International Journal of *Financial Studies*

MDPI

Article

Efficiency Analysis of Islamic Banks in the Middle East and North Africa Region: A Bootstrap DEA Approach

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Academic Editor: Nicholas Apergis

Received: 30 November 2016; Accepted: 8 February 2017; Published: 15 February 2017

Abstract: This paper measures and analyzes the technical efficiency of Islamic banks in the Middle East and North Africa (MENA) region during the period 2007–2012. To do this, the bootstrap Data Envelopment Analysis (DEA) approach was employed in order to provide a robust estimation of the overall technical efficiency and its components: pure technical efficiency and scale efficiency in the case of MENA Islamic banks. The main results show that over the period of study, pure technical inefficiency was the main source of overall technical inefficiency instead of scale inefficiency. This finding was confirmed for all MENA Islamic banks as well as for the two subsamples: Gulf Cooperation Council (GCC) and non-GCC Islamic banks. Furthermore, our results show that GCC Islamic banks had stable efficiency scores during the global financial crisis (2007–2008) and in the early post-crisis period (2009–2010). However, a decline in overall technical efficiency of all panels of MENA Islamic banks was recorded in the last two years of the study period (2011–2012). Thus, we recommend that MENA Islamic bank managers focus more on improving their management practices rather than increasing their sizes. We also recommend that financial authorities in MENA countries implement several regulatory and financial measures in order to ensure the development of MENA Islamic banking.

Keywords: technical efficiency; Islamic banks; MENA region; GCC; non-GCC; bootstrap DEA

JEL Classification: C15; C61; G21

1. Introduction

In the last years, global Islamic banking assets grew at an average annual rate of more than 17% between 2009 and 2013 to reach US$1.7 trillion in 2013 [1]. This value is expected to double by 2018, fueled by economic growth in Islamic financial markets. It is important here to note that the most important growth rates of Islamic banking assets have been recorded in the Middle East and North Africa (MENA) region, more specifically in the Gulf Cooperation Council (GCC) countries. These countries are considered as the largest domicile for Islamic banking assets, accounting for more than one-third of all Islamic banking assets worldwide [2].

Moreover, in the last years, most non-GCC MENA countries have favored the establishment of new Islamic banks and the expansion of Islamic banking activities. The exponential and rapid growth of the Islamic banking industry in the MENA region in recent years was mainly explained by the increasing wealth of oil-reach Muslim countries, especially from the Gulf region due to the increasing global dependence on oil and higher oil prices which boosted the demand for Islamic banking products.

In addition, most of Muslims in these countries have avoided conventional banking products in order to live in accordance with *Shariah* (Chong and Liu [3]).

Furthermore, many previous empirical studies showed that Islamic banks were relatively stable and have performed well during the last global financial crisis (see Hasan and Dridi [4], Cihak and Hesse [5], Beck et al. [6], Farooq and Zaheer [7], among others). Given this, assessing and analyzing the performance of Islamic banks in recent periods and especially during the period of the global financial crisis has become a subject of much interest worldwide. However, the review of literature revealed that few studies have been conducted in order to evaluate the performance of MENA Islamic banks, despite the fact that the most impressive growth rates realized by Islamic banks was recorded in the MENA region (see Srairi and Kouki [8], Ftiti et al. [9], Rosman et al. [10], etc.).

In this paper, we measure and analyze the technical efficiency of 33 Islamic banks operating in the MENA region during the period 2007–2012. This study contributes to the existing literature in several ways. It employs the Simar and Wilson's bootstrap Data Envelopment Analysis (DEA) approach [11], which is a robust method that allows for correcting the estimation bias and constructing confidence intervals for the estimated efficiency scores at desired levels of significance. In addition, it particularly focuses on Islamic banks from GCC countries and compares their technical efficiency with their counterparts from non-GCC countries. This is important because the diffusion of Islamic banks substantially vary across MENA countries. While most of the Islamic banking business is concentrated in the GCC countries, the number of Islamic banks is constantly increasing in non-GCC countries (see Ftiti et al. [9], Faye et al. [12] and Almarzoqi et al. [13]). Moreover, it provides an analysis of the technical efficiency changes in the case of MENA Islamic banks during the global financial crisis period (2007–2008) and in the post-crisis period (2009–2012).

The reminder of this paper is structured as follows. Section 2 provides a brief review of related literature. Section 3 describes the methodology employed. Section 4 presents the data and defines the variables used. Section 5 discusses the results obtained. Section 6 concludes.

2. Literature Review

In recent years, a significant number of studies has been achieved in order to evaluate and analyze the efficiency of Islamic banks by estimating different concepts, such as cost efficiency, profit efficiency, revenue efficiency as well as technical efficiency and applying different methods such as parametric and non-parametric models (see Brown [14], Hassan [15], Sufian [16], Tahir and Haron [17], Noor and Ahmad [18], among others). However, literature review reveals that few studies have focused on evaluating the efficiency of Islamic banks in the MENA region.

