

## *The role of ownership structure in explaining differences in efficiency: Evidence from the Algerian banking sector*

دور هيكل الملكية في تفسير فروقات الكفاءة: دليل من القطاع المصرفي الجزائري

**Fouad Hamdani**, The National High School of Statistics and Applied Economics

Laboratory of Applied Statistics (Kolea, Algeria), [fouadhamdani9@gmail.com](mailto:fouadhamdani9@gmail.com)

**Nora Lounici**, The National High School of Statistics and Applied Economics

Laboratory of Applied Statistics (Kolea, Algeria), [noralounici@yahoo.fr](mailto:noralounici@yahoo.fr)

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**Abstract:** This study aims to compare the performance of foreign and public banks as measured by cost and profit efficiency. To accomplish this, we use data on all the commercial banks operating in Algeria over the period 2003–2016. The stochastic frontier approach (SFA) is used to obtain the efficiency scores, which are then regressed on different bank characteristics. Interestingly, results show that public banks are more cost efficient than foreign banks, however they are less profit efficient.

**keyword:** Ownership structure ; cost and profit efficiency ; stochastic frontier analysis ; commercial banks ; Algeria

**JEL classification code :** D24, G21

**ملخص:** تهدف هذه الدراسة إلى مقارنة أداء البنوك الأجنبية والعامّة من حيث كفاءة التكلفة والربح. لتحقيق ذلك ، نستخدم بيانات عن جميع البنوك التجارية العاملة في الجزائر خلال الفترة 2003–2016. كخطوة أولى نقوم بتقدير درجات كفاءة التكلفة والربح عن طريق إستعمال طريقة التحليل الحدودي العشوائي (SFA) ، ثم كخطوة الثانية نستعمل درجات الكفاءة المتحصل عليها كمتغيرات تابعة في نموذج إنحدار خطي مع خصائص البنوك كمتغيرات مستقلة. مما يثير الاهتمام هو ان نتائج الدراسة تظهر أن البنوك العامة هي أكثر كفاءة من حيث التكلفة من نظيرتها الأجنبية ، ولكنها أقل كفاءة من حيث الربح.

**الكلمات المفتاحية :** هيكل الملكية؛ كفاءة التكلفة والربح؛ التحليل الحدودي العشوائي؛ البنوك التجارية؛ الجزائر

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*Corresponding author:* Fouad Hamdani, e-mail: [fouadhamdani9@gmail.com](mailto:fouadhamdani9@gmail.com)

## **1. Introduction :**

Algeria, like many other developing countries, undertook massive reforms to its banking sector in the 1990s, this was a part of a broader plan to go from a planned economy to a market economy. This reform which changed completely the landscape of the banking sector, allowed, among others, the liberalization of the market to national and foreign private investors, a market until then consisted only of six specialized public banks. The years that followed knew the establishment of three private domestic banks, all failed, and the entry of several foreign banks.

As of 2017, the Algerian banking sector was comprised of 20 commercial banks, six of which are public, and the remaining 14 are all private foreign banks composed of 10 subsidiaries, three branches of international banks and one joint venture. Public banks continue to dominate the sector, they hold 85.6% of total assets, among which the biggest two, Banque Nationale d'Algérie (BNA) and Banque Extérieure d'Algérie (BEA), hold nearly half of the industry total assets.

Two interesting questions arise as a result of the above: **is there a significant difference between public and foreign banks in terms of performance?** If yes, then **which form of ownership is associated with better performance?**

Bank performance can be studied from different angles, one can look at its competitiveness, efficiency, productivity or profitability. In this study, we focus on two efficiency concepts: cost and profit efficiency. By cost efficiency we mean bank's degree of success in producing a given level of output using the minimum possible cost, whereas profit efficiency means bank's degree of success in realizing the maximum possible profit. Efficiency is a very important economic concept since resources are limited.

Thus, in the present paper, we propose to evaluate the impact of ownership structure on the performance of banks as measured by cost and profit efficiency. This is done by examining the hypothesis that different ownership types lead to different efficiency levels.

To accomplish this, we use an unbalanced panel data of 20 commercial banks, all the commercial banks in Algeria, over the period 2003–2016. We first estimate cost and alternative profit efficiency

scores using a parametric technique, Stochastic Frontier Analysis (SFA), then in a second-stage regression, we regress the obtained efficiency scores on different bank characteristics, including a dummy variable that represents ownership type.

