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Determinants of bank state-owned efficiency, conventional private and Islamic banks in Algeria

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Abstract:

In this article, we examine the determinants of technical, pure technical and scale efficiency of state-owned, conventional private and Islamic banks in Algeria for the period between 2009 to 2018. We used the two-step approach which consists of calculating the efficiency scores of commercial banks using the Data Envelopment Analysis (DEA) and the fixed-effect panel model to find the determinants of the efficiency of commercial banks. The results of the DEA method show that the state-owned banks are the most efficient due to the many state supports. Conventional private banks also have good efficiency scores, but Islamic banks are slightly less efficient than other types of banks. On the other hand, the results of the fixed-effect panel model show that equity and loans are the main determinants of the efficiency of state banks, while equity, deposits, loans and inflation rate are the determinants of the efficiency of conventional private banks, and finally, the size

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of the bank and the importance of loans are the main determinants of the efficiency of Islamic banks in Algeria.

Keywords: technical efficiency, pure technical efficiency, scale efficiency, determinants of efficiency, DEA method, fixed-effect panel model, state banks, conventional private banks, islamic banks.

Jel Classification Codes :

1. INTRODUCTION

Two main phases characterized the constitution of the Algerian banking sector; the first relates to the establishment of an Algerian banking sector before 1990 and the second to liberalize it towards a private sector, both national and foreign. Until 1960, the banking landscape in Algeria was largely made up of private and foreign institutions. With independence in 1962, Algeria acquired the institutional and legal instruments necessary for its national sovereignty through the creation of the Algerian dinar in 1964 and the Central Bank of Algeria on December 13, 1962.

Then, the State exercised its monopoly on the banking sector by nationalizing the private establishments or by creating public establishments like the National Development Fund "CAD", which became the National Development Bank in 1972, and the Caisse Nationale d'Epargne et de Prévoyance "CNEP", through the creation of national companies such as the National Bank of Algeria, the Crédit Populaire d'Algérie "CPA", and the External Bank of Algeria "BEA" in order to take over the activity of dissolved foreign banks[†].

The state determined the interest rate and viewed banks and financial institutions as instruments exclusively for the development and financing of investments by public enterprises. With the promulgation of Law n ° 90-10 of April 14, 1990, relating to money and credit, the country's transition from a planned economy to a market economy was to be accelerated. It introduced, in the first place, the principle of the independence of the central bank from the public authorities by the separation between the real (economic) sphere and the monetary sphere.

The most decisive measures are the opening of the banking sector to domestic and foreign private capital and the free determination of bank interest rates by banks without state

[†] For more details see the book by (Naas, 2003)

intervention. Other measures include the law rehabilitating the role of the Central Bank in its missions, reorganizing the relations between the latter and the treasury, redefining the role of banks, and introducing international standards in the management of money and credit. The law creates new autonomous bodies (the currency and credit council and the banking commission) and establishes the principle of commerciality as a mode of governance of banks.

This law was replaced by ordinance n° 03-11 of August 11, 2003, relating to currency and credit, amended and supplemented by ordinance n° 10-04 of August 26, 2010, the objective of which was to remedy a certain number of dysfunctions observed in the conduct of economic reforms in general and banking reform in particular. The objective is also to strengthen financial security, the payment system, and the quality of the market, and to ensure financial stability.

Since the second half of 2014, the Algerian economy has entered a deep recession following the fall in oil prices. This prompted the country to resort to unconventional financing from 2017 (Bank of Algeria, 2017). As the Algerian financial system is based on the banking system, banks play an important role in financing the economy. Thus, despite the macroeconomic situation, banks in Algeria continue to post good results, particularly high levels of ROA and ROE ratios, but what about their efficiency? Were they affected by this situation? And what are the determinants of the efficiency of state-owned, conventional private and Islamic banks? These are the questions we will try to answer in this article.

According to financial literature, efficiency can be defined as the ability to produce a maximum (technical efficiency) or to optimize the allocation of resources (allocative efficiency) for a given technology, input level, and prices. Efficiency refers to the bank's ability to generate income from a given amount of assets and make profits from a given source of income. Note that the concept of

efficiency is relative since it refers to the best practices observed and not to a theoretical benchmark.

Technical efficiency (TE) compares a bank's current level of production with the best level of production it could have achieved with the same level of inputs. Pure technical efficiency is the measure of technical efficiency without the effects of scale efficiency (Rosman, Abd Wahab, & Zainol, 2014, p. 8). Greater pure technical efficiency indicates that the bank operates more efficiently. As for the efficiency of scale, it is the ability to generate large-scale outputs using fewer inputs. In other words, a larger size of banking operations (comparing TE with PTE) means better efficiency of scale which allows banks to achieve economies of scale.

The objective of this empirical study is to measure the efficiency of commercial banks in Algeria using the DEA method for the period from 2009 to 2018; this would allow us to see the impact of the fall in the price of oil on the efficiency of banks. Then we will find the determinants of efficiency using the fixed-effect panel model.

