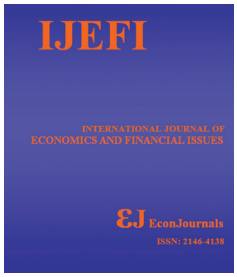

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Bootstrap DEA Efficiencies of the GCC Islamic Banks: Sources and Comparison During 2014-2016

Abdus Samad*

Department of Finance and Economics, Utah Valley University 800 W University PKWY Orem, UT 84058, USA.
*Email: abdus.samad@uvu.edu

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ABSTRACT

This paper, first, obtained three categories of efficiencies, overall bias-corrected technical efficiency (OTEBC), bias-corrected pure technical efficiency (PTEBC) and bias-corrected scale efficiency (SE) of the Islamic banks of the Gulf Cooperating Countries (GCC) during 2014-2016 using the Simar and Wilson (1998) Bootstrap data envelopment analysis (DEA). Second, decomposing the overall bias-corrected technical efficiency (OTEBC) the paper found the bias-corrected pure technical efficiency (PTEBC) and the bias-corrected scale efficiency (SE) were 91% and 59.8% respectively and thus PTEBC dominated the OTBBC (82.4%) and the SE (59.8%) of the GCC Islamic banks. Third, the paper found the sources of the inefficiency of the Islamic banks of the GCC was the DRS. Except the Islamic banks of Qatar, banks of the GCC countries were inefficient either because they operated under the IRS or DRS. DRS was the major source of inefficiency. Qatar Islamic banks demonstrated the highest level of efficiency in all three efficiency among GCC. The paper provides suggestions for future study.

Keywords: GCC Islamic Banks, Technical efficiency, Bootstrap DEA, Bias-corrected Technical Efficiency
JEL Classifications: C14, G21, G22

1. INTRODUCTION

GCC, Gulf Cooperating Countries, consists of Oman, Kuwait, Qatar, Bahrain, Saudi Arabia, and United Arab Emirates (UAE). They are all oil rich countries.

Among GCC, the financial service sector, bank in particular, is a dominant sector and is an important source of income for UAE and Bahrain. The financial industry is one of the largest non-oil contributors of Bahrain's real GDP. It contributes about 17.6 of GDP in 2018. One of the main beneficiaries of the regional boom driven by demand for oil is Bahrain's banking and financial services sector, particularly Islamic banking.

The UAE domestic market banks reported Dh2.84trn ($773bn) in assets at the end of the third quarter of 2018, making the UAE's banking sector the largest in the GCC region, according to the Central Bank of the UAE (CBU). Islamic banks account for about 20.4% of overall assets as of the third quarter of 2018. Dubai Islamic Bank, founded in 1975, was seen as the first sharia-compliant lender of its kind, marking the beginning of the broader Islamic finance segment.

In the GCC region, Kuwait is home to one of the oldest banking industries. The Emir of Kuwait issued a 30-year concession to a group of British investors to set up the nation's first bank in 1941. Today Kuwait has 11 domestic and 11 foreign banks and Kuwait's banking sector constitutes one of the oldest and one of the most developed financial industries in the Gulf region.

Oman's banking sector faced considerable challenges over recent years due to the struggling global economy and a decline in oil prices. Although conventional banks dominate Oman's banking sector, nonetheless, there is a vibrant Islamic banking operating

side by side with conventional banks. There are currently two Islamic banks operating in the sultanate – Bank Nizwa and Alizz Islamic Bank – as well as six Islamic windows operated by conventional institutions.

Among the GCC, the Qatar Financial Center (QFC) is one of the largest and fastest-growing business and financial centers in the Middle Eastern country with a significant 33% growth and nearly 200 companies registered on QFC's platform. Because of its growing financial institutions, Islamic financé in particular, Qatar is poised to become a leading hub for the financial sector. Within the Islamic finance, the Islamic banking sector is playing an important role in making Qatar a leading interconnected Islamic finance hub. In terms of total assets, Qatar's Islamic banking sector accounts for 82% in the Islamic finance with a total value of $107bn in the first half of 2019.

The dominant sector of Saudi Arabia is oil. The banking sector's growth of Saudi Arabia is tied to the growth of the economy fueled by the oil industry. When the global financial crisis hit the oil industry, its banking sector also faced challenges. Non-performing loans (NPLs) increased 125% in 2009 due to the rising number of credit defaults. Saudi Arabia is home of a number of dedicated Islamic Banks, as well as Islamic window operations offered through conventional banks. Al Rajhi Bank is the largest Islamic bank in Saudi Arabia, and also the largest Islamic bank internationally with assets of SAR325.2bn (USD87bn) at end-3Q15.