The literature on ownership structure and bank efficiency suggests that foreign banks operating in developing countries tend to be more efficient than public and private domestic banks. The empirical evidence that supports this conclusion is ample (e.g. Berger, Hasan, and Zhou (2009); Bonin, Hasan, and Wachtel (2005a, 2005b); Fries and Taci (2005); Hasan and Marton (2003); Isik and Hassan (2002a, 2002b); Micco, Panizza, and Yanez (2007)). However, for some developing countries this conclusion is reversed, see for example Yildirim and Philippatos (2007), Sensarma (2006), and Staub, e Souza, and Tabak (2010). As a result, it is not clear whether Algerian public banks are more or less efficient than foreign banks.

The study of the efficiency of the Algerian banking sector provide important insights into issues related to its privatization and liberalization, which can be of great value to the regulatory agencies and policy makers.

## **2. A brief review of the literature :**

Several studies document that foreign banks operating in developing countries tend to be more efficient than public and private domestic banks. For example, in an international study using 179 countries over the period 1995–2002, Micco et al. (2007) find that foreign banks located in developing countries tend to have higher profitability and lower costs than their private and state-owned counterparts. Another study using data from China find that foreign banks are more cost and profit efficient than state-owned banks, and that minority foreign ownership is associated with significantly improved efficiency (Berger et al., 2009). In another study, Bonin et al. (2005a, 2005b) using data from transitional countries of Europe find that foreign banks are more cost and profit efficient than government-owned banks.

Fries and Taci (2005) find that private banks are more cost efficient than state-owned banks, and privatized banks with majority foreign ownership are the most efficient. Similarly, Hasan and Marton (2003) using data from Hungary find that foreign banks and banks with

majority foreign ownership are more cost and profit efficient than domestic banks. Isik and Hassan (2002a, 2002b) using data from Turkey find that foreign banks are more cost and profit efficient than state-owned banks. Another study, Poghosyan and Poghosyan (2010), find that foreign greenfield banks are more cost efficient than domestic and foreign acquired banks in the case of eleven Central and Eastern European Countries.

However, the above conclusion does not hold for all developing countries. For example, Yildirim and Philippatos (2007) find that foreign banks are more cost efficient but less profit efficient than private domestic and state-owned banks in the case of twelve transition economies of Central and Eastern Europe. Another study using data from India find that foreign banks are less cost efficient than private and state-owned banks (Sensarma, 2006). Same results were found in a study using Brazilian data (Staub et al., 2010). To explain these differences, Claessens and Van Horen (2012) using data from 51 developing countries over the period 1999–2006, found that foreign banks perform better when from a high-income country and when regulation in the host country is relatively weak. They also perform better when larger and having a bigger market share, and when the host country has the same language and similar regulation as their home countries.

The literature on efficiency of financial institutions is rather scarce in Algeria, our country of interest, and in the Maghrib region as a whole. In a study of a sample of 14 Algerian banks over the period 2003–2012, Benzai (2016) finds that public banks are more cost efficient than foreign banks. Aiboud (2017) using a sample of 16 Algerian banks over the period 2002–2012 find that public banks outperformed their foreign counterparts in terms of technical efficiency. In another study, Boutheina and Moez (2013) using data from Tunisia find that private banks are more cost efficient than state-owned banks.

### **3. StudyMethodology :**

Efficiency measures to be estimated are cost and alternative profit efficiency as described in Berger and Mester (1997). In cost efficiency we measure how close the cost incurred by a given bank relative to the minimum cost incurred by the industry best-practice bank producing

the same level of output and subject to the same input prices. Whereas in alternative profit efficiency, we measure how close the profit realized by a given bank relative to the maximum profit realized by the industry best-practice bank producing the same output level and subject to the same input prices.

As mentioned, we use SFA to obtain cost/profit efficiency estimates. This technique consists of first constructing a frontier that include all banks that incurred minimum costs/realized maximum profits, after that we measure the distance that separate the cost/profit of other banks relative to this frontier. The frontier is stochastic in a sense that it allows for random fluctuations that can increase or decrease the cost/profit inefficiency of a given bank. For example, if a bank is faced with unfavourable conditions, then its inefficiency level is less than the distance between its cost and the relative frontier. It follows that the stochastic cost frontier is expressed by:

$$C_i = c(y_i, w_i, \beta, \varepsilon_i)(1)$$

Where  $C_i$  is the total cost of bank  $i$ ;  $y_i$  is a vector of outputs;  $w_i$  is a vector of input prices;  $\beta$  is a vector of parameters to be estimated; and  $\varepsilon_i$  is the composed error term.

