Pertanika J. Soc. Sci. & Hum. 23 (S): 219 – 236 (2015)

PERTANIKA JOURNALS

SOCIAL SCIENCES & HUMANITIES

Journal homepage: http://www.pertanika.upm.edu.my/

Technical Efficiency and Returns to Scale on Banking Sector: Empirical Evidence from GCC Countries

Fakarudin Kamarudin[1]*, Fadzlan Sufian[2], Annuar Md. Nassir[1,3] and Nazratul Aina Mohamad Anwar[1]

[1]Department of Accounting and Finance, Faculty of Economics and Management, Universiti Putra Malaysia, 43400 Serdang, Selangor Darul Ehsan, Malaysia
[2]Taylor's University, Lakeside Campus, 1 Jalan Taylor's, 50088, Subang Jaya, Selangor Darul Ehsan, Malaysia
[3]Financial Economics Research Center, Faculty of Economics and Management, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

ABSTRACT

This paper investigates the efficiency level of Gulf Cooperation Council (GCC) banks on technical efficiency (TE), pure technical efficiency (PTE) and scale efficiency (SE). Both PTE and SE represent potential factors that influence the efficiency of GCC banks. This study investigates a total of 43 GCC banks over the time period of 2007 to 2011. Data Envelopment Analysis (DEA), a non-parametric method using variable returns to scale (VRTS) under the Banker, Charnes, and Cooper (BCC) model, was applied, with assets and deposit as input, and loan and income as output. On average, results revealed that GCC Banks operate with an optimal scale. Nevertheless, the results were contaminated by the managerial inefficiency in utilising the recourses, although TE, or managerial efficiency, increased to 83.6% in 2011. Furthermore, the results also indicated that, while larger banks (the 22 largest) tend to operate at constant returns to scale (CRS) or decreasing returns to scale (DRS), smaller banks (the 21 smallest) were susceptible to operate at either CRS or increasing returns to scale (IRS).

Keywords: Technical efficiency, pure technical efficiency, scale efficiency, returns to scale, bank, Gulf Cooperation Council

ARTICLE INFO

Article history:
Received: 30 March 2015
Accepted: 10 September 2015

E-mail addresses:
fakarudinkamarudin@gmail.com / fakarudin@upm.edu.my (Fakarudin Kamarudin),
fadzlan.sufian@taylors.edu.my (Fadzlan Sufian),
annuar@upm.edu.my (Annuar Md. Nassir),
nazratulaina84@gmail.com (Nazratul Aina Mohamad Anwar)
* Corresponding author

ISSN: 0128-7702

INTRODUCTION

The Gulf Cooperation Council (GCC) was established in an agreement that took place on May 25th, 1981, in Riyadh, Saudi Arabia. The GCC bloc comprises of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates

(UAE). The six member countries declared that the aim of the GCC is to establish, in view of the special relations between them, joint destiny, common objectives and also similarity of political systems based on the Islamic belief.

The GCC has acquired remarkable financial wealth through their oil markets since the 1970's, a period during which these markets have prospered. To enhance the economics of the GCC, the well-functioning financial system is an important one for economic growth. The links between financial intermediation and economic growth focus on the key functions of financial systems in the saving-investment-growth nexus. Nissanke and Stein (2003) asserted that these include effective channelling funds from surplus to deficit units, ensuring an efficient transformation of funds into real productive capital. According to Levine (1998), the efficiency of financial intermediation affects a country's economic growth, and, at the same time, the bank (financial intermediation) insolvencies could result in systemic crises which have negative consequences on the economy as a whole. The financial intermediation also changes the maturity of the portfolios of savers and investors, while providing sufficient liquidity to the system as the need arises. In addition, the diversification and techniques of risk sharing and pooling affect the reduction of risks. The banking sector in GCC countries is one of the most important mechanisms of their financial system. In maintaining the stability of the banking system, a sustainable and healthy profitability is significantly important.

Nevertheless, there are many challenges that may have a significant impact on their ability to grow and operate within a more competitive environment. First, the sector is heavily dependent on oil sector activities. Oil still represents a very large portion of their export earnings and budget revenues. As a result of the over-dependence on oil, and the dominance of the public sector, growth in the region remains vulnerable to the vagaries of world oil markets and fluctuation in oil prices. The investors uncover limited profitable investment opportunities offered by the scope, from a few sectors such as real estate, trade and stock market activities. Therefore, banks restricted to focus on bank lending mainly in consumer loans, real estate, construction and trade finance. Second, the GCC has reduced competitive pressure on domestic banks through over-protection from foreign competition. However, GCC banks are expected to face massive competitive pressure from foreign banks since their eventual commitment to liberalise many financial services including banking through their membership in the World Trade Organisation (WTO). Finally, GCC banks are experiencing pressure to fulfil the increasing demand of international standards in terms of risk management, capital adequacy and accounting practise.

The capability of the GCC banks to face all these challenges depends on how efficiently they are performing. However,

very few research works have been carried out on the efficiency of the GCC banking sector. This study aims to investigate the technical efficiency (TE), pure technical efficiency (PTE) and scale efficiency (SE) of GCC banks. Furthermore, the technical inefficiency (TIE) of the GCC banks could be discovered through pure technical inefficiency (PTIE) or scale inefficiency (SIE). PTE represents managerial efficiency, while SE refers to the scale or size of operational efficiency. TE measures the proportional reduction in input usage that can be attained if the bank operates on the efficient frontier, or if the effectiveness of the limited set of inputs is used to produce maximum outputs. TE is related to managerial factors (Isik & Hassan, 2002). Meanwhile, PTE is the measurement of TE devoid of the scale efficiency or firm's SE effects (Coelli, 1998).

