

Efficiency of Tunisian Commercial Banks According to the Intermediation Approach

Ilhèm Gargouri¹

¹ School of Business, University of Sfax, Tunisia

Correspondence: Ilhèm Gargouri, School of Business, University of Sfax, BP 1081 Sfax 3018, Tunisia. Tel: 216-96-363-900. E-mail: ilhemgargouri@gmail.com

Received: March 8, 2013

Accepted: March 30, 2013

Online Published: April 24, 2013

doi:10.5539/ijef.v5n5p190

URL: <http://dx.doi.org/10.5539/ijef.v5n5p190>

Abstract

This work focuses on the performance of the banking sector through the analysis of the efficiency of Tunisian commercial banks according to intermediation approach. To measure the cost inefficiencies in banks in Tunisia, we use a translog specification for single-product cost function. The estimated cost efficiency shows a strong correlation between positive and significant efficiency scores according to the approaches (SFA) and (SFAA). The empirical results show that the efficiency cost, depending on the approach SFAA has evolved mixed between 1993 and 2010. Regarding the estimation of efficiency depending on the size of banks, the results show that banks in small and medium size of our sample show medium cost efficiencies better than those made by banks in large sizes. While on the side of profit estimates show that banks of large and medium sizes are more efficient than banks of smaller sizes. Internal determinants of the productive performance of Tunisian banks show that the preponderance of credit activity in relation to other outputs represents a source of efficiency for banks.

Keywords: bank efficiency, intermediation approach, translog cost function, Tunisia

1. Introduction

The banking system plays a crucial role in the functioning of the economy. For this reason, several studies have been conducted to determine the essential components of bank performance. One of these components is concerned with the notion of efficiency. The efficiency of financial institutions has long been investigated. The results have obvious implications for the management of banks seeking to improve operational performance and decision makers who are concerned about bank competition, bank security and soundness of banks.

There is a strong relationship between the efficiency and performance as they are interpreted in the same direction. Indeed, when a bank is efficient, it is obviously effective. According to Chaffai and Diesh (1998), bank profitability is dependent on the efficiency with which the bank organizes its production. Therefore, it seems that efficiency is a determinant of productivity and therefore the performance of the bank. The term performance is more comprehensive than the term efficiency. Moreover, according to the approach of performance in social management, performance covers the notion of productivity of men (efficiency) and social goals assigned to managers such as the development of skills and employee engagement (efficiency). Our goal is to test the hypothesis of positive correlation between efficiency and performance from some performance indicators and scoring efficiency.

Several studies on the efficiency of banks have adopted the intermediation approach (Florian 2012; Kablan 2012; Allen, Engert and Liu, 2006; Allen and Liu, 2005; Isik and Hassan, 2002; Burkart, Gonsard and Dietsch (1999); Chaffai 1998; Berger and Mester, 1997; Zaim, 1995). For example, the article by Burkart, Gonsard and Dietsch (1999) presented an analysis of the cost efficiency and profit efficiency of French banks. These authors showed that the average cost efficiency is around 12% and the dispersion of efficiency scores is quite low, which means that the French credit institutions are relatively close to each other in terms of productive performance. The average profit inefficiency is around 9% and it appears that the behaviors are more similar in terms of ability to extract profits.

2. Research Methodology

Our goal is to analyze the performance of the banking sector through the analysis of the efficiency of Tunisian banks. The first observation we can give on this subject is that there is no unanimity on the explicit definition and

measurement of inputs and outputs of a bank. In general, each input definition and production carries with it a particular set of concepts that influence and limit bank analysis of the characteristics of the production industry.

The data of our work is mainly based on activity reports published by banks and databases of the Tunisian Professional Association of Banks and Financial Institutions (TPABFI). Our sample consists of all commercial banks with the exception of two banks which are the Tunisian Solidarity Bank (TSB) and Arab Banking Corporation (ABC) who had no regular activity during the period of our study. In addition, for reasons of statistical homogeneity, we excluded from our study another small bank which is Citibank (CB).

Our work is limited to the deposit banks because they occupy the most important place in the financing of the Tunisian economy. In fact, over 90% of the savings is collected by commercial banks and over 80% of loans are granted by banks. Our final sample includes observations starting from 1993 to 2010, 18 years, corresponding to the period of banking sector reforms. It refers to 11 Tunisian commercial banks namely:

- T.B.C: Tunisian Banking Company
- A.N.B: Agricultural National Bank
- I.A.B.T: International Arab Bank of Tunisia
- I.U.B: International Union of Bank
- ATTI.B: Attijari Bank
- B.T: Bank of Tunisia
- U.B.T.I: Union Bank for Trade and Industry
- A.B: Amen Bank
- A.T.B: Arab Tunisian Bank
- H.B: Housing Bank
- B.F.T: Bank Franco-Tunisian

2.1 Using the Intermediation Approach

Our methodological approach is based on the intermediation approach which seemed the most appropriate to address our concern, given the importance of interbank activity and weight of the interest costs. Tunisian banks use the funds at their disposal to give primarily loans. It follows that the liability of Tunisian banks tends to be regarded as an input rather than output. It should be noted that deposits are the financial capital of the bank and are considered an input. It should be noted that the financial costs are included in our work.

2.2 Definition of Variables

Variables that will be analyzed are two in number: the banking inputs and the banking outputs.

2.2.1 The Bank Outputs

The outputs provided by the Tunisian commercial banks are classified into two categories: Total Credits (TC) and portfolios of securities. These two types of outputs are measured in monetary units, that is to say dinar directly from the bank's balance sheet.

2.2.1.1 Total Credits (TC)

The total of credits includes the Customer loans (CC) and interbank loans (PI). Indeed, customer loans portfolio is formed by discount accounts receivable from customers, loans on special resources and other loans to customers. While for interbank loans, they gather loans to banks and agencies, cash, Central Bank of Tunisia (CBT), certificates of deposit, treasury bills purchased and giro.

