Efficiency and Productivity of North African Banks Using the Data Envelopment Analysis Model

Ali Bourahli [1] ♦, Yassine Benzai [2]

[1] Laboratory ITMAM, Saida University (Algeria), ali.bourahli@univ-saida.dz

[2] Saida University (Algeria), benzai.yassine@gmail.com

Received: 14/05/2023 Accepted: 04/07/2023 Published: 20/07/2023

Abstract:

The present research paper aims to investigate the efficiency and productivity of commercial North African banks. In pursuance of this goal, 10 Algerian banks, 10 Tunisian banks, and 9 Moroccan banks mainly composed the study's sample, which was chosen based on the availability of the data from 2017 to 2020. The study employed an envelope analysis method in the randomization of the sample in order to address the study's question. This is achieved by displaying the levels of efficiency and productivity of banks and contrasting them with North African institutions, the data is based on the input-oriented VRS variable returns model. The latter has been applied in the DEAP program (vp2.1), and is considered one of the most important results is the knowledge of inefficient banks. The findings of the study revealed that Moroccan banks are more efficient than their Tunisian and Algerian counterparts, as Tunisian banks recorded an improvement in total efficiency by 2.1%, while Algerian banks recorded a decrease of 0.023%, on the other part, Moroccan banks recorded a slight decrease by 0.01%.

Keywords: bank efficiency, data envelope analysis, variable returns model.

♦ **Corresponding author.**

Introduction:

Banking institutions changed from being limited to carrying out the financial intermediation process to handling other investment activities as a result of the nature of the institution's activity and the development of that activity over time, and from commercial or specialized banks to comprehensive banks. This change has made the process of measuring banking efficiency a process that includes part of the doubt or the result. The difficulty of determining the exact measures that reflect the activity or the inputs and outputs of the bank, as there is no clear and definitive answer in this matter, and the researchers believe that there are two basic approaches through which the banking structure is analyzed, represented in the production approach and the mediation approach in addition to the operational approach and the modern approach.

Given that it was difficult to measure efficiency, banking organizations looked for a system to handle the problem. In order to accomplish the above, we used parametric and non-parametric statistical methods.

Data envelope analysis is one of the non-parametric methods that uses linear programming to compare the effectiveness of various decision-making units. Its main objective is to identify best practices, maximize outputs, or minimize inputs, and then more effectively accomplish the goals of the decision-making unit. Moreover, the random cost limit method is one of the most important parametric methods for measuring banks that rely on regression techniques to estimate the total cost function as a dependent variable for several independent variables.

The empirical data analysis approach and the random cost limit method differ in a number of ways. Nevertheless, despite these variations, combining the two approaches to create a comprehensive picture of the levels of efficiency and competition in banks is where the two approaches perform best. Results from using a single method on the same set of data would be viewed as less reliable.

Given the significance of gauging the effectiveness and productivity of commercial banksThe research at hand attempts to shed light on this issue by raising the following question:

- **What is the level of efficiency and productivity of commercial North African banks using the DEA data envelope analysis model?**

Research hypotheses:

- There is a discrepancy in the efficiency scores achieved by the sample banks.
- There is a possibility to avoid wasting banks' resources and increase their products by relying on more efficient reference banks.

Research objectives*:*

- Explaining the most important concepts related to efficiency and methods of its measurement.
- Identifying the data envelope analysis method as a non-parametric method used to measure efficiency.
- Identifying efficient banks that improve the selection of their inputs and outputs, and inefficient banks that have excess inputs and stagnant outputs.

Research methodology*:*

We relied on the analytical descriptive approach in order to tackle the primary issue as well as reveal the feasibility of the hypotheses by using both the descriptive approach in the theoretical aspect of the subject and the analytical approach in the applied study to investigate aspects related to bank efficiency using the data envelope method.

