Measuring the Cost Efficiency of Banks Operating in the MENA Region

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Abstract

This paper tried to model the efficiency of banks operating in the MENA region between 2005 and 2011, using the stochastic frontier technique. The sample under study included banks from 11 different MENA countries. The empirical results show that – on average – those banks could save up to 19% of their consumed resources while producing the same level of outputs. We also find a wide difference in efficiency among the MENA banking sectors, with scores ranging between 55% (for Egypt) and 97% (for UAE). Finally, by detecting the impact of several internal and external factors on the efficiency scores, we find that economic growth, inflations rates, corruption, exchange rates, trade openness, size of the government, bank capital, and bank profitability, all have a significant impact on bank efficiency.

Keywords: Stochastic Frontier; Efficiency; Productivity.
JEL classification: G21; D24.

1. Introduction

The banking sectors in the MENA region undergone substantial changes over the past twenty years aiming at enhancing bank soundness and performance, through boosting capital bases, implementing more efficient organisational structures, adopting more advanced risk management systems, introducing greater variety of services. This was coupled with the implementation of reform procedures by the authorities, including restructuring and privatising state-owned banks, and adopting tighter prudential regulation and supervision. In parallel, the MENA banking systems have witnessed a wave of deregulation represented by – among other things – the liberalisation of deposit and lending rates and removing restrictions on foreign institutions entry. These reforms aimed to increase the efficiency and productivity of banking sectors and to achieve more competitive operational environment. Consequently, banking competition has become increasingly strong and exerts considerable pressure on lending and deposit interest rates, which had a direct impact on the performance of banks operating in the MENA region.

The objective of this study is to investigate the productive performance of banks operating in the MENA region and to measure the risk-return preference using the production frontiers methodology and estimating a cost function of banks. These will be used to construct risk-return frontier for banks in order to assess their "relative performance". We will estimate a flexible stochastic cost function that integrates risk, capital constraint, and other specific and macroeconomic variables in the chosen specification. The use of stochastic cost frontier allows isolating the purely random error term that reflects the inefficiency of each bank and should therefore, lead to an accurate measure of performance, taking into account the effects of internal and external factors.

This study proceeds as follows. Section 2 will present an overview of the literature on bank efficiency using the production frontier approaches. Section 3 presents the methodology used in the paper. The chosen variables and data set are illustrated in Section 4. Finally, Section 5 contains the empirical results of the paper.

2. Review of the Literature

The analysis of banking efficiency has received significant attention in recent years. The first work that focused on this subject was that of Sherman and Gold (1985). The authors use the production approach to analyze the efficiency of 14 branches of the American Savings Bank using the DEA method and found an average technical efficiency of 96%, and that the inefficiency of some branches is attributed mainly to strong demand of transactions.

Allen and Rai (1996) compare the technical efficiency of banks in 15 industrialized countries between 1988 and 1992. Using a parametric estimation of cost function, they found that universal and big banks are generally more efficient, and banks with the highest efficiency scores are located in Japan, Australia, Germany, Sweden and Canada. In contrast, banks from France, Italy, the United Kingdom, and the United States are characterized by low scores efficiencies. Ferrier and Lovel (1990) use the DEA and the stochastic frontier to compare the efficiency of a sample of U.S. banks. They conclude that the two methods lead to similar estimations of average efficiency (84% for DEA and 90% for the stochastic frontier). Dietsch (1996) examines the productive efficiency of 375 banks and savings banks operating in France between 1988 and 1992 using parametric and deterministic cost function (free distribution model developed by Berger (1993)). The author shows that banks have an average productive efficiency between 70% and 80% and concluded that those banks could reduce their costs between 20% and 30% if they had adopted the best practices observed in the sample. He added that bank inefficiency is the result of bad management of production factors. Burkart et al. (1999) estimate the cost and profit efficiencies of a panel of large French banks. Their results show that the median values of cost and profit efficiencies are 88% and 93% respectively, which means that costs could be reduced on average by 12% and profits could be increased by 7% relative to the industry best practices.

Maudos and Pastor (2002) used the DEA technique to assess cost and profit efficiencies of Spanish commercial and savings banks over the period 1985-1996. The common frontier shows that the average cost efficiency of Spanish banks was 87% and higher than profit efficiency (57%). Chaffai and Dietsch (1999) estimate the productive efficiency of 655 medium-sized European banks from 11 European Union countries over the period 1992-1996 using a translog cost function. The estimation of the cost frontier shows that technical efficiency is on average 78%, which shows that proportional reduction of all factors of production of 22% on average, would allow banks to achieve same production levels as those with the best practices. Their results also show that banks in Luxembourg, the Netherlands and Austria have the highest efficiency scores followed by Germany and the United Kingdom, and have efficiency scores higher than the European average. They also found that banks in Belgium, France, Denmark, Italy, Portugal and Spain are characterized by low technical efficiency scores.

Casu and Molyneux (2000) analyzed the evaluation of the efficiency of 750 banks in 5 European countries (France, Germany, Italy, Spain and the UK) over the period 1993-1997 using DEA method. They obtained relatively low efficiency scores, which vary depending on the orientation chosen: they range from 59% (in 1993) to 64% (in 1997) under the assumption of constant returns to scale, from 61% (in 1993) to 68% (in 1997) under the assumption of variable returns to scale but oriented towards minimization of inputs, and from 62% (in 1993) to 69% (in 1997) under the assumption of variable returns to scale but oriented towards maximization of outputs. Finally, Casu et al. (2003) conducted an analysis of the productivity of 2000 banks in five European countries (France, Germany, Spain, Italy and the United Kingdom) for the period 1994-2000. They estimate the productivity of banks using a non-parametric frontier (Malmquist productivity index oriented towards maximization of outputs). Their results show that all countries have improved their productivity over that period, however, Spanish banks reported a greater improvement in overall productivity compared to other European banks. Spanish banks improved their productivity by 9.5% between 1994 and 2000, followed by Italian banks (8.5%). France, Germany and the UK were characterized by low productivity improvement: 1.8%, 0.6% and 0.1% respectively. The best performance of Italian and Spanish banks was mainly due to a more active integration of technological progress (10.9% and 9.2%, respectively) than other European banks.

