EFFICIENCY OF THE ALGERIAN BANKS IN THE POST LIBERALIZATION PERIOD

Ishaq HACINI, PhD*
Khadra DAHOU, PhD**

Abstract

This study investigates the efficiency of the banks in Algeria during the period of 2000-2012. For this end, the efficiency of fifteen banks is estimated using Data Envelopment Analysis model. Furthermore, the technical efficiency is decomposed to determine the pure technical and scale efficiencies of the Algerian banks. Based on the intermediation approach it is assumed that bank uses two inputs; total deposits and interest expenses, and produces three outputs; total loans, interest income and non-interest income.

The findings indicated that on average, the technical efficiency of the Algerian banks has improved during the period of study. The Algerian banks have achieved a high pure technical efficiency with an average equals 95%, while the scale efficiency is the main source of the banks technical inefficiency. In addition, the majority of the banks tend to operate at constant return to scale or decreasing return to scale.

Keywords: Efficiency, Data Envelopment Analysis, Algerian Banking System.

JEL Classification: C14, G21, G28

1. Introduction

In last two decades, the banks efficiency has received an increasing attention among researchers regarding to the importance of the banking efficiency. For the policymakers, the banking efficiency allows evaluating the impact of the adopted reforms and policies on the banking sector performance. Moreover, banking efficiency is an

*Member of LAPDEC laboratory, Associate Professor at the Faculty of Economics and Management, University of Mascara, Algeria, ishaq_zida@yahoo.fr.

**Associate Professor at the Faculty of Economics and Management, University of Tlemcen, Algeria, dahou.khadra@yahoo.fr

important indicator for the success of individual banks and the industry as a whole, in which only the efficient banks can maintain their position in market characterized by increasing competition and rapid technologies advances.

The banking efficiency measures the banks' ability for maximizing their outputs level without additional inputs, or minimizing their inputs level without reducing their outputs. Farrell (1957) developed a measure of the efficiency relying on the linear programming LP. This measure was built on the concept of relative efficiency which implies comparing the position of Decision Making Unit (DMU) with the best production frontier. In the literatures, there are two methods for measuring the banking efficiency; nonparametric method and parametric method. Among nonparametric models there is Data Envelopment Analysis (DEA). The principle of DEA is "envelops" "data" observations in order to construct a "frontier" that is used to analyze the DMUs' performance (Charnes, Cooper and Rhodes 1978). However, Liu, Lu, Lu, & Lin (2013) have conducted a survey about DEA applications from 1978 to 2010. They found that there is a pattern of technology-adoption process by researchers in DEA application, as they tend to adopt new developed models. They revealed that DEA model has been applied mainly in banking and health care fields for efficiency evaluation.

The Algerian banking system has passed through many stages. Thus, Algeria has inherited a well developed banking system from the French colonial, but this system had hampered the achievement of the development programs planned by the Algerian state. After that, the banking system has been dominated by the state to ensure the required financing of its investment programs and the stated-owned-enterprises. The economic crisis of 1986 has pushed the Algerian government to adopt important economic reforms in which the banking system development was the pillar of these reforms. Hence, the banking reforms of 1990 had a significant impact on the Algerian banking system, where these reforms have allowed liberalizing the banking sector from the state intervention. Furthermore, the reforms have encouraged opening the banking sector to privet investment to increase the competition level in the banking sector and improving the banks' performance. Based on the aforementioned, the study seeks to investigate the efficiency of the Algerian banks during the post-liberalization period 2000-2012.

2. Efficiency Definition

A general definition of efficiency was provided by the economist Vilfredo-Pareto: "A Pareto optimum is welfare maximum defined as a position [in an economy] from which it is impossible to improve anyone's welfare by altering production or exchange without impairing someone else's welfare." (Cooper, Seiford& Tone, 2006), this definition is known as “Pareto optimality” in Welfare economics. After that, Koopmans (1951) has extended the Pareto optimality concept to the production efficiency concept. He provided a formal definition for the unit technical efficiency: “a producer is technically efficient if an increase in any output requires a reduction in at least one other output, or an increase in at least one input, or if a reduction in any input requires an increase in at least one other input or a reduction in at least one output”. In other words, the production’ unit is efficient if and only if it is not possible to improve any input or output without worsening any other input or output. Accordingly, the inefficient unit is a unit that could improve its input or output levels without deterioration other input or output.

