

## Measurement of the Productivity of Algerian Banks: Using DEA- Based Malmquist Productivity Index Approach

قياس إنتاجية المصارف الجزائرية: استخدام نهج مؤشر إنتاجية مالمكوست القائم على تحليل مغلف البيانات

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### Abstract:

This paper aims to measure the productivity change in the Algerian banking sector, using DEA-based Malmquist Productivity Index Approach for 13 banks that operate in Algeria for a period between (2011-2015), the study aims to estimate the productivity change and its components (efficiency change and technological change) and making a comparison between the domestic, foreign and shared banks in terms of productivity. The results of the study demonstrated that the growth of productivity was highest in 2012-2013. The explanation for this can be attributed to technical progress; Algerian banks productivity regress was mainly attributable to technological change; the total factor productivity change indicates that four out of 13 banks increased their average annual productivity change; the domestic banks operate more efficiently on average than foreign and shared banks with scores of 1.182, 0.927, and 0.558 respectively.

**Keywords:** productivity change, Malmquist index, Algerian banks, efficiency change, technological change

**JEL Classification Codes:** O3, G2

ملخص:

تهدف هذه الورقة إلى قياس تغير الإنتاجية في القطاع المصرفي الجزائري، وذلك باستخدام نهج مؤشر إنتاجية مالمكوست القائم على تحليل مغلف البيانات في 13 بنكاً تشغل في الجزائر لفترة ما بين (2011-2015)، وتهدف الدراسة إلى تقدير التغير في الإنتاجية ومكوناتها (تغير الكفاءة والتغير التكنولوجي) وإجراء مقارنة بين المصارف المحلية والأجنبية والمصارف المشتركة من حيث الإنتاجية. بينت نتائج الدراسة أن نمو الإنتاجية بلغ أعلى مستوى له في الفترة 2012-2013. ويمكن أن يعزى تفسير هذا إلى التقدم التقني؛ وأن تراجع إنتاجية البنوك الجزائرية كان راجعاً في الأساس إلى التغير التكنولوجي؛ ويشير إجمالي تغير الإنتاجية إلى أن أربعة مصارف من أصل 13 مصرفاً زاد متوسط تغيرها السنوي في الإنتاجية؛ وأن المصارف المحلية تعمل بكفاءة أكبر في المتوسط من المصارف الأجنبية والمصارف المشتركة بدرجات 1.182 و 0.927 و 0.558 على التوالي.

الكلمات المفتاحية: تغير الإنتاجية، مؤشر مالمكوست، المصارف الجزائرية، تغير الكفاءة، تغير التكنولوجي.

تصنيفات JEL : 3O، 2G

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## **Introduction:**

Financial institutions play an essential role in the economy, which is considered necessary for blasting and enhancing the development in all sectors by providing financing to enable them to carry out their work and meeting their goals.

The Banks are monetary foundations that are authorized to accept deposits and provide advances to customers, including people, businesses, and associations. thus, the banks must review and develop their banking systems and work out their place relative to their competitors to remain competitive and meeting all their goals.

In Algeria, since Algeria's independence in 1962, the banking system has gone through many stages. Following that, the Algerian government intends to establish an Algerian banking system to finance various development programs (economic, social, and so on). To that end, new state-owned banks have been established; Furthermore, the Algerian government has nationalized foreign banks that have been operating in Algeria since the colonial period. The banking sector was completely controlled by the state from 1962 to 1985. ( Hacini & Dahou, 2018, p. 107)

The 1986 economic crisis compelled the Algerian government to implement significant economic reforms, with the development of the banking system serving as the cornerstone of these reforms. The transition from a centrally planned to a market economy entails structural reforms aimed at correcting macroeconomic imbalances, encourage foreign direct investment and expose Algeria's economy to international competition (HACINI & DAHOU, 2018, p. 146)

Since 1990, two major waves of reforms have set the Algerian banking system in motion. The first wave joined the global framework of economic system reforms aimed at the transition of the economy from a state-controlled and planned economy to a market economy, to adapt sectors to new financing and regulatory requirements. (Zerigui & Boulenouar, 2018, p. 94) Moreover, in 1990, the law on money and credit (LMC) was enacted, to establish a modern banking system capable of meeting market demands. The primary goals of this law were to transition from directed credit banks to market-determined credit banks, as well as to improve banking sector modernization and competition. ( Hacini & Dahou, 2018, pp. 107-108)

Productivity measurement is one of the most significant subjects that need special attention. Through the value of productivity indicators, the banks can demonstrate what it has achieved over a consecutive period and the attained indicators of competitive banks. In other words, measuring productivity over time enables banks to figure out where they are and face their competitors.

