

# **Discernible Differences in the Building Façades, but not in the Productivity Numbers: A Comparison Between Domestic and Foreign Banks in North Africa**

CHAFFAI Mohamed

Faculté des Sciences Economiques et de Gestion de Sfax, Sfax University, Tunisia

## Abstract

Foreign banks are usually seen as a potential driver of technology transfer and expertise in the host countries. This argument may be reinforced when banks parents belongs to developed country banking systems. To test these prior assumptions, we investigate the evolution of total productivity change by ownership structure using an homogeneous sample of commercial banks in North Africa over the period 2002-2014. Total factor productivity change is then decomposed into three components, technical change, efficiency change and scale change using a stochastic frontier model. We find a very low rate of productivity change in the studied banking systems, but foreign banks does not prove to be neither more productive nor a potential driver of technological or efficiency transfer in the region.

JEL. C13, D24, G21

## Introduction

Foreign banks could be an important driver for developing countries financial markets. According to Claessens et al. (1998), they can improve the quality of the financial services in host countries and force domestic banks through competition to imitate them, stimulate the banking services infrastructure through better supervision and more active legal framework. In addition, they can enhance countries funds access to the international financial markets. However, since foreign banks are under the control of their parent banks they are less risky in particular during the financial crisis and are more likely to be under political pressures in the host countries to provide loans to connected peoples. To sum up all these effects could be beneficial to improve the productivity of banks for the banking systems and foster the financial markets in the host countries. We can find in the literature other opponents view where foreign banks are considered as a source of instability since they have the possibility to withdraw domestic markets more easily, in case of great instability due to important political or financial crisis. In addition, foreign banks usually lend to their own country customers, the so called "follow-the-customer" or to the most lucrative host country customers, leaving the domestic banks to serve the others i.e., more riskier customers, that weakens the financial domestic market. These contrasting arguments should have an impact on the efficiency of the banking sector as a whole.

Within this framework, there is an important empirical literature on banking efficiency which compared the efficiency of banks according to ownership type, foreign, public, private, or other ownership structures. One of the main assumptions largely discussed considers that foreign banks have a "global advantage" since they may have easier access to their parent bank technology and expertise, which offer them a comparative advantage in terms of productivity and managerial efficiency. However, domestic banks seem to have another counter balancing advantage, the so called "informational advantage", as they may have better knowledge on the behavior of their customers in particular with respect to risk but also on the investments local market opportunities. The empirical literature also underline another advantage, namely most of domestic banks have a well developed branch network in their own country allowing them to have a great benefit in terms of customers portfolio. Remind that in most of the developing countries, switching cost for banks customers to close an account with their bank and open another with the competitor are quite high. Historically, in most

of the country's domestic banks are the oldest compared to foreign banks which are much recent, it is also the case in North Africa. In the same time, the technology is also transforming banking businesses, with the decline of the paper based payments and the emergence of online banking services among other services, which needs high level of knowledge and expertise in the information technology. Consequently, foreign banks should have a great benefit since they could be an important driver of technical progress in the host countries, in particular for those banks where parents belong to developed countries where technologies are widely developed. In those countries banking systems, financial markets are highly developed and competitive allowing easier technologies transfer across banks. For developing countries banks, this potential transfer from foreign banks if it exists, is conditioned by a skilled human capital disposal but also by good infrastructure in communication and information technologies.

The conclusions derived from empirical studies comparing bank efficiency with ownership should be distinguished between developed countries and developing countries banks. First the strategy toward foreign bank entry countries are different, as it is the case for the regulations within markets in the host countries. In a study conducted by Berger et al. (2000) for the developed countries banks case, the authors show that domestic banks are more efficient than foreign banks, and explain this result by their much better knowledge of the markets. By contrast, and for the developing countries case, the conclusions are much more controversial according to the country or the region under study, but in several cases foreign banks are found to perform much better. Claessens et al. (2001) propose the first study making a large international comparison of banking performances including 80 developed and developing countries. Based on simple efficiency ratios, cost and profit over total assets, they find that foreign banks have higher costs and are less profitable in developed countries, but they find opposite conclusions for developing countries banking systems. In subsequent studies based on more elaborated measures of bank efficiency, several authors reported mixed results for developing country banks, depending on the country, the sample period, and the methodology used to measure banking performance, Berger et al. (2000). These studies compare bank performance with ownership structure based on more elaborated index of performance, i.e. cost efficiency, profit efficiency or to a lesser extent total factor productivity change, TFP. According to this literature, we can find on one side that foreign banks outperform domestic banks in some studies, and on the other, the opposite conclusion in other studies, see Kumar and Gelati (2014) for an updated survey of this empirical literature. Furthermore, most of the authors focus on static measure of banking performance, cost efficiency, few studies compare TFP growth with ownership structure.

This paper builds on and extend this empirical literature in two ways: first it employs a parametric type productivity index based on the estimation of a stochastic cost frontier, this method is most suitable for small bank samples as it is the case in the North Africa region, but also explore the panel structure of the data. Second, country TFP growth rates is decomposed into three components (technical change, efficiency change, scale change) which are compared by ownership structure. Finally, by considering a more homogeneous subgroup of MENA countries, the North African banking system where foreign banks operators are closely the same in terms of parent bank owners, the conclusions of this study will provide a more precise comparison since characteristics for foreign banks are very similar. The main questions addressed are: What are the most important drivers of banking productivity growth in North Africa banking system? Are foreign banks more cost efficient than their counterparts in the region? Could foreign banks in North Africa be a real driver of technology and expertise transfer to foster the productivity of the banking system?

The paper is organized as follows. Section 2 reviews the literature on foreign banks efficiency comparison in MENA region. Section 3 reports the methodology used to estimated total factor productivity. Section 4 discusses the empirical results and Section 5 reports some robustness checks of the results. Section 6 concludes and suggests some policy implications.

## 2. Review of the literature related to MENA

There is an important wave of literature which compared the efficiency of foreign banks to their counterparts. Much of this literature is related to developed countries banks or developing and emerging countries banking systems, see Kumar and Gelati (2014)<sup>1</sup>. This literature did not find a clear and robust finding that foreign banks outperform domestic banks. We also notice that most of this literature focus on static measure of efficiency (cost or profit efficiency). Much limited empirical studies compared banking efficiency in MENA region with ownership structure, followed than this wave of literature. Some papers focused on the comparison of Islamic and conventional banks in the region Johnes et al. (2014), Ben Naceur et al. (2011), Srairi (2010), Chaffai and Hassan (2019) but we can find only a very handful of studies comparing foreign banks to domestic banks. These literature can be divided into two groups, those who focus on the experience of only one country (most of them), and those which take a group of countries in the region. Regarding foreign banks ownership and bank efficiency comparisons in a specific country, Isik and Hassan (2002) consider the case of Turkey during the 1998-1996 period. They employ both parametric cost and profit frontier models and non parametric models and find that foreign banks outperform domestic banks. This results is contested by the study of Yildirim (2002) who for the same country finds that public banks outperform foreign banks in terms of technical efficiency for the similar period. This essential conclusion has been also rejected in the study Fukuyama et al. (2011) when they consider a more recent period for Turkey, (1991-2007), the authors employ non parametric model and conclude that foreign banks are not more efficient than domestic banks<sup>2</sup>. Fethi et al. (2011) use the non parametric methodology and consider both cost efficiency and productivity of the Egyptian banking system for a large period (1984-2002). They do not provide comparison and tests of the efficiency components by ownership, but from their reported table results, foreign banks are neither the most efficient banks, nor the most productive in Egypt. Ariss (2008) estimate cost efficiency and find that foreign banks are as efficient as domestic banks in Lebanon. Assaf et al. (2011) also adopt the non parametric model in order to evaluate the Saudi Arabian banking performance in 2000-2007 period. In a second step they regress the banks inefficiency scores on inefficiency determinants including foreign bank dummy which proved to be negative and significant. There is also evidence that domestic banks outperform foreign banks in that country. We can also find empirical literature which compare bank efficiency pooling developed and developing countries. In a study including 105 countries for the period 1998-2008, Lensink et al. (2008) estimate a stochastic frontier model by pooling developed and developing countries and found that foreign banks negatively affect cost efficiency.

