BANK EFFICIENCY AND MONETARY POLICY: CASE OF TUNISIAN BANK INDUSTRY

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Abstract

The debate on efficiency and banking performance focused in this study on the monetary policy impact issue. Thus, using stochastic cost frontier approach, it seeks to examine the implications of policy monetary on banks' cost efficiency following the post revolution period. We employ the SFA model to assess the efficiency of Tunisian banks and analyze the impact of policy monetary on either the cost frontier or the cost efficiency. The main finding of this study indicates that the restrictive policy monetary helped reduce bank cost and positively influences efficiency. In addition, we find substantial unexploited cost scale economies. This suggests that policymakers need to consider further reform in these areas. We also find that state ownership has a significant positive impact on Tunisian banks' efficiency indicating that the public bank seems to be able to take advantage of political favoritism and appear more efficient than their private counterparts. However, size and credit risk proxy don't affect efficiency in this context.

Keywords: stochastic frontier, cost efficiency, monetary policy, credit risk, state ownership, scales economy.

JEL Classification: E52, G21, G28

1 Introduction

The measure of bank performance has its origins in the literature on the bankingand financial economy. The parametric method is the one used by excellencefor this purpose. Following this approach, Aigner et al. (1977), Battese and Corra (1977) and Van den Broek et al. (1980) introduced the Stochastic Frontier Analysis (SFA) method for measuring random noise.
This study is relevant because it provides the literature with some points of considerable importance. It links for the first-time monetary policy and banking performance through the concept of efficiency in the Tunisian context. In fact, the revolution has brought to light certain dysfunctions, the macroeconomic balances, strong point of Tunisia before the revolution, were seriously weakened. The Tunisian money market has seen a sharp reduction in lendable funds following the revolution, due to the decline in the cash flow of some institutional investors. Thus, the conduct of monetary policy was not an easy task. The debate on the efficiency bank is still raised. In this way, our research would be able to provide elements of answer on this subject. The main objective of this research is to understand the behavior of Tunisian banks in this unstable environment characterized by the presence of an important link between the government, politicians, companies and financial institutions. Our methodology will be based on the estimation of the stochastic cost function. This model was developed by Battese and Coelli (1995). It has become more popular because of its simplicity of calculation as well as its ability to examine the effects of various bank-specific and heterogeneous variables on cost efficiency.
Bank-specific or industry-specific and macroeconomic variables are taken into the most important studies as explanatory variables of bank efficiency. However,as it mentioned above, the impact of the government policy on the inefficiency ofTunisian banks has not been examined to date using the SFA approach. Thus, this paper also includes this factor such monetary policy as it may be important in explaining bank efficiency. In fact, while previous studies show that liquidity ratio (e.g. Allen and Rai (1996)), capital adequacy (e.g. Chen et al. (2011)), and domestic and foreign ownership are important determinants of bank efficiency. Our work is in line with previous research and highlights the role of monetary policy in increasing bank efficiency.

Hence, the main finding of this study indicates that the restrictive monetary policy helped reduce bank cost and positively influences efficiency. In addition, we find substantial unexploited cost scale economies. It suggests that the decision-makers in the government must take corrective action in this field.

For the following, our article is organized as follows. In the next section, we pass in review the current issues in Tunisia banking system. Section 3, lingerson previous studies focusing on the determinants of the efficiency bank. In section 4, we detail our data and research methodology. We then present the mainresults of the study and robustness tests and finally we present our conclusions.

2 An overview of the Tunisian banking industry

In Tunisian context, the banking system posts a high percentage of non-performingloans that represent 15.6% of total gross loans at the end of 2016, according to Standard and Poor's statistics. Despite the recent progress made by the Central Bank of Tunisia (BCT), in terms of regulation encouraging banks to increase their provisions, these, of the order of 60% at the end of 2016, remain relatively weak.

Table 1: The main macroeconomic data of Tunisia

Years	GDP growth	Debt to GDP	Deficit to GDP
2010	3.5%	40.4%	-1%
2011	-2.40%	44.60%	-3.30%
2012	3.70%	44.00%	-5.50%
2013	2.30%	46.00%	-6.90%
2014	2.30%	49.20%	-5.00%
2015	0.80%	58.00%	-4.80%
2016	1.00%	53.40%	-3.90%
Source: Tunisian Central Bank (TCB), 2017			

GDP growth has undergone a downturn in 2015, rising unexpectedly to 0.8%. The budget deficit has increased sharply: close to balance in 2010, it exceeded 6.9% of GDP in 2013 before declining to 5% in 2014, 4.8% in 2015 and 3.9% in 2016. Since 2010, Tunisia's debt ratio has increased by about 32%. But the public debt is considered to be sustainable by the IMF, this is due in particular to relatively long maturities (an average of ten years) and a low average interest rate, as Tunisia is indebted to international favorable conditions. In September 2015 the IMF agreed to

disburse USD 301 million. However, the deficit and public debt are the focus of attention, while the IMF's 2013–2015 program did not allow sufficient progress to be made on the necessary reforms. While the 2016–2020 strategic development plans is being finalized, it is urgent to design and implement the reforms that can boost Tunisia's competitiveness and attractiveness. Several sectors of activity such as agriculture and tourism are financed by public banks. These represent, in fact, 46% of the total assets of the Tunisian banking sector. The banking sector is a heavyweight sector in the Tunisian financial system. The financing provided by these banks in Tunisia is around 90%. Indeed, economic growth and job creation remain dependent on bank financing. Tunisian companies are financed at a level of 6 to 7% by the stock market. Microfinance and bonds do not contribute significantly to the global economy. The level of credit granted to the private sector reached 65% of Tunisia's GDP. This rate is significantly lower than that shown by other economic competitors who have been able to finance 80% of the private companies mentioned in Morocco and Jordan. Through a survey launched by the World Bank in 2017, Tunisia's credit easy-access rate has increased from 101 in 2016 to 126 in 2017. According to a study conducted by the IMF on the analysis of stability, Tunisia's banking sector is characterized by a weak local economy and a legacy of the previous regime that has led to non-performing loans, insolvency and deterioration in profitability. In addition, there were also misappropriated loans to good borrowers.

3 Review of related literature

3.1 Efficiency concept as measurement of banks' performance

Since Farrell (1957) study, which was the first attempt at empirical estimation of efficiency, pioneering efficiency studies have focused on highlighting the estimation method. Meeusen and van Den Broeck (1977), Aigner et al. (1977), Stevenson (1980), Jondrow et al. (1982) and Battese and Coelli (1988), Battese and Coelli (1992), Battese and Coelli (1995) have strongly marked this trend of research notably the use of the SFA method. Previous studies analyzing bank efficiency do not allow bank production decisions to affect banking risk. However, in the recent efficiency literature Hughes et al. (2000, 1999, 2001) , bank managers seek to maximize their utility, which is a function of market value and risk. The banking risk as well as the discount rate applied to the valuation of the present value of the costs and the flow of benefits are affected in this way. Thus, any production decision that would increase the expected profit and the discount rate applied to this profit could

not increase the market value of the bank. Fries and Taci (2005) have defended the idea of focusing on the profitability of banks as an indicator of progress. According to authors, higher cost efficiency would lead to changes and improvements in the service provided by the banking sector and in financial institutions. They states also that any productivity gain will contributes to global economic development. They conclude that the cost-efficiency ratio can be associated with other dimensions of banking performance, overall development, lending and products, but which cannot be measured directly at the bank level.

