International Business Research; Vol. 7, No. 4; 2014
ISSN 1913-9004 E-ISSN 1913-9012
Published by Canadian Center of Science and Education

Technical Efficiency of Tunisian Banks

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Received: January 6, 2014 Accepted: February 11, 2014 Online Published: March 26, 2014

doi: 10.5539/ibr.v7n4p170 URL: http://dx.doi.org/10.5539/ibr.v7n4p170

Abstract

The objective of this research is to study the technical efficiency of Tunisian banks for the period 2000–2011 using DEA (Data Envelopment Analysis) method. Our results suggest that this efficiency is valued at a score of 57.1%; the scores of pure technical efficiency and scale efficiency are respectively 64.7% and 86.9%. High bank capitalization positively affecting their technical efficiency; market share in terms of deposit of these banks negatively affects this efficiency. In addition, private banks are more efficient than their public counterparts.

Keywords: technical efficiency, DEA (Data Envelopment Analysis), Tunisian banks

1. Introduction

Financial activity continues to globalize today because of deregulation. It is justified by the pursuit of financial stability and the improvement of the performance of banks. The reforms initiated in Tunisia since 1986 have enabled Tunisian banks to intensify interbank competition and to improve efficiency. This change allowed them, on the econometric, to save a percentage of their physical or financial resources to avoid wastage. Indeed, they are more dynamic but much remains to be done to bring international standards of efficiency. Thus in this changing environment, the specific question of technical efficiency of Tunisian banks becomes a crucial issue.

Our goal here is twofold. In a first step, we use the DEA method to estimate the scores of overall technical efficiency and its two components, namely the pure technical efficiency and scale efficiency of Tunisian banks during the period 2000–2011. In the second step, the scores of overall technical efficiency are used in a regression model to determine the factors on which these banks may act to increase their efficiency levels and follow the requirements of an increasingly competitive environment. Thus, we will try to answer the following question: ***What is the level of technical efficiency and its two components of Tunisian banks and what are the factors behind the latter?***

This work is divided up into three parts. The first part will discuss the major empirical studies on the determinants of bank efficiency, the second will deal with the adopted research methodology and finally, the third part presents the empirical results found along with their interpretations.

2. The Determinants of Bank Efficiency: A Review of the Literature

Studies that have examined the determinants of efficiency of the banking sector are quite numerous. For example, Aly et al. (1990) Use the DEA approach to decompose the x-efficiency in technical and allocative efficiency. Their results show that the x-efficiency of U.S. banks has been relatively low, with the technical component which is more important than the allocative component as a source of inefficiency.

Ferrier and Lovell (1990) who carried out a study on a sample of 575 U.S. commercial banks found that 88% of these banks are exposed to increasing returns to scale. They also establish that economies of scale do not give big banks a low cost advantage. They also found that allocative inefficiency mainly due to excessive use of labor and poor use of capital. The most efficient banks in the sample belong to the category of small-sized banks. This is explained by the proper application of technology, which has allowed smaller banks to overcome the disadvantages of cost of capital and to leave their products more effective. Indeed, the evolution of technological progress has not failed to change the operation of the business of banking.

In the Tunisian context, Chaffai (1997) is the first who is interested in studying the efficiency of Tunisian commercial banks, and concluded that the total efficiency of these banks increased after the Liberal process initiated in 1986.

Another study by Chaffai and Dietsch (1998) in which they have shown in Tunisia, deposit banks are more efficient than development banks. In addition, they found that in the absence of a competitive environment, there is no clear trend in the evolution of efficiency over the period 1989–1995.

According to Cook et al. (2000), there is a negative and statistically significant relationship between the size and the credit issues, and efficiency of the Tunisian banking sector estimated by the DEA method during the period 1992–1997. In addition, their results show a positive and statistically significant ownership structure on bank efficiency, more efficient in their private banks than public ones.

More recently, three studies have investigated the efficiency of Tunisian commercial banks: Tazarki (2002) Hamrouni (2002) and Karray (2002). The first used the DFA (Distribution Free Approach) method on a sample of 12 commercial banks during the period 1989–1998 to determine the x-efficiency, economies of scale and scope. The results of the measurement of the x-efficiency suggest that only five Tunisian commercial banks have the best practices that the BFT, BNA, BS, BT and UBCI. Other banks in the sample were found however malpractice. The measurement of the x-inefficiency of banks in the sample varies in the interval [7%, 27%]. Among banks included, BNA occurs and as the most efficient bank.