In the literatures, many authors define efficiency as ratio between output and input, and do not make any differences between efficiency and productivity. On the contrary, Lovell (1993) describe the efficiency of a production unit as the ratio of observed output produced from given input to maximum potential output obtained from the same input, or the ratio of minimum potential input required to produce the given output to the observed input required to produce the same output. Therefore, the efficiency is a distance between the quantity of output and input of production unit, and the quantity of output and input of the best firms in the industry.

Farrell (1957) was the first that involved qualitative developments on efficiency concept. He developed a measure of the technical efficiency by using the linear programming LP model using the following concept; the efficiency is the amount of waste that can be eliminated without worsening any input or output. Cooper, Seiford& Zhu (2011) have defined the full efficient units; those units that could not improve output levels without expand input levels and could not reduce input levels without contract output levels. Therefore, an efficient unit uses strictly less of input or produces strictly more of an output, thus it uses no more inputs to produce no less output.

The efficiency can be estimated based on two orientations; Output-Orientation and Input-Orientation efficiency. The Output-Orientation efficiency means that DMU is Pareto-efficient if it is not possible to raise anyone of its output levels without lowering at least another one of its output levels and/or without increasing at least one of its input levels. The Input-Orientation efficiency means that the DMU is Pareto-efficient if it is not possible to lower anyone of its inputs levels without increasing at least another one of its input levels and/or without lowering at least one of its output levels (Thanassoulis, 2001).

Banker, Charnes& Cooper (1984) have differentiated between the pure technical efficiency and the scale efficiency. Pure technical efficiency measures the technical efficiency that is free from any scale efficiency. The researchers have revealed that if there are differences between technical efficiency and pure technical efficiency scores for a particular DMU, this indicates the existence of scale impact that can be measured by scale efficiency. Scale efficiency provides information about DMU's efficiency difference between the optimal size and the current size. This measure allows determining the gains from adjusting the scale size by operating at optimal size.

3. Model specification

The principle of DEA is "envelops" "data" (observation) in order to construct a "frontier" that is used to analyze the DMUs' performance. The originality of DEA model is backed to (Charnes et al., 1978) which built a model on the efficiency's approach of (Farrel, 1957). Farrel has attempted to develop methods for evaluating productivity for any productive organization. After that, he generalized his work to address the concept of efficiency. DEA constructs the best-practice frontier or piecewise linear obtained from the observed data set and depicts the distance between DMU and the frontier. Efficiency score ranging between zero and one, where DMUs those producing on the frontier are efficient and their scores are one, while DMUs those producing inside the frontier are inefficient and their scores are less than one (Thanassoulis, 2001). Speaking broadly, DEA technique defines an efficiency measure of production unit by its position relative to frontier of the best performance calculated mathematically by the ratio of weighted sum of outputs to weighted sum of inputs of different DMUs.

Charnes et al. (1978) proposed a model based on input-orientation and under constant returns to scale assumption, the model is known (CCR) model. They assumed that there are *N* DMUs (j = 1,2,…..,N) use *m* inputs to produce *n* outputs. DMUj use amount *xij* of input *i* to produce amount *yrj* of output *r* , where $xij \geq 0$, $yij \geq 0$, and each DMU has at least one positive input and one positive output value.

$$\theta^* = \min \theta$$

Subject to

$$\begin{aligned} &\sum_{j=1}^{N} x_{ij}\lambda_j \leq \theta x_{io} \qquad i = 1,2,\dots\dots\dots,m \\ &\sum_{j=1}^{N} y_{rj}\lambda_j \geq y_{ro} \qquad r = 1,2,\dots\dots\dots,n \\ &\lambda_j \geq 0 \qquad\qquad\qquad j = 1,2,\dots\dots\dots,N \end{aligned} \tag{3.1}$$