3.2 Internal determinants of cost efficiency

The banking business is confronted with a multitude of risks whose liquidity risk is considered the most important. This risk must be assessed primarily in economic times. A credit institution with a low liquidity ratio would be likely to damage the entire financial market and the bankruptcy of a bank could be inherent to the increased liquidity risk. In fact, the liquidity of a bank is a factor that guarantees the financial stability of any financial institution (Brunnermeier (2009)). Diamond and Dybvig (1983) confirm that a low level of asset liquidity reflects banks' vulnerability to rushes. As found in Podpiera and Weill (2008) and Tabak and Noronha (2011), a higher credit risk displayed by a financial institution as a result of the increase in non-performing loans and without any recourse to price compensation leads to a reduction in cost efficiency. DeYoung (1997) validates a positive relationship between cost efficiency and the examiners' scores in relation to the quality of banking management. In addition, this same study found that bank management ratings were more closely related to their asset quality ratings than any of their other ratings. The authors also note a negative relationship between non performing and cost efficiency. One of the factors determining the effectiveness of banks is capitalization. Djalilov and Piesse (2016), Trujillo-Ponce (2013) and Berger and Mester (1997) assume that own funds are related to the costs of banks are in relation to own funds. While, Aiello and Bonanno (2016) have validated a negative relation between profit efficiency and bank size. Otherwise, some studies suggest that size of the bank is determinant of profit efficiency. In fact, Mester (1993) argues that large banks with more diversified asset portfolios and economies of scale become more efficient. In addition, the impact of the nature of ownership on the effectiveness of Indian banks is not validated through previous work. A few researchers, such as Bhattacharyya et al. (1997) concluded that the banks with public ownership are more efficient than their private counterparts, while others such as Chakrabarti and Chawla (2005) concluded that private banks are

relatively the best-performers. Yap and Sufian (2018) argue that monetary independence has not favored the profitability of private sector banks. Li et al. (2014) add that Chinese state-owned firms are less efficient than those in the private sector, which is due to the cost structure and funding patterns. This study aims to determine the effect of property on the efficiency of Tunisian banks. Kumar and Gulati (2010) focused on the study of the impact of the nature of ownership on the effectiveness of Indian national banks. Based on non-parametric and linear technology, the stochastic frontier, the authors conducted the calculation of banks' efficiency scores of public and private sectors. Private sector banks dominated the formation of the efficient frontier of the Indian state banking sector. Similarly, the inefficiency of management and not of scale has caused overall technical inefficiency. In addition, with regard to public and private sector banks, differences in efficiency have been identified. Iannotta et al. (2007) point out that despite the low cost level of mutual banks, they are less profitable than state-owned banks. In addition, state banks are at higher risk of insolvency and their loan portfolios are rated as of poor quality. Mutual banks, on the other hand, have a better quality of loan forgiveness and also a low-level asset risk compared to private and public banks. Fries and Taci (2005) surveyed 289 banks in 15 Eastern European countries to examine the efficiency of bank costs. They can confirm that holding a large share of foreign holdings helps to reduce costs, given that bank reforms are not linearly associated with profitability. According to Vu and Nahm (2013), profitability is positively affected by the net interest margin. In addition, some research links the gap between an increased net interest margin and managerial or even economic inefficiency (Chortareas et al. (2012), Sanchez et al. (2013)).

3.3 External determinants of cost efficiency

Yap and Sufian (2018) argue that the indicators of governance are needed to rebalance the structure of Chinese economic. Therefore, they relate the efficiency of banks' profits and the economic rebalancing in a context of liberalization of the Chinese economy by using an index of economic freedom. Also Yap and Sufian (2018), contrary to Djalilov and Piesse (2016), put the hypothesis that the relationship between fiscal freedom and efficiency benefits to be significant. Chortareas et al. (2013) focus on the effect of financial freedom on the efficiency of banks and conclude that this financial freedom is more pronounced in countries with more free political systems with sound policies and better governance. In other research, Chortareas et al. (2012) conclude that strengthening capital restrictions and formal supervisory powers improves the efficiency of banks' operations.

On the other hand, they argue that interventionist surveillance and regulation policies can lead to increased inefficiency of banks. Moreover, many models, as far as we are aware, have developed the effects of restrictions on a number of aspects of the banking business on bank efficiency, but the role of economic freedom have not been analyzed Chan et al. (2016) examine during the period 2001-2008 in East Asia, the effect of financial market regulation and country governance on the efficiency of universal banks. Their out puts confirm that universal banks in this region are more or less profitable. Their studies also validate that countries with greater financial freedom and more independence have proven to be more profitable. Similarly, bank efficiency has been intimately linked to government efficiency.

4 Methodology

4.1 Stochastic Cost Frontier and Cost Efficiency model

Based on Farrell's research, frontier methodologies has been the subject of numerous studies seeking to measure bank efficiency over the last decade. In this regard, Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) are the most two significant alternatives approaches; the two approaches have been extensively considered as methodologies full-fledged and applied to a variety of business background. SFA supposes that production inputs and outputs are linked by a parametric function. In fact, as an alternative approach to DEA, the great merit of SFA is that it not only allows forcost inefficiency, but also circumstances the fact that random shocks (due to unexplained change in the cost or profit) can impact the output production.That way, the main idea behind SFA is that this approach composed error term with both symmetric error that captures the effects of random shocks, statisticalnoise and measurement error not associated with firm specific characteristics as well as one-sided error components that acknowledges effects of inefficiency relative to the stochastic frontier. That's why the SFA (cross-sectional) approachis preferred to assess the cost efficiency in our model. That's why the SFA (cross-sectional) approach is preferred to assess the cost efficiency in our model. Several extensions of stochastic frontier models have been suggested. We cite the model of Kumbhakar and Hjalmarsson (1998) and Battese and Coelli (1988, 1992). And numerous empirical studies (Pitt and Lee (1981)) have estimated stochastic frontiers and predicted firm-level efficiencies using the two-stage estimation procedure. In the first step they estimate the stochastic frontier and the efficiency level. And in the second step, these estimated efficiencies are regressed upon firm specific

variables in an attempt to identify some of the reasons for differences in predicted efficiencies between firms in an industry. However, the disadvantage with this approach is that the estimated cost efficiencies are not resulted of simultaneous interaction with variables that describe the bank's activity. It is therefore unlikely to obtain estimates which are as efficient as those that could be provided employing a single-stage estimation procedure. To address this situation, several authors such as Kumbhakar et al. (1991) and Reifschneider and Stevenson (1991) introduced models in which the inefficiency effects (U_i) are given as an explicit function of a vector of firm specific variables and a random error. Empirically, we follow Battese and Coelli (1995), who suggest a single-stage approach to allow exogenous factors to determine the mean of the inefficiency term's density function. The Battese and Coelli (1995) [1] model for the cross-sectional data was defined in two equations (1) and (2) as:

$$CT_i = f(y_i, p_i) + e_i \quad (1)$$

$$e_i = u_i + v_i \quad (2)$$

Where CT is observed cost of bank i, y is the vector of output level; p is the vector of input prices, v_i represent random errors, it assumed to be independently and identically distributed, $v_i \sim N(0, \sigma^2)$, and u_i are positively defined with an asymmetric distribution independent of those of the v_i. The most common assumption in the literature is that u_i takes the form of a normal truncated distribution $u_i \sim N(\mu_i, \sigma^2)$. Under these assumptions the mean of cost inefficiency effects, mu_i, can more formally be expressed as follows:

$$\mu_i = Z_i\rho \quad (3)$$

Where Z is a vector of variable which may influences the efficiency of a bank; and ρ is a vector of unknown parameters to be estimated.
It should be noted, however, that the most often used functional forms in stochastic frontier analyses f(.) are the Cobb-Douglas, Translog and Fourrier specification. Here, as is it suggested by Altunbaş and Chakravarty (2001), we opt for translog specification because this form was found to be an adequate representation of our used data.[2]

[1]Battese and Coelli (1995) is an extension of the studies of Huang and Li et al. (2014), Reifschneider and Stevenson (1991) and Kumbhakar and Hjalmarsson (1998).