The composed error term, as proposed in Aigner, Lovell, and Schmidt (1977), consists of two components: a symmetrical two-sided noise  $v_i$  that is supposed to capture errors of observation, measurement, and deviations due to random chocs outside the control of managers such as climate in agriculture or the performance of machinery in a plant. The other is an asymmetric non-negative component that represents cost inefficiency ( $u_i$ ), which corresponds to poor managerial performance. The inefficiency term is separated from random error using the conditional distribution of  $u$  given  $\varepsilon$  as proposed by Jondrow et al. (1982) and Battese and Coelli (1988). As a result, a point estimate of inefficiency is obtained using the mean  $E(u|\hat{\varepsilon})$  or the mode  $M(u|\hat{\varepsilon})$ , and cost efficiency can be defined as  $exp(-u)$ .

SFA requires the specification of the inputs and outputs of production and the functional form of the cost function. For the former we adopt the intermediation approach proposed by Sealey and Lindley (1977), in which banks are assumed to use physical capital, labour and deposits to produce earning assets: loans and other earning assets. Whereas for the latter, we use the translog specification, which is a

second order approximation of any unknown function, given its widespread usage in the literature and its relative flexibility. The cost frontier, which we add to it a time trend to capture the effects of technical progress, is expressed then by:

$$\begin{aligned} \ln \frac{C_{it}}{w_{2it}} = & \beta_0 + \sum_m \alpha_m \ln y_{mit} + \beta_1 \ln \left( \frac{w_{1it}}{w_{2it}} \right) + \delta_1 Trend \\ & + \frac{1}{2} \sum_m \sum_j \alpha_{mj} \ln y_{mit} \ln y_{jit} + \frac{1}{2} \beta_{11} \ln \left( \frac{w_{1it}}{w_{2it}} \right)^2 \\ & + \frac{1}{2} \delta_{11} (Trend)^2 + \sum_m \gamma_m \ln \left( \frac{w_{1it}}{w_{2it}} \right) \ln y_{mit} \\ & + \sum_m \varphi_m \ln y_{mit} (Trend) + \rho_1 \ln \left( \frac{w_{1it}}{w_{2it}} \right) (Trend) + v_{it} \\ & + u_{it} \end{aligned} \quad (2)$$

Where  $C_{it}$  is the total cost of bank  $i$  during year  $t$ , and it is equal to the sum of interest and non-interest expenses;  $y_m, m = 1,2$  is a vector of two outputs: total loans and other earning assets (securities such as government bonds and loans to other banks);  $w_k, k = 1,2$  is a vector of input prices: labor and physical capital price and the price of funds;  $\beta_0, \alpha_m, \beta_1, \delta_1, \alpha_{mj}, \beta_{11}, \delta_{11}, \gamma_m, \varphi_m, \rho_1$  are coefficients to be estimated;  $v_{it}$  is the random error and  $u_{it}$  is the cost inefficiency of bank  $i$  during year  $t$ . In addition, and to satisfy the condition of linear homogeneity in input prices, i.e.  $c(y_i, \lambda w_i, \beta) = \lambda c(y_i, w_i, \beta), \forall \lambda > 0$ , we normalized total cost and prices by  $w_2$  (price of funds).

Normally, we would have three input prices: the price of labour, physical capital and funds, but given that the number of employees per bank is not available, we follow Hasan and Marton (2003) and use the ratio of non-interest expenses over total assets as a proxy for labour and physical capital prices. The price of funds is equal to the ratio of interest expenses over total deposits.

Instead of using cross-sectional data and thus estimating efficiency scores separately for each year, we use panel data. This is because, as Schmidt and Sickles (1984) argues, having panel data can help relax some of the strong assumptions made in SFA. Our preferred model is the Battese and Coelli (1992) time varying model, called time decay

model, in which the inefficiency term is given by  $u_{it} = u_i \exp\{-\eta(t - T_i)\}$ , where  $\eta$  represents an unknown scalar to be estimated,  $t$  is the  $t$ th time period, and  $T_i$  is the number of time periods for each producer. In addition, we use the half normal distribution to characterize the distribution of the inefficiency term.

As with cost efficiency, to obtain alternative profit efficiency scores we need to estimate a stochastic profit frontier. This frontier is similar to the cost frontier given in (2) with two exceptions: (1) total cost is replaced by total profit after tax, which we add to it a constant  $\theta$ , equals to the absolute value of minimum profit plus one, to avoid taking the natural logarithm of a negative number or zero; (2) the composed error term becomes  $\varepsilon_{it} = v_{it} - u_{it}$ , indicating that inefficiency reduces profit. It should be noted that profit efficiency is a superior measure to cost efficiency, since it combines both costs and revenues, as there is greater inefficiency on the revenue side (Berger & Mester, 1997).

The estimation technique of the cost and alternative profit frontiers is the maximum likelihood method, which was carried out using the R package “*Frontier*” developed by Coelli and Henningsen (2013).

