_i^* is the cost minimizing vector of input quantities. Accordingly, the cost efficiency or economic efficiency is calculated as:

$$CE = w_i' x_i^* / w_i' x_i$$

The Allocative Efficiency is calculated residually by AE = CE/TE

5.0 Specification of Input and Output Variables

The evaluation of bank efficiency creates several problems which arise as a result of the nature and function of financial intermediaries, especially as banks are multi-product firms that do not produce or market physical products. One of the major problems in the study of bank efficiency is the specification of bank inputs and outputs.

Generally, there are two ways of measuring bank outputs; the production approach and the intermediation approach. Under the production approach, banks produce accounts of various sizes by processing deposits and loans, and incurring capital and labor costs. Thus, outputs are measured by the number of deposits and loan accounts or the number of transactions performed on each type of service provided, and costs are the operating costs needed to produce these products. This approach is rarely used because of lack of data.

Under the intermediation approach, banks are treated as financial intermediaries that combine deposits, labor and capital to produce loans and investments. The values of loans and investments are treated as output measures; labor, deposits and capital are inputs; and operating costs and financial expenses comprise total cost. Here it is possible to conduct two types of analysis: input-oriented and output-oriented analysis. In the first one, it is examined how much it is possible to reduce the amount of input used without reduction in the level of output. The second one examines the possibility of increasing of the level of output using the given level of inputs.

Thus, the choice of input and output variables constitute a major difficulty, which must be addressed carefully. This study uses the input-oriented intermediation approach. Accordingly, three inputs and two outputs are used consisting of the following:

Table-1: *The selected variables for the DEA analysis of efficiency of Islamic Banks in Bangladesh*

Character of Variable	Variable Name	Definition
Output	Investment Other Earning Assets	Total short-term and long-term investment Sum of investment securities, inter-banks fund sold, and other loan to special sectors
Input	Total Funds Fixed Assets Personnel Expenses	Total deposit plus total borrowed funds The sum of physical capital and premises Total expenditure on employees
Input price	Price of Funds Price of Fixed Assets Price of Personnel Expenses	Interest expenses on deposit and non-deposit funds plus other operating expenses divided by total funds Depreciation expenses divided by fixed assets Personnel expenses divided by total funds.

6. 0 Results and Findings

The estimated efficiencies are reported in the table 2. The table reports the efficiency scores of all the Islamic Banks for the period 2006-2011. For each year and each bank, OTE (Overall Technical Efficiency), PTE (Pure Technical Efficiency), SE (Scale Efficiency), AE (Allocative Efficiency), and CE (Cost Efficiency) scores are reported in the table. The table indicates that there has been a considerable change in the efficiency patterns over 2006-2011.

From the analytical table 2 it is exposed that, in the year 2006, there were three fully efficient banks in all aspects which comprises of Al-Arafah Islami Bank, First Security Islami Bank Limited, and EXIM Bank Limited. Another bank which was fully technically efficient but exhibited cost and allocative inefficiency was Shahjalal Islami Bank Limited. ICB Islamic Bank Limited was the most inefficient bank in the year 2006.

As indicated in the table 2, in the period 2007, only two banks (Islami Bank Bangladesh Ltd. and EXIM Bank Limited) were found to be fully efficient. Social Islami Bank, Al-Arafah Islami Bank & ICB Islamic Bank Limited were inefficient with OTE and SE. The mean score of both OTE and SE for all the banks was found to be 0.938. It is clear from the analysis that Social Islami Bank& ICB Islamic Bank Limited were suffering from serious inefficiencies as they were far away from the average performance of all banks taken together. All the banks were efficient according to PTE in this year. The mean score of AE and CE of all the banks were 0.960 and 0.902 respectively. Five banks (Social Islami Bank Limited, Al-Arafah Islami Bank Limited, First Security Islami Bank Limited, Shahjalal Islami Bank Limited & ICB Islamic Bank Limited) out of seven were found to be inefficient with AE and CE fronts in 2007.

