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The Determinants of Cost Efficiency of Islamic Banks using SFA Approach

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Abstract

This study aims to analyze empirically the determinants of the cost efficiency of Islamic banks by econometric modeling using panel data over the period 2005-2014. The sample is composed of 37 Islamic banks. To achieve this, we have used an extension of the stochastic boundary approach called "SFA". We compare efficiency between Islamic banks during our study period. In addition, we examine bank-specific variables and external variables that can explain sources of inefficiency and these reduce the cost efficiency scores over a given number of variables. The results show that only the annual inflation rate, the rate of return on assets and population density have a positive effect on cost efficiency. In addition, GDP per capita has a negative impact on cost efficiency, with a positive relationship between credit risk and cost efficiency. While, there is a significant negative relationship between the size of Islamic banks and its cost efficiency. Similarly, the operating cost ratio has a positive effect on cost efficiency. Finally, the equity ratio does not affect cost efficiency.

Keywords: Islamic banks, SFA, Cost effeciency, Determinants of cost efficiency.
JEL Classification:

1. Introduction

Islamic finance has been considered a controversial issue that has attracted many researchers so far. Over the past two decades, particular attention has been given to the Islamic banking system, both on a private and public level ; and thus, a deep and flared desire to understand this system emerged in almost every region of the world.

The Islamic banks had to improve their efficiency and develop their performances to maintain the durability. Thus, the estimate of efficiency became at the same time complex and obligatory, demanding more flexible alternative forms, flexible analysis of efficiency and techniques of more quantitative research.

In this study, we are going to examine the determinants of cost efficiency. Our study differs from other ones in several points. First, we are going to use a large number of Islamic banks (37 banks). We are also going to cover a wide range of countries (15 countries) and extend our study to cover a longer period from 2005 to 2014. In addition, we have compared the cost efficiency scores by country and by bank. These scores attempt to identify the possible factors to explain the observed differences in cost efficiency between the banks.

Literature on the calculation of the efficiency measures began with Debreu (1951) and Farrell (1957). In 1951 Debreu determined that the efficiency of the firm can be empirically measured by introducing the resource utilization coefficient, which mainly focused on output-input ratio measures. In 1957, Farrell established that the efficiency of the firm can be empirically calculated by proposing a method for estimating the efficiency frontier.

In the theoretical studies on the banking efficiency, several methods have been adopted. However, it is necessary to estimate the determinants of efficiency of the banks to specify a functional form which at the same time makes it possible to describe the production process and to take account of all the variables which can influence this process. This explains the adoption of SFA in our measurement of the efficiency of the Islamic banks. The residue, which is not explained by the model, is regarded as inefficiency (Mghaieth & Khanchel, 2015).

The rest of the article is structured as follows : Section 2 draft the review of the literature. Methodology is displayed in section 3, while section 4 shows and discusses the empirical results. Lastly, the conclusion of the study.

2. Littérature Review

2.1 Measuring the Cost-Effeciency of Islamic Banks

To measure the cost effectiency of our Islamic banks we will use the total cost. This variable is considered by Haron & Tahir (2010) as the measure of the efficiency of a bank. It has been used by many others, such as Baten & Begum (2014) and Mghaieth & Khanchel (2015). According to Bashir (2001), the assessment of efficiency and its determinants are essentially important because of the rapidly growing environment in the developmentof the economic structure of today. Therefore, it is necessary to determine which of the many potential determinants of emerging efficiency is the most important.

Hassan (2003) tested the relative efficiency of Islamic banks in Iran, Pakistan and Sudan during 1994-2001. He found that the average cost efficiency (stochastic cost frontier) is 52% during the study period. Mokhtar, Abdullah, & Al-Habshi (2006) found in their study that the technical efficiency and the average cost for the Islamic bank are respectively 80.1% and 86.0%. Haron, I Tahir (2010) measures the cost efficiency of Islamic banks in Africa, Europe, the Far East and Central Asia and the Middle East between 2003-2008, and found that it equals 43.6%. however, Rahman & Islam (2011) examined the cost efficiency of Islamic banks in Bangladesh during 2003-2007 and they estimated that it varied from 82% to 84%. A recent study by Baten, A Begum (2014) examined the relative efficiency of the Islamic banking industry in Bangladesh between 2001-2010 to find that the average cost-effectiveness was 43.9%.

Hence, the cost-efficiency of Islamic banks can be influenced by some internal and external factors on which we will concentrate in our study. To do so, our research is articulated on the following question : which are the principal determinants of the cost-efficiency of Islamic banks?

2.2 Determinants of Efficiency

Most of the earlier studies have shown that the principal determinants of the efficiency of Islamic banks have internal and external factors :

GDP per Capita

According to Bashir (2003): the higher GDP per capita has a positive impact on the bank's cost-efficiency. According to the study by Srairi (2010), the level of economic development measured by GDP per capita is significant and positively related to cost-efficiency. According to Ftiti, Nafti, & Sreiri (2013) GDP per capita is significant at 10% and it has a positive effect on cost efficiency.

The Average Annual Inflation Rate

Hassan & Bashir (2003) affirm that the rate of inflation does not seem to have a significant impact on the cost efficiency of a bank. Because of the inflation which was largely moderate in the countries of their sample between 2004-2010, Mghaieth & Khanchel (2015) found that the inflation rate is not associated with cost efficiency.

Population Density

According to Kablan & Yousfi (2013), the provision of banking services may be affected by population density. They estimate that, in countries where this variable is low, banking costs are higher and banks are not encouraged to increase their efficiency. So the relationship, according to these authors, is positive.

