Journal of Applied Finance & Banking, vol.2, no.5, 2012, 1-25
ISSN: 1792-6580 (print version), 1792-6599 (online)
Scienpress Ltd, 2012

Financial liberalization (FL), environment variables and cost efficiency of Tunisian banking system

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Abstract

In this paper, we tried to see if the Tunisian banks are ready to confront the different and main challenges of financial liberalization. The main objective of this paper is defined in this context. We investigate the cost efficiency of Tunisian universal banks over the period 1997–2006. We examine the influence of environmental variables on the bank cost-efficiency. We used a parametric approach stochastic "SFA". Our results generally indicate the deterioration of different financial indicators of Tunisian banking system, and show that there is a reduction in the level of cost-efficiency after introducing the environmental variables in the model. Our results suggest as well that private banks are more efficient than ownership banks; foreign banks are more efficient than domestic banks. Finally, we found that small and Medium-sized banks are more efficient than large banks.

JEL classification numbers: G21, F36, C13
Keywords: Financial liberalization, Cost-efficiency, Environment variables, SFA, Tunisian banks

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Article Info: *Received* : March 15, 2012. *Revised* : June 1, 2012
Published online : October 15, 2012

1 Introduction

The last two decades were marked in Tunisia by reforms that affected, in various degrees, all the sectors of the national economy. Among these sectors, like in many developing countries, the banking system has been transformed over through liberalization, the entry of private banks, the privatization of public-sector banks, and the tightening of prudential regulations. It has undergone with the help and the support from the International Monetary Fund (IMF) and the World Bank a progressive and a gradual process of liberalization that appears in a structural adjustment program. Indeed, it remains even difficult to identify the financial conditions, institutional, economic and political to succeed a liberal financial politics. But to assure a certain security and stability to the banking sector in a liberalized environment, some conditions are quite indispensable for the success of the financial liberalization. The development of the domestic financial system and particularly the efficiency of the banking system is therefore a necessary condition for the success of financial liberalization policy.

The main objective of this paper is to provide extensive information on the efficiency of Tunisian banking systems. To compare the cost efficiency of different Tunisian banking population we include the appropriate environmental variables in the cost frontier estimations. We then use bank specific variables to explain the sources of inefficiency across banks. We propose cost efficiency measures for the Tunisian banking system. We have a short panel data of 17 universal banks observed for 10 years. These banks are representative of the sector as they have more than 85% of the market. Therefore, the objective of this study is to know if the Tunisian banking system is ready to face the different and main challenges of the financial liberalization. In other words, is our banking system efficient to adopt to the deep transformations in their landscape and the constraints of financial liberalization?

The literature on bank efficiency and the role of environment variables is dominated by studies about the European banking industries. We accentuate in our analysis the impact of environmental conditions on the cost-efficiency of Tunisian banking system. In particular, three categories of environmental variables are taken into account: those that describe the financial performance, variables that describe the structure and regulation of the banking industry, and those that describe the main macroeconomic conditions. Our results suggest that, ignoring environmental variables, the cost-efficiency scores of Tunisian universal banks are quite high. However, when environmental variables are included, the cost-efficiency scores are reduced substantially.

The remainder of the paper is organized as follows: section 2 provides a review of the related literature. In section 3, we discuss the methodology and the econometric specification used to estimate the cost function. The data and variables are reported in Section 4. Section 5 reports the empirical results of the estimation. The paper's concluding remarks are provided in Section 6.

2 Brief literature review

Michel Dietsch and Ana Lozano-Vivas (2000) investigate the influence the environmental conditions have on the cost efficiency of French and Spanish banking industries. In this order, they chose the Distribution Free Approach (DFA) for a sample of 223 French banks and 101 Spanish banks over the years 1992–2002. They propose a comparison of the cost-efficiency of the banking industries in France and Spain, introducing the appropriate environmental variables[3] in the cost frontier estimations. They specified and estimated a common frontier without taking country-specific environmental variables into account. They found the cost-efficiency scores of Spanish banks are quite low compared to those of the French banks. When the environmental variables are included in the model, the differences between both banking industries are reduced substantially. Therefore, their result indicates that the country-specific variables are an important factor in explaining efficiency differences among the countries.

Weil, L (2004) used the parametric technique, SFA, to analyze the overall cost efficiency (OE) in the banking sector of seventeen European countries. The cross-section sample consisted of 640 banks for the financial year 1996/2000. He specified three outputs (loans, environmental variables, investment securities) and three prices: the price of labor, the price of purchased funds, and the price of physical capital. His findings indicate that, banks in Western European region are more efficient than banks in Eastern European region. Overall, his results demonstrate that environmental variables contribute significantly to the difference inefficiency scores between the two regions.

Oscar Carvallo and Adnan Kasman (2005) investigate the cost efficiency of the Latin American and Caribbean banking industries for a sample of 481 banks in 105 countries over the years 1995–1999 using a stochastic frontier model SFA. They used three inputs: loans, deposits, and other earning assets (investment securities). And three prices of factors of production: the price of labor, the price of purchased funds, and the price of physical capital. Their results suggest that, there is a wide range of inefficiency levels across countries. They found that, without environmental variables, the average cost-inefficiency score is around 17.8%. However, when environmental variables[4] are included in the model, efficiency levels increase remarkably in most countries. The efficiency level increases in 12 countries in the sample. They also found that on average, very

[3] Population density, Per capita income, Density of demand, Herfindhal index of concentration, Average capital ratio, Intermediation ratio, Number of branches per square kilometer.