3. Methodology: the Stochastic Frontier Approach to Measure Bank Performance

The use of productive efficiency frontiers provides a solution to model the behavior of a bank taking into account both risk and return. Some studies include the risk directly in the production frontier to determine the existing link between risk-taking and productive efficiency. In this approach, banks that adopt a less expensive production technology are easily able to control their level of risk.

The stochastic frontier was proposed for the first time, by Aigner et al. (1977) and Meeusen and van den Broeck (1977) who used a model with compound errors in which inefficiencies are assumed to follow an asymmetric distribution, while the random errors are assumed to follow a symmetric distribution of standard normal type. The relevant basic model can be written as follows (Grenne, 1990):

$$C_{it} = C(y_{it}, w_{it}, \beta).exp(v_{it} + u_{it}) \quad (1)$$

where C_i is the observed cost of production of bank i, y_i is the vector of output quantities, w_{it} is the vector of input prices, β is a vector of parameters to be estimated, v_i is a random error term of any sign, with a zero expected value, and u_i measures the inefficiency that increases production costs.

The inefficiencies that have to be added to the cost frontier must have an asymmetric distribution. The estimation of the parameters of the stochastic frontier is carried out by the choice of the probability distribution of terms v_i and u_i (Stevenson, 1980). Several distributions have been proposed in the literature for the inefficiency term: semi normal distribution, exponential distribution, normal truncated at zero or not, and gamma distribution. Following Grenne (1990), we adopt the assumption of a gamma distribution for the inefficiency term and a normal distribution for the error term. The foundations of the distribution assumptions lie on the fact that the inefficiency term cannot reduce costs and therefore, must have an asymmetric distribution. Conversely, the error term may increase or reduce costs, which legitimates a symmetric distribution. Following Lovell et al. (1982), the efficiency is calculated as the conditional of the term of efficiency, given the residual.

We estimate a system of equations consisting of a cost function and its equations from associated cost that are derived from Lemma Shepard. The estimation of this system adds degrees of freedom and allows for more efficient estimators than the estimation of a cost function with a single equation. Since the cost equations are equal to unity, we omit an equation from the associated cost. The standard constraints of symmetry are imposed. Similarly, the homogeneity conditions are imposed by normalizing the total cost and the prices of production factors. A Translog model is then estimated in order to obtain the cost efficiency scores cost as follows:

$$Ln\left(\frac{TC_{it}}{w_3}\right) = \alpha_0 + \sum_{i=1}^{3}\alpha_i Lny_{it} + \frac{1}{2}\sum_{i=1}^{3}\sum_{k=1}^{3}\eta_{ik} Lny_{it} Lny_{kt} + \sum_{j=1}^{3}\beta_j Ln\left(\frac{w_{jt}}{w_3}\right)$$
$$+\frac{1}{2}\sum_{j=1}^{3}\sum_{m=1}^{3}\theta_{jm} Ln\left(\frac{w_{jt}}{w_3}\right) Ln\left(\frac{w_{mt}}{w_3}\right) + \sum_{i=1}^{3}\sum_{j=1}^{3}\sigma_{ij} Lny_{it} Ln\left(\frac{w_{jt}}{w_3}\right) \quad (2)$$
$$+ v_{it} + u_{it}$$

where TC_i is the total cost, y_i represents the outputs (*i* = 1, 2, 3), w_j represents the inputs (*j* = 1, 2, 3), v_{it} represents the error terms that are assume to follow a normal distribution $N\left(0,\sigma_u^2\right)$ and to be independent of u_{it}, and u_{it} are the random terms that represent the inefficiencies in the production process.

It is assumed that these terms follow a normal distribution that is truncated at zero $N(\mu,\sigma_u^2)$ with:

$$\begin{cases} \mu = 0 \; for \; a \; semi - normal \; distribution \\ \mu = 0 \; for \; a \; truncated \; nomal \; distributon \end{cases}$$

The component of inefficiency must be observed indirectly. Jondrow Lovell et al. (1982) hold an explicit form for the semi-normal distribution:

$$E\left[u_i \middle| v_i\right] = \frac{\sigma\lambda}{\left(1+\lambda^2\right)}\left[\frac{f^*\left(v_i\lambda/\sigma\right)}{1-F^*\left(v_i\lambda/\sigma\right)} - \left(\frac{v_i\lambda}{\sigma}\right)\right] \quad (3)$$

where $\sigma^2 = \sigma_z^2 + \sigma_u^2$ and $\lambda = \sigma_u/\sigma_z$, *f** (*F**) is the density function (the distribution function) of a random standard normal variable.

If a truncated normal distribution is used, the equivalent expression is obtained by substituting($v_i\lambda/\sigma$) by:

$$\mu^* = \frac{v_i\lambda}{\sigma} + \frac{\mu}{\sigma\lambda} \quad (4)$$

This method provides unbiased estimators but suffers, according to Schmidt and Sickles (1984), from two main limitations:

1. The efficiency of a firm can be estimated but not in a consistent manner: the variance of the conditional distribution does not decrease when the sample size increases.
2. The estimation of the model and the decomposition of the error term require specific assumptions about the distribution of the random variable. Different assumptions about the distribution lead to different frontiers and different estimations of the degree of efficiency.

