Evaluating Efficiency of Islamic Banks Using Data Envelopment Analysis: International Evidence

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Abstract

This study investigates the efficiency of Islamic banks in four regions; Africa, the Far East and Central Asia, Europe and the Middle East during the period of 2003-2008. The non-parametric approach, Data Envelopment Analysis is utilised to analyse the technical and scale efficiencies of Islamic banks. Overall, the results suggest that mean efficiency of Islamic banks have declined over the period from 0.746 in 2003 to 0.544 in 2008. During the period of study, our results suggest that pure technical inefficiency has largely resulted in the overall inefficiency of Islamic banks. Using a series of parametric and non-parametric tests, our results indicate that there are significant differences in efficiencies between size and not between regions. Large sized banks tend to be efficient than the small and medium sized banks.

Keywords: Efficiency**,** Islamic Banks, Data Envelopment Analysis

1. Introduction

Islamic banking, which began as a theological dream and scholarly discussions among the Muslim economists, has today become a practical reality and accepted worldwide. Islamic banking and finance has transformed from an infant industry in the 1970s to one of the most viable and efficient alternative models of financial intermediation. The Islamic financial services industry has consistently chalked up double-digit growth with a presence in more than 100 countries. It is estimated that total financial assets of the industry now exceed US$1 trillion. World economic powers such as France, Germany, and even Russia are considering amending their financial laws with the purpose of accommodating the establishment of Islamic banks within their financial system.

The integration of Islamic finance into the global economy is marked by the growing awareness of and demands for investing in accordance with *shariah* principles, progress in developing regulatory framework and enhanced international linkages.

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However, the success of Islamic banking brings forth new challenges to the industry. These include lack of standard financial contracts and products, illiquidity issues, risks mitigation in the operational aspects and financing portfolios, and co-operation among the players within the industry.

These successes and challenges facing Islamic financial institutions have been widely documented. Nonetheless, there is still an acute dearth of literature which covers concepts and applications of Islamic banking worldwide as well as provides a comprehensive illustration of all major aspects of Islamic finance and banking on a more global scale. Having kept a close watch on the developments in Islamic finance and banking over the last two decades, we acknowledge that there are many issues yet to be resolved. Among the major areas that need in-depth study are related to productivity, efficiency and performance measurement.

The aim of this paper is to evaluate technical and scale efficiency of Islamic banks in Africa, the Far East and Central Asia, Europe and the Middle East for the period 2003 to 2008. The remainder of the paper is organised as follows. Section 2 reviews the literature on performance and efficiency studies in banking. Section 3 describes the data and methodology used in the study. Section 4 discusses the empirical findings and Section 5 concludes.

2. Performance and Efficiency Studies

Berger and Humphrey (1997), in their survey of 130 studies on efficiency analyses, found that a majority of these studies were done in the US banking industry. Despite the fact that efficiency studies are well a researched area in developed countries like USA and Europe, there are still limited studies focussing on the efficiency of Islamic banking.

There are a number of studies examining relative efficiency using DEA in conventional banks (Sufian and Abdul Majid 2007; Li 2006; Sufian 2006; Sufian 2004). Sufian and Abdul Majid (2007) analysed efficiency change of Singapore commercial banks during the period of 1993-2003. They found that commercial banks in Singapore exhibited an average overall efficiency of 95.4 percent. Li (2006) investigated the scale-efficiency and technology-efficiency of 14 Chinese commercial banks. She concluded that most banks have low comparative-efficiency. She also found that inefficient banks generally had input surplus. Sufian (2006) investigated the efficiency of non-bank financial institutions in Malaysia for the period 2000-2004. The study found that finance companies were more efficient than merchant banks and that the inefficiency was the result of pure technical inefficiency rather than scale inefficiency. Using DEA to examine the efficiency effects of bank mergers and acquisition in Malaysia, Sufian (2004) found that Malaysian banks exhibited a commendable overall efficiency level of 95.9 percent during 1998-2003 which indicates that the merger programme was successful.