Size

Consistent with the Bashir (1999) studies, this variable is measured using the natural logarithm of the total asset as a proxy.

Haron (1996) concluded that the size of the bank is not necessary to increase its efficiency. A study by Pratomo & Ismail (2006) used data from five Islamic banks in Malaysia from 1997 to 2004 and argues that the size of the bank is negatively correlated with its cost-efficiency. Wasiuzzaman & Tarmizi (2010) found the relationship is insignificant and the size is not important to affect the cost-efficiency of banks. The results of Mghaieth & El Mehdi (2014) affirm that banks with higher total assets are the most efficient ones (positive relationship between size and efficiency).

The Ratio of Equity to Total Asset

Hussein (2003) studied the cost frontier of a sample of 17 Islamic banks in Sudan between 1990 and 2000 using the stochastic approach. As a result, he found a positive relationship between the ratio (FP / TA) and the cost effectiency.

According to Mghaieth & Khanchel (2015), the ratio of equity to total assets has a non-significant impact on cost-efficiency (not a determining factor). Their results quadrate with those of Bashir (1999) for the samples of Islamic banks.

Profitability (ROAA)

According to Hassan (2006), the ROAA ratio is strongly correlated with the bank's cost efficiency. According to Ftiti, Nafti, & Sreiri (2013), the ROAA ratio is significant at 10% and has a positive effect on cost efficiency.

Credit Risk

According to the study of Srairi (2010)), there is a significant positive relationship between credit risk and cost efficiency. A recent study by Mghaieth & Khanchel (2015) shows that the coefficient measuring the credit risk is insignificant for cost-efficiency.

Operational Costs

The study of Khediri & Khedhiri (2009) on the effect of the factors contributing to the cost efficiency of Islamic banks in Africa during the period 1999-2009 shows that there is a negative relationship between bank operating costs and cost efficiency. Unlike the conclusion of Srairi (2010) who noted the existence of a negative relationship between this factor and cost efficiency, Mghaieth & Khanchel

(2015) concluded that operating costs are positively correlated and statistically significant for cost effeciency.

3. Methodology

3.1 Efficiency Scores

The initial specification of the SFA has been to a specific stochastic frontier function for transversal data. For our sample, the cost frontier is as follows:

$$TC_{ijt} = f(P_{ijt,} Y_{ijt,} E_{ijt,}) + \varepsilon_{ijt} \quad (1)$$

Where TC : total cost, P : vector of outputs, Y: price vector of inputs², E : vector of country-specific variables, $\varepsilon_{ijt} = V_{ijt} + U_{ijt}$: terms of inefficiencies corresponding to random fluctuations.
With V_{ijt} iid ~ N (0, σ_V^2) : indicates the error term. Uijt ~ 1/2 N (u, σ_u^2) the half normal distribution that captures the effects of the inefficiency which expresses the inefficiency factor which can increase the minimum cost. It should be emphasized that f () takes several functional forms such as Translog, CES, Cobb-Douglas, and so on. The parameterization of Battese & Corra (1977) makes it possible to replace σ_u^2 and σ_V^2 by : $\sigma^2 = \sigma_u^2 + \sigma_V^2$ and $\gamma = \sigma_u^2 / \sigma^2$ such that $0 < \gamma < 1$. The individual scores of efficiency-cost of the banks are calculated starting from the frontier estimated as follows: The score of cost efficiency : CostEFF = exp (U), with this approach, the scores of efficiency-costs calculated for each bank takes a value between one and the infinite one. In order to make our results comparable, we calculate the level of cost effectiency as follows : CostEFF = 1 / CEF; i.e. the efficiency-cost is measured by its inverse, which varies between zero and the unit. Thus, our scores of efficiency cost will be between 0 and 1 with a level close to 1 indicating a high level of efficiency. We use a model with two stages of Battese & Coelli (1992) applied to a translogaritmic function. For a sample of N banks, the frontiers of efficient costs are defined as follows: Ln CT_{it} = f (Y_{it}, P_{it}) + v_{it} + u_{it} with i= 1…N et t= 1…T.

Compared to the other functional forms, the function translog seems to us the most appropriate specification since it does not impose any restriction to the form of the cost function and allows to take into account the multiple complementarity links between the explanatory factors. We use the translog specification, our cost function for the model at (3 inputs and 2 outputs) takes the form of this equation:

$$\ln TC_{ijt} = \alpha_0 + \sum_{m=1}^{m} \alpha_m \ln P_{mit} + \sum_{s=1}^{s} \beta_s \ln Y_{sit} + 1/2 \sum_{m=1}^{m} \sum_{n=1}^{n} \alpha_{m,n} \ln P_{mit} * \ln P_{nit} + 1/2 \sum_{s=1}^{s} \sum_{r=1}^{r} \beta_{s,r} \ln Y_{sit} * \ln Y_{rit} + \sum_{m=1}^{m} \sum_{s=1}^{s} \phi_{m,s} \ln P_{mit} * \ln Y_{sit} + \ln FP + \boldsymbol{\varepsilon}_{it} \quad (2)$$

With : i∈ (1→37): indicates the numbers of banks, t∈ (1→10): indicates the years of study (2005→2014), m ∈ (1→3) : indicates the total number of inputs, s ∈ (1→2) : indicates the total number of outputs, lnTC : normal log of total costs, lnPm: normal log of the inputs price, lnYs : normal log of the outputs values, ln FP : normal log of equity, α, β and φ: parameters to be estimated and ε_{it}: term of error.

