Efficiency Analysis of the Banking Sector in Kuwait

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Abstract

This paper presents an assessment of the performance of commercial banks operating in Kuwait after and within a period of structural reforms and regulations, accompanied by an increasing competitiveness in the banking world. Two types of techniques are used for this purpose: (a) a non parametric technique – Data Envelopment Analysis (DEA) – to analyze the technical, allocative, cost, and scale efficiency of Kuwaiti commercial banks; and (b) a parametric technique – ordinary least squares (OLS) regression – to investigate the determinants of efficiency in these banks. Using panel data of seven banks for six years (1999 – 2004), the empirical results show improvements in the production efficiency over time. Furthermore, by using a slack-based efficiency measure, different efficiency frontier levels and more appropriate benchmarkers for inefficient banks are obtained. The statistical approach suggests significant relationships between the efficiency scores and financial performance.

تحليل كفاءة القطاع المصرفي في الكويت

وداد سعـــد
شوقي الموسوي

ملخص

تهدف هذه الورقة إلى تقييم أداء البنوك التجارية العاملة في الكويت، وذلك بعد فترة من الإصلاحات الهيكلية والتنظمية التي تزامنت مع ارتفاع فـي حـدة المنافسـة بين المصارف إقليمياً وعالمياً. لقد تم استخدام نوعين من التقنيات العلمية لهذه الغاية. الأولى ترتكز على إحدى طرق الأساليب الكمـية (Data Envelopment Analysis) لتحلـيل كفاءة الإنتاجية لدى البنوك التجارية العاملة في الكويت. أما الثانية فتعتمد على طريقة المربعات الجذرية الصـغرى لمعرفة المحددات والعوامل المؤثرة في كفاءة هذه المصارف. اعتمدت هذه الورقة على بيانات البنوك التجارية الستة التي تغطي الفترة الممتدة مـن 1999 إلـى 2004. وأظهـرت النـتائج التي تم التوصل إليها إلى وجود تحسن ملموس في الكفاءة الإنتاجية لهذه المصارف خلال الفترة المذكورة. وباعـتماد منحنى الكفاءة (efficiency frontier) تم تحديد المصارف الأكثر كفاءةً وتلك الأقل كفاءةً. كما تبين لنا أنه باستخدام متغيرات التباعد (slack variables) يصبح بإمكان كل مصرف من تلك الأقل كفاءةً تحديد المصارف الأكثر كفاءةً التي يمكنه اعتمادها كمعيار لتحسين كفاءته الإنتاجية. وأخيراً أظهرت النتائج الإحصائية وجود علاقة جوهرية بين الكفاءة والأداء المالي للبنوك التجارية العاملة في الكويت.

Introduction

The core of Kuwaiti's financial system is the banking sector. Kuwaiti banks are well capitalized, highly liquid and can withstand considerable shocks. This sector is comprised of a limited number of institutions: seven commercial banks, two specialized banks: (a) one operates under Islamic law, and (b) one is a branch of a foreign bank. The banking market is concentrated with the two largest banks accounting for about half of local banks' total assets, loans and deposits. These banks are mostly privately owned.

However, the banking sector has undergone major events during the last two decades (*Souk Al Manakh* crisis in 1982, Iraqi invasion and occupation in 1990). The subsequent recovery of the banking sector was facilitated by substantial government support and prudent fiscal and monetary policies.

[*] Associate Professor at the Faculty of Economics and Business Administration, Lebanese University, Hadat, Lebanon; e-mail: wsaad@ul.edu.lb
[**] Lecturer at the Faculty of Economics and Business Administration, Lebanese University , Hadat, Lebanon; email:chmoussawi@yahoo.com

Economic activity in Kuwait continues to rely highly on oil. Despite the large fluctuations in oil prices, regional threats and large swings in the local equities market, the authorities have successfully used regulations and supervision to safeguard the stability of banks.

To date, no bank in Kuwait has been closed or had its license revoked. Structural reforms and regulations have been established to face the challenges resulting from changes in the international economic environment and, for the banking sector, to be in line with international standards. Thus, the Central Bank of Kuwait (CBK) has introduced a system of market risk analysis in the assessment of capital adequacy. The Kuwait stock market exchange law was liberalized in August 2000 to allow foreigners to participate in the market. The CBK has indicated that it would not bail out a troubled bank in the future. The strategy of the authorities has been to accelerate non-oil activity growth through increase in the role of the private sector, including foreign direct investment, privatization

of government assets, deepening and widening of the financial sector by opening the domestic market to foreign banks. Under these considerations, the banking system should be able to face competition pressures, technological progress and consumer demand.

The aim of this paper is to explore the production performance of commercial banks operating in Kuwait over the six year period between 1999 and 2004 using two approaches: (a) a non parametric approach – Data Envelopment Analysis (DEA) – to assess the productive efficiency of these banks; and (b) a parametric approach – Ordinary Least Squares (OLS) regression – to investigate the determinants of the obtained efficiency scores.

Methodology

To measure the efficiency of commercial banks operating in Kuwait, the Data Envelopment Analysis (DEA) is utilized. This technique involves measuring the performance of each bank. The obtained efficiency scores are decomposed into technical, allocative, scale, and cost efficiencies. Given these measurements, a regression is employed to identify the determinants of the efficiency scores.