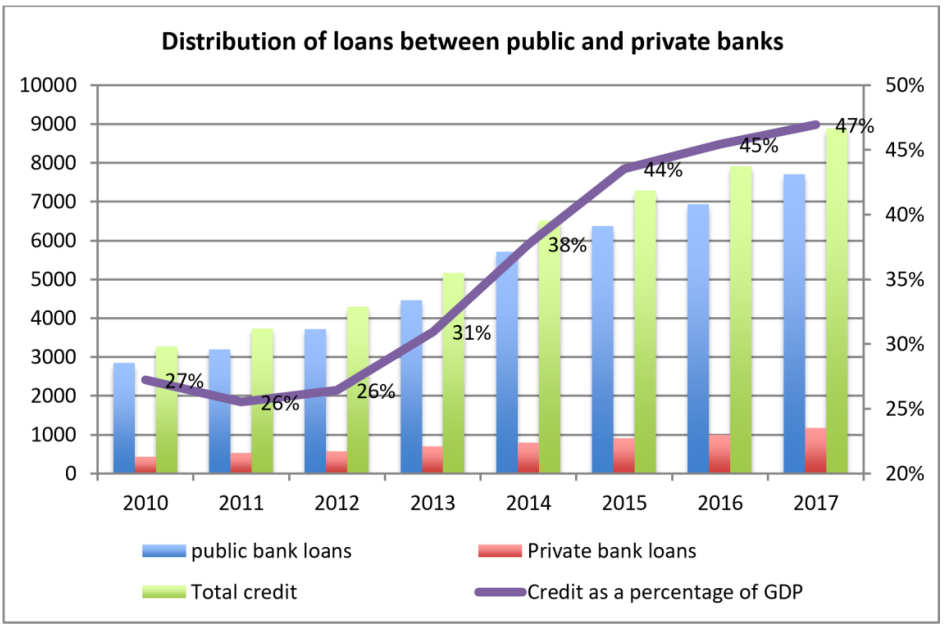
2. Characteristics of the Algerian banking sector

The Algerian banking sector remains predominated by public banks; they have a larger branch network than that of private banks (1,147 against 365 branches in private banks in 2017) (Bank of Algeria, 2017). Public banks are the main provider of funds to the economy as they held 87% of total loans in 2017. Since the bankruptcy of the Algerian private bank Alkhalifa[‡] in 2003, the

[‡]Khalifa bank, Algeria's first private bank (from 1999 to 2003), of the Khalifa group belonging to the owner Rafik Abdelmoumen Khalifa. The expansion of the Khalifa Group has been almost entirely financed by the fraudulent use of depositors' money (mainly public institutions) at Khalifa Bank. Its owner has succeeded in bribing everyone to build his empire. The bank went bankrupt leaving a value of 1.5 billion dollars to clean up. In its fall, it led to the end of the Khalifa group, the loss of 9000

government has imposed on public enterprises the obligation to deal exclusively with public banks. Although this obligation has been abolished, state-owned enterprises continue to deal with state-owned banks and thus make it difficult for private banks to gain a foothold in the market for loans and deposits of state-owned enterprises (International Monetary Fund, 2014, p. 14).

Fig.1. Distribution of loans between public and private banks from 2010 to 2017

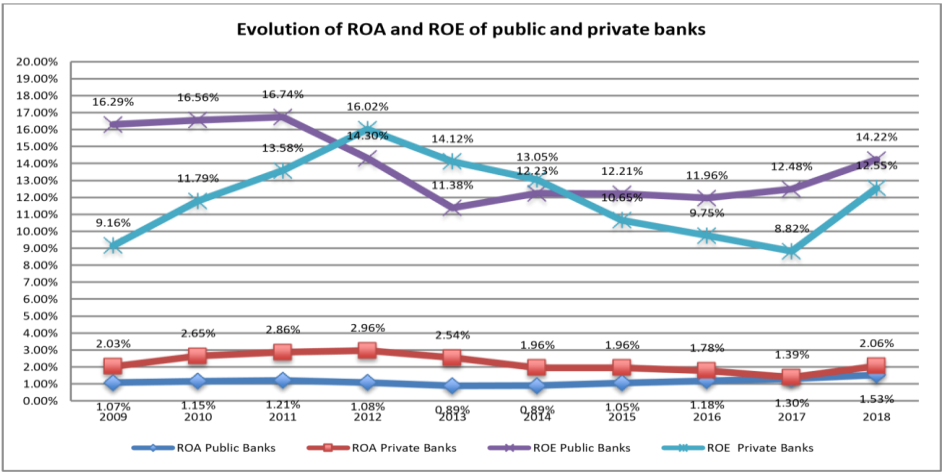


Source: Author's calculation based on data from (Bank of Algeria, 2017)

jobs, and the disappearance of the airline Khalifa Airways. The impact of the Khalifa affair on the business climate in Algeria has been disastrous. Four other national private banks were dissolved between 2003-2004 following the scandal. The opening up of the banking sector to the private sector has become an exclusive opening to the foreign private sector (El Kadi, 2007).

Banks remain profitable and well-capitalized, despite the slowdown in national economic activity due to the slow pace of expansion of the hydrocarbon sector since 2014. The average ROA of public banks is 1.13% and that of private banks is 2.22%. The average ROE of public banks is 13.88% against 11.95% of private banks.

Fig.2. Evolution of ROA and ROE of public and private banks from 2009 to 2018



Source: Author's calculations based on data from Centre National du Registre de Commerce (2022)

The Algerian banking sector is made up of twenty (20) banks and nine (09) financial institutions, all having their head office in Algiers (until the end of 2017). Authorized banks break down as follows:

- six public banks; - fourteen (14) private banks with foreign capital, including two Islamic banks; In order to encourage the activity of Islamic finance, also called participatory finance, the

State has consolidated the legal framework of this activity to remedy the legal vacuum by promulgating the new regulations of 2020 on the conditions for the exercise of the financial activity by Islamic banks and financial institutions.