1. Theoretical framework: an overview of the DEA model

1.1. Definition and development of the DEA method

When Edwardo Rhodes was a Ph.D. student at Carnegie Mellon University studying the evaluation of an educational program for a group of disadvantaged minority (black and Hispanic) pupils in public schools in the United States of America, he came up with the concept of the data envelope model. (Salem, 2018, p. 517). Rhodes at that time the problem of calculating the relative efficiency of these schools, using a set of inputs and outputs in the absence of price data, and this problem represented the beginning of the formulation of the basic model of the data envelope method, which was developed by Chames Cooper Rhodes and later known as the CCR model (Ismail, 2009, Pages 754-755). Rhodes' use of numerous outputs and inputs adds value, something Farrell was not able to do. The reason this approach is known as the "encompassing analysis of data" is those administratively efficient units are in the foreground and encircle (envelope) less efficient units. Competent, and as a result, analysis of the data covered by the competent units (Biljilali, 2018, p. 53).

According to its definition, the data empirical analysis method is a non-parametric approach that employs linear programming to assess the relative effectiveness of a group of understudied units, DMUs, and decision-making units. having a homogenous character and utilizing a variety of inputs and outputs(Al-Saidi, 2014, p. 19).

The DEA methodology is ordinarily employed when input and output pricing and decision-making units are unavailable since it does away with some of the assumptions and restrictions imposed on the process of traditional efficiency measurement. One might also take into account environmental factors from outside.

Each decision-making unit is given the option to select the inputs and outputs that it wants to give weight to the DEA identifies the relative weights of inputs and outputs as well as inefficient decision-making units in order to maximize the efficiency index for each decision-making unit (Elias, 2014, p. 45).

1.2. Limitations of using the data envelope analysis method:

One of the three requirements listed below must be met for the DEA strategy to be successful, according to a study conducted in 2006 by Cooper and a group of researchers:

- **The first rule*:*** To maintain the model's ability to distinguish between efficient and inefficient units, the sample size must be bigger than the product of the number of inputs by the number of outputs.

$$Ss \geq I \times O$$

Ss: DMU decision-making units.

I: input.

O: output.

- **The second rule*:*** The sample size has to be higher than the result of multiplying Issue 3's inputs and outputs (Al-Karim, 2009/2010, p. 118):

$$Ss \geq 3 (I + O)$$

- **The third rule*:*** The third rule states that if the model's validity is supported by the results, then no more than one-third of the sample under study should be completely qualified units (100%) (Tariq, 2018/2019, pg. 42).

$$DMU\ 100\%\ Efficient \geq 1/3 \times Ss$$

1.3. DEA data paradigms

1.3.1. The CCR constant economies of scale model

In 1978, Charnes-Coopr-Rhoders presented this model, which is represented by the initial edges of their names, CCR. In the study of the data envelope, this subsequent model is regarded as the primary one. The outputs it produces as it moves toward the efficient limits are known as the property of the stability of the return on production, and this characteristic is only considered appropriate when all of the units being compared are operating at their peak capacities. However, in practice, there are many barriers that prevent the units from reaching these capacities, such as competition financing and other restraints.

Consequently, by positioning the coordinates of inefficient decision-making units within the efficient frontier, the CCR model allows for the transformation of these inefficient units into effective ones. Through adjustments in the input direction, inputs can be enhanced (reduced), while adjustments in the output direction can enhance (increase) outputs. Therefore, the placement of the boundary wall, whether it is positioned towards the inputs or outputs, plays a crucial role in determining the potential improvement of inefficient units (Abdul Qader, 2011-2012, p. 50).

1.3.2. The mathematical formulation of the CCR constant economies of scale model.

Assuming that we have n decision-making units DMUn,..., DMU2, DMU1: DMU, each DMU has equal components of input and output and we denote the units by j where:

$$J = 1;\ldots..;n$$

The selected units ought to possess the following:

- ➔ A good efficiency should represent greater outputs and fewer inputs.
- ➔ Express the inputs and outputs of all DMUs in positive numbers.
- ➔ For either the resolver or the manager, the variables (inputs, outputs, and choice of DMU) must accurately represent the actual factors impacting efficiency.
- ➔ It's not necessary for the inputs or outputs to have the same units of measurement. (cash values, number of people, meters....) (W.W.coop.L.M Seiford, p. 22).