Among the previous researches that measured and analyzed the efficiency of MENA Islamic banks, some studies have found that pure technical inefficiency (*inefficiency caused by managerial underperformance*) was the main source of overall technical inefficiency of Islamic banks rather than scale inefficiency (*inefficiency caused by a wrong choice of the size of operations*). This result was confirmed by the study of Yudistira [19] which was one of the earliest studies that examined the efficiency of Islamic banks in the MENA region. He used the DEA method to estimate the technical efficiency of 18 Islamic banks operating in GCC, East Asian, African and Middle Eastern countries during the period 1997–2000.

In accordance with Yudistira's results and by employing the same method, Sufian and Nour [20] found that MENA Islamic banks suffered from pure technical inefficiency more than scale inefficiency during the period 2001–2006. This result was consistent with the study of Ben Hassine and Limani [21] who focused on a sample of 22 MENA Islamic banks over the period 2005–2009. They showed that MENA Islamic banks' technical inefficiency is caused mainly by pure technical inefficiency rather than scale inefficiency.

Similar results were found by Srairi and Kouki [8] in GCC countries. By applying the DEA method on a sample of 25 GCC Islamic banks over the period 2003–2009, they confirm that the overall technical inefficiency of GCC Islamic banks is mainly attributed to pure technical inefficiency (29.3%) instead of scale inefficiency (17%). In a recent study, Aghimien et al. [22] found that during all the study period (2007–2011), the sampled GCC banks (43 banks) were operating at an optimal scale of operation, which means that they were scale efficient. In addition, they showed that in the same period, GCC Islamic banks were managerially inefficient in exploiting their resources, which indicates that they suffer from pure technical inefficiency.

In contrast to these studies, literature review indicates that other empirical studies showed that for MENA Islamic banks the main source of overall technical inefficiency is scale inefficiency rather than pure technical inefficiency. This finding was confirmed by the studies of Rahman and Rosman [23] and Rosman et al. [10] by applying the DEA method on samples of Middle Eastern Islamic banks over the periods 2006–2009 and 2007–2010, respectively.

It is clear from this literature review that there is a lack of consensus between researchers concerning the sources of MENA Islamic banks' technical inefficiency. In addition, literature review reveals the existence of a major disagreement between researchers regarding the eventual impact of the latest global financial crisis on the efficiency levels of MENA Islamic banks. Srairi and Kouki [8] indicate that, on average, GCC Islamic banks increased their overall technical efficiency scores in the subprime crisis period (2007–2008) and in the post-crisis period. However, Rahman and Rosman [23] and Rosman et al. [10] confirm that the overall technical efficiency of Middle Eastern Islamic banks increased during the subprime crisis before decreasing in the post-crisis period (2009–2010). In another study, Ftiti et al. [9] have not found any significant effect of the subprime crisis on the overall technical efficiency levels of 30 GCC Islamic banks operating between 2005 and 2009.

3. Methodology

With reference to Simar and Wilson [11], the lack of consensus and the disagreement observed in the previous literature could be explained by the fact that all the previous studies have used the standard DEA method which is a deterministic method. This means that it does not effectively eliminate the negative influence of random errors and therefore it estimates biased efficiency scores. They also demonstrated that the estimated efficiency scores are sensitive to the sampling variations of the obtained frontier. To improve the standard DEA method, Simar and Wilson [11] developed the Bootstrap DEA approach which is a robust method able to provide measures of uncertainty for the efficiency scores, such as confidence intervals, and to correct the estimation bias.

Bootstrapping is based on the idea of repeatedly simulating the Data Generating Process (DGP)[1] (through resampling) and applying the original estimator to each simulated sample so that resulting estimates mimic the sampling distribution of the original estimator (see Efron [25], Efron and Tibshirani [26], Horowitz [27], Tortosa-Austina et al. [28], among others).

Following Simar and Wilson [11], the Bootstrap DEA approach can be summarized as follows:

(1) Calculate the DEA efficiency scores $\hat{\theta}_j$ for each Decision-Making Unit noted DMU$_j$, $j = 1, \ldots,$ n, that uses m different inputs x_{ij} ($i = 1, ..., m$), to produce s different outputs y_{rj} ($r = 1, ..., s$) by solving the following linear programming model:

$$\begin{aligned} & \theta^* = \text{Min}\ \theta \\ \text{s.t.}\quad & \textstyle\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{io} \quad i = 1, \ldots\ldots, m; \\ & \textstyle\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{ro} \quad r = 1, \ldots\ldots, s; \\ & \textstyle\sum_{j=1}^{n} \lambda_j = 1 \\ & \lambda_j \geq 0 \quad j = 1, \ldots\ldots, n; \end{aligned} \tag{1}$$

where θ^* is the technical efficiency score. $\theta^* < 1$ means that the evaluated DMU is technically inefficient. $\theta^* = 1$ indicates a full technically efficient DMU. $\sum_{j=1}^{n} \lambda_j = 1$ is the convexity

[1] The DGP is the joint probability distribution that is supposed to characterize the entire population from which the data set has been drawn (Poo [24]).

constraint. This model is the DEA model under the Variable Returns to Scale (VRS) assumption. It was developed by Banker et al. [29] in order to estimate the standard overall technical efficiency[2] and to decompose it into pure technical efficiency and scale efficiency.