Where, θ is the efficiency score and λ is the weight of DMU_j. When (3.1) linear programming problem is solved *N* times the efficiency score of each DMU is obtained. According to (Farrell 1957) definition, DMUs with θ< 1 are inefficient, while DMUs with θ = 1 are efficient units and lie on the best production frontier. To treat the slack problem some studies proposed the use of two-stage approach, where the first stage focus on minimizing the value θ and in second stage fixing the value of θ^* after maximizing the slacks according to the following linear program:

$$\min \theta - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{n} s_r^+\right)$$

Subject to

$$\begin{aligned} &\sum_{j=1}^{N} x_{ij}\lambda_j + s_i^- = \theta x_{io} \qquad i = 1,2,\dots\dots\dots,m \\ &\sum_{j=1}^{N} y_{rj}\lambda_j - s_r^+ = y_{ro} \qquad r = 1,2,\dots\dots\dots,n \\ &\lambda_j \geq 0 \qquad\qquad\qquad j = 1,2,\dots\dots\dots,N \\ &s_i^-,\ s_r^+ \geq 0 \end{aligned} \tag{3.2}$$

Where, *s-* is input slacks variable that measures any excess of inputs, and *s+* is output slacks variable that measures any excess of outputs. $\varepsilon > 0$is non-Archimedean element defined to be smaller than any positive real number. According to Farrell definition, If DMU*o* has θ^*=1 and $s_i^{-*} = s_r^{+*} = 0$, then this DMU*o* is fully efficient. If DMU_O has θ^*=1 and $s_i^{-*} > 0$, $s_r^{+*} > 0$, then this DMUo is weakly efficient, because DMUo is efficient but there is additional saving potential in inputs and opportunity for expansion of outputs (Cooper et al., 2011).

In the practice, the assumption of CRS is not valid because not all firms operate on the optimal size. In real world, the firms are operating in imperfect competition environment, or in regulated industry, or they are subjected to financial constraints. These factors might prevent the firms to operate at the optimal scale. Therefore, it is important to adjust the CRS assumption because the model under CRS assumption would lead to biased measures of technical efficiency that is violated by the scale efficiency. Hence, many researchers have interested to find solution to this situation, such as (Banker et al., 1984). They proposed DEA model that takes in account Variable Return to Scale (VRS) situations, this model is known as BCC model. (Banker et al., 1984) modified the CCR linear programming problem by adding additional constraint $\sum_{j=1}^{N} \lambda_j = 1$ that ensures that each DMU is benchmarked against DMUs of similar size. The input-orientation efficiency is expressed as follows:

$$\min \theta - \varepsilon \left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{n} s_r^+ \right)$$

Subject to

$$\begin{aligned}
&\sum_{j=1}^{N} x_{ij}\lambda_j + s_i^- = \theta x_{io} \qquad i = 1,2,\dots\dots\dots,m \\
&\sum_{j=1}^{N} y_{rj}\lambda_j - s_r^+ = y_{ro} \qquad r = 1,2,\dots\dots\dots,n \\
&\sum_{j=1}^{N} \lambda_j = 1 \\
&\lambda_j \geq 0 \qquad\qquad j = 1,2,\dots\dots\dots,N
\end{aligned} \tag{3.3}$$

Scale efficiency is the ratio of technical efficiency under CRS to the pure technical efficiency under VRS. Scale efficiency is calculated indirectly by decomposing technical efficiency into two components; pure technical efficiency and scale efficiency (Sufian& Abdul Majid, 2007), as follows:

$$TE = PTE * SE \quad (3.4)$$

4. Data and Sample

The study used annual data of 15 commercial banks operated in Algeria during the period 2000-2011. These banks are selected from 20 banks agreed by the central bank of Algeria until 2011. The number of the selected banks is limited to 15 regarding to the availability of data of these banks during the period of the study, where the most excluded banks are newly established banks. The banks sample information is presented in the appendix. The bank-specific data has been sourced from Bank-scope database, which is a worldwide database of the banks data. The period of the study is selected based on the fact that during this period the banking sector in Algeria has witnessed numerous changes among these changes the openness of the banking sector to the entry of the foreign banks. Therefore, it is interesting to investigate the efficiency of banks in Algeria during this period.

