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Abstracts

This paper investigates efficiency performance of thirty six banks operating in Gulf Cooperation Council (GCC) countries during the period 2006-2008[1]. Our results indicate in general GCC banks showed considerable pure technical efficiency in the past three years with the year 2007 exhibit the most efficient year, as the number of pure technical efficient banks reached 33 percent of the total banks compared to 25 percent in 2008. The fall in technical efficiency in 2008 is due to simultaneous fall in pure technical efficiency and the scale efficiency. The output loss caused by scale inefficiency (fall of scale operations below optimum level) in 2008 is estimated 16 percent compared to 5 percent in 2007. Our results also indicate scale efficiency is inversely related to banks' size implying a major source of scale inefficiency in GCC banks is due to sub-optimal size of operations. It is also indicated in the paper that scale efficiency is inversely related to risk, implying effective risk management policies may also enhance scale efficiency.

1. Introduction:

In the past decade monetary authorities in GCC countries embarked on regulatory reforms in the financial sector with the purpose of deepening their capital markets and enhancing competitiveness of the banking sector. In this context, laws have been enacted to improve prudential regulations of commercial banks, anti-money laundering policies were adopted and restrictions have been eased for capital mobility between GCC countries. The outcome of these policy reforms has been substantial surge in the banking activities as this can be viewed by the significant rise in the number of banks operating in the region in the last few years. The prudential regulations adopted by the central banks in GCC countries aimed at enhancing a competitive environment while protecting the banking industry from repercussions of financial markets. Further more,

[1] The six GCC countries include Saudi Arabia, UAE, Kuwait, Qatar, Sultinate Oman, and Bahrain.

the banking environment in GCC countries became more competitive in the past few years as all GCC countries accessed World Trade Organization (WTO) membership, which requires opening up banking sectors to foreign competition. Also the increasing integration among GCC capital markets enhanced the competitive nature of banking sector in the region as entry barriers removed between member states. An extensive literature has shown that higher levels of banks competition lead to lower cost of banks' services, increase access to finance, and increase efficiency. Thus, the more competitive GCC banking industry is becoming, it is less likely to deal with “too big to fail” scenario. As a result, estimation of GCC banks' efficiency performance based on their ability of rendering maximum possible financial services at a given available resources is helpful in exposing the competitive environment of the banking sector. In this paper we employed Data Envelopment Analysis (DEA) to investigate competitiveness in GCC banks based on efficiency performance of 36 banks operating currently in GCC countries. The DEA literature distinguishes two types of efficiency; technical efficiency and allocative efficiency. The technical efficiency refers to the ability of a decision-making unit (DMU) to produce as much output as possible at a given input level, or, to produce a given level of output employing the least possible input combination; whereas allocative efficiency refers to cost-minimizing mix of inputs, at a given relative input prices. Thus, technical efficiency allows minimization of input waste, to the extent that further reduction of inputs become infeasible. As a result, the DEA approach can enable banks to identify both sources of relative cost inefficiency - technical and allocative. Reducing excess inputs would increase technical efficiency, and selecting the cost-minimizing mix of inputs, given relative input prices, would lead to allocative efficiency. Banks that attain both types of efficiency gain an edge in the competition for private savings by competing more effectively with relatively cost-inefficient competitors[2].

In the past, DEA approach has been extensively employed in the banking efficiency literature. Miller and Noulas (1996) applied DEA methodology on North American banking sector. Unlike the case of large banks in US and UK, which experience economies of scale, Rezvanian and Mehdian (2002) show small and medium size commercial banks in Singapore enjoy economies of scale. Darrat et al (2002) employed DEA on a number of banks in Kuwait showing evidence of technical inefficiency.

Banks managers in GCC region should find results in this paper useful for identifying their efficiency status and for understanding better the causes of their success (or failure). This study may also benefit policy makers in GCC countries to improve the overall efficiency of the banking industry and to assess the degree to which domestic banks need reforms. While the primary purpose of the paper to assess efficiency performance of banks, we also investigate the sources of inefficiency by assessing the linkage between efficiency scores and key financial ratios.

The reminder of the paper is organized as follows. Section two illustrates basic features of GCC banking industry; section three present the methodology of the research; the final sections include the empirical analysis and the conclusion.

2- GCC banks: salient features

Some prominent features of the banking sector in GCC countries involve its dependence on traditional deposits as the main source of funds, and loans as the major source of income generation. As a result, the role of corporate bonds and foreign liabilities is very limited in the asset

[2] The efficiency concepts in this analysis refers to cost efficiency rather than information efficiency which has to do with transparency and disclosure aspects related to assets and commodity markets.

components of GCC banks. More specifically, it is indicated in the financial statements of 2007 and 2008, that GCC banks' deposits as a ratio of total banks liabilities, was 60 per cent, while corporate bonds constituted around 2 per cent of the total liabilities. On the asset side, loans and Islamic finance products take the highest proportion among the asset components, as they make about 50 percent of the total assets value in 2008 and 2007. The role of investment securities in the assets of GCC banks vary from a country to another, as they range between 23 percent in Saudi Arabia, and 8 percent in Qatar. Also to be noted that GCC banking sector is susceptible to high risk exposure due to concentration of finance in a few sectors in the economy including real estate and construction as well as household credits[3]. Financial statements in 2008 also indicate banks in GCC countries (with exception of Saudi Arabia) allocated 55 percent of total banks credit to real estate and household finances. However, allocation of funds in Saudi banks is relatively less skewed compared to other GCC banks, as the allocation of funds to real estate and household declines to 30 percent.