[2]Our model has a low number of observations. The use of the Fourrier specification would be inappropriate in this case because it will reduce the degree of freedom of

4.2 Model specification

This paper focuses on the performance of the Tunisian banks in terms of cost efficiency. When the banks are compared in terms of relative cost efficiency, it is important to use a single common frontier technology for all the banks. In other words, all banks entered in our model are supposed to employ the same specification function to transform input to output and thereby minimize costs. These inputs and outputs are assumed to be related by a translog cost function. At this level, the specification of the translogarithmic cost function requires a number of choices, particularly when it comes to defining the variables (output and input) that constitute the model. Indeed, choose the appropriate definition of Bank production is an important issue for research in Bank cost efficiency. Although the multi-producer nature of the banking enterprise is widely recognized, there is still no agreement on the explicit definition and measurement of a bank's inputs and outputs. The definition of bank "production" is a matter of ongoing debate. Two alternative models are the intermediation approach (Sealey Jr and Lindley (1977)) and the production approach (Benston (1965)). According to the first approach, the main purpose of the bank's activity is to transfer funds from savers to investors. Hughes and Mester (1993) show proof that deposits should be treated as inputs. There is also a production approach where banks are seen as a production unit which mainly producing services for account holders (Berger and Humphrey (1997)), yet it remains less common than the intermediation approach.[3]
Therefore, we follow the financial intermediation approach in which banks employ labor, physical capital and funding to produce loans and securities investments. We consider two outputs: Y1= loans measured by credit net, and Y2= securities assets and total investment security, each of these was measured as the average of its dinar amount at the end of each period. The input included are: labor, here we consider total asset to represent this variable due to lack of data about employee's number. Physical capital measured by fixed assets, and borrowed money used to fund the outputs

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the model, since the number of parameters to be estimated is very important. This postulate has been approved by many authors (Berger and Mester (1997), Altunba¸s and Chakravarty (2001), and Vennet (2002))

[3]The baking literature has found that different approaches to measuring output have generally led to similar conclusion concerning the cost structure and financial firm efficiency. (Mester (1992))

including deposits and other borrowed money. We follow the literature and approximate the wage rate, PL by dividing the dinar amount of personnel expenses over the volume of total asset. The price of capital PK is calculated as depreciation and other operating expenditure divided by the volume of fixed assets. The borrowed money price PF was peroxided by dividing interest expenses over deposits and other borrowed money. Following Mester (1993, 1996) and Berger and Mester (1997), weconsider the banks' risk preferences and the bank's output quality. Since both can affect efficiencies measures.

Berger and DeYoung (1997) show that loan quality and efficiency can be linked in several ways through the assumptions of bad luck, bad management and moral hazard. The level of loan loss provisions is a telling indicator of the banks' assets quality. Thus, we follow to 0Djalilov and Piesse (2016), and weconsider credit risk as the quotient of loan loss provision and total loan: q[4] =loan loss provision/total loan. Capital adequacy ratio is included to accountfor the risk of default which again can affect measures of inefficiency. Bergerand Mester (1997) show if a bank take high risks obtains substantial gains overanother that takes less risk and this bank might be labeled as more efficient. The capital adequacy ratio is included also because financial capital can be used to fund loans as a substitute for deposits or other borrowed money. This ratio was peroxided by k = Equity / Total Assets. To account the heterogeneity of the banks, we adopt the specification of Bos et al. (2009). This specification consists of including heterogeneity variables (zit), both in the cost function and in the inefficiency term. Similarly, as Bos et al. (2009), a macroeconomic shockmay affect the efficiency frontier as well as the inefficiencies. Our choice explains the presence of control variables in both equations 1 and 2. We use a dummyvariable for bank SIZE[5] to capture systematic differences across banks in our sample in

[4]Loan loss provisions/ total loans. An indicator of credit risk, which shows how much a bank is provisioning in year t relative to its total loans.

[5]Average mean of total asset during 2010-2016 was used to rank all institutions in order to determine whether they qualify to be a part of the large bank portfolio (size I). The large bank portfolio includes a minimum total asset of TD 3520,632 million. Size I¿ 3520,632 and Size II¡3520, 632. Dummy variable takes the value of 1 if the bank belongs to class I, 0 otherwise.

order to appropriately account for heterogeneity. Studies of Kwan (2006) and Sensarma (2006), have shown that differences in the size of banks can explain their level of efficiency. We also specify STATUS, a dummy variable that indicates whether the bank was public or private institution, which takes the value of 1 for the public bank and 0 otherwise In addition to heterogeneity variables, we add the policy rate, in order to analyze the impact of a monetary policy shock on the frontier and on inefficiencies. In line with the work of Battese and Coelli (1995) on estimation of cost efficiency by using a stochastic frontier approach, we specify stochastic frontier cost function for panel data as: Here outputs y, input prices p, control variables z (size bank, status effect and monetary policy) are defined as previously. Following Battese and Coelli (1995), the mean of cost inefficiency effects, μi, is further defined as:

$$LnCT = \alpha_0 + \sum \alpha_j Lny_j + \sum \beta_i Lnp_i \quad +1/2 \sum \sum \alpha_{i\,j} Lny_i Lny_j + 1/2 \sum \sum \beta_{i\,j} Lnp_i Lnp_j + \sum \sum \delta_{i\,j} Lnp_i Lny_j + f_k Lnk + f_q Lnq + 1/2 r_{k\,k} LnkLnk + r_{k\,q} LnkLnq + 1/2 r_{q\,q} LnqLnq + \sum h_{k\,j} LnkLny_j + \sum h_{q\,j} Lnq + Lny_j + \sum t_{k\,j} LnkLnp_j + \sum q_{q\,j} LnqLnp_j + \sum \eta z_t + vi - ui \quad (4)$$

Here outputs y, input prices p, control variables z (size bank, status effect and monetary policy) are defined as previously. Following Battese and Coelli (1995), the mean of cost inefficiency effects, μ_i, *is further defined as* :

$$u_{it} = \sum_{s=1}^{5} z_{st} + \omega_{it} \quad (5)$$

Where z_t is a vector of cost inefficiency determinants. Our model accounted for two categories of cost inefficiency determinants, such as: internal determinants, which are bank-specific factors (bank' size and bank's status), bank's aversion risk (k), credit risk (q) and a measure of liquidity, calculated as total loans/ total assets

(LTA)[6] We employed also external determinants represented by the monetary policy rate (PM).
ϖ is a random disturbance term with zero mean, with constant variance (σ^2), and truncated at $z_t\delta$. Therefore, u_i is assumed to be truncated at zero and followed iid N($z_t\delta$, σ^2). Once the cost efficiencies are determined and their scores are radially computed as below:

$$\mathrm{CE_i} = \exp(-\mathrm{u_k})^{-1} \qquad (6)$$

This specification contains 38 parameters. Nevertheless, to ensure that the Hessian of the cost function is symmetrical, the following equality needs to be satisfied for any pairs of variables y_i and p_j.

$$\frac{\partial^2 TC}{\partial Y_i \partial P_i} = \frac{\partial^2 TC}{\partial Y_i \partial P_J} \qquad (7)$$

The restrictions in the form of the linear homogeneity conditions and cost exhaustion are obtained by normalizing total costs, the price of labor and the price of capital by the price of deposit. The symmetry conditions state that:

$$\alpha_{i_j} = \alpha_{j_i}; \forall i,j(i.j = 1,\dots,n) and \beta_{i_j} = \beta_{i_j}; \forall i,j(\mathrm{i,j} = 1,\dots,\mathrm{m}) \qquad (8)$$

The linear homogeneity restrictions demand

$$\sum \beta_i = 1; \sum \beta_{i_j} = 0 \forall i; and \sum \delta_{i_j} = 0 \forall j \qquad (9)$$

The imposition of these restrictions (symmetry and homogeneity) leads to a gain of 8 degrees of freedom, We use maximum likelihood estimation to obtain both parameters estimate for equation (4) and the error components equation (5). Likelihood ratio (LR) test is suggested by Coelli (1995) to detect the presence of cost inefficiency in the model (H_0). We test the null hypothesis H_0: γ[7] = 0 versus H_1 : $\gamma > 0$, knowing that, variance parameters used are parameterized in the following forms: $\sigma^2 = \sigma^2 + \sigma^2$ and therefore γ is calculated as $\gamma = \frac{\sigma_u^2}{\sigma^2}$.