5. Inputs and Output Specification

Measuring the banks efficiency requires identifying the inputs and outputs of the banks. Despite the increasing interest in studying the banking efficiency, there is no consensus among the researchers about specific inputs and outputs of the banks. The selection is determined based on the definition of the bank firm and its activities, and the availability of data about the inputs and outputs. According to Sealey& Lindley (1977) there are two popular approaches for selecting the banks inputs and outputs variables; the production approach and the intermediation approach.

a. Production Approach: initiated by the contribution of (Benston 1964), this approach focuses on the bank's operational activities. It defines a bank as producer of services for customers. The bank uses input includes physical variables such as labor and physical capital to produce loans and deposits. Under this approach, inputs are measured by physical units and outputs are measured by

the number of the transactions or the documents during a period of time.

b. Intermediation Approach: according to this approach the bank is a financial intermediary between depositors and borrowers. It uses labor and capital to transform the collected funds (deposits) into loans and other assets (investment) (Sealey and Lindley 1977). This approach classifies the deposits as inputs, while the production approach treats the deposits as an output variable; also the production approach includes the operational costs, while the intermediation approach considers the operational costs as financial costs.

For this study, the intermediation approach is used. The banks are considering as multi-product firms that use two inputs and produce three outputs, Following to, (Sufian& Abdul Majid, 2007), (Akhtar 2010), (Yahya, Muhammad & Abdul Hadi, 2012). The inputs are (X_1) Total deposits, (X_2) Interest expenses, while outputs include (Y_1) Total loans which include loans to customers, loans and advances to banks, (Y_2) Interest income, (Y_3) Non-interest income. The table 1 presents the descriptive statistics of banks inputs and outputs.

Table 1

Descriptive Statistics of Inputs and Outputs (Million DA)

All years	Mean	S.D.	Maximum	Minimum
Inputs:				
Interest expenses	4366.619	3330.714	11879.55	1744.4
Outputs:				
	208321.1	79879.62	348779.4	92744.4
Interest Income	11333.63	3476.048	19113.5	7206
	3084.169	2028.798	6250.7	695.1

6. Empirical Results and Discussion

This section presents the results of efficiency measure of Algerian banks during the period (2000-2012). The study used the DEA method based on the input-orientation because banks have a control on their inputs and they can take decision about the appropriate amount of inputs used to generate specific amount of outputs.

Table 2

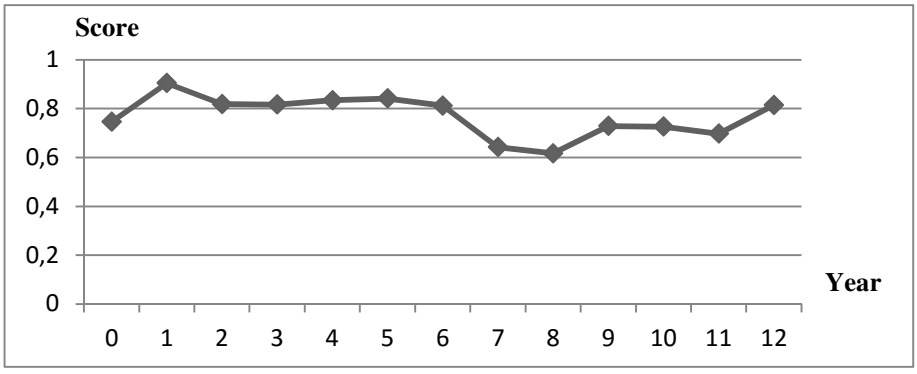
Technical Efficiency of Algerian Banks (2000-2012)