In the Islamic banking institutions, efficiency studies are still scarce. Several studies in Islamic banking focus on assessing the performance in terms of profitability and determinants of bank performance (Samad and Hassan, 1999; Bashir, 2001; Samad 2004; Haron and Azmi, 2004. Samad and Hassan (1999) applied financial ratios to assess the performance of the oldest Islamic bank in Malaysia, Bank Islam Malaysia Berhad, for the period 1984-1997. The study found that this bank performed better than conventional banks in terms of liquidity and risk measurement. Bashir (2001) performed regression analysis to determine the determinants of Islamic bank performance in the Middle East. The results indicate that adequate capital ratios and loan portfolios play an important role in explaining the performance of Islamic banks. Further, the results also indicate that the performance was mostly generated from customer and short term funding, non interest earning assets and overheads. Samad (2004) used profitability, liquidity risk and credit risks ratios to study the performance of Islamic banks and conventional banks in Bahrain. Nine financial ratios were used and the study found there was no major difference in performance between Islamic banks and conventional banks with respect to profitability and liquidity but there were significant differences in the credit performance. A study by Haron and Wan Azmi (2004) used the co-integration approach to examine the influence of internal and external factors on selected Islamic banks and found that factors such as liquidity, deposit items, asset structure, inflation and money supply did influence the profitability of banks.

However, the use of financial ratios has its limitations. According to Berger *et. al*., (1993), the first problem is that financial ratios are regarded as misleading indicators of efficiency because they do not control for product mix or input prices. Secondly, using the cost-to-asset ratio assumes that all assets are equally costly to produce and all locations have equal costs of doing business. Finally, the use of simple ratios cannot distinguish between X-efficiency gains and scale and scope efficiency gains.

Yudistira (2004) applied Data Envelopment Analysis to investigate the performance of 18 Islamic banks over the period 1997-200 and found that Islamic banks suffer slight inefficiencies and that efficiency differences across the sample appear to be mainly determined by country specific factors. Viverita *et. al*. (2007) and Kamaruddin *et. al*., (2008) also applied DEA to assess the cost and profit efficiencies of Malaysian Islamic banks and conventional banks for the period 1998 to 2004. The results generally suggest that an Islamic bank wasted around 30.5 percent of its inputs relative to the best-practice bank. The results also show that there existed about 30-37 percent inefficiencies in the operations of Islamic banks over the period of study. Mohamad *et. al*., (2008) examined the cost and profit efficiency of conventional versus Islamic banks using the Stochastic Frontier Approach. The results suggest that there are no significant differences between the overall efficiency results of the conventional and Islamic banks.

3. Data and Methodology

3.1 Data

The panel data set was obtained from non-consolidated income statements and balance sheets of Islamic banks in four regions; Africa, Europe, the Far East and Central Asia and the Middle East, for the period 2003 to 2008. The data was made available by the international banking database Bankscope of BVD-IBCA that provides individual time series (i.e. by bank). Table 1 presents the number of Islamic banks available in each region. However, the number of available data for analysis was much smaller than the actual number of banks. All data are selected from unconsolidated statements and converted into US dollars and inflation adjusted so that results are comparable between countries and regions.

Table 1: Number of Islamic Banks According to Regions

Region	2003	2004	2005	2006	2007	2008
Africa	7	6	8	9	7	6
Europe	2	2	2	3	3	2
Far East & Central Asia	3	4	11	18	20	19
Middle East	17	16	21	22	23	16
Total	29	28	45	60	63	53

Source: Bankscope, 2009

3.2 Specification of Inputs and Outputs

To measure the inputs and outputs, we used the intermediation approach in which DEA model consists of 2 outputs and 2 inputs. Table 2 presents the summary statistics of outputs and inputs used in this study.