The rejection of the null hypothesis, $H_0 : \gamma = 0$, suggests the existence of a stochastic cost frontier. The null hypothesis is rejected if the likelihood ratio (LR) is higher than

[6] This ratio indicates what percentage of the assets of the bank is tied up in loans in year t, and can be interpreted as a measure of bank liquidity risk

[7] The parameter $\gamma = \frac{\sigma_u^2}{\sigma^2}$ is the ratio between the variance associated to the inefficiency of the bank and total variance: it must vary between 0 and 1

the critical value [8]. According to Altunbaş and Chakravarty (2001), Carvallo and Kasman (2005) and Margono et al. (2010), the stochastic frontier, as it specified here, allow us to analyze scale economies. When a two outputs cost function is assumed, the economies of scale for Y_{it} is defined as:

$$SCL_{i_{j_t}} = \frac{\partial LnTC_{i_t}}{\partial LnY_{i_{j_t}}} \quad (10)$$

Where SCL_{jit} is the economies of scale for the j-th output, Equation (10) means that there are no economies of scale when SCL_{jit} is larger than 1, andif it is less than 1 there are economies of scale. In the case of this paper, the economies of scale for Y_{1it} and Y_{2it} are defined as:

$$S_{1_{i_t}} = \alpha_1 + \alpha_{1_1} LnY_{1_{i_t}} + \alpha_{1_2} LnY_{2_{i_t}} + \lambda_{1_1} LnP_{k_i} - t + \lambda_{1_3} LnP_{L_i} - t + h_{1_k} LnK_{i_t} + h_{1_q} Lnq_{i_t}$$

$$S_{2_{i_t}} = \alpha_2 + \alpha_{2_1} LnY_{1_{i_t}} + \alpha_{2_2} LnY_{2_{i_t}} + \lambda_{2_1} LnP_{k_i} - t + \lambda_{2_3} LnP_{L_i} - t + h_{2_k} LnK_{i_t} + h_{2_q} Lnq_{i_t} \quad (11)$$

In the case of two outputs, the overall economies of scale are measured as follows:

$$SCL_{it} = S_{1it} + S_{2it} \quad (12)$$

4.3 Data

Our research uses the cross-sectional sample data of 20 commercial banks domiciled and operated in Tunisia during the 2010–2016 period (totaling 140 observations), extracted from the bankscope database and missing data were obtained from Tunisian Bank Association reports. All financial data is nominated in terms of Tunisian dinar (millions).

In the seven years since the revolution, the Tunisian banking sector is experiencing very serious situations due mainly to mismanagement and lack of competition, which leads to under performance to the detriment of the entire economy. The availability of data imposes the period covered by this research and stopping at the year of 2016. Before going into more detail on the empirical finding, it seems relevant to make the Tunisian banking system a field of research into perspective in terms of its idiosyncrasies. This is why we will do a quick description of the variables in our sample in Table 1.

Table 1 exhibits the summary statistics of the main variables described above, where all monetary values are expressed in thousands of Tunisian dinars as well as the average prices of the inputs (in% for (PK), (PL) and (PF)), and ratios (q and k) are expressed in percentage term. Table 1 classes the data by bank status in

[8] Reject $H_0 if LR > \chi R^2$ (table value), where R = number of restrictions, and Kodde and Palm are used tables.

order to show how the financial situation of public banks differs from their private counterparts.

Table 2: The main macroeconomic data of Tunisia

Variables	Observation	Panel	Mean	Standard Deviation	Min	Max
All Banks						
TC: Total Cost	140	7	166.195	148.603	5.7	499.49
y1: Total of loans	140	7	2453,848	2205,189	25,800	7678,464
y2: Securities	140	7	313,105	438,629	0,100	1746,393
Pk: Price of fixed assets	140	7	200,331	652,172	6,344	426,515
Pf: Price of borrowed funds	140	7	8,266	44,077	0,305	466,022
Pl: Price of labor	140	7	1,359	0,467	0,250	2,460
k: Equity/ Total Assets	140	7	12,776	7,840	-3,940	59,608
q: Provision/ total loans	140	7	4,764	11,466	-3,870	91,885
TA: Total Asset	140	7	3520,632	3075,149	153,908	11955,68
Public Banks						
TC: Total of cost	21	7	365,959	66,763	263,399	499,498
y1: Total of loans	21	7	5639,071	914,952	3998,292	7371,767
y2: Securities	21	7	645,405	337,139	92,664	1194,503
Pk: Price of fixed assets	21	7	67,661	44,322	21,799	166,391
Pf: Price of borrowed funds	21	7	3,405	0,470	2,482	4,133
Pl: Price of labor	21	7	1,529	0,177	1,211	1,891
k: Equity/ Total Assets	21	7	8,150	4,325	-3,940	15,420
q: Provision/ total loans	21	7	4,312	3,745	1,270	12,410
TA: Total Asset	21	7	7457,948	1184,116	5452,089	9847,795
Private Banks						
TC: Total of cost	119	7	130,184	128,455	5,700	491,427
y1: Total of loans	119	7	1891,750	1860,694	25,800	7678,464
y2: Securities	119	7	254,464	429,244	0,100	1746,393
Pk: Price of fixed assets	119	7	223,743	704,985	6,344	426,515
Pf: Price of borrowed funds	119	7	9,123	47,786	0,305	466,022
Pl: Price of labor	119	7	1,329	0,496	0,250	2,460
k: Equity/ Total Assets	119	7	13,592	8,047	0,704	59,608
q: Provision/ total loans	119	7	4,841	12,315	-3,870	91,885
TA: Total Asset	119	7	2825,811	2766,958	153,908	11955,68
Prices, q and k ratio are expressed in %						

A look at table 1 acknowledges that the Tunisian banking market seems to have a relatively high degree of concentration and the dominance of public institutions that has expanded over the past years. Both These aspects are the consequence of the permanent support of the State to these banks. Moreover, the Tunisian banking sector appears characterized by relatively high-cost level; although data also indicates that the Tunisian banking system is well endowed with equity, as shown

by the Capital Adequacy Ratio ($k > 8\%$). Overall, the Tunisian banking market is relatively small. Its total assets are currently well below compared to Moroccan or Jordanian banks, for example. Regarding to the input prices, private banks display a higher level of physical capital price, this result is explained by the fact that fixed assets are significantly lower. These banks also record a higher level of financial capital prices, due to their lower deposit volume. Contrary, the labor price is higher for public banks, a number of factors might help to explain this finding such as the three Tunisian public banks seem to be suffering from a chronic overcrowding and trying to improve their credit quality, via the reduction of nonperforming loans, consumes as human as physical capital which raises costs. When we compare the average deposits received by public banks to their credit portfolio, and if we make the same comparison for private banks, we notice that public institutions grant more credits than their private counterparts, relative to the volume of deposits received. It is important to note that the volume of deposits of private banks is higher because they are more open to small savers. The credit portfolio of public banks is therefore high compared to their deposits because these banks incorrectly consider the credit exposure, long-term prospects and repayment capability. They have failed in their task of supporting entrepreneurs and profitable business; as a result, they have been faced to high level of non-repaid loans, notably by public enterprises and the tourism industry. While privately controlled banks have posted more balanced performance on all fronts, thanks to more professional management practices and the absence of moral hazard. In fact, since the early 2000s, public banks had entered a chronic imbalance between their risky commitments and their equity capital. And find it selves with a large percentage of bad loans (loans problem). Moreover, in the year of 2013, public banks were severely undercapitalized as the capital adequacy ratio was 7.63% in 2013 and 5.07% in 2014 compared to 8% required by Basle capital rules, due to an insufficient capital generation constrained by high dividend payouts, modest profitability, and mainly the excess of credit risk. Owing to the restructuring of these institutions, started in 2015, the capital adequacy ratio of Tunisian commercial banks increased from 5.07% in 2014 to 6.58% in 2015 and 6.6% in 2016. We notice that exists a net distinction between private banks sufficiently capitalized over the full period and public banks with lower capital adequacy ratio, reflecting the negative effect of the commercial banks' direct lending to the priorities sectors. The financial difficulties of Tunisian leading economic sector since 2011 have weighted on commercial public and private banks' solvency.