For this cost function, the error term $\varepsilon_{it} = v_{it} + u_{it}$ is composed of two elements. The first (u_{it} : asymmetric error term) represents the controllable factors and the second (v_{it} : the random error term) captures the uncontrollable effects (Aigner, Lovell, & Schmidt, 1977). We assume that v_{it} is identically and independently distributed according to the normal law N ($0,\sigma_V^2$) ; The non-negative effects of the inefficiencies that are supposed to be independently and identically distributed represent by the component u_{it}. Therefore, this component possesses a truncated normal distribution having an average μ and an unknown variance σ_μ^2 , N (μ, σ_μ^2).
Relying on (Berger & Mester, 1997), We incorporate the level of equity (FP)[1] as a quasi-fixed input to control for differences in the preferences in terms of catch in risk, which can occur because of the

[1] As suggested in (Mester, 1996) and consistent with (Berger & Mester, 1997), (Lozano-Vivas & Pasiouras, 2010) and (Rime & Stiroh, 2003)

financial distress, the regulation or of the asymmetry of information. (Berger & Mester, 1997) sustain that not taking into consideration the risk in estimating the scores of efficiency could produce a bias of scale. While efficiency could be badly measured because the efficient banks consider the good as well as the bad loans[2] in transforming the deposits into credit. In the case of three inputs and of two outputs, the trans log specification (14) comprises 25 parameters to be estimated. To reduce the number of these coefficients to be estimated and thus to gain in terms of degree of freedom, we will impose several restrictions. As Taktak (2010) quoted : So that the Hessian[3] of the cost function to be symmetric, equality $\frac{\partial^2 CT}{\partial xi\, \partial xj} = \frac{\partial^2 CT}{\partial xj\, \partial xi}$ must be checked for any pair of variables (x_i, x_j). The symmetry follows these restrictions :

$\beta_{jk} = \beta_{kj}$ et $\alpha_{hj} = \alpha_{jh}$ (Symmetry constraints).

On the other hand, any cost function must be homogeneous of degree one in input prices. So, a proportional increase in all prices generates an increase in the total cost in the same proportion without any effect on the demand of the factors of production.

This condition of homogeneity implies the following three constraints:

$$\begin{cases} \sum_k \alpha_k = 1 \quad \forall\, k \\ \sum_j \alpha_{hj} = 0\,; \quad \forall\, h \\ \sum_k \lambda_{jk} = 0 \quad \forall\, j \end{cases}$$

(Constraints of homogeneity)

These homogeneity constraints are imposed by standardizing the dependent variables and the input prices by the price of labor; That is to say, we will take in estimation;

$Ln\left(\frac{CT}{PL}\right)$;[4] $Ln\left(\frac{PK}{PL}\right)$ and $Ln\left(\frac{PF}{PL}\right)$ instead of $Ln(CT)$; Ln; $Ln(PK)$ and $Ln(PF)$[5].

This choice does not affect the results insofar as the estimates are obtained by the maximum likelihood method. The imposition of symmetry and homogeneity constraints makes it possible to compare the banks and also to substantially reduce the number of parameters to be estimated and thus to gain in terms of degrees of freedom. This one leads to a gain of 11 degrees of freedom (14 parameters of interest instead of 25).

The equation of our model is the following:

$$Eff = \delta_0 CGDP_{it} + \delta_2 INFR_{it} + \delta_3 DPOP_{it+} \delta_4 TAILLE_{it+} \delta_5 EQAS_{it+} \delta_6 ROAA_{it+} \delta_7 LOAS_{+} \delta_8 CTIR \quad (3)$$

Where Eff represents the cost efficiency score calculated from equation (2).

CGDP, INFR and DPOP are macroeconomic conditions.

SIZE and ROAA are two specific banking features.

EQAS, LOAS and CTIR are regulatory variables.

3.2 Hypothesis: Bank's Efficiency Determinant

After obtaining a measure of the cost efficiency of Islamic banks, we check the determining factors of the efficiency of the bank. For each determinant that we have, a hypothesis taking into account the results of previous studies.

After obtaining a measure of the cost efficiency of Islamic banks, we check the determining factors of the bank efficiency. For each determinant, we have a hypothesis taking into account the results of the previous studies.

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[2] (Berger & DeYoung, 1997) propose three relationships between loan quality and efficiency involving three different assumptions: bad luck and bad management and / or economic « behavior Behavior »

[3] A symmetric matrix

[4] La variable dépendante de la fonction de coût

[5] Lozano-Vivas & Pasiouras (2010) et Chaffai (1998)

H1 : There is a negative relationship between the GDP growth rate and the cost-efficiency.
H2 : The annual inflation rate has a positive effect on the cost efficiency of the Islamic banks.
H3 : Population density positively affects the cost effeciency of Islamic banks.
H4 : There is a significant negative relationship between the size of Islamic banks and its cost efficiency.
H5 : The capital adequacy ratio (EQAS) does not affect the cost efficiency.
H6 : The rate of return on assets (ROAA) has a positive impact on cost efficiency.
H7 : Credit risk (LOAS) is significant and negatively related to the cost efficiency
H8 : The operational cost (CTIR) is positively correlated and statistically significant at cost efficiency.

3.3 Data and Sample

We estimate the performance of Islamic banks using the analysis of efficiency scores. We use a sample of 37 Islamic banks. The data used in our sample comes from the BANKSCOPE database between 2005 and 2014. This sample is chosen according to well-known banks in the Islamic bank.