The growth of Islamic banking has been a phenomenon since emergence in GCC. The numbers of Islamic banks, as well as the market shares of Islamic banks, are increasing in the world. Based on Ernst and Young (2014) the total assets of the Islamic bank are around 1.7 trillion dollars. However, at the center of the growth of Islamic banking assets is the GCC. These countries provide the largest share of total assets, more than 33% of the total (Bahrini, 2017).

Dubai, Bahrain, and Abu Dhab have become the main hub of Islamic banking in the Gulf Cooperating Countries (GCC). The rise of the Islamic banking in the GCC was tied to their rapid oil-contributed economic growth. Before the financial crisis in 2008-2009, the OPEC countries, the GCC in particular, generated windfall wealth in the world financial markets because of the huge increase in oil prices.

The Islamic banking sector was in the forefront in providing the credit needs of the nation and became an essential factor for economic growth of the GCC. Although the decline of oil price affected their economic growth, the efficiency of the banking sector, Islamic banks in particular, remains unexplored.

Banks' inefficiency increases the cost of intermediation and harms the allocation of funds and the profitability of banks leading to bank failure (Samad, 2014). The increased efficiency in banks' deposit mobilization and loan advancement are key to successful entrepreneurs for enhancing the economic growth of a country (Schumpeter, 1911).

The study of the Islamic bank technical efficiencies across the GCC and the sources of inefficiencies are important for several reasons. The efficiency of the productivity of banks including Islamic banks is of great interest to public authorities supervising and regulating banks, bank managements and bank depositors and borrowers. Each of them is interested to know bank efficiency. In a competitive market environment, bank depositors and borrowers are certainly interested to know the efficiency status of individual banks before they deposit their hard-earned savings. The borrowers of bank move to the banks which are more efficient in advancing loans.

Although the study of efficiency is important, the survey of the banking literature shows not enough evidence of Islamic banking efficiencies studies across the GCC during 2014-2016, the post global crisis period. This study is an important contribution to the Islamic banking efficiency literature by providing the comparative highlights of OTE, PTE, and SE of the GCC Islamic banking industry.

This paper provides the following sequences: A brief characteristic feature of Islamic bank is outlined in section 2. Section 3 provides the survey of literature. Data and methodology are discussed in section 4. Section 5 provides empirical results and conclusions.

2. KEY CHARACTERISTIC FEATURES OF ISLAMIC BANK

As the basic principles of the operation of the Islamic bank are derived from the Quran and Sunnah and the Islamic banks do not charge interest, Islamic banks are a different breed of the financial institution. The corner-stone of Muslims' way of life.

First, Islamic banks only finance the business that are permitted by the Shariah law. As Islam prohibits the consumption and production of any harmful activity, such as wine, alcohol, and destructive weaponry, Islamic banks do not finance these production and consumption, irrespective of high profit prospects.

Second, the avoidance of riba (usury) in all financial transactions is a key distinguishing feature of Islamic banks. This is because, the Quran, the Divine book of Islam strongly prohibits riba in business transactions. The Quran says: "… Allah permitted trading and forbade riba" (Quran: 2: 275). However, neither the Quran nor the Prophet of Islam 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 banking and financing world.

Third, the prohibition of riba (usury) in Islam gave birth to the rise of the profit and loss sharing (PLS) mode of production. The PLS is the most important characteristic of the Islamic banks that distinguishes the Islamic banks from the interest-based conventional banks. The key features of profit and loss sharing

1 Umar b. al-Khattab said, "There are three thing:. 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;

(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; and (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 the PLS, the avoiding of fixed interest, and Shariah based business conduct.

3. SURVEY OF LITERATURE

This study mainly focuses on the cross-country bank efficiency studies. Important studies on a country-bank level efficiencies include the followings:

El-Gamal and Inanoglu (2004) estimated the comparative cost efficiency of the Turkish banks for 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.

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 pure technical efficiency during the period. They also found that the foreign banks had higher technical efficiency than the domestic banks.

Sufian (2009) made another study in estimating the various efficiencies and the determinants of these efficiencies of Malaysian. His studies found that the efficiencies were negatively related to bank expenses and economic conditions, while the efficiencies were positively related to loan intensity.

Kumer and Rachita (2008) examined the technical, pure technical and scale efficiencies of the 27 public sector banks of India just for 2004. The empirical evidence of the paper shows public sector banks operated at 88.5% level of TE i.e., the inefficiency was 11.5%. 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 (2009) estimated technical efficiency of the Bangladesh commercial banks using stochastic frontier approach and found that the average efficiency of the Bangladesh commercial banks was 69.6%.

Samad (2010) estimated the technical efficiency loan financing of Grameen bank developed by the Nobel Laureate, Dr. Muhammad Younus.