The Algerian banking system is characterized by poor coverage of banking services and the opportunities offered are considerable. Bank intermediation in Algeria is low compared to neighboring countries (see Table 1), with a population count for a bank machine of 26,309, Algeria is far from the norm of 5,000 inhabitants per bank counter. Since independence, Algeria has been sanctioned by its banking system, which despite its solidity, is unable to meet the needs of agents in need of financing or financing the country's development. This failure of the Algerian economy is mainly due to the lack of openness of the banking sector. The proof is that public banks hold the largest share of the market in terms of assets and credits to the economy.

Table 1: Some indicators of the banking systems of Algeria, Tunisia, and Morocco

Country	Number of banks	Total assets/GDP (in%)	Number bank of branches	Number of inhabitants per counter	Tier I capital ratio	ROA	ROE
Algeria	20	174,95%	1509	26 309	25,18%	2,0%	17,84%
Morocco	14	120%	5 388	5 450	11%	0,9%	10,5%
Tunisia	13	124,6%	1860	5 154	13,8%	1,2%	13,4%

Sources: Reports from the central banks of the three countries for the year 2017 (Bank of Algeria, Central Bank of Tunisia and BANK AL-MAGHRIB)

3. Determinants of banking efficiency, a review of the literature

Research on the determinants of banking efficiency tends to use two categories of indicators: internal variables and external variables. Internal variables are generally determinants-specific to banks, such as bank size, capital ratio, amount of loans, credit risk, return on assets (ROA), capital holding (state vs. private, national vs foreign), and the stock market listing. Regarding the external variables, they are linked to the economic, financial, and institutional environment. External variables can be the gross domestic product (GDP), inflation rate, market capitalization, financial structure and institutional variables, market concentration, and finally, the global financial crisis.

3.1 Capital: Some authors find that there is a positive relationship between the level of capitalization and banking performance such as (Singh and Fida, (2015); Rosman, Abd Wahab, & Zainol, (2014); Řepková (2015)). Berger and Bouwman (2013) find that high capital contributes to improving the survival possibilities and market shares of small banks at all times (during banking crises, market crises, and in normal times). Thus, capital higher levels help medium and large banks, especially in times of banking crises, to improve the probability of survival, as in the period of the credit crunch in the early 1990s.

However, other authors report that a higher capital-asset ratio leads to lower equity risk, and therefore the returns that investors seek will be low, because a very high capital-asset ratio (RCA) means that the bank operates too cautiously and ignores potentially profitable business opportunities, thus, after-tax gains are reduced

by the tax offered through interest deductibility (Saona Hoffmann, 2016). Sufian (2009) finds that the level of capitalization is negatively related to technical efficiency. The most efficient banks use more leverage (and less equity).

3.2 The size of the bank: It is generally measured by the total amount of its assets, and makes it possible to assess the existence of economies or diseconomies of scale in the banking sector. However, empirical studies provide conflicting results: Jiménez-Hernández et al. (2019) and Sufian et al. (2016) find a positive and significant relationship between the size and efficiency of the bank. In contrast, Isik & Hassan (2002) and Akin et al. (2009) found a negative effect of bank size on banking efficiency. Other authors such as Řepková (2015), Singh & Fida (2015) and Al-Gasaymeh (2016) did not find any significant results regarding the influence of bank size on efficiency.

3.3 Credit: The relationship between the importance of bank lending and efficiency has been discussed extensively in the literature. However, there is no consent on the effect of credits on banking efficiency. Batir et al. (2017) find that there is a positive and statistically significant relationship between the amount of loans and the banking efficiency of conventional banks and Islamic banks in Turkey during the years 2005 to 2013. Similarly, Berger and Merster (1997), Jiménez-Hernández (2019), Yildirim and Philippato (2007), Sufian (2009), Yin et al. (2013) also found a positive relationship between the ratio of loans to total assets and efficiency. In contrast, Brissimis et al. (2008) and Havrylchyk (2006) found a negative relationship between credit risk and efficiency. However, Řepková (2015) finds no significant relationship between credit risk and technical efficiency.

3.4 Liquidity risk: In the literature on banking efficiency, liquidity risk is measured either by the ratio of deposits to loans or by the ratio of liquid assets / total assets. Ariff & Can (2008) show that the coefficient of the loan/deposit ratio is significantly positive in a regression of the efficiency of Chinese banks, suggesting that banks with a significant credit activity make more efforts to capitalize the funds purchased, which increases efficiency.

Likewise, Řepková (2015) finds that liquidity risk has a positive impact on the efficiency of Czech commercial banks. In contrast, Brissimis et al. (2008) find a negative relationship between the ratio of liquid assets to total assets as an indicator of liquidity risk and bank efficiency.

3.5 Return on Assets (ROA): The profitability ratio measured by the return on assets (ROA) has been widely used in the literature as a determinant of banking efficiency. Some studies find a positive and statistically significant relationship between ROA and banking efficiency (Rosman, Abd Wahab, & Zainol, 2014; Sufian, 2009; Hassan, 2006; Singh & Fida, 2015). Banks with higher profitability ratios are generally preferred by customers. As a result, these banks are able to collect the largest share of deposits as well as the best potential creditworthy borrowers. From the point of view of intermediation activities, such conditions create a favorable environment for profitable banks to be more efficient (Sufian, 2009). However, some studies find that the variable ROA has a negative effect on banking efficiency (Tabak, Fazio, & Cajueiro, 2013; Řepková, 2015).