Assuming that the decision-making unit (DMUj) utilizes at least one and produces at least one output, and in the case of multiple inputs and outputs, linear programming techniques are used to determine the unit under evaluation's lowest input use at a particular level of output relative to other units, and this is from the standpoint of inputs. The maximum production that the unit that is being evaluated is capable of is determined in relation to the other units from the standpoint of outputs. As a result, the mathematical formulation for the DEA technique is presented as a linear program in accordance with the CRS constant economies of scale model from the viewpoint of outputs and inputs as follows (Zhu, 2009, p. 187):

From an output perspective

$$\text{Max z} \sum_{r=1}^{s} u_r y_{ro}$$

S.C

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{j=1}^{m} v_i x_{ij} \leq 0$$

$$\sum_{i=1}^{m} v_i x_{io} = 1$$

$$U_r . v_i \geq 0$$

From an input perspective:

$$\text{Max q} \sum_{i=1}^{m} v_i x_{ro}$$

S.C

$$\sum_{r=1}^{m} v_r x_{ij} - \sum_{i=1}^{s} u_r y_{rj} \geq 0$$

$$\sum_{r=1}^{s} u_r y_{ro} = 1$$

$$U_r . v_i \geq 0$$

whereas:

- J: The number of DMUs compared to each other in the DEA method
- DMUj: decision-making unit number j.
- Ø: Efficiency index of the unit under evaluation by DEA method.
- yrj: the value of the output r produced by the decision-making unit j.
- xij: the value of input i used by the decision-making unit j.
- r: the number of outputs produced by each DMU.
- I: The number of inputs used by each DMU.
- ur: coefficient or weight assigned by DEA to output r to reach 100% efficiency.
- vi: coefficient or weight allocated by DEA for input i to reach 100% efficiency.
- Yro: the value of output r produced by the unit under evaluation.

1.3.3. BCC variable economies of the scale model.

The BCC variable economies of scale model were created by Banker. Charnes. Cooper in 1984 is based on the variable returns to scale (VRS) hypothesis, which states that the operational processes of decision-making units can be at an increasing, constant, or decreasing size (Al-Jumawi, 2012, p. 15). It differs from the CCR model in that it provides an estimate of technical efficiency based on the volume of operations, in use to provide services to the beneficiary that is, it gives the efficiency associated with a certain volume of operations, and the model also determines the possibility of a variable return rate (fixed, increasing, decreasing), on the number of inefficient unit services resulting from a change in the quantity Inputs up to the level of efficiency (Bel Djilali, 2018, p. 59).

1.4. Mathematical formulation of the VRS/BCC variable economies of scale model

By incorporating the size constraint j=nj=1 into the mathematical formulation of the CRS model, the variable volume model VRS, which makes use of the same data as the CRS model, may be expressed as a linear program. The units are made to be the same size by this restriction (JOE, 2007, p. 6) We obtain the mathematical formulation of the VRS model from the perspective of inputs and outputs as follows by recreating the earlier formulation of the CRS model after translating it into a binary program and adding a size limit (Zhu, 2009, p. 188):

From an output perspective

$$\textbf{MaxØ}$$

$$\textbf{S.C}$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq \text{Ø}\, y_{ro}$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} \geq x_{io}$$

From an input perspective:

$$\textbf{MaxØ}$$

$$\textbf{S.C}$$

$$\sum_{j=1}^{n} \lambda_j y_{ij} \leq \text{Ø}\, x_{io} \quad i = 1,2,\ldots m \quad \text{(a)}$$

$$\sum_{j=1}^{n} \lambda_j x_{rj} \geq \text{Ø} y_{ro} \quad r= 1,2,\ldots,n \quad \text{(b)}$$

$$\lambda \geq 0 \quad j= 1,2,\ldots,n \quad \text{(c)}$$

2. The practical Part

2.1. The sample banks used in the study

We focused on commercial banks in our study to improve comparability through systems Banking for our sample because these institutions are thought of as homogeneous in terms of the services they offer. Our study includes a set of financial data for 29 commercial banks from three countries in the North African region (10 Algerian banks, 10 Tunisian banks, and 09 Moroccan banks), and they were selected according to the availability of information during the period 2017-2020.