2.2.1.2 Securities Portfolios (PT)

Portfolios securities represent securities portfolios and investments considered services provided by the bank. Securities portfolios included as a line item in the balance sheet (PT = trading securities portfolios + investment portfolios). To measure banking, we have taken as a proxy aggregate output (Q) obtained by aggregation method proposed by BHH (1982) and is as follows:

$$Q_t = \frac{\sum_s n_{si}}{\sum_s \bar{n}_s} \bar{Q}$$

With: Q_i : Aggregate output of the bank i ;

s : Banking services mentioned above (CC, PI and PT);

n_{si} : The amount of the output s of the bank i ;

$\bar{Q}$: A geometric average of the sum of different bank outputs defined as: $\bar{Q} = \pi_i [\sum_s n_{si}]^{\frac{1}{m}}$;

m : The number of banks in the sample;

$\bar{n}_s$: A geometric average of bank outputs defined as: $\bar{n}_s = \pi_i [n_{si}]^{\frac{1}{m}}$.

2.2.2 Banking Inputs

The outputs listed above are produced by the combination of factors of production, namely labor input (L), physical capital input (K) and the financial capital factor (F). Various forms of deposits which constitute the financial capital input are considered, as stipulated supporters of intermediation approach. These inputs are measured as follows:

- L : The number of employees;
- K : Net Fixed Assets;
- F : Borrowing from (CBT), money market and specialized agencies + Demand deposits Customer deposits + Savings + Coupon accounts and other financial terms + Other amounts due to customers + Special resources + Bonds and other loans.

2.2.3 Bank Production Costs

Endogenous variable is defined by the Total Cost (TC), which includes all the operating and financial costs. Financial costs are mainly interest expenses. Operating costs correspond to the costs of labor and capital, that is to say, the payroll and general operating expenses.

2.2.4 Bank Input Prices

After determining the cost of each input bank, we can evaluate the prices of these inputs. In fact, the price of each factor of production is measured by the ratio between its cost and quantity. Bank input prices are determined as follows:

- The price of labor " P_L " is obtained by dividing personnel expenses by the number of bank employees: $P_L = \frac{CL}{L}$
- The price of physical capital " P_K " is obtained by dividing the general operating expenses by property: $P_K = \frac{CK}{K}$
- The price of financial capital " P_F " is obtained by dividing the financial burden on borrowed resources: $P_F = \frac{CF}{F}$

Table 1 shows the descriptive statistics (mean, standard deviation, minimum and maximum) of the total cost, total profit, aggregate output, inputs and their prices. We emphasize that public banks (TBC, ANB and HB) are ranked the first in almost all inputs and outputs. Thus, they have larger amounts of deposits, capital, labor, total credit. Only (IABT) ranks sometimes with these three banks.

But on the prices of inputs, we note that private banks offer higher salaries. The price of physical capital and financial capital are relatively lower compared to the price of labor. The (IABT) offers the highest salary about one and a half times higher than the average TBC. This could be explained by the different recruitment policies between banks (in terms of qualifications, for example).

Table 1. Descriptive statistics of sample variables

Variable	Observations	average	Standard deviation	Minimum	Maximum
<i>CT</i>	198	90501	58370	3276	246630
<i>PROFT</i>	198	111070	72665	5701	324268
<i>L</i>	198	1393	826	180	3154
<i>K</i>	198	27902	21850	673	101347
<i>F</i>	198	1237630	910448	53928	3965021
<i>PL</i>	198	15,7903	6,8127	5,3676	34,4047
<i>PK</i>	198	0,8304	0,5193	0,1698	2,9897
<i>PF</i>	198	0,0445	0,0170	0,0097	0,1169
<i>TC</i>	198	1221445	895009	43076	4013283
<i>PT</i>	198	140678	140316	253	654960
<i>Q</i>	198	1389036	1028474	46737	4413806

• Source: Calculated from data provided by the (TPABFI). We note that these data are in thousands of dinars, with the exception of labor (L) which is measured by the number of employees.

3. Analysis of the Econometric Method Used

The method of stochastic frontier when panel data assumes that the specific inefficiency of the company varies over the time, which is the major advantage of this method of efficiency estimation. For our work, we use the cost function translogarithmique.

3.1 The Translog Cost Function

To measure the inefficiencies cost in banks in Tunisia, we use a translog specification for single-product cost function:

$$\begin{aligned} \ln(CT)_{it} = & \alpha_0 + \beta_Q \ln(Q_{it}) + \frac{1}{2} \beta_{QQ} [\ln(Q_{it})]^2 \\ & + \sum_j \alpha_j \ln(P_j)_{it} + \sum_j \beta_j Q \ln(P_j)_{it} \ln(Q_{it}) + \frac{1}{2} \sum_j \sum_k \beta_{jk} \ln(P_j)_{it} \ln(P_k)_{it} + v_{it} + u_{it} \end{aligned} \quad (1)$$

$i \in (1 \rightarrow 11)$: Denotes the number of banks;

$t \in (1 \rightarrow 18)$: Refers to years of study. (1993 $\rightarrow$ 2010)

$j \in \{L, K, F\}$

With:

CT_{it} : The cost function to estimate the bank i in year t .

Q_{it} : The aggregate output of bank i at time t .

PL_{it} : The price of labor bank i at time t .

PK_{it} : The price of physical capital factor of bank i at time t .

PF_{it} : The price factor financial capital of bank i at time t .

v_{it} : The term random error identically and independently distributed according to a normal law $N(0, \sigma_v^2)$.

u_{it} : The term asymmetric error measuring inefficiency: $u_{it} \rightarrow N(m_{it}, \sigma_u^2)$.

Distribution of random term (u_{it}) on the extent of inefficiency is that of a truncated normal distribution with zero variance (σ_u^2) and expectation (m_{it}) defined by: $m_{it} = Z_{it} \delta$

Where (δ) is a vector of (p) parameters to be estimated, and (Z_{it}) a vector of (p) variables can affect the efficiency of bank (i) at time t . However, the Hessein the cost function is symmetric, the equality $\left(\frac{\partial^2 CT}{\partial x_i \partial x_j} = \frac{\partial^2 CT}{\partial x_j \partial x_i} \right)$ must be satisfied for any pair of variables (x_i) and (x_j).

Symmetry leads to the following restrictions: $\beta_{jk} = \beta_{kj}$; $j, k \in \{L, K, F\}$

In addition, any cost function must be homogeneous of degree one in input prices. Thus a proportional increase in prices increases the total cost in the same proportion without demand factors being affected. This homogeneity condition implies other constraints expressed as follows:

$$\sum_j \alpha_j = 1; \sum_j \beta_{jk} = 0; \sum_j \beta_{jQ} = 0 \text{ Avec: } j, k \in \{L, K, F\}$$

Homogeneity constraint is taken into account by normalizing the Total Cost (TC), the price of physical capital (P_K) and the price of financial capital (P_F) by the price of capital work (P_L). A choice that does not affect the results since the estimators are obtained by the method of maximum likelihood.