### **3.1.Data :**

The dataset consists of balance sheets and income statements of all the commercial banks operating in Algeria, 20 banks in total, over the period 2003–2016. This dataset is obtained from two main sources: from Bankscope database, which contains financial information about numerous banks across the globe; and from the National Centre of The Trade Register (CNRC), which has a database that contains the financial statements of all the commercial firms operating in Algeria. We also use banks annual reports, as obtained from their websites, in the case of missing values.

The panel data is unbalanced since four foreign banks were established after 2003, and two banks at the end of 2003. Overall, it consists of 257 bank-year observations, 84 observations for six public banks and 173 observations for 14 foreign banks. However, and due to data unavailability for some years, and, to a lesser extent, the exclusion of the first year of operation for banks that were established during or after 2003, the sample size was reduced to 210 bank-year observations.

Table 1 presents the means of key performance measures and characteristics for the sample banks according to ownership type.

Foreign banks are more profitable than public banks since return on assets and net interest margin are both significantly higher for foreign banks, 0.8% vs 2.2% and 2.9% vs 5.7%, respectively. Interestingly, we notice that foreign banks have a higher ratio of non-interest expenses, 1.2% vs 2.3%, indicating that public banks are better than foreign banks in managing their operating costs. Furthermore, and even though public banks tend to lend significantly more loans, when adjusted for size we find no significant difference between the two ownership forms (43.8% vs 46.8%). In addition, it is worth noting that public banks are significantly larger in terms of total assets, 1 210.271 vs 71.916 billion Algerian dinars; collect significantly more deposits as a percentage of total assets, 81.1% vs 60.9%; rely significantly less on commission revenues, 0.6% vs 2.3%; have a significantly smaller equity ratio, 6.6% vs 24.3%; and have a higher level of loan loss provision, 8.6% vs 3.2%.

#### **4. Study Results :**

Table 2 gives a summary of the cost and profit frontiers estimates as described in equation (2). From the table we read that  $\gamma = \sigma_u^2 / \sigma^2$  is equal to 85.1% for the cost frontier, indicating that the percentage of inefficiency in the composite error term is relatively large. The same parameter is equal to 7.1% for the profit frontier, suggesting that random error dominates inefficiency and therefore there is no need to account for it in the profit frontier model. To further investigate the issue, we used the likelihood ratio test to compare an average response model, OLS without inefficiency, to our cost and profit frontiers. The results suggest the rejection of the null hypothesis of no inefficiency at the 1% significance level, therefore the stochastic frontier is the preferred model.

Mean cost efficiency is equal to 84%, indicating that the average bank wastes 16% of its cost relative to the best practice bank in the sample, or similarly, the average bank can produce the same output using 16% less costs. Likewise, mean profit efficiency is equal to 62.8%, suggesting that on average banks tend to realize 37.2% less



profits than the best practice bank in the sample. As a result, there seems to be more inefficiency on the profit side than on the cost side, implying that Algerian commercial banks tend to be better at controlling costs than at generating revenues, since profit is equal to revenues minus production costs. In addition, we notice that the standard deviation of the cost and profit measures are relatively high, 11% and 16,2% respectively, indicating the existence of a large disparity between banks in terms of cost and profit efficiency.

Figure 1 and 2 represent the evolution of mean cost and profit efficiency according to ownership type. We notice a significant decline of cost efficiency over the study period for both foreign as well as public banks. Mean cost efficiency for foreign banks went down from 91% in 2003 to 76.4% in 2016, a deterioration of 15 percentage points, though for some years it recorded a slight improvement. The same thing applies for public banks, mean cost efficiency went down from 93.3% in 2003 to 75.1% in 2016, a deterioration of 18 percentage points. With regard to profit efficiency, we notice a significant improvement for both ownership types. Mean profit efficiency for foreign banks went up from 49.8% in 2003 to attain 77.7% in 2016, an improvement of 28 percentage points. Similarly, it went up from 37.5% in 2003 to 65.9% in 2016 for public banks, that is an improvement of 28 percentage points. In addition, and to our surprise, public banks, represented by a triangle in the graph, outperformed foreign banks in terms of cost efficiency. For all the study period public banks are more cost efficient than foreign banks, except for the last year. This relationship does not hold for the case of profit efficiency, public banks are less profit efficient than foreign banks for all the study period, except for the years 2005 and 2006. Interestingly, 2005 is the year when the Algerian government announced the privatization of one of its banks, *CréditPopulaire d'Algérie* (CPA), a decision which, we suppose, pushed public banks to become more profit efficient so as to keep their

status.

Cost efficiency is negatively related to profit efficiency, the sample correlation coefficient is equal to -36.7% for foreign banks and -07.9% for public banks and it is significant at the 1% level, suggesting that cost efficient banks tend to be profit inefficient, and similarly, profit efficient banks tend to be cost inefficient.