As for the extent of economies of scale, the results show that 75% of banks in the sample studied have constant returns to scale, except the big banks (STB, BNA and BIAT) benefiting from decreasing returns to scale . As economies of scope, this would appear insignificant.

Given the financial reforms that have characterized the Tunisian banking landscape, Homrani (2002) conducted an assessment of the efficiency after the merger between two public banks. The results show that the merger between the acquiring bank (BNT) and the target bank (BNDA) has generated increasing efficiency gains.

Karray (2002) evaluated the performance of Tunisian banks in terms of productive efficiency for both pre and post deregulation alternating periods. The author concluded that the average productive efficiency of Tunisian banks improved after deregulation. For small banks, such improvement is more expressed in terms of their scale efficiency. The increase in scores of productive efficiency of these banks is rather attributed to the scale efficiencies and not to technical efficiency. In this sense, the author concluded that deregulation appears to play an important role in the initiation of Tunisian commercial banks to make adjustments to the optimal scale especially for small banks, through their ability to adapt to new deregulated market requirements.

Interbank competition caused by the financial reforms induced narrowing interest margins and encouraged accordingly credit institutions to move towards non-traditional activities to gain additional profits. In this context, the banking literature that examines the impact of non-traditional activities on the efficiency of banks is abundant.

For example, Siems and Clark (1997) estimated bank efficiency including non-traditional activities and found that the failure to take account of these activities has substantial economic effects and statistics on measures of efficiency.

Rogers (1998) applied DEA method to study the cost effectiveness, efficiency, income and profit efficiency of U.S. banks. He used non-interest income as a symbol of non-traditional activities. He noted that there is underestimation of the level of bank efficiency when these activities are neglected.

Similarly, in his study on the efficiency of U.S. banks during the period 1991–1997, Stiroh (2000) found that the failure to consider non-traditional activities led to an underestimation of efficiency.

Isik and Hassan (2003) used non-traditional activities such as output for measuring the efficiency of the Turkish banking sector during the period 1980–1990. They found that the efficiency of private and foreign banks tend to be underestimated with the exclusion of non-traditional activities. They demonstrated that the inclusion of these activities has improved technical efficiency and pure technical efficiency of private banks in Turkey respectively from 61.9% and 78.9% to 65.4% and 84.9%. For foreign banks, technical efficiency and pure technical efficiency has increased to 86.1% and 90.9%, an improvement of respective 2.9% and 2.7%. They noted that public banks have benefited from a slight increase. They suggest that non-traditional activities have more impact on the private and foreign banks.

Using the SFA method, Lieu et al. (2005) studied the influence of non-traditional activities on the efficiency of Taiwanese banks. They estimated and compared the cost inefficiency of these banks during the period 1998–2001 by the adoption of two different models (i.e., with and without non-traditional activities such as output). They found that omitting these activities, there is an underestimation of bank efficiency of about 5%. They suggest that the major banks are associated with greater efficiency and increased capacity to develop non-traditional activities. They also found that banks with higher productivity of employees tend to be more efficient. Finally, they suggest that during the study period the economies of scale and economies of scope were observed for both models.

Pasiouras (2008) used DEA to estimate sores efficiency of Greek commercial banking sector during the period 2000–2004. His results indicate that the inclusion of provisions on loans as input increases the efficiency score, but the off-balance sheet does not have a significant impact.

For Belkhiria (2009) who carried out a study on the impact of non-traditional activities on the performance of 10 Tunisian commercial banks measured by their cost efficiencies, lending activity is not a determinant of the efficiency of these banks because of the problem of non performing loans and the size of the credit institutions which implies stagnant economies of scale. Concerning non-traditional activities, they showed a significant and positive effect on bank efficiency.

Darrat et al. (2002) found that the causes of the inefficiency of Kuwaiti banks are technical and allocative origin because of the lack of value for money that banks have.

In the same vein, Karray and Chichti (2006) examined the efficiency of Tunisian commercial banks during the period 1999–2002. Using DEA method, they found an increasing trend in levels of efficiency from one year to another. Differentiating credit institutions according to the size of their assets, they found that large banks are more efficient than small banks. Indeed for the first, the inefficiencies are allocative origin rather than technical, however the inefficiencies of small banks rather explained by inefficiencies of scale.