The measurement of banking productivity is one of the essential requirements to improve the performance of banks that have a greater impact on the financial result of banks. Thus, it must

adapt to changes that had been dictated by globalization and economic development to meet the challenge of the future. The study pursues to shed light on the evaluation of the productivity and its components of Algerian banks and making a comparison between the domestic, foreign and shared banks in terms of productivity during the period of 2011-2015.

▪ **Problematic:**

Based on what is mentioned above, the problem of this study has been formulated in the following question: What is the level of change in the total productivity of Algerian banks based on the results of the Malmquist Index for the period 2011-2015?

To answer this study question the following sub-questions are formulated:

1. What is the efficiency level of Algerian banks?
2. How much has the productivity of Algerian banks changed during the period under study?
3. Which factor is responsible for the regression in the productivity of Algerian banks?
4. Which group of banks is the most productive of the three types of banks?

▪ **Hypotheses:**

To answer the problem of research, we suggest the following hypotheses:

1. There is a variation in the efficiency levels of Algerian Banks;
2. There is a variation in the productivity of Algerian banks between the years approved in the study;
3. The regression in the productivity of Algerian banks is due mainly to technological change;
4. There is a variation in the productivity levels of groups of banks approved in the study.

▪ **Methodology:**

In order to respond to the problem of study and validate hypotheses, the deductive approach was used in terms of description and analysis in order to give a picture of the development of banks operating in Algeria and to present concepts of data envelopment analysis and Malmquist Productivity measurement, and extrapolation through quantification of the productivity of banks operating in Algeria using the Malmquist index during the period 2011-2015.

▪ **Literature Review:**

From previous studies that used DEA approach and Malmquist index to measure productivity change, we find:

(Khalili, Rahamni , & Alrasheedi, 2019) Used DEA and Malmquist productivity index (MPI) Methodologies. To estimate the productivity of 42 profit-making branches of a private bank in Tehran province (Iran) during the period 2014-2016. The study intended to identify those indexes which are influential in finding the degree of efficiency and effectiveness of bank branches. The results pointed out that scale efficiency had the greatest impact on technical efficiency in the case study.

( Hacini & Dahou, 2018) Investigated the differences in technical, pure technical, and scale efficiencies of domestic and foreign banks in Algeria for the period 2000-2012. The study used annual data of 10 foreign banks and 05 domestic operated in Algeria. By using the Data Envelopment Analysis model and non-parametric, the results show that the banks in Algeria could improve their technical efficiency by 23%. Besides; it seems the banks in Algeria suffer from scale inefficiency. On the other hand, the foreign banks in technical efficiency are due to their superiority in scale efficiency.

In a research made by (Marković, Knežević, Brown, & Dmitrović, 2015) in Serbian, the emphasis was put measuring the productivity based on information from the financial statement, using data envelopment analysis and Malmquist index to estimate the individual bank efficiency and productivity changes within this period (2007-2010). This paper shows that the productivity decrease in the banking sector is due to the reduction of technology rather than technical efficiency for the observed period.

(Kalluci, 2018) Used Malmquist productivity index and its components to calculate the efficiency change and technological change for banks in Albanian, the dataset includes the end of year data of (16) banks that operate in Albanian, for the period (2006-2017). The results show that the Albanian banking sector for the period under analysis experienced a decrease in productivity, which mainly is due to a lack of technical improvements. On another side, efficiency has improved during this period, and this result is driven by improvements in pure efficiency and scale efficiency.

( Rodoni, Salim, Amalia, & Syahri , 2017) used data envelopment analysis as for measuring efficiency and thus Malmquist index as for measuring productivity, for the period (2009-2013) the data comes from (12) Islamic banking in Indonesia, and (16) Islamic banking in Malaysia, and (5) Islamic banking in Pakistan, the result of research found that Islamic banking industry in Indonesia is facing inefficiency, Malaysia also experiences the problem of inefficiency but the condition is better compared to Indonesia, Pakistan among the closest country that could reach an efficiency rate level for their Islamic banks, the causes of inefficiency are from external factors, and the current condition shows the like hood of negative growth of productivity for Malaysia Islamic banks the cause by technological aspects.