Panel	Efficient Banks	Mean	Maximum	Minimum	S.D
2000	02	0.74	1	0.37	0.240
2001	04	0.90	1	0.66	0.151
2002	02	0.81	1	0.61	0.170
2003	04	0.81	1	0.58	0.186
2004	04	0.83	1	0.52	0.173
2005	05	0.84	1	0.54	0.185
2006	05	0.81	1	0.44	0.200
2007	02	0.64	1	0.39	0.188
2008	03	0.61	1	0.31	0.263
2009	04	0.72	1	0.37	0.245
2010	04	0.72	1	0.41	0.223
2011	05	0.69	1	0.4	0.237
2012	05	0.81	1	0.41	0.216
Average	04	0.76			

Table 2 presents a summary of the bank technical efficiency' scores under constant of return scale assumption for each year from 2000 to 2012. The general view reveals that technical efficiency of the Algerian banks have progressed during the period of the study, in which the technical efficiency mean moved from 0.74 in 2000 to 0.81 in 2012. The progression of the technical efficiency can be decomposed into four stages as the figure 1.

Figure 1

Technical Efficiency of Algerian Banks during (2000-2012)



First stage from 2000 to2001, it is characterized by the increase of technical efficiency to reach the point of 0.90, which is the maximum score during all the period of the study. Second stage from 2001to2006, it is characterized by the stabilization of the technical efficiency above the value of 0.80. Third stage from 2006 to2008, the technical efficiency has witnessed a decline by 20 percent. In this stage the Algerian banks realized the lowest score during the study period with 0.61. Fourth stage from 2008 to 2012, technical efficiency started retrieving its previous level above 80 percent.

By analyzing each year alone, in 2000, Algerian banks have exhibited technical efficiency of 0.74, which suggests that the Algerian banks on average have wasted 26 % of inputs when transforming the deposits to loans according to the intermediation approach. In 2001, the technical efficiency score of Algerian banks increased by 22 % to reach 0.90, which is the highest score during the period of the study. This result suggests that the Algerian banks on average used their inputs more efficiently, where they have reduced the level of the waste in the inputs to reach 10 %. This improvement may be explained by the reforms adopted by the government and the beginning of the entry of foreign banks which helps to improve the performance of banking sector in Algeria.

In 2002, the technical efficiency declined to 0.81. The same banks BBA and ABC, which are foreign banks, have maintained their positions as the pest performers with technical efficiency score 100%. BDL bank, which is a public bank, is the worst performer with score of 0.61. From the year of 2002 to 2006, the Algerian banks have exhibited a stabilized technical efficiency, in which it fluctuated between 0.81 and 0.84. In this period, the foreign banks performed well comparing to the public banks, where all the efficient banks in this period were foreign banks, in which 04 banks in 2003, 04 banks in 2004, 05 banks in 2005 and 05 banks in 2006. While, always the lowest efficiency score was registered by a public bank. In 2007, the technical efficiency deteriorated by 21 % to reach 0.64 with just two efficient banks TBA and FDB, while the lowest score of efficiency was registered by CPA bank with 0.39. The deterioration of the Algerian banks' efficiency has continued in 2008 to reach 0.61, which is the worst score during all the period of the study. SBA bank was the worst performer with score equals 0.31.

However, the international financial crisis might affect indirectly the financial system in Algeria because the decrease of the

global demand caused by the crisis led to a contraction in hydrocarbons exportations and consequently a reduction in the country's revenues and this affected negatively the performance of the public banks. In addition, the international financial crisis has affected the Algerian banking system through the foreign banks operated in Algeria, where those banks have transactions with their parents' banks abroad. After that, the Algerian banks have improved their technical efficiency. In 2012, the technical efficiency of the Algerian banks has retrieved their previous level above the level of 0.8.

The overall technical efficiency was decomposed into pure technical efficiency and scale efficiency by relaxing the constant return to scale assumption and estimating the DEA model under the variable return to scale.