All this information is of value and benefit to investors, managers and consumers. This study also employed the non-parametric data envelopment analysis (DEA) method. Rickards (2003) discovered that, although widely employed to evaluate bank efficiency in the West, DEA is less known within the banking sector in developing countries, including the GCC countries. This study attempted to fill in this gap via several investigations on the efficiency of GCC banks using recent data (2007-2011). Additionally, this study also contributes in the methodology part by applying the DEA methods.

The study is set out as follows: the next section provides the related literature in terms of the efficiency of banks throughout the world, and the use of the DEA method in evaluating a bank's efficiency. Most of the works in the body of literature focus more on Islamic banking since most of the banks in GCC countries are also based on the Islamic banking system. Section 3 outlines the approach to the measurement of banks' TE, PTE and SE, and data used to construct the efficiency frontiers. Section 4 discusses the results, and finally, the paper concludes in section 5.

LITERATURE REVIEW

Ramanthan (2007) examined the performance of banks operating in the six countries of the Gulf Cooperation Council (GCC). This study employed the DEA method on data recorded during the time period of 2000 to 2004. Only 15 of the 55 banks are rated as efficient under constant returns to scale (CRS), or TE. The number of efficient banks has nearly doubled to 27 under variable returns to scale (VRS), or PTE, and the additional 12 banks could not register unit CRS efficiencies due to size limitations (also known as scale inefficiency). Further analysis has shown that the selected banks in all six countries have registered the same efficiencies for a five-year period (2000 to 2004). There was a significant increase in the TE of selected banks in Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and UAE during the time period of 2000 to 2004.

Srairi (2010) found that Islamic banks in GCC countries, on average, are less cost and profit efficient compared

to conventional banks. There are several reasons that may explain the lower cost and profit efficiencies of these Islamic banks. The main factor that leads to the lower efficiency in the Islamic banks is their size. They discover that the size of the average Islamic bank is smaller than that of a conventional bank. Olson and Zoubi (2008) examined the performance of Islamic and conventional banks in the GCC country banking sectors by using five different accounting ratios categories, namely, profitability, efficiency, credit risk, liquidity, and risk ratios. They concluded that Islamic banks are more profitable than their conventional counterparts.

Yudistira (2004) conducted an analysis of the efficiency levels of Islamic Banking in an empirical analysis of 18 Islamic banks during the period of 1997-2000, which were made available by the London-based International Bank Credit Analysis LTD's BankScope database. The samples were grouped by total assets in which banks with assets worth over $600 million were categorised as large sized banks, and banks below this level were categorised as small-to-medium sized banks. Concentrating on SE, it is clear that the largest degrees of SIE come from large size Islamic banks (i.e., DRS). It is worthy to note that all but one of the large size Islamic banks in 1997 to 1998 exhibited DRS, whilst in 1999 to 2000, most large size banks showed CRS. The level of TIE in 1998 is more attributable to PTIE than SIE.

Size (SE) and technology are also important considerations. Research by Ferrier and Lovell (1990) on a sample of 575 US commercial banks found that 88% exhibited IRS (a result which supports our choice of the VRTS variant of the DEA model). Somewhat surprisingly, the most efficient banks in the sample belonged to the smallest sized class. This was attributed to the successful application of technology, which allowed smaller banks to overcome capital cost disadvantages and distribute products more effectively. The results proved that the banks were higher in PTE compared to SE.

The earliest attempt to use DEA for banking was reported by Sherman and Gold (1985) in the context of evaluating different branches of a bank. Subsequently, there are several studies that have also applied the DEA method in measuring the banking sector's efficiency. Due to the heavy concentration on the US, DEA has quickly become a popular method in evaluating the financial institutions' efficiency among researchers in other nations. The DEA method was widely used to evaluate banking institutions during the late 1980s, and particularly in the 1990s. Berger and Humphrey (1997) discovered 130 studies on the efficiency of the banking sector in 21 countries; among them, 116 were published between 1992 and 1997.

The DEA method was used by Alirezaee *et al*. (1998) to examine a number of bank branches in Canada comprising data on 1,282 banks. They suggested that the average branch efficiency score varied inversely with the number of branches in the sample, and directly with the total number

of inputs and outputs. In fact, there are many studies that applied the DEA method to identify the efficiency of the banks (e.g., Vassiloglou & Giokas, 1990; Sherman & Ladino, 1995; Golany & Storbeck, 1999; Kantor & Maital, 1999) in the context of evaluating branches of a bank. Meanwhile, other studies compared the performance of different banks in various countries using the DEA method [e.g., Darrat *et al*. (2002) in Kuwait; Wheelock & Wilson (1999) in the USA; Saha & Ravisankar (2000) in India; Stanton (2002) in Canada; Brown (2001) in Australia; Mercana *et al*. (2003) in Turkey].

As a conclusion, based on the works mentioned above, most International Islamic banks face a similar problem, where their PTIE outweighs their SIE. In other words, although Islamic banks have been operating on a relatively optimal scale of operations, they were managerially inefficient to exploit their resources. On the other hand, the opposite is true for international conventional banks. Most of these studies have presented inefficiency from the scale side (wrong scale of operations). This indicates that large and small sized banks normally operated under IRS and DRS. However, the number of research works on the TE, PTE and SE in GCC banks is limited, since most of the literature covered focuses on developed countries. There is therefore a gap in the literature created by the majority of these studies, which have mainly concentrated on the TE, PTE, SE, cost efficiency and profit efficiency of the banking sectors in developed countries. Meanwhile, few works have been devoted to investigate the technical efficiency concepts of the GCC banking sector, which presents the most important efficiency concept, since it may influence the profitability of the banks. In light of this gap in the related literature, this study seeks to provide the empirical evidence, particularly on TE, PTE and SE in the GCC banking sector.

METHODOLOGY

Sources of Data

The present study gathered data from a list of top 43 commercial GCC banks from 2007 to 2011. The primary source for financial data was obtained from the BankScope database produced by the Bureau van Dijk which provided the banks' balance sheets and income statements. Bankscope database contains specific data on 25,800 banks world-wide, including commercial banks in GCC countries. Furthermore, BankScope database presents the original currencies' data of the specific countries and provides the option to convert the data to any other currencies. The data are updated monthly. United States Dollar (USD) is used in this study since the study involved six countries in GCC bloc in order to maintain the homogeneity.