The table below represents the definition of our dependent and independent variables and their measurements :

Table 1. The matrix of variables

Types of variables	Notations	Definition
Dependent Variables	TC : Total cost	Personal expenses + Profit expenses + operating expenses
Inputs	L : labor F : funds K : Physical capital	Number of employees funds Net fixed assets (depreciation)
Price of inputs	PL : price of labor[6] PF : price of fund[7] PK : price of physical capital	Personal expenses /total asset Profit expenses[8] / total deposits Operating expenses / fixed assets
Outputs	Y_1 : Net loans Y_2: other earning assets	Net loans Investment Bond + bond + certificate of deposit
Explanatory Factors		
macroeconomic Variables	CGDP : GDP per capita INFR : annual average rate of inflation DPOP : population density	GDP/ total population (CPIt- CPIt-1)/ CPIt-1 Number of inhabitants / area in km^2
Determinants of efficiency	TAILLE : size EQAS : capital adequacy ROAA : profitability LOAS : credit risk CTIR : operational costs	Logarithm of total assets equity/ total assets Net Profit /average total assets Total Loans/ total assets Costs/ incomes

[6] Rather than using the number of employees we use total assets for lack of data. However, our approach is consistent with several previous studies such as Pasiouras, Tanna, & Zopounidis (2009), (Carvallo & Kasman, 2005) and (Maudos, Pastor, Pérez, & Quesada, 2002).
[7] The price of the fund is calculated by the total interest expense.
[8] Our sample only includes Islamic banks, so this ratio will be calculated by the profit charges on each bank to total deposit.

4. Empirical Analysis

4.1 Descriptive Statistics

4.1.1 Outputs and Input Prices

Table 2 shows that the total cost means decreased from 0.086 in 2005 to 0.074 in 2014. This can be explained by the good management costs in the Islamic banks (in our sample).

The average of other productive assets on the total assets (Y_2 / total assets) decreased from 0.355 in 2005 to 0.300 in 2014 with a standard deviation equal to 0.232 and a total average of 0.340. With regard to the prices of labor, no specific changes are observed except a continuous decrease. The average decline from 0.355 in 2005 to 0.300 in 2014 means that total assets are in continuous growth that may be due to the possession of a larger amount of liquidity or the increase in deposits collected by the bank. The price of physical capital has grown remarkably since its average has risen from 2.521915 in 2005 to 118.4792 in 2014. Throughout our study period, the average values of price of the funds are below the total average, except in 2010.

Table 2. Descriptive statistics of dependent variables, outputs and prices of cost function inputs per year

Dependent and independent variables		Years									
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
TC/TA	Mean	0.0859147	0.0837994	0.0804648	0.0702623	0.0713614	0.0691942	0.0674764	0.0737895	0.0718279	0.0742362
	Min	0.0195259	0.0173099	0.0263399	0.018104	0.0193114	0.017376	0.0169129	0.0154258	0.0157346	0.0159685
	Max	0.8060883	0.7941701	0.6327926	0.3972613	0.4520907	0.3031578	0.2993963	0.2846154	0.3167419	0.3570659
	Std.D	0.1371452	0.1292062	0.1050628	0.0779676	0.0861497	0.0678651	0.0653752	0.0725872	0.3167419	0.0825158
Y_1/TA	Mean	0.6383815	0.4674201	0.4525942	0.4801721	0.4795651	0.4762191	0.4425687	0.4768805	0.4813326	0.4789686
	Min	0.0019947	0.0191645	0.0003905	0.002186	0.0035048	0.0012441	0.0010552	0.0007447	0.0454825	0.0162832
	Max	6.465161	0.8708848	0.8174599	0.7254013	0.8276198	0.9305266	0.8548225	0.8218004	0.7908723	0.8589942
	Std.D	1.008921	0.2302463	0.2164723	0.2078452	0.2210813	0.2420303	0.2302852	0.2181328	0.2026746	0.2246055
Y_2/TA	Mean	0.3547867	0.3922558	0.3883492	0.3526711	0.3178223	0.3475631	0.3260911	0.3195278	0.298012	0.2997237
	Min	0.0312005	0.0485298	0.0635076	0.1021594	0.0018321	0.0544463	0.0544568	0.0666212	0.0125767	0.0286958
	Max	0.9154299	0.9271404	0.9890268	0.9448723	0.9273246	1.045439	0.9042561	0.909893	0.862076	.9192252
	Std.D	0.2351709	0.2473715	0.2280578	0.2280413	0.2290749	0.2463685	0.2201543	0.2141169	0.2304306	.2475486
PL	Mean	0.0153224	0.0141252	0.0141523	0.0121119	0.0113461	0.0117004	0.0118888	0.011328	0.0109903	0.0112577
	Min	0.0019282	0.0005637	0.0008936	0.0035984	0.0027851	0.0031066	0.0027682	0.0025458	0.0019942	0.0015590
	Max	0.1191432	0.0859189	0.1202149	0.041888	0.0463429	0.0566012	0.052381	0.0431931	0.0246854	0.0245392
	Std.D	0.0191371	0.0145789	0.0192074	0.0079107	0.0085819	0.0092681	0.0084978	0.006743	0.0046397	0.0053091
PK	Mean	2.521915	5.577598	5.960941	3.052909	3.022651	6.103428	10.36511	22.24039	6.964771	118.4792
	Min	0.0076707	0.0046973	0.0074074	0.0049581	0.0049001	0.0058384	0.006031	0.0073266	0.0069878	0.0067563
	Max	33	120	138	59	40.66667	146.9697	327.4783	733.4375	159.6939	4264.75
	Std.D	5.976703	20.20025	22.82405	9.661801	7.664209	24.44039	53.64328	120.2482	26.32413	700.606
PF	Mean	0.0781406	0.0767826	0.0993791	0.0671672	0.084333	0.7532978	0.0817423	0.0533994	0.1289717	0.077385
	Min	0.0016849	0.010073	0.0090331	0.0066272	0.0017315	0.0012359	0.0010614	0.0008638	.0009341	0.0014111
	Max	1.306921	1.040181	0.7365944	0.4237797	0.6607929	25.68421	0.955267	0.3397054	3.251111	1.354284
	Std.D	0.2125935	0.1698802	0.1605778	0.0981105	0.1560269	4.213506	0.173035	0.0706611	0.5297824	0.220386