3.6 Ownership of capital: It has been widely documented in the literature that the ownership of capital (state, national private, foreign private, or joint stock banks) is an important determinant of

the performance of banks. Thus, analyzing the performance of foreign banks against that of domestic banks is also important for policymakers to detect the effects of removing entry barriers on bank performance. However, there is also controversial evidence on the relationship between ownership of capital and performance.

Sufian et al. (2016) reports that productive efficiency is positively related to foreign ownership of Malaysian banks, implying that foreign-owned banks tend to be relatively more efficient than domestic banks, while it is negatively related to state ownership of banks. However, Vu & Nahm (2013) found that, on average, state-owned banks in Vietnam are more profitable than private banks due to the significant advantages in favor of state-owned banks. Moreover, the largest state- owned companies in the areas of gas, oil, electricity, and coal are domiciled at the level of state banks. They linked this result in part to the guarantees granted by the state to state commercial banks allowing them to access less expensive funds. Thus, banks of Australian, Japanese, American, and European origin perform better in terms of profitability than Vietnamese national banks and banks from other Asian countries.

Yin et al. (2013) examined the relationship between bank ownership and the technical efficiency of banks in China between 1999 and 2010 (after accession to the WTO). They found that the majority of state-owned banks are less efficient than other commercial banks. Likewise, Berger et al. (2006) found that the Big Four banks in China (state-owned banks) were the least efficient and that the majority of foreign banks performed the best between 1994 and 2003; thus, minority foreign ownership significantly improved the efficiency of banks in China.

Fries and Taci (2005) examined the cost efficiency of 289 banks in 15 post-communist countries of Eastern Europe between 1994 and 2001. The results indicate that privatized banks with majority foreign participation are more efficient than private banks. National banks, although both are more efficient than state-owned banks. Similar are the results in the article by Awdeh and El Moussawi (2009) who found that Lebanese banks that hold majority foreign ownership saw an improvement in their efficiency over the period 1996 and 2005, while banks that hold majority foreign ownership domestic majority ownership and subsidiaries of foreign banks experienced a decrease in efficiency over the same period.

3.7 The stock market listing: There are few studies that have analyzed the relationship between stock market listing and banking efficiency. Isik and Hassan (2002) find that banks whose shares are listed on the Istanbul Stock Exchange are technically more efficient, in accordance with the market discipline hypothesis. On the other hand, Sufian (2016) finds that technical efficiency is negatively related to the stock market listing, implying that the Malaysian capital market has not exerted discipline on bank management, thus rejecting the hypothesis of market discipline.

3.8 Financial leverage: Sufian (2009) examined the efficiency of the Malaysian banking sector during the Asian financial crisis of 1997. He reports that the most efficient banks use more leverage (and therefore less capital). The results suggest that the less efficient banks could have been involved in riskier transactions but prefer to hold more equity. However, a huge build-up of external debt financing relative to equity increases the leverage risk of banks.

The impact of macroeconomic factors on the performance of banks has also been widely discussed in the literature. We distinguish among others: GDP, inflation rate, financial structure, and institutional variables, market concentration, and finally the financial crisis and the price of oil.

3.9 GDP: GDP growth is considered a major determinant of banking performance. Johnes et al. (2014) and Vu and Nahm (2013), have shown the existence of a positive relationship between GDP growth and banking efficiency. The higher the GDP, the better the economic situation. Banks tend to concentrate in countries with high levels of GDP (Hasan, Koette, & Wedow, 2009). In contrast, Sufian (2016) find that GDP growth improves the business climate and reduces barriers to entry for banks. This would increase competition and therefore weaken the profitability of banks in Malaysia. Other studies find a negative relationship between GDP growth and banking efficiency (Batir, Volkman, & Gungor (2017); Řepková (2015); akhun & Avkiran (2009)).

3.10 The inflation rate: Many studies on the impact of inflation on banking performance find a positive effect (Ishfaq, Khan, & ullah, 2015; Tan & Floros 2012). According to Perry (1992), the relationship between inflation and the performance of banks depends on the anticipation of inflation. If inflation is anticipated, banks can adjust interest rates in a timely manner, resulting in revenues that grow faster than costs and having a positive impact on profitability. Conversely, if inflation has not been anticipated, banks may find it difficult to adjust interest rates, resulting in banking costs rising faster relative to income. This will therefore have a negative impact on the profitability of banks. However,

other studies find that the rate of inflation negatively affects the performance of banks (Batir, Volkman, & Gungor, 2017; Vu & Nahm, 2013).

3.11 The development of financial markets: Some authors have found the existence of a positive relationship between banking efficiency and the level of development of financial markets such as (Tan & Floros, 2012; Vu & Nahm, 2013). However, other authors report that the development of stock markets negatively affects banking efficiency (Johnes, Izzeldin, & Pappas, 2014; Grigorian & Manole, 2002).

3.12 Regulations: Chortareas et al. (2012) found that the strengthening of capital requirements or the power of supervision can have a positive impact on the efficiency of banks operating in 22 European countries between 2000 and 2008. This is due to several factors, in particular, the reduction of the likelihood of financial difficulties, reduction of agency problems, and market power. In contrast, regulatory restrictions on banking activities and private supervision appear to negatively affect the efficiency of banks. Additionally, the functioning of national political systems can affect the efficient functioning of banks. Checking for more general national characteristics may explain the differences in efficiency between banks. The authors also report that corruption control has dramatically improved the efficiency of banks in the same sample.