[4] Density of population, GDP per capita ($),Deposits/ km2 ($),Concentration index (%), Equity/total assets, Loan/ deposits, Roads, paved (% of total roads) GDP growth (%), and Money/ GDP

small and very large banks are significantly more inefficient than large banks. Moreover, the largest economies in the region tend also to be the most inefficient.

Steven Fries and Anita Taci (2005) employed the stochastic frontier approach to examine cost efficiency in the banking systems (289 banks) of the 15 East European countries over the period 1994–2001. They included several environmental variables (country-level variables)[5] in the estimation of the cost function. They found that banking systems with a higher intermediation ratio have significantly lower costs. And a higher share of non-loan assets in total assets of a bank is positively associated with higher costs. They also found a significant positive association between GDP per capita and banking costs but no association between inflation and costs. Their findings are also, private banks are more efficient than state-owned banks, and privatized banks with majority foreign ownership are the most efficient and those with domestic ownership are the least.

Using a stochastic frontier approach, incorporating firm-specific and country-related variables for data from 1998 to 2003, Lensink et al (2008) investigates the cost efficiency of 2095 commercial banks in 105 countries. They examined the influence of environmental variables (country-level variables and institutions)[6] on the foreign ownership-bank efficiency relationship. The results indicate generally country-level factors that increase cost efficiency are higher GDP, concentration rate, and lower nominal interest. Also, their results suggest that on average, domestic banks are more efficient than foreign banks. Finally, their study indicates the importance of well developed institutions for the efficient operation of foreign banks.

3 Methodology

This paper utilizes the stochastic frontier approach (SFA), as developed by Aigner et al. (1977) and applied to banks by Ferrier and Lovell (1990) to calculate measures of cost efficiencies for each bank in the sample. The stochastic cost frontier has the following general form:

$$TC_{it} = f(w_{it}, y_{it}, z_{it}\,;\, B) + \varepsilon_{it}, \quad i = 1, 2\ldots\mathrm{N}, \quad t = 1, 2\ldots\mathrm{T} \qquad (1)$$

The model can also be re-specified in log linear form as:

[5] Per capita GDP (in US$), Nominal market interest rat (in %), Deposits per square kilometre (in US$/km2), Assets share of five largest banks (in %), Asset share of majority foreign-owned banks (in %), Average ratio of total loans to total deposits, Average ratio of capital to asset of the sector (in %), and EBRD transition indicator for banking reform (index, 1-4).

[6] GDP per capita, Nominal interest rate, Concentration rate, and Domestic credit to private sector.

$$\ln TC_{it} = \ln f(w_{it}, y_{it}, z_{it}; B) + \varepsilon_{it} \quad (2)$$

Where i,t index the bank and year, respectively, TC represents the bank's total costs in logarithm form, ν is a vector of input prices in logarithm form, y is a vector of outputs in logarithm form, z is country-specific environmental variables, E is a vector of all parameters to be estimated, ε is an error term. N is the number of banks, T is the number of years. This approach disentangles the error term in two components: component of inefficiency and a component of random error.

$$\varepsilon_{it} = \vartheta_{it} + \mu_{it}$$

The first one, μ_i captures cost inefficiency. The second one, ϑ_i captures measurement error and random effects, good and bad luck. It is assumed that ϑ_i is distributed as a symmetric normal $\left(\vartheta_i \sim N(0, \sigma_\mu^2)\right)$ and that μ_i is identically distributed as a half-normal $\left(\mu_i \sim N(0, \sigma_\vartheta^2)\right)$. Also, ϑ_i is distributed independently of μ_i. The stochastic frontier approach supposes that $\mu_i \geq 0$ and that is, higher bank inefficiency is associated with higher cost.

For our cost efficiency function, we use the transcendental logarithmic specification. Which can be specified as follows:

$$\begin{aligned} \ln TC_i = a_0 + \sum_i a_i \ln w_i + \sum_j \beta \ln Y_j + \frac{1}{2}\sum_i \sum_m a_{im} \ln w_i \ln w_m \\ + \frac{1}{2}\sum_j \sum_k a_{jk} \ln Y_j \ln Y_k + \sum_i \sum_j \delta_{ij} \ln w_i \ln Y_j + \sum_i \varphi_i \end{aligned} \quad (3)$$

Where w_m and w_i are input prices and Y_j and Y_k are outputs quantities. In estimating Eq. (1) with this specific functional form, we impose constraints on symmetry $a_{im} = a_{mi}$ and $\delta_{ij} = \delta_{ji}$, $\forall\ i, j$, homogeneity in prices, and adding-up,

$$\sum_m a_{im} = \sum_m a_{mi} = \sum_j \delta_{ij} = 0, \quad \forall\ i\,.$$

We follow Jondrow et al. (1982) that showed that the variability, σ, can be used to measure a firm's mean efficiency, where. Firm-level measures of inefficiency are usually given by the mean and mode of the conditional distribution of μ_i given ε_i. Jondrow et al. (1982), an estimate of the bank level inefficiency measures can be derived from the composite error term as follows:

$$E\left(\mu_i \middle/ \varepsilon_i\right) = E_i = \frac{\sigma\lambda}{1+\lambda^2}\left(\frac{\not{\Phi}(\varepsilon_i\lambda/\sigma)}{\Phi(\varepsilon_i\lambda/\sigma)} + \frac{\varepsilon_i\lambda}{\sigma}\right)$$

Where, E_i is the inefficiency level of the *i*th bank, $E\left(\mu_i / \varepsilon_i\right)$ is the expectation operator. The general procedure for estimating cost inefficiency from Eq. (3) is to estimate equation coefficients and the error term $\varepsilon_{it} = \vartheta_{it} + \mu_{it}$ and to calculate efficiency for each observation in the sample.