5 Empirical funding

This section outlines and compares the different econometric models used in the estimations below. The SFA efficiency results are obtained from applying Maximum likelihood using Frontier version 4.1 (Coelli (1996). It is worth noting that the computed t-statistics for the partial slope coefficients could be biased and leads to misleading conclusions from hypothesis testing. To address this concern, we have

reestimated regression model 1 by entering each heterogeneous variable one at a time into the base model. The empirical findings do not qualitatively change our results. Therefore, our analysis consists of five models. Model 1, which is the base model, includes only bank-specific effects as internal determinants of frontier and inefficiency cost, while subsequent models will include one heterogeneous variable in addition to the bank-specific effects, of which Model 2 considers monetary rate, Model 3 incorporates state ownership, Model 4 includes size. However, model 5 contains all three variables. That isto say Model 5 is the special or broader case of the subsequent models. The regression results focusing on the relationship between cost efficiency and the explanatory variables are presented in Table 3. Table 3 shows results for five different specifications of Eq. (4)-(5). In the following, we first discuss internal parameter estimates for the five stochastic cost models. Second, we elaborate on the influence of the monetary policy. Third we examine the robustness ofour model. And finally, we compare scores and scales efficiencies.

Table 3: Efficiency Score Per Year

Variables **Cost frontier parameters**	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Intercept	2,281***	2,832***	2,564***	1,368*	0,668*
LnY1	0,305***	-0,023	0,170	0,864	0,909*
LnY2	0,299***	0,418**	0,325*	-0,025	0,048
LnPk/PF	-0,339	-0,410**	-0,497**	-0,141	0,072
LnPL/PF	1,852***	1,888***	0,190***	1,202**	0,917
Lnq	0,026	-0,148	0,045	-0,043	-0,038
Lnk	-0,898***	-1,076***	-0,947**	-0,631	0,038
LnPkLnPk	0,067**	0,066**	0,081***	0,054*	0,025
LnPkLnPL	-0,392***	-0,389***	-0,374***	-0,310***	-0,250**
LnPLLnPL	0,196***	0,186***	0,169**	0,188**	0,104
LnY1LnY1	0,067**	0,088**	0,063	-0,002	0,005
LnY1LnY2	-0,125***	-0,113**	-0,088	-0,830	-0,042
LnY2LnY2	0,109***	0,094**	0,090***	0,058*	0,072***
LnY1LnPK	0,052	0,090	0,093	-0,023	-0,016
LnY1LnPL	-0,343**	-0,378***	-0,367***	-0,135	-0,180
LnY2LnPK	-0,117**	-0,141***	-0,130***	-0,062	-0,067
LnY2LnPL	0,239***	0,270***	0,241***	0,101 0,162*	
LnkLnk	-0,006	-0,033	-0,030	-0,011	-0,055
LnkLnq	-0,007	0,057	-0,014	-0,002	-0,026
LnqLnq	0,015	0,005	0,010	0,016	0,015
LnkLnY1	0,184***	0,288***	0,238**	0,109	-0,008
LnkLnY2	-0,044	-0,099	-0,101	-0,003	-0,018
LnqLnY1	0,016	0,039	-0,007	0,024	0,040
LnqLnY2	-0,031**	-0,028*	-0,006	-0,028*	-0,007
LnkLnPK	0,198***	0,197***	0,221***	0,176*	0,072
LnkLnPL	-0,180	-0,178	-0,206	0,003	0,113

LnqLnPK	-0,021	-0,018	-0,032	0,071	0,153
LnqLnPL	-0,016	-0,052	-0,011	-0,020	-0,106*
PM		-0,108*			-0,028**
PM-1		0,150			0,123
Size				0,016	0,176
State ownership			-0,022		-0,041
Inefficiency parameters					
Intercept	0,343***	0,615***	0,355***	0,393***	0,563***
Q	-0,002	-0,023	-0,010	-0,002	
K	0,006***	0,007***	0,004**	0,044*	0,021
LTA	-0,578***	-0,590***	-0,522***	-0,632***	-0,731***
PM		-0,491			0,064
PM-1		-0,063**			-0,014
Size				-0,068	0,003
State ownership			-0,124*		-0,506***
sigma-squared	0,009***	0,010***	0,008***	0,941***	0,008***
Gamma	0,998***	1,000***	1,000***	1,000***	0,999***
LR	70,870***	82,840***	72,850***	73,230***	81,090***
number of restriction	5	7	6	6	9
Note: * significant at a 10% significance level, ** significant at a 5% significance level, *** significant at a 1% significance level					

5.1 Implication of internal factors

5.1.1 Liquidity risk

Concerning the liquidity results, LOANS/TA has a negative sign and is statistically significant at the 1% level in the five models. This indicates that with more loans cost efficiencies will be high. This is consistent with the literature and supports the view that the loans market, especially credit to households and firms is risky and profitable. Allen and Rai (1996) find that banks more aggressive, more engaged in credit activity, tend to be better managed. Nevertheless, it could be the case, that the fewer the funds tied up in liquid investments the higher we might expect profitability and therefore efficiency to be (Eichengreen and Gibson (2001)). This result is not surprising as the loan is the main source of income compared to other bank assets, such as government securities

5.1.2 Credit risk

With regard to the measure of credit risk, we note at the outset that the coefficients on the loan loss provisions to loans ratio (q) exhibit negative signs and are not significant in all regression models. The choice of the proxy may contain some answers because it may not be the best for characterizing credit risk. Some authors have used other proxies for credit risk such as non-performing loans ratio. This result,

if it were significant, would indicate that banks with higher credit risk exhibits lower cost inefficiency level and radially higher cost efficiency level. But as the relationship is insignificant, the relation is not conclusive. Given that the government widely intervenes in Tunisian's banking sector to finance risky projects under the state, we do not expect the market to be enough efficient to price for risk. Hence, the negative sign of this coefficient is not expected. This suggests that Tunisian banks should find a solution to improve the transparency of their activities, which has proved increasingly problematic in recent years. In fact, the inability of financial institutions to recognize impaired assets and create reserves for write-offs of these assets is causing serious banking problems. Thus, improving the transparency of the banking sector would greatly help banks to assess credit risk more effectively and avoid problems association.

5.1.3 Capital adequacy

The model suggests a positive sign for the capital ratio (k) variable, which is a measure of bank's capital strength. This implies higher level of equity would increase the cost inefficiency and hence, in the same vein, reduces cost efficiency. In other words, it means that better capitalized banks are not necessarily more efficient. The result is consistent with previous studies such as Trujillo-Ponce (2013) providing support to the argument that the cost of raising equity is known to be higher than raising deposits and thus, resulting in lower cost efficiency. As long as the cost of capital, particularly, the cost of equity is the most expensive bank liability. However, Berger and Mester (1997) postulated that equity capital is linked to the banks' measured cost in two different ways: As lower capital ratios suggest a relatively risky position, resulting in lower efficiency and in other side, higher levels of equity might reduce the cost of capital, leading a positive impact on the banks' efficiency. Furthmore, a capital increase may raise expected profits by reducing the expected costs of the financial distress, including bankruptcy (Molyneux (1993) and Berger (1995)). As Tunisia's interest rate is controlled and its capital market is thickly regulated and monitored, we do not expect the market forces will address in the banks' capital soundness when determining the cost of financing. On the other hand, higher capitalization especially due to the injection of capital through a huge of state recapitalization operations will likely reduce the bank cost efficiency. Thus, the result is consistent with our expectation.