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4.1.2 Descriptive Statistics of the Explanatory Variables of Efficiency

Tables 3 and 4 present the descriptive statistics of the explanatory variables.

Since macroeconomic variables have different units of measurement, there is a large difference in the descriptive statistical values of all these variables. First, per capita GDP (CGDP) has grown steadily over the period of our study. Forinstance in 2011, this variable (9100809 USD) is higher than the total average (7795008 USD). The growth of this ratio leads us to measure the economic performance of a country which is the improvement of the standard of living. As for the second macroeconomic variable, the inflation rates of the countries, the gap between the average rates in our sample is important, it varies greatly year-over-year. Thus, these rates have averages above the total one mainly in 2008-2011-2012-2013 and 2014. This variable influences the real economy in two specific fields : it affects the production and the economic efficiency. Finally, there is also a continuous and significant variation between the values of the population density. This ratio has increased from 190.22inhab/km^2 in 2005 to 277.11inhab/km^2 in 2014 and it has been above the total average since 2009 (242.54inhab/km^2). In addition to macroeconomic variables, there areother bank-specific factors such as :

- The size, on average, which follows a steadily increasing curve, begins with 6,634 in 2005 and reaches 7,741 in 2014 and since 2009, it has averages above the total one (7,389).
- The ratio of financial profitability (ROAA) : Table 4 shows that the return on assets (ROAA) varied between -26.057 and 21.385. The total average ROAA is 1.659 with a standard deviation of 3.062.

Among the variables related to structure and regulation, we selected the following three ratios :

- In terms of risk aversion as measured by the ratio of equity to total assets (EQAS), banks are the least risk averse and are, on average, more profitable during the years in focus related to our sample since it has seen a remarkable reduction of the average from 0.244 in 2005 compared to 0.195 in 2014. There was a difference between the equity values as the standard deviation is 0.194.
- The average of credit risk has undergone an average in the event of a reduction and is very close during 2009-2010 and 2011 and with an average of 0.506 and a standard deviation of 0.398.
- Finally, there is a remarkable difference between the operational cost ratio values since its standard deviation is 0.505, the average of this ratio varies between 0.621 in 2005 and 0.594 in 2014 with a total average of 0.598.

Table 3: Descriptive statistics of the explanatory variables of banking efficiency for the sample of 37 Islamic banks, 2005-2014

Dependent and independent variables		Years									
		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
CGDP	**Mean**	3077807	3661200	4769314	5636008	5846363	7037347	9100809	1.02e+07	1.33e+07	1.53e+07
	Min	1611.788	1885.563	2142.982	2609.312	2723.15	3103.212	3312.828	3476.649	3692.203	3850.025
	Max	2.81e+07	3.34e+07	4.37e+07	5.16e+07	5.36e+07	6.46e+07	8.36e+07	9.39e+07	1.22e+08	1.41e+08
	Std.D	8833243	1.05e+07	1.37e+07	1.62e+07	1.69e+07	2.03e+07	2.63e+07	2.95e+07	3.84e+07	4.44e+07
INFR	**Mean**	5.976019	5.849212	6.808812	12.82118	6.013589	6.458298	7.989519	9.380881	10.12769	8.204857
	Min	0.6993596	2.00747	2.027353	3.526003	-4.863278	-2.425257	-0.3644477	0.6640673	1.100691	1.890377
	Max	13.43312	11.93955	17.21305	25.54984	13.64777	13.88114	22.11212	37.39336	39.26636	36.90776
	Std.D	3.981801	3.274446	4.467789	6.798353	5.477501	4.770395	7.382633	11.42708	12.68071	9.819908
DPOP	**Mean**	190.2229	203.4259	216.7187	230.4102	244.8239	256.2454	263.8292	269.2041	273.4577	277.1061
	Min	3.060141	3.145204	3.22915	3.312848	3.39762	3.484428	3.573514	3.664565	3.757334	3.851388
	Max	1171.641	1271.362	1368.757	1468.128	1574.703	1655.274	1702.756	1731.918	1752.503	1768.74
	Std.D	350.1575	380.5658	410.1933	440.434	472.99	497.5032	511.7685	520.3873	526.3876	531.0671
TAILLE	**Mean**	6.634452	6.952481	7.219405	7.384857	7.472714	7.578567	7.565254	7.62565	7.721705	7.741454
	Min	0.74733	1.017231	1.333776	1.730885	1.686057	2.131073	2.230582	2.253932	2.46842	2.194217
	Max	14.37845	14.55492	15.01595	15.13696	15.33524	15.64405	15.84478	16.16078	16.29917	16.49252
	Std.D	2.639693	2.615715	2.653775	2.643425	2.69593	2.72364	2.695134	2.761857	2.753306	2.875462
ROAA	**Mean**	2.483676	2.586892	2.608289	1.978777	1.171216	0.5314054	1.165128	1.020174	1.912486	1.134514
	Min	-5.292	-8.634	-2.239	0 .01	-5.761	-26.057	-4.659	-10.385	-0.852	-8.431
	Max	15.797	13.598	13.405	6.212	6.668	7.576	7.077	7.969	21.385	5.645
	Std.D	3.533423	3.818518	2.606018	1.701491	1.908709	4.770967	1.901715	2.875117	3.394853	2.079791
EQAS	**Mean**	0.2442564	0.2020151	0.1922959	0.1961676	0.1814463	0.1743373	0 .173748	0 .1884633	0.1808459	0.1954351
	Min	0.0413	-0.017	0.0304	0.0423	0.0455	0.039	0.039	-0.0169	0 .0056	-0.0808
	Max	0 .9924	0.9725	0.9589	0.9496	0 .7979	0.7985	0.8105	0.987	0.955	0.943
	Std.D	0.2256961	0.2032886	0.1847112	0.1871396	0.1751282	0.1633401	0.1731536	0.2098292	0.1979106	0.2263138
LOAS	**Mean**	0.6623384	0 .4855531	0 .4663217	0.4948084	0.4975005	0.4945061	0.4637127	0.4974168	0.5015847	0.500054
	Min	0 .0019947	0.0191645	0.0003905	0.002186	0 .0035048	0.0012441	0.0010552	0.0007447	0.0454825	0.0274336
	Max	6.756352	0.8727552	0 .8218	0.7443935	0.8371318	0.9897467	0.8811553	0.9686198	0.927494	1.005589
	Std.D	1.054796	0.2396476	0.2236522	0.2152837	0.2302359	0.250368	0.2403152	0.2316844	0.2141607	0.237847
CTIR	**Mean**	0.6214132	0.5553839	0.5616339	0.5089709	0.5664055	0.6371163	0.5857987	0.7714741	0.5734441	0.5943181
	Min	0 .19408	0.15699	0.23505	0.20496	-0.3331308	0.25567	0.28207	0.22832	0.2317	0.26519
	Max	2.69477	2.26509	1.50127	0 .90482	0.9469	3.163583	1.59387	8.41509	1.34896	1.29641
	Std.D	0.4543206	0.3659189	0.2692871	0.1896617	0.2387192	0.4603906	0.2377854	1.303266	0.2137795	0.225519