4 The Data and Variables

4.1 Data

In this study, the data is taken from Tunisia's Professional Association of Banks and Financial Institutions APTBEF, which collect and publish yearly the balance sheets and other information on the Tunisian banking activities, the National Institute of Statistics (INS).and the Central Bank of Tunisia (BCT). We will give estimates of cost efficiency via a sample of 17 Tunisian universal banks observed. These banks are National Agricultural Bank (BNA), Tunisian Banking Company (STB), Bank of Tunisia (BT), International Banking Union (UIB), Banking Union for Trade and Industry (UBCI), Amen Bank (AB), Arab Tunisian Bank (ATB), Attijari Bank Of Tunisia (ATTIJARI BANK), Bank of Housing (BH), Arab International Bank Of Tunisia (BIAT), Tunisia And Emirates Bank (BTE), Franco-Tunisian Bank (BFT), Tuniso-Kuwaiti Bank (BTK), Tuniso-Libyan Bank (BTL), Citibank, Stusid Bank, Tunisian Qatari Bank (TQB). Four universal banks were not retained Bank for Financing Small/Medium Businesses (BFPME), Arab Banking Corporation (ABC), and Tunisian Solidarity Bank (BTS). The data are annual covering the period 1997-2006.

4.2 Variable outputs and inputs

One of the crucial issues to build a model for the assessment of banking efficiency is the identification of appropriate inputs and outputs. Five approaches are well established in the banking literature, and they are usually used in production/cost banking studies. These are the production, the intermediation, the asset, user-cost and value-added approaches. In the present study, the choice of cost, price and output variables included in the specification is determined by the availability of data and by our view on the way that banks operate and what they produce. In this paper we follow the value-added approach (Berger and Humphrey (1992), Humphrey and Pulley (1997), Dietsch and Lozano-Vivas (2000) Oscar Carvallo and Adnan Kasmanb (2005)) to identify banking outputs and inputs. Therefore, this study considers deposits as input and output at the same time. This choice is justified by the fact that in the Tunisian context, the banking sector operates with a logic where the banks use the labor and capital factors to collect

deposits, and at the same time use the funds at their disposal (the sum of deposits) to pursue a massive policy of loans. It seems more logical that the deposits of Tunisian banks are read as an input and an output at the same time. Furthermore, the specification assumes three input prices and three output quantities. The first input price is the price of labor. This price is defined as the ratio of personnel expenses (PE) scaled by total assets (TA). The second input price is the price of physical capital. This price is calculated by dividing fixed capital depreciation by fixed assets. The third input price is the price of purchased funds. This price is calculated as the ratio between total interest expenses and total deposits. The outputs estimated in the value-added approach are: 'total deposits'; and 'total loans'.

The following tables (Table 1 and Table 2) present average values of assets, capital stock, costs and average values of bank outputs, and inputs prices (in thousand Tunisian dinars) of different variables to be used in the model.

Table 1: Descriptive statistics of main variables

Variable	Global Average	large banks	Small and Medium Banks
Total assets	1338400,51	2442971,19	565201,032
Total capital stock	155623,217	226945,645	105697,517
Output			
Loans	1123937,04	2075533,94	457819,214
Deposits	1087541,48	2031701,65	426629,359
Inputs			
personnel expenses	20667,5423	38423,4423	8238,41238
fixed capital depreciation	5136,67318	8437,44430	2826,13340
Interests incurred and similar charges	37167,5088	69330,5982	14653,3463
Total costs	71624,1609	130291,297	30557,1653
Prix des inputs			
w1 : Price of Labor	0,0294150	0,0153796	0,0392397

w2 : price of physical capital	0,3371957	0,2346220	0,4089972
w3 : Price of funds	0,0427193	0,0339708	0,0488433

Source: Tunisia's Professional Association of Banks and Financial Institutions APTBEF

Table 2: Descriptive statistics of main variables

Variable	domestic banks	Foreign and Mixed banks
Total assets	2258336,66	694445,2
Total capital stock	219320,713	111034,97
Output		
Loans	1925543,66	562812,41
Deposits	1854954,06	550352,67
Inputs		
personnel expenses	34826,6886	10756,14
fixed capital depreciation	8245,87774	2960,23
Interests incurred and similar charges	63661,6643	18621,6
Total costs	119408,233	38175,31
Prix des inputs		
w1 : Price of Labor	0,0166284	0,0383656
w2 : price of physical capital	0,2370055	0,4073287
w3 : Price of funds	0,0351463	0,0480205

Source: Tunisia's Professional Association of Banks and Financial Institutions APTBEF

Table 1 and Table 2 provide some descriptive statistics for the variables of the model specification. Comparing the mean values. There is a fairly significant difference between different populations of banks. First, their total costs are quite different: the "large banks" and "domestic banks" have an average of personnel expenses, and Interests incurred and similar charges much higher than those of "small and medium" sizes and "foreign and mixed banks", respectively. Second,

concerning outputs and input prices, “domestic banks” and “large banks” have lower prices of inputs than those of “foreign and mixed banks”, and “small and medium banks”, respectively. Also, “domestic banks” and “large banks” distribute a lot more loans and collect a lot more deposits than “foreign and mixed banks” and “small and medium banks”, respectively.