The aim of the present study is to investigate the relative efficiency of public and foreign banks. To this end, we compare their cost and profit efficiency scores over the period 2003–2016. We start our analysis by conducting a simple *t*-test for unequal variances, the results are shown in table 3. Mean cost efficiency of public banks is equal to 85.8% not significantly higher than that of foreign bank, which equals to 83.2%, suggesting that there is no significant difference between public and foreign banks in terms of cost efficiency. On the contrary, mean profit efficiency of public banks is equal to 56.7% significantly lower than that of foreign banks, which is equal to 65.8%, implying that foreign banks are more profit efficient than public banks.

To check the robustness of the obtained results of the *t*-test, we regress cost and profit efficiency scores against a set of bank-specific characteristics using the least squares dummy variables model (LSDV), OLS with a set of bank dummies. The regression equation takes the following form:

$$EFF_{it} = \beta_0 + \beta_k X_{k,it} + bank_i + \varepsilon_{it} \quad (3)$$

Where  $EFF_{it}$  is the cost (profit) efficiency of bank  $i$  during year  $t$ ;  $\beta_0$  is the intercept;  $X_{k,it}$  is a set of independent variables that represent bank-specific characteristics,  $\beta_k$  is their coefficients;  $bank_i$  represents a set of 20 bank dummies; and  $\varepsilon_{it}$  is the error term. Note that to avoid the dummy variable trap we removed the Arab Banking Corporation (ABC) bank dummy variable from the regression.

The independent variables include: our variable of interest, public ownership, which is a dummy variable that takes a value of one if a given bank is public, and a value of zero if it is foreign; the natural logarithm of total assets which represents the size of banks; the ratio of loan loss provision to total loans which represents the size of non-performing loans in the portfolio of banks; and a number of variables (equity, loan, deposit, other earning assets, and commission) as ratios of total assets. Estimation results are given in table 4.

The  $R^2$  for the cost and profit efficiency regressions is respectively equal to 92.7% and 97%, indicating that the estimated models account for a great share of the variation in cost and profit efficiency. Hence, the two models fit the data well.

The coefficient on public ownership for the case of cost efficiency is positive and significant at the 1% level, indicating that public banks are on average 16.4% more cost efficient than foreign banks. On the contrary, the same coefficient is negative and significant at the 1% level for the case of profit efficiency, implying that public banks are on average 28.8% less profit efficient than foreign banks. These results suggest that Algerian public banks are more cost efficient but less profit efficient than foreign banks. Our finding for the case of cost efficiency is in contrast with most studies that compare the efficiency of foreign and public banks in developing countries, but it is in line with those obtained by Sensarma (2006) for the case of India, Staub et al. (2010) for the case of Brazil, and Benzai (2016) for the case of Algeria. On the other hand, our finding for the case of profit efficiency is similar to most studies undertaken in developing countries.

Berger et al. (2009, p.123) explain that it is unlikely that public banks “are reasonably adept at managing their costs but extremely incompetent in managing their revenues”. They argue that these banks spend few resources on the screening of potential borrowers prior to granting loans and on monitoring them after the credit is issued, which

reduces costs in the short run but results in poor revenues in the long run, due to non-performing loans. Another argument is that foreign banks tend to offer better quality outputs, by investing in new technologies, which results in a higher cost but increased revenues (Berger & Mester, 2003).

In the context of the Algerian banking market, the observed low cost efficiency of foreign banks relative to public banks can be explained in part by the higher cost incurred by foreign banks due to expanding their branch networks. Indeed, according to the 2017 annual rapport of the Bank of Algeria, the number of branches of foreign banks went up from 152 branches in 2006 to 364 in 2017, that is 212 new branches were established in a period of 12 years. On the contrary, the number of new branches established by public banks was extremely modest in comparison, due principally to the fact that public banks have already a large network of branches that covers all the national territory; the number of branches established by public banks went up from 1 126 in 2006 to merely 1 145 in 2017, an increase of only 19 branches. Therefore, the high cost of establishing new branches explain in a large part the low cost efficiency observed for foreign banks.

Another possible reason is the fact that employees of foreign banks tend to be better remunerated than their public counterparts. According to a survey conducted by the National Office of Statistics (ONS) in 2017, managerial staff of private institutions in the financial sector earn higher salaries than their public counterparts; the net average monthly salary is 118 367 Algerian dinars for private institutions versus only 67 877 Algerian dinars for public institutions. It should be noted that since public banks are larger in size in comparison to foreign banks, one argument would be that public banks benefited from economies of scale so as to reduce their costs. However, this argument is ruled out since larger banks tend to be less cost efficient, as indicated in further

analysis below.