Regarding the empirical literature belonging to MENA region and comparing foreign and domestic banks, Ariss et al. (2007) are pioneer when they estimate a Malmquist productivity index for the Gulf country banking system and decomposed productivity growth rate into technical change, efficiency change and technical efficiency change using a non parametric model. Using data from 1999 to 2004, the authors show that productivity declined over the studied period due mainly to technological regress and a fall in technical efficiency. More recently, Chaffai and Hassan (2019) estimate a meta cost and profit frontier in a large sample of banking systems in MENA. Inefficiency is then decomposed into managerial inefficiency and technology inefficiency, he did not find evidence that foreign banks owned by developed country banking systems could be the driver for technology efficiency in the region using a data for (2002-2012). To sum up, whether by considering single country experience or

---

<sup>1</sup> Among the 30 studies reviewed, the authors found that foreign banks perform better only in 17 cases while domestic banks are better in 9 cases.

<sup>2</sup> There is no consensus on the results for Turkey, the conclusions seem to depend on the studied period but also on the efficiency model used.

the MENA region, whatever is the methodology to estimate bank performance has been employed, there is no strong conclusion that foreign banks outperform domestic banks in the region. Also, except the papers by Isik and Hassan (2002), Fethi et al. (2011) or Ariss et al. (2011), most of the empirical studies focus on a static measure of efficiency, which is a particular component of bank total productivity. What would be interesting is to evaluate the dynamic of the efficiency, i.e. the productivity growth rate of the banking system to capture the long run path to see whether one bank type is really more productive than the other. The decomposition of TFP into technical change, efficiency change and scale change will provide a more fine view for policy makers in the region on the potential efficiency advantage of foreign banks compared to their counterparts in the region.

### 3. The methodology

In order to compare the efficiency of North African banks, we follow the traditional and most commonly used stochastic cost frontier model. This methodological choice is made for several reasons. First, cost minimization assumption could be an objective shared by most of the banks as they compete in the same markets whatever is their ownership structure. Second, compared to other dual models, such as profit or revenue frontier models, the behavioral assumptions are more restrictive, for example profit maximization may not be an objective for state owned banks which may pursue other social objectives. With respect to the small bank sample, the other non parametric method based on DEA (Data Envelopment Analysis) methodology, which also could be used to estimate bank productivity, will induce estimation bias in particular when we derive estimates of efficiency scores. First, the Malmquist productivity index needs to construct frontier envelop by year and by country, due to very limited number of banks in the sampled countries, the efficiency scores will be poorly estimated, Simar and Wilson (1998). Second, the non parametric method did not allow to exploit the panel data structure of the sample to capture unobservable heterogeneity which may be considered as inefficiency in the DEA model. Earlier investigations in this field include Casu et al. (2004) who found that most of the European banking productivity growth has been brought by technical change in the 1990s.

Let  $C$  denote the total cost of a bank which produce a vector of outputs  $Y=(y_1, \dots, y_m)$  and uses a vector of inputs  $X=(x_1, \dots, x_k)$  at the observed vector prices  $P=(p_1, \dots, p_k)$ . The bank cost structure being approximated by the flexible Translog form and where linear homogeneity in input prices are imposed is specified by:

$$\begin{aligned} \text{Log}(TC_{it} / p_{kit}) = & a0_i + \sum_{j=1}^M b_j \text{Log}(y_{jit}) + \frac{1}{2} \sum_{j=1}^M \sum_{j'=1}^M b_{jj'} \text{Log}(y_{jit}) \text{Log}(y_{j'it}) + \\ & \sum_{h=1}^{k-1} a_h \text{Log}(p_{hit} / p_{kit}) + \frac{1}{2} \sum_{h=1}^{k-1} \sum_{h'=1}^{k-1} a_{hh'} \text{Log}(p_{hit} / p_k) \text{Log}(p_{h'it} / p_{kit}) + \quad (1) \\ & \sum_{j=1}^M \sum_{h=1}^{k-1} c_{jh} \text{Log}(y_{jit}) \text{Log}(p_{hit} / p_{kit}) + \sum_{m=1}^M d_m \text{Log}(y_{jit}) t + \sum_{m'=1}^{k-1} e_{m'} \text{Log}(p_{hit} / p_{kit}) t + f \cdot t + 0.5g \cdot t^2 + u_{it} + v_{it} \\ & i = 1, \dots, N_i \text{ banks, } t = 1, \dots, T \text{ time periods} \end{aligned}$$

The total error structure is composed of two terms, the cost inefficiency component  $u \geq 0$  plus the random error term  $v$ . The trend component included assumes non neutral Hicks technical progress.

This is a general specification panel data stochastic cost frontier, while  $u_{it} \rightarrow |N(0, \sigma_u^2)|$  and  $v_{it} \rightarrow N(0, \sigma_v^2)$  which is the standard stochastic frontier formulation. Bank fixed effect is introduced in the cost frontier specification which capture all unobserved characteristics specific to each bank. The frontier is

estimated by the maximum likelihood method and the inefficiency components by the Jondrow et al.(1980) conditional estimator.

Total factor productivity growth TFP is obtained by totally differentiating the cost function with respect to time, following Denny et al. (1981) the most common standard decomposition of TFP change is the sum of three components:

$$TFP = TC + Scale + EC \quad (2)$$

Where:

$$TC = -\frac{\partial \ln(TC)}{\partial t} = -\left( \sum_{m=1}^M d_m \text{Log}(y_{jit}) + \sum_{m'=1}^{k-1} e_{m'} \text{Log}(p_{hit} / p_{kit}) + f + g \cdot t \right) \quad (3)$$

$$Scale = (1 - RTS) \sum_{j=1}^M \left[ \frac{\varepsilon_{cy_j}}{\sum_m \varepsilon_{cy_m}} \right] \quad (4)$$

$$\varepsilon_{cy_j} = \frac{\partial \ln(TC)}{\partial \ln y_j} = b_j + \sum_{j'=1}^m b_{jj'} \text{Log}(y_{j'it}) + \sum_{h=1}^{k-1} c_{jh} \text{Log}(p_{hit} / p_{kit}) + d_j \cdot t \quad (5)$$

$$RTS = \left( \sum_{j=1}^m \varepsilon_{cy_j} \right)^{-1} \quad (6)$$

$$EC = -\frac{\partial u_{it}}{\partial t} \quad (7)$$

pure technical change TC, which measure the shift down of the cost function if technical progress is present. The second term capture the impact of the scale economies on productivity. If return to scale are increasing, its impact on TFP is positive,  $\varepsilon_{cy_j}$  the cost elasticity with respect to each output being positive. In the opposite case, if the return to scale is decreasing,  $RTS < 1$ , its impact on productivity will be negative. Finally the last term, EC capture the efficiency change effect, its impact being positive if managerial efficiency improves over time and negative in the opposite case. All these components are obtained from the estimation of the stochastic cost frontier (1) and the inefficiency components. Notice that the TFP decomposition used in this paper (2) could be extended to take into account for market imperfections Denny et al. (1981) or when the cost function specification include external factors such us deregulation effect on TFP, Kumbhakar and Lozano (2005). Kumbhakar and Lovell (2000) also propose another extended decomposition with three components by adding the impact of allocative inefficiency (i.e. total cost inefficiency being decomposed into pure technical inefficiency and allocative inefficiency). Those extended decompositions needs other detailed data which are not disposable for our sampled banks, so we restrict the TFP decomposition to the most standard case. To sum up, total factor productivity is decomposed into three terms, technical change (TC), scale efficiency change (SC) and technical efficiency change (EC) and is called the Malmquist productivity index.