Table 2: Descriptive Statistics of Inputs and Outputs Used (In Thousands of US dollars)

		2003	2004	2005	2006	2007	2008
Outputs							
Total	Mean	1,093,610	1,585,236	1,484,156	1,528,650	1,852,388	961,565.2
Loans	Median	104,554.7	139,236.9	125,824.4	224,654.7	223,414.9	552,146.1
	S.D	2,114,034	3,059,019	3,336,259	3,522,194	4,258,800	1,336,165
	Min.	70.91	67.09	12.23	1.43	16.52	128.87
	Max.	6,823,074	11,410,184	14,035,798	14,175,755	1,7067,432	6,407,470
	N	25	22	32	45	47	39
Other	Mean	550,921.7	645,809.6	548,588.5	509,594.1	641,241.3	428,208.6

Earnings	Median	59,424.97	93,568.85	83,225.12	103,611	167,884.6	240,560
Assets	S.D	1,373,060	1,412,537	1,306,152	1,357,492	1,555,884	471,715.6
	Min.	68.04	216.45	346.32	3,279.51	2,452.753	8,249.58
	Max.	6,375,219	6,425,786	6,900,219	8,688,932	9,891,165	1,687,000
	N	25	22	32	45	47	39
Inputs							
Total	Mean	1,342,289	1,852,138	1,682,086	1,817,018	2,331,644	1,305,187
Deposits	Median	144,579.2	291,559.1	175,256.9	252,520.7	341,324.5	564,920.2
	S.D	2,542,554	3,276,890	3,518,485	4,146,872	5,284,742	1,648,458
	Min.	2,712.216	4,495.43	5,506.2	677.95	5,254.25	5,370.47
	Max.	9,758,136	12018463	14,441,879	17,764,697	22,473,228	6,827,369
	N	25	22	32	45	47	39
Overhead	Mean	47,952.63	69102.07	71,716.02	70,132.09	95,801.61	35,439.09
Expenses	Median	6,143.34	7613.142	7,958.43	11,303.19	14,480.9	19,298.78
	S.D	100,947.6	136914	174,366.5	188,462.1	283,445.9	52,784.31
	Min.	1,294.55	1329.962	214.35	375.018	307.32	291.44
	Max.	366,396.6	433986.7	757,263.3	976,770.5	1,486,695	212,471.1
	N	25	22	32	45	47	39

3.2 Methodology

In this study we employed the non-parametric measure, the DEA. It is non-parametric because it requires no assumption on the shape or parameters of the underlying production function. DEA is a linear programming technique based on the pioneering work of Farrell's efficiency measure (1957), to measure the different efficiency of decision-making units (DMUs). Assuming the number of DMUs is *s* and each DMU uses *m* inputs and produces *n* outputs. Let DMU_k be one of *s* decision units, $1 \leq k \leq s$. There are *m* inputs which are marked with X_i^k (i = 1, ..., *m*), and n outputs marked with Y_j^k (j = 1,...., *n*). The efficiency equals the total outputs divide by total inputs. The efficiency of DMU_k can be defined as follows:

$$\sum_{j=1}^{n} u_j Y_j^k$$

The efficiency of DMU_k = _____ (1)

$$\sum_{i=1}^{m} v_i X_i^k$$

X_i^k, $Y_j^k \geq 0$, $i = 1, \ldots, m$, $j = 1, \ldots, n$, $k = 1, \ldots, s$

$u_j, v_i \geq 0$, $i = 1, \ldots, m$, $j = 1, \ldots, n$

The DEA program enables one to find the proper weights which maximise the efficiency of DMU and calculates the efficiency score and frontier. The CCR model originated by Charnes *et. al*. (1978), has led to several extensions, most notably the BCC model by Banker *et. al*. (1984). The CCR and BCC models can be divided into two terms; one is the input oriented model; the other is the output oriented model. The input orientation seeks to minimize the usage of inputs given a fixed level of output while the output orientation maximizes the level of output for a given level of inputs. The CCR model assumes constant returns to scale (CRS) which means one unit input can get fixed value of output. The BCC model assumes variables returns to scale (VRS).

In this study we chose the input oriented model and used a dual problem model to solve the problems. The CCR dual model is as follows:

$$\begin{aligned} &\text{Min } \theta - \varepsilon\left[\sum_{i=1}^{m} S_i^- + \sum_{k=1}^{n} S_j^+\right] \\ &\text{s.t.} \quad \sum_{i=1}^{s} \lambda_r X_i^r - \theta X_i^k + S_i^- = 0 \qquad i = 1, \ldots, m \\ &\qquad \sum_{i=1}^{s} \lambda_r Y_j^r - S_i^+ = Y_j^r \qquad j = 1, \ldots, n \end{aligned} \tag{2}$$

$\lambda_r \geq 0$ $r = 1, \ldots, s$

$S_i^- \geq 0$ $i = 1, \ldots, m$

$S_j^+ \geq 0$ $j = 1, \ldots, n$

Where

θ is the efficiency of DMU

S_i^- is the slack variable which represents the input excess value,

S_j^+ is the surplus variable represents the output shortfall value,

ε is a non-Archimedean number which represents a very small constant,

λ_r means the proportion of referencing DMU_r when measure the efficiency of DMU_k.