In terms of ownership, the banking sector in GCC countries is largely dominated by private domestic ownership, revealing some kind of entry barriers for foreign non-GCC investors. The data in table (1), divide ownership structure into five categories, including, private domestic; foreign GCC; foreign non-GCC; government; and royal family ownership. The absence of foreign non-GCC ownership in GCC banking sector is evidence of presence of strong barriers against non-GCC foreign ownership in a number of countries especially in Kuwait, Qatar, and UAE. However, it seems there is a substantial cross-border ownership among some GCC states (with exception of Saudi Arabia and Kuwait), as the percentage of foreign GCC ownership is quite significant. It is also to

[3] Interested readers can refer to AL-Hassan et al (2010), for more details about this issue.

be noted that there is quite considerable government presence in GCC banks ownership, notably in Saudi Arabia and UAE, where the government ownership reaches up to 70 in some banks operating in these countries. As contrary to the common perception, royal families ownership in GCC banks is very minimal except in UAE.

Financial soundness ratios presented in table (2) indicate, banks in GCC countries are well capitalized as the capital adequacy ratios during the period 2006 – 2008, are well above the minimum required levels, and as the declining ratios of the non-performing loans reveal prudential regulation soundness[4]. Despite the high quality of assets, reflected by the low ratios of the non-performing loans in all GCC banks, the profitability measure indicated by return-on-asset ratios (ROA) are a bit below the standard international levels for most of GCC banks, indicating resource under utilization. The ranking of the GCC banks in terms of key financial ratios including deposits, and investments, show banks in Saudi Arabia and United Arab Emirates lead GCC banks in terms of size indicators, while banks in Sultinate Oman ranked among the smallest in the group.

[4] The minimum required level is currently about 12 percent in Bahrain and Kuwait, 11 percent in UAE, 8 percent in Saudi Arabia, and 10 percent in Oman and Qatar.

Table (1): Banks ownership structure*

	Ownership (%)	Number of Banks
Bahrain		**11**
- Private domestic	100 to 33	9
- Foreign GCC	65 to 5	9
- Non-GCC	66	1
- Government	49 to 4	2
- Royal Family	-	-
Kuwait		**9**
- Private domestic	100 to 51	9
- Foreign GCC	-	-
- Non-GCC	-	-
- Government	49 to 2	4
- Royal Family	-	-
Oman		**7**
- Private domestic	90 to 16	7
- Foreign GCC	35 to 15	3
- Non-GCC	49 to 10	3
- Government	27 to 7	5
- Royal Family	10	1
Qatar		**9**
- Private domestic	100 to 50	9
- Foreign GCC	40 to 10	3
- Non-GCC	-	-
- Government	50 to 18	2
- Royal Family	-	-
Saudi		**11**
- Private domestic	100 to 20	11
- Foreign GCC	-	-
- Non-GCC	40 to 3	7
- Government	70 to 6	9
- Royal Family	-	-
UAE		**19**
- Private domestic	100 to 20	19
- Foreign GCC	20 to 11	3
- Non-GCC	-	-
- Government	77 to 3	16
- Royal Family	70 to 12	6

* For the year 2008.
Source: Bankscope, and authors' estimate.

Table (2): Financial soundness

	2006	2007	2008
1/ Capital Adequacy Ratio (%)			
- Bahrain	22	21.0	18.1
- Kuwait	21.8	18.5	16.0
- Oman	17.2	15.8	14.7
- Qatar	13.5	12.2	15.1
- Saudi Arabia	21.9	20.6	16.0
- UAE	16.6	14.0	13.3
2/ NPLs to total Loans (%)			
- Bahrain	4.8	2.3	2.3
- Kuwait	3.9	3.2	3.1
- Oman	4.9	3.2	2.1
- Qatar	2.2	1.5	1.2
- Saudi Arabia	2.0	2.1	1.4
- UAE	6.3	2.9	4.0
3/ RAO (%)			
- Bahrain	2.1	1.2	1.3
- Kuwait	3.2	3.4	3.2
- Oman	2.3	2.1	1.7
- Qatar	3.7	3.6	2.9
- Saudi Arabia	4.0	2.8	2.3
- UAE	2.3	2.0	2.3

Source: AL-Hassan et al, table 4, page 20.