Banking technology being multiproduct, the cost frontier model is a commonly used methodology to estimate productivity growth and its components. The recurrent question to conduct this analysis, is to define what banks are producing and what are they using as inputs in their production process. This is an old debate among researchers in this field who agree to the existence of two approaches called the

production approach and the intermediation approach. The first one considers only physical inputs (labor and physical capital) and the outputs is measured by the number of transactions and accounts. On the other hand, the second approach includes deposits as an additional input, and takes loans and investments as outputs generally measured by total loans and other sources of revenues, Berger and Humphrey (1997). Most of the empirical literature uses the intermediation approach which is followed in this paper.

The panel data structure of the data allow us to take account of the unobservable heterogeneity of banks characteristics which may be confused with inefficiency. We estimate a stochastic frontier using the true fixed effect model, Greene (2005). This is the most flexible model which takes into account of the bank heterogeneity of the data set without imposing any restrictive structure on the evolution of the inefficiency component in the cost frontier. Kumbhakar et al. (2014) discusses the importance of this model to take into account for unobservable heterogeneity with panel data stochastic frontier among other models. Notice that traditional panel data stochastic frontier models does not distinguish between unobserved bank heterogeneity and inefficiency, Battese and Coelli(1995), Kumbhakar (1990), Cornwell et al. (1990). Unobserved heterogeneity across banks may be confused with productivity, for this reason we prefer the Greene (2005) model.

#### 4. Empirical results

We consider a homogeneous sample of countries group in North Africa, including Algeria, Morocco and Tunisia. The banking system has some common characteristics, (i) the importance of public banks which is measured by the share of public banks assets in total bank which varies between 90.5% in Algeria, 41% in Tunisia and 27.6% in Morocco (ii) most of the foreign countries bank parents in the three countries have the same banks' home countries, (BNP-Paribas, Société Générale or Crédit Industriel et Commercial, CIC), or from Gulf countries (only active in Tunisia and Algeria) (iii) the share of foreign banks in the banking system is very low. The data used comes from Bank Scope and cover the period 2002-2014, and include a sample of 34 banks and 383 observations. We also retain the most commonly used definition of foreign banks when the share in bank by foreigners capital exceeds 50%. Finally the sample is restricted to commercial banks, the most active players in each country financial market, so investment banks are excluded. All the monetary variables have been deflated by each country price index, 2000 being the base year.

Regarding the importance of foreign banks in the sampled countries, it is commonly used to calculate the penetration rate (a measure of foreign bank presence) measured by the total assets of foreign banks divided by the total banking sector assets in each country and year. This rate is very low in Algeria 8.8%, followed by Morocco 22%, and Tunisia 26% which is the most opened country to foreign banks in North Africa. Notice that the low penetration rate in Algeria may reflect heavy regulatory barriers to foreign entry. Table 1 reports and compares by using a simple difference in means test some activity bank's variables by ownership and country. Domestic banks have much bigger size, provide much higher loans and have more other earning assets than foreign banks. By contrast, except Algerian banks which seems on average less costly than their counterparts, both Tunisian and Moroccan banks have no differences in average costs by ownership.

We start the analysis by conducting a likelihood ratio test in order to check whether the three countries share a common technology frontier, the test highly reject the null assumption at the 99% confidence level, which suggests heterogeneity of the technology across the countries<sup>3</sup>. So, we estimate a stochastic frontier model by country, and from the parameters estimates we calculate the TFP growth rate of each country banking system and its three components discussed in the methodology. The results of the stochastic frontiers are summarized in Table A1 in the appendix. Furthermore, for each country we conduct several tests, constant return to scale assumption is rejected for each country, the assumption of no technological progress (no shift over time of the cost frontier) is rejected, and finally the assumption that  $(\sigma_u^2 = 0)$  no inefficiency in each country banking system. All these assumptions are highly rejected at more than 99% of confidence, as reported by the Wald tests presented in Table A2 in the appendix. We can conclude that the three components have an impact on the TFP of the studied banking systems over the studied period.

Table1: Descriptive statistics

Country	Variable Name	Domestic banks	Foreign banks	t-test
Algeria	Penetration (%)	-	8.8	
	Total Assets	11195584.7	987429.1	8.86***
	Loans	4289483.0	503549.6	7.65***
	Other Earnings	4625075.4	147058.9	6.63***
	Average Cost (%)	2.66	3.96	-6.53***
	# Banks	6	8	
	# Observations	69	77	
Morocco	Penetration (%)	-	22.36	
	Total Assets	12218935.4	5977032.4	3.96***
	Loans	6681096.4	4333080.6	2.48***
	Other Earnings	4434406.3	1034316.5	5.53***
	Average Cost (%)	4.29	4.51	-1.04
	# Banks	5	3	
	# Observations	62	36	
Tunisia	Penetration	-	26.12	
	Total Assets	3345057.4	1623687.1	8.29***
	Loans	2381465.7	1079439.6	8.89***
	Other Earnings	637815.5	401681.5	3.30***
	Average Cost (%)	4.91	4.89	0.15
	# Banks	8	5	
	# Observations	77	58	

#### 4.1. TFP components comparison

Return to scale (RTS) are estimated by country and year according to equation (6). Table 2 reports the average RTS by country and by ownership category. We also report the mean difference test of the equality of RTS between domestic and foreign banks by country. Overall, RTS is greater than one and significant in Algeria and Tunisia but less than one in Morocco. These results suggests that there are potential scale economies which could be obtained if the Algerian and Tunisian banks increase their operations through mergers for example; an expansion of their activities will contribute to lower their average cost and consequently will improve their productivities. In contrast, Moroccan banks are in the opposite situation, on average they are in a situation of diseconomies of scale, which mean

<sup>3</sup> The likelihood ratio test statistic with their p-value of the Khi2 test (numbers in parentheses) is equal to 275.81(0.000)

contracting their activities at least for the largest banks is an important issue to render them more productive. Comparing RTS by bank ownership category, suggests that on average there is no difference in RTS between foreign banks and domestic banks in Algeria and Tunisia, but a significant difference for Moroccan banks. The overall RTS is much closer to one for foreign banks, (0.98) than for local banks (0.93), and suggests that domestic banks are oversized in Morocco with respect to their cost structure. Overall, the results suggests that foreign banks are not operating at their optimal size in the three countries.

Another important component of TFP growth is technological progress. This component is obtained from the parameters estimates of each country from equation (3), which measure the shift of the cost frontier over years. A downward shift means the total cost is decreasing over time due to technological progress, while an upward shift means a technology regress.