Table 3

Pure Technical Efficiency of Algerian Banks (2000-2012)

Panel	Efficient Banks	Mean	Maximum	Minimum	S.D
2000	04	0.84	1	0.46	0.211
2001	05	0.91	1	0.71	0.141
2002	05	0.94	1	0.79	0.093
2003	06	0.95	1	0.75	0.098
2004	09	0.95	1	0.72	0.087
2005	10	0.98	1	0.9	0.032
2006	09	0.96	1	0.82	0.062
2007	08	0.90	1	0.62	0.124
2008	12	0.97	1	0.79	0.061
2009	13	0.98	1	0.82	0.048
2010	12	0.97	1	0.78	0.058
2011	13	0.98	1	0.85	0.051
2012	09	0.99	1	0.93	0.022
Average	09	0.95			

Table 3, generally, shows that the Algerian banks have exhibited a high pure technical efficiency score during the study period. The mean of the pure technical efficiency did not fall under the level of 0.84, thus the waste in the employed inputs did not exceed than 16 % in the worst years. In 2012, the Algerian banks on average

have realized a good efficiency where they have used their inputs efficiently, in which they have wasted only 1% of the employed inputs. Likewise, in 2012, all banks were fully efficient except one bank that has realized a score of 0.93.

Concerning the Scale efficiency the table 4 reveals that the Algerian banks have exhibited high scale efficiency score in the beginning of the period, and then the mean has deteriorated gradually. The decline of scale efficiency of the Algerian banks during this period may be due to the intensification of the competition in Algerian banking sector regarding to the deregulation of banking activities and the entry of foreign banks. Thus, the competition has pushed mainly the public banks to increase their size of operations by opening more branches and diversifying their services, and consequently, reduce their operating cost by operating at a large size. Therefore, the Algerian banks and mainly the public banks have displayed increased scale inefficiency because most of those banks have operated at inappropriate size.

Table 4

Scale Efficiency of Algerian Banks (2000-2012)

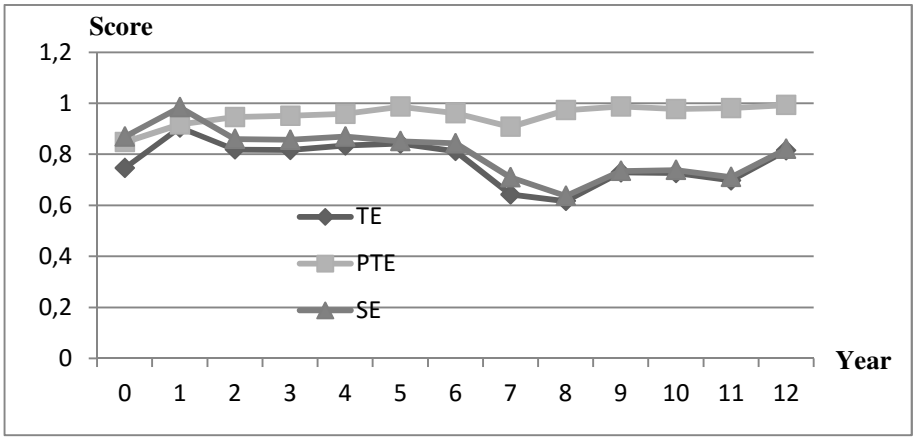
Panel	Efficient Banks	Mean	Maximum	Minimum	S.D
2000	02	0.87	1.00	0.76	0.100
2001	05	0.98	1.00	0.93	0.028
2002	02	0.86	1.00	0.73	0.118
2003	04	0.86	1.00	0.58	0.156
2004	05	0.87	1.00	0.65	0.157
2005	06	0.85	1.00	0.59	0.177
2006	05	0.84	1.00	0.44	0.189
2007	02	0.71	1.00	0.46	0.180
2008	03	0.64	1.00	0.31	0.269
2009	04	0.73	1.00	0.41	0.237
2010	04	0.74	1.00	0.46	0.209
2011	05	0.71	1.00	0.40	0.234
2012	05	0.82	1.00	0.41	0.216
Average	04	0.80			

The figure 2 shows that the values of the average of the overall technical efficiency of the Algerian banks are less than the

scale and pure technical efficiencies average during all the years of the study. In addition, the average of the scale efficiency is less than the average of the pure technical efficiency.