3.13 Market concentration: As for the relationship between market concentration and bank performance, hypotheses have been proposed in the literature: the structure-conduct-performance (SCP) hypothesis according to which the concentration of market

promotes a low degree of competition and confers monopoly powers; the "efficient structure paradigm" hypothesis developed by Demsetz (1973) to gain market share and achieve higher profits. Hou and Zhang (2014) find that intense competition in the market forces banks to develop advanced technical and managerial skills, which translates into increased technical efficiency (sample of Chinese banks).

The quiet life hypothesis argues that firms in a concentrated market have difficulty reducing costs due to: unproductive spending to increase and maintain monopoly power, lack of profit- maximizing behavior, and/or the existence of inefficient managers (Berger & Hannan, 1998). Homma et al. (2014) have used data from Japan to test the above hypotheses and report that, consistent with the efficient structure hypothesis, Japanese banks are expanding. They also report that, consistent with the quiet life hypothesis, market concentration decreases bank efficiency.

Rafael Bautista, Sánchez, and Sobrino (2014), using a sample of 3,952 European Union banks, found that the level of banking competition has a negative relationship with the economic performance of banks. This can only be demonstrated for medium and small-sized banks due to the geographic diversification of the larger entities. As a result, less concentrated banking systems like those in Austria or Germany with a larger number of entities are less favorable to bank efficiency.

Sufian et al. (2016), measuring the impact of the concentration of the Malaysian banking sector, found that the concentration ratio of the three banks shows a positive and statistically significant sign at the 1%

level in all the estimated regression models, and therefore its results support clearly the structure-conduct-performance (SCP) hypothesis.

3.14 The global financial crisis: Singh et al. (2017) found that large banks in Arab countries suffered from a pure and technical decline in efficiency during the period of the financial crisis (2007-2010), but were able to recover and perform better over the years — the period 2011-2013. This means that banks were not able to produce equal amounts of outputs using equal amounts of inputs or less during the period of the financial crisis; the average decline in technical efficiency during the financial crisis was due to the deterioration of pure technical efficiency of 3.99% during the same period. This would reflect the region's finance connection with the international financial system, which clearly resulted in lower levels of technical and pure efficiency.

4. Data and methodology

In this study, we use the balance sheets and income statements collected from the National Center of the Trade Register from 2009 to 2018 for a sample covering the twenty banks operating in Algeria, including six state banks, twelve conventional private banks, and two Islamic banks. The other macroeconomic variables were taken from the site of the Central Bank of Algeria. The choice of the period would allow us to see whether the drop in oil prices has affected the level of efficiency of commercial banks in Algeria.

Regarding research methodology, a famous study by Berger and Humphrey (1997) on banking efficiency measurement techniques categorized these techniques into two main groups: parametric and

nonparametric. Based on an analysis of 130 studies primarily from American and European countries, Berger and Humphrey found that the most common methods were SFA (Stochastic Frontier Analysis) and DEA (Data Envelopment Analysis).

The use of the Data Envelopment Analysis (DEA) method to measure the efficiency of the Decision Making Unit (DMU) has grown exponentially. DEA has been recognized as a modern performance measurement tool (Emrouznejad & Yang, 2018). The main reasons for the popularity of DEA are that it does not require pre-specification of the production function, it is a linear technique and can be used for small samples (Gardener, Molyneux, & Nguyen-Linh, 2011).

However, before presenting the DEA method, we must first consider which bank production model will be used and which will allow the definition of the Input and Output variables for DEA. There are four approaches in the literature: the production approach, the intermediation approach, and more recently, the value-added approach and the operational approach (Sufian, 2009, p. 59). According to the production approach, developed by Benston (1965), a financial institution is defined as a producer of services for account holders and it uses only physical inputs, such as labor and capital, to produce deposits and miscellaneous assets (measured by the number of deposit and loan accounts in a bank or by the number of transactions for each product). The intermediation approach, on the other hand, assumes that financial firms act as an intermediary between savers and borrowers and considers total loans and securities as outputs, while deposits and social and physical capital are defined as inputs (Sufian, Kamarudin, & Mofhd Noor, 2014).

Charnes et al. (1978) proposed a model which had an input orientation and assumed constant returns to scale (CRS). Constant returns to scale (CRS) assume that all banks (DMUs) operate at an optimal scale as a linear frontier. Subsequent papers have examined other hypotheses, such as (Färe, Grosskopf, & Logan, 1983; Banker, Charnes, & Cooper, 1984), in which models of variable returns to scale (VRS) are proposed. DEA CRS appears as follows:

Suppose there are data on N inputs and M outputs for each of the I firms. For the i-th enterprise, these are represented by the column vectors xi and qi respectively. The N × I input matrix, X, and the M × I output matrix, Q, represent the data for all I firms. This involves solving the following linear program:

$$\begin{cases} \min_{\theta,\lambda}\theta. \\ \text{st: } -q_i + Q\lambda \geq 0. \\ \theta x_i - X\lambda \geq 0. \\ I1'\lambda = 1. \\ \lambda \geq 0. \end{cases}$$

Where θ is the efficiency score of the i-th firm, with $0 \leq \theta \leq 1$ and a value of 1 indicating a point on the frontier and therefore a technically efficient firm, as defined by Farrell (1957). λ represents a vector of constants Ix1.