Cross country-bank level bank efficiency studies include the followings:

Hassan (2006) applied both parametric method (SFA) and non-parametric frontier methods (DEA) in assessing 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 and found Islamic banks were more cost inefficient than profit inefficient meaning that Islamic banks were more efficient in profit-making and technical inefficiency dominated the scale efficiency. His study confirmed the findings of Yudistira (2004) who examined the cross-country technical efficiency of 18 Islamic banks of GCC, East Asian, African and Middle Eastern countries during the period 1997-2000and found that the overall technical inefficiency score of Islamic banks was on average just over 10%.

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

Applying the panel DEA, Sufian (2009) 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 score of the MENA Islamic banks were higher than the technical efficiency of the Asian Islamic banks. Pure technical inefficiency was less prominent than the scale inefficiency i.e. scale inefficiency was the major source of inefficiency.

Noor and Ahmad (2012) investigated the efficiency of 78 Islamic banks operating in 25 countries during the period 1992-2009 using DEA and found that the technical efficiency of many Islamic banks in the world have increased during and after the global financial crisis period. According to them the financial crisis has decreased trust in the conventional banking system in favor of the Islamic banking model. They further found that the pure technical efficiency scores of sampled Islamic banks were higher than their scale efficiency scores which contradicted the findings of Sufian (2009) and Yudistira (2004).

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

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

Hassine and Limani (2014) examined 22 MENA Islamic banks over the period 2005-2009 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 DEA and bootstrap DEA and found that the technical inefficiencies of the MENA Islamic banks were mainly attributed to pure technical inefficiencies (17.9%) rather than scale inefficiencies (9.1%).

Nafla and Hammas (2016) compared the technical efficiencies of Islamic banks vis-à-vis conventional banks of eight countries and then determined the determinants of the technical efficiencies using DEA Tobit model. They found that the asset quality of the Islamic banks had a positive impact during the crisis.

Sum of findings: The survey of literature found no unanimity of conclusions (i) Regarding the sources of Islamic banks' technical inefficiency. (ii) there is no consensus among researchers concerning the technical efficiency of Islamic banks during and after the global financial crisis. (iii) There was no study of the comparative technical efficiencies of Islamic banks of Bahrain and UAE. (iv) No previous study used bootstrap DEA method for estimating bias-corrected technical efficiencies, except Bahrini (2016).

4. DATA AND METHODOLOGY

4.1. DATA

The bank inputs, used in this study, are: (i) bank capital, (ii) employee wages, and (iii) bank deposit. The bank outputs are (i) earning assets and (ii) gross loans.All inputs and output data for the Islamic banks of all GCC countries were obtained from Bank-Scope for the period of 2014-2016. Total number of banks under this study was 34. Of these 12 from Bahrain, 9 from UAE, 4 each were from Saudi and Kuwait, 3 from Qatar, and 2 from Oman.

4.2. Methodology

The DEA has two versions. The DEA model originally proposed by Charnes et al. (1978) is known as the CCR model. It measures the technial efficiency of the DMU under the assumption of constant returns to scale (CRS). As all DMUs do not operate under the CRS, Banker et al. (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 graph [Figure 1].
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): TE_{CRS} = PQ/PF.

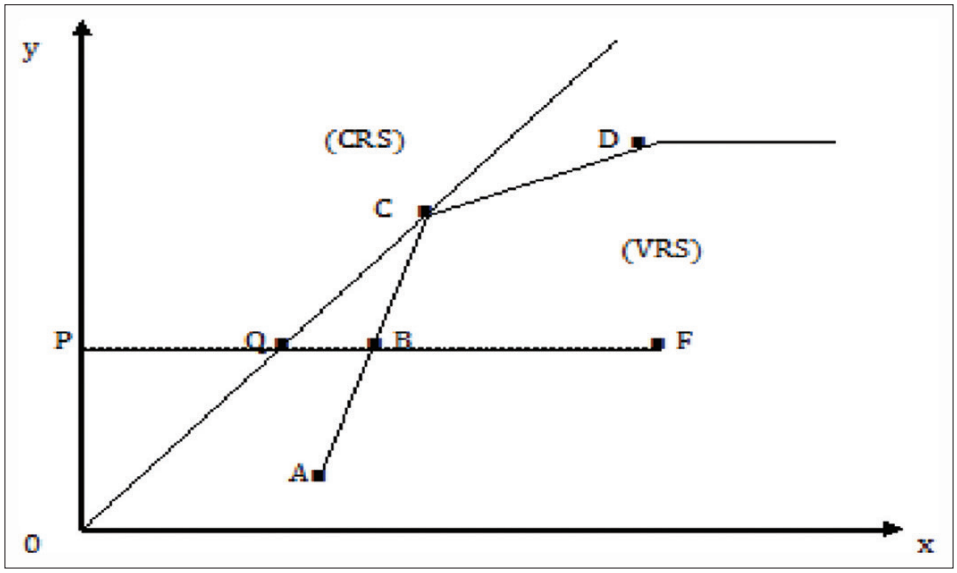
The pure technical efficiency score (under VRS frontier): TE_{VRS} = PB/PF.