Data Envelopment Analysis (DEA)

This non-parametric efficiency measurement approach developed by Farrell (1957) defines a simple measure of firm efficiency which is capable to measure

for multiple inputs. Technical efficiency and allocative efficiency are two components proposed by Farell (1957) that consist in the firm's efficiency components. The combination of both efficiency components produces the overall efficiency. Farrell's (1957) concept can best be illustrated by a single output and two input case, in the unit isoquant diagram.

In this study, the GCC banks are modelled as multi-product firms producing two outputs and two outputs (Ariff & Can, 2008; Kamarudin *et al*., 2014a; 2014b; 2013; Sufian *et al*., 2014; 2013a; 2013b; 2012; Sufian & Kamarudin, 2014) using intermediation approach. Outputs consist of total loans (y1), which include short-term loan and long-term loan and income (y2), which include income derived from investment of depositors' funds and other income from banking operations. Meanwhile, two inputs selected, namely, total asset (x1), which include cash and short-term funds and other assets and the last is deposit (x2) that include deposit from customers and other banks. All the variables were measured in United States Dollar (USD) (refer Table 1).

TABLE 1
Summary statistics of the Variables input and output in the DEA model
(in million USD)

Year		Loan (y1)	Income (y2)	Asset (x1)	Deposit (x2)
2011	**Min**	30.700	5.950	322.507	125.913
	Max	54017.420	2954.368	82954.757	69172.564
	Mean	15846.848	939.826	25779.872	20073.932
	SD	13424.152	783.064	21559.059	17405.487
2010	**Min**	34.212	1.426	231.290	86.244
	Max	38256.637	2739.780	75299.204	64931.177
	Mean	14573.653	920.431	23783.797	18420.388
	SD	11497.315	750.079	18876.693	15181.320
2009	**Min**	50.907	4.533	300.558	127.615
	Max	36736.773	2779.680	68653.924	58175.310
	Mean	13941.828	966.232	22489.905	17521.954
	SD	10753.566	735.521	17363.273	14074.479
2008	**Min**	7.800	9.784	344.628	131.183
	Max	37265.786	3178.320	59147.203	49215.469
	Mean	13770.485	1073.880	21959.831	17381.946
	SD	10368.568	801.027	15975.606	12880.195
2007	**Min**	50.916	8.059	413.553	158.608
	Max	27716.514	2817.517	55732.230	45744.299
	Mean	10673.287	980.716	18857.663	14800.455
	SD	7926.643	733.803	13723.864	11192.612

Sources: Bankscope database and authors' own calculations.

Fig.1 is a conventional isoquant/ isocost graph for a single output being produced by two inputs. The unit isoquant (*yy'*) shows various combinations of the two inputs (x_1, x_2) which can be used to produce 1 unit of the single output (y). The Decision Making Unit (DMU) at *E* is productively (or overall) efficient in choosing the cost minimising production process given the relative input prices (represented by the slope of the isocost *WW'*). As illustrated in Figure 1, the ratio *OQ/OR* measures the technical efficiency of the production at point *R*, whereas *OQ/OR* compares the minimum input required for the production of one unit to the observed input usage in the firm. Thus, *1-OQ/OR* measures the proportion of inputs that could be reduced without reducing output. Hence,

$$TE = \frac{OQ}{OR}$$

The ratio *OP/OQ* measures allocative efficiency of the firms input usage. The costs in point *P* are equal to the costs in the overall productively efficient point *E* but lower than in point *Q*. The ratio of *1-OP/OQ* then measures the possible input savings that could be reduced if the inputs were used in the right proportions. Hence,

$$AE = \frac{OP}{OQ}$$

A measure for overall efficiency (productively efficient) can be obtained by adding technical and allocative efficiency together. In Figure 1, the total efficiency is represented by the ratio of *OP/OR*. Total inefficiency reveals total waste of inputs, thus shows how much costs could be reduced if the firm operates at the efficient point *E* instead of point *R*. Hence,

$$OE = \frac{OP}{OR}$$

In short, a DMU at *Q* is allocatively inefficient in choosing an appropriate input mix, while a DMU at *R* is both allocatively (in the ratio of *OP/OR*) and technically inefficient (in the ratio of *OQ/OR*), resulted from excessive amount of both inputs usage (x_1 and x_2) compared to the DMU at *Q* in producing the same level of output (y).

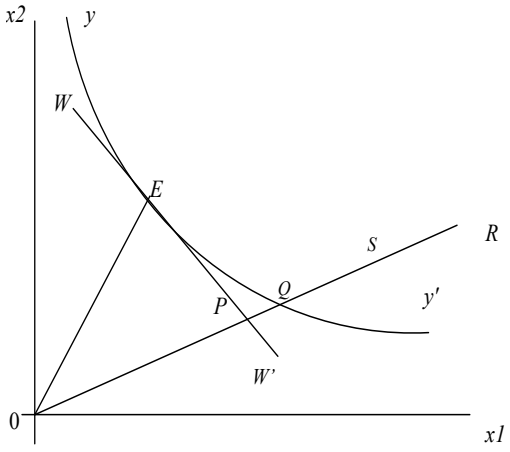

Fig.1: Farrell Technical Efficiency

The extensions to multiple inputs and/ or outputs can easily be achieved through the use of parametric or non-parametric approaches. Bauer *et al*. (1998) pointed out that these approaches differ in terms of the assumptions made about the shape of the frontier, the treatment of random error and the distributions assumed for inefficiency and the random error.