Figure 2

Overall Technical, Pure Technical and Scale Efficiencies of Algerian Banks during (2000-2012)



This implies that the overall technical inefficiency in Algerian banks is mainly attributed to scale inefficiency rather than the pure technical inefficiency. This suggestion relative to the scale inefficiency as a major source of overall technical inefficiency is consistent with the findings of the following studies (Wheelock et Wilson 1999), (Isik et Hassan 2002) and (Sufian et Habibullah 2012).

The dominant effect of scale inefficiencies on the technical Algerian banks indicates that most Algerian banks have been operated at non-optimal scale of operations. In other words, the fundamental problem of the Algerian banks is the under-utilization of inputs, rather than managerial best practice. Since the scale inefficiency is the major source of banks inefficiency, it is important analyzing the nature of return to scale of the Algerian banks. As has been mentioned before, a bank can operate at CRS, in which the increase in inputs results in the outputs increase by the same percentage of the inputs increase. The study has followed the method of (Coelli, Rao &Batesse, 1998) to identify the nature of returns to scale.

Table 5 reports the nature of return to scale of Algerian banks. In general, the Algerian banks tend to operate at CRS or DRS. In

2000, two banks have operated at the correct-scale, while the other have operated at DRS. In 2001, all banks have succeeded to operate at the optimal scale in except of one bank that has operated at DRS. Thereafter, most of the Algerian banks have operated at DRS, and the other have operated at CRS. However, quite few banks have exhibited an IRS.

Concerning the banks operating at DRS, these banks have experienced diseconomies of scale by increasing their size to be larger than the optimal size, thus, the increase of their outputs were smaller than the increase in their inputs. According to McAllister & McManus (1993) the small banks have generally exhibited IRS, while the large banks tend to exhibit DRS and at best time at CRS. Hence, most of the Algerian banks mainly the public banks are large banks and this may explain the DRS of the Algerian banks. On other hand, Burki&Niazi(2006) have found that the majority of the state-owned banks exhibit DRS confirming to the extra cost incurred by them. They have revealed that, after the period of reforms and as a consequence of competition, the state-owned banks were meeting excess demand for financial services by producing more than the optimal scale.

Table 5

Nature of Returns to Scale (2000-2012)

	Bank CRS	Bank DRS	Bank IRS
2000	02	05	00
2001	06	01	00
2002	02	04	01
2003	04	04	00
2004	05	06	01
2005	05	07	00
2006	05	08	01
2007	02	11	01
2008	03	12	00
2009	04	10	00
2010	04	10	01
2011	05	10	00
2012	05	05	00

7. Conclusion

The purpose of this thesis was investigating the efficiency of Algerian banks during the period of 2000-2012. The study has demonstrated that the banking reforms adopted by the Algerian government in the early nineties has contributed in enhancing the banks efficiency. On average the Algerian banks have realized a level of 76% technical efficiency, which is more than the technical efficiency level of MENA banks that realized scores ranged between 70% - 73% on average (Olson and Zoubi 2011).

The Algerian banks have achieved a high pure technical efficiency with an average equals 95%, and in the worst situations the pure technical efficiency score did not decline under the level of 84%. In addition, the Algerian banks have displayed 80% as score of scale efficiency. However, the increasing of competition in Algerian banking sector regarding the entry of foreign banks has forced the banks to increase their operations size by opening more branches. Thus, this made the banks operating at inappropriate scale which has caused these banks exhibit scale inefficiency. The main source of the banks technical inefficiency is the scale inefficiency which implies that the banks' failure to operate at the optimal scale is the fundamental problem of the Algerian banks.

The Algerian banks should adopte new technologies such as computerazing the banking opeartions which allows benefitting from the economies of scale and scope and consequently reducing the scale inefficiency. On other hand the foreign banks have realized high performance comparing to the public banks because the foreign banks did not subject to any governmental pressure in determinng their credit policies and rules. Therefore, the public banks should be more liberal in choosing their management styles and credit rules in manner increasing the banks profitability and reducing the nonperforming loans.