Table 2: Average return to scale

Country	overall	Domestic banks	Foreign banks	t-test
Algeria # obs	1.146 142	1.155 69	1.138 73	0.96 (0.337)
Morocco # obs	0.951 98	0.932 62	0.983 36	-4.35*** (0.000)
Tunisia # obs	1.043 130	1.037 72	1.050 58	-1.26 (0.209)

The most dynamic banking system is Morocco where technical progress contribute in decreasing total costs by 1.88% per year. This dynamic is supported mainly by domestic banks, on average between 2002 and 2014, local banks use 24.24% less inputs to produce the same level of output with the technology of 2002; foreign banks benefit is limited to 1.33%. For the two other countries, the overall impact of technical progress is low but negative meaning technological regress. For Tunisian banks, foreign banks have a positive technical progress coefficient, but very low score 0.31% per year. However, for this last country if we divide the total period into two sub-periods, before the Arab spring event 2011 and after, technical progress was negative -0.98% (for domestic banks) -1.38% (for foreign banks), but positive after 2011, 0.86% (for domestic banks) and 1.63% (for foreign banks). Significant technical progress in Tunisia after 2011 may be attributed to the novo entry of foreign banks in the banking system. Overall, except for Tunisian banks and for a very short sub-period (2012-2014) there is no evidence that foreign banks have higher rate of technical progress and are a real driver of technology transfer for the North African banking systems.

Table 3: Average technical progress in percentage

Country	overall	Domestic banks	Foreign banks	t-test
Algeria # obs	-0.05 142	0.49 69	-0.56 73	1.36 (0.174)
Morocco # obs	1.88 98	2.04 62	0.16 36	8.056*** (0.000)
Tunisia # obs	-0.84 130	-0.52 72	0.31 58	-4.306*** (0.209)



The last TFP component is obtained by calculating the yearly variation of cost efficiency scores by bank. We report in Table 4 the average cost efficiency by country and ownership structure. It measures by how much each country banking system is efficient in terms of cost, i.e. by measuring the distance between each bank observed cost with the minimum cost of each country efficient bank frontier. This efficiency score capture cost efficiency of each banking system, i.e. technical and allocative efficiency, hereafter called managerial efficiency. The scores across countries are not comparable, since they are obtained from different frontiers with different countries data. However, within a specific country efficiency scores by ownership are comparable since the frontier envelope is constructed for all the banks within each country. From the last column in Table 4 we can conclude that there is no significant statistical difference between foreign banks and domestic banks in terms of efficiency, even if in Algeria and Morocco domestic banks are slightly more efficient than foreign banks, the difference in means being statistically not significant.

Table 4: Average cost efficiency

Country	overall	Domestic banks	Foreign banks	t-test
Algeria	0.87	0.889	0.858	1.624
# obs	142	69	73	(0.106)
Morocco	0.919	0.92	0.915	0.352
# obs	98	62	36	(0.726)
Tunisia	0.956	0.955	0.957	-0.398
# obs	130	72	58	(0.691)

#### 4.2. Country productivity growth rates comparison

To conduct a deeper comparison of the three banking systems with ownership structure, we now assess the productivity change across the countries by estimating the Malmquist index equation (2) which is the sum of three components, technical progress, efficiency change and scale efficiency change. It allows us to compare TFP across countries and ownership structure, but also to identify the major driver of TFP growth of each banking system. As it has been discussed earlier, these results are based on country specific cost frontier model estimates. Growth rates are now comparable, which was not the case for the efficiency scores comparisons across countries as mentioned below. Table 5 reports the annual decomposition TFP growth rates by ownership and country. Overall, banking average TFP change over the period is relatively high in Algeria (2.35%), but much more low in the other two countries, with annual growth rates, (0.18%) in Tunisia and (0.14%) in Morocco. Figures a, b, c in the Appendix exhibits the distribution of TFP growth rates by country and ownership, and shows that the foreign bank distribution is slightly skewed to the left compared to domestic bank TFP distribution, which means that foreign banks does not outperform domestic banks. Table 5 provides also the evolution of TFP over the studied period, Algerian banks seems to be the most productive country, where TFP shows important productivity growth rates reaching more than 8% in 2003, 2011 and 2013. Furthermore, productivity has a positive trend in this country since 2011. However, there is no similar trend in productivity in Tunisia or in Morocco at least since 2010. For this last country the highest level of productivity has been realized in 2008 and 2010, 4.5% and 3.36% respectively, while in Tunisia 2003 and 2011 were the most productive years for the banking sector, 2.4% and 3.05% respectively. The high productivity level registered by the Algerian banking system could be explained by the years of strong economic performances owing to high oil prices, the economy being highly dependent on hydrocarbon, which seems to have a beneficial impact at least for the public banking

system. By contrast, the decline in the Tunisian productivity since 2011, may also be linked to the Arab spring event and the implied low growth rate of the Tunisian economy.

With respect to the banking TFP driver, there is no common conclusion across countries. In Algeria, 90% of banking productivity seems to be mainly brought by scale efficiency change. Efficiency change contribution is much more modest 7.8%, but much more limited impact of technical progress on bank TFP in this country. As indicated in Table 4, and except for two years (2010,2014), scale economies is the main source of productivity in the Algerian banking system. For the case of Morocco, the first driver of productivity is technical progress, its overall impact on TFP is 1.35% on average, but it reach much higher levels during the period 2003-2008, more than 1.5% per year. However, this positive impact was highly compensated by a double negative impact of scale -1% and efficiency deterioration -0.15%. In other words, Moroccan banks are on average over sized which penalize them in terms of productivity. This result could be explained by the strategy of some banks to increase their size enough to concur African countries banking systems. Attijari Wafa banks and also BMCE are now more and more active in Africa. Tunisian banking system seems to be the "bad student" among the three countries. The three TFP components are weak and never exceeds even 0.5% per year. The scale component being very low an contributes by about 0.18% to productivity, while the two other components have an insignificant impact on productivity. However, if we consider the two sub-periods, before the Arab spring events and after, technical change starts to be an interesting driver of productivity of the Tunisian banking system, and contribute by about 1% per year since 2012, due mainly to novo banking entry and the restructuring of the Tunisian banking system after the Arab spring events. This result should be interpreted with caution and needs to be validated if the same trend persists in the forthcoming years. Overall, for all the three countries, efficiency change has very limited role in affecting banking system productivity change, which suggests that the North African banking systems, in particular in Algeria, Morocco and at a lesser extent Tunisia, could improve their productivity by focusing on managerial efficiency. The lack of real competitive force in the North African the banking may explain why there is no real force to improve managerial efficiency and spur the productivity of banks. For the monetary authorities in the region, reinforcing competition among banks could be a driver for such improvement, but also through incentive measure policies to improve bank efficiency.