5.1.4 Impact of the Size

As discussed in section 3.2, we specify dummies variables for different banking sizes to either shift the frontier or determine bank efficiency. On the basis of total assets, we allocate banks to two equally distributed size classes. Size is used to capture the fact that larger banks are better placed than smaller banks in exploiting economies of scale. Referring to the impact of bank size on the cost frontier, it is observed from

Table 3 that this variable is not significantly different from zero in both sets of regressions (4) and (5). According to this finding, size variable doesn't affect the cost frontier. It implies that bank size is not accounted for by market forces in determining the banking cost and thus the price of credit. This could be the result of distortion due to the claimed interest rate controls implemented by the central bank after the revolution. We furthermore don't find a significant size impact on cost efficiency. The result is consistent with previous studies providing a nonlinear relationship between cost efficiency and size. (Maudos et al. (2002)). In fact, the link between size and cost efficiency is again controversial in the literature. The first views find evidence for a positive relationship between cost efficiency and bank size include Goddard et al. (2004), Bikker and Hu (2002) and Molyneux and Thornton (1992). Following Mester (1993), these authors suggest that the size of the bank serves as an indicator of the bank's ability to diversify, thus large banks have a more diversified portfolio of assets, so they are better able to manage risk and distribute their products in the most efficient way. Furthermore, other authors such as Ferrier and Lovell (1990) find that an increase in bank size leads to higher levels of marketing and operational and bureaucratic costs. So, according to this idea, the link between cost efficiency and size would be negative. Other researchers however conclude the nonlinear relationship between cost efficiency and size mainly for developing countries. Thus, it is conjectural that the role of bank size is dependent on the level of sophistication and development of the banking sector. Again, our finding is not surprising since the Tunisian banking system lacks a leader, in fact, we can't identify the top "influencers" who lead the charge in such a disturbed sector.

5.1.5 Impact of state ownership

In order to control for the effect of public ownership of bank, we use dummies variables as specified in section 3.2 that indicates whether the bank was public or private institution. We distinguish 3 public banks namely BNA, STB and BH and 17 other private banks. Results on the cost frontier side are less informative given the insignificant estimate results in both models (3) and (5). The lack of relationship between the bank cost state ownership could be an indication that given the continued support of central bank, public banks are less fostered to innovate and establish stringent management measures and controlling their costs. Nevertheless, we find a positive link between state ownership and cost efficiency shown by a negative sign of its coefficient in the inefficiency component. Suggesting that private bank do not itself justify higher level of cost efficiency. This finding could be an indication that private owned banks are assumed to be more constraints by capital market discipline than public banks, leading to be more focused on the earning side than on controlling the cost side. Additionally, the effects of the internal consolidation process going along with mergers and acquisitions of some private banks such as

UIB[9] , UBCI[10] and BTK[11] have been usually seen earlier on the earning side than on the cost side. Again, this is not surprising as the public bank seem to be able to take advantage of political favoritism, which tends to have a big place in the current context, and thus appear more efficient. The impact of the state ownership on the bank efficiency was heavily discussed in the literature but it often provides mixed or inconclusive results.

5.2 Does the monetary policy foster cost and bank efficiency?

The impact of monetary policy on bank's costs and efficiencies was slightly discussed in the literature. Thus, to address this concern, we attempt to analyze the short and medium-term impact of monetary policy on the cost and efficiency of Tunisian banks. To do it, we entered the policy rate (PM) and it's lagged value of one period (PM-1) into model (2). Given the asymmetry information issues that may arise from a restrictive monetary policy, we expected that the increasing of policy rate would shift upward the stochastic cost frontier. The results of our diagnostics suggest that the PM have significant negative relation with cost function, while its lagged value shows an insignificant impact. The negative coefficient that is associated with PM suggests that a restrictive monetary policy will reduce costs and radially will shift downward the frontier. Against all odds, a monetary tightening seems to reduce the cost of the banks! Nevertheless, this result is troubling, since the majority of the authors believe that above a certain threshold, a rise in credit rate can lead to adverse selection phenomena that crowd out the least risky borrowers and increase the proportion of very risky borrowers. These loans will incur additional administrative costs to the bank, thus leads to an increase in interest costs and the expected costs of financial distress, including bankruptcy. Level of the interest rate has helped banks improve their cost during the study period and is consistent with Optimal lending theory Townsend (1979), Gale and Hellwig (1985) this theory provides a micro-economic foundation for the bank credit agreement by demonstrating that it minimizes audit costs in the presence of asymmetric information. We think rather that the origin of this negative sign lies in the study period. We have indeed been interested in the post-revolution period, characterized by the absence of clear rules of credit granting. In this context, the central bank's monetary policy proves to be enabled of affecting banking behavior in terms of credit distribution; this suggests the rigidity and slow rate adjustment in the credit market. The rigidity of interest rates can also be explained by the renegotiation led by banks with firms in difficulty in case of rising rates: to avoid bankruptcies, banks prefer to moderate the rate increases. As shown

[9] The French group Société Générale acquires 52% of the capital of the UIB in 2002

[10] The French group BNP Paribas acquires 50.08% of the capital of the UBCI

[11] French group Caisse d'épargne acquires 60% of the capital of the BTK in 2007

in Table3, restrictive monetary policy with increasing of policy rate will reduce bankcost inefficiencies over the medium term and radially increases cost efficiencies This negative effect on bank inefficiency can be explained by a mark-up behavior of the banks, which reflects their interest cost in their credit rate. It canbe explained likewise by a particular management of bank assets that wouldlead banks to sell securities at the period of monetary tightening in order to preserve their credit commitments. The inertia of credit is no doubt due to the existence of automatic credit lines, especially to large companies, which are not called into question at each cyclical turnaround. But it is also possible that the monetary policy shocks are due to inflation expectations of the Central Bank. In this case, the rise in inflation observed after the monetary shock would only be the achievement of this anticipation. This finding is expected as given a perfectly anticipated inflationary environment and the lending rate will be adjusted upward to compensate for the corrosion of money value (Windram (2007)). Asa result, bank efficiency increases (not adjusted for inflation).

5.3 Robustness checks

To further check the robustness of our results, we included separately the heterogeneous variables in the models (2), (3) and (4), and then we also estimated a model (5) using the all variables retained. We used likelihood ratio tests to determine whether the inefficiency effect is significant in the considered models (1-5). It can be observed from Table 3 that for all models estimated the LR statistics for over identifying the variance of efficiency tests shows that at the1% significance level is higher compared to the critical value tabulated by Kodde and Palm (1986). Suggesting that the parameters $\gamma = \frac{\sigma_u^2}{\sigma_v^2}$ are significant. Thus, these findings reject the null hypothesis, that the variance of efficiencyσ^2 is zero and hence that the U_{it} term should be removed from the model. So, this finding implying that inefficiency prevails among Tunisian banks. Therefore, SFA is an appropriate specification of the five cost models chosen. Overall, it can be noticed from Table 3 that the regression models perform reasonably well with the baseline and heterogeneous variables coefficients staying mostly the same: they maintain the same magnitude, the same sign, they stay significant as they were so in the baseline regressions. We also performed the incremental regression by removing individual independent variables from the model (5) and by checking the effect on the value of LR. Among all the variables removed, policy rate has altered the value of to a highest degree as the value for the LR changes from 81.09 to 41.41This substantial decrease in the value of the LR shows the importance of monetary policy in the model. Otherwise all in all the results remain robust in terms sign and significance levels. For brevity purposes, we do not report the findings in the paper, but are available upon request.

5.4 Cost efficiencies estimate

The cost efficiency scores for the Tunisian banks estimated based on the common

frontier model (model 1) are summarized in table 4. The mean value of cost efficiency for the all banks was estimated to be0.7819, with a range from 0.4968to 0.9989. It indicated that output can be increased on average by 21.81% with the same amount of inputs as before. The quarter of the banks was under 69.18% efficient. The frequency distribution of cost efficiency indices is summarized in table 5. These indices indicated that 11 banks (55%) had an efficiency level below 0.8. About 75% of banks were in an efficiency level of 0.7 or above Thus, there is a considerable room for improvement in the cost efficiencies of Tunisian banks. In summary, these statistics were quite comparable to those reportedby previous frontier studies in banking industry in developing countries. For example, the overall average level of cost efficiency computed from the studies presented by Chaffai (1998) is around 0.65. The cost efficiency levels were significantly higher for public banks than private one. Indeed, BH, BNA and STB show a good deal of efficiency, and thus are labeled as most efficient in this study. For example, the mean cost efficiencies for public banks were 0.9792.The corresponding values for the private banks were 0.747. Also, in terms of standard deviations, cost efficiency estimates showed a lower degree of variability under the public system than under the private one. Of such result implies that these public banks are the main providers of credit to the economy. Although these public banks are the most efficient in our sample, they suffer from several problems, mainly the importance of the operating expenses and especially the staff costs. These banks continue to make significant efforts to reduce their operating expenses. These banks still have a poor quality of assets themselves under provisioned. In spite of the permanent support of the State to reduce this scourge, these banks still suffer from their active participations in the financing of tourism, sector considered ”priority” by the public authorities and which alone holds a quarter of the unpaid credit of the banking sector.