The non-parametric Data Envelopment Analysis (DEA) method was employed

with the variable returns to scale (VRS) model to measure input-oriented technical efficiency of GCC banks. The VRS model was proposed by Banker, Charnes and Cooper (1984). The BCC model (VRS) extended the CCR model proposed by Charnes, Cooper and Rhodes (1978). The CCR model presupposes that there is no significant relationship between the scale of operations and efficiency by assuming CRS and it delivers OE or TE. The CRS assumption is only justifiable when all DMUs (decision making unit) are operating at an optimal scale. However, firms or DMUs in practice might face either economies or diseconomies of scale. Thus, if one makes the CRS assumption when not all DMUs are operating at the optimal scale, the computed measures of TE will be contaminated with SIE.

Banker, Charnes and Cooper (1984) extended the CCR model (CRS) by relaxing the CRS assumption. The resulting BCC model was used to assess the efficiency of DMUs characterised by VRTS. The VRTS assumption provides the measurement of PTE, which is the measurement of TE devoid of the SE effects. In fact, the TE measure the efficiency of the DMU's managerial. The PTE measure the efficiency of the DMU's pure managerial without contaminated by scale. Meanwhile, the SE measures the size of the DMU. If there is a difference between the TE and PTE scores of a particular DMU, it then indicates the existence of SIE (Coelli, 1996). The score of TE will take a value between zero and one. If the score shows less than one, it indicates that DMU is relatively and technically inefficient and not operating at the efficiency frontier. On the other hand, DMU is considered as fully technically efficient if the TE's score shows the value of one (i.e., operating at the efficiency frontier).

The Constant Returns to Scale Model (CRS) under the CCR model

Assume there are data on *K* inputs and *M* outputs on each of *N* firms or DMU's. For the *i-th firm or DMU*, these are represented by the column vectors x_i and y_i, respectively. The *K* x *N* input matrix, *X* and the *M* x *N* output matrix, Y represent the data for all N firms or DMU's. For each firm, all outputs were measured over all inputs in the form of ratios as $u'y_i / v'x_i$, where u is an *M* x 1 vector of output weights and v is a *K* x 1 vector of input weights. As such, the following mathematical programming is used to solve the optimal weight (Coelli *et al*., 1998):

$$\begin{aligned} &\max_{u,v} && (u'y_i / v'x_i), \\ &\text{subject to} && u'y_j / v'x_j \le 1, \qquad j = 1,2,\ldots,N \\ &&& u, v \ge 0. \end{aligned} \tag{1}$$

One problem with this particular ratio formulation is that it has infinite number of solutions as the original mathematical formulation is not linear. Thus, to avoid this, one can impose the constraint $v'x_i$, which provides:

$$\begin{aligned} &\max_{\mu,v} && (\mu' y_i), t && v'x_i = 1, \\ &\text{subject to} && \mu' y_j - v'x_j \le 0, && j = 1,2,\ldots,N, \\ & && \mu, v \ge 0, \end{aligned} \tag{2}$$

Where the change of notation from u and v to μ and v is used to stress that this is a different linear programming problem. Using the dual form of the above problem, one can derive an equivalent *envelopment* form as:

$$\begin{aligned} &\min_{\theta,\lambda} && \theta, \\ &\text{subject to} && -y_i + Y\lambda \ge 0, \\ & && \theta x_i - X\lambda \ge 0, \\ & && \lambda \ge 0, \end{aligned} \tag{3}$$

Where,
θ is a scalar and
λ is a $N \times 1$ vector of constant.

This envelopment form involves fewer constraints than the multiplier form $(K + M < N + 1)$, and hence is generally the preferred form to solve (Coelli *et al*., 1998).

The Variable Returns to Scale Model (VRS) and Scale Efficiency (SE) Under the BCC model

The Variable Returns to Scale Model (VRS)

The CSR linear programming problem could be simply modified to account for VRS by adding the convexity constraint: $N1'\lambda = 1$ to equation 3 to provide (Coelli *et al*., 1998):

$$\begin{aligned} &\min_{\theta,\lambda} && \theta, \\ &\text{subject to} && -y_i + Y\lambda \ge 0, \\ & && \theta x_i - X\lambda \ge 0, \\ & && N1'\lambda = 1 \\ & && \lambda \ge 0, \end{aligned}$$

Where,

$N1$ is a $N \times 1$ vector of ones (4)

This approach forms a convex hull of intersecting planes which envelope the data points more tightly than the CRS conical hull and thus provides technical efficiency scores greater than or equal to those obtained using the CRS model.

Calculation of Scale Efficiencies (SE)

TE scores obtained from a CRS DEA can be divided into two components; one due to SIE and one due to the PTIE. This may be completed by conducting both a CRS and a VRS DEA upon the same data. If there is a difference in two TE scores of DMU, it indicates that DMU has SIE and the SIE could be measured from the difference between the VRS TE (PTE) score and CRS TE (TE) score (Coelli *et al*., 1998). Although the SE measure will provide information concerning the degree of inefficiency resulting from the failure to operate with CRS, it cannot provide the information as to whether a DMU is operating in an area of increasing returns to scale (IRS) or decreasing returns to scale (DRS). This may be determined by

running an addition DEA problem with non-increasing returns to scale (NIRS) imposed. This can be done by altering the DEA model in equation 4 by substituting the $N1'\lambda = 1$ restriction with $N1'\lambda \leq 1$, to provide:

$$\begin{aligned} &\min_{\theta,\lambda} \theta, \\ \text{subject to} \quad &-y_i + Y\lambda \geq 0, \\ &\theta x_i - X\lambda \geq 0, \\ &N1'\lambda \leq 1 \\ &\lambda \geq 0, \end{aligned} \tag{5}$$

Therefore, the nature of the scale inefficiencies, due to either IRS or DRS, could be determined by the difference between the NIRS TE and VRS TE score: if the VRS TE @ PTE $\neq$ NIRS TE, then DMU is operating at IRS; if the VRS TE @ PTE = NIRS TE, then DMU is operating at DRS.