The scale efficiency score: SE = PQ/PB.

From this, we can deduce that $TE_{CRS} = TE_{VRS}$ 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 no DMUs to be evaluated. Each DMUj, $j = 1, \ldots, n$ uses m different inputs, noted ($i = 1, \ldots, m$), to produce different outputs, noted ($r = 1, \ldots, s$). The technical efficiency score for a particular DMU, called DMUo, is determined by solving the following linear programming problem. The technical efficiency

Figure 1: Constant returns to scale and variable return to scale efficiency frontiers (Coelli et al., 2005)



score θ for a particular DMU, called DMUo, is determined by solving the following linear programming problem:

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

θ<1 Means that the evaluated DMU is technically inefficient. θ=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).

This paper first applied the bootstrap-data envelopment analysis (bootstrap DEA) to obtain the efficiencies, θ*: overall bias-corrected technical efficiencies (BC-TE) and bias corrected pure technical efficiencies (BC-PTE). The bootstrap DEA is used because the DEA method suffers from serious shortcomings, according to Simar and Wilson (1998,2000). (i) the DEA method is deterministic. That is, the efficiency score obtained by the DEA does not allow for random error such as machine failure or power out. It thus overestimates the efficiency scores of the DMU and leads to biased efficiency (Simar and Wilson, 1998). (ii) The DEA efficiency score is a calculation and is not an estimate as it does not have statistical properties such as any confidence level attached to it and confidence estimate with confidence interval values. Bootstrap is a data-based simulation method 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 the data. As the replicated data set approximates the original data, the sampling distributions of the sample mean and standard deviations generated from the repeated sampling are close to the original ones. The bootstrap-DEA, introduced first by Simar and Wilson (1998) provides the estimated efficiency scores of each DMU generated from numerous 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 and obtained by solving a linear programming problem for each data point k (k=1,…, K):

$$\hat{F}_k^0(\mathrm{Y_{k,}X_k},\ \mathrm{Y},\ \mathrm{X}\,|\,\mathrm{CRS}) = \theta \tag{2}$$

$$\text{s.t.}\ \sum_{k=1}^{k} Z_k \mathrm{Y_{km}} \ge \mathrm{Y_{km}}\theta_m, \mathrm{m}\ = 1,\ \ldots, \mathrm{M}$$

$$\hat{F}_{k}^{0}(\mathrm{Y_{k,}\ X_k,\ Y,\ X|CRS}) = \theta \tag{3}$$

$$\sum_{k=1}^{k} Z_k \mathrm{X_{kn}} \le \mathrm{X_{kn}}, \mathrm{n}\ = 1,\ \ldots, \mathrm{N}$$

$$\mathrm{Z_K} \ge 0$$

Where Y is K × M matrix of available outputs, X is K × 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 ≤θ≤1, with a value of 1 indicating a point on the frontier and hence a technically efficient DMU; i.e., outputthe of the DMU cannot be increased without increasing inputs. A DMU is inefficient when the value of θ<1; that is, a given output can be produced by reducing inputs of the DMU.

Bias is calculated as follows:

$$\mathrm{Bias}(\hat{\theta}_k) = E(\hat{\theta}_k) - \hat{\theta}_k$$

$$\mathrm{Bias}(\hat{\theta}_k) = B^{-1}\sum_{k=1}^{k}(\hat{\theta}_{*k}) - \hat{\theta}_k$$

The bias-corrected efficiency score can be expressed as:

$$\tilde{\theta}_k = \hat{\theta}_k - \mathrm{bias}(\hat{\theta}_k) = 2\hat{\theta}_k - B^{-1}\sum_{k=1}^{k}(\hat{\theta}_{*k})$$

4.2.1. Input-output controversy and model selection

In a production of coal mine, output is the amount of coal and inputs are labor and capital. However, in the multiproduct firm such as the bank which produces a series of services and uses a vector of inputs, deciding inputs and outputs are not easy to determine and it has become controversial. Based on the 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 accounts 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.

Using the definition of Sealey and Lindley (1977), this paper estimated the following model using the bootstrap DEA:

$$\mathrm{loan_i} = \beta_0 + \beta_1\,\mathrm{CAP_i} + \beta_2 \mathrm{salary} + \beta_3 \mathrm{Deposit_i} \tag{4}$$

Where
$\mathrm{loan_i}$ = total loans + total earning assets. They are considered as output.

Inputs of the bank are: Fixed capital (CAP), employee salary (EMEXPSE), and total deposits (DEPOST).The descriptive statistics of inputs and output variables are provided in Table 1.

All variables were in US thousand dollars. Table 1 shows that the mean of all variables increased during 2014-2016.