These limitations are potentially avoidable if the estimation of the production frontier is constructed using panel data. To overcome the problem of the invariance degree of efficiency in time, three models are available: the model of Cornwell et al. (1990), the model of Kumbhaker (1990), and the model of Battese and Coelli (1992, 1995). The first two models allow the degree of efficiency to vary with time but they do not take into account the effects of certain (specific and macroeconomic) variables on the efficiency of each bank. The model proposed by Battese and Coelli (1992, 1995) is more practical than the two previous models for two reasons. Firstly, it allows the level of efficiency to vary over time. Secondly, it takes into account the effects of interactions among the variables that represent inefficiency and factors of production. Following Battese and Corra (1977) we replace σ_v^2 and σ_u^2 by $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \sigma_u^2/(\sigma_u^2 + \sigma_v^2)$, where the parameter γ must be between zero and unity.

Finally, we base on the work of Battese and Coelli (1995) that developed a stochastic frontier model in which the term representing the inefficiency (u_{st}) is an explicit function of specific variables to the production units, which we want to detect their impact on efficiency. To take into account the influence of specific explanatory variables on efficiency, we assume that u_{it} follows a normal distribution truncated at zero $N\left(m_{st}, \sigma_u^2\right)$ with $m_{it} = \delta_0 + z_{it}\delta$, where z_{it} is a $(1 \times p)$ vector of variables that influence the efficiency of production units and δ a vector of $(1 \times p)$ parameters to be estimated. Using this specification of stochastic cost frontier allows isolating the purely random error term from the one that reflects the inefficiency of the evaluated unit and should therefore lead to a more accurate measure of efficiency, while taking into account the effects of some specific variables that evolve over time. More specifically, the efficient frontier not only takes into account the risk-return preferences of bank's management, but also the impact of capital regulation and certain (bank specific or macroeconomic) variables on efficiency.

4. Data and Variables Specifications

We follow Allen and Rai (1996), Hughes and Mester (1998), Dietsch and Lozanos-Vivas (1997) to define the variables used in this study. We consider three outputs and three inputs. The outputs are: (1) loans to customers, (2) bad loans and (3) off-balance sheet activities.

To proxy for (credit) risk, we have 2 variables: non-performing loans that provide an ex-post measure of risk, and provisions for loan losses that represent an ex-ante measure of risk. Besides, data on non-performing loans is unavailable for the majority of banks in the sample. Thus, we proxy risk by provisions for doubtful loans. We also introduce three production factors: (1) interest expenses, (2) personnel expenses and (3) other operating expenses. These factors form the majority of bank charges and have the advantage of being measurable quantities (amount borrowed, number of employees, and amount of capital or number of branches), which allows calculating factors' unit price.[1] The prices of the three production factors are computed as follows: (1) the price of labor is measured by the average wage per bank, (2) the price of physical capital is measured by the ratio of total expenditure associated with the utilization of bank equipment to bank capital, and (3) the price of financial resources is measured by the ratio of financial charges to deposits. The used performance variables and the variables representing the economic environment are the following:

a) The corruption perception index (CPI) developed by International Transparency, which is a composite index that aggregates data from investigation and rating agencies. A score of ten indicates the absence of corruption, and a score of zero indicates a systematic and significant corruption.
b) Economic developments measured by the growth rate of gross domestic product (GGDP).
c) The inflation rate measured by the change in consumer price index (INF).
d) The real exchange rate that measures the competitiveness of the national economy (RER).
e) The trade dependency ratio, defined as the ratio of the sum of exports and imports to gross domestic product (TDR).
f) The size of government measured by the ratio of total government revenue to gross domestic product (GRR).
g) Bank profitability measured by net profit-to-total asset ratio (ROA).

[1] The lack of depreciation of physical capital prevents measuring accurately the cost of physical capital.

h) Bank capitalization measured by equity-to-total asset ratio (CAP).
i) Bank liquidity approximated by liquid assets-to-total asset ratio (LIQ).
j) Bank management quality measured by staff expenses-to-total operating expenses ratio (MAN).

The above variables allow measuring the choice of the risk-return combination of the bank through the production frontier taking into account the existence of an undesirable output(s). Besides, they allow detecting the impact of bank capital regulation. We use a methodology that integrates credit risk in the cost stochastic frontier and allows studying the efficiency of banks, their sensitivity to risk, the impact of capital regulation and the effect of institutional and environmental factors on bank performance.

The estimation of the degree of efficiency of banks operating in the MENA region is conducted on 12 banking systems: Lebanon (with a sub-sample of 39 banks), Saudi Arabia (12 banks), Qatar (5 banks), Kuwait (8 banks), Jordan (14 banks), United Arab Emirates (16 banks), Tunisia (19 banks), Bahrain (8 banks), Oman (8 banks), Morocco (10 banks), Egypt (24 banks), and Turkey (24 banks). We exploit accounting data taken from the Bankscope banking database, covering seven years of annual data (2005-2011). Tables (1) and (2) present some descriptive statistics for the sample.