(2) Generate a random sample of size n $\{\theta^*_{1b}, \ldots, \theta^*_{nb}\}$ by drawing with replacement from $\{\hat{\theta}_1, \ldots, \hat{\theta}_n\}$. The "*smoothed bootstrap*" is employed here by using the kernel density estimation and the Silverman's [31] reflection method, in order to avoid the "*naive bootstrap*" giving a poor estimate of the DGP (see Simar and Wilson [11] for a detailed explanation).

(3) Compute a pseudo data set $\{(x^*_{jb}, y_j);\ j = 1, \ldots\ldots, n\}$, where $x^*_{jb} = \frac{\hat{\theta}_j}{\theta^*_{jb}} x_j$ in order to construct the reference bootstrap technology.

(4) Compute the bootstrap estimate $\hat{\theta}^*_{jb}$ of the efficiency scores $\hat{\theta}_j$ for each DMU$_j$, j = 1, ..., n, by solving the bootstrap counterpart of the linear programming model previously presented.

(5) Repeat steps 2–4 B number of times, in order to provide a set of bootstrap estimates $\{\hat{\theta}^*_{jb};\ b = 1, \ldots\ldots, B\}$ for j =1, ..., n,. Following Simar and Wilson [32], B should be equal to 2000 in order to give a reasonable approximation of confidence intervals.

After computing the bootstrap estimates, we are now able to construct $(1-\alpha)$-percent confidence intervals for the efficiency scores of each DMU$_j$, j = 1, ..., n (α equal 0.05 in our case). To do this, we need to know the distribution of $(\hat{\theta}_j - \theta_j)$ in order to find values a_α and b_α such that:

$$\text{Prob}(-b_\alpha \leq \hat{\theta}_j - \theta_j \leq -a_\alpha) = 1 - \alpha \tag{2}$$

Simar and Wilson [32] demonstrated that it is impossible to find the values a_α and b_α since the distribution of $(\hat{\theta}_j - \theta_j)$ is unknown. To deal with this problem, they show that we can find values $\hat{a}_\alpha$ and $\hat{b}_\alpha$ from the distribution of the bootstrap estimates $\{\hat{\theta}^*_{jb};\ b = 1, \ldots\ldots, B\}$ such that:

$$\text{Prob}(-\hat{b}_\alpha \leq \hat{\theta}_j - \theta_j \leq -\hat{a}_\alpha) \approx 1 - \alpha \tag{3}$$

where $\hat{a}_\alpha$ and $\hat{b}_\alpha$ are the approximated values of a_α and b_α computed by sorting the values $(\hat{\theta}^*_{jb} - \hat{\theta}_j)$ for $b = 1 \ldots\ldots, B$ in increasing order and then deleting $(\alpha/2 \times 100)$-percent of the elements at either end of the sorted list. By setting $-\hat{a}_\alpha$ and $-\hat{b}_\alpha$ equal to the endpoints to the sorted array $(\hat{a}_\alpha \leq \hat{b}_\alpha)$, the $(1-\alpha)$-percent confidence interval for the efficiency score of each DMU$_j$, j = 1, ..., n, is estimated as follows:

$$\hat{\theta}_j + \hat{a}_\alpha \leq \theta_j \leq \hat{\theta}_j + \hat{b}_\alpha \tag{4}$$

Furthermore, the bootstrap approach allows us to assess the bias of the estimated efficiency scores $\hat{\theta}_j$, j = 1, ..., n, as follows:

$$\widehat{\text{Bias}}_j(\hat{\theta}_j) = B^{-1} \sum_{b=1}^{B} \hat{\theta}^*_{jb} - \hat{\theta}_j \tag{5}$$

From Equation (5), the bias-corrected estimation of each efficiency score θ_j, j = 1, ..., n, is determined as follows:

$$\hat{\hat{\theta}}_j = \hat{\theta}_j - \widehat{\text{Bias}}_j(\hat{\theta}_j) \tag{6}$$

Nevertheless, it is important to mention that the bias-correction should not be used unless:

$$\hat{\sigma}^2 < \frac{1}{3}\left[\widehat{\text{Bias}}_j(\hat{\theta}_j)\right]^2 \tag{7}$$

where $\hat{\sigma}^2$ represents the sample variance of the bootstrap values.

[2] Efficiency scores estimated under Constant Returns to Scale (CRS) assumption. This was done by solving the linear programming model in Equation (1) without the convexity constraint ($\sum_{j=1}^{n} \lambda_j = 1$) (see Coelli et al. [30]).