3- Methodology:

Several alternative DEA models have been employed in banks efficiency literature. The DEA models differ according to difference in the shape of the efficient frontier. In this paper we employed two DEA models. We use the CCR (Charnes, Cooper, and Rohdes, 1978), and BCC (Banker, Charnes, and Cooper, 1984). The CCR and BCC models differ as the former evaluates scale as well as technical inefficiencies simultaneously, whereas the latter evaluates pure technical efficiency. In other words, for a DMU to be considered as CCR efficient, it should be both scale and pure technically efficient. For a DMU to be BCC efficient, it only needs to be pure technically efficient. As a result, the ratio of CCR efficiency score over the BCC score gives the scale efficiency index. The main objective of a DEA study is to project the efficient DMUs onto the most efficient frontiers of the DMUs in the sample, under the assumptions of constant return to scale and change in return to scale. There are two directions, input-oriented approach that aims at reducing the input amounts by as much as possible at a given level of output, and the output-oriented, approach that maximizes output levels at a given input level.

In the following we discuss briefly the main concepts behind each of these models.

3.1: Basic DEA models:

In vector and matrix notation the input-oriented CCR model, with a real variable θ and a non-negative vector $\lambda = (\lambda_1,..\lambda_n)^T$ of variables can be expressed as:

(LP_0) min θ (1)

subject to:

$$\theta x_0 - \lambda x \geq 0 \quad (2)$$

$$y_0 - \lambda y \leq 0 \quad (3)$$

$$\lambda \geq 0 \quad (4)$$

Where y_0 and x_0 are respectively the output and the input levels related to the specific DMU_0 under investigation, and *y* and *x* are matrices denoting output and input variables. The objective function in equation (1) minimizes the input level, whereas the constraints in equations (2) and (3) constrain the minimization of input within a feasible region, and equation (4) stipulates non-negativity constraint of the input and output weights.

The problem (LP_0) has a feasible solution at θ=1, $\lambda_0 = 1$, $\lambda_i = 0$ (j≠0). Hence the optimal θ, denoted by θ^*, is not greater than 1. On the other hand, since x>0, and y>0, the constraint (4) forces λ to be nonzero because $y_0>0$. Putting all this together, we have $0 < \theta^* \leq 1$. The input excesses S^- and the output shortfalls S^+ can be identified as:

$$S^- = \theta x_0 - \lambda x \qquad (5)$$

$$S^+ = y_0 - \lambda y \qquad (6)$$

With $S^- \geq 0$, $S^+ \geq 0$ for any feasible solution (θ, λ) of DLP_0.

If an optimal solution $(\theta^*, \lambda^*, S^{-*}, S^{+*})$ above satisfies $\theta^*=1$ with zero-slacks ($S^{-*}=0, S^{+*}=0$), then the DMU_0 is called CCR-efficient. Otherwise, the DMU_0 is called CCR-inefficient. Thus, full CCR-efficiency needs to satisfy:

(i) $\theta^*=1$

(ii) All slacks are zero.

The first of these two conditions is referred to as “radial efficiency”. It is also referred to as “technical efficiency” because a value of $\theta^*<1$ means that all inputs can be simultaneously reduced without altering the proportion in which they are utilized. Because $(1-\theta^*)$ is the maximal proportionate reduction allowed by the production possibility set, any further reductions associated with nonzero slacks will necessarily change the input proportions[5]. Hence the inefficiencies associated with any nonzero slack identified in the above two phase procedure are referred to as “mix inefficiencies”. “Weak efficiency” is sometime used when attention is restricted to condition (i). The conditions (i) and (ii) taken together describe what is also called “Pareto-Koopmans” efficiency. The weak efficiency also called “Farrell efficiency” because nonzero slack, when present in any input or output, can be used to effect additional

[5] When input orientation is chosen, technical efficiency shows the potential to reduce the amounts of inputs used in producing current quantities of outputs under the assumption of constant-return-to scale technology.

improvements without worsening any other input or output. On the other hand CCR-efficiency refers to satisfaction of both (i) and (ii) conditions.

The input-oriented BCC model evaluates the efficiency of DMU_0 (0=1,...n) by adding to the constraints in (2) – (4), the new constraint $e\lambda = 1$, and solving for the minimum objective function in equation (1).

It is clear that difference between CCR and BCC models is present in the free variable u_0, which is the dual variable associated with the constraint which also does not appear in the CCR model.

If BBC_0 satisfies θ_B^*=1 and has no slack ($S^{-*} = 0, S^{+*} = 0$) then the DMU_0 is called BCC-efficient, otherwise it is BCC-inefficient.

Figure (1)