Table 1: Descriptive statistics of the sample – 2005 (figures in $ millions)

		Total Assets	Total Loans	Fixed Asset	Total Deposits	Total Equity	Loans Losses Reserves	Interest Expense	Personnel Expenses	Other Operating Expenses	Net Income	Total Cost
BAH	Av.	7,962.5	3,057.7	46.1	3,353.1	817.7	97.8	196.0	48.3	28.8	89.4	273.0
	SD	8,861.6	3,029.7	54.0	3,446.8	818.9	132.9	226.0	49.6	29.9	79.8	299.8
	CV	1.1	1.0	1.2	1.0	1.0	1.4	1.2	1.0	1.0	0.9	1.1
EGY	Av	3,841.3	1,737.9	23.5	3,189.5	225.6	246.7	183.4	20.9	47.8	14.3	252.1
	SD	6,400.0	2,863.9	25.7	5,450.2	252.2	414.9	334.6	32.9	61.6	35.3	419.1
	CV	1.7	1.7	1.1	1.7	1.1	1.7	1.8	1.6	1.3	2.5	1.7
JOR	Av	3,179.1	1,396.1	37.9	2,250.3	427.7	71.0	67.6	31.9	31.6	64.8	131.1
	SD	6,828.2	3,020.6	67.9	4,810.3	967.2	115.4	169.2	64.8	69.7	123.8	303.2
	CV	2.2	2.2	1.8	2.1	2.3	1.6	2.5	2.0	2.2	1.9	2.3
KUW	Av	8,725.4	5,091.5	114.1	5,376.0	1,269.6	267.6	195.9	63.1	52.6	262.8	311.7
	SD	6,732.1	3,902.9	130.7	4,654.1	867.2	181.2	139.8	54.2	52.0	224.2	240.8
	CV	0.8	0.8	1.2	0.9	0.7	0.7	0.7	0.9	1.0	0.9	0.8
LEB	Av	1,888.5	378.8	47.2	1,524.9	144.8	2,192.6	74.7	13.9	10.4	17.5	85.3
	SD	2,911.2	550.0	75.2	2,414.5	250.9	13,176.8	114.8	19.3	13.9	35.9	128.0
	CV	1.5	1.5	1.6	1.6	1.7	6.0	1.5	1.4	1.3	2.1	1.5
MOR	Av	8,932.3	3,893.5	212.8	6,729.3	708.5	160.3	96.2	89.8	76.5	91.1	262.6
	SD	5,023.8	2,433.7	129.7	4,394.5	631.5	211.4	56.8	55.7	47.4	156.6	155.8
	CV	0.6	0.6	0.6	0.7	0.9	1.3	0.6	0.6	0.6	1.7	0.6
OMA	Av	1,687.6	1,236.5	13.1	1,164.2	261.4	85.3	30.6	21.8	15.8	40.0	68.3
	SD	1,604.2	1,160.1	9.3	1,084.3	231.5	79.6	31.0	20.8	14.9	38.0	66.2
	CV	1.0	0.9	0.7	0.9	0.9	0.9	1.0	1.0	0.9	1.0	1.0
QAT	Av	5,401.8	3,176.6	5,090.0	56.7	181.7	85.1	225.5	116.0	37.8	182.2	379.3
	SD	5,059.8	3,278.3	4,688.7	49.3	161.8	67.0	223.2	100.0	39.0	162.5	355.7
	CV	0.9	1.0	0.9	0.9	0.9	0.8	1.0	0.9	1.0	0.9	0.9
SAU	Av	16,517.7	10,243.6	171.2	11,942.1	2,167.4	314.2	265.3	142.2	111.0	605.6	518.4
	SD	11,246.7	7,224.1	130.7	8,588.8	1,525.5	268.5	166.8	100.4	81.1	489.2	320.8
	CV	0.7	0.7	0.8	0.7	0.7	0.9	0.6	0.7	0.7	0.8	0.6
TUN	Av	1,100.8	811.5	22.7	703.2	151.4	125.7	28.2	17.4	11.8	7.3	57.5
	SD	1,151.1	859.1	27.4	814.5	150.3	175.7	33.3	20.3	14.1	9.8	66.6
	CV	1.1	1.1	1.2	1.2	1.0	1.4	1.2	1.2	1.2	1.3	1.2
TUR	Av	10,471.4	4,858.4	240.4	6,053.2	1,225.5	217.3	626.6	147.9	203.1	231.6	977.5
	SD	14,995.2	6,552.9	461.2	8,264.7	1,854.1	342.3	856.6	187.7	284.8	347.7	1,298.0
	CV	1.4	1.4	1.9	1.4	1.5	1.6	1.4	1.3	1.4	1.5	1.3
UAE	Av	5,679.0	3,559.0	40.4	3,867.9	870.7	98.1	133.7	40.0	25.3	192.0	199.0
	SD	6,403.9	4,136.4	38.9	4,462.4	788.7	86.6	160.7	38.5	25.4	209.9	216.1
	CV	1.1	1.2	1.0	1.2	0.9	0.9	1.2	1.0	1.0	1.1	1.1

Notes: BAH: Bahrain, EGY: Egypt, JOR: Jordan, KUW: Kuwait, LEB: Lebanon, MOR: Morocco, OMA: Oman, QAT: Qatar, SAU: Saudi Arabia, TUN: Tunisia, TUR: Turkey, and UAE: United Arab Emirates.

Table 2: Descriptive statistics of the sample – 2011 (figures in $ millions)