#### 4.3. Country-specific productivity growth components by ownership

We analyze now the productivity of each country banking system by bank type and year. As we can see from Table 6 and except for Algeria (+1.84%), average TFP gap between domestic banks and foreign banks is weak,(-0.45% in Morocco, 0.05% in Tunisia). Overall, as it can be seen from the last column of Table 6, the difference in means of TFP by bank type is not statistically significant, which suggests that no difference in productivity between foreign and domestic bank whatever is the country. Moreover, if we consider yearly difference based on annual TFP growth rates, there is no evident trend of the superiority of foreign banks in terms of TFP, except for two years foreign banks outperform domestic banks, 2007 in Algeria, or 2004 in Tunisia. Overall, foreign banks are not more productive than their counterpart in North Africa. If we look now to the technical change impact on productivity, this component is the most important driver of banking TFP in Algeria and in Morocco. It has increased by 1% per year in Algeria for domestic banks, but with negative impact -0.44% for foreign banks. In Morocco, TP impact is +2% per year for domestic banks, while it is 0.12% for foreign banks. Finally, in Tunisia, TC impact is very limited -0.5% per year for domestic banks against 0.33% for foreign banks. This country is very special, according to the recent political change, if we consider the after Arab spring events (2011), the average rate of TC is 1.63% for foreign banks which outperform domestic banks 0.86%. To sum up, foreign banks are far from being the driver of the banking technology in these countries.

Table 5: TFP components by country and year

Year	TFP	TC	SC	EC
<b>Algeria</b>				
2003	0.0855	-0.0418	0.0615	0.0686
2004	0.0054	-0.0515	0.0368	0.0250
2005	0.0336	-0.0479	0.0271	0.0544
2006	-0.0309	-0.0328	0.0535	-0.0330
2007	-0.0213	-0.0111	0.0332	-0.0446
2008	0.0102	-0.0005	0.0283	-0.0182
2009	0.0307	0.0014	0.0151	0.0141
2010	-0.0465	0.0130	-0.001	-0.0585
2011	0.0885	0.0144	0.0293	0.0448
2012	0.0057	0.0310	0.0047	-0.0300
2013	0.0959	0.0375	0.0150	0.0434
2014	0.0219	0.0564	0.0001	-0.0346
<b>Mean</b>	<b>0.0235</b>	<b>0.0025</b>	<b>0.0212</b>	<b>-0.0018</b>
<b>Morocco</b>				
2003	-0.0092	0.0120	-0.0193	-0.0019
2004	-0.0280	0.0115	-0.0189	-0.0207
2005	0.0013	0.0171	-0.0016	-0.0081
2006	0.0142	0.0179	-0.0246	0.0209
2007	-0.0148	0.0149	-0.0276	-0.0021
2008	0.0457	0.0155	-0.0063	0.0365
2009	-0.0113	0.0159	-0.0097	-0.0175
2010	0.0336	0.0113	-0.0066	0.0288
2011	0.0066	0.0108	-0.0030	-0.0011
2012	-0.0232	0.0112	-0.0056	-0.0287
2013	-0.0097	0.0115	-0.0024	-0.0187
2014	0.0015	0.0109	0.0028	-0.0121
<b>Mean</b>	<b>0.0014</b>	<b>0.0134</b>	<b>-0.0100</b>	<b>-0.0015</b>
<b>Tunisia</b>				
2003	0.0242	-0.0151	0.0072	0.0237
2004	0.0055	-0.0139	0.0045	0.0138
2005	-0.0281	-0.0110	-0.0030	-0.0142
2006	0.0072	-0.0094	0.0088	0.0078
2007	0.0061	-0.0082	0.0064	0.0079
2008	-0.0133	-0.0043	0.0001	-0.0091
2009	0.0056	-0.0026	0.0024	0.0059
2010	0.0038	0.0014	0.0008	0.0015
2011	0.0305	0.0062	-0.0003	0.0246
2012	-0.0151	0.0093	-0.0006	-0.0238
2013	0.0109	0.0118	0.0003	-0.0013
2014	0.0016	0.0152	0.0005	-0.0141
<b>Mean</b>	<b>0.0018</b>	<b>-0.0013</b>	<b>0.0018</b>	<b>0.0001</b>

Scale components contribution to TFP is important only in Algeria, whatever is the bank type, but its impact on productivity is much more important for foreign banks +2.81% compared to domestic banks 1.38%. Being unable to reach high productivity rates through technical change and efficiency change, Algerian foreign banks have improved their scale in order to increase their productivity and to better compete with domestic banks which have much larger size. The last component, efficiency change is very low whatever is the country or the bank type, which suggests that neither domestic nor foreign bank did improved their efficiency during the studied period in order to become more productive.

Table 6: TFP components by bank type

Year	Domestic banks				Foreign banks				t-test
	TFP	TC	SC	EC	TFP	TC	SC	EC	
Algeria									
2003	0.0986	-0.0304	0.0315	0.0975	0.0459	-0.0504	0.1514	-0.0182	-
2004	-0.0214	-0.0585	0.0275	0.0046	0.0255	-0.0445	0.0437	0.0404	-0.755
2005	0.0893	-0.0502	-0.0001	0.1395	-0.0221	-0.0457	0.0543	-0.0307	0.598
2006	-0.0120	-0.0351	0.0348	-0.0078	-0.0498	-0.0305	0.0685	-0.0582	0.336
2007	-0.1739	0.0005	0.0234	-0.1950	0.1313	-0.0227	0.0430	0.1059	-4.40***
2008	0.0727	0.0098	0.0201	0.0427	-0.0523	-0.0093	0.0354	-0.0792	0.966
2009	0.0880	0.0142	0.0099	0.0639	-0.0381	-0.0139	0.0215	-0.0457	1.468
2010	-0.0797	0.0261	-0.0040	-0.1017	-0.0066	0.0018	0.0020	-0.0066	-0.962

2011	0.1053	0.0330	0.0157	0.0565	0.0741	-0.0016	0.0408	0.0348	0.358
2012	0.0230	0.0467	0.0013	-0.0249	-0.0092	0.0175	0.0076	-0.0344	0.457
2013	0.1139	0.0457	0.0149	0.0533	0.0804	0.0305	0.0150	0.0348	0.611
2014	0.0629	0.0592	0.0104	-0.0067	-0.0132	0.0540	-0.0088	-0.0584	1.368
<b>Mean</b>	<b>0.0326</b>	<b>0.0100</b>	<b>0.0138</b>	<b>0.0058</b>	<b>0.0146</b>	<b>-0.0044</b>	<b>0.0281</b>	<b>-0.0094</b>	<b>0.652</b>
Morocco									
2003	0.0267	0.0169	-0.0216	0.0047	0.0217	0.0021	-0.0148	-0.0150	0.783
2004	-0.0208	0.0166	-0.0264	-0.0225	0.0383	0.0012	-0.0038	-0.0169	-0.296
2005	-0.0476	0.0265	-0.0021	-0.0326	0.0010	0.0014	-0.0006	0.0410	-0.901
2006	0.0218	0.0267	-0.0310	0.0174	-0.0074	0.0032	-0.0138	0.0267	-0.106
2007	0.0284	0.0237	-0.0384	0.0174	-0.0207	0.0002	-0.0096	-0.0346	1.086
2008	-0.0152	0.0232	-0.0099	0.0125	-0.0110	0.0028	-0.0003	0.0766	-0.860
2009	-0.0180	0.0240	-0.0148	-0.0138	0.0339	0.0023	-0.0012	-0.0237	1.145
2010	0.0077	0.0172	-0.0102	0.0552	-0.0009	0.0016	-0.0006	-0.0151	1.426
2011	0.0329	0.0171	-0.0052	0.0091	0.0276	0.0003	0.0005	-0.0181	1.60
2012	-0.0263	0.0184	-0.0090	-0.0381	-0.0017	-0.0008	-0.0000	-0.0131	-0.236
2013	0.0233	0.0180	-0.0038	-0.0436	-0.0041	0.0007	-0.0001	0.0227	-0.786
2014	0.0074	0.0174	0.0048	-0.0247	-0.0053	0.0000	-0.0006	0.0087	-0.675
<b>Mean</b>	<b>-0.0002</b>	<b>0.0206</b>	<b>-0.0138</b>	<b>-0.0043</b>	<b>0.0043</b>	<b>0.0012</b>	<b>-0.0035</b>	<b>0.0033</b>	<b>0.040</b>
Tunisia									
2003	-0.0000	-0.0195	0.0130	0.0266	-0.0277	-0.0096	0.0013	0.0208	-
2004	-0.0323	-0.0179	0.0035	-0.0073	-0.0196	-0.0078	0.0058	0.0403	-2.091*
2005	-0.0194	-0.0149	-0.0049	-0.0278	0.0428	-0.0052	-0.0000	0.0063	-1.471
2006	0.0130	-0.0130	0.0058	0.0297	0.0161	-0.0052	0.0119	-0.0142	3.326***
2007	0.0027	-0.0116	0.0070	0.0330	-0.0440	-0.0041	0.0057	-0.0223	1.902*
2008	0.0257	-0.0079	-0.0012	-0.0060	0.0790	0.0001	0.0016	-0.0127	-0.098
2009	-0.0046	-0.0056	0.0004	-0.0128	-0.0226	0.0010	0.0047	0.0282	-2.597**
2010	0.0622	-0.0014	-0.0008	0.0098	-0.0142	0.0048	0.0028	-0.0084	0.342
2011	0.0210	0.0026	0.0010	0.0294	-0.0173	0.0105	-0.0019	0.0190	0.243
2012	-0.0287	0.0055	-0.0005	-0.0314	-0.0139	0.0138	-0.0007	-0.0147	-1.288
2013	-0.0294	0.0085	0.0006	0.0142	0.0233	0.0158	-0.0000	-0.0198	1.048
2014	-0.0025	0.0118	0.0003	-0.0047	0.0081	0.0193	0.0007	-0.0253	0.517
<b>Mean</b>	<b>0.0016</b>	<b>-0.0051</b>	<b>0.0011</b>	<b>0.0025</b>	<b>0.0011</b>	<b>0.0033</b>	<b>0.0027</b>	<b>-0.0027</b>	<b>-0.545</b>