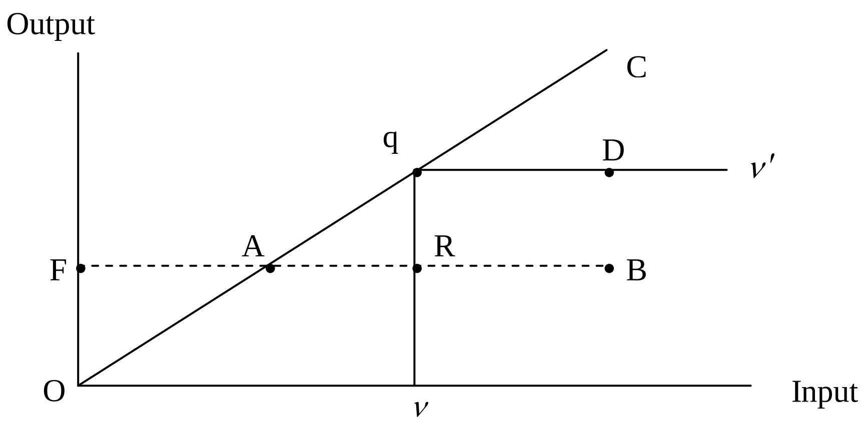

Figure 1, exhibits the DMU_s, A, R, B, q, and D each with one output and one input. The efficient frontier of the CCR model is the line (OAC), that passes through the origin. The frontier of the BCC model consists of the lines connecting v, R, q and D. The production possibility set is the area enclosing the frontier lines. At point B, a DMU is CCR and BCC inefficient. But at point q, a DMU is CCR and BCC efficient. Generally, the CCR-efficiency does not exceed BCC-efficiency. The inefficiency score of the point B inside the frontier according to CCR model is computed as ratio FA/FB (reflecting how close point B would be to point A, along the radial line OC). Thus, according to CCR model a DMU should reduce its inputs by $(1-\theta_i)$ in order to be at the efficiency frontier at point A. However, when the BCC model (variable return to scale technology) is taken into account, the overall technical efficiency reveal pure technical efficiency, which is given by the ratio $FR / FB = \sigma_i$, which measures the scope for efficiency improvement at current scale of operation. It is important to note that scale efficiency can be affected by poor management within the organization or disadvantageous operating environment. Thus, scale efficiency which is $\pi_i = \theta_i / \sigma$ measures the extent to which a bank can take advantage of return-to-scale by altering its size towards optimal scale. The fraction of output lost due to scale inefficiency can be computed as $(1-\pi_i)$. Scale efficiency equal one unit at any point along the CCR frontier line OC, at which production technology exhibits constant return to scale. Scale inefficiency can arise due to variable (increasing or decreasing) return to scale. On the other hand, pure technical inefficiency occurs because a DMU uses more inputs than needed (input waste). Alternatively, pure technical inefficiency can be can be caused by inefficient implementation of the production plan in converting inputs to outputs (managerial inefficiency). However scale inefficiency could be due to divergence of DMU from the most productive scale size. Therefore decomposing technical efficiency into pure technical and scale efficiencies allows us to gain insight into the main source of inefficiency.

3.2: Regression Analysis:

An important question to be addressed at this stage is: how efficiency scores of banks are associated with key financial drivers? The standard procedure to answer such a question is to estimate the effect of key financial ratios on the efficiency scores of banks in each country. The financial ratios include profitability measures represented by return-on-assets (ROA); a measure of risk management denoted by loan-to-deposits ratio (LDR); and a measure of a bank size represented by the ratio of each bank's deposit to total banks' deposits in each country. The LDR variable is meant to reflect the relationship between efficiency and risk taking propensity, in which higher LDR implies a higher risk propensity.

The dependent variable in each panel regression includes the efficiency scores of CCR and scale efficiency. The panel data covers the sample period 2006-2008, treating banks in each country as a panel. The regression equations can be expressed as:

$$Y_{it} = X'_{it}\beta + e_{it} \qquad for \quad t = 1,2,3; \quad i = 1,2,\ldots\ldots N_i$$
$$where \quad E(e^2{}_{it}) = \sigma^2{}_i \quad and \quad E(e_{it}e_{jt}) = 0$$
$$for \quad i \neq j \; cross \; section \; independence$$

Where y is efficiency scores, and the x vector is the explanatory variables (ROA, LDR, and the bank size variable), and Ni is the number of banks in each country. A Lagrange multiplier statistics can be employed to test for the heteroscedasticty. The null-hypothesis of homoscedasticity can be rejected if the statistic exceeds the critical value from a Chi-square distribution with N-1 degrees of freedom[6].

[6] The Breusch-Pagan (1980) Lagrange multiplier test gives a test for a diagonal covariance matrix (that is no cross-section correlation) .Under the null-hypothesis of a diagonal covariance structure the statistic has asymptotic Chi-square distribution, with N(N-1) df.