Using the SFA method for estimating the cost-efficiency scores of commercial banks in Hong Kong, work Kwan (2006) found that the average of x-efficiency of these banks was approximately 16–30%. In addition, large banks were considered less efficient than small banks. In this context, the size effect seems to be related to differences in the characteristics of the portfolio of banks.

Weill (2006) compared the technical efficiency of banks in the domestic property and banks to foreign ownership in Poland and the Czech Republic using the data envelopment analysis (DEA) to estimate the efficiency scores. He showed that banks with foreign ownership have better technique efficiency than credit institutions to the domestic property. In addition, he noted that the advantage of efficiency does not depend on differences in business structure or size between the two categories of banks.

In the world of banking as in other sectors, investment in new technology has had a positive effect on the efficiency of credit institutions. In this context, Hachana and Omri (2007) argue that investment in computer hardware positively affects the x-efficiency of Tunisian banks during the period 2000 to 2006.

Pasiouras and al. (2007) found that the capitalization has a significant and positive effect on the technical efficiency of Greek cooperative banks during the period 2000–2004, but it has no effect on either the allocative efficiency or on x-efficiency of these banks. They also found a positive relationship between bank efficiency and size.

According to Pasiouras (2008), banks that have developed their activities abroad appear to be more technically efficient than those that run only on the national level. For him, the loan and market power increase the efficiency of these banks.

Using DEA method, Sufian (2009) estimated the efficiency of the Malaysian banking sector during the Asian banking crisis in 1997; he found a significant and negative relationship between bank deposits and levels of efficiency. This implies that banks have small market shares are less efficient than banks with large market shares. On the other hand, results show that credit institutions which have ratios of loans relative to total assets amounted have higher efficiency scores. This positive relationship can be explained by the efficient market hypothesis, in fact the most efficient banks can achieve lower production costs, allowing them to offer more reasonable credits and win larger market share compared to inefficient banks. In addition, the variables ownership structure, size and profitability have a positive and significant effect on the efficiency of the Malaysian banking sector. He explained this by the fact that privately owned banks, large banks or those with high profitability are more efficient than public ownership of banks, small banks or those with low levels of profitability.

More recently, Staub et al. (2010) studied the cost efficiency, technical efficiency and allocative efficiency of Brazilian banks during the period 2000–2007; they used the DEA method to estimate the scores of efficiency. The results show that these banks had low levels of x-efficiency compared to banks in Europe and the United

States. For the period with high macroeconomic volatility (2000–2002), the x-inefficiency of Brazilian banks can be attributed mainly to technical inefficiency rather than allocative inefficiency. They also found that public banks have a significant efficiency cost that foreign banks and private level.

Manlagñit, MCV (2011) examine the cost efficiency of Philippine commercial banks using the SFA method for estimating the efficiency scores. The results show that the level of inefficiency is important for national banks and risk and asset quality negatively affect the efficiency of these banks. This substantial increase in the cost-inefficiency could be attributed to the adverse effects of the Asian crisis of 1997, the cost of banking reform and regulatory changes that have been adopted to stabilize and strengthen the sector.

Williams (2012) examined the relationship between bank efficiency and market power for a sample of 419 commercial banks in Latin America for the period 1985–2010. The results suggest that the restructuring of banks has encouraged competition to the detriment of market power, and they had efficiencies under conditions of monopolistic competition.

Ayadi (2013) studied the x-efficiency of Tunisian commercial banks for the period 1996–2010 using DEA method. The results suggest that the cost efficiency of the sector is estimated at a score of 41.0%. Market share in terms of deposit of the banks and their involvement in risky activities including a credit negatively affecting their efficiency. High bank capitalization positively influences the latter. In addition, state-owned banks are more efficient than their private counterparts.

A review of the empirical literature on banking efficiency shows that the results of its review differ between countries, types of banks and estimation methods used. It seems indeed, that the selection the most appropriate method to use to measure the efficiency of banks is important.

3. Empirical Study

First we start by introducing some methodological elements necessary for the efficiency measure, and then we proceed to the presentation of the sample and data.

3.1 Method DEA

For the purpose of our study, we choose the DEA (Data Envelopment Analysis) to measure efficiency. We consider this approach as the most appropriate for the following reasons: First, this approach provides a higher degree of flexibility because it does not force us to choose a functional form of the border that links inputs and outputs imposed to all banks in our sample. Second, this method allows easy decomposition of technical efficiency into pure technical efficiency and scale efficiency and x-efficiency into technical efficiency and allocative efficiency when input prices are included. Third, the scores obtained with the DEA can obtain a aggregate score, which indicates the efficiency of each bank in relation to a set of compatible banks.