		Total Assets	Total Loans	Fixed Asset	Total Deposits	Total Equity	Loans Losses Reserves	Interest Expense	Personnel Expenses	Other Operating Expenses	Net Income	Total Cost
BAH	Av	10,989.5	5,548.4	87.5	6,190.3	1,371.8	280.5	167.1	84.6	49.8	119.5	301.5
	SD	10,982.1	5,951.5	112.3	6,063.8	1,440.8	265.2	221.2	95.6	49.3	122.8	361.3
	CV	1.1	1.0	1.2	1.0	1.0	1.4	1.2	1.0	1.0	0.9	1.1
EGY	Av	7,050.0	2,717.1	49.2	5,800.3	508.2	256.1	312.4	52.8	59.0	61.4	424.2
	SD	11,373.4	3,562.2	51.3	9,822.2	508.3	385.9	615.3	87.8	89.2	103.5	759.8
	CV	1.7	1.7	1.1	1.7	1.1	1.7	1.8	1.6	1.3	2.5	1.7
JOR	Av	5,593.1	2,677.9	80.9	3,897.8	859.1	160.2	86.3	52.4	45.4	49.9	184.1
	SD	11,332.3	5,522.9	129.8	7,898.6	1,913.9	340.8	163.7	97.0	80.0	79.1	340.3
	CV	2.2	2.2	1.8	2.1	2.3	1.6	2.5	2.0	2.2	1.9	2.3
KUW	Av	19,322.3	12,170.9	491.1	11,588.7	2,669.1	655.8	227.8	144.4	143.9	209.7	516.1
	SD	18,690.1	11,178.1	933.6	10,989.8	2,735.3	644.9	238.8	155.7	218.4	360.5	606.3
	CV	0.8	0.8	1.2	0.9	0.7	0.7	0.7	0.9	1.0	0.9	0.8
LEB	Av	4,307.4	1,243.4	52.0	3,572.4	359.6	8.5	135.4	33.8	22.6	55.7	158.5
	SD	6,709.4	1,920.7	81.5	5,690.8	573.4	15.2	209.0	54.0	35.3	103.8	243.8
	CV	1.5	1.5	1.6	1.6	1.7	6.0	1.5	1.4	1.3	2.1	1.5
MOR	Av	17,523.1	12,443.4	369.9	12,059.8	1,522.9	434.5	295.9	206.1	155.5	198.8	657.4
	SD	11,805.2	8,081.1	249.8	8,266.7	1,218.0	303.2	200.2	150.2	113.3	187.0	461.6
	CV	0.6	0.6	0.6	0.7	0.9	1.3	0.6	0.6	0.6	1.7	0.6
OMA	Av	5,294.8	3,826.8	57.9	3,777.3	682.5	135.5	61.2	53.6	39.6	78.7	154.4
	SD	5,701.3	3,933.0	58.7	3,703.4	654.9	145.6	61.7	50.9	43.5	94.3	153.8
	CV	1.0	0.9	0.7	0.9	0.9	0.9	1.0	1.0	0.9	1.0	1.0
QAT	Av	25,870.2	16,463.4	24,534.7	176.8	642.5	237.5	961.5	228.9	108.2	640.4	1,298.7
	SD	32,435.9	21,241.9	30,961.3	120.4	816.4	232.8	1,138.8	223.2	78.0	822.0	1,432.3
	CV	0.9	1.0	0.9	0.9	0.9	0.8	1.0	0.9	1.0	0.9	0.9
SAU	Av	32,809.3	19,089.6	300.1	25,101.6	4,623.3	598.2	115.5	258.0	202.4	697.4	576.0
	SD	23,966.1	13,020.3	273.4	18,910.7	3,196.8	412.0	111.4	187.5	168.5	630.1	448.8
	CV	0.7	0.7	0.8	0.7	0.7	0.9	0.6	0.7	0.7	0.8	0.6
TUN	Av	1,892.6	1,408.4	36.5	1,231.4	231.0	270.0	40.6	27.5	15.5	5.0	83.6
	SD	1,851.8	1,442.7	47.6	1,315.4	278.9	364.6	45.2	29.9	17.1	4.3	88.3
	CV	1.1	1.1	1.2	1.2	1.0	1.4	1.2	1.2	1.2	1.3	1.2
TUR	Av	22,324.3	13,696.5	208.8	12,799.0	2,521.2	442.9	881.1	258.5	312.2	382.1	1,451.8
	SD	29,742.4	17,499.9	299.8	16,095.8	3,361.0	546.5	1,125.7	304.7	382.1	546.7	1,799.3
	CV	1.4	1.4	1.9	1.4	1.5	1.6	1.4	1.3	1.4	1.5	1.3
UAE	Av	16,605.5	11,077.5	161.9	10,644.1	2,327.4	477.5	230.2	131.5	91.2	277.5	453.0

	SD	19,531.9	13,004.8	152.3	11,989.5	2,316.1	483.8	239.0	127.3	90.0	337.9	435.6
	CV	1.1	1.2	1.0	1.2	0.9	0.9	1.2	1.0	1.0	1.1	1.1

Notes: BAH: Bahrain, EGY: Egypt, JOR: Jordan, KUW: Kuwait, LEB: Lebanon, MOR: Morocco, OMA: Oman, QAT: Qatar, SAU: Saudi Arabia, TUN: Tunisia, TUR: Turkey, and UAE: United Arab Emirates.

5. Empirical Results

The final form of the cost function is constructed by introducing the variables defined above in the cost frontier represented by the flexible translog form. The maximum likelihood method is used to estimate the parameters of the cost function. Knowing the values of the parameters and their standard deviations is crucial, since testing their significance allows concluding, firstly, if they influence the variability of the banking cost, and secondly, these parameters allow calculating the efficiency scores for each bank and for each country. Finally, we estimate two specifications of the cost frontier by the maximum likelihood method with $\bar{u}_i = \partial_0 + Z\partial$.

5.1 Degree of Cost Efficiency of MENA Banks

Table (3) presents the estimated coefficients. The estimation procedure is done in three main steps (Battese and Coelli, 1992, 1995). We first estimate the cost function by the ordinary least squares method to obtain starting values for the coefficients of the variables and the estimated value of σ_v^2. These estimations[2] are then used in a second stage where the likelihood is evaluated for values for γ between zero and one. The value of the highest likelihood obtained is used to calculate the new parameters and σ_v^2. These latter serves finally as starting values for the iterative procedure that will produce the maximum likelihood estimations.