Table 2: Technical, Allocative and Cost Efficiency of Islamic Banks in Bangladesh for the period 2006-2011

Banks Name	2006						2007					
	OTE	PTE	SE	AE	CE	Returns	OTE	PTE	SE	AE	CE	Returns
Islami Bank Bangladesh Limited	0.869	1	0.869	0.991	0.861	drs	1	1	1	1	1	
Social Islami Bank Limited	0.888	0.983	0.904	0.978	0.869	irs	0.79	1	0.79	0.993	0.784	irs
Al-Arafah Islami Bank Limited	1	1	1	1	1		0.985	1	0.985	0.993	0.978	irs
EXIM Bank Limited	1	1	1	1	1		1	1	1	1	1	
First Security Islami Bank Limited	1	1	1	1	1		1	1	1	0.975	0.975	
Shahjalal Islami Bank Limited	1	1	1	0.818	0.818		1	1	1	0.892	0.892	
ICB Islamic Bank Limited	0.823	0.832	0.989	0.811	0.668	irs	0.79	1	0.79	0.869	0.687	irs
Mean score:	**0.94**	**0.974**	**0.966**	**0.943**	**0.888**		**0.938**	**1**	**0.938**	**0.96**	**0.902**	

Banks Name	2008						2009					
	OTE	PTE	SE	AE	CE	Returns	OTE	PTE	SE	AE	CE	Returns
Islami Bank Bangladesh Limited	0.949	1	0.949	0.99	0.939	drs	0.957	1	0.957	0.988	0.946	drs
Social Islami Bank Limited	0.795	0.842	0.944	0.994	0.79	irs	1	1	1	1	1	
Al-Arafah Islami Bank Limited	0.997	1	0.997	0.993	0.989	drs	1	1	1	1	1	
EXIM Bank Limited	1	1	1	0.988	0.988	-	1	1	1	1	1	
First Security Islami Bank Limited	1	1	1	1	1	-	1	1	1	0.99	0.99	
Shahjalal Islami Bank Limited	0.904	1	0.904	0.985	0.891	drs	1	1	1	0.875	0.875	
ICB Islamic Bank Limited	1	1	1	1	1	-	0.89	1	0.89	0.943	0.839	irs
Mean Sore:	**0.949**	**0.977**	**0.97**	**0.993**	**0.942**		**0.978**	**1**	**0.978**	**0.971**	**0.95**	

Banks Name	2010						2011					
	OTE	PTE	SE	AE	CE	Returns	OTE	PTE	SE	AE	CE	Returns
Islami Bank Bangladesh Limited	0.916	1	0.916	0.986	0.904	drs	0.984	1	0.984	0.987	0.972	drs
Social Islami Bank Limited	0.951	1	0.951	0.992	0.944	irs	1	1	1	1	1	
Al-Arafah Islami Bank Limited	1	1	1	1	1		1	1	1	1	1	
EXIM Bank Limited	1	1	1	1	1		1	1	1	1	1	
First Security Islami Bank Limited	1	1	1	0.941	0.941		1	1	1	0.932	0.932	
Shahjalal Islami Bank Limited	0.954	0.954	1	0.977	0.932		0.991	0.993	0.998	0.987	0.979	drs
ICB Islamic Bank Limited	0.78	1	0.78	0.902	0.703	irs	0.885	1	0.885	0.904	0.8	irs
Mean Score:	**0.943**	**0.993**	**0.95**	**0.971**	**0.918**		**0.98**	**0.999**	**0.981**	**0.973**	**0.955**	

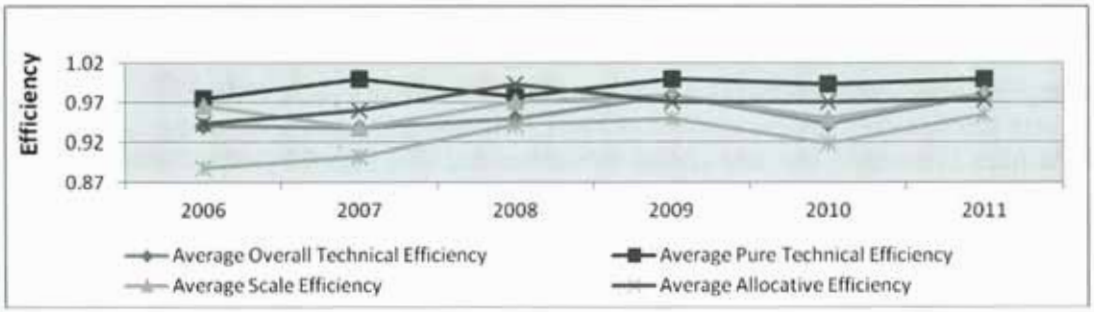
Source: Author's Calculation

Note: PTE = Pure Technical Efficiency, OTE= Overall Technical Efficiency, SE= Scale Efficiency, AE= Allocative Efficiency, DRS= Decreasing Return to Scale, IRS= Increasing Return to Scale.

In the year 2008, interestingly ICB Islamic Bank Limited recorded a significant improvement in efficiency and became the most efficient bank in this year along with First Security Islami Bank Limited. But Exim Bank Limited, which was fully efficient in all aspects in 2006 and 2007, became inefficient with AE and CE in this year. The mean scores of OTE, PTE, SE, AE, and CE for all the banks were 0.949, 0.977, 0.970, 0.993, and 0.942 respectively. Social Islami Bank was the most inefficient as it was far away from the average performance of all the banks.