If the constraint below is adjoined, the CCR dual model is known as the BCC model.

$$\sum_{r=1}^{s} \lambda_r = 1 \tag{3}$$

Equation (3) frees CRS and makes the BCC model to be VRS. For the measurement of efficiency, the CCR model measures overall efficiency (OE) of a DMU, and the BCC model can measure both the pure technical efficiency (PTE) and scale efficiency (SE) of the DMU. The relationship of OE, PTE and SE is as the equation (4) below.

$$OE = PTE \times SE \tag{4}$$

DEA technique has been applied successfully as a performance measurement tool in many fields including the manufacturing sector, hospitals, pharmaceutical firms, banks, education and transportation.

In this study, an input orientation as opposed to output orientation has been adopted.

4. Findings

To take account of the year effects, we chose to calculate different technology per year which implicitly incorporates time effects of our analysis instead of computing a common benchmark for the whole accumulated sample (209 over the 6 year period). Table 3 presents the descriptive statistics of the various efficiency scores of Islamic banks for the year 2003 to 2008. The results suggest that Islamic banks exhibited a mean overall efficiency score of 0.746 in the year 2003 before recording the highest mean overall efficiency score of 0.824 in the year 2004. The Islamic banks mean overall efficiency declined to 0.607 in 2005, 0.525 in 2006, 0.587 in 2007 and 0.544 in 2008. The decomposition of overall efficiency into pure technical efficiency and scale efficiency suggest that pure technical inefficiency (failure to minimise costs for a given output vector) dominates scale inefficiency (failure to operate at the minimum efficient scale), in determining the efficiency of Islamic banks for all years, except 2003. This implies that during 2004 to 2008, Islamic banks have been inefficient in controlling their costs rather than operating at the wrong scale of operations.

The information on efficiency results for Islamic banks grouped by region (Middle East and Non-Middle East) and size (large medium and small) provides significant insights into the analysis. The results are reported in Table 4. As can be seen from the table, Islamic banks in the Middle East region perform better in terms of overall efficiency than their non Middle East counterparts, for all years under study except in 2004 and 2007. Thus, these findings contradict those found by Yudistira (2004) and Viverita *et. al*., (2007).

We further analysed the size efficiency relationship by grouping the sample of Islamic banks by total assets. Banks with more than USD600 million were considered large and banks below this level were categorised as small and medium sized. Observing the overall efficiency, large sized banks tend to be more efficient than the small and medium sized banks. Hence this result supports Yudistira's (2004) findings that larger Islamic banks were more efficient. Focussing on the scale efficiency, the results are rather mixed. Scale inefficiencies seem apparent from the large sized bank in 2005, 2006 and 2007 with the lowest score of 0.761 in 2006. Meanwhile small and medium sized banks show the largest degree of inefficiencies in 2003, 2004 and 2008, with the lowest score of 0.756 in 2008.

Table 3: Descriptive Statistics of Efficiency Measures, 2003-2008

	Mean	**Median**	**Minimum**	**Maximum**	**SD**
2003 (N = 25)					
Overall efficiency	0.746	0.831	0.201	1.000	0.264
Pure technical efficiency	0.867	0.928	0.382	1.000	0.174
Scale efficiency	0.852	0.969	0.212	1.000	0.228
2004 (N = 22)					
Overall efficiency	0.824	0.877	0.390	1.000	0.182
Pure technical efficiency	0.884	0.945	0.505	1.000	0.146
Scale efficiency	0.926	0.986	0.669	1.000	0.109
2005 (N = 32)					
Overall efficiency	0.607	0.576	0.033	1.000	0.308
Pure technical efficiency	0.746	0.870	0.089	1.000	0.300
Scale efficiency	0.830	0.954	0.041	1.000	0.238
2006 (N = 44)					
Overall efficiency	0.525	0.511	0.061	1.000	0.329