Data Envelopment Analysis (DEA)

DEA is a linear programming-based technique used for measuring the relative efficiency of a fairly homogenous set of decision making units (DMUs) that use multiple inputs to produce multiple outputs. Examples of such DMUs to which DEA has been applied are: banks, hospitals, insurance companies, libraries and university departments.

A unit is said to be efficient relative to another if: (a) It produces the same level of output with fewer inputs; or (b) It produces more output with the same inputs. The efficiency of a unit is evaluated by comparing its efficiency to the " best practice " units of the sample. "Best practice" units form the efficiency frontier. The efficiencies are called the efficiency scores. After the evaluation of the relative efficiency of the entire DMUs, subsequent analysis would show how inputs and outputs may be changed to be in line with the "best practice" units.

DEA suggests the benchmark for each inefficient DMU at the level of its individual mix inputs and outputs. The idea of efficiency was first developed by Farrel (1957). This was later put forward by Charnes, Cooper, and Rhodes in (1978) and received then the name of Data Envelopment Analysis. The latter proposed a model for assessing the efficiency of a unit under the assumption of constant returns to scale (CRS). This model was further extended by Banker, Charnes, and Cooper (1984) to allow for a production (cost) frontier with variable returns to scale (VRS).

Two kinds of models are derived from the DEA approach: (a) An efficient output target model that seeks to identify technical efficiency as proportional increase in output production; and (b) An efficient input target model which measures technical efficiency as a proportional reduction in input usage. More precisely, input-oriented models are those where DMUs are deemed to produce a given amount of outputs with the smallest possible amount of inputs.

The choice of the orientation is obvious in some studies. For instance, in firms where the focus is on cost-control, the appropriate choice would be an input orientation. In this study, the input-oriented model that assumes variable returns to scale (VRS) is adopted. This DEA model is stated as follows:

DEA model	DEA model with slacks
$\text{Minimize } h^\circ$ $\text{Subject to } h^\circ x_{ik} - \sum_{j=1}^{n}\lambda_j x_{ij}$ $\sum_{j=1}^{n}\lambda_j y_{rj} \geq y_{rk}$ $\sum_{j=1}^{n}\lambda_j = 1$ $h^\circ \text{ free}$ $\lambda_j \geq 0, \ \forall j$	$\text{Minimize } h_k = h^\circ - \varepsilon\left[\sum_{i=1}^{m} S_i^{0-} + \sum_{r=1}^{S} S_r^{0+}\right]$ $\text{s.t. } h^\circ x_{ik} - \sum_{j=1}^{n}\lambda_j x_{ij} - S_i^{0-} = 0 \quad i = 1,......,m$ $\sum_{j=1}^{n}\lambda_j y_{rj} - S_r^{0+} = y_{rk} \quad r = 1,......,s$ $\sum_{j=1}^{n}\lambda_j = 1$ (1) $h^\circ \text{ free and } \lambda_j \geq 0, \ \forall j$ $S_i^{0-}, S_r^{0+} \geq 0 \quad 0 < \varepsilon < 1$

where:

h^0 is the efficiency score of the DMU^0 under analysis
In banking, a bank constitutes a DMU
n is the number of DMUs under analysis
y_{rj} is the value of output r for DMU j
x_{ij} is the value of input i for DMU j
m is the number of inputs
s is the number of outputs
λ_j is the intensity factor showing the contribution of DMU j in the derivation of the efficiency of DMU_k in the envelopment model.

S_i^{0-}, S_r^{0+} are slack variables accounting for extra savings in input i and extra gains in output r. Efficiency is achieved only when $h^0 = 1$ and $S_i^{0-} = 0, S_r^{0+} = 0$.

If a DMU is inefficient, it may become efficient by adjusting output and input as follows:

$$y_{rk}^* = y_{rk} + S_r^{0+}$$
$$x_{ik}^* = h^0 x_{ik} - S_i^{0-}$$

However, leaving the constraint $\sum_{j=1}^{n}\lambda_j = 1$ out of the model changes the VRS model to constant returns to scale (CRS). Moreover, a non increasing returns to scale (NIRS) model is obtained by substituting the constraint $\sum_{j=1}^{n}\lambda_j = 1$ by $\sum_{j=1}^{n}\lambda_j \leq 1$.

This study is based on the input-oriented method under the assumption of VRS. The use of this approach allows the calculation of not only cost and technical efficiencies but also, the other two components of productive efficiency which are denoted as allocative efficiency and scale efficiency.

The economic efficiency which is referred to as cost efficiency is composed of technical and allocative efficiency. The technical efficiency is defined by Nunamaker (1985) as a measure of the ability of a DMU to avoid waste by producing as much output as input usage will allow, or using as little input as output level will allow. Another decomposition occurs at the level of technical efficiency, which may be considered to be composed of scale and pure technical efficiency. The scale efficiency is the measure of the ability to avoid waste by operating at, or near, to the most productive scale. The way in which these efficiencies are related, is shown in Figure 1.