( Sufian, 2007) Investigated the productivity changes of Malaysian Islamic banks during the post-crisis period (2001-2004), by applying a non-parametric Malmquist productivity index method, the sample of the study consists of (15) Malaysian Islamic banks. the result of

the paper found that Malaysian Islamic banks productivity has exhibited an inverted U-shaped behavior during the period of the study, the domestic bank has exhibited higher productivity growth compared to its foreign counterparts, the decomposition of the productivity change index suggests that Malaysian Islamic banks productivity progress was mainly attributable to technological change rather than efficiency change during the years 2002 and 2003 while the opposite was true during the year 2004.

( Faizal , Afif, & Nizam , 2018) examined the efficiency of domestic and foreign Islamic banks in Malaysia between (2008-2015) using (16) Islamic banks in Malaysia, by using data envelopment analysis in measuring the efficiency level of each Islamic bank and comparison between the performance of domestic and foreign Islamic banks In the country. The paper also employed the Malmquist productivity index to gauge the changes in its components between the same subjects and timeframe, The results of paper found that the domestic Islamic banks are considered more efficient than most domestic Islamic banks outperforming the foreign Islamic banks, the study also found that based on the Malmquist productivity index, the least efficient banks based on DEA have Improved in technical efficiency, technology, and total factor productivity.

### **1-Efficiency and productivity:**

The efficiency summarizes the idea to produce with the best way, which means that efficiency is focused on the use of minimum inputs to produce the best output. It depends on the optimized use of resources to generate the best products with the minimum costs (Jaouadi & Zorgui, 2014, p. 316). In the banking sector, efficiency means that a bank would have more effectively reached its goals. Efficiency means positive things, prosperity, competitiveness, financial security, raise revenues, giving its clients high confidence. Productivity is a measure of how efficient a bank's production is on average. It can be represented as the output to input ratio in the manufacturing process.

To measure the efficiency and productivity we used data envelopment analysis and Malmquist productivity index the following is overview of both methods:

#### **1-1 Data envelopment analysis:**

DEA is a non-parametric technique that generates a relative efficiency score for each DMU based on a comparison of weighted outputs to inputs. The relative efficiency score is typically reported as a number between 0 and 100 percent, or 0 and 1. A unit with a score of less than 100 percent is considered inefficient in comparison to other units in the sample. ( K Avkiran, 2006, p. 3)

In the data envelopment analysis, the efficiency of the decision-making unit was measured in two ways: (Sendhil R, Kumar, Singh, Verma, Venkatesh, & Gupta , 2017, p. 82)

**1-1-1 Input-oriented model:** it attempts to determine whether the DMU can reduce its current input while still producing the same number of outputs.

**1-1-2 Output-oriented model:** it attempts to determine whether the DMU can increase its current output using the current input level.

Three basic methods are used in data envelopment analysis. Are to:

- Constant Return to Scale (CRS) Method

- Variable Return to Scale (VRS) Method.
- Full Cumulative Method.

In this study, the CRS Method was used. Charnes, Cooper, Rhodes (CCR) proposed using linear programming to measure the efficiency of all decision-making units in the DEA method, which was first developed in 1978. Initially, the DEA method was only used to measure technical activity and was based on the Constant Return to Scale (CRS) assumption. ( AKDOGAN , 2019)

It is a model that investigates the necessary reduction input combination to achieve the best output without changing the output level. The following is a definition of this model: ( Yildirim, 2015)

$$Enb h_j = \frac{\sum_{r=1}^n u_r y_r}{\sum_{i=1}^m v_i x_i}$$

### 1-2 Malmquist Productivity Index:

The Malmquist index measures changes in efficiency over time. It is calculated as the sum of catch-up or recovery terms and frontier-shift or innovation terms derived from DEA technologies. The Malmquist productivity index, developed by Malmquist in 1953, is an index that represents total factor productivity growth or a bank or decision-making unit. ( Moses & Olaleye , 2015, p. 3), which assesses the change in productivity between two data points by calculating ratios of a specific value (increase/decrease rate) between two periods. ( Faizal, Afif , & Nizam , 2018, p. 149) The DMUi at the time 1 is  $(x_i^1, y_i^1)$  and at the time 2 is  $(x_i^2, y_i^2)$ . The efficiency score of the DMUi  $(x_i^1, y_i^1)^{t1}$  is measured by the technological frontier  $t_2 : d^{t2}((x_i, y_i)^{t1})(t_1 = 1, 2 \text{ and } t_2 = 1, 2)$ . To calculate for the efficiency change, technological change, and Malmquist index, the following formulas can be used: ( Wang, Tibo, & Nguyen , 2020, p. 6)