This method initially introduced by Charnes et al. (1978) is a non-parametric approach, based on sample data; the data envelopment analysis involves using mathematical programming to construct an efficient virtual frontier. Operations on that border correspond to 100% efficient entities, while those outside this boundary are not totally efficient.

In this context, the DEA has been defined by Charnes et al. (1978) as: "A mathematical programming model applied to observed data (That) provides a new way of obtaining empirical estimates of external relationships such as the production functions and/or efficiency production possibility surfaces that are the cornerstones of modern economics".

The DEA can be considered in two ways: input orientation and one output, the results differ depending on whether they adopt the assumption of constant returns to scale (CRS model: Constant Return to Scale) or returns scale variables (VRS model: Variable Return to Scale).

These two models are presented in the following paragraphs:

3.1.1 CRS Model

Referring to Kalaitzandonakes et al. (1992), we consider a sample of k firms where each uses M inputs to produce different N outputs.

Baskets of inputs and outputs are reduced by the DEA to a pair (input, output) qualified by Charnes and al (1978): virtual input and virtual output.

For a firm in the sample, we can obtain this measure by solving the following mathematical programming model:

$$Max_{\alpha,\beta}\alpha Y_i / \beta X_i$$

S.C

$$\alpha Y_j / \beta X_j \leq 1$$

For j = 1, 2…k

Where:

α et β are the vectors of coefficients to be estimated;

Yi and Xi respectively vectors reviewing inputs and outputs of the firm "i".

For each firm, the program maximizes the ratio of virtual output / virtual input, forcing not to exceed 1. Thus, firms in the sample are necessarily located on or below the efficient frontier.

Charnes and Cooper (1962) have developed a process for fractional programming models for a formulation of the previous model in the following linear form:

$$Min\theta$$

S.C

$$Y\lambda \geq Y_i$$

$$\theta X_i - X\lambda \geq 0$$

$$\theta \text{ any, } \lambda \geq 0$$

Where:

Y = [Y1, …, Yk] is a matrix N * k outputs.

X = [X1... XK] is a matrix M * k inputs.

Yi and Xi are respectively, the vectors of inputs and outputs of the firm "i".

θ is a scalar of arbitrary sign.

λ is a vector of dimension k positive coefficients to be estimated.

The optimal solution is a measure of its technical efficiency is given by the resolution of this problem.

3.1.2 The VRS Model

According to Coelli et al. (1998): "the CRS assumption is only appropriate when all firms are operating at an optimal scale. Imperfect competition constraints on finance etc., way cause a firm to be not operating at optimal scale".

VRS model is proposed for the first time by Banker et al. (1984), this model is an extension of the CRS model but takes into account situations where returns to scale are not constant. In this case, the CRS model can be modified taking into account the hypothesis of variable returns to scale. Simply add a constraint on the parameters of intensity CRS model, we obtain:

$$Min\theta$$

S.C

$$Y\lambda \geq Y_i$$

$$\theta X_i - X\lambda \geq 0$$

$$\theta \text{ any, } \lambda \geq 0$$

$$N1'\lambda = 1$$

Where:

N1 is a N* 1 vector of units.

To Coelli et al. (1998), a good measure of scale efficiency of a firm is the difference between the index of technical efficiency obtained through DEA type CRS and the obtained by the DEA type VRS. On the same database to get such a measure, these researchers suggest performing a DEA, CRS type and another VRS type. If there is a difference for a given firm in the efficiency index measured by these two types of DEA, this implies that the firm does not operate at an optimal scale. The scale inefficiency is the result of the difference between

CRS technical inefficiency and VRS technical inefficiency.

In this work, we use the DEA input-oriented variable returns to scale. First, the input-oriented method allows us to determine the cost savings of input possible to achieve for each unit of the sample if it was as efficient as the firm best practices. Second, this method can test the hypothesis of scale variable returns that is most consistent with the environment of imperfect competition in which credit institutions operating in Tunisia, in fact, the hypothesis scale constant returns is only appropriate if the firm operates at an optimal scale, which is not always the case.

3.2 Application

The period of this study covers the years range between 2000–2011; the data used are taken from the annual reports of the APTBEF (Association Professionnelle Tunisienne des Banques et des Etablissements Financiers).