RESULTS AND DISCUSSION

This section discusses the TE change of the GCC banks measured by the DEA method, and its decomposition into PTE and SE components. In the event of the existence of SIE, this study could potentially provide evidence on the nature of the returns to scale for each bank.

According to DeYoung and Hasan (1998), Bauer *et al*. (1998). and Isik and Hassan (2002), constructing an annual frontier specific to each year is more flexible and suitable than estimating a single multiyear frontier for the banks in the sample. Based on earlier studies and for the purpose of the study, separating the annual efficiency frontier for each year is more preferable. Therefore, five separate frontiers were constructed for the study. According to Isik and Hassan (2002), the principal advantage of having panel data is the ability to observe each bank more than once over a period of time. The issue is also critical in a continuously changing business environment due to the fact that the technology of a bank that is most efficient in one period may not be the most efficient in another. In addition, it may also reduce the problems related to the lack of random error in DEA by allowing an efficient bank in one period to be inefficient in another, assuming that the errors due to luck or data problems are not consistent over time (Isik & Hassan, 2002).

Efficiency of the GCC banks

Table 2 illustrates the mean efficiency scores of the GCC banks for 2011 (Panel A), 2010 (Panel B), 2009 (Panel C), 2008 (Panel D), 2007 (Panel E) and all years (Panel F). The results suggested that the GCC banks' mean TE had an increasing trend from 80.8% to 86.2% during the period of 2007 to 2008, and recorded a decrease of 81.6% to 81% during the period of 2009 to 2010, before rising again to 83.6% in 2011. The decomposition of TE into its PTE and SE components suggested that PTIE dominates SIE of GCC banks for all the years covered.

The results for all banks in all years (Panel F) have, in general, confirmed the earlier findings that the managerial factor

is the dominant one in influencing GCC banks' efficiency. During the period of 2007 to 2011, the results from Panel F suggested that GCC banks exhibited a mean TE of 82.6%, with input waste of 17.4%. The decomposition of the TE into its PTE and SE components suggested that the inefficiency could be attributed mainly to PTIE (12.3%), rather than SIE (6.3%).

Thus, the results imply that GCC banks could have produced the same amount of outputs with only 82.6% of the amount of inputs used. In other words, GCC banks could have reduced their inputs by 17.4%, and still produced the same amount of outputs. Overall, the results implied that, during the period of the study, although the banks had been operating on a relatively optimal scale, they were managerially inefficient to exploit their resources to the fullest.

TABLE 2
Summary statistics of bank efficiency scores in GCC (2007 to 2011)

Efficiency Measures	No. DMUs	Min	Max	Mean	Std. Dev.
Panel A : All Banks 2011					
Technical Efficiency	43	0.449	1.000	0.836	0.132
Pure technical efficiency	43	0.471	1.000	0.899	0.127
Scale Efficiency	43	0.621	1.000	0.931	0.074
Panel B : All Banks 2010					
Technical Efficiency	43	0.361	1.000	0.810	0.152
Pure technical efficiency	43	0.534	1.000	0.888	0.132
Scale Efficiency	43	0.361	1.000	0.912	0.101
Panel C : All Banks 2009					
Technical Efficiency	43	0.283	1.000	0.816	0.169
Pure technical efficiency	43	0.396	1.000	0.869	0.142
Scale Efficiency	43	0.398	1.000	0.937	0.112
Panel D : All Banks 2008					
Technical Efficiency	43	0.274	1.000	0.862	0.148
Pure technical efficiency	43	0.277	1.000	0.887	0.151
Scale Efficiency	43	0.841	1.000	0.973	0.036
Panel E : All Banks 2007					
Technical Efficiency	43	0.308	1.000	0.808	0.134
Pure technical efficiency	43	0.353	1.000	0.843	0.127
Scale Efficiency	43	0.547	1.000	0.959	0.082
Panel F : All Bank All Years					
Technical Efficiency	215	0.274	1.000	0.826	0.148
Pure technical efficiency	215	0.277	1.000	0.877	0.136
Scale Efficiency	215	0.361	1.000	0.942	0.087

Sources: Bankscope database and authors' own calculations.

Scale Inefficiency on Increase Returns to Scale (IRS) and Decrease Returns to Scale (DRS)

As previously mentioned, banks could operate at CRS or VRS, where CRS signifies that an increase in inputs results in a proportionate increase in outputs, while VRS means that a rise in inputs results in a disproportionate rise in outputs. Further, a bank operating at VRS could be either at DRS or IRS. Thus, DRS showed that an increase in inputs resulted in lesser output, while IRS indicated that an increase in inputs resulted in a higher increase in outputs.

During the period of the study, only Abu Dhabi Commercial Bank seemed to have dominated the efficiency frontier CRS at a 100% level compared to other GCC banks. In general, the results indicated that, while large banks (the 22 largest) tend to operate at 15.24% of CRS, or 67.62% of DRS, (refer to Table 3), small banks (the 21 smallest) tend to operate at 18.81% of CRS, or 42.57% of IRS (refer to Table 4). These findings are similar to several earlier studies (e.g., McAllister & McManus, 1993; Drake, 2001; Yudistira, 2004). To recap, Drake (2001) posited that a further increase in the size of bank would only result in a smaller increase of outputs for every proportionate increase in the inputs of large banks, resulting from the fact that the large banks were operating at DRS during these periods. Based on the results, the banks exposed to higher DRS and categorised under large sized banks (large on total assets) are the National Commercial Bank and Emirates Bank International PJSC, since their DRS is at 100%.