4. Data and Variables

4.1. Data

The data used in the empirical framework consists of inputs and outputs obtained from the financial statements of MENA Islamic banks over the period 2007–2012. Our sample includes 33 Islamic banks operating in the MENA region (Panel A). To add more depth to our analysis, we divide the main sample into two sub-samples: 17 GCC Islamic banks (Panel B) and 16 non-GCC Islamic banks (Panel C). In order to ensure the comparability of data across different MENA countries, all the values used are converted to U.S. dollar using the correspondent average exchange rates for each year and deflated by the Customer Price Index (CPI) of each country.

4.2. Variables

The variables used to estimate the technical efficiency of MENA Islamic banks are inputs and outputs. Two main approaches have been used in the literature to define banks' inputs and outputs: the production approach and the intermediation approach (see Fethi and Pasiouras [33], Sharma et al. [34], among others.). The production approach considers banks as a production unit, which produces outputs such as loans and deposits by using inputs such as labor and capital. The intermediation approach considers banks as financial intermediaries providing funds to borrowers by collecting deposits from savers, which means that they use deposits and labor as inputs to produce loans and other earning assets (Sealey and Lindley [35]).

Following Berger and Humphrey [36], the intermediation approach is the one preferred and most used in the literature because it evaluates banks as a whole while the production approach is better for evaluating bank branches. Indeed, the majority of previous studies on the efficiency of Islamic banks have used the intermediation approach (Yudistira [19], Sufian and Nour [20], Mobarek and Kalonov [37], Aghimien et al. [22], etc.). Given this, in our study, we adopt the intermediation approach, according to which, MENA Islamic banks are considered as financial intermediaries that produce two outputs: total loans (Y1), which include *Murabaha* and deferred sales, *Ijara* (leasing and hire purchase), *Mudarabah* (profit-sharing) and *Musharakah* (partnership); and other earning assets (Y2), which include investments in companies, securities, properties and real estate. They use three inputs: labor (X1), determined as the amount of staff costs; fixed assets (X2), valued as the book value of property, plant and equipment; and total deposits (X3), valued as the amount of customers' funds and funds from banks and other financial institutions.

Table 1 below presents the mean and the standard deviation values of the inputs and the outputs used in the estimations.

Table 1. Descriptive statistics of outputs and inputs (in US$ million).

		Outputs		Inputs		
		Total Loans (Y1)	Investment Portfolio (Y2)	Labor (X1)	Fixed Assets (X2)	Total Deposits (X3)
2007	Mean	2587.077	823.805	41.024	107.003	3086.277
	Std	4438.200	2201.676	78.924	269.096	5799.622
2008	Mean	2850.608	1025.127	44.617	130.665	3621.562
	Std	4605.444	3163.074	84.393	331.632	6844.633
2009	Mean	3120.620	1034.002	45.715	136.638	3861.140
	Std	4861.921	3045.888	86.986	331.697	6790.052
2010	Mean	3483.911	786.852	46.614	148.633	4208.558
	Std	6115.853	1633.461	84.434	391.114	7420.107
2011	Mean	3761.604	959.868	50.712	166.882	4362.321
	Std	7005.744	1839.884	91.087	405.044	8360.321
2012	Mean	4140.703	987.048	54.527	156.086	4673.127
	Std	7962.652	1841.203	93.956	377.165	9500.599

Note: Std means Standard deviation. Source: Author's calculation on data obtained from the financial statements of Middle East and North Africa (MENA) Islamic banks.

Table 1 shows that the mean values of Total loans (Y1) and Total deposits (X3) have grown steadily during the entire period of study with a superiority of deposits. This indicates that the intermediation activity of MENA Islamic banks has not been negatively affected during the global financial crisis (2007–2008), as was the case of conventional banks. However, from Table 1, we can state that the activities of MENA Islamic banks based on an investment portfolio were characterized by a great variability over the study period. This could be explained by a great difference in terms of investment portfolio values across MENA Islamic banks, especially between large sized GCC Islamic banks and small non-GCC Islamic banks.

5. Results

In this paragraph, we discuss the results found by applying the bootstrap DEA approach on the three selected panels of MENA Islamic banks (Panels A, B and C) over the period 2007–2012.

5.1. Overall Technical Efficiency Scores

By applying the bootstrap DEA approach, we compute the standard overall technical efficiency scores (EFF_STD), the bias of estimation (BIAS), and the bias-corrected overall technical efficiency scores (EFF_BC). Table 2 below presents the estimated scores for panels A, B and C:

Table 2. Standard and bias-corrected overall technical efficiency scores.