2.2. Study data and variables

Due to the significance of utilizing, evaluating, and accepting results, the empirical analysis of data requires careful selection of inputs and outputs. In this study, we employed the mediation approach to assess the efficiency of the examined banks. Under this approach,

banks are perceived as intermediaries that facilitate the transfer of funds from savers to investors and convert them into loans and other assets. This approach acknowledges the complexity of banks' operations, involving multiple inputs and outputs that are not uniform, thereby necessitating appropriate choices. The identified items for study inputs and outputs are as follows:

input: Input1: Fixed Assets. /Input2: Deposits & Short-term funding + Interest Expense + Overheads**.**

Output: Loans and Other Earning Assets are aggregated into one output.

Since the majority of studies focused on efficiency believe that the banking sector must have high technical efficiency, the DEAP program (vp 2.1) was used to estimate the technical efficiency of the commercial banks of the study's sample during the period 2017-2020 under the assumption that the production function of the banks undergoes a variable ladder return VRS with an input orientation. Its main goal is to identify the proportional amounts of inputs that must be decreased to ideal levels in comparison to a set amount of output in order to achieve maximum efficiency.

2.3.Results of the measured efficiency according to the obtained VRS model

Table(01): Indicators of technical competence in Tunisian bank

	Name of the Bank	crste	vrste	scale
1	ARAB BANKING CORPORATION TUNISIE	0.404	0.649	0.622 drs
2	ARAB TUNISIAN LEASA	1	1	1
3	ATTIJARI LEASING	0.884	0.994	0.890 drs
4	BEST LEASING	0.450	0.530	0.850 drs
5	MONDERN LEASING	0.846	0.977	0.865 drs
6	ARAB INTERNATIONAL LEASE	1	1	1
7	CITIBANK	1	1	1
8	& TUNISIE LEASING FACTORING	0.897	1	0.897 drs
9	UNIFACTOR	0.544	0.609	0.894 irs
10	WIFACK INTERNATIONAL BANK	0.108	0.132	0.816 irs
	MEAN	0.713	0.789	0.883

Source: DEAP model output

Based on the aforementioned, the technical efficiency of Tunisian banks is estimated to be 78.90% on average, which equates to approximately 21.1% of the banks' resources (deposits, fixed assets, and various expenses) that were not used efficiently and were wasted during the production process. This ratio represents the best bank.

We also observe that the efficiency ratio for Tunisian banks is highly variable; nowadays, some banks report an efficiency ratio of 100% for example ARAB TUNISIAN LEASA, LEADING ARAB INTERNATIONAL, or CITIBANK

Some banks, like WIFACK International Bank, receive very low rates, yet they are still able to increase their efficiency because they are experiencing an increasing return while other banks are experiencing a declining peaceful return.

Table (02): Banking productivity of Tunisian banks

	Name of the bank	Effch	techch	pech	sech	tfch
1	ARAB BANKING CORPORATION TUNISIE	0.977	1.155	1.155	0.846	1.128
2	ARAB TUNISIAN LEASA	0.880	1.073	0.997	0.883	0.945
3	ATTIJARI LEASING	0.878	1.073	1.002	0.876	0.939
4	BEST LEASING	0.870	1.047	0.921	0.945	0.911
5	MODERN LEASING	0.930	1.177	0.909	1.024	1.094
6	ARAB INTERNATIONAL LEASE	1	1.166	1	1	1.166
7	CITIBANK	1	0.716	1	1	0.7116
8	& TUNISIE LEASING FACTORING	1.001	1.081	1	1.001	1.082
9	UNIFACTOR	0.961	1.140	0.932	1.032	1.096
10	WIFACK INTERNATIONAL BANK	2.103	1.482	1.965	1.070	3.115
	MEAN	1.021	1.096	1.059	0.965	1.119

Source: DEAP model output

whereas :

- ➔ Effch: the change in total technical efficiency.
- ➔ Techch: The change in technology.
- ➔ Pech: Change in absolute technical competence.