3.2.1 Presentation of the Sample

The sample consists of 17 banks which are as follows:

Societe Tunisienne De Banque (STB)

Banque Nationale Agricole (BNA)

Banque Internationale Arabe De Tunisie (BIAT)

Banque De L'Habitat (BH)

Amen Bank (AB)

Banque Attijari De Tunisie (ATTIJARI BANK)

Union Internationale De Banques (UIB)

Banques De Tunisie (BT)

Arab Tunisian Bank (ATB)

Union Bancaire Pour Le Commerce Et L'Industrie (UBCI)

Banque Franco-Tunisienne (BFT)

Citi Bank

Banque Tuniso-Koweitienne (BTK)

Stusid Bank

Banque De Tunisie Et Des Emirats (BTE)

Banque Tuniso-Libyenne (BTL)

Banque Tunisienne De Solidarite (BTS)

3.2.2 Definition of Data

Before defining the data, we choose the approach as related to banking production. And considering the operation of the Tunisian banking system where banks use deposits collected to be involved in a credit policy, it seemed more logical to adopt the approach of mediation. This approach assumes that the bank collects deposits to transform them into loans including labor and capital in the process of transformation, as opposed to the production approach which assumes that the bank uses labor and capital to produce deposits and loans.

Thus, according to the intermediation approach inputs and outputs are shown in the following table:

Table 1. Inputs and outputs

Inputs	Outputs
L: labor	Y_1: total customer loans
K: physical capital	Y_2: portfolio investment
F: financial capital	

Inputs:

- L = number of bank employees.
- K = net fixed assets.
- F = total bank deposit.

Outputs:

- Y1 = wallet discount receivable + customer loans on special resources + other loans to customers.
- Y2 = is a line item in the balance sheet.

4. Empirical Results and Interpretations

We will focus, first of all the scores of efficiency of Tunisian banks in our sample, then the explanatory factors of the latter.

4.1 Efficiency of Tunisian Banks

The mean values of the scores of Global Technical Efficiency (GTE), Pure Technical Efficiency (PTE) and Scale Efficiency (SE) are plotted in the following table:

Table 2. Efficiency scores during the period 2000–2011

Banks	ETG	ETP	EE
STB	0.499	0.581	0.843
BNA	0.384	0.396	0.970
BIAT	0.672	0.726	0.945
BH	0.367	0.379	0.964
AB	0.768	0.787	0.973
ATTIJARI BANK	0.583	0.586	0.993
UIB	0.477	0.593	0.837
BT	0.611	0.627	0.975
ATB	0.541	0.562	0.974
UBCI	0.796	0.848	0.939
BFT	0.728	0.869	0.777
CITIBANK	0.058	0.356	0.168
BTK	0.527	0.636	0.876
STUSID BANK	0.720	0.787	0.916
BTE	0.614	0.716	0.878
BTL	0.421	0.538	0.795
BTS	0.939	1.000	0.941
Mediums	0.571	0.647	0.869

The global technical efficiency of the sector during the study period is estimated at an average score of 57.1 %, which means that the average bank in the sample is 57.1 % efficient compared to the bank with the best practices. This is reflected by the fact that the average inefficiency score averages at around 42.9% (1-0.571). In other words, a bank in the sample uses an input quantity greater than 42.9% compared to the efficient bank to produce the same amount of output. This is what emerges from the definition of technical efficiency, which measures the ability of a unit to produce maximum outputs for a given level of inputs.

The average level of pure technical inefficiency is 35.3% (1-0.647); this translates into the fact that an average bank in our sample can reduce the amount of input used by 35.3% compared to the most efficient banks.

The average level of scale inefficiency is 13.1% (1-0.869); this translates into the fact that an average bank in our sample can reduce costs by 13.1% compared to the most efficient banks in order to benefit from economies of scale.

In total, the global technical efficiency is the product of pure technical efficiency and scale efficiency. In our study, the global technical inefficiency of banks was 42.9% with a pure technical inefficiency of 35.3% and scale inefficiency 13.1%. This observation indicates that the inefficiency is more of an under-utilization of inputs that returns to scale inappropriate. To overcome this problem of inefficiency average bank must master the technical aspects of production; optimally allocate available resources through better management and limitation of waste, in order to maximize production.

4.2 Factors explaining Efficiency of Tunisian Banks

Econometric analysis of panel data seems to be a way more relevant research to estimate the determinants of technical efficiency of Tunisian banks that take into account two dimensions: individual and temporal, to better understand the different determinants could explain this bank efficiency.