Using the CRS specification when not all companies operate at the optimum scale results in technical efficiency measures that are confused with Scale efficiency (SE). Using the VRS specification allows for a more accurate calculation of technical efficiency with consideration of the effects of scale efficiency. The CRS linear programming problem can be easily modified to account for

varying returns to scale by adding the convexity constraint: I1'λ = 1 to equation (2) to provide:

$$\begin{cases} \min_{\theta.\lambda}\theta. \\ \text{st: } -q_i + Q\lambda \geq 0. \\ \theta x_i - X\lambda \geq 0. \\ I1'\lambda = 1. \\ \lambda \geq 0. \end{cases}$$

Where I1 represents I x 1 vectors of ones. This approach provides technical efficiency scores greater than or equal to those obtained using the CRS model. The convexity constraint (Il'λ = l) essentially ensures that an inefficient firm is only compared to firms of similar size. Thus, the relative technical efficiency is calculated by the equation: Efficiency = (weighted sum of outputs)/ (weighted sum of inputs) (Charnes A. , Cooper, Lewin, & Seiford, 1994, p. 6).

To obtain the scale efficiency scores of each bank, it is necessary to first run a DEA CRS model and another VRS, and then break down the technical efficiency scores obtained from the DEA CRS model into two components, one due to the scale inefficiency and the other due to "pure" technical inefficiency (i.e., TE in the VRS model). If there is a difference between the technical efficiency scores between the CRS and VRS models for a given bank, this indicates that the bank has an inefficiency of scale. This means that: $TE_{CRS} = TE_{VRS} \times SE$, so all these measurements are between 0 and 1.

In our study, we chose an Input-oriented DEA VRS model to calculate the efficiency scores (TE, PTE and SE) of banks in Algeria, with the intermediation approach, because it is the most suited to the data collected. The selected input variables are as follows: customer deposits (including demand deposits), fixed assets, and equity. For the output

variables, we have chosen the total of customer loans, the result and commitments of, guarantee given to customers.

Table 2: Variables for the DEA analysis for all banks in thousand dinars

	Variables (in thousands of AD)	Number of observations	Average	Standard deviation	Min	Max
Inputs Variables	Fixed asset	200	7 338 051,43	8 486 329,95	7 029,00	30 783 541,00
	Deposits	200	411 201 443,31	605 234 025,02	2 407 620,00	2 602 795 806,27
	equity	200	52 907 390,59	75 479 890,18	9 434 708,00	390 222 075,00
Outputs Variables	Credits	200	274 322 994,71	427 112 874,27	569 395,00	2 112 245 392,40
	The result	200	6 907 730,72	11 145 592,14	-568 474,26	76 775 609,74
	off-balance sheet commitments	200	57 276 778,66	111 611 538,93	0,00	672 761 880,00

Source: Author's calculations based on data from Centre National du Registre de Commerce (2022)

Regarding the determinants of efficiency, we have chosen to use the fixed-effect panel data model (it is the most appropriate for the study in terms of statistical results); it will be a question of using the scores efficiency as a dependent variable and regressing them on the various variables internal and external to banks which can positively or negatively influence their efficiency. The basic equation for the regression is:

$$\theta_{ijt} = \alpha + \beta 1\ ln\ \text{deposits}_{ijt} + \beta 2 ln\ \text{total assets}_{ijt} + \beta 3\ ln\ \text{equity}_{ijt} + \beta 4\ \text{loans/asset}_{ijt} + \beta 5\ \text{deposits/loans}_{ijt} + \beta 6\ ln\ \text{GDP}_{jt} + \beta 7\ \text{inflation}_{jt} + \varepsilon_{ijt}$$

θ represents technical efficiency TE (constant returns to scale), pure technical efficiency PTE (variable returns to scale), and SE (efficiency of scale) as a dependent variable, while α is a constant.

β1 to β7 are the coefficients of the independent variables, a positive sign will indicate that the variable has a positive effect on efficiency, a negative sign will indicate a negative influence on efficiency, and, finally, ε is the error term.

5. Discussion of empirical results

The results of the DEA method are obtained using the application Win4DEAP 2 version 1.1.2. Table 3 represents the averages of technical efficiency, pure technical efficiency, and scale efficiency scores for state banks, private banks, Islamic banks, and for all banks.

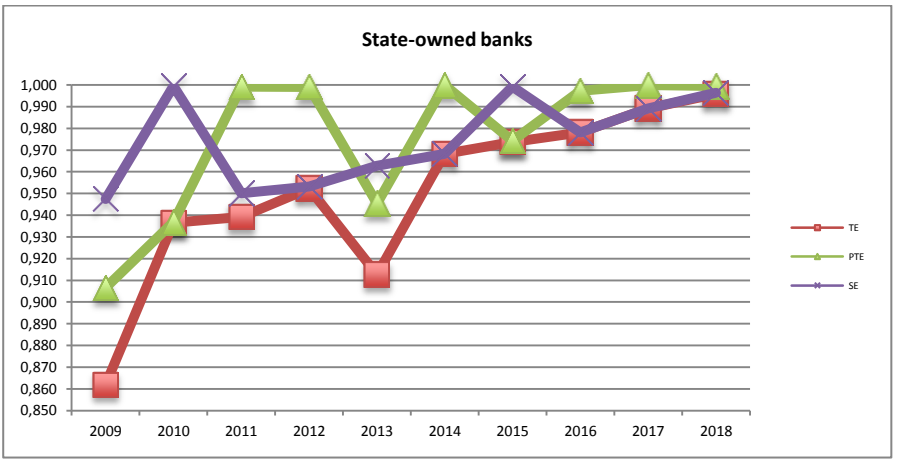
Table 3. Efficiency score results (technical efficiency. pure technical efficiency. and scale efficiency)