Table 1: Descriptive statistics of inputs and outputs[3] during 2014-2016

Year	Inputs			Outputs	
2014	Emexpse	CAP	Deposit	Earning asset	Loans
Mean	121542.9	248860.7	9617442	10151520	9307737
Median	57157.00	55958.50	3973306	6144731	4096797
Maximum	670428.0	2996455	68287216	56302479	70668215
Minimum	5096.000	11.00000	345.0000	119603.0	15425.00
Std. Dev.	162747.6	549294.2	13824536	12863267	13668601
			2015		
Mean	130235.5	187212.3	10273026	11107785	10257864
Median	57675.50	52301.50	4616206	6768841	4692426
Mean	130235.5	187212.3	10273026	11107785	10257864
Median	57675.50	52301.50	4616206	6768841	4692426
Maximum	709612.0	1487715	68752441	57597674	73868214
Minimum	1851.000	15.00000	348.0000	118501.0	76782.00
Std. Dev.	167680.2	312638.8	14181603	13770289	14510861
			2016		
Mean	137330.2	194401.3	10456504	11837604	10946594
Median	61925.50	56363.00	4670834	7371659	4991745
Maximum	786636.0	1729377	72691507	61767157	76161478
Minimum	1843.000	30.00000	348.0000	118009.0	29568.00
Std. Dev.	178348.3	337893.5	14794926	14587484	15181520

Table 2: Over-all DEA technical efficiency (DEAOTC) and the bias-corrected over-all technical efficiency (OTEBC), and bias during 2014-2016

Year	DEAOTE	OTEBC	BIAS
2014	0.858	0.815*	0.042
2015	0.864	0.826*	0.038
2016	0.867	0.833*	0.033
Mean	0.863	0.824*	0.037

Table 3: Over-all bias-corrected technical efficiency (OTEBC), Pure bias-corrected technical efficiency (PTEBC), and scale efficiency (SE) during 2014-2016

Year	OTEBC	PTEBC	SE
2014	0.815	0.908*	0.528
2015	0.826	0.909*	0.601
2016	0.833	0.902*	0.597
Mean	0.824	0.91*	0.598

5. EMPIRICAL RESULTS

The empirical results of all efficiencies (Overall-technical efficiency (OTE[2]), overall-bias-corrected technical efficiencies (OTECB), and biases (BIAS)) are presented in Table 2.

The decomposition of the overall technical efficiencies (OTEBC) into pure technical efficiencies (PTEBC), known as managerial efficiency, and scale efficiency (SE) are presented in Table 3.

The sources of inefficiencies across the GCC countries' Islamic banks are presented in Tables 2-8.

The average overall DEA technical efficiency (OTE) of the Gulf Islamic banks, in Table 2, was 86.3% suggesting average redundancy/wastage of inputs of banks was 13.7%. When the DEA technical efficiency (OTE) is compared with bootstrap bias-corrected efficiencies (OTEBC), it was found that the average bootstrap bias-corrected technical efficiency was 82.4% which suggest that DEA efficiencies (OTE) exaggerated/overestimated bank efficiencies. Based on the estimate of overall bias-corrected technical efficiency it was found was that the average inefficiency of the Isalmic banks was 17.6%.

When efficiencies were compared across years, it showed that both DEA (OTE) and bootstrap bias corrected (OTEBC) the average technical efficiency of the GCC bank increased marginally during 2014-2016. The average overall bias-corrected technical efficiency (OTEBC) of the GCC banks was 82.4%.

Using a 90% confidence interval, (C.I) estimate, Table 2 shows that the average bias in estimating technical efficiency is 3.7%.

Over-all bias-corrected technical efficiency (OTEBC) is decomposed into pure bias corrected technical efficiency (PTEBC) and scale efficiency SE). The pure bias corrected technical efficiency (PTEBC) is known as managerial efficiency. It represents the efficiency of management in using resources of firms. On the other hand, scale efficiency (SE)/inefficiency represents whether firms operate below or above the optimum capacity level of firms.

The decomposition of bank bias-corrected technical efficiency into PTEBC and SE is presented in Table 3 for understanding the sources of inefficiency.

Table 3 showed that the average bias corrected overall technical efficiency (OTEBC), the bias corrected pure technical efficiency (PTEBC) and the bias-corrected scale efficiency (SE) of the GCC banks were 82.4%, 90.6%, and 57.5% respectively during 2014-2016.[3]

2 OTE is DEA efficiency.

3 All inputs and outputs are in million dollars. Number of total banks is 34

Table 4: Country-wise comparison of overall bias-corrected technical efficiency (OTEBC) among the GCC banks

Country	2014	2015	2016	Mean
Bahrain	0.816	0.788	0.825	0.81
UAE	0.804	0.811	0.819	0.81
Saudi	0.807	0.814	0.822	0.81
Kuwait	0.823	0.84	0.851	0.84
Qatar	0.865	0.878	0.895	0.88
Oman	0.788	0.81	0.825	0.81
Mean	0.815	0.826	0.833	0.82