However, the improvement in efficiency scores is relatively important for theentire sample (see table 8, Appendix). This improvement is certainly due to the fact that the state is aware of the problem of non-performing loans that threatens the survival of the Tunisian banking system. This is why the state decided to settle the debts of the public companies by the banks. Given the importance of the amount of bad loans in their portfolios, this program has benefited the public banks first.

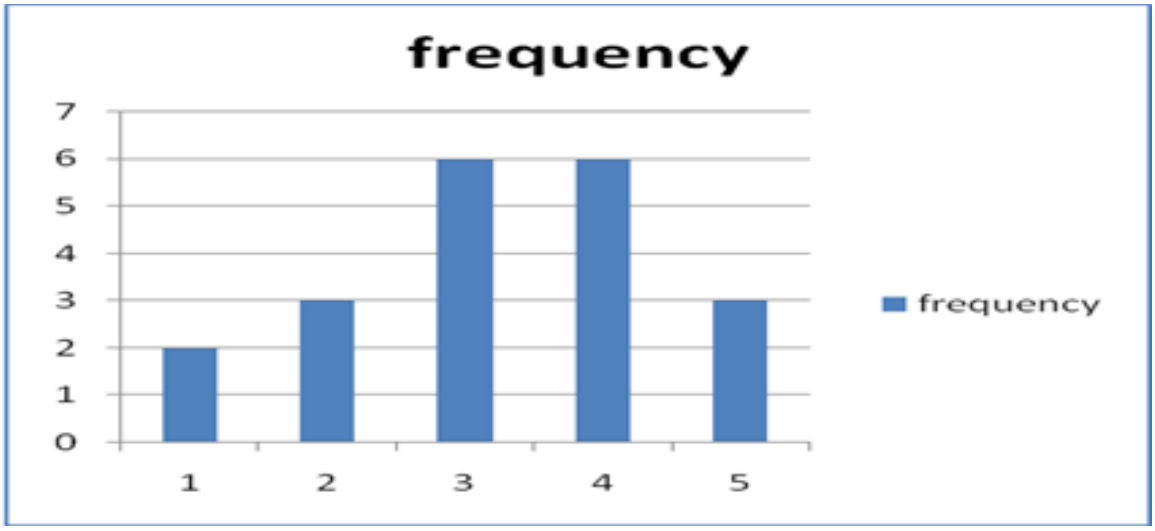
Table 4: Score efficiency

	Mean	Median	Maximum	Minimum	Std. Dev.	Observations
ABC	0.897206	0.889618	0.986780	0.795974	0.065550	7
AMEN˙BANK	0.744574	0.718002	0.844658	0.691889	0.061197	7
ATB	0.835480	0.841089	0.866400	0.785998	0.026789	7
ATTIJARI	0.765150	0.764777	0.800243	0.727735	0.029230	7
BARAKA˙BANK	0.725167	0.748487	0.947826	0.501861	0.163950	7

BH(a)	0.987928	0.992394	0.999361	0.969447	0.011585	7
BIAT	0.836676	0.846506	0.892827	0.766261	0.047714	7
BNA(b)	0.984269	0.984471	0.999045	0.963441	0.012380	7
BT	0.817379	0.825711	0.862969	0.740410	0.040368	7
BTE	0.736605	0.659000	0.998658	0.596919	0.180082	7
BTK	0.582262	0.578551	0.622466	0.539677	0.026681	7
BTL	0.830725	0.851930	0.984137	0.703117	0.096636	7
CITYBANK	0.862179	0.856071	0.997289	0.754759	0.088636	7
STB(c)	0.965637	0.947557	0.998957	0.939386	0.028515	7
STUSID	0.768331	0.737374	0.994530	0.696525	0.102419	7
TQB	0.650393	0.647824	0.721414	0.594094	0.039041	7
UBCI	0.678840	0.718664	0.728483	0.580659	0.065568	7
UIB	0.590723	0.618160	0.667789	0.496851	0.074198	7
WIFAK˙IB	0.672694	0.609707	0.996079	0.561661	0.155154	7
ZITOUNA	0.706026	0.627752	0.973866	0.585941	0.143269	7
(a), (b) and (c) are pubic banks						

Table 5: Frequency distribution of cost efficiency score

value	number	percentage
0,5-0,6	2	10
0,6-0,7	3	15
0,7-0,8	6	30
0,8-0,9	6	30
0,9-1	3	15



5.5 Efficiency scale

Estimates from the model (1) are used to determine whether economies of scale exist. Table 5 reports some descriptive statistics for the estimates of economies of scale. Movements of the overall economies of scale for all banks are more or less the same during the period. The estimated value of SEC is under 1 throughout the period. Though this means that overall economies scale exists during this period, banks show unexploited ray scale economies. The mean scale efficiencies are around 45%, suggesting that approximately equal amounts of resources are lost because of scale inefficiencies. All banks are operating below efficient scale, and the mean SCE is under 50% suggesting that the Tunisian bank would have to be larger in order to maximize cost scale efficiency for its product mix and input prices. And thus, the bank's product mix could be produced at lower average cost by increasing the scale of output. Therefore, there seem to be many cost efficiencies gains to be made from Tunisia banks' changing their sizes, as long as the banks have not reached their optimal size. This finding, coupled with the results presented in section d/ suggesting that size is not accounted for by market forces in determining the banking cost and the price of credit and also the Tunisian banking system is highly fragmented and largely surpassed by the prudential requirements imposed by globalization. So, according to this idea, it should be noted that the Tunisian banking system lacks a national champion able to play its full role in financing the economy and businesses.

6 Conclusion

This study investigates the impact of bank-specific characteristics and monetary policy on bank's efficiency in the Tunisian's banks. And further examines whether or not economies of scale exist in the industry. By using the stochastic cost frontier approach, we have estimated the annual cost efficiency scores of 20 commercial banks for the 2010-2016 periods. The estimation results suggest

Table 6: Scale Efficiency

Banque	Mean	Median	Maximum	Minimum	Std. Dev.	Observations
BIAT	0,41472859	0,41417025	0,4510596	0,41417025	0,02213445	7
BNA	0,40108044	0,41664547	0,42494017	0,40108044	0,0120353	7
STB	0,44867255	0,40877269	0,43687866	0,40877269	0,05361575	7
AMEN BANK	0,4722567	0,49715898	0,54477718	0,4722567	0,02355841	7
BH	0,44140637	0,44152372	0,45722197	0,44140637	0,01507776	7
ATTIJARI	0,45269226	0,44090801	0,46736098	0,44090801	0,01453142	7
ATB	0,48979326	0,46218772	0,46887427	0,46218772	0,00758175	7
BT	0,4610114	0,51861442	0,54009854	0,4610114	0,01895964	7
UIB	0,42740415	0,3961231	0,4416711	0,3961231	0,03505658	7