In this research, we selected some variables that seem to explain better global technical efficiency of Tunisian banks. Estimating function is:

$$\mathrm{ETG}_{i,t} = \alpha + \beta_1 KA + \beta_2 MS_{i,t} + \beta_3 OWN_{i,t} + \beta_4 logTA_{i,t} + \varepsilon_{i,t} \quad (1)$$

- $KA_{i,t}$: a variable that refers to the degree of capitalization of the bank i in year t, it is the ratio of equity / total assets. A high ratio of KA is an indicator of a high bank capitalization that can positively affect bank efficiency. As a positive sign of the coefficient of this variable is expected.

- ***MSi,t:*** is the market share in terms of deposit of bank i in the year t. It is the ratio of total bank deposit of each in relation to the sum total of all deposit banks in the sample. A high ratio of MS notes that banks with larger market shares would be the most efficient. Thus, a positive sign for the coefficient of this variable is expected.

- $OWN_{i,t}$: a dummy variable for the ownership structure of the bank i in year t. It takes the value 0 for state banks and the value 1 for private banks. Several theoretical and empirical studies have shown that private banks and privatized institutions are considered more efficient than public banks because of their greater capacity to reduce costs. Thus, a positive sign for the coefficient of this variable is expected.

- $logTA_{i,t}$: This variable refers to the size of the bank i in the year t measured by the logarithm of total assets. It is included in the model to account for differences in bank efficiency caused by the size effect. More specifically, it is used to confirm if it is related to economies or diseconomies of scale. Thus the coefficient of logTA can show a positive (presence of economies of scale) or a negative (presence of diseconomies of scale). Thus, the expected sign is ambiguous.

4.3 Empirical Results and Interpretations

In the following before applying the method of generalized least squares (GLS) and the interpretation of results, we will apply homogeneity test, Hausman test, heteroscedasticity test, autocorrelation test and contemporaneous correlation test.

4.3.1 Econometric Tests

Performing a correlation matrix allows analysis pair wise correlations between explanatory variables. Obtaining coefficients of correlation greater than 0.5 is indicative of a problem of multicollinearity between the variables involved.

Table 3. Correlation matrix

	etg	ka	ms	own	logta
etg	1.0000				
Ka	0.1516*	1.0000			
ms	-0.1436*	-0.4118*	1.0000		
own	0.3200*	0.2140*	-0.4355*	1.0000	
logta	-0.0990	-0.3752*	0.3001*	-0.4624*	1.0000

For the estimated model, the correlation matrix shows that the level of correlation between the variables is low, which justifies the absence of multi-collinearity.

- *Homogeneity test*

The first thing that should be checked is the homogeneous or heterogeneous specification data. In this context, particular attention is paid to the Chow test, which examines whether the regression coefficients are stable compared to the observations used.

Table 4. Homogeneity test

Chow statistic		Absence of individual effects test / Presence of individual effects
model	0.0000	Presence of individual effects

We have Prob> F = 0.0000 <5%, the results of the homogeneity test showed that our data have a heterogeneous structure, it is necessary to model the individual effects either fixed-effects or random effects. Therefore, the Hausman specification test is required.

- *Hausman test*

Table 5. Hausman tests

Hausman statistic test		Random effects / Fixed effects
Model	0.0100	Fixed effects

We have Prob> chi2 = 0.0100 <5%, so the fixed effects model is most appropriate.

- *Heteroscedasticity test*

The notion of heteroscedasticity opposes that homoscedasticity which corresponds to the case where the error variance of the variables is constant. On the contrary, we speak of heteroscedasticity when the variances of the variables examined are different, ie we say that there is heteroscedasticity when the variance of the residuals of the model is not constant. In our work, we will use the Wald test to test the presence of heteroskedasticity.

Table 6. Heteroscedasticity test

Wald statistic test		Absence of heteroscedasticity / Presence of heteroscedasticity
Model	0.0000	Presence of heteroscedasticity

We have Prob> chi2 = 0.0000 <5%, so we have a presence of heteroscedasticity.

- *Autocorrelation test*

This autocorrelation error is found mainly in the time series models where the influence of an error from one period to another is plausible. We use the autocorrelation test Wooldridge in stata which hypothesis H_0 is the absence of first order autocorrelation.