Within these constraints, we obtain the following transformed model:

$$\begin{aligned} \ln\left(\frac{CT}{PL}\right)_{it} = & \alpha_0 + \alpha_Q \ln(Q_{it}) + \frac{1}{2} \beta_{QQ} [\ln(Q_{it})]^2 + \alpha_K \ln\left(\frac{PK}{PL}\right)_{it} + \alpha_F \ln\left(\frac{PF}{PL}\right)_{it} \\ & + \beta_{KQ} \ln\left(\frac{PK}{PL}\right)_{it} \cdot \ln(Q_{it}) \\ & + \beta_{FQ} \ln\left(\frac{PF}{PL}\right)_{it} \cdot \ln(Q_{it}) + \beta_{LK} \left[\ln(PL_{it}) \cdot \ln(PK_{it}) - \frac{1}{2} [\ln(PL_{it})]^2 - \frac{1}{2} [\ln(PK_{it})]^2 \right] \\ & + \beta_{LF} \left[\ln(PL_{it}) \cdot \ln(PF_{it}) - \frac{1}{2} [\ln(PL_{it})]^2 - \frac{1}{2} [\ln(PF_{it})]^2 \right] \end{aligned}$$

$$+\beta_{KF} \left[\ln(PK_{it}) \cdot \ln(PF_{it}) - \frac{1}{2} [\ln(PK_{it})]^2 - \frac{1}{2} [\ln(PF_{it})]^2 \right] + v_{it} + u_{it} \quad (2)$$

3.2 Test of Homogeneity Total

We start first by testing complete homogeneity: the latter is noted as Fisher's test A; $B = A_i$, B_i in the result file of TSP. The letter A is the constant here, while the letter B denotes the vector of coefficients of the explanatory variable.

$$H_0^1: \beta_i = \beta \quad \forall i \in [1, N]$$

$$H_a^1: \exists (i, j) \in [1, N] / \beta_i \neq \beta \text{ or } \alpha_i \neq \alpha_j$$

As part of our sample, the realization of the Fisher statistic associated with the test H_0^1 , denoted F_1 is 0.7385.

The software also shows the number of degrees of freedom for this statistic (Note that F_1 followed a Fischer with $[(N-1)(K+1)]$ and $[NT-N(K+1)]$ degrees of freedom).

Given the size of our sample and the number of explanatory variables ($K = 9$), we must compare the value of this achievement to the threshold of a Fischer $F(100, 88)$. The software gives us directly the p-value associated with this test. In this instance, the p-value indicates here that until the 75% threshold, the null hypothesis can not be rejected. So our panel represented by equation (2) is completely homogeneous (pooled). This homogeneity is explained by the fact that banks in our sample are of the same nature (commercial banks and we excluded development banks and offshore banks). In addition, these banks are indirectly controlled and supervised by the State and apply the same banking reforms.

We can regain our panel structure (pooled model) performing the test H_0^3 that is to test the equality of N individual constants α_i :

$$H_0^3: \alpha_i = \alpha \quad \forall i \in [1, N]$$

$$H_a^3: \exists (i, j) \in [1, N] / \alpha_i \neq \alpha_j$$

This test is denoted as Fisher's test A; $B = A_i$, B in the result file of TSP. This test is to confirm or refute the test results H_0^1 , given the fact that reducing the number of linear restrictions can increase the power of the test of Fischer (Note that with F_3 followed a Fischer $[(N-1)$ and $N(T-1)-K]$ degrees of freedom, ie by an $F(10; 178)$). As part of our sample, the realization of the Fisher statistic indicates a value of 1.5786. The p-value (0.5536) is well above the 5% threshold. So we can not reject H_0 equality of constants α_i .

3.3 Determination of the Level of Inefficiency

Added to the estimation of the efficiency of Tunisian banks, our goal is to highlight the link between performance and productive variables in banking supervision on the one hand and external variables on the other. Since each bank has its own characteristics, this study uses the internal characteristics of the bank to assess managerial efficiency. The first relates to the financial characteristics of banks and the second concerns its organizational characteristics.

3.3.1 The Financial Characteristics

Financial characteristics are assessed by three variables:

3.3.1.1 Variable Trade Policy

To examine the relationship between efficiency and trade policy of banks, we used the following ratio: total active credit (**RC**). Given the nature of the debt economy, causing economic agents in Tunisia to be funded primarily through the banking system, it is tempting to equate this indicator with an enviable achievement, which is a performance as it relates to deposits collected, the ability to refinance the money market and the importance of equity. A bank is successful in this regard when this ratio is high. Thus a positive impact ratio (**RC**) on bank efficiency is expected.

3.3.1.2 Variable Regulatory

Among the variables related to the regulation, it holds the weight of equity to total assets (**CAP**), variable reflecting the state of regulatory constraints on capital: its orientation depends on the degree of risk aversion.

3.3.1.3 Variable PPC

To account for the influence of non-performing loans on efficiency in the banking sector, we introduce the variable (**PPC**) measured by the ratio of provisions for credit losses (as a proxy of non-performing loans) to total loans: a negative impact is expected.

3.3.2 The Organizational Characteristics

Organizational characteristics are assessed by two variables: the variable logarithm of total assets (**Ln(TA)**) and the variable Trend (**T**).

3.3.2.1 Variable Logarithm of Total Assets (Ln (TA))

The final impact of this variable on expected efficiency depends on the critical size. Indeed, Aly et al (1990), Berger et al (1993) found a positive relationship between size and efficiency of large U.S. banks, and Isik et al (2005) for banks in Jordan. On the other hand, Hermalin and Wallace (1994), Kaparakis et al. (1994), De Young and Nolle (1996), Isik and Hassan (2002a) found a negative relationship. However, other studies did not find any significant relationship between the size and the level of efficiency, for example the work of Aly and al. (1990), Cebenoyan and al. (1993), Mester (1993), Pi and Timme (1993), Mester (1996), Berger and Hannan (1995), Berger and Mester (1997) and Chang and al. (1998).