Table 3: Descriptive statistics of main variables

Variable	Public bank, mixed	Public bank, domestic
Total assets	187588,175	2451759,546
Total capital stock	105232,9	236804,3001
Output		
Loans	142152,875	2156101,072
Deposits	64599,85	1974621,479
Inputs		
personnel expenses	2204,25	38963,04331
fixed capital depreciation	1026,15	6511,585182
Interests incurred and similar charges	3862,425	68159,52362
Total costs	8071,2	126029,1824
Prix des inputs		
w1 : Price of Labor	0,013048947	0,018880707
w2 : price of physical capital	0,547703734	0,246085648
w3 : Price of funds	0,062300176	0,035289321

Source: Tunisia’s Professional Association of Banks and Financial Institutions APTBEF

Table 3 and Table 4 present different variables according to the ownership structure (two types of public banks and two types of private banks). We observe that the average total cost of privatized domestic bank is extensively more elevated than those of privatized foreign bank. Also, we find that public domestic bank have an average total costs much higher than those of public bank mixed. Concerning outputs, privatized domestic bank and public domestic bank distribute a lot more loans and collect a lot more deposits than privatized foreign bank and

public mixed bank, respectively. About input prices, privatized domestic bank and public mixed bank have lower prices of inputs than those of privatized foreign bank and public domestic bank, respectively.

Table 4: Descriptive statistics of main variables

Variable	Privatized bank, foreign	Privatized bank, domestic
Total assets	1032349,883	2000439,495
Total capital stock	114903,0167	196009,2634
Output		
Loans	843252,1	1618133,776
Deposits	874187,886	1695397,506
Inputs		
personnel expenses	16457,4	29311,54897
fixed capital depreciation	4249,616667	10558,26782
Interests incurred and similar charges	28461,05	57664,51865
Total costs	58244,71667	110580,3019
Prix des inputs		
w1 : Price of Labor	0,05524342	0,013625332
w2 : price of physical capital	0,313745493	0,224898857
w3 : Price of funds	0,038500735	0,034955655

4.3 Environmental Variables

As in Dietsch and Lozano-Vivas (2000), Oscar Carvallo and Adnan Kasman (2005), Environmental variables are categorized in three groups. The first group is called ``main conditions'' and includes a measure of density of population, income per capita, and density of demand. The density of population is measured by the ratio of inhabitants per square kilometer. We suppose that banking services supply in areas of low population density would engender higher banking costs. Finally,

the density of demand, measured by total deposits per square kilometer is a relevant factor in determining efficiency. This variable can affect bank efficiency. Banks that operate in an economic environment with a lower deposit per square kilometer would probably have higher expenses and costs. Finally, the income per capita of a country, however, affects numerous factors related to the demand and supply for deposits and loans. Because, a high level of GDP per capita in a country affect positively savings and the repayment capacity of households. Thereafter, it has a positive effect on bank efficiency.

Table 5: Descriptive statistics of environmental variables

Environmental variables	Global Average	large banks	Small and Medium Banks
Main conditions			
Density of demand	6,6471577	12,4179552	2,6075995
GDP per capita (TND)	0,0018935		
Density of population	62,2659		
Bank structure and regulation			
intermediation ratio	1,4777728	1,0310433	1,7904834
average capital ratio	0,2200401	0,0923812	0,3094013
Financial performance			
Return on average equity (in %) ROE	0,0181309	0,0674765	-0,0164110
Return on average assets (in %) ROA	0,0005225	0,0068687	-0,0039199

Sources: the National Institute of Statistics (INS), the Central Bank of Tunisia (BCT) and Tunisia's Professional Association of Banks and Financial Institutions (APTBEF)

The second group of environmental variables, named "bank structure and regulation" includes an average capital ratio, and intermediation ratio. The average capital ratio is calculated as the ratio between total capital stock (TCS) and total assets (TA). A low Average capital ratio could generate higher banking costs. Usually, an inverse relationship exists between inefficiency and average capital ratio (Oscar Carvallo and Adnan Kasman, 2005) "because less equity implies higher risk taken at greater leverage" (Dietsch and Lozano-Vivas, 2000).

Therefore, a lower capital ratio leads to lower efficiency levels. The second type intermediation ratio is calculated by dividing total loans by total deposits. Higher intermediation ratio could be associated with lower costs of the banking sector, this situation generate higher banking efficiency. For this reason, we will anticipate an inverse relationship between intermediation variable and inefficiency. The intermediation variable captures the ability of domestic banking industries to convert deposits into loans.