Pure technical efficiency	0.658	0.755	0.080	1.000	0.338
Scale efficiency	0.811	0.955	0.130	1.000	0.254
2007 (N = 47)					
Overall efficiency	0.587	0.571	0.033	1.000	0.312
Pure technical efficiency	0.688	0.728	0.145	1.000	0.298
Scale efficiency	0.847	0.970	0.185	1.000	0.228
2008 (N = 39)					
Overall efficiency	0.544	0.545	0.024	1.000	0.283
Pure technical efficiency	0.697	0.751	0.117	1.000	0.276
Scale efficiency	0.774	0.859	0.202	1.000	0.234

Note: SD = Standard Deviations

Table 4: Efficiency Results According to Region and Bank Size

	Year	**Overall Efficiency**	**Pure Technical Efficiency**	**Scale Efficiency**
Grouped by Region				
Middle East	2003	0.772	0.894	0.864
Non Middle East	2003	0.706	0.827	0.833
Middle East	2004	0.786	0.854	0.921
Non Middle East	2004	0.879	0.928	0.934
Middle East	2005	0.625	0.808	0.794
Non Middle East	2005	0.589	0.684	0.865
Middle East	2006	0.560	0.752	0.783
Non Middle East	2006	0.499	0.590	0.833
Middle East	2007	0.556	0.722	0.762
Non Middle East	2007	0.608	0.665	0.905
Middle East	2008	0.569	0.801	0.686
Non Middle East	2008	0.533	0.651	0.812
Grouped by Size				
Large	2003	0.914	0.951	0.962
Small and Medium	2003	0.758	0.822	0.809

Large	2004	0.859	0.870	0.990
Small and Medium	2004	0.803	0.893	0.890
Large	2005	0.748	0.926	0.806
Small and Medium	2005	0.533	0.652	0.842
Large	2006	0.657	0.885	0.761
Small and Medium	2006	0.436	0.507	0.845
Large	2007	0.700	0.849	0.832
Small and Medium	2007	0.469	0.520	0.863
Large	2008	0.607	0.786	0.785
Small and Medium	2008	0.443	0.554	0.756

We then analysed further by testing whether there were any significant differences between size and region, using both parametric and non parametric tests. The results are reported in Table 5 below. The results clearly show that there are significant differences at the 5 percent level in terms of size but not in terms of region.

Table 5: Summary of Parametric and Non Parametric Tests on Size and Region

	Parametric Test		**Non-Parametric Test**	
SIZE				
Individual Tests	Analysis of Variance (ANOVA)	*t*-test	Kolgomorov-Smirnov (K-S) test	Mann-Whitney (Wilcoxon Rank-Sum) test
Hypotheses	$\text{Mean}_d = \text{Mean}_f$		$\text{Distribution}_d = \text{Distribution}_f$	$\text{Median}_d = \text{Median}_f$
Test Statistics	*F* (Prb > *F*)	*t* (Prb > *t*)	K-S (Prb > K-S)	*z* (Prb > *z*)
OE	15.398 (0.000)	3.924 (0.000)	2.186 (0.000)	-3.526 (0.000)
PTE	35.611 (0.000)	5.967 (0.000)	2.553 (0.000)	-4.930 (0.000)
SCALE	0.104 (0.747)	-0.323 (0.747)	0.778 (0.581)	-0.425 (0.671)
REGION				
OE	1.060 (0.304)	1.030 (0.304)	1.279 (0.076)	-0.932 (0.351)
PTE	8.872 (0.003)	2.979 (0.003)	1.409 (0.038)	-2.656 (0.008)
SCALE	3.312 (0.070)	-1.820 (0.070)	0.827 (0.500)	-0.948 (0.343)

We now focus on the developments of the Islamic banks' returns to scale, as shown in Table 6. Over the six-year period, the share of inefficient Islamic banks has increased

from 76 percent in 2003 to 84.6 percent in 2008. From the table also we find that the number of Islamic banks experiencing economies of scale (IRS) has decreased substantially from 48 percent in the year 2003 to 35.9 percent in the year 2008. The share of scale efficient banks (operating at CRS) has declined from 24 percent in 2004 to 15.4 percent in 2008. On the other hand, the share of Islamic banks experiencing diseconomies of scale (DRS) has increased substantially from 28 percent in 2003 to 48.7 percent in 2008.