YEAR	EFF_STD	BIAS	EFF_BC
Panel A: *ALL BANKS*			
2007	0.886	0.076	0.810 *
2008	0.899	0.071	0.828 *
2009	0.881	0.083	0.799 *
2010	0.889	0.071	0.819 *
2011	0.792	0.124	0.668 *
2012	0.790	0.121	0.670 *
Mean	0.856	0.091	0.765
Panel B: *GCC BANKS*			
2007	0.914	0.066	0.849 *
2008	0.929	0.071	0.858 *
2009	0.926	0.066	0.859 *
2010	0.921	0.065	0.856 *
2011	0.826	0.135	0.691 *
2012	0.912	0.065	0.847 *
Mean	0.905	0.078	0.827
Panel C: *NON-GCC BANKS*			
2007	0.965	0.030	0.936 *
2008	0.937	0.053	0.884 *
2009	0.911	0.080	0.831 *
2010	0.905	0.080	0.825 *
2011	0.923	0.063	0.859 *
2012	0.825	0.191	0.634 *
Mean	0.911	0.083	0.828

Notes: * denotes an efficiency score that is statistically different from 1 at 5%, which means that its value is between the lower and the upper bound of the 95% confidence interval. Details on confidence intervals for each bank in each year are available upon request; Panel A (*ALL BANKS*) includes 33 Islamic banks from 11 MENA countries; Panel B (*GCC BANKS*) includes 17 Islamic banks from five Gulf Cooperation Council (GCC) countries, which are Bahrain (five banks), United Arab Emirates (four banks), Kuwait (three banks), Qatar (two banks) and Saudi Arabia (three banks); Panel C (*NON-GCC BANKS*) includes 16 Islamic banks from six countries: Jordan (two banks), Yemen (one bank), Iran (two banks), Egypt (two banks), Tunisia (one bank) and Sudan (eight banks). Source: Author's calculations from the results obtained by using the FEAR software (Paul W. Wilson, Department of Economics, Clemson University, Clemson, SC, USA) [36]. EFF_STD: standard overall technical efficiency scores; BIAS: bias of estimation; EFF_BC: bias-corrected overall technical efficiency scores.

From Table 2, we can see that there is an important positive bias of 0.091 for Panel A, 0.078 for Panel B and 0.083 for Panel C. This means that for all the three panels, the standard overall technical efficiency scores are overestimated by 9.1%, 7.8% and 8.3%, respectively. Moreover, Table 2 shows that all the standard efficiency scores are not significant at 5% meaning that they are not statistically different from 1. In contrast, all the bias-corrected efficiency scores are statistically significant at 5%. This is consistent with the findings of Simar and Wilson [11] who demonstrated that it is more appropriate to use the bootstrapped DEA estimates.

By considering only the EFF_BC, we can state from Table 2 that all MENA Islamic banks (Panel A) have an average efficiency score of 0.765 over the period 2007–2012. This means that their overall technical inefficiency is about 0.235 (1 − 0.765) on average, which suggests that they use 23.5% more inputs to produce the same amount of outputs compared to totally efficient banks (score equal to 1). In addition, Table 2 reveals a great similarity between average scores of overall technical efficiency of GCC and non-GCC Islamic banks (Panels A and B) over the period 2007–2012 (scores around 0.83). This means that their level of overall technical inefficiency is around 0.17 (1 − 0.83), on average, which means that they are able to reduce their inputs by 17%, without changing their output levels, to be fully efficient.

5.2. Decomposition of Overall Technical Efficiency

By employing the DEA model under the VRS assumption, the bootstrap DEA approach allows us to measure the EFF_BC and to decompose it into pure technical efficiency (EFF_PURE) and scale efficiency (EFF_SCALE). Table 3 below presents the efficiency scores for all the three panels of MENA Islamic banks.

Table 3. Bias-corrected overall technical efficiency and its components.

YEAR	EFF_BC	EFF_PURE	EFF_SCALE
Panel A: *ALL BANKS*			
2007	0.810 *	0.868 *	0.932 *
2008	0.828 *	0.898 *	0.923 *
2009	0.799 *	0.891 *	0.898 *
2010	0.819*	0.868 *	0.945 *
2011	0.668 *	0.745 *	0.900 *
2012	0.670 *	0.709 *	0.946 *
Mean	0.765	0.830	0.924
Panel B: *GCC BANKS*			
2007	0.849 *	0.923 *	0.919 *
2008	0.858 *	0.924 *	0.930 *
2009	0.859 *	0.924 *	0.932 *
2010	0.856 *	0.923 *	0.943 *
2011	0.691 *	0.909 *	0.858 *
2012	0.847 *	0.809 *	0.929 *
Mean	0.827	0.902	0.918
Panel C: *NON-GCC BANKS*			
2007	0.936 *	0.964 *	0.968 *
2008	0.884 *	0.944 *	0.935 *
2009	0.831 *	0.910 *	0.912 *
2010	0.825 *	0.938 *	0.879 *
2011	0.859 *	0.871 *	0.985 *
2012	0.634 *	0.635 *	0.986 *
Mean	0.828	0.877	0.944

Note: * denotes an efficiency score significant at 5%. Source: Author's calculations from results obtained by using the FEAR software (Paul W. Wilson [36]). EFF_PURE: pure technical efficiency; EFF_SCALE: scale efficiency.