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
state-owned Banks	TE	0,862	0,937	0,939	0,952	0,913	0,968	0,974	0,978	0,989	0,996
	PTE	0,907	0,937	0,999	0,999	0,945	1,000	0,974	0,997	1,000	1,000
	SE	0,948	1,000	0,950	0,953	0,963	0,968	0,999	0,978	0,989	0,996
Conventional private banks	TE	0,822	0,873	0,905	0,979	0,935	0,928	0,963	0,946	0,943	0,950
	PTE	0,989	0,979	0,959	0,987	0,947	0,983	0,988	0,987	0,977	0,974
	SE	0,828	0,890	0,941	0,992	0,986	0,945	0,974	0,957	0,962	0,975
Islamic Banks	TE	0,546	0,671	0,935	0,945	0,941	1,000	0,888	0,841	0,816	0,981
	PTE	1,000	0,997	0,976	0,953	0,953	1,000	0,977	0,954	0,945	1,000
	SE	0,546	0,675	0,959	0,991	0,987	1,000	0,908	0,879	0,859	0,981
All Banks	TE	0,807	0,864	0,917	0,968	0,929	0,947	0,959	0,945	0,944	0,967
	PTE	0,966	0,974	0,972	0,987	0,947	0,990	0,983	0,987	0,981	0,984
	SE	0,835	0,887	0,941	0,980	0,979	0,957	0,975	0,955	0,960	0,982

Source: author's calculations using Win4DEAP 2 application

According to the results of the table, we observe an improvement in the three types of efficiency of all the banks during the study period, despite the macroeconomic situation characterized by the fall in oil prices since the second half of the year 2014. Thus, on average, the technical efficiency of public banks is the highest followed by conventional private banks and Islamic banks are the least efficient.

Fig.3. Evolution of TE, PTE and SE of state-owned banks from 2009 to 2018

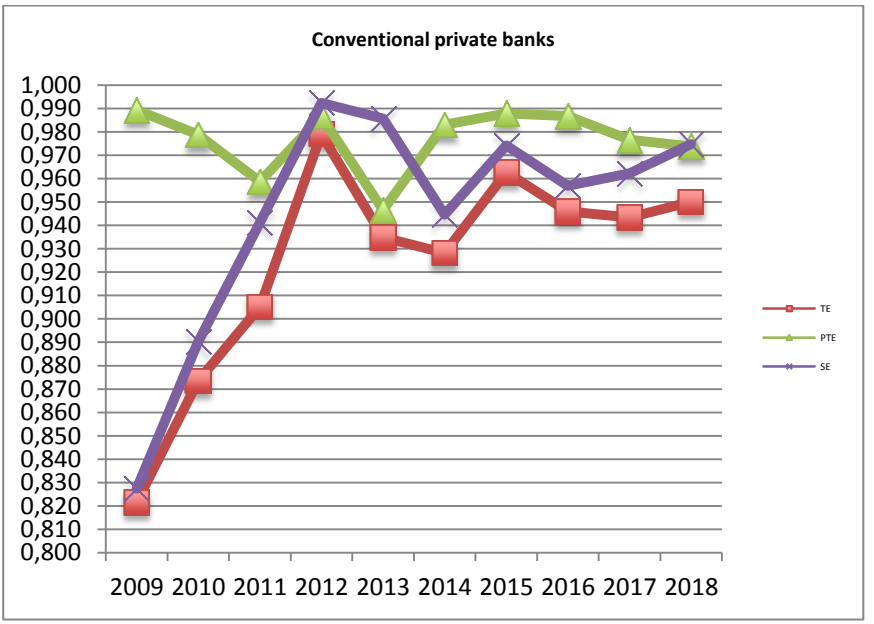


Source: made by the author from the results of the DEA method

According to the results, public banks are the most efficient, with efficiency scores hovering around 100% over the past three years. This is justified by the fact that public banks have the largest market shares in terms of assets, deposits and loans. Added to this is the numerous state support for public banks through the buyout by the Public Treasury of non performing loans, the numerous recapitalizations of public banks to remedy the drop in liquidity

following the fall in oil prices. Some authors have found state-owned banks to be the most efficient (Yin, Yang. & Mehran, 2013; Vu & Nahm, 2013).

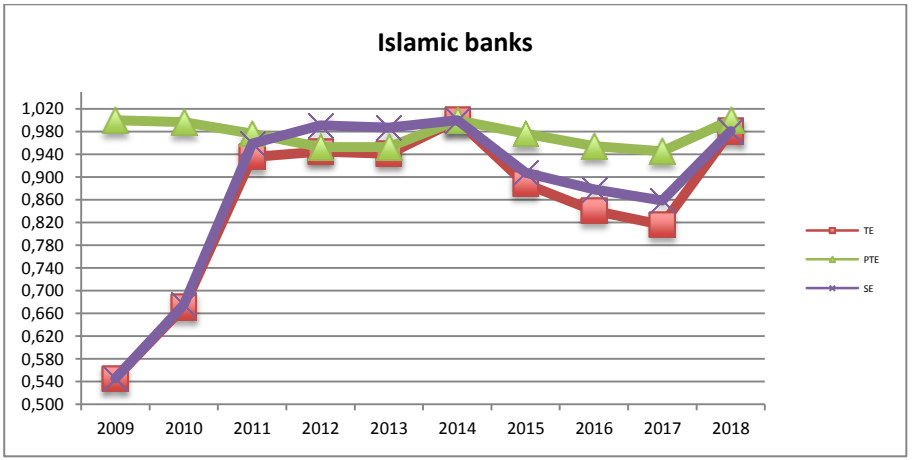
Fig.3. Evolution of TE, PTE and SE of conventional private banks from 2009 to 2018



Source: made by the author from the results of the DEA method

Private banks also recorded very good efficiency scores despite the country's macroeconomic conditions. Between 2009 and 2012, the decline in technical efficiency was due to scale efficiency, which means that some banks did not operate at an optimal size. Between 2012 and 2014, there was a slight decrease in the three types of efficiency, then a recovery from 2015.