➔ Sech: change in scalar efficiency (efficiency of scale).

➔ Tfpch: change in total factor productivity.

As a result, we draw the conclusion that Tunisian banks' total efficiency has slightly improved by 2.1%. This shows that Tunisian banks are operating at their optimal size level since efficiency is rising while peaceful efficiency causes a -0.04% decline in total efficiency.

Table (03): indicators of technical competence in Algerian banks

	Name of the bank	crste	vrste	scale
1	BANQUE NATIONALE D'ALGERIE	1	1	1
2	CREDIT POPULAIRE D'ALGERIE	0.879	0.882	0.997 irs
3	BANQUE DE DEVELOPPEMENT LOCAL	0.884	0.885	0.999 irs
4	BANQUE EXTERIEURE D'ALGERIE	1	1	1
5	BNP PARIBAS ELDJAZAIR	0.719	0.718	0.993 drs
6	SOCIETE GENERALE ALGERIE	0.909	1	0.909 irs
7	ARAB BANKING CORPORATION-ALGERIA	0.893	1	0.893 irs
8	ALBARAKA OF ALGERIA	0.703	0.719	0.979 irs
9	GULF BANK ALGERIA	0.654	0.703	0.931 drs
10	TRUST BANK ALGERIA	1	1	1
	MEAN	0.864	0.891	0.970

Source: DeAP model outputs

Based on our analysis, the average technical efficiency of Algerian banks is estimated to be 89.1%. This indicates that, on average, 10.9% of the banks in our study (with variations in deposits, fixed assets, and expenses) are operating below the optimum level and have room for improvement in their production process. It is noteworthy that this figure represents the efficiency of the best-performing bank in our study.

Additionally, we observe that the percentage of banks varies less than that of Tunisian banks, so that even when some banks, such as Nationalism d'Algérie, Trust Bank Algeria, and Banque Exterieure d'Algérie, record 100% fully efficient rates, the banks did not deviate significantly from the efficiency of the efficiency, resulting in the last percentage of GULF Bank Algeria being 70.3%.

Table (04) Banking for Algerian banks

	Name of the bank	Effch	techch	pech	sech	tfch
1	BANQUE NATIONALE D'ALGERIE	1	0.975	1	1	0.975
2	CREDIT POPULAIRE D'ALGERIE	0.959	0.983	0.961	0.998	0.942
3	BANQUE DE DEVELOPPEMENT LOCAL	0.943	0.995	0.960	0.982	0.938
4	BANQUE EXTERIEURE D'ALGERIE	1	0.958	1	1	0.958
5	BNP PARIBAS ELDJAZAIR	0.970	1.070	1.048	0.925	1.038
6	SOCIETE GENERALE ALGERIE	1.010	0.946	1	1.010	0.956
7	ARAB BANKING CORPORATION-ALGERIA	1.039	1.039	1	1.039	1.079
8	ALBARAKA OF ALGERIA	0.920	1.068	0.974	0.945	0.982
9	GULF BANK ALGERIA	0.935	1.051	0.982	0953	0.983
10	TRUST BANK ALGERIA	1	1.038	1	1	01.038
	MEAN	0.977	1.011	0.992	0.985	0.988

Source: DEAP model output

Based on the results, we can confirm that the total efficiency of Algerian banks has experienced a slight decline of -0.03%. This decline can be attributed to both a decrease in absolute efficiency of -0.01% and a decline in scale efficiency of -0.02%. The decrease in absolute efficiency indicates that banks have faced challenges in controlling the amount of resources they use. Despite this decline, the productivity indices of the banking sector in Algeria have remained relatively stable throughout the study period. However, there has been a small improvement of 0.01% in the technological progress of the banking industry.