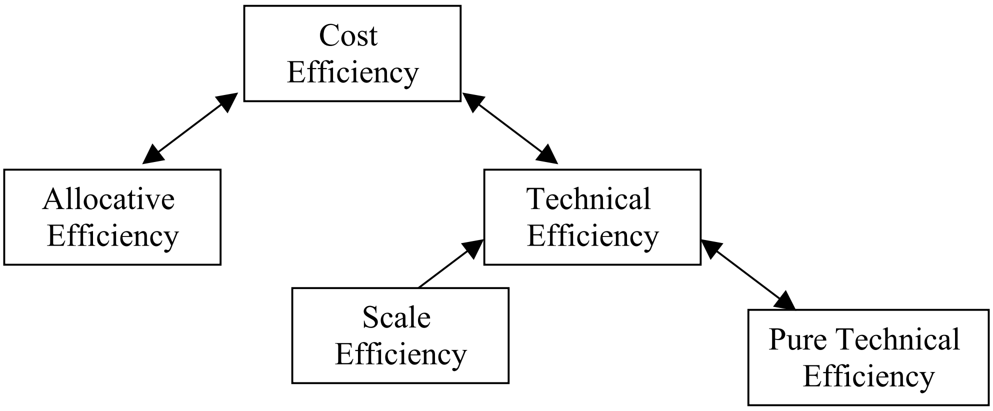

Figure 1. Efficiency decomposition.

Aly, Grabovsky, Pasurka and Rangan (1990), adopted this approach in their study and elaborated a four-step process that led to the assessment of the four types of efficiency: (a) cost efficiency; (b) technical efficiency; (c) allocative efficiency; and (d) scale efficiency.

Cost Efficiency (CE). The measure of cost efficiency is obtained via a two-stage assessment process. For each DMU, the following problem is first solved:

$$\begin{aligned} &\text{Min } x.p \\ \text{Subject to } &y \le zY \\ &x \ge zX \\ &z \ge 0 \end{aligned} \qquad \text{(Model 2)}$$

where:

p is a m × 1 vector of input prices
x is a 1 × m vector of observed quantities of inputs used by a specific DMU
y is 1 × s vector of observed quantities of outputs produced by a specific DMU
Y is an $n \times s$ matrix of observed outputs
X is an $n \times m$ matrix of observed inputs
z is a 1 × n vector of intensity parameters (weights) associated with each observation or DMU
n is the number of DMUs

This estimation (with the z only constrained to be non-negative) produces estimates of cost efficiency relative to a CRS frontier. The solution vector x^* of Model 2 is the cost minimizing input vector for the input price vector p and the output vector y.

Secondly, for each DMU, the following ratio is calculated to obtain CRS cost efficiency:

$$CE = \frac{x^*.p}{x.p} = \frac{\text{Computed minimum cost}}{\text{observed cost}}$$

This measure is the proportion by which the DMU could multiply its costs and still produce the same output.

Technical Efficiency (TE). The technical efficiency can be obtained by solving the following input-oriented VRS linear program for each DMU:

$$\begin{aligned} &\text{Min } T \\ \text{Subject to } \quad & y \le zY \qquad\qquad \text{(Model 3)} \\ & Tx \ge zX \\ & z \ge 0 \\ & \sum_{i=1}^{n} z_i = 1 \end{aligned}$$

where *T* is a scalar representing the technical efficiency score.

In Model 3, the summation constraint on intensity parameters *z* imposes VRS. Given a level of output, the obtained scores T^* indicate by how much inputs may be reduced for an inefficient observation to be comparable with similar, but more efficient DMUs.

Allocative Efficiency (AE). The cost efficiency may be decomposed into technical and allocative efficiency. The technical efficiency is given by solution $TE = T^*$ and the cost efficiency is CE. Following this, it becomes simple to calculate the AE by $AE = CE/TE$.

Scale Efficiency (SE). Again, in Model 3, the elimination of the summation constraint changes the model to CRS. The SE measure may be calculated as the ratio of CRS technical efficiency to VRS technical efficiency,

$$SE = TE_{\text{CRS}} / TE_{\text{VRS}}$$

where:
TE_{CRS} is the technical efficiency under CRS
TE_{VRS} is the technical efficiency under CRS.
Pure TE is measured relative to the VRS frontier.

The DEA method has been extensively used in banking literature to evaluate the performance of banking institutions. Sherman and Gold (1985) were among the first to present a study on the application of this method on banks. Pastor, Perez, and Quesada (1997) compared the efficiency of many European banks to the American ones. Maudos and Pastor (1998) also utilized the DEA technique to assess the efficiency of Spanish banks. Another study on the performance of the banking sector in Portugal was published by Canhoto and Dermine (2000). Alam (2001) evaluated the technical efficiency and the productivity of American banks with assets greater than 500 million dollars each. Recently, an assessment of between-country bank efficiency involving five European countries (France, Germany, Spain, Italy, and UK) was conducted by Casu, Girardone and Molyneux (2003), involving 2000 banks and adopting an output orientation analysis.