Table3: Results of the estimation of the stochastic cost function

Variables (outputs, Inputs)	Coefficient	Standard-error	*t*-ratio
C	9.908	0.563	17.61
LnY_1	-0.013	0.055	-0.24
LnY_2	0.290	0.035	8.39
LnY_3	-0.467	0.076	-6.14
LnY_1LnY_1	-0.019	0.007	-2.59
LnY_1LnY_2	0.029	0.012	2.39
LnY_1LnY_3	0.073	0.010	7.18
LnY_2LnY_2	0.016	0.007	2.43
LnY_2LnY_3	-0.053	0.008	-6.77
LnY_3LnY_3	-0.006	0.004	-1.77
Lnw_1	-0.499	0.067	-7.40
Lnw_2	1.082	0.072	14.98
Lnw_1Lnw_1	0.023	0.003	7.64
Lnw_1Lnw_2	-0.062	0.007	-9.36
Lnw_2Lnw_2	0.036	0.005	7.64
LnY_1Lnw_1	0.004	0.008	0.48
LnY_1Lnw_2	-0.002	0.005	-0.41
LnY_2Lnw_1	0.052	0.007	7.39
LnY_2Lnw_2	-0.020	0.007	-2.72
LnY_3Lnw_1	0.037	0.004	10.05

[2] The constant and variance being biased, are corrected by the adjusted least squares method (see Coelli (1995)).

LnY_3Lnw_2	-0.057	0.007	-7.70
Specific and environmental variables	Coefficient	Standard-error	t-ratio
C	1.846	0.103	17.92
CPI	0.144	0.023	6.37
INF	0.035	0.018	1.92
GGDP	-0.059	0.011	-5.36
NER	-0.001	0.001	-2.36
TDEP	0.376	0.055	6.84
GRR	0.090	0.038	2.36
CAP	1.430	0.080	17.88
MAN	1.010	0.142	7.09
ROA	-1.672	0.605	-2.77
LIQ	0.003	0.005	0.66
Sigma-squared	***0.171***	***0.007***	***25.52***
Gamma	***0.069***	***0.010***	***6.60***

The gamma value (γ) is significant at 1% with a value of 0.069. This means that the inefficiency plays an important role in explaining the distance from the cost frontier. Nevertheless, the role of random factors is equally important. We note that the model used is valid only if the parameter γ associated with the (in)efficiency and the coefficients δ of the endogenous variables that influence bank efficiency, are all statistically different from zero. We test the null hypothesis $H_0: \gamma = \delta_0 = \delta_1 = \cdots = \delta_{10} = 0$ against the alternative hypothesis that the coefficients are different from zero, except for γ that has to be positive. The likelihood ratio λ used in the test, follows a chi-square with a degree of freedom r (the number of restrictions imposed in H_0, i.e. r = 12). This λ is equal to 340.108 and higher than the critical value at 5%. Thus, H_0 is rejected.

The cost efficiency scores are shown in Table (4). These results show that the efficiency scores are on average equal to 81% for the entire sample. It can be concluded that – on average – the banks in operating the MENA region between 2005 and 2011 could save an average of 19% of their physical or financial resources and produce the same levels of outputs. In other words, banking costs could be reduced by an average of 19%, if banks had adopted the best practices observed in the sample.

Table 4: Efficiency scores of MENA banking sectors (2005-2011)

	MEAN	**MAX**	**MIN**	**SD**	**CV**
BAH	0.94	1.00	0.67	0.075	0.080
JOR	0.93	0.99	0.84	0.028	0.030
KUW	0.87	0.98	0.70	0.063	0.073
LEB	0.80	1.00	0.49	0.126	0.160
MOR	0.65	0.74	0.57	0.042	0.065
EGY	0.55	0.97	0.32	0.119	0.215
OMA	0.95	1.00	0.88	0.027	0.028
QAT	0.91	0.96	0.79	0.045	0.049
SAU	0.84	0.98	0.70	0.066	0.078
TUN	0.91	1.00	0.78	0.046	0.051
TUR	0.70	0.98	0.48	0.106	0.150
UAE	0.97	0.99	0.92	0.010	0.010
The whole sample	**0.81**	**1.00**	**0.32**	**0.157**	**0.194**

We observe that some countries have higher performance than others: United Arab Emirates, Oman, Bahrain, Jordan, Qatar and Tunisia have recorded efficiency scores above 90%. Other countries such as Kuwait, Saudi Arabia, and Lebanon have cost efficiency scores that range between 80% and 87%. The other countries, namely Turkey, Egypt and Morocco have cost efficiency scores below 70%.

Several factors could explain this level of cost inefficiency: 1) the technology and quality of inputs, 2) the scale of production or the productive dimension of the bank, 3) the allocation of resources, 4) the differentiation and product heterogeneity, and 5) the quality of bank management (X-efficiency). These factors combine together to reveal two types of inefficiency that can cause the observed cost inefficiency of banks in the MENA region: (1) technical inefficiencies and (2) allocative inefficiencies. Technical inefficiencies correspond to the differences between actual levels of products and inputs and their efficient levels. In other words, banks, that are technically inefficient, produce too much or too little of a given product, or they use too much or too little of a given factor of production, even if they set prices correctly. Therefore, technical inefficiencies results from a poor control of prices of production factors, an inadequate organization, or an inability to achieve objectives. As for allocative inefficiencies, they result from sub-optimal production decisions because they are taken on the basis of incorrect estimation of relative prices of outputs or inputs. These two types of inefficiency result in increased costs incurred by the bank and thus, an increase in its X-inefficiency.

Regarding the dispersion of efficiency scores, the results in Table (4) show a significant difference of efficiency of 70% between the most and the least efficient banks in the sample. This result means that the banks are widely dispersed in terms of productive performance. In addition, the results show that on average: (1) the dispersion of cost efficiency measured by the coefficient of variation is large and around 19%, (2) the dispersion decreases with an increasing level of efficiency. Countries with higher level of cost efficiency are those characterized by a low coefficient of variation. The dispersion of cost efficiency is contained in a very small interval [1%, 5%] for countries whose degree of cost efficiently is greater than 90%. For Kuwait, Saudi Arabia and Lebanon that recorded cost efficiency scores between 90% and 80%, their dispersion is contained in the [7%, 16%] interval. Finally, Turkey, Morocco and Egypt, which record the lowest cost efficiency, are characterized by a wide dispersion of their efficiency score [6%, 21%].