3.3.2.2 Trend Variable (T)

To take account of technological developments in the Tunisian banking sector during the period of our study, a positive impact on productive efficiency is expected. To isolate the effects of the internal characteristics of the bank on efficiency, it is necessary to control by other factors that were used as determinants of bank efficiency. We also examine how the efficiency of the banking sector is related to the structure of the banking market. Therefore, we analyze the competition by Tunisian banks index approach, and more specifically by the index of concentration of Herfindahl Hirshman Index (**HHI**).

Several studies have highlighted a negative relationship between concentration and efficiency (Fecher and Pestieu, 1993; Berger and Hannan 1997), while others have identified a positive relationship. Indeed, the Cournot model of oligopolistic behavior, predicts that market power is positively related to the profitability and efficiency, as banks with large market shares can charge higher prices, discourage competition and be more productive (Berger 1995; Berger and Mester 1997; Weill, 1998, Isik and Hassan 2003; Isik and al. 2005 for banks in Jordan).

The final impact of the expected concentration on efficiency is therefore ambiguous.

Thus, the expected random term on the extent of inefficiency is defined by:

$$m_{it} = \delta_0 + \delta_1 T_{it} + \delta_2 TA_{it} + \delta_3 IHH_{it} + \delta_4 PPC_{it} + \delta_5 CAP_{it} + \delta_6 RC_{it} \quad (3)$$

Table 2 shows the main statistical characteristics of the variables of inefficiency term.

Table 2. Statistical characteristics of the explanatory variables of the inefficiency term

Variable	Observations	Average	Standard deviation	Minimum	Maximum
ln(TA)	198	13,9163	0,9372	11,3833	15,3646
HHI	198	0,1252	0,0098	0,1125	0,1410
PPC	198	0,0812	0,0530	0,0013	0,2593
CAP	198	0,0790	0,0315	0,0192	0,1780
RC	198	0,6695	0,1111	0,4193	0,8825

4. Interpretation of Model Results

To assess the relevance of the results obtained in this analysis, on the one hand we have based our arguments on the significance of the explanatory variables used in this study and on the other hand, we have based on apparent sign of the coefficient. The estimated parameters of the cost frontier function (II) are shown in the following table. Coefficients and degrees of efficiency of each bank are estimated by the method of maximum likelihood using the software FRONTIER 4.1 (Coelli, Prasada Rao and Battese, 1998). It uses alternative parameterization of the likelihood function, which substitutes:

$$\sigma_u^2 \text{ and } \sigma_v^2 \text{ by } \sigma^2 = \sigma_u^2 + \sigma_v^2 \text{ and } \gamma = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2} \in [0, 1]$$

In particular, a value of zero indicates that the deviations around the border are entirely due to noise, while a value of unity indicates that all deviations are due to inefficiency. The quality of the estimates is satisfactory and the coefficients are significant at the threshold of 1%.

From Table 3, the first result that can be drawn concerns the test of maximum likelihood. In fact, this test checks whether a model is generally explanatory. When the empirical ratio in question (**L.R**) is greater than the theoretical value of chi-square at the 1% level, we conclude that the fit is generally considered explanatory. In our case, the

overall explanatory model, the theoretical value of chi-square, 21.67, at the 1% and 9 degrees of freedom is less than the respective empirical ratio (the degree of freedom is the number of exogenous variables model).

The second result shows that the parameter is significantly different from zero. This result rejects the hypothesis that the variance of the efficiency is zero. Therefore the term can not be excluded from the regression and parameter estimation by ordinary least squares method is inadequate.

Table 3. Parameter estimates of the translog cost function (SFAA)

C		Coefficient	Standard deviation	Student's t-Tests
Constant	α_0	7,07	1,557	4,540
LN (Q)	β_Q	-0,0879	0,250	0,351
LN (Q) ^2	β_{QQ}	0,0386	0,021	1,867
LN (PKL)	α_{KL}	-0,063	0 ,243	-0,261
LN (PFL)	α_{FL}	1,276	0,345	3,696
PKQ	α_{KQ}	-0,019	0,014	-1,347
PFQ	α_{FQ}	-0,016	0,017	-0,690
BLK	BLK	0,055	0,028	1,954
BLF	BLF	-0,061	0,040	1,509
BKF	BKF	-0,103	0,044	-2,315
Square Sigma	$\sigma^2 = \sigma_u^2 + \sigma_v^2$	0,008	0,001	7,646
gamma	γ	0,376	0,111	3,393
Log of Vraisemblance	195,712			
LR Test	85,607			
Nombre of restrictions		8		
Nombre of iterations		38		

4.1 Hypothesis Testing for the Model Parameters

Before interpreting the results of the function of stochastic cost frontier we make various specification tests. The following table presents a number of statistical tests based on the likelihood ratio, which are expected to examine our model in comparison to more limited forms.

The first hypothesis examines the extent to which it is possible to assume a more limited form of the translog specification of the cost function. Indeed, this first hypothesis examines whether the cost function can be represented by a Cobb-Douglas. This hypothesis is rejected at a significance level of 99%. Other additional hypotheses examine alternative features of the equation that determines the cost inefficiency, because the cost function remains in its translog form.

The second hypothesis is to examine whether it is possible to assume a model in which the cost inefficiency does not exist, ie, if it is possible to work with a model of ordinary least squares (OLS). This hypothesis is strongly rejected at a significance level of 99%. The third hypothesis examines the case in which the inefficiency is not a linear function of the independent variables. This hypothesis is strongly rejected at the 1% level. In the latter case, we performed the reasonableness test to test the hypothesis of technological change in the Tunisian banking sector. The null hypothesis of no technological change was strongly rejected at the 1% level.

In conclusion, the proposed model represents an improvement when compared to functional characteristics and particularly restrictive in comparison with these characteristics in which the inefficiency component is not based on financial and managerial variables that determine the activity of the bank.