With regard to the lower performance of public banks in terms of profit efficiency, a very convincing argument is the social and development role played by public banks, which forces them to finance socially profitable but economically unprofitable projects. To give an example, Algerian public banks finance three employment assistance programs, ANGEM, ANSEJ and CNAC, in which the interest rates are heavily subsidized and the majority of which end up classified as non-performing loans. For the record, 42% of the matured loans in this category were transformed to classified loans in 2017. Another argument is the periodic recapitalization of public banks by the government, which results in a moral hazard situation where public banks, and because they are not held accountable for their lending decisions, engage in lending that does not meet commercial criteria.

Other interesting findings include: larger banks are significantly less cost efficient but more profit efficient than small banks. To be more precise, an increase of one percent in total assets is associated with a decrease of 6% in cost efficiency and an increase of 9% in profit efficiency. Banks with a higher percentage of equity to total assets are significantly less cost efficient but more profit efficient. Similarly, banks with a higher percentage of other earnings assets to total assets are significantly less cost efficient but more profit efficient. In addition, an increase of total loans as a percentage of total assets is associated with an increase in profit efficiency.

## **5. Conclusion :**

The present study investigated the impact of ownership structure on the performance of banks as measured by cost and profit efficiency. Results show that ownership type is indeed an important determinant of the efficiency levels of Algerian banks. Interestingly, public banks are found to be more cost efficient than foreign bank, however they are less

profit efficient. In addition, we found evidence that cost efficiency worsened over the study period whereas profit efficiency improved.

It should be noted that the findings for the case of cost efficiency are not sufficient to conclude that public ownership of banks is superior to that of foreign ownership. This is because profit efficiency is a superior measure of performance, given that it includes both costs and revenues. In addition, and as we showed, foreign banks are incurring higher costs because they are focused on reinforcing their presence in the Algerian banking sector, to the contrary of public banks who already have a well established presence. Further research should focus on explaining the reasons for the documented higher performance of public banks in terms of cost efficiency but lower performance in terms of profit efficiency.

## **6. References:**

- 1- Aiboud, K. (2017), L'impact de la libéralisation financière sur l'efficacité de l'intermédiation bancaire : le cas de l'Algérie, Doctorat en Sciences Economiques, Université d'Oran 2, Oran, Algeria.
- 2- Aigner, D., Lovell, C. K., & Schmidt, P. (1977), Formulation and estimation of stochastic frontier production function models, *Journal of econometrics*, 6(1), pp.21-37.
- 3- Battese, G. E., & Coelli, T. J. (1988), Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data, *Journal of econometrics*, 38(3), pp.387-399.
- 4- Battese, G. E., & Coelli, T. J. (1992), Frontier production functions, technical efficiency and panel data: with application to paddy farmers in India, *Journal of productivity analysis*, 3(1-2), pp.153-169.
- 5- Benzai, Y. (2016), Mesure de l'Efficiences des Banques Commerciales Algériennes par les Méthodes Paramétriques et Non Paramétriques, Docteur En Sciences Economiques, Université Abou Bakr BELKAID, Tlemcen, Algeria.

- 6- Berger, A. N., Hasan, I., & Zhou, M. (2009), Bank ownership and efficiency in China: What will happen in the world's largest nation? *Journal of Banking & Finance*, 33(1), pp.113-130.
- 7- Berger, A. N., & Mester, L. J. (1997), Inside the black box: What explains differences in the efficiencies of financial institutions? *Journal of Banking & Finance*, 21(7), pp.895-947.
- 8- Berger, A. N., & Mester, L. J. (2003), Explaining the dramatic changes in performance of US banks: technological change, deregulation, and dynamic changes in competition, *Journal of financial intermediation*, 12(1), pp.57-95.
- 9- Bonin, J. P., Hasan, I., & Wachtel, P. (2005a), Bank performance, efficiency and ownership in transition countries, *Journal of Banking & Finance*, 29(1), pp.31-53.
- 10- Bonin, J. P., Hasan, I., & Wachtel, P. (2005b), Privatization matters: Bank efficiency in transition countries, *Journal of Banking & Finance*, 29(8-9), pp.2155-2178.
- 11- Boutheina, B., & Moez, L. (2013), Efficience des banques commerciales Tunisiennes: etude par l'approche de frontière stochastique, *Panaeconomicus*, 60(1), pp.103-132.
- 12- Claessens, S., & Van Horen, N. (2012), Being a foreigner among domestic banks: Asset or liability? *Journal of Banking & Finance*, 36(5), pp.1276-1290.
- 13- Coelli, T. J., & Henningsen, A. (2013), frontier: Stochastic Frontier Analysis, R package (Version 1.1), Retrieved from <http://CRAN.R-Project.org/package=frontier>.
- 14- Fries, S., & Taci, A. (2005), Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries, *Journal of Banking & Finance*, 29(1), pp.55-81.
- 15- Hasan, I., & Marton, K. (2003), Development and efficiency of the banking sector in a transitional economy: Hungarian experience, *Journal of Banking & Finance*, 27(12), pp.2249-2271.