The final group of environmental variables named "financial performance" consists of variables such as return on assets (ROA = net income/total assets) and return on equity (ROE = net income/capital stock). Usually, an inverse relationship exists between inefficiency and variables of financial performance.

Table 6: Descriptive statistics of environmental variables

Environmental variables	domestic banks	Foreign and Mixed banks
Main conditions		
Density of demand	11,337657	3,3638083
GDP per capita (TND)		
Density of population		
Bank structure and regulation		
intermediation ratio	1,0451108	1,7806361
average capital ratio	0,0921829	0,3095400
Financial performance		
Return on average equity (in %) ROE	0,0747930	-0,0215325
Return on average assets (in %) ROA	0,0077120	-0,0045101

Sources: the National Institute of Statistics (INS), the Central Bank of Tunisia (BCT) and Tunisia's Professional Association of Banks and Financial Institutions (APTBEF)

Table 5 and Table 6 presents average values of environmental variables over the 1997-2006 period. The mean values of the banking industry and regulation variables show that there are important differences between different populations of Tunisian banks. In particular, the capital ratio of "large banks" and "domestic banks" is more elevated than those "small and medium banks" and "foreign and mixed banks", respectively. Another difference between different populations of

Tunisian banking industries is that the intermediation ratio is lower in "large banks" and "domestic banks" than "small and medium Banks "and "foreign and mixed banks", respectively.

Turning to financial performance, these arithmetic means suggest large differences between different populations of Tunisian banks. "Large banks" and "domestic banks" have a return on average equity and return on average assets much higher than those of "small and medium banks" and "foreign and mixed banks", respectively.

Finally, these arithmetic means suggest large differences in the main conditions of Tunisian banking activities. The density of demand is higher in "large banks" and "domestic banks" than in "small and "medium banks" and "foreign and mixed banks", respectively. The population density is higher in Tunisia. But, its per capita income is higher weak.

Table 7: Descriptive statistics of environmental variables

Environmental variables	Public bank, mixed	Public bank, domestic
Main conditions		
Density of demand	0,394840474	12,06907572
Bank structure and regulation		
intermediation ratio	2,828027564	1,09517
average capital ratio	0,552716673	0,08544408
Financial performance		
Return on average equity (in %) ROE	-0,108566499	0,039222128
Return on average assets (in %) ROA	-0,01885887	0,004231091

Source: the National Institute of Statistics (INS), the Central Bank of Tunisia (BCT) and Tunisia's Professional Association of Banks and Financial Institutions APTBEF

As seen in Table 7 and Table 8, there are large differences in all Environmental variables between Public banks and Privatized bank. In particular, the intermediation ratio, the average capital ratio, the return on equity, the return

on assets, and the density of demand (deposits per square kilometer) varies greatly across different populations of Tunisian banks (ownership structure).

Table 8: Descriptive statistics of environmental variables

Environmental variables	Privatized bank, foreign	Privatized bank, domestic
Main conditions		
Density of demand	5,343120139	10,36243204
Bank structure and regulation		
intermediation ratio	1,082375218	0,978365355
average capital ratio	0,147422377	0,101168158
Financial performance		
Return on average equity (in %) ROE	0,036490083	0,122220773
Return on average assets (in %) ROA	0,005055635	0,012353172

Source: the National Institute of Statistics (INS), the Central Bank of Tunisia (BCT) and Tunisia's Professional Association of Banks and Financial Institutions APTBEF

5 Empirical results

5.1 The Efficiency Correlates

The following table summarizes the average values of different variables to be used in the model. It reports two sets of estimation results based on the conditional mean approach. One specification allows for environmental variables to influence the position of the cost efficiency frontier and the other does not.

The estimation results reveal a number of important characteristics of the cost function of banks and the correlates of bank inefficiencies in Tunisian economy. Most coefficients for input prices and output have a positive sign, and are statistically significant at the 1%, 5% and 10% significance level.

The logistic parameter estimates and simple correlation coefficients are shown in Table 9 and Table 10. All coefficients for input prices have a positive sign. The price of labor is significant but the price of physical capital and the price of funds are not significantly related to costs. These estimates show a positive relationship between input prices and cost inefficiency. The loans variable is

significantly negative, but the deposit variable, is significantly positive. It seems, however, as if, in general, higher prices or higher output except for deposit factor generate higher total costs.

Table 9: Panel estimation of stochastic cost efficiency frontier and correlates of bank inefficiencies