$$EC = \frac{d^2((x_i, y_i)^2)}{d^1((x_i, y_i)^1)}$$

$$TC = \left[ \frac{d^1((x_i, y_i)^1)}{d^2((x_i, y_i)^1)} \times \frac{d^1((x_i, y_i)^2)}{d^2((x_i, y_i)^2)} \right]^{\frac{1}{2}}$$

$$MI = C \times F = \frac{d^2((x_i, y_i)^2)}{d^1((x_i, y_i)^1)} \times \left[ \frac{d^1((x_i, y_i)^1)}{d^2((x_i, y_i)^1)} \times \frac{d^1((x_i, y_i)^2)}{d^2((x_i, y_i)^2)} \right]^{\frac{1}{2}}$$

$$MI = \left[ \frac{d^1((x_i, y_i)^2)}{d^1((x_i, y_i)^1)} \times \frac{d^2((x_i, y_i)^2)}{d^2((x_i, y_i)^1)} \right]^{\frac{1}{2}}$$

1. If  $MI \geq 1$  then DMUi has made a progress.
2. If  $MI < 1$  then DMUi has made a regress.
3. If  $MI = 1$  then DMUi has made no progress or a regress.

The first type of Malmquist productivity index was provided by Caves, Christensen, and Diewert in their study (Caves, Christensen, & Diewert, 1982). They extended the idea of Sten

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Malmquist 1953, published in *Trabajos de Estadística* a quantity index for use in consumption analysis. (Grifell-Tatjé & C. A. K., 1999) The Malmquist productivity index compares the productivity change of decision-making units over two time periods. It is the result of the terms Catch-up and Frontier-shift. Catch-up or recovery refers to the degree to which a decision-making unit (DMU) improves or degrades efficiency; frontier shift (or innovation) refers to a change in the efficiency of its frontier between two time periods. (Soltane Bassem, 2014, p. 3)

The three approaches to TFP growth are growth accounting, regression analysis, and frontier analysis (Kataoka, 2020) Growth Accounting (GA) is an index number-based approach that uses the neoclassical production framework to estimate the rate of productivity change residually, i.e. by examining how much of an observed rate of change in a unit's output can be explained by the rate of change in the combined inputs used in the production process. (Giraleas, Emrouznejad, & Thanassoulis, 2012, p. 674). Regression analysis is a technique for fitting the "best" line through a series of observations. The term "best" line refers to a line that is fitted in such a way that the sum of squared differences between the observations and the line itself is minimized. (Sarstedt & Mooi, 2014, p. 194) The frontier concept is consistent with Farrell's (1957) definition of a structural efficiency score, which measures how well an industry keeps up with the performance of its best firms. (Camanho & Dyson, 2006, p. 39) The MPI gives important information that can be used to know the different aspects of productivity changes of decision-making units over time.

**2- The data**

**2-1 The sample of the study**

**Table (1):** the sample of the study.

No.	code	Name of bank	Type of bank
01	BNA	Banque Nationale d'Algérie	Domestic bank
02	BDL	Banque de Développement Local	Domestic bank
03	BEA	Banque Extérieure d'Algérie	Domestic bank
04	CNEP	CNEP bank	Domestic bank
05	CPA	Credit populaire d'Algérie	Domestic bank
06	AL BB	Al Baraka Bank	Foreign bank
07	CAB	Citi Algeria Bank	Foreign bank
08	CB	Calyon-Bank	Foreign bank
09	FB	Fransa bank	Foreign bank
10	BNP Paribas	B.N.P / Paribas	Foreign bank
11	AL SB	Al Salam Bank	Shared bank
12	AGB	Algeria Gulf Bank	Shared bank
13	TAB	Trust Algeria Bank	Shared bank

**Sources:** the personal effort according to the official sites of banks

**2-2 Input and output:**

**Table (2):** Input and output variables used in this study.

period	input	output
2011-2015	Total assets	Return on assets
	equities	Return on equities

**Sources:** researchers' preparation

Total assets and equities were used as inputs while return on assets and return on equities were used as outputs in the efficiency calculations of these banks. The data comes from Bank annual reports of 13 banks operate in Algeria (five domestic banks, five foreign banks, three shared banks)

In the current study, we apply the output-oriented constant return to scale DEA-based Malmquist productivity index approach (frontier analysis), for calculating the results, the study used DEAP version 2.1 software.