Table 5: Comparison of bias-corrected pure technical efficiency (PTEBC) among the GCC banks

Country	2014	2015	2016	Mean
Bahrain	0.833	0.889	0.88	0.87
UAE	0.905	0.907	0.903	0.91
Saudi	0.929	0.907	0.933	0.92
Kuwait	0.927	0.931	0.928	0.93
Qatar	0.953	0.956	0.946	0.95
Oman	0.902	0.862	0.841	0.87
Mean	0.908*	0.909*	0.902*	0.91

Table 6: Comparison of bias-corrected scale efficiency (SE) among the GCC banks

Country	2014	2015	2016	Mean
Bahrain	0.624	0.674	0.648	0.649
UAE	0.423	0.473	0.449	0.448
Saudi	0.453	0.472	0.449	0.458
Kuwait	0.490	0.578	0.506	0.525
Qatar	0.812	0.884	0.881	0.859
Oman	0.316	0.702	0.924	0.647
Mean	0.520	0.631	0.643	0.598

The SE efficiencies of the Islamic bank of GCC countries marginally increased suggesting that the scale inefficiency decreased during 2014-2016.

When the three efficiencies, (OTEBC), PREBC, and SE, were compared, it showed that the managerial efficiency dominated both OTEBC and SE. The average BTEBC, 91%, was higher than those of both OTEBC, 84.4% and SE, 59.8%.

The average inefficiency of the Gulf Islamic banks due to inefficiency of the optimum loan size was 42.4 (100-57.5) and it dominated the inefficiency of due managerial inefficiency. The average PTEBC was 90.6% suggesting the average managerial inefficiency (PTEBC) of GCC banks was 9.4% compared to 17.6% inefficiency in OTEBC. This result confirms the finding of Srairi and Kouki (2012).

When three efficiencies, OTEBC, PTEBC, and SE, were compared, it was found that the dominant source of inefficiency was scale inefficiency. As the average scale efficiency (SE) of the GCC banks during 2014-2016 was 59.8%, the average scale inefficiency was (1-0.59.8) = 40.2% compared to the average managerial inefficiencies of 9%.

A comparison of efficiencies, OTEBC, PTEBC, and SE, across the Islamic banks of the GCC countries during 2014-2016 is presented in Tables 4-6, respectively.

Table 4 shows the rank of efficiency level of the Islamic banks among the GCC. Ranking shows Qatar first, Kuwait second, and the rest of the countries are the same. The mean efficiency of the Islamic banks of Qatar, 88%, was the highest among the GCC Islamic banks. The average overall technical efficiency, OTEBC, of the Qatar Islamic banks was 88% and was higher than the GCC average of 82% during 2014-2016.

The average overall technical efficiency of the Islamic banks of Kuwait was 84% and was the second highest among the GCC Islamic banks during the period.

The average efficiencies (OTEBC) of the UAE, Oman, Saudi, and Bahrain Islamic banks were 81% and was the same as the average of GCC.

Although Bahrain and UAE were the front runner in introducing the Islamic banking operation and were the main hub of the Islamic banks, the average OTEBC of these countries were behind the technical efficiency of Qatar and Kuwait. One possible reason for this was that the number of banks of these countries under this study was very few compared to the number of banks from Bahrain and UAE.

Table 5 shows the ranking of pure technical efficiency level of the Islamic banks among the GCC. Ranking shows Qatar was the first, Kuwait was second, and the rest of the countries were the same. The mean pure efficiency of the Islamic banks of Qatar, 95%, was the highest among the GCC Islamic banks. The average pure technical efficiency, PTEBC, of the Qatar Islamic banks, 95%, was higher than the GCC average efficiency of 91% during 2014-2016. The management inefficiency level of the Qater Islamic banks was 5% (100-95=5%).

The average pure technical efficiency of the Islamic banks of Kuwait was 93% and was the second highest among the GCC Islamic banks during the period. The management inefficiency level of the Kuwait Islamic banks was 5% (100-93=7%).

The average pure technical efficiency of the Islamic banks of Saudi Arabia and UAE was 92% and 91% respectively and was the second highest among the GCC Islamic banks during the period suggesting management inefficiency level of the Saudi and UAE Islamic banks was 8% and 9% respectively.

The management efficiency level found to be lowest for the Islamic banks of Bahrain and Oman. The average pure technical efficiency of the Islamic banks of Bahrain and Oman was 92% for both countries.

Although Bahrain and UAE were the front runner in introducing the Islamic banking operation and were the main hub of the Islamic banks, the average OTEBC of these countries were behind the technical efficiency of Qatar and Kuwait. One possible reason for this was that the number of banks of these countries under this study was very few compared to the number of banks from Bahrain and UAE.