According to McAllister and McManus (1993), on the other hand, small banks have generally exhibited IRS. The result is consistent with what has been discovered from this study, where small GCC banks faced IRS in their operations during the period of the study. The smaller banks, which have been operating at IRS, could achieve significant cost savings and efficiency gains by increasing their scale of operations, mainly because proportionate increases in inputs in small banks would result in more than proportionate increases in outputs. In other words, substantial gains could be attained from altering the scale via internal growth or through mergers and acquisitions in the sector. Therefore, the banks that experienced IRS should eliminate their SIE via internal expansion, or would become a prime target for acquiring banks because it could create value from underperforming banks, and in turn eliminate redundancies and inefficiencies (Evanoff & Israelvich, 1991). Based on the results, banks that were exposed to higher IRS and categorised under small size banks (small on total assets) are Arcapita, Investcorp and Bank of Kuwait & Middle East. Radam *et al*. (2008) discovered that small enterprises are relatively more technically efficient than medium enterprises due to the efficient use of inputs. Therefore, the efficient usage of resources (input) for the small and large sized firms could contribute to higher returns.

TABLE 3
Evolution of efficiency score for the largest GCC banks, 2007 to 2011

No	Bank	Total Assets	2011	2010	2009	2008	2007	Count bank in %			Count bank in no.		
		USD (million)			RTS			CRS	IRS	DRS	CRS	IRS	DRS
1	National Commercial Bank	339152.06	drs	drs	drs	drs	drs	0.00	0.00	100.00	0	0	5
2	Qatar National Bank	266758.53	drs	drs	drs	drs	irs	0.00	20.00	80.00	0	1	4
3	National Bank of Abu Dhabi	263577.12	drs	drs	drs	drs	crs	20.00	0.00	80.00	1	0	4
4	SAMBA	239791.84	drs	drs	drs	drs	crs	20.00	0.00	80.00	1	0	4
5	Al-Rajhi Banking & Invest Corp	230616.13	drs	drs	drs	crs	crs	40.00	0.00	60.00	2	0	3
6	Emirates Bank International PJSC	226324.64	–	–	–	drs	drs	0.00	0.00	100.00	0	0	2
7	National Bank of Kuwait	225543.48	drs	drs	drs	drs	crs	20.00	0.00	80.00	1	0	4
8	Riyad Bank	216535.59	drs	drs	drs	drs	irs	0.00	20.00	80.00	0	1	4
9	Abu Dhabi Commercial Bank	211531.65	crs	crs	crs	crs	crs	100.00	0.00	0.00	5	0	0
10	Kuwait Finance House	202837.30	drs	drs	drs	crs	irs	20.00	20.00	60.00	1	1	3
11	Saudi British Bank	165566.17	drs	drs	drs	drs	irs	0.00	20.00	80.00	0	1	4
12	First Gulf Bank	164582.73	drs	drs	drs	drs	irs	0.00	20.00	80.00	0	1	4
13	Banque Saudi Fransi	162687.17	drs	drs	drs	drs	irs	0.00	20.00	80.00	0	1	4
14	Arab National Bank	149281.93	drs	drs	drs	drs	irs	0.00	20.00	80.00	0	1	4
15	National Bank of Dubai	140867.66	–	–	–	drs	irs	0.00	33.33	66.67	0	1	2
16	Arab Banking Corp	140315.00	drs	drs	drs	crs	irs	20.00	20.00	60.00	1	1	3
17	Mashreqbank	119695.00	drs	drs	drs	crs	irs	20.00	20.00	60.00	1	1	3
18	Dubai Islamic Bank	118215.66	drs	drs	drs	drs	irs	0.00	20.00	80.00	0	1	4
19	Gulf International Bank	103511.80	irs	irs	irs	crs	irs	20.00	80.00	0.00	1	4	0
20	Union National Bank	98204.55	drs	drs	drs	drs	irs	0.00	20.00	80.00	0	1	4
21	Gulf Bank	86659.21	drs	drs	crs	crs	irs	40.00	20.00	40.00	2	1	2
22	Abu Dhabi Islamic Bank	84118.88	drs	drs	drs	drs	irs	0.00	20.00	80.00	0	1	4
								15.24	***17.14***	***67.62***	***16***	***18***	***71***

CRS = constant returns to scale, DRS = decreasing returns to scale, IRS = increasing returns to scale. Count Bank (CRS) = number of times a bank has appeared on the efficiency frontier during the period of study. Count Year (CRS) = number of banks appearing on the efficiency frontier during the year

TABLE 4
Evolution of efficiency score for the smallest GCC banks, 2007 to 2011

No	Bank	Total Assets	2011	2010	2009	2008	2007	Count bank %			Count bank in no.		
		USD (million)			RTS			CRS	IRS	DRS	CRS	IRS	DRS
1	Commercial Bank of Qatar	81939.45	drs	crs	crs	irs	irs	40.00	40.00	20.00	2	2	1
2	Bank Muscat	75879.58	drs	drs	drs	drs	irs	0.00	20.00	80.00	0	1	4
3	Saudi Hollandi Bank	75321.55	drs	drs	drs	drs	irs	0.00	20.00	80.00	0	1	4
4	Burgan Bank	74637.15	–	drs	drs	crs	irs	25.00	25.00	50.00	1	1	2
5	Commercial Bank of Kuwait	70096.66	drs	drs	drs	drs	irs	0.00	20.00	80.00	0	1	4
6	Saudi Invest Bank	67676.04	drs	drs	crs	crs	irs	40.00	20.00	40.00	2	1	2
7	Doha Bank	58976.60	drs	drs	drs	crs	irs	20.00	20.00	60.00	1	1	3
8	Qatar Islamic Bank	56120.30	drs	drs	drs	irs	irs	0.00	40.00	60.00	0	2	3
9	Al-Ahli Bank of Kuwait	53758.38	drs	drs	drs	crs	irs	20.00	20.00	60.00	1	1	3
10	Commercial Bank of Dubai	48939.11	crs	drs	crs	crs	irs	60.00	20.00	20.00	3	1	1
11	Ahli United Bank KSC	41168.67	–	drs	drs	crs	irs	25.00	25.00	50.00	1	1	2
12	Bank Al Jazira	40268.16	drs	drs	irs	drs	irs	0.00	40.00	60.00	0	2	3
13	National Bank of Bahrain	28506.38	drs	drs	irs	irs	irs	0.00	60.00	40.00	0	3	2
14	National Bank of Oman	24169.83	crs	crs	crs	irs	irs	60.00	40.00	0.00	3	2	0
15	Bank of Sharjah	23478.20	drs	drs	crs	irs	irs	20.00	40.00	40.00	1	2	2
16	Arcapita	20490.60	irs	irs	irs	irs	irs	0.00	100.00	0.00	0	5	0
17	Investcorp	18969.50	irs	irs	irs	irs	irs	0.00	100.00	0.00	0	5	0
18	Investbank	12773.11	–	crs	crs	crs	irs	75.00	25.00	0.00	3	1	0
19	United Gulf Bank	11595.00	irs	irs	irs	irs	irs	0.00	40.00	60.00	0	2	3
20	United Arab Bank	10705.00	irs	irs	crs	irs	irs	20.00	80.00	0.00	1	4	0
21	Bank of Kuwait & Middle East	1612.54	–	irs	irs	irs	irs	0.00	100.00	0.00	0	4	0
								18.81	***42.57***	***38.61***	***19***	***43***	***39***