Table 4. Tests of hypothesis likelihood ratio on the parameters of the stochastic cost frontier approach according to (SFAA)

Null hypothesis H_0	Log of Vraisemblance	LR Test*	Critical Value $\chi^2_{0.99}$ **
(1) $H_0: \beta_{QQ} = \alpha_{KQ} = \alpha_{FQ} = BLK = BLF = BKF = 0$ ¹	148,05	95,32	16,81
(2) $H_0: \gamma = \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$ ²	152,91	85,61	18,47
(3) $H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$ ³	152,90	98,13	16,59
(4) $H_0: \delta_1 = 0$ ⁴	152,90	85,60	7,88

Notes: (*) It should be noted that the likelihood ratio test is given by the following statistic: $LR = -2[\ln(H_0) - \ln(H_1)]$; where $\ln(H_0)$ and $\ln(H_1)$ represent the logarithms of the likelihood of the estimated models under the null and alternative hypothesis. This statistic is asymptotically follows chi-square with two degrees of freedom as the number of restrictions under the null hypothesis. (**) Value likelihood ratio test given by the table. 1. The cost function can be represented by a Cobb-Douglas. 2. The term inefficiency has no effect. 3. The inefficiency is not a linear function of the independent variables. 4. No technological change in the Tunisian banking sector.

4.2 Interpretation of Efficiency Scores

Our goal is to interpret the evolution of efficiency scores over time. Indeed, the following table shows annual estimates respectively of cost inefficiency scores obtained from the two approaches (SFAA) and (SFA). By definition, the method (DFA) can not give annual scores, but only an estimation of the average efficiency over the entire period (that is to say by bank). From this table, we see that the efficiency cost, depending on the approach (SFAA) has evolved mixed between 1993 and 2010. This allows to deduce that the efficiency of Tunisian commercial banks fluctuates. This result was verified by Chaffai and Dietsch (1998) and Cook, Hababou and Gordon (2000). It is from 2000 that the Tunisian banking sector marked a steady increase in efficiency, saving the cost efficiency scores large enough to reach, in 2009, its highest level of the period which is to the order of 85.67%. In fact, the average cost efficiency has increased by 8.17% during the period 2000-2005.

Table 5. Average scores of cost efficiency in time according to the approach (SFAA)

	1993	1994	1995	1996	1997	1998
SEC*	0,6428 (0,1363)	0,6348 (0,1237)	0,6374 (0,1350)	0,6303 (0,1317)	0,6419 (0,1289)	0,6571 (0,1217)
	1999	2000	2001	2002	2003	2004
SEC	0,6739 (0,1152)	0,7010 (0,1153)	0,7351 (0,1127)	0,7412 (0,1103)	0,7928 (0,1050)	0,7696 (0,1058)
	2005	2006	2007	2008	2009	2010
SEC	0,7871 (0,0985)	0,7846 (0,0941)	0,8103 (0,0895)	0,8322 (0,0797)	0,8567 (0,0761)	0,8513 (0,0693)
AVERAGE	0,7322 (0,1315)					

On the approach (SFA), we see that the average efficiency has increased during our study. Indeed, examining the evolution of cost efficiency over the study period, we note that efficiency levels increase from one year to another almost on a regular basis. Indeed, the efficiency scores have increased from 68.37% in 1993 to 74.62% in 2010. In fact, the average cost efficiency has increased by 6.25% during the period 1989-2006.

Table 6. Cost efficiency average scores in time according to the approach (SFA)

	1993	1994	1995	1996	1997	1998
SEC	0,6837 (0,1413)	0,6877 (0,1397)	0,6916 (0,1382)	0,6955 (0,1367)	0,6993 (0,1352)	0,7032 (0,1336)
	1999	2000	2001	2002	2003	2004
SEC	0,7069 (0,1321)	0,7107 (0,1306)	0,7144 (0,1291)	0,7181 (0,1277)	0,7217 (0,1262)	0,7253 (0,1247)
	2005	2006	2007	2008	2009	2010
SEC	0,7289 (0,1233)	0,7324 (0,1218)	0,7359 (0,1204)	0,7394 (0,1190)	0,7428 (0,1176)	0,7462 (0,1162)
AVERAGE	0,7158 (0,1246)					

4.3 Evolution of Efficiency Scores between Banks

According to the approach (S.F.A.A), the bank (ANB) is classified as the least efficient in terms of cost. Conversely, (BFT) seems to be the most efficient bank in terms of its ability to minimize its costs. The graph shows the average scores of cost efficiency by bank.

Table 7. Average scores on cost efficiency by banks (Banks are arranged in ascending order of efficiency scores)

S.F.A.A					
ANB	TBC	IABT	HB	AB	ATTI.B
0,6093 (0,1144)	0,6327 (0,0936)	0,6547 (0,0888)	0,6912 (0,0906)	0,7011 (0,0703)	0,7103 (0,0771)
IUB	BT	UBTI	ATB	BFT	
0,7315 (0,0878)	0,7376 (0,0856)	0,7512 (0,0968)	0,8537 (0,0958)	0,9810 (0,0198)	
ANB	IABT	TBC	HB	AB	ATTI.B
0,5517 (0,0281)	0,5800 (0,0270)	0,5946 (0,0265)	0,6691 (0,0230)	0,6794 (0,0225)	0,7091 (0,0209)
IUB	UBTI	BT	ATB	BFT	
0,7237 (0,0200)	0,7436 (0,0189)	0,7631 (0,0177)	0,8701 (0,0104)	0,9891 (0,0009)	
IUB	UBTI	IABT	ATTI.B	ATB	ANB
0,8814	0,8917	0,9048	0,9048	0,9064	0,9168
TBC	BT	AB	BFT	HB	
0,9310	0,9345	0,9431	0,9614	1	

Note: The type difference in parentheses.

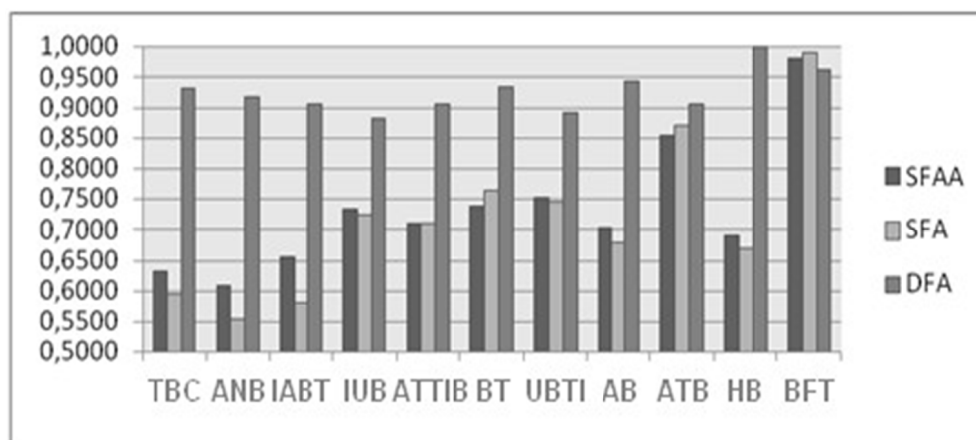


Figure 1. Average scores of cost efficiency by bank (According to the different approaches)

4.3.1 Estimated Cost Efficiency

Banks of small and medium size of our sample show better than average efficiencies realized by banks of large sizes. In this context it's important to emphasize that the results by size of banks, shown in the following table, draw a trend toward decreasing relationship between the size and the degree of efficiency cost.