Regression Analysis

It is particularly important, however, not only to identify "inefficiency", but also to explain where it is derived from. Thus, the efficiency scores from the DEA model are regressed on variables representing the financial performance of the banks under study. An OLS regression model is used for this purpose. This model may be written as follows:

$$y_{it} = \alpha + X_{it}^{'}\beta + u_{it} \qquad i = 1,\ldots\ldots\ldots,n$$
$$t = 1,\ldots\ldots\ldots,T$$

with i denoting for banks, and t denoting for time. α is a scalar, β is $K \times 1$, y_{it} represents the efficiency score for the bank i at time t, X_{it} the itth observation on k explanatory variables (financial variables in this study), and u_{it} denotes the disturbance. The sign and the significance of the coefficients of financial variables indicate the direction and the influence. Standard hypothesis testing may be used to assess the significance and strength of the relationship.

Data and Variables

Defining inputs and outputs of a bank has been a challenging and controversial task in banking literature. Before discussing the selection of variables involved in this study, it is useful to understand the banking process. Three approaches in the banking literature discuss the activities of banks (Golany and Roll, 1989):

- The production approach which emphasizes the commercial activity at the bank, where they act as services providers for depositors and borrowers. The outputs are presented by, loans, savings and the number of transactions on these accounts. The production factors considered are physical inputs such as, land, labor and capital that needed to produce desired outputs (Ferrier and Lovell, 1990).

- The intermediation approach is complementary with the first approach and describes the banking activities as intermediating funds between savers and borrowers. In this approach, inputs and outputs are evaluated in money units. The inputs include the deposits collected and funds borrowed from financial market and the outputs are the volume of loans and investments (Athanassopoulos and Thanassoulis, 1995)[1].

- The modern approach has the novelty of integrating risk management and information processing into the analysis. One of the most innovative features of this approach is the introduction of the quality of banks' assets and the probability of banks' failure in the estimation of costs. In this approach, capital adequacy, asset quality, management, earnings and liquidity derived from the financial tables of the bank are used as variables in the performance analyses (Mercan and Yolalan, 2000).

Most banking studies have adopted either the production or the intermediation approach. There is debate in the literature over what approach is more appropriate. This dilemma has incited some authors, notably Nathan and Neave (1992), to adopt a hybrid approach considering deposits and loans as outputs without excluding the financing expenses of production cost. Based on this last approach, a number of variables are defined for the evaluation of productive performance of banks operating in Kuwait. The inputs and outputs are measured as follows:

Outputs:

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[1] See also Sealey and Lindley (1977).

- Deposits
- Loans
- Off-balance sheet activities

Inputs
- Capital
- Labor
- Finance capital

Three inputs are considered:
- The capital input is proxied by the level of fixed assets.
- Labor is proxied by general and administrative expenses. The use of this proxy is necessitated due to the unavailability of data on employee numbers across the sample. The price of labor is measured by the ratio of staff expenses to total assets.
- The ratio of expenditures associated with the utilization of the bank equipment to fixed assets is used as the price of the capital, and the price of finance capital is assessed by the ration of interest paid to deposits.

Since DEA is a linear programming-based method for assessing the comparative efficiency of homogeneous organizational units, the study is focused on commercial banks operating in Kuwait. The Kuwait financial sector is made up of seven commercial banks that follow international banking standards. The empirical results of this study are derived from the analysis of the seven commercial banks for a six-year period between 1999 and 2004, except for the bank of Bahrain and Kuwait whose data were available over the period 2000 to 2004.

The banks covered in this study are:

1. Al Ahli Bank of Kuwait (ABK)
2. Burgan Bank (BB)
3. Bank of Kuwait and the Middle East (BKME)
4. Commercial Bank of Kuwait (COMBK)
5. Gulf Bank (GB)
6. National Bank of Kuwait (NBK)
7. Bank of Bahrain and Kuwait (BBK)

Panel data used in the study came from individual bank reports and the CBK for the years 1999-2004. The use of panel data is attributed to two reasons: (a) Pioneering DEA studies on the banking sector used a relatively small number of observations compared to the number of considered variables. As a result, there was a tendency to obtain high levels of efficiency scores for various DMUs (Sherman and Gold, 1985; Oral and Yolalan, 1990). To overcome this problem, panel data for seven banks over 6 years were used. Thus, the presence of 41 observations allows the calculation of more accurate efficiency scores for all commercial banks operating in Kuwait; and (b) The other reason is to analyze the movements in bank and overall efficiency over time. It allows for inter-temporal comparisons (comparing the efficiency score of a bank for a particular period with its efficiency score for an adjacent time period). It also allows obtaining an estimate of overall efficiency scores for the entire sample.

Table 1 outlines some descriptive statistics of time varying inputs and outputs data used in this study. It shows the mean (*m*), the standard deviation (σ), the maximum (Max), the minimum (Min), and the coefficient of variation (*cv*) of the different inputs and outputs, over all commercial banks in Kuwait, for the 1999, 2001, and 2004 fiscal years.