Provided by: stata11

Table 4. Descriptive statistics of the explanatory variables of banking efficiency for the sample of 37 Islamic banks

Variable	Observation	Mean	Std.D	Min	Max
CGDP	370	7795008	2.52e+07	1611.788	1.41e+08
INFR	370	7.963006	7.872646	-4.863278	39.26636
DPOP	370	242.5444	463.4509	3.060141	1768.74
TAILLE	370	7.389654	2.69512	0.74733	16.49252
ROAA	370	1.659256	3.061589	-26.057	21.385
EQAS	370	0.1929011	0.1943095	-0.0808	0.9924
LOAS	370	0.5063796	0.3982189	0.0003905	6.756352
CTIR	370	0.5975959	0.5051529	-0.3331308	8.41509

Provided by: stata11

4.2 Estimation of Efficiency Scores

4.2.1 The Estimation of the Results of Cost Frontier

The parameters and the scores of cost effectiency for each bank are estimated by the maximum likelihood method using the STATA 11 software. In particular, a value of γ null indicates that deviations around the efficient frontier (deviations in relation to best practices) are due to the symmetric error v_{it} i.e. that σ_u^2 and the random term u_{it} interpreted as being the degree of inefficiency degenerates and consequently the parameters of the model can be estimated by the least squares (OLS) method. However, a value of γ equal to the unit indicates that all deviations are due to the inefficiency ($\sigma_u^2 = 1$). The estimated parameters of the stochastic frontier on the basis of the stochastic frontier of the cost appear in the following tables :

Table 5. Estimated Cost Function Parameters

Parameters	Notation	Coefficient	P_value
α_0	Constante	2.426	0.000*
α_1	Ln(PK/PL)	-0.221	0.000*
α_2	Ln(PF/PL)	0.735	0.000*
β_1	$Ln(Y_1)$	0.387	0.000*
β_2	$Ln(Y_2)$	0.312	0.000*
α_{11}	$Ln(PK/PL)^2$	0.030	0.000*
α_{12}	Ln(PK/PL)Ln (PF/PL)	-0.042	0.000*
α_{22}	$Ln(PF/PL)^2$	0.007	0.446
β_{11}	$Ln(Y_1)^2$	0.050	0.000*
β_{22}	$Ln(Y_2)^2$	0.065	0.000*
β_{12}	$Ln(Y_1)Ln(Y_2)$	-0.105	0.000*
ϕ_{11}	$Ln(PK/PL)Ln(Y_1)$	0.020	0.015**
ϕ_{21}	$Ln(PF/PL)Ln(Y_1)$	0.010	0.333
ϕ_{12}	Ln(Pk/PL) $Ln(Y_2)$	-0.009	0.303
ϕ_{22}	$Ln(PF/PL)Ln(Y_2)$	-0.046	0.000*
	Ln(FP)	0.140	0.002*
Sigma-squared $\sigma^2 = \sigma_u^2 + \sigma_v^2$		5.652774	
Gamma $\gamma = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2}$		0.9879939	
Log of the likelihood function = -82.741003 LR Test = 5879.13 (*) significant at the 1% level (**) significant at the 5% level (***) significant at the 10% level			