The average efficiency reaches Indeed, 86.20% for small banks, 71.44% for medium-sized banks and 57.54% for large banks. This confirms the words of Berger and De Young (1997), suggesting that inefficiencies are primarily the result of a misallocation of financial resources (deposits and borrowed funds) and of miscalculating the risk of non-performing loans which is on a large scale in financial institutions and public and private banks of large sizes.

Table 8. Average scores of cost efficiency in Tunisian commercial banks according to their size

Great banks		Medium banks		Small banks	
TBC	0,5946	IUB	0,7315	UBTI	0,7512
ANB	0,5517	ATTI.B	0,7103	ATB	0,8537
IABT	0,5800	BT	0,7376	BFT	0,9810
		AB	0,7011		
		HB	0,6912		
Average	0,5754	Average	0,7144	Average	0,8620
Industry average 0,7173					

4.3.2 Explanatory Factors of the Productive Performance of Tunisian Banks

The estimated parameters and the hope of inefficiency (III) are shown in Table 9. These estimates of the determinants of productive efficiency provide a first insight into the managerial assumptions that we would evaluate.

Table 9. Explaining the level of cost inefficiency

Constant	δ_0	-3,453	0,538	-6,413
T	δ_1	-0,039*	0,006	-6,968
LN (TA)	δ_2	0,222	0,034	6,504
IIH	δ_3	5,896	1,255	4,694
CNP	δ_4	0,931*	0,314	2,965
CAP	δ_5	-0,239	0,465	-0,515
RC	δ_6	-3,653	0,117	-3,119
Square Sigma	$\sigma^2 = \sigma_u^2 + \sigma_v^2$	0,008	0,001	7,646
gamma	γ	0,376	0,111	3,393
Log of Vraisemblance	195,712			
LR Test	85,607			
Nombre of restrictions		8		
Nombre of iterations		38		

Note: * A positive sign indicates a significant and negative impact of the variable on inefficiency score of the bank and have a positive effect on cost efficiency.

Our results show that there is a negative relationship between the provision for credit losses (as a proxy for non-performing loans) and the level of cost inefficiency. This result can tell us that after a deterioration in the level of productive efficiency of Tunisian banks in a year, the amount of non-performing loans increases in the following year. This evidence was also confirmed by testing Spearman correlations and Kendall. Spearman's rho (which is equal to -0.4919 and significant at 1%) and Kendall's score (which is equal to -6861 and significant at 1%) allow us to reject the hypothesis H_0 that the non-performing loans and cost efficiency are independent. Negative signs tests show that the two variables are negatively correlated.

We also find a positive relationship between the variable capitalization and cost efficiency but not significant. After the period has been marked by fluctuations in the cost efficiency Tunisian banking sector has improved

considerably. Thus, even if the process of modernization and reorganization was launched in 1997, it is from the year 2000 that we could report a significant effect of this process on bank efficiency scores. Which justifies the negative sign and significant coefficient on Trend (T), reflecting technological developments in the banking industry.

In fact, investments in new technologies at the interbank clearing or development of the network atmosphere (ATM), were allowed to develop banking with a lower cost. But some time was needed so that the predicted effects of these investments appear because these new technologies are accompanied by a reorganization of the business and a new allocation of functions to the bank.

Technological advance has a positive effect on the development of the banking sector mainly in the field of information technology and communication. In fact, this technological advance has created new channels of distribution of banking products and services such as online banking, Internet, electronic funds transfer and others. These changes reduce transaction costs and increase competition in the banking sector. Thanks to technological progress, we can properly perform several operations with minimum cost such that the operation of collection or analysis and provision of information.

In addition, new technologies have contributed greatly to the transparency of information which was often hidden for strategic reasons. The information is obtained quickly and with less cost. Technology is a favorable asset to improve the profitability of banks. It is present at all stages of the bidding process. Innovation in products can also be a competitive advantage. Each bank has to offer a new product or service that will take advantage and increase its visibility.

In addition, we find a positive relationship between cost efficiency and total assets ratio credits (RC), which is a measure of credit risk. This result suggests that the most active banks in the credit segment tend to be more efficient.

As logarithm of total assets ($\ln(TA)$), its coefficient is significantly positive for the banking sector. This source of inefficiency appears to be related to the critical size, that is to say the presence of diseconomies of scale. Thus, the size of the bank affects negatively the level of efficiency. The more the size increases, the more the efficiency level decreases.

This result shows that Tunisian banks do not have the managerial capacity to manage an important total assets. The more the size increases, the more the waste of resources increases. This result is consistent with the work of Hermalin and Wallace (1994), Kaparakis et al. (1994), DeYoung and Nolle (1996), Isik and Hassan (2002a) who found a negative relationship between efficiency and total assets.

Finally, concerning the structure of the banking market which is measured by the index of concentration of Herfindahl Hirshman Index (HHI), its impact on bank efficiency is negative. This result can be supported by the fact that financial liberalization in the banking sector in Tunisia was meant as it seems, to increase competition, to improve the productive efficiency of banks.

Which justifies the negative impact of the market share variable (PM) on the level of efficiency. In fact, the three major Tunisian banks (ANB, TBC and IABT) which are less efficient on average, share almost 50% of market share of the Tunisian banking sector. This shows that the concentration is less beneficial in terms of efficiency in Tunisian commercial banks than the competition. Therefore, these banks will be forced to diversify their activities.