**3- Results:**

**Table (3):** mean Technical efficiency CCR values of the Algerian banks.

bank	Technical efficiency				
	2011	2012	2013	2014	2015
BNA	0.703	0.468	0.236	0.463	0.308
BDL	0.216	0.227	0.303	0.279	0.691
BEA	0.435	0.489	0.048	0.463	0.481
CNEP	0.144	0.136	0.048	0.649	1.000
CPA	0.515	0.500	0.592	1.000	0.685
AL BB	0.756	0.874	1.000	0.977	1.000
CAB	1.000	1.000	1.000	1.000	1.000
CB	1.000	1.000	1.000	1.000	1.000
FB	1.000	1.000	1.000	1.000	1.000
BNP Paribas	1.000	0.860	0.921	0.945	0.930
AL SB	1.000	1.000	0.100	0.506	1.000
AGB	1.000	0.807	0.560	0.695	0.922
TAB	1.000	0.478	0.196	0.500	1.000
mean	0.751	0.680	0.608	0.729	0.847

**Sources:** DEAP program outcome.

Table 3 shows the mean technical efficiency values for banks operating in Algerian for the period 2011-2015.

Technical efficiency (CCR) value for 2011 is 75% i.e. their technical inefficiency value is 25%.

Technical efficiency (CCR) value for 2012 is 68% i.e. their technical inefficiency value is 32%.

Technical efficiency (CCR) value for 2013 is 60 % i.e. their technical inefficiency value is 40%.

Technical efficiency (CCR) value for 2014 is 72 % i.e. their technical inefficiency value is 28%.

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Technical efficiency (CCR) value for 2015 is 84 % i.e. their technical inefficiency value is 16%.

Technical inefficiency value reveals that Algerian banks would have been able to obtain the same quantity of output using (25%, 32%, 40%, 28%, 16%) less input during the period under study, respectively.

2015 was the year with the highest technical efficiency (CCR) for the banks operating in Algeria, while, 2013 saw the lowest technical efficiency.

**Table (4):** Malmquist productivity index scores (2011-2015)

bank	2011-2012	2012-2013	2013-2014	2014-2015	Average
BNA	0.645	2.110	0.251	2.576	1.3955
BDL	1.173	0.121	6.676	2.153	2.53075
BEA	1.024	1026.544	0.703	0.001	257.068
CNEP	0.985	0.463	2.177	13.050	4.16875
CPA	0.943	0.848	11.505	0.077	3.34325
AL BB	0.906	1138.247	0.001	375.734	378.722
CAB	0.664	0.915	1.066	0.685	0.8325
CB	1.023	0.892	1.013	1.126	1.0135
FB	0.828	0.989	0.413	1.228	0.8645
BNP Paribas	0.937	0.917	0.987	1.000	0.96025
AL SB	0.862	0.841	0.034	8.336	2.51825
AGB	0.753	0.047	6.214	3.434	2.612
TAB	0.001	1.951	0.000	32.871	8.70575
Average	0.82646154	167.298846	2.38769231	34.0208462	51.1334615

**Sources:** DEAP program outcome.

In table 4 we can see that the MPI score of the thirteen Algerian banks increased significantly during the 2011-2015 period. The average score of 0.826 in 2011 increased to 34.020 in 2015 (an increase of 3723.5 percent). If we examine the productivity of each bank, AL BB's score rose from 0.906 to 375.734 (an increase of 37482.8 percent), followed by TAB's score rose from 0.001 to 32.871 (an increase of 3287 percent), CNEP's score rose from 0.985 to 13.050 (an increase of 1206.5 percent), AL SB's score rose from 0.862 to 8.336 (an increase of 747.4 percent), AGB's score rose from 0.753 to 3.434 (an increase of 268.1 percent), BNA's score rose from 0.645 to 2.576 (193.1 percent). BDL's score rose from 1.173 to 2.153 (an increase of 98 percent), FB's score rose from 0.828 to 1.228 (an increase of 40 percent), CB's score rose from 1.023 to 1.126 (an increase of 10.3 percent), BNP Paribas's score rose from 0.937 to 1.000 (an increase of 6.3 percent), CAB's score rose from 0.664 to 0.685 (an increase of 2.1 percent), except for CPA and BEA, the MPI score decreased, where CPA's score retreated from 0.943 to 0.077 (-86.6 percent), BEA's score retreated from 1.024 to 0.001 (-102.3 percent).