4. Results and analysis

Since our primary concern in this study is country level analysis, rather than individual bank analysis, table (3) present the mean efficiency scores of the banking industry in GCC countries during the sample period 2006 - 2008. On regional level, the overall technical efficiency fell in 2008, by 32 per cent compared to its level in 2007, due to simultaneous fall in pure technical efficiency by 22 per cent and the scale efficiency by 11 per cent. The output loss due to scale inefficiency in 2008 estimated as 16 percent compared to 5 percent in 2007. A similar result can also be concluded from the appendix tables 4 &5, as the number of GCC banks which are pure technical efficient fell in 2008 to 25 percent compared to 33 percent in the preceding year. Table (3) also shows that the contribution of pure technical efficiency in the overall technical efficiency is relatively smaller compared to the scale efficiency contribution across all GCC countries. This implies the overall technical efficiency in GCC banks can be improved by targeting some key financial ratios associated with pure technical efficiency. The regression results in table (4), present the relationship between the efficiency scores and some financial ratios. The financial ratios include a measure of profitability denoted by return-on-assets; a measure of risk variable denoted by loan-to-deposit ratio; and a bank size variable represented by the ratio of bank's deposit to the total banks' deposits in each country. Results in table (4) reveal that scale efficiency is inversely related to banks' size (though insignificant for all except Kuwait) implying a major source of scale inefficiency in GCC banks is sub-optimal size of operations. A similar result can also be concluded from appendix tables (1) & (8), as the top five largest banks in terms of deposit and investment capital in 2008, experienced scale inefficiency arising from decreasing return to scale, whereas the smallest five banks in the group experienced scale inefficiency due to increasing return to scale[7]. It is also indicated in the table that scale efficiency is inversely related to the risk variable, indicating effective risk management policies can enhance scale efficiency. Since the impact of the three explanatory variables is more significant on pure technical efficiency compared to scale efficiency in Saudi banks, it is very likely that the overall technical efficiency in Saudi banks can be improved by tackling the banks' size and the risk variables.

[7] The appendix table (8) show that the top five largest banks in terms of deposits and investment capital are UAE and Saudi banks, namely they are EBI, AUB, SAB, SABB, and Riyadh bank. But the smallest banks are in Sultinate Oman and Bahrain, namely Ahli bank, BDOF, OIB, CBI, and BSB.

Table (3): Mean efficiency

Country	2008	2007	2006	#of banks
Saudi:				8
- tech	0.44	0.72	0.96	
- pure	0.58	0.77	0.82	
- scale	0.81	0.93	0.83	
Output loss	0.19	0.07	0.17	
Kuwait				7
- tech	0.73	0.90	0.71	
- pure	0.74	0.91	0.91	
- scale	0.97	0.98	0.78	
Output loss	0.03	0.02	0.22	
UAE				8
- tech	0.51	0.85	0.65	
- pure	0.67	0.89	0.68	
- scale	0.80	0.96	0.95	
Output loss	0.20	0.04	0.05	
Qatar				4
- tech	0.63	0.86	0.66	
- pure	0.78	0.87	0.69	
- scale	0.84	0.97	0.96	
Output loss	0.16	0.03	0.04	
Bahrain				4
- tech	0.61	0.74	0.55	
- pure	0.77	0.85	0.76	
- scale	0.79	0.88	0.78	
Output loss	0.21	0.12	0.22	
Oman				5
- tech	0.40	0.86	0.67	
- pure	0.49	0.87	0.92	
- scale	0.84	0.99	0.72	
Output loss	0.16	0.01	0.28	
Regional				36
- tech	0.55	0.82	0.70	
- pure	0.67	0.86	0.79	
- scale	0.84	0.95	0.83	
Output loss	0.16	0.05	0.17	

Notes:
1-Values in this table computed from the appendix tables (1) - (3) .
2-technical efficiency= (pure technical efficiency)(scale efficiency).
3-Values computed using DEA frontier software of Joe Zhu, 2010.

Table (4): Regression results

	Technical efficiency	Scale efficiency		Technical efficiency	Scale efficiency
Saudi:			**Kuwait**:		
x	1.21*	-0.51	x	0.65*	-0.06*
(p-value)	(0.00)	(0.19)	(p-value)	(0.00)	(0.00)
z	0.039*	0.001	z	0.06*	0.005*
(p-value)	(0.05)	(0.92)	(p-value)	(0.00)	(0.01)
h	-0.10*	-0.004	h	0.002	0.0001
(p-value)	(0.06)	(0.10)	(p-value)	(0.08)	(0.54)
c	1.27*	1.30	c	0.29*	0.96*
(p-value)	(0.01)	(0.00)*	(p-value)	(0.03)	(0.00)
R^2	0.49	0.27	R^2	0.98	0.99
LM	(0.79)	(0.09)	LM	(0.02)*	(0.00)*
B-Pagan	(0.14)	(0.37)	B-Pagan	(0.68)	(0.72)
UAE:			**Qatar**:		
x	0.25	-0.45	x	0.11	-0.31
(p-value)	(0.54)	(0.24)	(p-value)	(0.32)	(0.12)
z	0.013	0.003	z	0.12*	0.07*
(p-value)	(0.74)	(0.82)	(p-value)	(0.01)	(0.04)
h	-0.0001	-0.003*	h	0.004	-0.01*
(p-value)	(0.94)	(0.03)	(p-value)	(0.39)	(0.04)
c	0.67*	1.27*	c	-0.06	2.08*
(p-value)	(0.00)	(0.00)	(p-value)	(0.89)	(0.00)
R^2	0.15	0.02	R^2	0.93	0.37
LM	(0.79)	(0.03)*	LM	(0.84)	(0.21)
B-Pagan	(0.002)*	(0.32)	B-Pagan	(0.07)	(0.27)
Bahrain:			**Oman:**		
x	0.073	-0.31	x	-0.03	-0.93
(p-value)	(0.71)	(0.12)	(p-value)	(0.63)	(0.80)
z	-0.05	0.07*	z	0.003*	-0.001
(p-value)	(0.63)	(0.04)	(p-value)	(0.02)	(0.30)
h	0.001	-0.01*	h	-0.004*	-0.004*
(p-value)	(0.67)	(0.04)	(p-value)	(0.00)	(0.00)
c	0.66*	2.08*	c	0.58*	1.23*
(p-value)	(0.02)	(0.00)	(p-value)	(0.00)	(0.00)
R^2	0.04	0.14	R^2	0.25	0.05
LM	(0.49)	(0.28)	LM	(0.84)	(0.00)*
B-Pagan	(0.20)	(0.23)	B-Pagan	(0.002)*	(0.31)