Fig.3. Evolution of TE, PTE and SE of Islamic banks from 2009 to 2018



Source: made by the author from the results of the DEA method

The activity of Islamic banks is not very developed. Until 2018, only two private banks exercise this activity in Algeria. Islamic banks experienced low-efficiency scores between 2009 and 2011 (mainly due to one bank). However, efficiency scores improved until 2014. A slight decrease was recorded between 2014 and 2017, and a recovery in 2018.

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Results for the determinants of the efficiency of the three groups of commercial banks:

Table 4. Panel fixed-effect model results determining the technical. pure technical. and scale efficiency of the three groups of banks.

		Bank internal variables					Macroeconomic variables	
		ln Deposits	**ln asset**	**ln equity**	**Loans/asset**	**Liquidity**	**Ln GDP**	**Inflation**
State Owned Banks	**TE**	-0,032043	0,188518	-0,157803***	0,395513	-0,014655	0,086687	0,004904
	PTE	-0,108643	0,273688	-0,107300**	-0,098442	-0,052348	0,091834	0,006268
	SE	0,066559	-0,069317	-0,058154	0,523633***	0,042448	0,006850	-0,001050
Conventional Private Banks	**TE**	-0,066844**	0,319854***	-0,339845***	0,485424***	-0,003323	0,052240	0,012763**
	PTE	0,006673	0,027647	-0,084034**	0,179362***	0,001416	-0,034143	0,003792*
	SE	-0,073832***	0,297748***	-0,264463***	0,326485***	-0,004651	0,088572	0,008376
Islamic Banks	**TE**	0,015038	- 0,343921*	0,388427	1,574133***	0,001859	0,285177	0,004592
	PTE	-0,017604	0,037435	-0,399481	0,302934	0,039610	0,234725	-0,007537
	SE	0,028881	- 0,398426*	0,738910	1,322315***	-0,029733	0,142240	0,012759

Source: made by the author from the results of Eviews 9 software

***: the probability ≤1%, **: the probability ≤5%, *: the probability ≤10%. The pure technical efficiency (PTE) regression model of Islamic banks is not globally significant because the probability of Ficher-statistic is 20%.

According to the results of the model, equity represented by the natural logarithm of equity has a negative and statistically significant impact on the technical efficiency and the pure technical efficiency of public banks, this means that public banks operate too cautiously and ignore potentially profitable business opportunities.

The second reason is regulatory pressures which force banks to hold more equity to cover risks. However, the importance of lending has a positive and statistically significant impact on the efficiency of scale of public banks.

Regarding conventional private banks, the results show that the importance of deposits (represented by the natural logarithm of deposits) and equity (ln equity) have a negative and statistically significant impact on technical efficiency and the efficiency of scale of conventional private banks. So, as with public banks, conventional private banks operate very cautiously, ignore potentially profitable business opportunities, and are also subject to the same regulatory pressures that require them to hold more equity to cover risks.

The importance of the credits has a positive and statistically significant impact on the three types of efficiency. Bank size represented by the natural logarithm of total assets has a positive and statistically significant impact on technical efficiency and scale efficiency. The inflation rate has a positive impact on the technical efficiency and the pure technical efficiency of private banks; this means that conventional private banks anticipate the inflation rate in their activities.

For the two determinants of technical efficiency and scale efficiency for Islamic banks, the size of the bank represented by the natural logarithm of its total assets has a negative impact on the technical efficiency and scale efficiency of Islamic banks, while the importance of loans has a positive and statistically significant impact on both types of efficiency (TE and SE).

6. Conclusion

The Algerian banking sector remains predominated by public banks, despite attempts to open up the banking system since the 1990s. The level of banking services in Algeria remains low and the six state banks have the largest shares of Market. Banks in Algeria show good ROA and ROE performance indicators over the study period, despite the slowdown in the country's economy following the fall in oil prices since the second half of 2014.

The objective of the study is to find the determinants of the efficiency of the three groups of commercial banks in Algeria, state banks, conventional private and Islamic banks between 2009 and 2018. For this purpose, we used the DEA method under the intermediation approach to calculate technical, pure technical and scale efficiency scores. The results show that the six state-owned banks are the most efficient due to the many state supports. Conventional private banks also have good efficiency scores, but Islamic banks are slightly less efficient than other types of banks.

Regarding the determinants of bank efficiency, we used the fixed-effect Panel model. The results showed that for state-owned banks, equity have a negative and statistically significant effect on technical efficiency and pure technical efficiency. The size of the credit has a positive and statistically significant impact on the efficiency of scale.

For conventional private banks, the results showed that the importance of credit, the size of the bank, and the rate of inflation have a positive and statistically significant impact on efficiency. In

contrast, deposits and equity have a negative and statistically significant impact on efficiency.

Finally, the size of the bank has a negative and statistically significant impact on the efficiency of Islamic banks, while the importance of loans has a positive and statistically significant impact on the efficiency. We did not find a relationship between liquidity risk and the size of GDP with the efficiency of the three groups of banks.

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