The results show that AL BB had the highest productivity score of (37482.8 percent), followed by TAB (3287 percent), CNEP (1206.5 percent), AL SB (747.4 percent), AGB

(268.1 percent), BNA (193.1 percent). BDL (98 percent), FB (40 percent), CB (10.3 percent), BNP parisbas (6.3 percent), CAB (2.1 percent), CPA ( -86.6 percent), BEA (-102.3 percent), The average percentage increase for the thirteen banks over the studied period was 3723.5 percent.

**Table (5):** annual mean of MPI for 2011-2015

period	efficiency changes	Technological change	Malmquist productivity index
2- 2011-2012	0.746	0.716	0.534
3- 2012-2013	2.204	0.892	1.967
4- 2013-2014	0.350	0.948	0.332
5- 2014-2015	1.838	0.973	1.788
mean	1.014	0.876	0.889

**Sources:** DEAP program outcome.

Table 5 presents the average change for each period compared to the previous period, in the Malmquist productivity index and its components. The results show that Malmquist productivity index has been less than 1, for the period 2011-2012, it showed regress. Similarly, for the period 2013-2014, it showed regress as well. That is due to a decrease in both efficiency and technological change during the two periods (2011-2012) and (2013-2014). As for the two periods 2012-2013 and 2014-2015, the results Of the Malmquist productivity index show progress. That is due to efficiency changes. Hence, Algerian banks' productivity regress was mainly attributable to technological change rather than efficiency change, which has negatively affected the total productivity changes.

**Table (6):** Malmquist productivity index of banks during the period 2011-2015

	bank	EFFCH	TECHCH	PECH	SECH	TFPCH
Domestic	BNA	0.979	0.989	0.813	1.204	0.968
	BDL	1.212	0.986	1.337	0.906	1.194
	BEA	0.951	0.98	1.025	0.927	0.932
	CNEP	1.908	0.994	1.624	1.175	1.897
	CPA	0.924	0.993	1.074	0.861	0.918
Mean						<b>1.182</b>
Foreign	AL BB	4.467	0.916	1.072	4.165	4.094
	CAB	1.000	0.816	1.000	1.000	0.816
	CB	1.000	1.01	1.000	1.000	1.01
	FB	1.026	0.782	1.000	1.026	0.803
	BNP parisbas	0.974	0.986	0.982	0.991	0.960
Mean						<b>0.927</b>
Shared	AL SB	0.777	0.868	1.000	0.777	0.675
	AGB	0.967	0.962	0.98	0.987	0.930
	TAB	0.18	0.391	1.000	0.18	0.070
Mean						0.558
mean		1.014	0.876	1.055	0.961	0.889

**Sources:** DEAP program outcome.

Table 6 presents the result generate, for each of 13 banks under analysis, for total factor productivity change, its components efficiency change and Technological change and the subcomponents of efficiency change, Pure efficiency changes, and Scale efficiency changes. For the period 2011-2015, the total factor productivity change indicates that four out of 13 banks increased their average annual productivity change, as for efficiency change, only three out of 13 banks improve their performance. Two of the banks did not show any efficiency change. That is due to scale inefficiency rather than pure inefficiency. As for technological change, only one bank out of 13 banks showed a change in technological change.

From the five banks that fall under domestic, only two banks showed an increase in the total factor productivity change, they are CNEP and BDL with scores of 1.897, 1.194 respectively. Three of the banks showed a decrease in the total factor productivity change.

From the five banks that fall under foreign, only two banks show an increase in the total factor productivity change, they are AL BB and CB with scores of 4.094, 1.01 respectively. Three of the banks showed a decrease in the total factor productivity change.

As for shared banks, the total factor productivity index value of shared banks was never recorded above 1 for the period under study.

The measurement under the Malmquist productivity index demonstrates that the domestic banks operate more efficiently on average than foreign and shared banks with scores of 1.182, 0.927, and 0.558 respectively.