Table (05): indicators of technical competence in Moroccan banks

	Name of the bank	crste	vrste	scale
1	ATTIJARIWAFA BANK	0.975	1	0.975 drs
2	BANK ALMAGHRIB	1	1	1
3	BANQUE MAROCAINE DE COMMERCE EXTERIER	0.898	0.937	0.957 drs
4	BANQUE MAROCAINE POUR LE COMMERCE ET L'INDUSTRIE BMCI	1	1	1

5	CITIBANK – MAGHREB SA	1	1	1
	CREDIT AGRICOLE DE MAROC	0.883	0.904	0.977 drs
6	CREDIT DU MAROC	0.910	0.912	0.998 drs
7	MAROC LEASING	1	1	1
8	SOCIETE GENRALE MAROCAINE DE BANQUES	0.952	0.962	0.990 drs
	MEAN	0.958	0.969	0.988

Source: DEAP model output

In addition to that, we see that the technical efficiency of Moroccan banks is estimated at 96.9% on average, meaning that only about 3.1% of the banks' resources (deposits, fixed assets, various expenses) were not used efficiently during the production process, and this is in relation to the best bank, and in general Moroccan banks are considered more efficient than its Tunisian and Algerian counterparts.

There are banks that obtained a relatively lower percentage, like CREDIT DU MAROC, whereas four banks, like CITIBANK - MAGHREB SA and MAROC LEASING, registered 100% full efficiency. We should also note that all banks are unable to increase their peaceful efficiency because they are currently experiencing a negative peaceful return drs.

Table (06): Banking productivity of Moroccan banks

	Name of the Bank	Effch	techch	pech	sech	tfch
1	ATTIJARIWAFA BANK	0.998	1.007	1	0.998	1.005
2	BANK ALMAGHRIB	1	1.040	1	1	1.040
3	BANQUE MAROCAINE DE COMMERCE EXTERIER	0.994	1.005	0.992	1.001	0.999
4	BANQUE MAROCAINE POUR LE COMMERCE ET L'INDUSTRIE BMCI	0.987	1.002	0.987	1	0.989
5	CITIBANK – MAGHREB SA	1	0.998	1	1	0.998
6	CREDIT AGRICOLE DE MAROC	0.992	1.002	0.987	1.006	0.994
7	CREDIT DU MAROC	1.002	1.003	1.002	1	1.005
8	MAROC LEASING	1	0.968	1	1	0.968
9	SOCIETE GENRALE MAROCAINE DE BANQUES	1.016	1.006	1.012	1.003	1.023

	MEAN	0.999	1.003	0.998	1.001	1.002

Source: DEAP model output

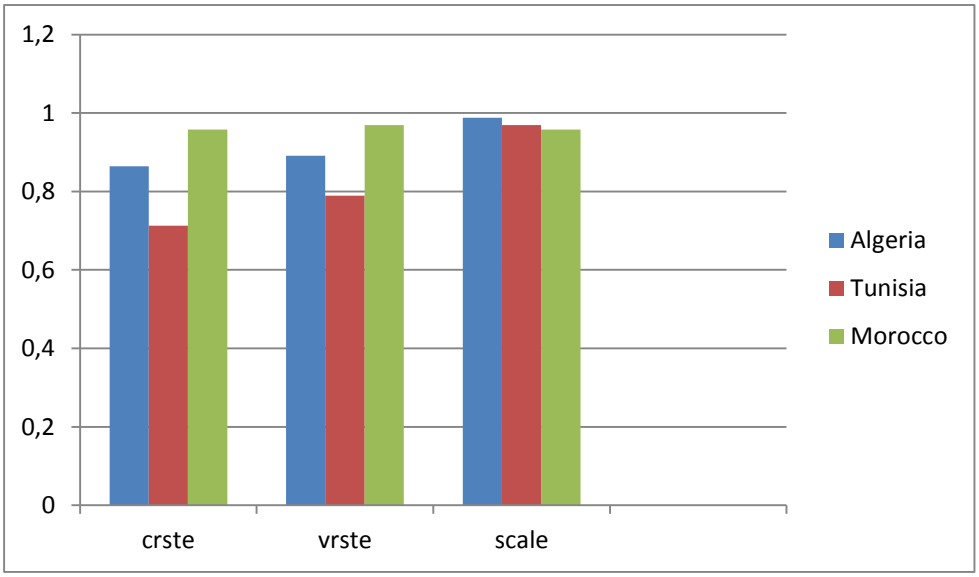
According to the table, the overall efficiency of Moroccan banks has experienced a very slight decrease of -0.01%. This decrease can be attributed to a decline in absolute efficiency of -0.01%. However, there has been a slight improvement in the technological progress of the banking industry by 0.03%. On the other hand, peaceful efficiency has contributed to enhancing overall efficiency by 0.01%.