Table 1. Descriptive Statistics of the Input and Output Data (Variables are in millions of Kuwaiti dinars)

	Mean	Max	Min	SD (σ)	CV(cv)
1999					
Loans	647.47	1291.47	333.19	337.14	0.52
Deposits	1426.40	3218.24	740.52	916.97	0.64
Off-Balance Sheet Activities	386.91	1073.53	129.02	343.88	0.89
Interest Paid	75.92	149.82	42.95	38.36	0.51
Staff Expenses	10.74	25.50	6.59	7.37	0.69
Fixed Assets	42.148	104.922	17.033	33.6036	0.79
2001					
Loans	778.37	1563.26	425.01	404.28	0.52
Deposits	1506.06	3834.90	651.69	1072.28	0.71
Off-Balance Sheet Activities	399.08	1259.93	145.54	388.91	0.97
Interest Paid	59.69	129.47	38.51	31.50	0.53
Staff Expenses	11.35	27.47	6.89	7.21	0.64
Fixed Assets	83.6148	335.71	15.418	117.942	1.41
2004					
Loans	1196.84	2774.72	764.69	722.15	0.60
Deposits	1409.80	3244.64	844.50	837.23	0.59
Off-Balance Sheet Activities	561.74	1560.98	165.44	470.21	0.84
Interest Paid	38.58	76.25	21.26	18.01	0.47
Staff Expenses	13.65	34.40	7.19	9.37	0.69
Fixed Assets	18.2529	40.942	6.345	10.9302	0.59

The coefficient of variation (σ/m) indicates that the dispersion of the data remains relatively constant over the consecutive four years. Moreover, this dispersion is relatively homogenous among the different considered variables. It may be noted in Table 1 that the coefficient of variation has its values within narrow intervals: [0.51, 0.89] in 1999, [0.52; 1.41] in 2001, [0.47, 0.84] in 2004.

DEA and Regression Results

To perform the efficiency analysis, an input-oriented mode is utilized which is consistent with the aim of attaining efficiency through cost minimization of Kuwaiti banks.

The DEA analyses were handled under the assumption of VRS and the obtained scores were decomposed into various measures of efficiency to provide additional insights on the contribution of each one to the total cost of inefficient bank.

Table 2 presents the time varying DEA efficiency scores for all banks. It consists of the full set of TE, AE, SE and CE, together with some descriptive statistics of the efficiency measures. It is clear from Table 2 that the average of TE has improved over time. This upward trend may be noticed by the increase in TE score which goes from 63% in 1999 to 91% in 2004.

The overall mean of the TE is not very high, around 79%, indicating a mean of TE around 21%. This result is very much in line with previous DEA studies on financial institutions (Berger and Humphrey, 1997) and shows that there is a waste of 21% of the total cost assumed by the production technology. It is important to note that the dispersion is fairly high since the lowest ranked bank reveals a handicap of 59% with respect to the "best practice" ones. This inefficient bank could reduce its inputs by 59% while keeping the same level of outputs.

Table 2 Time Varying Radial Measures of the Productive Efficiency of Kuwaiti Banks under the Assumption of Variable Returns to Scale (1999-2004)

No	Bank	1999				2000				2001			
		TE	AE	CE	SE	TE	AE	CE	SE	TE	AE	CE	SE
1	ABK	0.64	0.81	0.52	1.00	0.65	0.87	0.57	1.00	0.65	0.71	0.46	1.00
2	BB	0.65	0.67	0.43	1.00	0.65	0.69	0.45	1.00	0.55	0.87	0.48	1.00
3	BKME	0.97	0.86	0.82	1.00	1.00	0.78	0.78	1.00	0.87	0.82	0.72	1.00
4	COMBK	0.62	0.99	0.61	1.00	0.65	0.95	0.61	1.00	0.72	0.99	0.72	0.98
5	GB	0.49	1.00	0.49	1.00	0.72	1.00	0.72	0.97	0.66	1.00	0.66	0.96
6	NBK	0.41	0.99	0.40	0.92	0.46	0.96	0.45	0.83	0.49	0.96	0.48	0.77
7	BBK	-	-	-	-	1.00	1.00	1.00	1.00	0.96	1.00	0.96	1.00
	Mean	**0.63**	**0.88**	**0.55**	**0.99**	**0.73**	**0.89**	**0.65**	**0.97**	**0.70**	**0.91**	**0.64**	**0.96**
	Maximum	**0.97**	**1.00**	**0.82**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**0.96**	**1.00**	**0.96**	**1.00**
	Minimum	**0.41**	**0.67**	**0.40**	**0.92**	**0.46**	**0.69**	**0.45**	**0.83**	**0.49**	**0.71**	**0.46**	**0.77**
	Standard deviation	**0.19**	**0.13**	**0.15**	**0.03**	**0.20**	**0.12**	**0.20**	**0.06**	**0.17**	**0.11**	**0.18**	**0.08**
	Coefficient of Variation	**0.30**	**0.15**	**0.28**	**0.04**	**0.27**	**0.14**	**0.30**	**0.07**	**0.24**	**0.12**	**0.28**	**0.09**

N.B. TE = technical efficiency CE = cost efficiency
AE = allocative efficiency SE = scale efficiency

Table 2 . Cont.