Regarding the evolution of cost efficiency, the results in Table (5) show a mixed trend of cost efficiency during the period under study. In fact, Bahrain, Jordan and Tunisia have witnessed a decrease in efficiency scores between 2005 and 2011. Other countries, such as Morocco, Turkey, Saudi Arabia and Qatar have experienced an increase in cost efficiency. Whereas Lebanon, Kuwait, Egypt and the United Arab Emirates have experienced a stable level of cost efficiency.

Table 5: Evolution of the cost efficiency over the period 2005-2011

Countries	Year	MEAN	MAX	MIN	SD	CV
BAH	2005	0.98	1	0.96	0.011	0.011
	2006	0.97	1	0.96	0.011	0.011
	2007	0.96	1	0.95	0.017	0.017
	2008	0.97	0.98	0.96	0.006	0.006
	2009	0.96	0.97	0.95	0.007	0.008
	2010	0.95	0.97	0.92	0.016	0.016
	2011	0.78	0.93	0.67	0.092	0.118
JOR	2005	0.96	0.99	0.94	0.010	0.011
	2006	0.95	0.98	0.93	0.015	0.016
	2007	0.93	0.98	0.90	0.020	0.022
	2008	0.95	0.98	0.93	0.013	0.014
	2009	0.92	0.99	0.90	0.023	0.024
	2010	0.91	0.98	0.88	0.027	0.030
	2011	0.90	0.97	0.84	0.031	0.034
KUW	2005	0.86	0.98	0.81	0.053	0.061
	2006	0.86	0.98	0.78	0.056	0.065
	2007	0.86	0.98	0.79	0.062	0.072
	2008	0.84	0.97	0.76	0.067	0.080

	2009	0.93	0.98	0.88	0.031	0.033
	2010	0.88	0.98	0.77	0.058	0.066
	2011	0.86	0.97	0.70	0.079	0.092
LEB	2005	0.80	0.98	0.80	0.082	0.103
	2006	0.66	0.96	0.66	0.095	0.144
	2007	0.68	0.97	0.68	0.100	0.147
	2008	0.77	1	0.77	0.095	0.124
	2009	0.82	0.97	0.82	0.073	0.090
	2010	0.97	0.99	0.97	0.009	0.009
	2011	0.81	0.99	0.81	0.080	0.099
MOR	2005	0.62	0.64	0.57	0.026	0.041
	2006	0.62	0.64	0.57	0.026	0.042
	2007	0.66	0.69	0.57	0.037	0.056
	2008	0.68	0.72	0.61	0.035	0.052
	2009	0.63	0.67	0.58	0.027	0.043
	2010	0.68	0.71	0.63	0.023	0.034
	2011	0.70	0.74	0.66	0.027	0.039
EGY	2005	0.57	0.97	0.36	0.137	0.241
	2006	0.56	0.83	0.36	0.116	0.207
	2007	0.53	0.88	0.32	0.122	0.229
	2008	0.53	0.825	0.36	0.114	0.216
	2009	0.54	0.81	0.33	0.116	0.216
	2010	0.59	0.85	0.34	0.103	0.175
	2011	0.57	0.86	0.32	0.125	0.219
OMA	2005	0.967	1	0.95	0.015	0.016
	2006	0.942	1	0.912	0.025	0.027
	2007	0.927	1	0.876	0.037	0.04
	2008	0.957	1	0.944	0.018	0.019
	2009	0.956	1	0.939	0.019	0.02
	2010	0.95	1	0.932	0.022	0.023
	2011	0.934	1	0.909	0.029	0.031
QAT	2005	0.89	0.94	0.81	0.050	0.057
	2006	0.87	0.93	0.79	0.059	0.069
	2007	0.89	0.93	0.82	0.043	0.048
	2008	0.93	0.94	0.90	0.018	0.019
	2009	0.95	0.96	0.92	0.018	0.019
	2010	0.94	0.96	0.91	0.019	0.020
	2011	0.92	0.96	0.89	0.026	0.028
SAU	2005	0.78	0.91	0.70	0.062	0.079
	2006	0.79	0.90	0.73	0.052	0.066
	2007	0.81	0.94	0.74	0.055	0.067
	2008	0.83	0.94	0.72	0.057	0.069
	2009	0.88	0.97	0.82	0.035	0.040
	2010	0.90	0.98	0.85	0.029	0.032
	2011	0.90	0.98	0.85	0.031	0.035
TUN	2005	0.93	1.00	0.83	0.039	0.042
	2006	0.92	0.99	0.84	0.045	0.049
	2007	0.90	0.98	0.78	0.055	0.061
	2008	0.92	0.98	0.80	0.043	0.046
	2009	0.89	0.97	0.79	0.052	0.058
	2010	0.92	0.96	0.80	0.041	0.045
	2011	0.91	0.95	0.82	0.039	0.043

TUR	2005	0.62	0.922	0.51	0.093	0.150
	2006	0.65	0.95	0.49	0.098	0.150
	2007	0.70	0.91	0.58	0.085	0.120
	2008	0.76	0.96	0.63	0.093	0.122
	2009	0.74	0.98	0.53	0.106	0.143
	2010	0.73	0.98	0.48	0.107	0.146
	2011	0.72	0.98	0.62	0.089	0.123
UAE	2005	0.97	0.99	0.95	0.011	0.012
	2006	0.97	0.98	0.92	0.015	0.016
	2007	0.97	0.99	0.95	0.010	0.010
	2008	0.97	0.98	0.96	0.007	0.007
	2009	0.98	0.98	0.97	0.005	0.005
	2010	0.98	0.98	0.96	0.006	0.006
	2011	0.98	0.99	0.97	0.005	0.006

5.2 Explanatory factors of cost efficiency of MENA banks

Following Battese and Coelli (1995), we introduce directly into the stochastic cost function a vector of bank specific variables and economic environment variables to test their impact on productive performance. Table (6) shows the results of regression performed using the parametric approach.