If we look at the returns to scale by size measured in thousands of US dollars, we find that from the sample of 120 observations, 39 or 18.57 percent of all Islamic banks are operating at CRS. The majority (81.43 percent) are scale inefficient (operating at DRS or IRS). Of the scale inefficient Islamic banks, 35.23 percent are large Islamic banks and 46.13 percent are small and medium sized banks. Of the banks experiencing DRS, the majority, 27.14 percent are large banks and 13.33 percent are small and medium sized banks. Whereas of the banks experiencing IRS, the majority, 32.8 percent, are small and medium sized banks and only 8.09 percent are large Islamic banks. This suggests that while small and medium sized banks have generally exhibited IRS, the large banks tend to exhibit DRS and at best, CRS.

Table 6: Returns to Scale (RTS) Analysis

		RTS			
Year	**No of banks/Percentage share**	**IRS**	**CRS**	**DRS**	**Total**
2003	No. of banks	12	6	7	25
	% share	48.0	24.0	28.0	100
2004	No. of banks	13	7	2	22
	% share	59.1	31.8	9.1	100
2005	No. of banks	9	4	19	32
	% share	28.1	12.5	59.4	100
2006	No. of banks	18	7	20	45
	% share	40.0	15.6	44.4	100
2007	No. of banks	20	9	18	47
	% share	42.6	19.1	38.3	100
2008	No. of banks	14	6	19	39

	% share	35.9	15.4	48.7	100
RTS by Size					
Large	No. of banks	17	18	57	92
	% share	8.09	8.57	27.14	43.80
Small & Medium	No. of banks	69	21	28	118
	% share	32.8	10.0	13.33	56.13

Note: RTS = returns to scale, IRS = increasing returns to scale, CRS = constant returns to scale, DRS = decreasing returns to scale

5. Conclusions

This paper aimed to measure the relative efficiency of Islamic banks in four regions; Africa, the Middle East, the Far East and Central Asia and Europe for the period 2003 to 2008. In this paper we calculated technical, pure technical and scale efficiency measures using the non-parametric technique, Data Envelopment Analysis. Several conclusions can be drawn from this study. Firstly, the overall efficiency results suggest that inefficiency varies across years, 0.746 in 2003, 0.824 in 2004, 0.607 in 2005, 0.525 in 2006, 0.587 in 2007 and 0.544 in 2008. Secondly, our results suggest that pure technical inefficiency (failure to minimize costs for a given output vector) dominates scale inefficiency (failure to operate at the minimum efficient scale) in determining the efficiency of Islamic banks during the period under study.

Further, our results suggest that banks in the Middle East region were more efficient that the non Middle East counterparts in four of the six years under study. Yudistra (2004) however found that banks outside the Middle East were more efficient. Thirdly, the parametric and non-parametric tests suggest that there were significant differences between sizes but not between regions. This suggest that while small and medium sized banks have generally exhibited IRS, large banks tend to exhibit DRS and at best, CRS.

Finally, our results suggest that the number of Islamic banks experiencing IRS declined slightly from 48 percent in 2003 to 35.9 percent in 2008. The share of scale efficient banks, i.e. operating at CRS declined sharply from 24 percent in 2003 to 15.4 percent in 2008, while Islamic banks experiencing DRS, increased sharply from 28 percent in 2003 to 48.7 percent in 2008. Examination of the sample of Islamic

banks according to size, over the six-year period, shows that while on average 8.57 percent are operating at CRS, the majority, 35.2 percent are scale inefficient (DRS or IRS). On the other hand, 10 percent of small and medium sized Islamic banks are operating at CRS while 46 percent are operating at DRS or IRS. We have also found that small and medium sized banks experiencing IRS are more numerous than large banks.

As a caveat, the results 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 cost and profit efficiency, allowing results to be compared.

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