Table 7. Autocorrelation test

Autocorrelation statistic test		Absence of autocorrelation / Presence of autocorrelation
Model	0.0211	Presence of autocorrelation

We have Prob> chi2 = 0.0211<5%, so we have presence of autocorrelation.

- *Contemporaneous correlation test*

As for correlation, again something we need to pay attention to is the possibility of error correlation between individuals. To test correlation of inter-individual errors, we use the Friedman test.

Table 8. Contemporaneous correlation test

Correlation statistic test		Absence of correlation / Presence of correlation
Model	0.0032	Presence of correlation

We have Prob> chi2 = 0.0032 <5%, so we have a problem of contemporaneous correlation.

Finally, heteroscedasticity, autocorrelation and contemporaneous correlation are situations frequently encountered in the data, it is important to know how to detect and correct.

4.3.2 Application

In the presence of heteroscedasticity, autocorrelation and contemporaneous correlation, method of Ordinary Least Square (OLS) is not effective, then we use Generalized Least Squares (GLS) method.

Table 10. The estimation results with fixed effects

etg	Coef	Std. Err.	z	P>|z|
ka	.0961436	.0440526	2.18	0.029**
ms	-.6091712	.1541742	-3.95	0.000 ***
own	.0872042	.0235702	3.70	0.000 ***
logta	.0014866	.0051775	0.29	0.774
_cons	.4548801	.0946496	4.81	0.000
Time periods =	12			
Wald chi2(4) =	40.18			
Number of obs =	204			
Number of groups =	17			

Note. ** A significant at 5%; *** A significant at 1%.

As for the case of KA variable, the results show a significant coefficient with the expected positive sign. This contribution expected sign is justified by the fact that increasing the degree of capitalization of banks in our sample results in greater efficiency. This result allows us to say that a well-capitalized bank faces future bankruptcy costs low, which reduces its cost of capital. Thus, a high bank capitalization can positively affect the efficiency of the bank providing healthy banking system and reducing risk-taking incentives in credit decisions.

Regarding the MS variable, its coefficient is significant and displays an unexpected negative sign; this suggests that the market share in terms of filing of Tunisian banks in our sample negatively influences their efficiencies.

The table shows that the dummy variable for ownership structure OWN displays an expected sign, it is significant and positively correlated with the technical efficiency of banks in our sample. Therefore, private banks are more efficient than their public counterparts. This can be explained by the fact that efficiency of these banks is favored by the shareholding by private institutions, most of which have trained staff and are able to evolve in a liberal economy with major management capacity. In addition, we can say that in a developing country as Tunisia, the state plays the crucial role in the economic life and the private sector alone is unable to ensure the proper functioning of the economy.

The results shown in Table 10 show that the size of the bank approximated by the variable log TA is not significant; this suggests that the advantage of the technical efficiency of Tunisian banks in our sample is not influenced by the size.

5. Conclusion

At this study, we examined the scores of technical efficiency and its two components, namely the pure technical efficiency and scale efficiency of Tunisian banks for the period 2000–2011 using the DEA method. Then, we applied the approach of panel data to study the determinants of technical efficiency of these banks.

The results suggest that the latter is evaluated at a score of 57.1%; the scores of pure technical efficiency and scale efficiency are respectively 64.7% and 86.9%. High bank capitalization positively affecting their technical efficiency; market share in terms of deposit of these banks negatively affecting the latter; private banks are more efficient than their public counterparts. In addition, the advantage of the technical efficiency of banks in our sample is not influenced by the size.

Bank efficiency can be positively affected by investment in non-traditional activities. These activities can improve the latter because they do not cause a lot of expenses for banks, unlike traditional intermediation activities that require huge expenditures such as the establishment of new agencies, as well as investment in new technologies to change the methods by which customers have access to banking products and services. In this context, changes undergone by Tunisian banks have resulted in the option of diversifying their activities. Indeed, we are witnessing reconciliation operations between financial institutions, such as the merger between banks and insurance companies giving birth to "Bank-insurance". Thus, it should be noted that there are other avenues of research that can be explored. Indeed, it would be very interesting to study the impact of the sale of insurance products on the efficiency of Tunisian banks.

It should be noted that Tunisia is living a historic moment, indeed the year 2011 has been marked by the January 14 Revolution in Tunisia and its impact on the Tunisian banking sector, its weakness and immobility have become a major concern. In this context, too undercapitalized, banks no longer play their engine role in the economy. Indeed, because of insufficient capital, they are unable to increase their loan volumes and then they are unable to improve their efficiency.

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