No	Bank	1999				2000				2001			
		TE	AE	CE	SE	TE	AE	CE	SE	TE	AE	CE	SE
1	ABK	0.67	0.57	0.38	1.00	0.87	0.69	0.60	1.00	0.78	0.78	0.60	1.00
2	BB	0.54	0.91	0.49	1.00	0.76	0.92	0.70	1.00	0.58	0.89	0.51	1.00
3	BKME	0.89	0.70	0.62	1.00	1.00	0.97	0.97	1.00	1.00	0.90	0.90	1.00
4	COMBK	0.78	0.98	0.76	1.00	1.00	1.00	1.00	1.00	1.00	0.83	0.83	1.00
5	GB	0.69	0.99	0.68	0.99	1.00	0.99	0.99	1.00	1.00	1.00	1.00	0.94
6	NBK	0.90	0.81	0.72	0.72	1.00	0.98	0.98	0.88	1.00	1.00	1.00	0.97
7	BBK	1.00	1.00	1.00	1.00	1.00	0.97	0.97	1.00	1.00	1.00	1.00	1.00
	Mean	**0.78**	**0.85**	**0.67**	**0.96**	**0.95**	**0.93**	**0.89**	**0.98**	**0.91**	**0.91**	**0.83**	**0.99**
	Maximum	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Minimum	**0.54**	**0.57**	**0.38**	**0.72**	**0.76**	**0.69**	**0.60**	**0.88**	**0.58**	**0.78**	**0.51**	**0.94**
	Standard deviation	**0.16**	**0.17**	**0.20**	**0.11**	**0.10**	**0.11**	**0.16**	**0.05**	**0.17**	**0.09**	**0.20**	**0.02**
	Coefficient of Variation	**0.21**	**0.20**	**0.30**	**0.11**	**0.10**	**0.12**	**0.18**	**0.05**	**0.19**	**0.10**	**0.24**	**0.03**

The AE measures the ability of a bank to avoid waste by producing a level of output at the minimal possible cost. The mean of the AE goes from 88% in 1999 to 91% in 2004 with certain fluctuations. The overall mean is 90%. Thus, there is a waste of 10% in the total cost resulting from inappropriate allocation of the resources. The level of dispersion of the AE is lower than that of the TE since the coefficient of variation of the AE is 20% against 30% for the TE. According to this measure, only the allocatively efficient banks choose the optimal proportions of inputs according to the prices. In fact, the best banks operating in Kuwait are those

that, knowing the prices of resources, choose the less costly combinations of factors and offer the more profitable combinations of services. Such banks are allocatively efficient, because they adapt themselves better than the others to the competition constraints and, in particularly, to the price constraints.

As to the CE, results show that it has considerably improved over the period 1999-2004. The mean of the CE lies between 55% in 1999 and 83% in 2004 (except for 2003 where the CE = 0.89). It is obvious that the Kuwaiti commercial banks reduced their total costs by 28%. This implies that the cost inefficiency is around 28%. This reduction is attributable to the improvement in the TE and especially the AE which went up from 88% in 1999 to 91% in 2004.

The dispersion of the CE is very high (coefficient of variation is equal to 30%). This is due to the fact that the least efficient banks present a handicap of 62% with respect to the "best practice" ones. This suggests that improving the overall efficiency of banks could reduce the bank cost by 62%. As a result, the Kuwaiti banks could reduce their total cost by 62% if they adopt the choices of the "best practice" banks. Therefore, this inefficiency evaluates the gains that inefficient Kuwaiti banks could realize if they used the same techniques and took the same choices as those which adopt planning that minimizes the costs of production.

As to SE, it has an overall mean of 97%. This high scale of efficiency reflects the homogeneity of Kuwaiti banks. The analysis of this measure shows that its contribution to inefficiency is not important. However, this is a part of the explanation of the inefficiency revealed in certain banks. The possible residual reduction in inputs has not yet been taken into account.

All inefficient banks can benefit by carefully examining best practices by banks in their peers groups. The slack variables introduced in the model are defined to express the input excesses S^- and the output shortfalls S^+. The proportional (radial) reduction analyzed above does not lead to the efficiency defined by Pareto (see Koopmans, 1951) which states that a DMU is efficient if and only if: (a) Its efficiency score is equal to 1; and (b) It has zero slack values.

Solving a linear programming model that takes into account the presence of slack variables S^- and S^+, for all banks, leads to the determination of the production frontier formed by efficient banks. The inefficiency of each bank is measured in a radial(2) way with respect to the frontier. This allows for detection of the presence of similarities between banks by comparing the inefficient ones with their peers.

Table 3 presents TE and SE scores under the VRS along with the slack variables and the potential peer banks over the period 1999-2004. The sample banks are presented in an ordinal logic. The first choice involves banks that are strictly dominating the evaluated bank. At the second level, the proposed peer banks are virtual ones and are obtained by the reduction of all factors. At the third level, it is supposed that the hypothesis of a convex production frontier is verified.

The results of the radial measures presented in Table 3 show that COMBK, GB, NBK and BBK are technically efficient under the VRS. These banks constitute the production frontier and are used as peers for the remaining inefficient banks. The nominated banks are considered to be technically efficient, because they have better management of the technical aspects of the production than the others and, consequently, arrive at offering the maximum services with minimum resources.