Table 6: Results of the regression of the efficiency scores on the variables pertaining to the management strategy and the economic environment

	Coefficient	**Standard-error**	***t*-ratio**
C	1.846	0.103	17.92*
CPI	0.144	0.023	6.37*
INF	0.035	0.018	1.92**
GGDP	-0.059	0.011	-5.36*
NER	-0.001	0.001	-2.36**
TDEP	0.376	0.055	6.84*
GRR	0.090	0.038	2.36**
CAP	1.430	0.080	17.88*
MAN	1.010	0.142	7.09*
ROA	-1.672	0.605	-2.77*
LIQ	0.003	0.005	0.66

Notes: Total number of observations – 1393, number of banks = 91. * and ** statistically significant at the 1% and 5% respectively.

Table (6) shows that most of the variables have the expected sign except *GGDP* and *ROA*. The results show that the corruption indicator positively affects the bank efficiency at the 1% level. Thus, any increase in the corruption perception index (i.e., less corruption) results in an improvement in bank efficiency. This result is consistent with those of La Porta et al. (1997, 1998) which show that a legal system characterized by well-functioning financial institutions protects banks and guarantees the contracts and therefore, allows banks to increase their efficiency. In fact, corruption is a feature of a failed legal and institutional system, which increases uncertainty and the inability of banks to recover loans in case of loan defaults. This could result in an increase in provisions for doubtful loans and consequently, an increase in bank costs.

Our results reveal a positive link between inflation and bank efficiency and statistically significant at the 5% level, which suggests that inflation improves the efficiency of banks. While inflationary pressures results in an overvaluation of bank charges, higher lending rates allows banks to increase the pool of loans, income, profits and productive efficiency.
The relationship between economic growth rate and efficiency is negative, which could be explained by the fact that the instability of economic growth (often accompanied by a decline in the demand for financial services and an increase in loan defaults) negatively affects the productive performance of banks. Another possible explanation is that during periods of economic expansion, banks try to increase the quality of services offered to customers, to innovate, and to adopt more expensive production techniques. All that could result in a reduction in their productive efficiency.

The link between exchange rate and efficiency is negative and statistically significant at the 5% level. This result shows that unfavorable change in exchange rates could result in revenue volatility, an increase in provisions for loan losses, an increase in costs, and thus a deterioration of bank efficiency. The relationship between efficiency and the degree of dependence on foreign trade is positive and statistically different from zero at the 1% level. This result could be explained by the fact that the openness of the national economy may be accompanied by an improved business productivity and an increase in loans granted by banks. The improvement of the productivity and profits of companies results in a decrease in the probability of default and lower provisions for bad debts, a reduction in costs, and therefore improved efficiency.

The results show a positive and significant at the 1% level between the size of government and banking efficiency. The increase in the size of government may have positive impact on the banking sector especially when public spending is rationalized and channeled to productive public investment projects (infrastructure, education, hospitals, etc...). Regarding the link between capitalization ratio and efficiency, our results show a positive and statistically significant relationship at 1% level. Thus, higher capitalization is associated with better managerial efficiency and vice versa. Another possible explanation is that capital constraint affects the perception of risk by bank managers which may lead to a more conservative behavior and the requirement of higher risk premiums. This result was confirmed by other studies such as Kwan and Eisenbeis (1997), Stavarek (2004), and Isik and Hassan (2003).

The quality of management has a positive and significant impact on bank efficiency at the 1% level. This positive link between MAN and efficiency indicates that banks transfer part of their expenses to borrowers and depositors allowing them to reduce their total cost and improve their efficiency. Another possible explanation is that the increase in staff costs as a percentage of operating costs could result in an increase in productivity and therefore the productive performance of banks. The relationship between bank profitability and productive efficiency is negative and statistically significant at 1%. Two hypotheses can be advanced to explain this result. The first is the X-inefficiency hypothesis (Leibenstein, 1970), inspired by the managerial theory. Under this assumption, the inefficiency reveals organizational problems. Thus, the problems of organization suggests that some banks, though well positioned in their markets (with good profitability for example) solve the problems of reorganization of the banking industry less than others in periods of innovation and restructuring. In addition, banks with high level of profit or market power would not have more incentive than others to make efforts to improve productivity and control costs. The second hypothesis is inspired by the theory of imperfect competition. Particularly, if competition is important, well positioned banks in terms of cost, can choose a business policy (probably aggressive) which does not allow them to be successful in terms of profitability. In other words, some banks that make efforts in productivity choose their input efficiently, and have more control over their costs, seem to have difficulties to increase their margins because they face competitive conditions and do not have market power that allows realizing significant profits.

Finally, liquidity does not appear to be a determinant of bank efficiency since our results indicate an insignificant link between liquidity and bank efficiency.

6. Conclusion

This study tried to model the behavior of banks operating in the MENA region using a stochastic cost function with undesirable output. This methodology integrates risk in the bank production function and thus, studies the efficiency of banks taking into account their preferences for risk, the impact of capital regulation and some other specific and environmental variables. The results reveal inefficiency, on average of about 20% for banks in the sample. The misuse of inputs generates an average increase of banking costs by 20%. The results show that this inefficiency is not only due to the misallocation of resources, but also to several internal and external factors, such as economic growth, inflation rate, trade openness, corruption, and capital requirements.

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