Provided by: stata11

The table above indicates that the quality of the estimates is overall satisfactory since the estimates show good results and the coefficients of the variables are partly significant at the threshold of 1%. The principal results of this table are :

- On 14 regressions to estimate the cost efficiency, we have 12 statistically significant regressions for the cost efficiency.
- The test of the ratio of maximum likelihood makes it possible to check if a model is globally explanatory. When the empirical value of the ratio in question (LR Test) is greater than the theoretical value of chi-square at the threshold of 1%, we conclude that the adjustment considered is overall explanatory. In our case, the theoretical value of chi-square with 15 degrees of freedom (number of exogenous variables of the model) is equal to 30.58, being lower than the empirical ratios (5879.13). Therefore, our model is globally explanatory.
- The parameters γ_A and γ_B are significantly different from zero. These results reject that the variance of the inefficiency σ_u^2 is zero. Thereby, the term u_{it} can not be excluded from regression and the estimation of parameters by the ordinary least squares method is inadequate. Moreover, these results also justify the decomposition of the error into two terms; an inefficiency component and a random error component.
- The constant terms are significant and of positive signs.
- The parameters β_1 and β_2 of the frontier cost function are statistically significant; That is, the Y_1 (net loans) and Y_2 (other productive assets) outputs are significant at the threshold of 1%. Thus, they have an influence on the TC. This means that an increase in the level of production Y_1 and a rise of total costs, and consequently these outputs have a negative impact on the cost efficiency of the Islamic banks in our sample.
- The parameters α_1 and α_2 represent respectively the prices of physical capital and of funds (the inputs PK and PF). Table 5 (cost function) indicates that these two coefficients are statistically significant with the same sign (positive); the physical capital and the fund act positively on the function of bank costs (thus negatively on cost efficiency : higher costs). Thus, a variation of the cost can be explained by a variation in input prices. The terms of the coefficients of the crossed inputs (α_{12}) are statistically significant for the cost function. This confirms the presence of perimeter savings in the Islamic banks of our sample. The parameter β_{11} represents the impact of the joint production of two outputs Y_1 on the total costs. Indeed, the collection by the bank both net lending, saves its resources, that is the existence of shared costs. This parameter is significant for the frontier cost function. The interaction between the prices of physical capital and funds is represented by the terms of the coefficients of the crossed inputs (α_{12}) and it is significant in our model.
- The parameters ϕ_{11}, ϕ_{21}, ϕ_{12} and ϕ_{22} representing the impact of the inputs on the products of the bank, are partly statistically significant. For example, in our cost function model, $\varphi 11$, it is statistically significant and of positive sign, this implies that net lending (Y_1) is more facilitated by the use of physical capital rather than by the fund.

4.2.2 Analysis of Cost Efficiency Scores

Tables 6 and 7 show the scores of cost efficiency per bank and per year. On average, the scores of cost efficiency of our overall sample are 0.660 which means, on average, the banks in our sample can reduce their cost to the level of 34% compared to the performance of the most efficient banks.

Table 6. Average efficiency scores by bank

The Banks	Cost Efficiency
Albaraka Bank Tunisia	0.930
Islamic corporation	0.930
Bank AlJazira JSC	0.826
Bank al bilad	0.550
Alrajhi Bank	0.721
Bank al wava	0.487
Al baraka bank egypte	0.452
Faisal IB of egypte	0.338
Qatar islamic bank SAQ	0.931
Al Baraka bank	0.519
Faisal islamic bank	0.539
Omdurman national bank	0.636
Al baraka banking	0.538
kuwait finance house	0.764
Liquidity management center	0.970
Bank Al-khaier	0.877
Bank saderat Iran	0.703
Bank tejarat	0.749
Bank of industry and mine	0.936
Bank of mellat	0.690
Jordan islamic bank	0.489
Islamic international arab bank	0.778
kuwait finance house	0.620
Ahli united bank QSC	0.648
Boubyan bank	0.192
sharjah islamic bank	0.897
Dubai islamic bank	0.791
Abu dhabi islamic bank	0.719
First habib modaraba pakistan	0.087
Standard Chartered Modaraba	0.677
First National Bank Modaraba	0.306
Affin Islamic Bank Berhad	0.716
RHB Islamic Bank Berhad	0.596
Bank Islam Malaysia Berhad	0.607
Kuwait Finance House (Malaysia)	0.819
Kuveyt Turk Katilim Bankasi A, S	0.866
Islamic Bank of Thailand	0.538
Overall Average	0.257

Table 7. Average Efficiency Scores by Year

Years	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Overall Average
Cost Efficiency	0.517	0.516	0.516	0.515	0.514	0.514	0.513	0.513	0.512	0.512	0.257

By analyzing Table 7, that recapitulates the mean levels of cost efficiency per year, we find that:

- Throughout the study period, the banks did not keep a constant position, in terms of cost efficency.
- The values were very close to each other. The inter-temporal comparison over the 10 years of our study of the scores suggests that the decrease in the last two is very low since the average of cost efficiency ratio goes down from 51.7% in 2005 to 51.2% in 2014.

4.3 Regression of the Determinants of Efficiency

Since the dependent variable (scores of cost efficiency) taking the values in the interval] 0, 1], and since we can not proceed an OLS regression, we present a procedure for the estimation of the parameters of the determinants (factors) of the efficiency based on the maximum likelihood method : it is the Tobit model which was introduced by Tobin in 1958. In addition, Fried et al. (1999) are the authors who recommended the the use of the regression, doubly censured, Tobit as an alternative approach to OLS because it can manage the distribution of the degrees of characteristics of efficiency. It is particularly recommended when the values of the dependent variable belong to a precise interval.