The result of the higher efficiency of the Qatar Islamic bank should be cautiously interpreted because the number of banks of Qatar under this study was only three, compared to the number of banks of Bahrain and UAE. The number of Islamic banks under study was twelve and nine respectively.

Table 6 shows the ranking of scale efficiency (SE) of the Islamic banks among the GCC. Ranking shows Qatar Islamic banks was the first, Bahrain and Oman Islamic banks was the second, and UAE and Saudi Islamic banks' scale efficiency was the lowest.

The mean scale efficiency of the Islamic banks of Qatar, 85.9%, was the highest among the GCC Islamic banks. The average scale efficiency, SE, of the Qatar Islamic banks, 85.9%, was higher than the GCC average efficiency of 59.8% during 2014-2016.

The average scale efficiency of the Islamic banks of Bahrain and Oman was 64% and was the second highest among the GCC Islamic banks during the period.

The average scale efficiency of the Islamic banks of UAE and Saudi Arabia was the lowest. The average scale efficiency of the Islamic banks of UAE and Saudi Arabia was 44.8% and 45.9% respectively and was below the regional average of 59.8%.

An examination of scale efficiency (SE), in Table 6, shows that the average scale efficiency increased over the years from, 52.8% to 63.1%. To 64.3% during the year 2014, 2015, 2016 respectively.

A comparison of examination of the sources of inefficiency revealed, in Table 7, that the major source of inefficiency was the decreasing returns to scale (DRS). The average scale inefficiency of the GCC Islamic banks resulted from decreasing returns to scale (DRS). Banks did not operate on the optimum size. On average, 59.7% of the GCC banks were inefficient due to the reason that they were operating under DRS. 11.3% of the GCC Islamic banks were scale inefficient due to the IRS.

On the other hand, only 27.3% of the banks were scale efficient as they were under the CRS.

Comparison of country-wise scale inefficiencies of the Islamic bank showed that the Islamic banks of Qatar operate under constant returns to scale (CRS) during each of the 3 years (2014-2016) suggesting that the Islamic banks of Qatar were scale efficient. They operate at an optimum loan financing capacity among the GCC Islamic banks. So, there was no scale inefficiency for the banks of Qatar. All three Islamic banks of Qatar operated in CRS and thus were scale efficient.

4 out of 11, i.e. 36.3% of the Islamic banks of Bahrain was scaled efficiently as they operate under CRS. 6 out of 11banks, i.e. 54.5% of the Islamic banks were scaled inefficiency due to decreasing returns to scale (DRS) and 1 bank out of 11, ie. 9% of the banks was scale inefficient due to the IRS. The major source of inefficiency was the DRS.

7 out of 9 Islamic banks, i.e., 77.7% of the Islamic banks of UAE was scale inefficient due to the DRS.

All banks, 4 out of 4, i.e., 100% of the Islamic banks of Kuwait were scale inefficient due to the DRS. The source of inefficiency was DRS.

3 out of 4 banks, i.e. 75% of the Islamic banks of Saudi Arabia was scale inefficient and the major source of inefficiency was due to the DRS.

In sum, among two sources of inefficiency, IRS and DRS, the major source of the inefficiency of the Islamic banks of the GCC was due to the DRS. Most Islamic banks operated under the DRS during the 2014-2016.

5.1. Policy Prescriptions

The paper found that among three inefficiencies, scale inefficiency dominated the GCC Islamic banks, the paper provides policy prescriptions. Bank managements of the GCC banks should emphasize more on improving scale efficiency as it is a dominant source of inefficiency among three inefficiencies**.**

Table 7: Sources of inefficiency of GCC Islamic banks during 2014-2016

Year	IRS[1]	CRS[2]	DRS[3]
2014	12.5%	25%	62.5%
2015	12.5%	31.5%	56.25%
2016	9%	30.4%	60.6%
Mean	11.3%	27.3%	59.7%

[1]IRS: Increasing returns to scale, [2]CRS: Constant returns to scale, [3]DRS: Decreasing returns to scale

Table 8: Country-wise Sources of Inefficiency of the Islamic Banks

Country	Banks	2014			2015			2016		
		IRS	CRS	DRS	IRS	CRS	DRS	IRS	CRS	DRS
Bahrain	11	1	4	6	1	4	6	1	4	6
UAE	9	1	1	7	1	1	7	1	1	7
Saudi	4		1	3		1	3		1	3
Kuwait	4			4		1	4			4
Qatar	3		3			3			3	
Oman	2	1			1				1	

6. CONCLUSIONS

This paper applied the DEA and the bootstrap DEA for estimating the 90% confidence interval estimate of the bias-corrected overall technical efficiency (OTEBC), bias-corrected pure technical efficiency (PTEBC), and bias corrected scale efficiency (SE) during 2014-2016.