References

1. Akhtar, M. H. (2010). "Technical Efficiency and Productivity Growth of Saudi Banks: A Data Envelopment Analysis Approach". *Global Business Review*, 11 (2): 119–133.
2. Banker, R. D., Charnes, A., and Cooper, W. W. (1984). "Some models for estimating technical and scale inefficiencies in data envelopment analysis". *Management Science*, 30: 1078–92.

3. Benston, G. (1964). “Economies of scale and marginal cost in banking operations”. *National Banking Review*, 2: 507-549.
4. Burki, A. A., and Niazi, G. K. (2006). “Impact of Financial Reforms on Efficiency of State-owned”, *Private and Foreign Banks in Pakistan*. CMER working paper series.
5. Charnes, A., Cooper, W. W., and Rhodes, E. (1978). “Measuring the efficiency of decision making units”. *European Journal of Operational Research*, 2: 429-444.
6. Coelli, T., Rao, D. P., and Batesse, G. E. (1998). “An Introduction to Efficiency and Productivity Analysis”. *Boston: Kluwer Academic Publishers*.
7. Cooper, W. W., Seiford, L. M., and Tone, K. (2006). “Introduction to Data Envelopment Analysis and Its Uses”.*Springer*.
8. Cooper, W. W., Seiford, L. M., and Zhu, J. (2011). “Data Envelopment Analysis: History, Models, and Interpretations”.*DansHandbook on Data Envelopment Analysis* (1-39). Springer US.
9. Farrell, M. J. (1957). “The Measurement of Productive Efficiency”. *Journal of the Royal Statistical Society*, 120: 253-290.
10. Isik, I., and Hassan, M. K. (2002). “Technical, scale and allocative efficiencies of Turkish banking industry”. *Journal of Banking & Finance*, 26: 719–766.
11. Koopmans, T. C. (1951). “Analysis of Production as an Efficient Combination of Activities”.*Dans T. C. Koopmans, Activity Analysis of Production and Allocation*(33-97). New York: J. Wiley.
12. Liu, J. S., Lu, L. Y., Lu, W., and Lin, B. (2013). “A survey of DEA applications”. *Omega*, 41: 893–902.
13. Lovell, C. (1993). “Production Frontiers and Productive Efficiency”. Dans C. L. Fried, & S. Schmidt, *The Measurement of Productive Efficiency. New York: Oxford University Press*.
14. McAllister, P. H., and McManus, D. A. (1993). “Resolving the scale efficiencies puzzle in banking”. *Journal of Banking and Finance*, 17 (3): 389-405.
15. Olson, D., and Zoubi, T. A. (2011). “Efficiency and bank profitability in MENA countries”. *Emerging Markets Review*, 12: 94-110.
16. Sealey, C., and Lindley, J. T. (1977). “Inputs, Outputs and a Theory of Production and Cost at Depository Financial Institutions”. *Journal of Finance*, 32 (4): 1251-1266.

17. Sufian, F., and Abdul Majid, M.-Z. (2007). “Singapore banking efficiency and its relation to stock returns: a DEA window analysis approach”. *International Journal of Business Studies*, 15 (1): 83-106.
18. Sufian, F., and Habibullah, M. S. (2012). “Developments in the efficiency of the Malaysian banking sector: the impacts of financial disruptions and exchange rate regimes”. *Progress in Development Studies*, 12: 19-46.
19. Thanassoulis, E. (2001). “Introduction to the Theory and Application of Data Envelopment Analysis. A Foundation Text with Integrated Software”.*New York: Springer.*
20. Yahya, M. H., Muhammad, J., and Abdul Hadi, A. R. (2012). “A comparative study on the level of efficiency between Islamic and conventional banking systems in Malaysia”. *International Journal of Islamic and Middle Eastern Finance and Management*, 5 (1): 48-62.
21. Wheelock, D. C., and Wilson, P. W. (1999). “Technical Progress, Inefficiency, and Productivity Change in U.S Banking 1984-1993”. *Journal of Money, Credit, and Banking,* 31 (2): 212-234.

.