	With environmental variables		
Variable	Coefficient	Ecart-type	T-Student
α_0 : (constant)	-1,48E+01	9,87E-01	-1,50E+01
ln (Y_1)	-9,75E-10	1,47E-10	-6,64E+00
ln (Y_2)	3,16E-01	9,91E-02	3,19E+00
ln(Y_{31})	4,21E-09	1,23E-09	3,43E+00
ln(Y_{32})	-4,23E-02	1,35E-01	-3,14E-01
ln(Y_{33})	5,48E-10	2,79E-10	1,97E+00
ln(Y_{34})	1,66E-02	1,88E-01	8,86E-01
ln(Y_{35})	-9,08E-12	4,71E-10	-1,93E-02
ln(Y_{36})	-3,49E+00	3,06E-01	-1,14E+01
ln(Y_{37})	-9,14E-10	4,11E-10	-2,23E+00
ln (W_1)	4,00E-01	1,28E-01	3,12E+00
ln (W_2)	1,33E-10	9,41E-11	1,42E+00
ln (W_3)	1,45E-01	8,09E-02	-1,79E+00
ln (W_1)^2	-2,75E-10	1,28E-10	-2,14E+00
ln (W_1) × ln(W_2)	3,79E-02	7,92E-02	4,78E-01
ln(W_1) × ln(W_3)	8,45E-11	1,25E-10	6,77E-01
ln (W_2)^2	4,81E-02	5,93E-02	8,12E-01
ln(W_2) × ln(W_3)	-1,51E-10	1,06E-10	-1,42E+00
ln (W_3)^2	-7,24E-02	5,94E-02	-1,22E+00
ln (Y_1)^2	1,98E-10	9,34E-11	2,12E+00
ln (Y_1) × ln (Y_2)	2,08E-01	1,59E-01	1,31E+00
ln (Y_2)^2	-1,78E-10	1,64E-10	-1,08E+00
ln (W_1) × ln (Y_1)	6,25E-02	5,13E-02	1,22E+00
ln (W_1) × ln (Y_2)	-1,07E-10	9,03E-11	-1,18E+00
ln (W_2) × ln (Y_1)	-2,66E-02	1,31E-02	-2,03E+00
ln (W_2) × ln (Y_2)	-2,26E-11	1,07E-10	-2,10E-01
ln (W_3) × ln (Y_1)	2,88E-02	1,88E-02	1,54E+00
ln (W_3) × ln (Y_2)	1,16E-10	2,73E-10	4,24E-01
$\sigma^2 = (\sigma_\mu^2 + \sigma_\theta^2)$	1,06E+02	1,08E+00	9,85E+01
$\gamma = ((\sigma_\mu^2) / (\sigma_\mu^2 + \sigma_\vartheta^2))$	9,99E-01	8,03E-05	1,24E+04
η	-2,06E+01	4,03E+00	-5,11E+00
log likelihood function	-0.67183383E+02		

Table 10: Panel estimation of stochastic cost efficiency frontier and correlates of bank inefficiencies

	Without environmental variables		
Variable	Coefficient	Ecart-type	T-Student
α_0 : (constant)	8,77E-01	1,00E+00	8,77E-01
ln (Y_1)	-8,32E-10	1,05E-02	-7,91E-08
ln (Y_2)	4,21E-01	1,00E+00	4,21E-01
ln(Y_{31})			
ln(Y_{32})			
ln(Y_{33})			
ln(Y_{34})			
ln(Y_{35})			
ln(Y_{36})			
ln(Y_{37})			
ln (W_1)	4,40E-09	5,93E-01	7,41E-09
ln (W_2)	4,00E-01	1,00E-01	4,00E-01
ln (W_3)	4,97E-10	1,33E-02	3,73E-08
ln $(W_1)^2$	2,21E-01	1,00E+00	2,21E-01
ln (W_1) × ln(W_2)	-7,90E-11	8,35E-03	-9,46E-09
ln(W_1) × ln(W_3)	2,37E-01	1,00E+00	2,37E-01
ln $(W_2)^2$	-1,19E-10	5,19E-03	-2,29E-08
ln(W_2) × ln(W_3)	3,51E-02	1,00E+00	3,51E-02
ln $(W_3)^2$	-6,47E-11	5,07E-03	-1,28E-08
ln $(Y_1)^2$	4,05E-02	1,00E+00	4,05E-02
ln (Y_1) × ln (Y_2)	-2,49E-10	8,02E-01	-3,11E-10
ln $(Y_2)^2$	-4,97E-03	1,00E+00	-4,97E-03
ln (W_1) × ln (Y_1)	7,04E-11	1,11E-02	6,33E-09
ln (W_1) × ln (Y_2)	-6,96E-02	1,00E+00	-6,96E-02
ln (W_2) × ln (Y_1)	3,12E-10	6,04E-02	5,16E-09
ln (W_2) × ln (Y_2)	-5,62E-03	1,00E+00	-5,62E-03
ln (W_3) × ln (Y_1)	-6,30E-11	8,55E-03	-7,36E-09
ln (W_3) × ln (Y_2)	5,52E-02	1,00E+00	5,52E-02
$\sigma^2 = (\sigma_\mu^2 + \sigma_\vartheta^2)$	9,53E-02	1,00E+00	9,53E-02
$\gamma = ((\sigma_\mu^2)/(\sigma_\mu^2 + \sigma_\vartheta^2))$	5,00E-02	1,00E+00	5,00E-02
η	-5,41E-18	1,00E+00	-5,41E-18
log likelihood function	-0.39181353E+02		

More than half coefficients on the environmental variables in the estimation of the cost function are statistically significant at the 1%, 5% and 10% confidence level. As can be seen in Table 9 and Table 10, the coefficient on per capita income has an insignificant negative sign. Therefore, its affect partially the total cost. This

implies that an increase in GDP lowers total costs and increase cost efficiency. The weak level of per capita income affect negatively the saving (S) and it has a negative effect on the capacity of household repayment, and thereafter generate a negative effect on the banking efficiency and increase cost efficiency. The coefficient on density of population is significantly positive. The coefficient on density of demand is significantly positive, with the absence of a correlation between this variable and the total cost.