We can account for these results by the fact that (ANB) is heavily involved in the agricultural sector subject to weather conditions and thereby erecting in a very risky sector, which implies that the bank has relatively high provision risks and therefore very low margins. The (TBC) continues its role as the centerpiece of the economic state policy in financing industrial firms which are in difficulty. In addition to that, (IABT) finances a large part of SMEs whose size is lower and whose risk of default is high.

The results of the efficiency side of profit show a positive and significant relationship between efficiency and profit capitalization ratio. This shows that an increase in bank capitalization leads to an improvement in the quality of capital and subsequently an increase for banks. In addition, this could be explained by the fact that, in light of the high standards of equity, banks may decide to replace loans by alternative forms of capital (see Vanhooose, 2007; Pasiouras and al. 2008).

However, it is hard to notice that our estimates do not imply causality between productive efficiency and managerial behavior. We simply find a correlation between non-performing loans and cost efficiency, which supports the view that most Tunisian banks are saddled with an overhang of non-performing loans which obviously affect their efficiency levels.

5. Conclusion

In this model, we have used an extension of the stochastic frontier approach which assumes a truncation parameter specific to each bank. This allowed us to assess changes in the level of cost efficiency of Tunisian commercial banks and to identify relationships between the productive performance and a combination of internal and external determinants.

The estimated cost efficiency shows a strong correlation between positive and significant efficiency scores according to the approaches (SFA) and (SFAA). The empirical results show that the efficiency cost, depending on the approach SFAA has evolved mixed between 1993 and 2010.

Regarding the estimation of efficiency depending on the size of banks, the results show that banks of small and medium size of our sample show medium cost efficiencies better than those made by banks of large sizes. While on the side of profit, estimates show that large and medium-sized banks are more efficient than smaller ones.

Focusing on the determinants of internal productive performance of Tunisian banks, our results show that the preponderance of credit activity in relation to other outputs represents a source of efficiency for banks.

Among the factors that negatively affect the level of efficiency, there is the size. Thus, the larger the size, the more the level of efficiency decreases. In addition, a negative relationship between the provision for credit losses (as a proxy for non-performing loans) and the level of cost inefficiency is clear. Finally, concerning the structure of the banking market, we find a negative relationship with bank efficiency. This shows that a competitive environment is more beneficial in terms of efficiency for Tunisian commercial banks.

References

- Abdelkhalek T., & Solhi, S. (2009). Efficience et productivité des banques commerciales marocaines: approche non paramétrique. *Economic Research Forum, Working papers* 01/2009.
- Allen, J., & Engert, W. (2007). Efficience et concurrence dans le secteur bancaire canadien. *Revue de la banque de CANADA*. Été 2007.
- Allen, J., & Liu, Y. (2005). Efficiency and Economies of scale of large Canadian Banks. Document de travail n° 2005-13. *Banque du Canada, et Revue canadienne d'économie*, 40(1), 225-244.
- Allen, J., Engert, W., & Liu, Y. (2006). Are Canadian Banks Efficient? A Canada-U.S. Comparison. Document de travail n° 2006-33. Banque du Canada.
- Aly, H., Grabowsky, R., Pasurka, C., & Rangan, N. (1990). Technical, Scale and Allocative Efficiencies in U.S. Banking: An Empirical Investigation. *The Review of Economics and Statistics*, 72, 211-218. <http://dx.doi.org/10.2307/2109710>
- Ben Naceur, S. (2003). The determinants of the Tunisian banking industry profitability: Panel evidence 1980-2000. *Papier présenté à la 11^e conférence de L'Economic Research Forum (EFR)*. Marrakech. Novembre.
- Berger, A. N. (1995). The Profit-structure Relationship in banking: Test of Market-Power Efficient-Structure Hypothesis. *Journal of Money, Credit and Banking*, 27, 404-431. <http://dx.doi.org/10.2307/2077876>
- Berger, A. N. (2007). International comparisons of banking efficiency. *Financial Markets, Institutions and Instruments*, 16(3), 119-144. <http://dx.doi.org/10.1111/j.1468-0416.2007.00121.x>
- Berger, A. N., & De Young, R. (1997). Problem Loans and Cost Efficiency in Commercial Banks. *Journal of Banking and Finance*, 21, 849-870. [http://dx.doi.org/10.1016/S0378-4266\(97\)00003-4](http://dx.doi.org/10.1016/S0378-4266(97)00003-4)
- Berger, A. N., & Hannan, T. H. (1995). The Efficiency Cost of Market Power in the Banking Industry: A Test of the 'Quiet Life' and Related Hypotheses. *Working Paper*, Board of Governors of the Federal Reserve System.
- Berger, A. N., & Mester, L. (1997). Inside the black box what explains differences in the efficiencies of financial institutions? *Journal of Banking & Finance*, 21(7), 895-947. [http://dx.doi.org/10.1016/S0378-4266\(97\)00010-1](http://dx.doi.org/10.1016/S0378-4266(97)00010-1)
- Berger, A., & Hannan, T. (1997). Using Measures of Firm Efficiency to Distinguish among Alternative Explanations of the Structure-Performance relationship in banking. *Managerial Finance*, 23, 6-31. <http://dx.doi.org/10.1108/eb018599>
- Berger, A., Humphrey, D., & Smith, F. W. (1993). Economies d'échelle, fusions, concentration et efficacité. *Revue d'Economie Financière*, n° 27, Hiver.