We finally report in Table 7 a summary of the results by pooling the three countries together in a regression model where TFP is regressed on ownership structure, and other bank characteristics, bank size, measured by the logarithm of bank total assets, a measure of market concentration measured by the share of the three largest banks market share in each country, a measure of bank business model measured by the ratio of loans to total deposit. The variable foreign is decomposed in column 2, into developed country banks parents and Arab countries parents. The idea behind this definition is to check whether the foreign banks status differs according to the bank owners, more precisely as it has been discussed earlier that developed countries banks could be a driver of TFP for the banking system in the region. The equation includes country dummies variables and is estimated by the Arellano and Bond GMM method. As reported in Table 7, the absence of serial correlation at the second order along with non significance of the Sargan statistics confirm the validity of the instruments in the GMM estimator. Regarding the control variable, bank assets size is negative and significant which suggests that large banks are less productive than small and medium sized banks. The concentration variable CR3, is significant and with a negative sign which imply that more concentrated markets leads to lower banking productivity. This result is in line with "Quiet Life Hypothesis"<sup>4</sup>, for the banking market in North Africa.

<sup>4</sup> Banks with market power would rather enjoy monopolistic rents by charging more fees for their customers from a "quiet life" as opposed to reach higher productivity.

Table 7: TFP determinants in North African banking system, 2002-2014

Variables	(1)		(2)	
TFP <sub>t-1</sub>	-0.21***	(-22.83)	-0.22***	(-17.30)
Ln(total assets)	-0.02***	(-5.13)	-0.02***	(-6.16)
Loans/Deposits	-0.01	(-0.61)	0.02	(0.77)
CR3	-0.41***	(-12.74)	-0.32***	(-4.18)
Foreign	-0.02	(-1.51)		
Foreign developed countries			-0.04**	(-2.11)
Foreign Arab countries			0.01	(0.51)
Dummy Morocco	-0.06***	(-3.50)	-0.06***	(-2.38)
Dummy Tunisia	-0.18***	(-7.52)	-0.15***	(-3.28)
Constant	0.63***	(10.64)	0.52***	(7.26)
Obs	285		285	
Sargan	26.36		24.45	
ar(1)	-3.71 ***		-3.61 ***	
ar(2)	-1.05		-1.01	

Regarding the foreign ownership coefficient is significant at the 90% level of significance if we consider a one tailed test, column (1). Hence, on average, foreign owned banks in the three studied countries are slightly less productive than domestic banks, the omitted category. In column (2) foreign banks status is desegregated into two categories according to the nationality of their ownership, i.e. developed countries banks (French banks), Arab countries banks (Gulf banks). The implicit idea and according to the empirical literature, is that developed countries banks are more able to diffuse the updated banking technology and expertise which could be a driver for productivity. It is surprising that developed country parent banks, has a negative and significant impact on productivity in the region, while foreign Arab bank owners has no significant impact on bank productivity in North African banking systems. We can conclude here that in the region foreign banks owned by developed countries could not be the driver for productivity and technology transfer for the banking system. This conclusion is on line with a previous finding in MENA region and based on another methodology, i.e. meta frontier, where developed country banks did not prove to have higher technology than domestic banks, Chaffai and Hassan (2017). For example, for Morocco where foreign banks are 100% French banks, technical change contribution to TFP is two times more important for domestic banks compared to foreign banks. There are four possible explanations of this result. First, developed countries banks are known to make fund transfers to their mother banks which render them more costly in the host country. Unfortunately, fund related transfers is not a public information even it is valuable with the central banks, by contrast domestic banks do not have to make similar transfers which give them a cost advantage. The second explanation, is that foreign banks from developed countries are also known to have a niche of their customers which need to be better served (corporate and non corporate), the so called "follow-the-customer" assumption. These customers have high switching costs, and do not really need sophisticated banking services using the most advanced technology. Third, updated banking technology for foreign banks needs high qualified human skills which may be difficult to find in the host countries. Finally, heavy entry regulations and supervision in the region banking system may constitute a frame for foreign banks to expand their activities when for

example the host country imposes restrictions on the foreign banks share on the capital structure, on reserve deposit requirement or by making heavy restrictions on profit transfer or even in the staff recruitment from developed countries banking systems. This could explain why foreign banks coming from developed countries banking systems are not more productive than domestic banks.

## 5. Robustness checks

To check the sensitivity of the results to the statistical model used to estimate the cost frontier, we conduct a robustness check by using alternative estimation method for the stochastic frontier. This model is based on the Battese and Coelli (1995) specification where the inefficiency error component is assumed to follow a truncated half normal distribution where the mean depends on time, time squared, and the foreign ownership dummy<sup>5</sup>. This alternative model has been used in several studies comparing bank efficiency ownership with panel data, Fries and Taci (2005), Lensink et al. (2008). We reject the common frontier assumption by the likelihood ratio test, which suggests the heterogeneity of the banking technology across countries. To save space we will just report the TFP growth rates decomposition by country, results are displayed in Table A3 in the appendix. The results prove to be qualitatively robust even if they differ slightly in magnitude. The correlation coefficient between the two TFP measures, based on the two estimation methods is very high 0.849. Moreover, from the results of Table A3, the country average TFP growth rates over the studied period is 1.6% in Algeria, but the rates are very low, in -0.4% in Morocco and -0.2% in Tunisia. The difference test of TFP means by ownership type is not significant whatever is the country. Except the Moroccan case, technological progress for domestic banks is weak and negative. Moreover, the impact of efficiency change on TFP is also very low for both foreign and domestic banks. Finally, the scale effect contribution to TFP is positive for foreign Algerian banks, but negative for Moroccan foreign banks. Most of these conclusions are qualitatively the same as those obtained previously, i.e. foreign banks could not be neither the driver for technological progress for the studied banking systems nor for improving the managerial efficiency.