The remaining banks are assumed to be relatively inefficient. Their inefficiency varies between 0.56 and 0.83. The lowest score 0.56 corresponds to BB which may be compared to NBK ($\lambda = 0.026$), and BBK ($\lambda = 0.974$). This one is followed by ABK which has a score of 0.63, and then BKME that assumes a score of 0.83. These last two banks may be compared to NBK. Both NBK and BBK lie on the technically efficient production frontier and are the closest to BB. Similarly, BBK is the closest one to ABK and BKME.

The presence of values for the slack variables P_1, P_2, and P_3 indicates an under-use of the funds allocated to these factors. The linear programming constraints related to these factors are not

(2) Färe and Lovell (1978) proposed a non radial measure for efficiency.

satisfied. Thus, to improve its production and manipulation of the inputs, ABK should examine the practice of NBK and BBK, and especially BBK since it has a higher weight (λ = 0.974). The remaining inefficient banks, i.e. BKME and COMBK, are tackled similarly.

Table 3. Optimal Radial Measures of the Productive Efficiency of Kuwaiti Banks under the Assumption of Variable Returns to Scale (1999-2004)

No.	Bank	TE	SE	Reference banks (peers)		S_{y1}^{+}	S_{y2}^{+}	S_{y3}^{+}	S_{P1}^{-}	S_{P2}^{-}	S_{P3}^{-}
1	ABK	0.63	0.92	6 (0.026)	7 (0.974)	5.97	0.00	0.00	0.00	36.13	7.46
2	BB	0.56	1	7 (1.00)		5.00	0.00	20.07	0.00	72.09	5.60
3	BKME	0.83	1	7 (1.00)	-	4.00	0.00	156.97	68.03	0.00	8.50
4	COMBK	1	0.60	4	-	0.00	0.00	0.00	0.00	0.00	0.00
5	GB	1	0.5	5	-	0.00	0.00	0.00	0.00	0.00	0.00
6	NBK	1	0.48	6	-	0.00	0.00	0.00	0.00	0.00	0.00
7	BBK	1	1	7	-	0.00	0.00	0.00	0.00	0.00	0.00
	Mean	**0.86**	**0.78**			**2.14**	**0.00**	**25.29**	**9.72**	**15.46**	**3.08**

N.B. Banks are classified according to the total of balance sheet.
Numbers in parentheses are values of λ associated with reference banks.
TE and SE refer to technical efficiency and scale efficiency respectively.

It is now particularly important to investigate the determinants of variations in the efficiency scores. It is clear from Table 3 that there is noticeable difference in the efficiency among the commercial banks.

To identify the determinants of bank efficiency, an OLS model is estimated using panel data consisting of 41 observations. In this model, the OLS is integrated for the whole sample over a six-year period from 1999 to 2004.

The natural logarithm of the dependent variable (efficiency scores) and the explanatory variables are taken into account to reduce the disturbing influence of extreme values. Using the within regression, estimates of the regression parameters are taken. The explanatory variables used in the regression are: total assets (TA), loans to total assets ratio (LTA), return on assets (ROA), capital to total assets ratio (CATA), total cost to total assets ratio (TCTA), and provisions for doubtful debt to total assets ratio (PDTA).

Table 4 presents the results of the OLS model. Results show an insignificant relationship between the bank size (LnTA) and the production efficiency of Kuwaiti commercial banks measured by the TE, AE and the CE. Thus, the presence of economies of scale in Kuwaiti commercial banks, is not confirmed since the semi-elasticity estimates relative to the three specifications are not statistically significant. The presence of the size effect means that, having the same score efficiency, the banks do not exploit in the same manner the production possibilities offered by their current sizes.

In other words, a part of the productive inefficiency of banks probably results from inadequate sizes. Thus, the case of Kuwait banks does not mean that these banks operate at their optimal scale. It means that these banks use, on the average, their current sizes to exploit in the same manner the production possibilities and other factors such as organization factor could explain the efficiency of commercial banks operating in Kuwait. It is possible that commercial banks in Kuwait operate under increasing returns to scale or their inefficiency is partly related to inadequate sizes.

Table 4. Explanation of the Variation of the Productive Efficiency of Kuwaiti Banks

	Efficiency scores		
Financial Variables	**LnTE**	**LnAE**	**LnCE**
C	2.189 (1.072)	-0.179 (-0.33)	1.434 (0.75)
LnTA	-0.679 (-0.675)	0.025 (0.09)	0.094 (0.09)
LnLTA	0.944*** (3.11)	0.234*** (3.27)	1.391*** (4.21)
LnROA	0.072 (1.00)	0.098*** (4.36)	0.099 (1.33)
LnCATA	-0.672* (-2.00)	-0.349*** (-3.663)	-0.912*** (-2.97)
LnTCTA	0.334** (2.26)	0.070 (0.98)	0.586*** (2.99)
LnPDTA	-0.008 (-0.33)	-0.035*** (-6.26)	-0.039* (-1.95)
R^2	**0.57**	**0.62**	**0.66**

Notes: 1. TE = technical efficiency, AE = allocative efficiency, CE = cost efficiency.
2. Values in parentheses are the t tests.
* 10% level of significance
** 5% level of significance
*** 1% level of significance

As to the LnLTA variable, it appears to be positively and significantly related to the three measures, at the 1% level of significance. This result is compatible with the findings of Allen and Rai (1996) which indicate that banks involved in loan activity are better managed.