Based on the mean values of the estimated efficiency scores, Table 3 shows that all the three panels of MENA Islamic banks are more scale efficient than pure technically efficient during the period 2007–2012. This suggests that pure technical inefficiency is the major source of overall technical inefficiency for MENA Islamic banks over the period of study. These results are in accordance with those of previous studies (see Srairi and Kouki [8], Sufian and Nour [20], Ben Hassine and Limani [21] and Aghimien et al. [22]).

By considering Panel A only, our findings show that the average pure technical inefficiency score of All MENA Islamic banks is about 0.17 (1 − 0.83) while the scale inefficiency is valued as 0.076 (1 − 0.924). This means that by improving their management practices (pure technical efficiency), MENA Islamic banks could avoid wasting 17% of their inputs, on average. In addition, they could save only 7.6% of their inputs by raising their sizes to reach the optimum scale (scale efficiency). Given this, it is more judicious for MENA Islamic banks to focus on increasing their pure technical efficiency.

These remarks are also valid when we consider the two other panels (Panel A and B). Indeed, results show that both GCC and non-GCC Islamic banks suffer from pure technical inefficiency more than scale inefficiency.

Furthermore, our results show that non-GCC Islamic banks are more scale efficient than GCC Islamic banks. In order to understand the differences between GCC and non-GCC Islamic banks in terms of scale efficiency, we should determine whether these banks are operating under increasing or decreasing returns to scale. To do this, we re-estimate the DEA model in Equation (1) by imposing an assumption of Non-Increasing Returns to Scale (NIRS)[3]. The results obtained under the NIRS assumption allowed us to identify the nature of returns to scale of GCC and non-GCC Islamic banks over the period 2007–2012. Following Rahman and Rosman [23] and Rosman et al. [10], we present, in Table 4 below, the percentage share of Islamic banks by nature of returns to scale:

Table 4. Percentage of Islamic banks by nature of returns to scale between 2007 and 2012.

YEAR	IRS	CRS	DRS
Panel B: *GCC BANKS*			
2007	18%	35%	47%
2008	18%	59%	24%
2009	18%	53%	29%
2010	12%	47%	41%
2011	41%	29%	29%
2012	24%	29%	47%
Mean	22%	42%	36%
Panel C: *NON-GCC BANKS*			
2007	44%	44%	13%
2008	63%	19%	19%
2009	50%	25%	25%
2010	63%	25%	13%
2011	81%	13%	6%
2012	63%	25%	13%
Mean	60%	25%	15%

Note: IRS: Increasing returns to scale; CRS: Constant returns to scale and DRS: decreasing returns to scale.

Table 4 shows that over the period of study (2007–2012), the majority of non-GCC Islamic banks are operating under IRS (60% on average) while GCC Islamic banks are, most of the time, operating under DRS (36% on average) or under CRS (42%). These results indicate that by increasing their inputs, non-GCC Islamic banks could increase their outputs more than proportionately, which allows them to realize cost reductions (economies of scale). In contrast, when GCC Islamic banks increase their inputs,

[3] This was done by solving the linear programming model in Equation (1) after substituting the convexity constraint ($\sum_{j=1}^{n} \lambda_j = 1$) with the constraint $\sum_{j=1}^{n} \lambda_j \leq 1$ (see Coelli et al. [30]).

their outputs would increase proportionately (CRS) or less than proportionately (DRS) which do not allow them to reduce their production costs (diseconomies of scale). This could be explained by the fact that non-GCC Islamic banks are small-sized banks compared to GCC Islamic banks which are mostly of large sizes.

To further analyze the evolution of overall technical efficiency and its components in the case of MENA Islamic banks during the period 2007–2012, we present Figure 1.

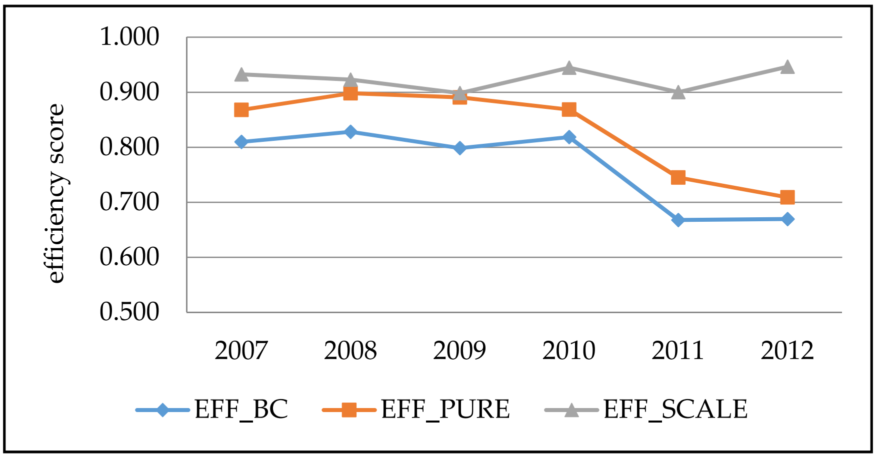

Figure 1. Bias-corrected overall technical efficiency scores and their components in the case of all MENA Islamic banks (Panel A) between 2007 and 2012. EFF_BC: bias-corrected overall technical efficiency scores; EFF_PURE: pure technical efficiency; EFF_SCALE: scale efficiency.