The coefficients on return on assets (ROA) and return on equity (ROE) standards measures of profitability are significantly negative. ROA and ROE are performance measure and it should be inversely related to inefficiency. Therefore, these financial performances have on average a positive effect on efficiency. Therefore, banking systems with a higher intermediation ratio (ratio of total loans to total deposits) have significantly lower costs. The coefficient capital ratio is insignificantly negative and indicates that banks with greater average capital ratio exhibit lower level of inefficiency. The coefficient intermediation ratio is statistically not significant and has a positive sign. Therefore, a positive relationship exists between intermediation ratio and cost inefficiency. A higher amount of loans per unit of deposits thus increases banking costs.

We found an average cost efficiency score of 0.947 (an average cost inefficiency score of 0.053). The results suggest the presence of cost inefficiency in all banking systems. The average value indicates that banks produce with 0.053 of cost inefficiency. The average value of 0.053 means that the banks in our sample could have saved about 5.3% of total cost if they had used the best practice technology. We conclude that, the values of cost efficiency scores by ownership structure and by size; show that differences in efficiency levels between the different populations banking are very low (nearly non-existent).

When the environmental variables are included in the model, cost efficiency levels decreased remarkably in all Tunisian banks in the sample. After introducing the environmental variables in the model, the average cost-efficiency scores by bank diminishes; and they vary between 38.51% (BNA) and 88.25% (BQT) instead of 91.11% (BNA) and 96.73% (ATB), with an average of 60.67% instead of 94.70%, indicating that the average bank in the sample could reduce its cost by 39.33% if it was to match its performance with the best-practice bank. Overall, the results show that average efficiency levels for Tunisian banks are lower than the results obtained without environmental variables. Therefore, this result indicates that the environmental variables are an important factor in explaining efficiency differences among the Tunisians banks.

Several arguments can be provided to explain the high level of cost inefficiency (39.33%) in the banking industry in Tunisia. This low level of cost efficiency score can be explained by the support policy implemented by the Central Bank of Tunisia (BCT) to banks that carry a high level of non-performing loans (NPL).

Table 11: Average cost inefficiency scores, 1997–2006

bank	cost efficiency estimates (cost frontier Without environmental variables)	cost efficiency estimates (cost frontier with environmental variables)
BNA	0,911092247	0,385158514
ATB	0,967367408	0,763113394
STB	0,94405056	0,45039244
BIAT	0,935696328	0,427475068
UIB	0,946875189	0,510459536
BT	0,959980616	0,664933902
UBCI	0,955873715	0,611530038
BH	0,95659068	0,410875234
AB	0,954547411	0,530406456
Attijari Bank	0,941866582	0,452525859
Citi Bank	0,942990385	0,513299645
BFT	0,949059065	0,770325452
BTL	0,956120933	0,790517624
BTE	0,949904416	0,859014409
BQT	0,95140807	0,882566892
STUSID BANK	0,946401229	0,704702584
BTK	0,929613392	0,586821974
average	0,947025778	0,606712884

Evolution of non-performing loan ratio

Année	1996	1997	1998	1999	2000	2001
	2002	2003	2004	2005	2006	2007
NPL/	25,1	23	19,5	18,8	21,6	19,2
Total	20,8	23,9	23,7	20,9	19,3	17,6
assets%						

Source: The Annual Report of the Central Bank of Tunisia (BCT) and Tunisia's Professional Association of Banks and Financial Institutions APTBEF

The lack of transparency and its insufficiency resulting from the political pressure that dominates the state investment decisions, creates an environment of uncertainty in expectations of banks, which leads them to overestimate the quality of projects proposed to it, this situation pushes banks Tunisian to continue to be obstructed by large volumes of non-performing loans (NPL), which constitute the main source of inefficiency and vulnerability of the Tunisian banks. It is necessary to mention that these banks benefit from the intervention policy of the central bank as a last resort ultimately hampering any effort to minimize cost. The bad portfolio quality of the Tunisian banking sector with reference to the high volume of non-performing loans (NPL), generate low profitability of banks Tunisian (average ROE= 0,0181309 and average ROA= 0,0005225) compared to international standards.

5.2 Cost efficiency by type, Size, and Ownership Structure

Table 12 presents evidence of banks' inefficiency for various types of size of credit institutions and ownership structures. The results indicate that large banks[7] are, in general, less cost efficient than small banks[8] (72.96%) and medium-sized banks[9] (59.56%). This classification can be explained by the fact that the majority of the largest banks in Tunisia are public institutions that are currently created to promote some political agenda. In addition, the low level of cost efficiency of large banks is essentially comes back to the specialization of these banks, in spite of the enactment of the law 2001-65 of 10 July 2001 which consists of the universality of banking. The big bank National Agricultural Bank (BNA) is the least efficient bank, and it was a bank that specializes in agricultural loans, the sector is the main source of increased bad debts with the tourism sector. Again, the Bank of Housing (BH) remains the dominant bank of habitat credits, its share remains elevated in this market and that is around 55% in 2008, after she was 100% before the implementation of this law, which generate an improvement of the competitive spirit between Tunisian banks. Also, the big banks have the highest volumes of NPLs 38% for STB and 34.8% for the BNA in 2007. Thereafter, they are less efficient than those of the medium and small size that have the lowest volume of NPL, with 7% for BT or 16.5% for UBCI. The three big banks BNA, STB and BH, were burdened for a long time by debts of state, also, these banks are submitted to a public control, which can lead to decrease the efficiency level.