- Burkart, O., Gonsard, H., & Dietsch, M. (1999). L'efficience coût et l'efficience profit des établissements de crédit français depuis 1993. *Bulletin de la commission bancaire*, 20(Avril), 43-66.
- Cebenoyan, A. S., Cooperman, E. S., Register, C. A., & Hudgins, S. C. (1993). The relative Cost Efficiency of Stock Versus Mutual S&Ls: A Stochastic Cost Frontier Approach. *Journal of Financial Services Research*, 7, 151-170. <http://dx.doi.org/10.1007/BF01046903>
- Chaffai, M. E. (1998). Estimation des Inefficacités Techniques et Allocatives des Banques de Dépôts Tunisiennes: une Frontière de coût Fictif. *Economie et Prévision*, 5, 117-129. <http://dx.doi.org/10.3406/ecop.1998.5942>
- Chaffai, M. E., & Dietsch, M. (1998). Productive efficiency performances of Tunisian and Moroccan banks: an econometric analysis using panel data. Paper presented at the *ERF Fourth annual conference*, Beirut 7-9 September.
- Chang, C., Hasan, I., & Hunter, W. (1998). Efficiency of Multinational Banks: An Empirical Investigation. *Applied Financial Economics*, 8, 1-8.
- Coelli, T. J., Prasada Rao, D. S., & Battese, G. E. (1998). *An Introduction to Efficiency and Productivity Analysis*. Boston, U.S.A: Kluwer Academic Publishers. <http://dx.doi.org/10.1007/978-1-4615-5493-6>
- Cook, W. D., Hababou, M., & Gordon, S. R. (2000). The effects of Financial Liberalization on the Tunisian Banking Industry: A Non-Parametric Approach. *Working Paper*, Schulich School of Business, York University.
- De Young, R., & Nolle, D. E. (1996). Foreign-Owned Banks in the United States: Earning Market Share of Buying it? *Journal of Money, Credit, and Banking*, 28(4), 622-636. <http://dx.doi.org/10.2307/2078074>
- Dietsch, M. (1992). *Coûts et concurrence dans l'industrie bancaire*. Rapport pour le Conseil National du crédit et l'Association Française des Banques, Mars, 98 p.
- Dietsch, M. (2005). *La place de la concurrence dans l'organisation et le fonctionnement du secteur bancaire*. Cycle de conférences: Droit, Economie et Justice dans le secteur bancaire.
- Fecher, F., & Pestieu, P. (1993). Efficiency and Competition in OECD Financial Services. In Fried H. O., C. A. Lovell & S. S. Schmidt (Eds.), *the Measurement of Productive Efficiency*. OUP.
- Florian, L. (2012). Effet de la concurrence sur l'efficience bancaire en Afrique: le cas de l'UEMOA. *CERDI, Etudes et Documents*, E 2012.2, Janvier.
- Hermalin, B., & Wallace, N. (1994). The Determinants of Efficiency and Solvency in Savings and Loan. *Rand Journal of Economics*, 25, 361-381. <http://dx.doi.org/10.2307/2555767>
- Isik, I., & Hassan, M. K. (2002a). Technical, scale and allocative efficiencies of Turkish banking industry. *Journal of Banking and Finance*, 26, 719-766. [http://dx.doi.org/10.1016/S0378-4266\(01\)00167-4](http://dx.doi.org/10.1016/S0378-4266(01)00167-4)
- Isik, I., & Hassan, M. K. (2002b). Cost and profit efficiency of the Turkish banking industry: An empirical investigation. *The Financial Review*, 37, 257-280. <http://dx.doi.org/10.1111/1540-6288.00014>
- Isik, I., & Hassan, M. K. (2003a). Governance, corporate control and Efficiency of the Turkish Banking Industry. *Journal of Business Finance and Accounting*, 30(9-10), 1363-1421. <http://dx.doi.org/10.1111/j.0306-686X.2003.05533.x>
- Isik, I., & Hassan, M. K. (2003b). Financial Disruption and Bank Productivity: The 1994 Experience of Turkish Banks. *The Quarterly Review of Economics and Finance*, 43, 291-320. [http://dx.doi.org/10.1016/S1062-9769\(02\)00194-1](http://dx.doi.org/10.1016/S1062-9769(02)00194-1)
- Isik, I., Gunduz, L., & Omran, M. (2005). Impacts of Organizational Forms, Stock Performance and Foreign Ownership on Bank Efficiency in Jordan: A Panel Study Approach. *Communication à l'Economic Research Forum*, 19-21 Décembre 2005.
- Kablan, S. (2012). *Efficacité des institutions de microfinance en UEMOA: une approche outreach-intermédiation financière*. Equipe de Recherche sur l'Utilisation des Données Individuelles Temporelles en Economie (ERUDITE); Université Paris-Est Créteil Val-de-Marne (UPEC); 30/04/2012.
- Kaparakis, E. I., Miller, S. M., & Noulas, A. G. (1994). Short-Run Cost Inefficiency of Commercial Banks: A Flexible Frontier Approach. *Journal of Money, Credit and Banking*, 26(4), 875-893. <http://dx.doi.org/10.2307/2077953>
- Koetter, M., Kolari, J. W., & Spierdijk, L. (2008). Efficient Competition? Testing the 'quiet life' of U. S banks

- with Adjusted Lerner Indices. Paper presented at *the 44 th Bank Market Structure Conference*, Federal Reserve Bank of Chicago.
- Lapteacru, I., & NYS, E. (2011). L'impact de la concurrence sur l'efficience des banques: le cas des PECO. *Revue Economique*, 62. <http://dx.doi.org/10.3917/reco.622.0313>
- Mester, L. J. (1993). Efficiency in the Savings and Loan Industry. *Journal of Banking & Finance*, 17, 267-286. [http://dx.doi.org/10.1016/0378-4266\(93\)90032-9](http://dx.doi.org/10.1016/0378-4266(93)90032-9)
- Mester, L. J. (1996). A study of bank efficiency taking into account risk-preferences. *Journal of Banking and Finance*, 20, 1025-1045. [http://dx.doi.org/10.1016/0378-4266\(95\)00047-X](http://dx.doi.org/10.1016/0378-4266(95)00047-X)
- Pasiouras, F., Liadaki, A., & Zopounidis, C. (2008). Bank efficiency and share performance: evidence from Greece. *Applied Financial Economics*, 18, 1121-1130. <http://dx.doi.org/10.1080/09603100701564346>
- Pi, L., & Timme, S. (1993). Corporate Control and Bank Efficiency. *Journal of Banking and Finance*, 17, 515-530. [http://dx.doi.org/10.1016/0378-4266\(93\)90050-N](http://dx.doi.org/10.1016/0378-4266(93)90050-N)
- Vanhooose, D. (2007). Theories of Bank Behavior Under Capital Regulation. *Journal of Banking and Finance*, 31(12), 3680-3697. <http://dx.doi.org/10.1016/j.jbankfin.2007.01.015>
- Weill, L. (1998). Concurrence et efficience dans la banque: modélisation théorique et vérification empirique. *Revue Française d'Economie*, 13(2), 101-127. <http://dx.doi.org/10.3406/rfeco.1998.1051>
- Zaim, O. (1995). The effect of financial liberalization on the efficiency of Turkish commercial banks. *Applied Financial Economics*, 5, 257-264. <http://dx.doi.org/10.1080/758536876>