Table 8. Tobit Regression of Cost Efficiency Determinants

Parameters	Notation	Coefficient	P_value
δ_0	Constante	2.408764	0.000*
δ_1	CGDP	-1.46e-08	0.001*
δ_2	INFR	0.018199	0.191
δ_3	DPOP	-0.000674	0.001*
δ_4	TAILLE	-0.1099613	0.007*
δ_5	EQAS	1.358776	0.009*
δ_6	ROAA	0.1129156	0.001*
δ_7	LOAS	-0.5541134	0.016**
δ_8	CTIR	0.4508145	0.028**
(*) significant at the 1% level (**) significant at the 5% level (***) significant at the 10% level			

Provided by: stata11

Table 8 respectively shows the results of the influence of factors on the cost efficiency of Islamic banks

CGDP: The GDP per capita has a low and statistically significant negative impact on cost efficiency. Which implies that the level of banking efficiency is dependent on the economic growth of the country of our sample. Our results confirm some earlier studies such as, Mghaieth & Khanchel (2015). In addition, Sufian (2009) found a negative effect of the growth rate of GDP on efficiency.

INFR: The annual inflation rate does not affect the cost efficiency since it is statistically insignificant. According to Demirgüç-Kunt & Huizinga (1999) and Asli Demirgüç-Kunt, Laeven, & Levine (2004), an increase in the inflation rate must have a positive effect on the performance of banks. At the same time, a strong inflation can affect the competitive behavior of banks and induce them to cope with competition by the establishment of the new expensive agencies which implies a deterioration in cost efficiency (Kasman & Yildirim, 2006).

DPOP: The population density has a low and significant negative impact on cost efficiency, hence if the population density increases by 1%, cost efficiency decreases by 67.4%. This result differs from some earlier work such as Ftiti, Nafti, & Sreiri (2013).

SIZE: Size has a negative and significant relationship with the cost effectiency of Islamic banking institutions, which suggests that the banks of big size in terms of total assets are the most inefficient. A recent study by Mghaieth & Khanchel (2015) reports a positive relationship between size and cost efficiency.

EQAS: Regarding the impact of regulatory conditions, we observe that the requirements of higher equities affect the cost efficiency. The value taken by the coefficient of the ratio of equity to total assets is statistically significant as a positive sign. Another explanation, inspired by the theory of moral hazard, is that banks with low levels of equity can increase their risk-taking.

ROAA: the ratio of financial profitability has a positive effect on the cost efficiency of the Islamic banks in our sample. Indeed, the more the bank seeks to improve its

economic profitability, the more it tends to reduce its costs, therefore to consolidate its efficiency. This indicator of efficiency and its link with the evolution of bank profitability is important. This result corroborates that of some similar studies like Ftiti, Nafti, & Sreiri (2013). The banks indicate that the highest profitability ratios are generally the most preferred by customers (Sufian, 2009)

LOAS: There is a statistically negative relationship between credit risk and cost efficiency. Credit risk has a largely significant effect of 0.016 (significance at 5%). If the credit risk increases by 5%, then the cost efficiency decreases by -0.554%.

CTIR: In terms of operational costs, there is a positive and significant relationship between this variable and cost efficiency. When the operational cost ratio increases by 1%, the efficiency increases by 45.08% which is statistically significant of 0.028 (significance of 5%).

5. Conclusion

The objective of this study is to estimate the cost efficiency of Islamic banking institutions during the period of 2005-2014, while identifying the explanatory factors for efficiency, considering a two-stage model (Battese & Coelli, 1992) applied to a translog function. This study is justified because it makes it possible to draw the attention of the various banking stakeholders on the factors specific to the banks and the external factors that are likely to explain the level of banking efficiency. In the light of this study of the efficiency of the Islamic banking system and its evolution during the last 10 years, several emerging findings are remarked. Using an SFA approach, the empirical results show that the average of cost efficiency levels are 66%. Thus, if Islamic banks use available inputs in an efficient way in terms of cost, they can reduce their total costs by about 34%. The results obtained in our sample of banks reveal that, for the study period, the trend of the evolution of the scores of cost efficiency is rather mixed and difficult to conclude. Moreover, they show that these efficiency levels are linked, in the same order, to bank-specific variables as to external factors. Finally, our analysis shows that the improvement of the scores of cost efficiency is important in a relative way in banks. The results of the determinants of efficiency demonstrated that:

Concerning the bank-specific characteristics :

- A positive and statistically significant effect of the financial profitability ratio (ROAA) on cost efficiency.
- There is a negative and statistically significant relationship of bank size (SIZE) and cost efficiency.

Concerning the impact of macroeconomic conditions:

- The higher annual inflation rates (INFR) do not influence cost efficiency.
- A negative and statistically significant effect of the GDP per capita (CGDP) on cost efficiency.
- Population density (DPOP) has a negative and statistically significant effect on cost efficiency.
- Concerning the impact of the regulatory conditions:
- There is a positive effect of capital adequacy ratio (EQAS) on cost efficiency.
- Credit risk (LOAS) has a negative effect on cost efficiency.
- The operational cost ratio (CTIR) has a positive impact on the cost efficiency.

This study could be considered of great interest as it makes it possible to explain the variations of efficiency between the Islamic banks. This makes it possible to identify bank-specific variables on which Islamic bank managers can act to increase their efficiency levels and compete domestically and internationally.

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