UBCI	0,49795446	0,44674565	0,47972818	0,44674565	0,01949888	7
BTK	0,54001317	0,54428141	0,57193711	0,54001317	0,01817869	7
TQB	0,54478992	0,53034714	0,63677115	0,53034714	0,07312436	7
STUSID	0,56568376	0,55285112	0,5735609	0,55285112	0,01136464	7
BTE	0,55619547	0,56344861	0,65605298	0,55619547	0,04179017	7
BTL	0,4964081	0,53367458	0,55782723	0,4964081	0,01746189	7
ABC	0,64817358	0,47158608	0,49934514	0,47158608	0,04678648	7
WIFAK IB	0,60692773	0,77175179	1,03096277	0,60692773	0,12968389	7
CITYBANK	0,45032819	0,37290454	0,47316224	0,37290454	0,07945433	7
BARAKA BANK	0,49978699	0,52379297	0,5752085	0,49978699	0,03560278	7
ZITOUNA	0,47468038	0,4603851	0,54652976	0,4603851	0,0405508	7

that the proxy of liquidity risk (Loans/TA) exerts positive impacts on Tunisian's bank efficiency, while the capital adequacy (k) has a negative impact. The positive sign of the coefficient associated to (Loans/TA) indicates that higher (lower) level of loans banks can undertake increases (reduces) banks 'efficiency, which is consistent with the view that less regulatory control allows banks to engage in various activities and generate income from non-traditional sources. Furthermore, higher level of equity would reduce cost efficiency implying that better capitalized banks are not necessarily more efficient. We also find that state ownership has a significant positive impact on Tunisian banks' efficiency indicating that the public bank seems to be able to take advantage of political favoritism, and appear more efficient than their private counterparts. However, size and credit risk proxy don't affect efficiency in this context. Interestingly, the impact of monetary policy on either the cost frontier or the cost efficiency is significant. The negative relation with cost function implies that a restrictive monetary policy will reduce costs and radially will shift downward the frontier. While restrictive policy positively influences efficiency. This may simply imply that banks find the means to preserve their credit commitments at the time of monetary tightening, and takes advantage of the inflationary context to make gains. We also find substantial unexploited cost scale economies. This could indicate that banks may have the opportunity to make many gains in efficiency by changing their size. Also suggests that Tunisian banks do not operate at their optimal size. Thus, this study recommends that the policymakers will be more incline to find ways to obtain the optimal utilization of capacities as well as making the best use of their resources. We close with a caveat that the empirical results of this study have founded a number of weaknesses in Tunisian bank performance. Several possible policy conclusions arise from this that may improve the sector and increase efficiency. Firstly, banks suffer from a lack of capital, and also struggle with regulatory fragility. Indeed, the capital requirements remain low compared to international requirements. By comparison, regulatory capital adequacy ratio and Tier 1 ratio requirements are respectively 10% and 7% in Tunisia, whereas these thresholds are

set at 12 and 9% in Morocco. In addition, Tunisian banks refer to the Basel II requirements for their regulatory capital adequacy ratios, hence the neglect of certain risks. Hence, from a regulatory point of view, the performance of the banking sector will be based onits operational performance. Thus, policy guidance is expected to strength the resilience and performance of the banking institutions with the aim of intensifying the robustness and stability of the banking sector. Secondly, it would be desirable to improve domestic banking concentration in order to ensure the stability of the financial system but also of overall economy which is financed, more than 90%, by the banks. The implementation of a regulatory framework allowing the development of synergies that favor the bringing together of banks is therefore necessary. And finally, and because the system remains little transparent and hardly marks, at this stage, evolution compared to the previous system the State can support the banking sector by significantly improving the monetary regulation towards a less administered regulation allowing to abolish certain financing habits that are incompatible with flexible interest rates and that lasted only because the authorities did not dare to vary interest rates significantly. Overall, the results indicate that bank efficiency is determined by banking and institutional variables. However, future research could incorporate specific information on management expertise, and the level of corruption in banks as well as macroeconomic variables, such as monetary and fiscal freedom as well as public spending, to understand profitability in institutions financial.

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Appendix

Table 7: efficiency score per year

Observations	2010	2011	2012	2013	2014	2015	2016
ABC	0.986780	0.889618	0.970109	0.795974	0.858765	0.906086	0.873111
AMEN˙BANK	0.691889	0.706444	0.704717	0.726808	0.718002	0.844658	0.819497
ATB	0.846092	0.841089	0.866400	0.857207	0.832764	0.818808	0.785998
ATTIJARI	0.786718	0.729362	0.727735	0.756203	0.800243	0.791009	0.764777
BARAKA˙BANK	0.766710	0.748487	0.947826	0.850199	0.744617	0.501861	0.516469
BH	0.999081	0.976295	0.999361	0.992394	0.969447	0.994388	0.984527
BIAT	0.892827	0.846506	0.866715	0.874483	0.828524	0.781416	0.766261
BNA	0.985271	0.975720	0.983772	0.963441	0.998162	0.984471	0.999045
BT	0.829346	0.740410	0.795916	0.825711	0.816738	0.862969	0.850563
BTE	0.596919	0.611572	0.627377	0.665744	0.659000	0.998658	0.996962
BTK	0.622466	0.601139	0.566953	0.578551	0.539677	0.594338	0.572713
BTL	0.805630	0.703117	0.724322	0.851930	0.984137	0.861966	0.883971
CITYBANK	0.856071	0.754759	0.961166	0.997289	0.796257	0.805963	0.863749
STB	0.944346	0.940465	0.939386	0.998957	0.997014	0.947557	0.991731
STUSID	0.753703	0.707784	0.726686	0.761715	0.994530	0.737374	0.696525
TQB	0.656103	0.721414	0.647824	0.662783	0.647121	0.623409	0.594094
UBCI	0.727614	0.728483	0.721307	0.718664	0.685104	0.590051	0.580659
UIB	0.532195	0.496851	0.512632	0.618160	0.647887	0.667789	0.659549
WIFAK˙IB	0.585896	0.609707	0.611915	0.593273	0.561661	0.750327	0.996079
ZITOUNA	0.973866	0.685021	0.830397	0.627752	0.623060	0.616147	0.585941

Table 8: Efficiency Scale Per Year

Banque	2010	2011	2012	2013	2014	2015	2016
BIAT	0,4510596	0,44187039	0,41417025	0,40924859	0,42193538	0,39558093	0,3921637
BNA	0,42494017	0,41936709	0,40191669	0,40382689	0,39252449	0,42095065	0,41664547
STB	0,43485798	0,4206594	0,3935328	0,35152783	0,28872538	0,43687866	0,40877269
AMEN BANK	0,51546214	0,49126797	0,47629496	0,49467307	0,49715898	0,54477718	0,52682662
BH	0,45722197	0,44756971	0,44417457	0,41245642	0,4238595	0,44152372	0,43832703
ATTIJARI	0,46736098	0,46175483	0,44539431	0,43770924	0,42870782	0,44090801	0,432721
ATB	0,46614674	0,45678928	0,44945954	0,45264454	0,46218772	0,46887427	0,46703336
BT	0,54009854	0,49758875	0,49421749	0,51189964	0,51861442	0,53936509	0,5321863
UIB	0,39113459	0,3961231	0,34944543	0,37367586	0,4416711	0,43805103	0,43008819
UBCI	0,42447375	0,44674565	0,43814635	0,44209545	0,46182463	0,47972818	0,47045474
BTK	0,57193711	0,5600665	0,52513536	0,53185368	0,54428141	0,55056069	0,52405892
TQB	0,61802652	0,63677115	0,56509978	0,53034714	0,46287771	0,47830559	0,46086277
STUSID	0,5735609	0,5601068	0,54287654	0,55224757	0,53888966	0,55285112	0,55423558
BTE	0,65605298	0,60822988	0,58156933	0,56344861	0,54627877	0,54710519	0,54211974
BTL	0,53367458	0,5132059	0,51356806	0,5359731	0,53343952	0,55782723	0,55424363
ABC	0,49934514	0,46549644	0,36980621	0,42163615	0,47158608	0,49449991	0,4854114
WIFAK IB	0,76419429	0,77836542	0,76713311	0,77175179	0,7318666	1,03096277	1,02237487
CITYBANK	0,45769733	0,47316224	0,32721502	0,24083029	0,40252069	0,37290454	0,35600932
BARAKA BANK	0,5752085	0,55628829	0,46633633	0,52379297	0,52953982	0,52337659	0,4997127
ZITOUNA	0,51058648	0,54652976	0,42750355	0,45998314	0,47050113	0,4603851	0,44727349