CRS = constant returns to scale, DRS = decreasing returns to scale, IRS = increasing returns to scale. Count Bank (CRS) = number of times a bank has appeared on the efficiency frontier during the period of study. Count Year (CRS) = number of banks appearing on the efficiency frontier during the year

CONCLUSION

This paper examined the relative efficiency of the banks in GCC countries by analysing the technical efficiency, pure technical efficiency and scale efficiency of GCC banks over the period of 2007-2011. The non-parametric Data Envelopment Analysis (DEA) approach was used to examine the efficiency of these banks. The empirical findings suggest that PTIE outweighs SIE in these GCC banks. During the period of 2007 to 2011, the results suggested that GCC banks exhibited a mean TE of 82.6%, with an input waste of 17.4%. The decomposition of TE into its PTE and SE components suggested that the inefficiency could mainly be attributed to PTIE (12.3%) rather than SIE (6.3%).

This may indicate that the overall results of the GCC banks imply that, during the period of study, although the banks had been operating on a relatively optimal scale, they were managerially inefficient to exploit their resources to the fullest. In addition, the empirical findings suggest that only Abu Dhabi Commercial Bank has dominated the efficiency frontier (CRS) compared with the other GCC banks. In general, the results indicate that, while large banks (the 22 largest) tend to operate at CRS or DRS, small banks (21 smallest banks) tend to operate at CRS or IRS. Therefore, the banks experiencing IRS (Arcapita, Investcorp and Bank of Kuwait & Middle East) should eliminate their SIE via internal expansion, or they would become a prime target for acquiring banks because it could create value from underperforming banks and eliminate redundancies and inefficiencies (Evanoff & Israelvich, 1991). On the other hand, GCC banks operating at DRS (National Commercial Bank and Emirates Bank International PJSC) are advised not to increase their size or be involved with mergers and acquisitions events, mainly because a further increase in the size of the bank will only result in a smaller increase of outputs for every proportionate increase in inputs of the large banks.

These empirical findings are expected to contribute significantly to the existing knowledge on the operating performance of the GCC banking sector. Nevertheless, the study has also provided further insights into bank's specific management, as well as to the policymakers, with regard to attaining optimal utilisation of capacities, improvement in managerial expertise, efficient allocation of scarce resources, and the most productive scale of operation of banks operating in GCC countries. Moreover, this study may also facilitate directions for sustainable competitiveness of the GCC banking sector operations in the future.

ACKNOWLEDGEMENTS

The authors would like to thank the editors and the anonymous referees of the journal for their constructive comments and suggestions, which have significantly helped to improve the contents of the paper. The usual caveats apply.

REFERENCES

Alirezaee, M., Howland, M., & van de Panne, C. (1998). Sampling size and efficiency bias in data envelopment analysis. *Journal of Applied Mathematics and Decision Sciences, 2*(1), 51-64.

Ariff, M., & Can, L. (2008). Cost and profit efficiency of Chinese banks: A non-parametric analysis. *China Economic Review, 19*(2), 260-273.

Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science, 30*(10), 78-92.

Bauer, P. W., Berger, A. N., Ferrier, G. D., & Humphrey, D. B. (1998). Consistency conditions for regulatory analysis of financial institutions: A comparison of frontier efficiency methods. *Journal of Economics and Business, 50*(2), 85-114.

Berger, A., & Humphrey, D. (1997). Efficiency of financial institutions: international survey and directions for future research. *European Journal of Operational Research, 98*(2), 175-212.

Brown, R. (2001). *Data envelopment analysis: application issues in the financial services sector* (pp. 01-05). University of Melbourne, Melbourne.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operations Research, 2*(6), 429-44.

Coelli, T. (1996). A guide to DEAP: Version 2.1: A data development analysis (computer program). *Working Paper 96/08, CEPA, University of New England, Armidale* (pp. 1-49).

Coelli, T., Prasada, R., & Battese, G. (1998). *An introduction to efficiency and productivity analysis*. Boston, MA: Kluwer Academic Publishers.

Darrat, A.F., Topuz, C., & Youzef, T. (2002). *Assessing cost and technical efficiency of banks in Kuwait.* Paper presented at the ERF's 8th Annual Conference in Cairo, ERF, Cairo. Retrieved 9 August, 2005, from www.erf.org.eg

DeYoung, R. & Hasan, I. (1998). The performance of De Novo commercial banks: A profit efficiency approach. *Journal of Banking and Finance, 22*(5), 565-587.

Drake, L. (2001). Efficiency and Productivity Change in UK Banking. *Applied Financial Economics, 11*(5), 557–71.

Evanoff, D. D., & Israelvich, P. R. (1991). Productive efficiency in banking. Ec*onomic Perspectives, Federal Reserve Bank of Chicago, 15*(4), 11-32.

Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of Royal Statistical Society Association, 120*(3), 253-281.

Ferrier, G., & Lovell, C. A. K. (1990). Measuring cost efficiency in banking: econometric and linear programming evidence. *Journal of Econometrics, 46*(1), 229-45.

Golany, B. & Storbeck, J. (1999). A data envelopment analysis of the operational efficiency and bank branches. *Interfaces, 29*(3), 14-26.

Isik, I., & Hassan, M. K. (2002). Technical, scale and allocative efficiencies of Turkish banking industry. *Journal of Banking and Finance, 26*(4), 719-766.

Kamarudin, F., Nordin, B. A. A., & Nasir, A. M. (2013). Price efficiency and returns to scale of banking sector in gulf cooperative council countries: Empirical evidence from Islamic and conventional banks. *Economic Computation and Economic Cybernetics Studies and Research, 47*(3), 215-236.

Kamarudin, F., Nordin, B. A. A., Muhammad, J., & Hamid, M. A. A. (2014a). Cost, revenue and profit efficiency of Islamic and conventional banking sector: Empirical evidence from Gulf Cooperative Council countries. *Global Business Review, 15*(1), 1-24.

Kamarudin. F., Nasir, A. M., Yahya, M. H., Said, R. M., & Nordin, B. A. A. (2014b). Islamic banking sectors in Gulf Cooperative Council countries. Analysis on revenue, cost and profit efficiency concepts. *Journal of Economic Cooperation and Development, 35*(2), 1-42.

Kantor, J., & Maital, S. (1999). Measuring efficiency by product group: integrating DEA with activity-based accounting in a large Mideast Bank. *Interfaces,* 29(3), 27-36.

Levine, R., (1998). The legal environment, banks, and long-run economic growth, *Journal of Money, Credit and Banking, 30*(3), 596-613.

McAllister, P. H. & McManus, D. A. (1993). Resolving the scale efficiencies puzzle in banking. *Journal of Banking and Finance, 17*(2), 389-405.

Mercana, M., Reismanb, A., Yolaland, R., & Emel, A. B. (2003). The effect of scale and mode of ownership on the financial performance of the Turkish banking sector: results of a DEA-based analysis. *Socio-Economic Planning Scie*nces, *37*(3), 185-202.

Murillo-Zamorano, L. R. (2004). Economic efficiency and frontier techniques. *Journal of Economic Surveys, 18*(1), 33−77.

Nissanke, M., & Stein, H. (2003). Financial globalization and economic development: toward an institutional foundation. *Eastern Economic Journal, 29*(2), 287-308.

Olson, D. & Zoubi, T. A. (2008). Using accounting ratios to distinguish between Islamic and conventional banks in the GCC region. *International Journal of Accounting, 43*(1)*,* 45-65.

Radam, A., Abu, M. L., & Abdullah, A. M. (2008). Technical efficiency of small and medium enterprise in Malaysia: a stochastic frontier production model. *International Journal of Economics and Management, 2*(2), 395-408.

Rickards, R. (2003). Setting benchmarks and evaluating balanced scorecards with data envelopment analysis. *Benchmarking: An International Journal, 10*(3), 226-45.

Saha, A., & Ravisankar, T. S. (2000). Rating of Indian commercial banks: a DEA approach. *European Journal of Operational Research, 124*(1), 187-203.

Sherman, H. D. & Gold, F. (1985). Bank branch operating efficiency: evaluation with data envelopment analysis. *Journal of Banking and Finance, 9*(2), 297-315.

Sherman, H. D., & Ladino, G. (1995). Managing bank productivity using data envelopment analysis (DEA). *Interfaces, 25*(2), 60-73.

Srairi, S.A. (2010). Cost and profit efficiency of conventional and Islamic banks in GCC countries. *Journal of Productivity Analysis, 34*(1), 45-62.

Stanton, K. R. (2002). Trends in relationship lending and factors affecting relationship lending efficiency. *Journal of Banking & Finance, 26*(1), 127-52.

Sufian, F., & Kamarudin, F. (2014). Efficiency and Returns to Scale in the Bangladesh Banking Sector: Empirical Evidence from the Slack-Based DEA Method. *Inzinerine Ekonomika - Engineering Economics, 25*(5), 549-557.

Sufian, F., Kamarudin, F., & Noor, N. H. H. M. (2012). Determinants of Revenue Efficiency in the Malaysian Islamic Banking Sector. *Journal of King Abdulaziz: Islamic Economics, 25*(2), 195-224.

Sufian, F., Kamarudin, F., & Noor, N. H. H. M. (2013a). Assessing the revenue efficiency of domestic and foreign Islamic banks: empirical evidence from. *Jurnal Pengurusan, 37*(1), 77-90.

Sufian, F., Kamarudin, F., & Noor, N. H. H. M. (2014). Revenue Efficiency and Returns to Scale in Islamic Banks: Empirical Evidence from Malaysia. *Journal of Economic Cooperation and Development*, *35*(1), 47-80.

Sufian, F., Muhammad, J., Nordin, B. A. A., Yahya, M. H., & Kamarudin, F. (2013b). Assessing the Effect of Mergers and Acquisition on Revenue Efficiency: Evidence from Malaysian Banking Sector. *International Journal of Economic Research*, *10*(2), 309-325.

Vassiloglou, M., & Giokas, D. (1990). A study of the relative efficiency of bank branches: an application of data envelopment analysis. *Journal of Operational Research Society, 41*(7), 591-7.

Wheelock, D. C., & Wilson, P. W. (1999). Technical progress, inefficiency, and productivity change in US banking 1984-1993. *Journal of Money, Credit and Banking, 31*(2), 212-34.

Yudistira, D. (2004). Efficiency in Islamic Banking: an Empirical Analysis of 18 Banks. *Islamic Economic Studies, 12*(1), 1-18.