During the year 2009, three banks comprising of Exim Bank Limited, Al-Arafah Islami Bank, Social Islami Bank were fully efficient in all aspects of efficiency. In this year, Social Islami Bank Limited exhibited a highly significant improvement in efficiency than the previous years. Another two banks which were full technically efficient but inefficient in AE and CE were First Security Islami Bank Limited and Shahjalal Islami Bank Limited. The average scores of OTE, PTE, SE, AE, and CE for all the banks taken together were 0.978, 1.00, 0.978, 0.971, and 0.950 respectively. Al-Arafah Islami Bank and Exim Bank Limited were fully efficient in both the year 2010 and 2011. Again ICB Islamic Bank Limited was the most inefficient bank during these years. Average efficiency of all the Islamic Banks for the period 2006-2011 is projected in the following figure:

Figure-1: *Year-wise Average Efficiency of all the Islamic Banks*



Source: Author's calculation

Table 3 exposed the ranking of the Islamic banks on the basis of average efficiency scores for the period 2006 to 2011.

Table 3: *Ranking of the Islamic Banks on the Basis of Average Efficiency*

Name of the Bank	OTE	PTE	SE	AE	CE	Average	Ranking
Islami Bank Bangladesh Ltd.	0.945833	1	0.945833	0.990333	0.937	0.9638	4
Social Islami Bank Ltd.	0.904	0.970833	0.9315	0.992833	0.897833	0.9394	6
Al-Arafah Islami Bank Ltd.	0.997	1	0.997	0.997667	0.9945	0.997233	2
EXIM Bank Limited	1	1	1	0.998	0.998	0.9992	1
First Security Islami Bank Ltd.	1	1	1	0.973	0.973	0.9892	3
Shahjalal Islami Bank Ltd.	0.974833	0.991167	0.983667	0.922333	0.897833	0.953967	5
ICB Islamic Bank Limited	0.861333	0.972	0.889	0.904833	0.782833	0.882	7
Average (Approximately)	95%	99%	96%	97%	93%		

Source: Author's calculation

As shown in the table 3, most of the banks recorded high levels of pure technical efficiency or scale efficiency or both, resulting in higher overall technical efficiency, but lower cost efficiency. The overall technical efficiency averaged around 95% for the banks under study. This suggests that the bank might increase one or more of their current outputs by around 5% without reduction in their other outputs or without a need for more inputs. The allocative efficiency scores averaged around 97% which reflects that most of the banks have almost succeeded to combine inputs and outputs in their optimal proportions in the light of their prevailing prices. The cost efficiency estimated for the banks under study averaged around 93% under constant return to scale over 2006-2011. This cost estimate suggests that the same level of output could be produced with approximately 93% of their current inputs if banks under study were operating on the most efficient frontier. Among all the Islamic banks, EXIM Bank Limited was the most consistently efficient bank over all the years and Al-Arafah Islami Bank secured the second position. First Security Islami bank, Islami Bank Bangladesh limited, Shahjalal Islami Bank, and Social Islami Bank secured the 3rd, 4th, 5th and 6th position respectively. On the other hand, ICB Islamic Bank was the most inefficient bank over all the years excluding the year 2008; especially huge gap is in the OTE, AE and CE which mean that this bank has some problems in managing of their business, setting of their products, allocating of their resources and managing of their costs.

7.0 Conclusion

Several conclusions can be drawn from the study. Firstly, the Islamic commercial banks in Bangladesh exhibited high efficiency over all the years. Six banks out of seven exhibited average efficiency above 90%. This is because the banks strive to keep themselves at par with the best practice ones for the obvious reasons. It is also important to note that the Islamic banks have to compete not only among themselves but also with the conventional banks by providing innovative Islamic products, and efficient management in resource allocation and saving money. In the recent years there have been a significant development in banking operation and technologies and most of the Islamic banks have adopted the technologies with efficient management and scale of operations.

Further, our results suggest that Social Islami Bank and ICB Islamic Bank Limited exhibited increasing returns to scale (IRS) in almost all the fiscal years under study, which indicates that these banks are smaller than the most productive scale size. Furthermore, Islami Bank Bangladesh Limited consistently exhibited decreasing returns to scale (DRS), suggesting that the bank exceeded its most productive scale size.

Finally, as a caveat, the results of this research should be interpreted with great caution since previous research differs substantially across different estimation procedures. Further study should use other estimation approaches and look at the revenue and profit efficiency, allowing results to be compared.

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