First, the paper found that the DEA efficiency, 86.3% overstated the efficiency of the Islamic banks compared to the bootstrap DEA efficiency of 82.4% with a 90% confidence attached to it.

Second, the paper found from the comparison of three categories of efficiency, OTEBC, PTEBC, and SE, that the dominant source of inefficiency was scale inefficiency. The average scale efficiency (SE) of the GCC banks during 2014-2016 was 59.8 compared to the average of OTEBC, 82.4%, and the PTEBC of 91%. Results suggest (i) the average scale inefficiency, the average pure technical inefficiency, and the average overall technical inefficiency of the GCC Islamic banks were 39.2%, 9%, and 17.6% respectively, (ii) the pure technical efficiency (PTEBC), known as managerial efficiency, dominated the all efficiencies. The 91% pure technical efficiency means the managerial inefficiency of the GCC Islamic banks was 9%.

Third, decomposition of the sources of scale efficiency/inefficiency found that among two sources of inefficiency, IRS and DRS, the major source of the inefficiency of the Islamic banks of the GCC was due to the DRS. Most Islamic banks operated under the DRS during the 2014-2016. On average, 59.7% of the GCC banks were inefficient due to the reason that they were operating under DRS. 11.3% of the GCC Islamic banks were scale inefficient due to the IRS. On the other hand, only 27.3% of the banks were scale efficient as they operated under the CRS.

Fourth, a comparison of efficiencies of the Islamic banks among the Gulf countries found (i) the Islamic banks of Qatar were the most efficient in all three efficiencies, OTEBC, PTEBC, and SE. All three banks of Qatar were scale efficient in all 3 years, 2014-2016. The OTEBC and PTEBC of the Qatar Islamic banks 88% and 95% respectively and were highest among the GCC. (ii) Islamic banks of Saudi Arabia were the least scale efficient country among the GCC. The scale efficiency (SE) of the Saudi Islamic banks was 45.8%.

As the number of years, 2014-2016, are short, results of the study of the Islamic bank efficiency should be interpreted and considered cautiously. Similarly, results of the Islamic banks of Qatar should be counted cautiously because there are only three Islamic banks of Qatar under this study.

As the number of years consisted of only 3 years and the number of banks of Qatar and Oman was limited, this paper suggests future study should include more Islamic banks and more extended periods.

Bank managements of the GCC banks should emphasize more on improving scale efficiency as it is a dominant source of inefficiency among three inefficiencies.

REFERENCES

Bahrini, R. (2016), Technical efficiency analysis of MENA Islamic banks during and after the global 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 Africa region, 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., Prasada 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, H. (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.

Ernst Y. (2014), World Islamic Banking Competitiveness Report 2014-15. Ernst and Young Marketing Business. Available from: http://www.ey.com/Publication/vwLUAssets/EY-world-islamicbanking-competitiveness-report-2014-15/$FILE/EY-worldislamic-banking-competitiveness-report-2014-15.pdf.

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 efficiency: Evidence from MENA Islamic banks. Journal of Applied Finance and Banking, 4, 237-253.

Kumer, S., Rachita, 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.

Nafla, A., Amine, H. (2016), Islamic finance, financial crisis, and determinants of financial stability: Empirical evidence throughout the two approaches. Journal of Islamic Banking and Finance, 4(1), 47-59.

Noor, M.A.N., 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 and 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. (2014), Noninterest expenses, early warning and bank failures: Evidences from US failed and non-failed bank. Journal of Accounting and Finance, 14(4), 25-37.

Samad, A. (2009), Measurement of inefficiencies in Bangladesh banking industry using stochastic frontier production function. Global Journal of Business Research, 3(1), 41-48.

Samad, A. (2010), Estimate of production efficiency: Evidence from Grameen bank microfinancing. Global Review of Business and Economic Research, 6(2), 183-189.

Samad, A. (2013), Impact of global financial crisis: Evidence from the cross-country Islamic banks. British Journal of Economics, Finance

and Management Sciences, 7, 54-63.
Schumpeter, J.A. (1911). The Theory of Economic Development. Cambridge, MA: Harvard University Press.
Sealey, 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.
Simar, L., Wilson, P.W. (2000), Statistical inference in nonparametric frontier models: The state of the art. Journal of Productivity Analysis, 13, 49-78.
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., Noor, M.A.N. (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.
Sufian, F. (2009), Determinants of bank efficiency during unstable macroeconomic environment: Empirical evidence from Malaysia. Research in International Business and Finance, 23, 54-77.
Sufian, F., Majid, M.Z.A. (2006), Bank ownership, characteristics and performance: A comparative analysis of domestic and Foreign Islamic banks in Malaysia. Journal of King AbdulAziz University-Islamic Economics, 21(2), 3-38.
Yudistira, D. (2004), Efficiency in Islamic banking: An empirical analysis of eighteen banks. Islamic Economic Studies, 12, 1-19.