By considering all MENA Islamic banks (Panel A), Figure 1 indicates that all the estimated efficiency scores were relatively stable during the global financial crisis period (2007–2008) and in the early post-period (2009–2010). Figure 1 also reveals that MENA Islamic banks' overall technical efficiency declined significantly at the end of the post-crisis period (2011–2012). This decline was mainly caused by the increase of their pure technical inefficiency. These findings are consistent with the results found by Rahman and Rosman [23] and Rosman et al. [10].

To add more depth the to this analysis, we present Figures 2 and 3 which illustrate the evolution of bias-corrected overall technical efficiency and its components in the case of GCC and non-GCC Islamic banks (Panel B and C), respectively, during the period 2007–2012.

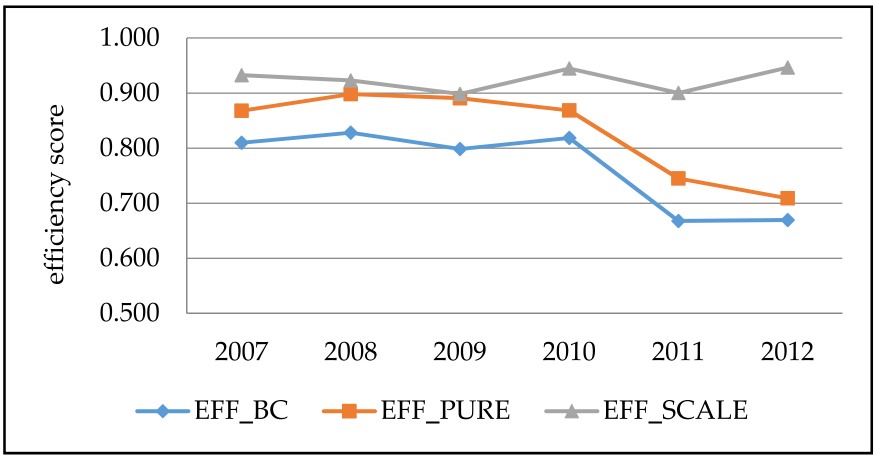

Figure 2. Bias-corrected overall technical efficiency scores and their components in the case of GCC Islamic banks (Panel B) during the period 2007–2012.

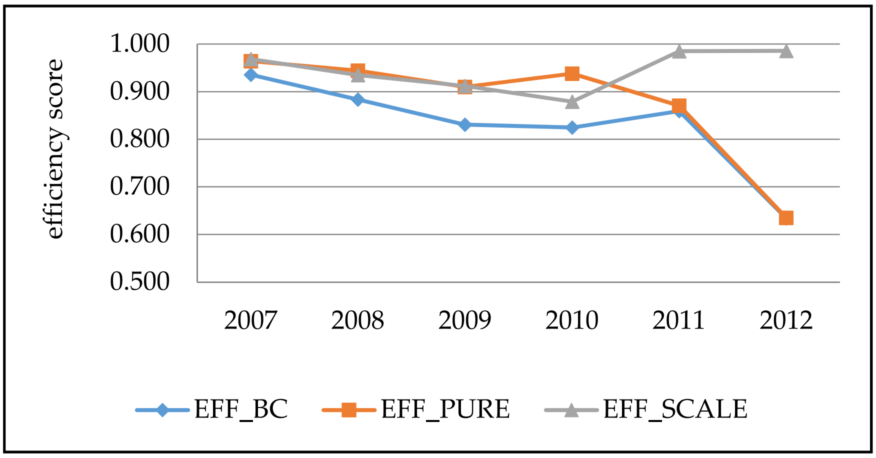

Figure 3. Bias-corrected overall technical efficiency scores and their components in the case of non-GCC Islamic banks (Panel C) during the period 2007–2012.

It is clear from Figures 2 and 3 that there is a relative stability of the efficiency scores only for GCC Islamic banks during the period (2007–2010). Indeed, GCC Islamic banks have succeeded in keeping stable their levels of pure technical and scale efficiency while non-GCC Islamic banks saw their efficiency scores decrease between 2007 and 2010. This could be explained by the fact that the global financial crisis gave the GCC Islamic banks the opportunity to increase their market shares in terms of credits and deposits, given that the performance of conventional banks has been negatively affected (see Hasan and Dridi [4], Johnes et al. [39], and Alqahtani et al. [40]). This was not the case for non-GCC Islamic banks, which have not benefitted from any advantage over their conventional counterparts during the global financial crisis. Indeed, the performance of non-GCC conventional banks was not affected negatively by the crisis because of their limited linkage to the global banking system (see Mashal [41] and Zarrouk [42]).