Furthermore, the results show a positive relationship between the LnROA and the three efficiency measures. Accordingly, high return is due to good management of the productivity. Thus, the positive relationship between the activity of loans and the productive efficiency may be explained by the decrease of bad debts and the amount of provisions. This has the effect of reducing the level of costs and improving bank efficiency.

LnROA is a main variable of profitability considered in the analysis. As expected, the regression shows a statistically significant relationship between the LnROA and one specification, the AE. In theory, a good productive efficiency, which indicates a good organization of the production, should lead to a good profitability. Moreover, the productive efficiency and the profitability are positively correlated. Good management of the costs is an important determinant of price and margin policy. The positive correlation between profitability and the productive efficiency may be explained by the fact that, to improve their profitability, the Kuwaiti banks are incited to enhance the productive efforts of and to improve the management of the production costs. The more a bank tries to improve its profitability, the more it has a tendency to lower its costs and therefore to improve its productive efficiency.

The sign of the estimates related to the LnCATA is negative and statistically significant at 1% level of significance in the two last estimated specifications and at 10% level of significance on the first one. The negative correlation between productive efficiency scores and the level of capitalization in banks may be explained by the high costs that represent this latter. However, when banks get funds on the national or international markets, they are indebted at a lower risk premium in their respective cost of debt. This advantage reduces the total cost of the banks and allows improving their productive efficiency. However, it is important to note that the ratio of capital to total assets is not really an appropriate measure of risk.

The coefficients of the LnTCTA are positive and statistically significant in two specifications. This implies that when banks adopt a more active policy in the remuneration of employees, it will result in an improvement in the productivity and hence, an amelioration of the organizational and managerial efficiency of the commercial banks operating in Kuwait

Finally, with the exception of the TE, the link between the risk indicator LnPDTA and the AE and the CE, is negatively significant. This translates the fact that banks with low risk activities are the more efficient over the period 1999-2004. This not surprising, since the increase in provisions for doubtful debts is one of the reasons that causes an augmentation of the costs. Mastering the level of provisions will allow good management of the costs and, hence, an improvement of the efficiency (Berger and De Young, 1997).

These results allow interrogating about the behavior of banks *vis-à-vis* risk. Theory and empirical studies indicate that banks show a neutral attitude toward risk (Hughes, Mester and Moon, 1995). Banks which limit their risks are supposed to have the best performance. In fact, their objective is not to maximize a pure profit but an adjusted profit to risk.

Some essential strategies of banks with high level of performance is to establish long-run bank lending relationships (Sharpe, 1990), select the best projects, and watch the behavior of their clients in order to reduce risk. However, these strategies will increase the operating costs of banks but could allow a decrease in the number of failures which subsequently, will be reflected in a rise in the profitability received from loans. Moreover, a good organization and a high quality of risk management are behind any decrease in operating costs and any improvement in the profitability.

The determinants of productive efficiency relative to commercial banks operating in Kuwait are numerous. Attention is focused on those supposedly to be most sensitive to changes. Examples of those currently affecting the Kuwaiti banking sector are reforms, liberalization and regulations, to name but a few. The influence of the chosen determinants on the efficiency is not unequivocal. The efficiency depends particularly on the global strategy of management of the bank and its ability to react well to changes in its environment.

Conclusion

The purpose of this paper is to examine the production efficiency of commercial banks operating in Kuwait after and within a period of structural reforms and regulations. A panel data set of 41 observations over the six-year period between 1999 and 2004 has been analyzed.

A two-stage procedure was used: (a) Efficiency scores were calculated for each bank using a DEA minimizing cost model under variable returns to scale (VRS), and (b) At the next stage, these scores were explained using a variety of financial factors that are expected to affect the observed inefficiencies. This task was achieved by using a regression analysis based on the OLS model.

The decomposition of the efficiency scores into four components – (a) technical, (b) allocative, (c) scale, and (d) cost efficiencies – provided additional insight on the scores of productivity change and also provided the analytical foundation for empirical analysis of the contributions of specific financial variables to productivity change.

Empirical results indicated that efficiency trend seems to be upward during the sample period with an overall average of 79%. This is despite the presence of inefficient banks that still need to raise their productive efficiency and improve the overall quality of management. The regression analysis resulted in conclusions that are well in line with other DEA studies on relative bank efficiency.

The importance of this study resides in the fact that it can provide useful insights and direction for improvement to the bank's management. It is also useful to economists and policy-makers in evaluating and improving the economic performance of the banking sector in Kuwait. However, the source of disadvantage for these banks is merely the local market structure and limited competition under which they operate. Their financial environment is characterized by highly protected markets and centralized regulatory regimes. Benchmarking commercial banks operating in such restrictive regimes against commercial banks in more liberalized financial environments can be extremely important for banks operating in countries expecting changes in their financial environments.

Further research should look into the development of between-Arab country efficiency comparison that can provide an empirical benchmark upon which banking institutions may assess their performance.

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