- 16- Isik, I., & Hassan, M. K. (2002a), Cost and profit efficiency of the Turkish banking industry: An empirical investigation, *Financial Review*, 37(2), pp.257-279.
- 17- Isik, I., & Hassan, M. K. (2002b), Technical, scale and allocative efficiencies of Turkish banking industry, *Journal of Banking & Finance*, 26(4), pp.719-766.
- 18- Jondrow, J., Lovell, C. K., Materov, I. S., & Schmidt, P. (1982), On the estimation of technical inefficiency in the stochastic frontier production function model, *Journal of econometrics*, 19(2-3), pp.233-238.
- 19- Micco, A., Panizza, U., & Yanez, M. (2007), Bank ownership and performance. Does politics matter? *Journal of Banking & Finance*, 31(1), pp.219-241.
- 20- Office National des statistiques (2017), Résultats de l'enquête annuelle sur les salaires auprès des entreprises -Mai 2017-, <http://www.ons.dz/IMG/pdf/EnquetesalaireMai2017.pdf>, (consulted on 05/08/2019).
- 21- Poghosyan, T., & Poghosyan, A. (2010), Foreign bank entry, bank efficiency and market power in Central and Eastern European Countries, *Economics of transition*, 18(3), pp.571-598.
- 22- Rapport annuel de la Banque d'Algérie 2017, [https://www.bank-of-algeria.dz/pdf/rapportba2017/chap6\\_2017.pdf](https://www.bank-of-algeria.dz/pdf/rapportba2017/chap6_2017.pdf), (consulted on 05/08/2019).
- 23- Schmidt, P., & Sickles, R. C. (1984), Production frontiers and panel data, *Journal of Business & Economic Statistics*, 2(4), pp.367-374.
- 24- Sealey, C. W., & Lindley, J. T. (1977), Inputs, outputs, and a theory of production and cost at depository financial institutions, *The Journal of Finance*, 32(4), pp.1251-1266.
- 25- Sensarma, R. (2006), Are foreign banks always the best? Comparison of state-owned, private and foreign banks in India, *Economic Modelling*, 23(4), pp.717-735.



26- Staub, R. B., e Souza, G. d. S., &Tabak, B. M. (2010), Evolution of bank efficiency in Brazil: A DEA approach, *European Journal of Operational Research*, 202(1), pp.204-213.

27- Yildirim, S. H., &Philippatos, G. C. (2007), Efficiency of banks: recent evidence from the transition economies of Europe, 1993–2000, *European Journal of Finance*, 13(2), pp.123-143.

## 7. Appendices :

*Table 1 :Mean banks performance measures and characteristics according to ownership type.*

	<i>Total</i>	<i>Ownership type</i>	
		<i>Public</i>	<i>Foreign</i>
<i>Return on assets</i>	0.017	0.008	0.022
<i>Return on equity</i>	0.118	0.118	0.118
<i>Net interest margin</i>	0.048	0.029	0.057
<i>Loan ratio</i>	0.459	0.438	0.468
<i>Deposit ratio</i>	0.673	0.811	0.609
<i>Equity ratio</i>	0.187	0.066	0.243
<i>Commission ratio</i>	0.018	0.006	0.023
<i>Non-interest expenses ratio</i>	0.020	0.012	0.023
<i>Loan loss provision ratio</i>	0.049	0.086	0.032
<i>Total assets (bil DA)</i>	439.127	1 210.271	71.916

*Note:* return on assets is a ratio of profit after tax over total assets. Return on equity is a ratio of profit after tax over equity. Net interest margin is equal to interest income minus interest expenses over total assets. Loan, deposit, equity, commission and non-interest expenses are all ratios of total assets. Loan loss provision is a ratio of total loans. **Source:** author calculation based on data from Bankscope and CNRC.