Table (07): the general average of (creste, vrste, scale) for the countries under study

	creste	vrste	scale
Algeria	0.864	0.891	0.970
Tunisia	0.713	0.789	0.883
Morocco	0.958	0.969	0.988

Source: DEAP model output

Figure No. (01): The general average of (creste, vrste, scale) for the countries under study



Source: DEAP model output

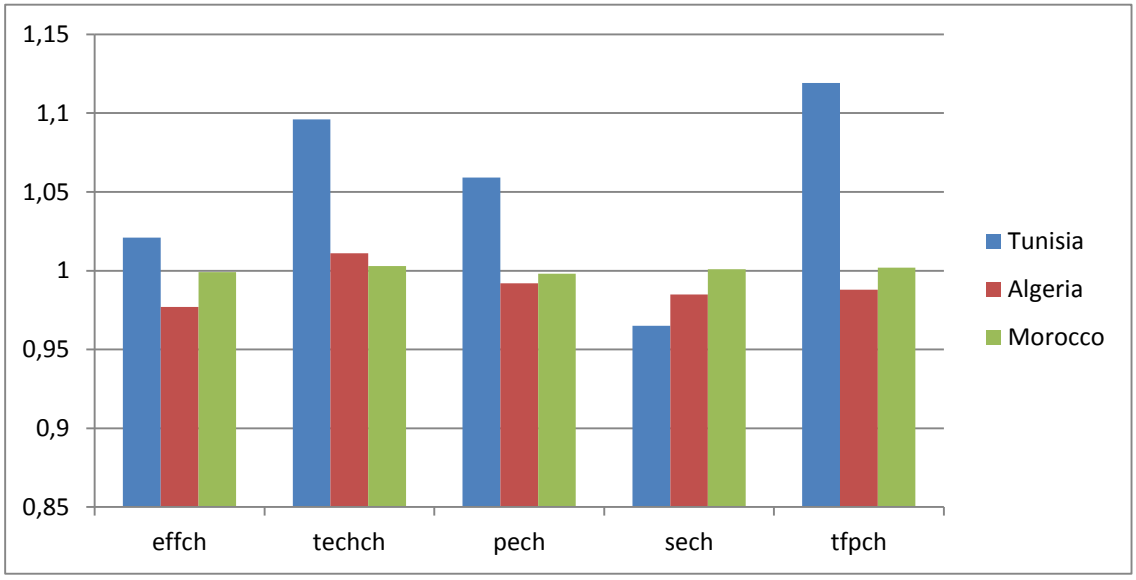
According to the data in the table above, Moroccan banks are more effective than Algerian and Tunisian banks between 2017 and 2020, presuming that the production function of banks is subject to a variable VRS with input orientation.

Table (08): General average of (effch, techch, pech, sech, tfch) for the countries under study

	Effch	techch	pech	sech	tfch
Tunisia	1.021	1.096	1.059	0.965	1.119
Algeria	0.977	1.011	0.992	0.985	0.988
Morocco	0.999	1.003	0.998	1.001	1.002

Source: DEAP model output

Figure (02): General average of (effch, techch, pech, sech, tfch) for the countries under study



Source: DEAP model output

According to the above table and figure, Tunisian banks recorded the highest values for each of the changes in total technical efficiency, technological change, absolute technical efficiency, and total factor productivity, with the exception of the change in peaceful efficiency, which showed a decline and in which the Moroccan banks attained the highest percentage.