Note: x = bank power, z = ROA, h=loans as % of deposits.
SE = scale efficiency. * Significant under 5% significant level.
LM test (p-values) for cross-section heteroskedasticity.
B-Pagan LM test (p-values)for diagonal covariance matrix.

5. Concluding remarks:

To measure technical efficiency of commercial banks in GCC countries we used Data Envelopment Analysis (DEA) based on the intermediation approach of banking services, which entails banks produce financial services using inputs. The input variables include salaries & wages and deposits; while the output variables include loans and net incomes[8]. The sample period of the research extend from 2006 to 2008, and includes thirty six banks operating currently in GCC countries. Our results indicate in general GCC banks showed considerable pure technical efficiency in the past three years, with the year 2007 exhibits the most efficient year, as the number of efficient banks reached 33 percent compared to 25 percent in 2008[9]. It is interesting to realize that GCC banks experienced some inefficiencies in the year 2008 as this was the year of international financial crisis and crude oil price fall from over hundred dollars per barrel. The fall in overall technical efficiency in 2008 is due to simultaneous fall in pure technical efficiency and the scale efficiency. The output loss due to scale inefficiency (divergence of output from its optimum scale level) in 2008 is estimated 16 percent compared to 5 percent in 2007[10]. It is also indicated, the contribution of pure technical efficiency in the overall technical efficiency is relatively smaller compared to the scale efficiency contribution across all GCC countries. This imply the overall technical efficiency in GCC banks can be improved by targeting some key financial ratios that influence pure technical efficiency. These financial ratios include a measure of profitability, measured by return-on-assets; a measure of risk indicator

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[8] Other studies define inputs as total expenses on labor (salaries & wages), capital (book value of fixed assets) and deposits (demand and saving deposits).

[9] Technical efficiency can be divided into pure technical efficiency which implies efficient implementation of production plan of converting inputs into outputs; and scale efficiency which refers to scaling banks services to the most productive scale size.

[10] Technical efficiency can be divided into pure technical efficiency which implies efficient implementation of production plan in converting inputs into outputs, and scale efficiency which implies divergence of decision making units from the most productive scale size.

denoted by loan-to-deposit ratio; and a measure of bank size represented by the ratio of bank's deposit to the total banks' deposits in each country. Our results indicate scale efficiency is inversely related to banks' size (though insignificant for all except Kuwait) implying a major source of scale inefficiency in GCC banks is sub-optimal size of operations. It is also indicated in the paper that scale efficiency is inversely related to the risk variable, implying effective risk management policies may also enhance scale efficiency. Since the impact of the three explanatory variables is more significant on pure technical efficiency compared to scale efficiency in Saudi banks, it is very possible that the overall technical efficiency of Saudi banks can be improved by tackling both banks' size and the risk variables.

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Appendix (1): Efficiency scores (2008)

Bank	Technical efficiency	Pure technical efficiency	Scale efficiency	RTS
Riyad Bank	0.448	0.591	0.758037	Decreasing
Bank Al Jazira	0.312	0.325	0.96	Increasing
SAIB	0.452	0.457	0.989059	Increasing
SHB	0.365	0.374	0.975936	Decreasing
BSF	0.546	0.755	0.723179	Decreasing
SABB	0.459	0.609	0.753695	Decreasing
ANB	0.446	0.561	0.795009	Decreasing
SAB	0.542	1.00	0.542	Decreasing
NBK	1.00	1.00	1	Constant
GULF BANK	0.571	0.573	0.99651	Increasing
CBK	1.00	1.00	1	Constant
ABK	0.225	0.273	0.824176	Increasing
BKM	0.697	0.700	0.995714	Increasing
KIB	1.00	1.00	1	Constant
burgan bank	0.641	0.649	0.987673	Decreasing
NBZ	0.579	0.852	0.679577	Decreasing
ZCB	0.545	0.565	0.964602	Decreasing
CBI	0.338	0.382	0.884817	Increasing
FGB	0.662	0.875	0.756571	Decreasing
UNB	0.551	0.554	0.994585	Increasing
CBD	0.559	0.569	0.982425	Decreasing
EBI	0.396	1.00	0.396	Decreasing
mashreq bank	0.464	0.600	0.773333	Decreasing
NBB	1.00	1.00	1	Constant
BBK	0.531	0.564	0.941489	Increasing
AUB	0.362	0.526	0.688213	Decreasing
BSB	0.555	1.00	0.555	Increasing
Ahli bank	0.336	0.606	0.554455	Increasing
BDOF	0.420	0.475	0.884211	Increasing
bank muscat	0.439	0.467	0.940043	Decreasing
NBO	0.417	0.445	0.937079	Increasing
OIB	0.422	0.475	0.888421	Increasing
QNB	0.644	1.00	0.644	Decreasing
CBQ	0.856	1.00	0.856	Decreasing
Doha bank	0.579	0.604	0.958609	Decreasing
ABQ	0.476	0.526	0.904943	Increasing

Note: See appendix for the acronyms under DMUs.