Figures 2 and 3 also show that the end of the study period (2011–2012) was very difficult for GCC and non-GCC Islamic banks that were less technically efficient. In the case of GCC Islamic banks, this underperformance can be explained by the negative impact of the global financial crisis on the real economy. Indeed, the real estate markets of many GCC countries have declined after the global financial crisis, which has negatively affected the performance of GCC Islamic banks as a large number of contracts are backed by real estate and property as collateral. This means that Islamic banks in GCC countries were not directly impacted by the global financial crisis, however they were affected later when this financial shock overflowed from the financial sector to the real economy, causing an economic slowdown. Our results are consistent with the findings of many empirical studies such as Alqahtani et al. [40] and Zarrouk [42] among others, which demonstrated that the initial impact of the global financial crisis on the GCC Islamic banks' efficiency was limited. However, with the impact of the crisis moving to the real economy, the efficiency of GCC Islamic banks has decreased significantly. By considering non-GCC Islamic banks, Figure 3 shows that they have succeeded in improving their scale efficiency in the last two years of the study period (2011–2012) by increasing the size of their operations in order to earn economies of scale. However, this was not enough to ameliorate their overall technical efficiency levels that have declined during all the years between 2007 and 2012. This was due mainly to the increase in their pure technical inefficiency, especially at the end of the period.

Furthermore, the decrease of technical efficiency levels of GCC and non-GCC Islamic banks in the post-crisis period could be explained by the fact that they are facing several challenges that could negatively affect their performance compared to conventional banks. Several comparative studies have found that MENA Islamic banks were less technically efficient than conventional banks, particularly in the post-crisis period (see Mobarek and Kalonov [37], Johnes et al. [39], among others). This was argued by the fact that MENA Islamic banks suffer from a legal framework that is not adapted to their specific nature, a scarcity of qualified human capital, and a lack of diversification and innovation. In addition, they operate in less competitive banking markets (see Polemis [43], Apergis and Polemis [44], among others). These conditions are more favorable for conventional banks which enjoy several advantages over Islamic banks because of their bigger asset size, better access to financial markets, long history and experience, more developed technologies, etc. (Kamarudin et al. [45]).

6. Conclusions

In this paper, we have measured and analyzed the technical efficiency of MENA Islamic banks during the period 2007–2012. To do this, we have employed the Simar and Wilson's [11] bootstrap DEA approach, which allowed us to estimate the bias-corrected efficiency scores for each bank and to construct confidence intervals at desired levels of significance. This approach also allowed us to decompose the obtained bias-corrected overall technical efficiency scores into pure technical efficiency and scale efficiency scores.

By considering all banks in the sample (Panel A), our results show that, over the period of study, overall technical inefficiency of MENA Islamic banks is mainly caused by pure technical inefficiency rather than scale inefficiency. A similar result was found in the case of the two sub-samples: GCC Islamic banks (Panel B) and non-GCC Islamic banks (Panel C).

Furthermore, the analysis of efficiency changes over the period of study suggests that Islamic banks in the MENA region, particularly those that are operating in GCC countries, performed well during the period 2007–2010 which includes the global financial crisis period. In fact, all estimated efficiency scores of GCC Islamic banks were more stable and did not decrease during the crisis period (2007–2008) and in the early post-crisis period (2009–2010). In contrast, non-GCC Islamic banks experienced a slight decline of their efficiency scores in the same period. However, the last two years of the study period (2011–2012) were difficult for all MENA Islamic banks. Indeed, their overall technical efficiency declined, due mainly to an important decrease in pure technical efficiency while scale efficiency increased, especially for non-GCC Islamic banks.

In total, our study implies that the managers of MENA Islamic banks should focus more on improving their management practices in allocating resources (pure technical efficiency) than on increasing the size of their operations to earn economies of scale (scale efficiency). In addition, we recommend that policy-makers in MENA countries develop the supervisory and legal framework in order to minimize the risks related to the exposure of Islamic banks to economic downturns. Other measures are also needed to ensure the sustainable growth of the MENA Islamic banking industry, such as strengthening and elaborating a suitable system of supervision, regulation that takes into consideration the specificities of Islamic financing products and developing qualified human capital. Moreover, it is important for supervision authorities in the MENA countries to opt for reforms that promote higher competition in their banking markets. This would allow MENA Islamic banks to diversify their portfolio loans and to provide more standardized and innovative products which would increase their market shares and therefore improve their performance.

Conflicts of Interest: The author declares no conflict of interest.

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