## 6. Conclusion

This study has attempted to compare the dynamic of the efficiency between foreign banks and domestic banks in North African banking systems using a stochastic cost frontier approach. Exploring the panel structure of the data, TFP growth rate is decomposed into three main components, technical change, scale change and efficiency change. The main findings of the paper is that foreign banks in the region does not outperform domestic banks neither in terms of annual productivity growth rates nor in its specific components. It is also shown that foreign banks could not be the driver to transfer bank technology from their mother country more advanced banking system, an assumption currently advanced from banking scholars, no statistical difference in technological change difference with ownership has been evidenced. Moreover, according to our results, there is no evidence too, that foreign banks could be beneficial for the banking system by their higher managerial efficiency compared to their counterparts. However, some differences in productivity growth linked to bank size effect have been evidenced in Algerian and Moroccan banking system. Scale impact has a positive impact to improve banking productivity in the first country while it has a negative impact for the second country. To sum up, from all the statistics reported on the efficiency components of foreign banks in the region, there is no significant differences in efficiency with domestic banks whatever is the component considered. Overall, foreign banks in the region does not seem to be a real driver to enhance the efficiency of the local banking system. Their presence could reinforce the assumption of

---

<sup>5</sup> Results could be obtained upon request

"follow your customers", where bank strategy is not aggressive enough for the domestic banks in North Africa in terms of cost efficiency. In terms of economic policy, neither foreign banks coming from developed countries or the Arab countries outperform domestic banks in terms of managerial efficiency nor in the technology transfer. For managerial efficiency, to improve it, banking authorities should reinforce competition across banks, the search for "outsiders" could be an issue. For example, allowing telecom operators which are very active in the region to provide financial services, at least basic payment services could render the banking system more competitive. Also, by granting licenses for on-line banking could also be an important motive for both domestic and also for foreign banks to compete more and to improve their managerial and also technology efficiency. To our knowledge, even if some banks have established on-line banking services in the region, the customers need to pay for that services, banks does not really use this service to reduce operating costs at the branch level and improve their managerial efficiency. In fact developing transactional website will contribute to reduce paper based transactions and consequently the operating costs at the branch level, which may render the banks more cost efficient and more productive. Moreover, even if telecom operators are able to develop easily some payment or money transfer services as it is the case in some African developing countries for example, North African telecom operators are not yet allowed to provide such services and to compete with banks. Since domestic banks are good performers compared to foreign banks, to improve their productivity, the monetary authorities should extend their market by allowing them to operate for example within the North Africa region or in Africa. The Moroccan banking system experience could be an example to follow, a Moroccan large bank is now highly active in Tunisia, while two important banks start to open branches and deliver banking services in some African countries. This could be the challenge for the North African banking system, and it's "political development banking view" in the forthcoming years.

## References

- Ariss R. T., Rezvanian R., Mehdian S. M. (2007) Cost Efficiency, Technological Progress and Productivity Growth of Banks in GCC Countries. *International Journal of Business*, 12 (4), 471-491
- Assaf A. G., Barros C. P., Matousek R. (2011) Technical efficiency in Saudi banks. *Expert Systems with Applications*, 38, 5781-5786
- Battese, G., Coelli T. (1995) A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical Economics* 20, 325-332
- Ben Naceur S., Ben Khediri H., Casu B. (2011) What drives the performance of selected MENA banks? A meta frontier analysis, IMF, WP/11/34
- Berger, A., Humphrey, D.(1997) Efficiency of financial institutions: International survey and directions for future research. *European Journal of Operational Research* 98, 175-212
- Berger, A. N., DeYoung R., Genay H., Udell G. F. (2000) The globalization of financial institutions: The evidence from cross-border banking performance. *Brookings-Wharton Papers on Financial Services* 3: 23-158
- Casu, B. , Girardone, C. , Molyneux, P. (2004). Productivity change in European banking: A comparison of parametric and non-parametric approaches. *Journal of Banking and Finance*, 28 , 2521-2540
- Chaffai M. Hassan K. (2019) Technology Gap and Managerial Efficiency: A Comparison between Islamic and Conventional Banks in MENA. *Journal of Productivity Analysis*, *forthcoming*
- Claessens, S., Demirguc-Kunt, A., Huizinga, H.(2001) How does foreign bank entry affect domestic banking markets. *Journal of Banking and Finance* 25 (5), 891-911
- Cornwell, C., Schmidt P., Sickles R. (1990). Production frontiers with cross-sectional and time-series variation in efficiency levels. *Journal of Econometrics* 46,185-200
- Denny. M., D. Fuss, Waverman L. (1981) The measurement and interpretation of Total Factor Productivity in the regulated sector: The electric utility industry, in T. Cowing and R. Stevenson, *Productivity measurement in regulated industries* (Academic Press, New York)
- Fethi M. D., Shaban M., Weyman-Jones T. (2008) Liberalization, Privatization and the Productivity of Egyptian Banks: A non Parametric Approach. *The Services Industries Journal*, 31 (7), 1143-1163
- Fries S., Taci A. (2005) Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries. *Journal of Banking and Finance*, 29, 55-81
- Fukuyama, H., Matousek R. (2011) Efficiency of Turkish banking: two-stage network system. Variable returns to scale model. *Journal of International Financial Markets, Institutions and Money*, 21 (1), 75-91
- Greene W.(2005) Reconsidering heterogeneity in panel data estimators of the stochastic frontier model. *Journal of Econometrics* 126, 269-303
- Isik, I., Hassan, M.K. (2002) Technical, Scale and Allocative Efficiencies of Turkish Banking Industry. *Journal of Banking and Finance* 26, 719-766



- Johnes J., Izzeldin M., Pappa V., (2014). A comparison of performance of Islamic and conventional banks. *Journal of Economic Behavior & Organization*, S93-S107
- Kumar S., Gulati R. (2014) *Deregulation and efficiency of Indian banks (India Studies in Business and Economics)*, Springer
- Kumbhakar S. (1990) Production frontiers, panel data and time-varying technical inefficiency. *Journal of Econometrics*. 46, 201-212
- Kumbhakar S., Lovell, C. A. K. (2000) *Stochastic frontier analysis*. Cambridge University Press
- Kumbhakar, S. C., Lien, G., Hardaker, J. B. (2014) Technical efficiency in competing panel data models: A study of Norwegian grain farming. *Journal of Productivity Analysis* 41(2), 321–337
- Lensink R., Meesters A., Naaborg I. (2008) Bank efficiency and foreign banks: Do good institutions matter? *Journal of Banking and Finance*, 32, 834-844
- Simar L., Wilson P.W. (1998) Sensitivity analysis of efficiency scores: How to bootstrap in non parametric frontier models. *Management Science* , 44, 49-61
- Srairi S. A., (2010). Cost and profit efficiency of conventional and Islamic banks in GCC countries. *Journal of Productivity Analysis*, 34, 45-62