*Values computed using DEA frontier software of Joe Zhu, 2010.

Appendix (2): Efficiency scores (2007)

Bank	Technical efficiency	Pure technical efficiency	Scale efficiency	RTS
Riyad Bank	0.71880	0.75407	0.953227	Decreasing
Bank Al Jazira	0.91236	0.92316	0.988301	Increasing
SAIB	0.58457	0.59076	0.989522	Increasing
SHB	0.54335	0.59621	0.91134	Decreasing
BSF	0.79466	0.87108	0.91227	Decreasing
SABB	0.71656	0.74531	0.961425	Decreasing
ANB	0.71765	0.74086	0.968672	Decreasing
SAB	0.78838	1.00000	0.78838	Decreasing
NBK	0.94445	1.00000	0.94445	Decreasing
GULF BANK	0.99683	1.00000	0.99683	Decreasing
CBK	0.99518	1.00000	0.99518	Decreasing
ABK	0.73543	0.73581	0.999484	Increasing
BKM	0.85330	0.86168	0.990275	Increasing
KIB	0.79580	0.79940	0.995497	Increasing
burgan bank	1.00000	1.00000	1	Constant
NBZ	1.00000	1.00000	1	Constant
ZCB	1.00000	1.00000	1	Constant
CBI	0.82806	0.83103	0.996426	Increasing
FGB	0.83422	0.86780	0.961304	Decreasing
UNB	0.78395	0.78725	0.995808	Increasing
CBD	0.88569	0.88624	0.999379	Increasing
EBI	0.79067	1.00000	0.79067	Decreasing
mashreq bank	0.71832	0.75264	0.954401	Decreasing
NBB	0.64071	0.65298	0.981209	Increasing
BBK	0.76507	0.76747	0.996873	Increasing
AUB	0.83028	1.00000	0.83028	Decreasing
BSB	0.74697	1.00000	0.74697	Increasing
ahli bank	1.00000	1.00000	1	Constant
BDOF	0.86270	0.86688	0.995178	Increasing
bank moscat	0.92026	0.92100	0.999197	Increasing
NBO	0.90613	0.91417	0.991205	Increasing
OIB	0.65032	0.67309	0.966171	Increasing
QNB	0.79196	0.83338	0.950299	Decreasing
CBQ	1.00000	1.00000	1	Constant
Doha bank	0.90460	0.90517	0.99937	Increasing
ABQ	0.75453	0.78013	0.967185	Increasing

*Values computed using DEA frontier software of Joe Zhu, 2010.

Appendix (3): Efficiency scores (2006)

Bank	Technical efficiency	Pure technical efficiency	Scale efficiency	RTS
Riyad Bank	0.55910	0.71789	0.77881	Decreasing
Bank Al Jazira	1.00000	1.00000	1	Constant
SAIB	0.93991	1.00000	0.93991	Decreasing
SHB	0.53386	0.57198	0.933354	Decreasing
BSF	0.72807	1.00000	0.72807	Decreasing
SABB	0.55548	0.74172	0.748908	Decreasing
ANB	0.58346	0.68799	0.848065	Decreasing
SAB	0.65051	1.00000	0.65051	Decreasing
NBK	0.73283	1.00000	0.73283	Decreasing
GULF BANK	0.85750	0.86073	0.996247	Decreasing
CBK	1.00000	1.00000	1	Constant
ABK	0.52289	0.65363	0.799979	Decreasing
BKM	0.64690	0.65935	0.981118	Increasing
KIB	0.50954	0.56205	0.906574	Decreasing
burgan bank	0.73343	0.74626	0.982808	Increasing
NBZ	0.59532	0.62737	0.948914	Decreasing
ZCB	1.00000	1.00000	1	Constant
CBI	0.53233	0.58389	0.911696	Decreasing
FGB	0.67818	0.67888	0.998969	Increasing
UNB	0.73198	0.74909	0.977159	Increasing
CBD	0.65787	0.67535	0.974117	Decreasing
EBI	0.48645	0.51538	0.943867	Decreasing
mashreq bank	0.56701	0.65191	0.869767	Decreasing
NBB	0.47075	0.47113	0.999193	Decreasing
BBK	0.63344	0.66140	0.957726	Decreasing
AUB	0.65845	1.00000	0.65845	Decreasing
BSB	0.44395	1.00000	0.44395	Increasing
ahli bank	1.00000	1.00000	1	Constant
BDOF	0.70190	0.77005	0.911499	Decreasing
bank moscat	0.58608	0.69063	0.848616	Decreasing
NBO	0.54848	0.60494	0.906668	Decreasing
OIB	0.51436	0.54184	0.949284	Decreasing
QNB	0.64373	0.65136	0.988286	Decreasing
CBQ	0.72370	0.79466	0.910704	Decreasing
Doha bank	0.70083	0.71227	0.983939	Decreasing
ABQ	0.58595	0.60586	0.967138	Decreasing

*Values computed using DEA frontier software of Joe Zhu, 2010.