#### **4- Discussion:**

It is necessary to calculate the productivity of decision-making units for proper planning and execution of decisions taken by the management. The present study estimates the productivity change in Algerian banks over the period 2011-2015.

2015 was the year with the highest technical efficiency (CCR) for the banks operating in Algeria, while, 2013 saw the lowest technical efficiency. Technical efficiency can be accomplished by optimum utilization of input resources.

The results reveal that AL BB had the highest productivity score of (37482.8 percent), followed by TAB (3287 percent), CNEP (1206.5 percent), AL SB (747.4 percent), AGB (268.1 percent), BNA (193.1 percent). BDL (98 percent), FB (40 percent), CB (10.3 percent), BNP Paribas (6.3 percent), CAB (2.1 percent), CPA (-86.6 percent), BEA (-102.3 percent), The average percentage increase for the thirteen banks over the studied period was 3723.5 percent. The highest productivity score of Al Baraka is because it is an Islamic bank many studies had pointed out that Islamic banks more efficiently than traditional banks.

For the period 2011-2015, productivity growth occurred during 2012-2013 and 2014-2015. The growth was highest in 2012-2013. The total factor productivity change indicates that four out of 13 banks increased their average annual productivity change, as for efficiency change, only three out of 13 banks improve their performance. Two of the banks did not show any efficiency change. That is due to scale inefficiency rather than pure inefficiency. This result confirmed ( Hacini & Dahou, 2018) banks in Algeria suffer from scale inefficiency. (Khalili, Rahamni , & Alrasheedi, 2019) Also found that scale efficiency had the greatest impact on technical efficiency in the case study.

Algerian banks' productivity regress was mainly attributable to technological change, which has negatively affected the total productivity changes. This result confirmed ( Rodoni, Salim, Amalia, & Syahri , 2017) found that the current condition shows the like hood of negative growth of productivity for Malaysia Islamic banks caused by technological aspects. (Marković, Knežević, Brown, & Dmitrović, 2015) also found that the productivity decrease in the banking sector is due to the reduction of technology rather than technical efficiency for the observed period. This result contrasted (Kalluci, 2018) found that the Albanian banking sector, experienced a decrease in productivity, which mainly is due to lack of technical improvements.

The measurement under the Malmquist productivity index demonstrates that the domestic banks operate more efficiently on average than foreign and shared banks with scores of 1.182, 0.927, and 0.558 respectively. This result is confirmed with the results described in previous studies. For instance ( Faizal, Afif , & Nizam , 2018) found that the domestic Islamic banks outperforming the foreign Islamic banks. ( Sufian, 2007) Also found that the domestic banks have exhibited higher productivity growth compared to their foreign counterpart. This result contrasted ( Hacini & Dahou, 2018) they found that foreign banks are relatively more technically efficient than domestic banks.

### **Conclusion:**

In the current study, we have employed the output-oriented constant return to Scale DEA-based Malmquist productivity index approach to compare Algerian banks' productivity and its components, using the MPI in a period from 2011 to 2015. The inputs and outputs criteria were selected based on an extensive literature review of the previous works in the field of measuring productivity in banking industries. According to the results of the technical efficiency CCR method we found that:

- 2015 was the year with the highest technical efficiency (CCR) for the banks operating in Algeria, while, 2013 saw the lowest technical efficiency.

Over the total sample period, based on the Malmquist index our results showed that:

- Productivity growth occurred during 2012-2013 and 2014-2015;
- The growth was highest in 2012-2013, The explanation for this can be attributed to technical progress, Average technical efficiency shows the optimal use of resources available to a bank;
- Progress in technical efficiency is due to pure technical efficiency rather than scale efficiency;
- Algerian banks' productivity regress was mainly attributable to technological change, the Average of technological change refers to modern technology is not used in production processes, which harms bank performance;
- The domestic banks operate more efficiently on average than foreign and shared banks with scores of 1.182, 0.927, and 0.558 respectively.

To improve technical efficiency, technology, and total factor productivity in the Algerian banking sector, the management should consider the following actions:

- Introduction of new technology to improve the investment climate;

- Increasing the size of banks to increase technical efficiency;
- Working in accordance with the principles of Islamic Sharia by financing the purchase of commercial real estate in accordance with the provisions of Islamic Sharia for the purposes of investment and development using Murabaha and Istisna contracts.

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