**Table 2** :Summary of the stochastic cost and profit frontiers estimates.

	Cost efficiency	Profit efficiency
<b>Mean</b>	0,840	0,628
	(0,110)	(0,162)
<b>Log likelihood</b>	46,187	-395,655
$\sigma^2$	0,208	2,556
$\gamma$	0,851	0,071

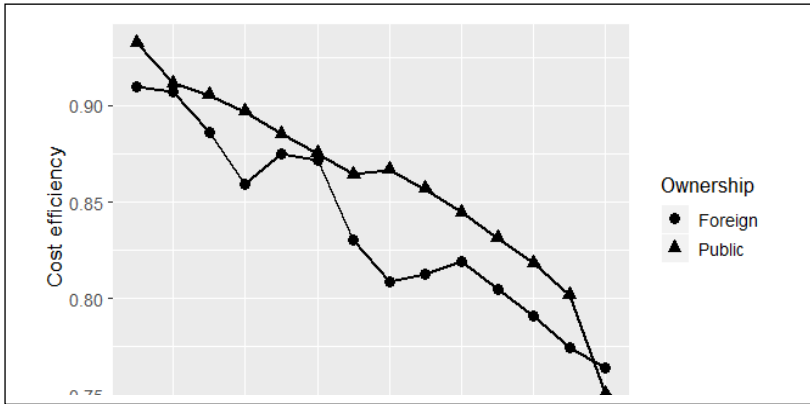
*Note:* standard deviations are in parentheses. *Source:* realized by the authors.

**Table 3** :Results of the t-test and mean cost and profit efficiency according to ownership type.

	Cost efficiency	Profit efficiency
<b>Mean by ownership</b>		
<b>Public (A)</b>	0.858	0.567
	(0.078)	(0.243)
<b>Foreign (B)</b>	0.832	0.658
	(0.122)	(0.085)
<b>Difference (A) - (B)</b>	0.026*	-0.091***
<b>t-statistic</b>	1.886	3.034

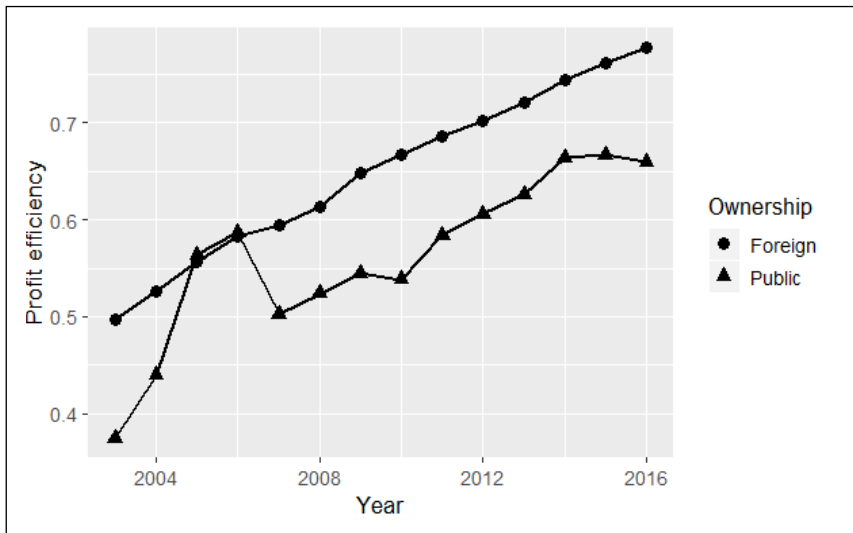
*Notes:* standard deviations are in parentheses. *t*-statistics are in absolute values. \*\*\* and \* indicate significance at the 1% and 10% levels, respectively. *Source:* realized by the authors.

*Fig. 1 :Evolution of mean cost efficiency according to ownership type.*



*Source: realized by the authors using R version 3.5.2.*

*Fig. 2 :Evolution of mean profit efficiency according to ownership type.*



**Table 4** : Estimation results of the effects of ownership type on the cost and profit efficiency of Algerian commercial banks.

<i>Dependent variables</i>	<i>Cost efficiency</i>	<i>Profit efficiency</i>
<i>Intercept</i>	2.371*** (0.102)	-1.650*** (0.102)
<i>Public ownership</i>	0.164*** (0.019)	-0.288*** (0.019)
<i>Ln (total assets)</i>	-0.060*** (0.004)	0.093*** (0.004)
<i>Equity</i>	-0.127*** (0.039)	0.270*** (0.038)
<i>Loan loss provision</i>	0.020 (0.040)	-0.061 (0.040)
<i>Loan</i>	-0.020 (0.022)	0.097*** (0.022)
<i>Deposit</i>	0.003 (0.010)	-0.005 (0.010)
<i>Other earning assets</i>	0.078*** (0.020)	-0.092*** (0.020)
<i>Commission</i>	-0.058 (0.254)	0.023 (0.253)
<i>N</i>	170	170
<i>F statistics</i>	69.4	176.1
<i>R<sup>2</sup></i>	0.927	0.970

*Notes:* estimates of bank dummies are suppressed for both regressions. Standard errors are in parentheses. \*\*\* indicate significance at the 1% levels.

*Source:* realized by the authors.