## Appendix

Table A1: Stochastic cost frontier parameter estimates by country

Parameters	Algeria		Morocco		Tunisia	
	Coef	std	Coef	std	Coef	std
$\ln(y1)$	1.241***	(0.438)	1.289	(1.161)	0.266	(0.303)
$\ln(y2)$	-0.110	(0.143)	-3.676***	(0.776)	0.932**	(0.373)
$\ln(pl/pf)$	0.516	(0.356)	-7.789***	(1.749)	0.948**	(0.417)
$\ln(pk/pf)$	-0.376	(0.302)	1.440***	(0.493)	0.445	(0.373)
$0.5*(\ln(y1))^2$	-0.025	(0.046)	-0.106	(0.131)	0.220***	(0.029)
$0.5*(\ln(y2))^2$	0.025**	(0.011)	0.173***	(0.037)	0.125**	(0.043)
$\ln y1 * \ln y2$	-0.003	(0.015)	0.114*	(0.062)	-0.181***	(0.037)
$\ln y1 * \ln(pl/pf)$	0.038	(0.045)	0.589***	(0.143)	-0.042	(0.040)
$\ln y1 * \ln(pk/pf)$	-0.024	(0.030)	-0.069	(0.066)	-0.091***	(0.028)
$\ln y2 * \ln(pl/pf)$	0.038*	(0.020)	0.080*	(0.045)	0.023	(0.056)
$\ln y2 * \ln(pk/pf)$	-0.003	(0.016)	-0.041	(0.027)	0.037	(0.037)
$0.5*(\ln(pl/pf))^2$	0.361***	(0.042)	0.979***	(0.226)	0.168*	(0.087)
$0.5*(\ln(pk/pf))^2$	0.170***	(0.040)	0.067	(0.053)	0.127***	(0.037)
$\ln(pl/pf) * \ln(pk/pf)$	-0.207***	(0.030)	-0.271***	(0.096)	-0.030	(0.053)
$t$	-0.088	(0.103)	0.188**	(0.087)	-0.121*	(0.060)
$0.5*(t)^2$	-0.016***	(0.004)	0.001	(0.001)	-0.003**	(0.001)
$\ln(y1)*t$	0.014	(0.010)	0.010	(0.011)	0.003	(0.003)
$\ln(y2)*t$	-0.011**	(0.004)	-0.022***	(0.008)	0.007*	(0.004)
$\ln(pl/pf)*t$	-0.014*	(0.008)	-0.018	(0.013)	-0.004	(0.005)
$\ln(pk/pf)*t$	0.035***	(0.007)	-0.007	(0.005)	0.002	(0.004)
EQUITR	1.575***	(0.306)	1.737***	(0.281)	0.248*	(0.148)
Bank dummies	yes		yes		yes	
$\ln(\sigma_u)$	-3.150***	(0.119)	-5.238***	(0.158)	-5.612***	(0.124)
$\ln(\sigma_v)$	-19.480***	(2.613)	-13.036***	(0.713)	-16.296***	(1.083)
log likelihood	120.589		162.822		270.092	
N	142		98		130	

$y1$  = loans;  $y2$  = other earnings;  $pl$  = labor price;  $pk$  = physical capital price;  $pf$  = financial input price; *EQUITR* is equity to total assets ratio.

\*\*\*, \*\*, \* is the significance level, 99%, 95% and 90% respectively

Table A2: Wald tests results

Country	Constant return to scale	No technological progress	No managerial inefficiency
Algeria	68.32 (0.000)	20.52 (0.022)	2.2 x10 <sup>9</sup> (0.000)
Morocco	950.92 (0.000)	30.68 (0.000)	1.3 x10 <sup>7</sup> (0.000)
Tunisia	609.78 (0.000)	1998.16 (0.000)	4.59 x10 <sup>6</sup> (0.000)

numbers between parentheses are the p-values

Table A3: Robustness checks, average TFP components 2003-2014

Country	Bank type	TFP	TC	SC	EC
Algeria	All	0.0161	0.0065	0.0092	-0.0052
	Domestic	0.0234	0.0144	0.0022	-0.0003
	Foreign	0.0088	-0.0010	0.0157	-0.0100
Morocco	All	-0.0040	0.0075	-0.0092	-0.0026
	Domestic	-0.0091	0.0020	-0.0069	-0.0048
	Foreign	0.00472	0.0171	-0.0132	0.0012
Tunisia	All	-0.0021	-0.0017	-0.0002	0.0011
	Domestic	-0.0022	-0.0030	0.0002	0.0020
	Foreign	-0.0019	0.0000	-0.0005	-0.0001

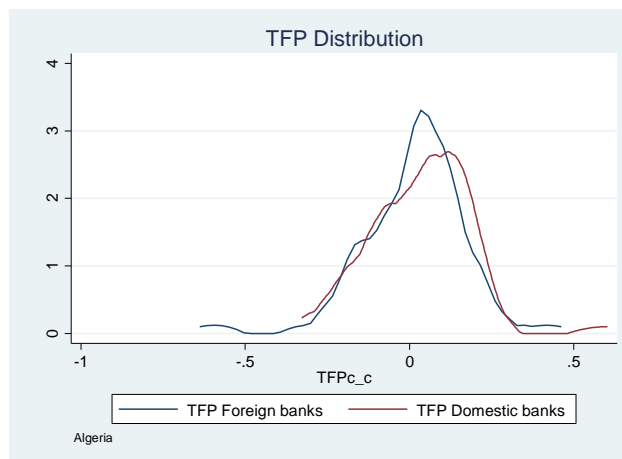


Figure a

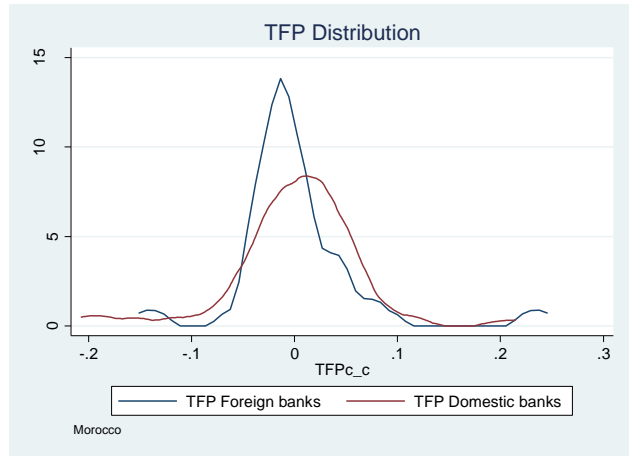


Figure b

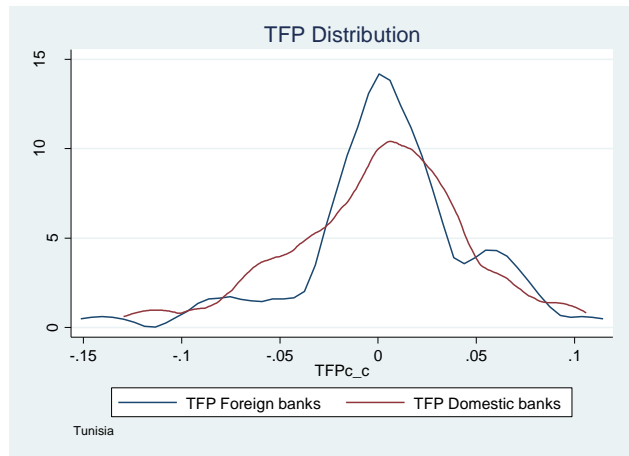


Figure c