Conclusion:

The present research paper focused on studying the variable returns to scale (VRS) model using the input-oriented Data Envelopment Analysis (DEA) method. The study specifically examined North African countries, including 10 Algerian banks, 10 Tunisian banks, and 9

Moroccan banks. The selection of these banks was based on the availability of information for the period from 2017 to 2020. The research yielded the following results:

- According to estimates, the technical efficiency of Tunisian banks is 78.90% on average, or around 21.1% of the banks' resources (deposits, fixed assets, and different expenses) that were not employed effectively during the production process.
- According to estimates, the technical efficiency of Algerian banks is 89.1% on average, which means that 10.9% of their resources (deposits, fixed assets, and other expenses) were not used in the production process effectively.
- The technical efficiency of Tunisian banks is estimated at 96.9% on average, or about 3.1% of the banks' resources (deposits, fixed assets, various expenses) that were not utilized efficiently during the production process. Moroccan banks are considered more efficient than their Tunisian and Algerian counterparts.
- Where Tunisian banks recorded an improvement in overall efficiency by 2.1%, Algerian banks recorded a decrease of 0.023%, while Moroccan banks recorded a slight decrease of 0.01%.

This study examined the numerous benefits of the data envelope analysis approach as a non-parametric instrument that enjoys strong discrimination and a straightforward methodology for evaluating the performance of various institutions. As a result, we recommend the following through it:

- Banks that haven't reached the necessary efficiency levels should reevaluate how they're using their resources and make the necessary modifications.
- The need for Algerian banks to use these methods to measure their efficiency.
- Establishing centers specialized in measuring the efficiency of institutions such as universities to exploit their resources, which will reflect positively on their economic performance.

List of references

- Joe Zhu. (2009). **Quantitative Models for Performance Evaluation and Benchmarking DEA.** Boston, USA, ‹187.
- Kaoru Tone W.W.coop.L.M Seiford. (ND). **data Envelopment Analysis.** OP. Cit ‹p 22.

- Z, WADE, D COOK JOE. (2007). **Modeling data Irregularities and Structural Complexities in Data Envelopment Analysis**. Springer Science + Business Media ،6.
- Tarik Ben Kassmi. (2018/2019). **An attempt to build a model to measure the efficiency of exploitation in industrial enterprises**. Ph.D. thesis, Department of Al-Nasir Heights, University of Mohamed Kheidar Biskra.
- Boumaraf Elias. (2014). **Measure the efficiency of banks using the data envelope analysis method.** Journal of the Economic Researcher, first issue, Setif University.
- Shaalan Minya, Yasmina Ibrahim Salem. (2018)**. Measuring the efficiency of insurance companies using the data envelope analysis method - a study of the Algerian market -**. Journal of Ijtihad for Legal and Economic Studies, Volume 07 (Issue 06).
- Talha Abdel Qader. (2011-2012). **An attempt to measure the efficiency of the Algerian university using the DEA method, a case study of Saida University.** p. 50. Abu Bakr Belkaid University, Tlemcen.
- **Fatiha Bel Djilali. (2018). Using the data envelope analysis method (DEA) to try to measure the relative efficiency of Moroccan banks (standard study 2012)**. Journal of Financial and Internet Economics and Business Administration, Issue 05, 53.
- Kourishi Mohammed Al Jamoui. (2012). **Measuring the efficiency of health services in Algerian hospitals using the DEA method, an applied study of a sample of hospitals for the year 2011.** Researcher Journal (Issue 11), 15.
- Muhammad bin Ali Al-Saeedi. (2014). **Requirements for improving the relative efficiency of the academic departments of the College of Education at Sultan Qaboos University using the data envelope method.** Education Sciences Journal (Issue 03), p. 19.
- Mohamed Abdel Rahman Ismail. (2009). Evaluating the performance of data envelope analysis models in the presence of extreme observations. Public Administration Journal, Vol. 49, 754-755.
- Mansouri Abd el Karim. (2009/2010). **An attempt to measure the efficiency of commercial banks using the empirical data analysis method.** Ph.D. thesis, majoring in economic analysis, University of Tlemcen.