Appendix 4: Efficiency scores (2008-2006)

Bank	Technical efficiency	Pure technical efficiency	Scale efficiency
Riyad Bank	0.5753	0.687653	0.830025
Bank Al Jazira	0.741453	0.749387	0.982767
SAIB	0.658827	0.682587	0.97283
SHB	0.480737	0.514063	0.94021
BSF	0.689577	0.87536	0.78784
SABB	0.577013	0.698677	0.821343
ANB	0.58237	0.663283	0.870582
SAB	0.660297	1	0.660297
NBK	0.892427	1	0.892427
GULF BANK	0.808443	0.811243	0.996529
CBK	0.998393	1	0.998393
ABK	0.49444	0.554147	0.874546
BKM	0.7324	0.740343	0.989036
KIB	0.768447	0.78715	0.967357
burgan bank	0.791477	0.79842	0.99016
NBZ	0.724773	0.826457	0.876164
ZCB	0.848333	0.855	0.988201
CBI	0.56613	0.598973	0.93098
FGB	0.7248	0.807227	0.905615
UNB	0.688977	0.69678	0.989184
CBD	0.700853	0.710197	0.985307
EBI	0.557707	0.83846	0.710179
mashreq bank	0.58311	0.668183	0.865834
NBB	0.70382	0.708037	0.993467
BBK	0.64317	0.66429	0.965363
AUB	0.61691	0.842	0.725648
BSB	0.581973	1	0.581973
Ahli bank	0.778667	0.868667	0.851485
BDOF	0.661533	0.703977	0.930296
bank muscat	0.648447	0.692877	0.929285
NBO	0.62387	0.654703	0.944984
OIB	0.528893	0.56331	0.934625
QNB	0.69323	0.828247	0.860862
CBQ	0.8599	0.931553	0.922235
Doha bank	0.728143	0.74048	0.980639
ABQ	0.605493	0.63733	0.946422

Note: The numbers in entries represent the average scores.

Appendix 5: Ranking leading indicators

DMU	Deposits	Net proft	investment
Riyad Bank	6	7	4
Bank Al Jazira	26	26	20
SAIB	17	23	12
SHB	16	19	15
BSF	8	9	9
SABB	5	8	6
ANB	9	11	7
SAB	3	2	1
NBK	10	3	10
Gulf bank	15	16	22
CBK	18	15	26
ABK	19	34	23
BKM	25	24	27
KIB	31	25	30
Burgan bank	20	18	29
NBZ	4	5	13
ZCB	11	13	17
CBI	32	33	33
FGB	12	10	14
UNB	14	17	25
CBD	23	21	24
EBI	1	1	2
Mashreq bank	13	12	8
NBB	27	27	21
BBK	30	28	19
AUB	2	4	3
BSB	36	36	31
Ahli bank	35	35	35
BDOF	34	32	36
Bank Muscat	22	22	18
NBO	29	29	32
OIB	33	31	34
QNB	7	6	11
CBQ	21	14	16
Doha bank	24	20	5
ABQ	19	34	28

Note: See appendix for abbreviations of DMUs.

Appendix 6: Key to abbreviations and acronyms

Country	Bank's Name	Acronym
Saudi Arabia	Riyad Bank	Riyad Bank
	Bank Al Jazira	Bank Al Jazira
	The Saudi Investment Bank	SAIB
	Saudi Hollandi Bank	SHB
	Banque Saudi Fransi	BSF
	The Saudi British Bank	SABB
	Arab National Bank	ANB
	Saudi American Bank	SAB
Kuwait	National bank of kuwait	NBK
	Gulf bank	Gulf bank
	The commercial bank of kuwait	CBK
	Al-ahly bank of kuwait	ABK
	Bank of kuwait and middle east	BKM
	kuwait international bank	KIB
	Burgan bank	Burgan bank
UAE	National bank of abu dhabi	NBZ
	Abu dhabi commercial bank	ZCB
	Commercial bank international	CBI
	First gulf bank	FGB
	Union national bank	UNB
	Commercial bank of dubai	CBD
	Emirates bank international	EBI
	Mashreq bank	Mashreq bank
Bahrain	National bank of bahrain	NBB
	Bank of Bahrain & kuwait	BBK
	Al Ahli united bank	AUB
	The bahraini saudi bank	BSB
Oman	Ahli bank	Ahli bank
	Bank dhofar al omani al fransi	BDOF
	Bank moscat	Bank moscat
	National bank of oman	NBO
	Oman international bank	OIB
Qatar	Qatar national bank	QNB
	The commercial bank of qatar	CBQ
	Doha bank	Doha bank
	Al Ahli bank of qatar	ABQ