[7] which have total assets of less than 2 billion dinars
[8] which have total assets of less than 1 billion dinars
[9] which have total assets ranging between 1 and 2 billion dinars

Table 12: Average cost and profit inefficiency
(by type, size and ownership structure)

Type	Cost efficiency
Size	
Large	0,488563852
Medium	0,595641159
Small	0,72960694
Ownership	
Domestic	0,51993815
Foreign	0,570185695
mixed	0,764724697
Private	0,656694144
• Privatized bank, foreign	0,572958408
• Privatized bank, domestic	0,540938475
Public	0,562285097
• Public bank, mixed	0,809200377
• Public bank, domestic	0,50418791

This policy of financing of real estate, agriculture and tourism sectors (40% of loans to the tourism sector are considered non-performing), through the pursuing a policy of easy credit, contributed to the heaviness of non-performing loans (NPL). Also, the big-sized banks have more expenses on average (personnel expenses, Interests incurred and similar charges) than those of small and medium sizes. Our result is conform with results found by Allen N. Berger et al (2009),), through their empirical studies on a sample of 38 commercial banks in China during the period 1994-2003, which suggests that the four big banks are less efficient. Same result found by Fu and Heffernan (2006), through their empirical studies on the cost efficiency of Chinese banks during the period 1993-2002, the four big banks are least efficient. Also Simon H. Kwan (2006) through his empirical work on the efficiency of banks in Hong Kong during 1992-1999 also found that smaller banks are more efficient than large banks.

Foreign banks (57.01%) and mixed banks (76.47%) are significantly more cost efficient than domestic banks (51.99%). This superiority efficiency score of foreign banks and mixed banks can be explained by better resource management and better organization of foreign banks through the spirit of know-how. Also, this category of the bank poster on average of expenses less elevated than domestic banks. This superiority of scores of foreign and mixed bank efficiency has been confirmed by most empirical work on efficiency in the banking industry. Berger

and Humphrey (1997) survey 130 efficiency studies of financial institutions, of which a few address the impact of foreign ownership. They found that foreign banks in transition and developing markets show higher efficiency than their domestically-owned counterparts. Christos Staikouras, Emmanuel Mamatzakis, Anastasia Koutsomanoli-Filippaki (2008) examined the cost efficiency in the banking sector of six South Eastern European countries over the period 1998–2003. They found that foreign banks and banks with higher foreign bank ownership involvement are associated with lower inefficiency.

Also, the empirical analysis suggests that, on average, public banks (56.22%) are less efficient than private banks (65.66%), but there are differences among public banks. Public bank, with majority mixed ownership are the most efficient (80.92%) and those with domestic ownership are the least (50.41%). Again, it appears that on average a privatized bank, domestic (54.09%) is less efficient than a privatized bank, foreign (57.29%). This inferiority efficiency score of public banks can be explained by the bad organization of these, because of the insufficiency of the competitive spirit. It is necessary to mention here, that the public banks constitute a sector where the role of the state is primordial. Subsequently, it exerts forces regulation and a protection for public banks, which do not put them under an obligation to act in an efficient manner. Our findings of the superiority cost efficiency of private banks compared to public banks are consistent with that of ME. Chaffai (1998). Also, Steven Fries, Anita Taci (2005) examined the cost efficiency of 289 banks in 15 East European countries. They found that the state banks are significantly less efficient than private banks.

6 Conclusion

This paper examines the influence of ownership type, size and environmental variables on the bank efficiency of 17 Tunisian universal banks over the period 1997–2006. Our findings, based on the stochastic frontier approach, indicate a generally, without environmental variables, the cost-efficiency scores of Tunisian banks are higher. So, when environmental variables are included in the model, the cost efficiency scores are reduced substantially. Overall, our results demonstrate that environmental variables contribute significantly to the difference in efficiency scores between the different populations of Tunisian banks.

This paper also investigates the sources of inefficiency. It indicates generally the deterioration of different financial indicators of Tunisian banking system. Tunisian banks continue to be obstructed by large volumes of non-performing loans (NPL), which constitute the main source of their inefficiency and their vulnerability. The bad portfolio quality with reference to the high volume of NPL, generate low profitability of Tunisian banks (average ROE= 0,0181 and average ROA= 0,0005) compared to international standards. In

addition, banks tend to be more efficient in countries that have higher income per capita, higher density of demand. Usually, positive relationship exists between efficiency and average capital ratio. The positive relationship between intermediation variable and efficiency is expected. In particular, all these variables are low in Tunisia. So, they constitute a source of inefficiency of the Tunisian banks.

The empirical analysis suggests that, on average, domestic banks are less efficient than foreign banks. In addition, private banks are more cost efficient than state-owned banks. Moreover small and medium-sized banks are significantly more efficient than large banks.

Acknowledgements. We would like to thank Maktouf Samir, Laaridhi Noureddine, Inoubli Abdelmajid for their constructive comments and suggestions on an earlier draft of the paper.

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