

Measuring the efficiency of commercial banks using the Data Envelopment Analysis Model An applied study of a sample of Algerian commercial banks

HIRECHE ABDELKADER

TIARET University (Algeria), abdelkader.hireche@univ-tiaret.dz

 ORCID: <https://orcid.org/0009-0007-5602-1141>

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Abstract:

This study is designed to assess the efficiency of commercial banks in Algeria, focusing on both technical and scale efficiency. The goal is to identify the efficient banks that have been able to utilize the available inputs to achieve higher outputs, as well as to pinpoint the inefficient banks that have not been able to achieve higher outputs with the inputs available to them. Additionally, the study seeks to identify the necessary improvements that inefficient banks must implement in order to achieve total relative efficiency.

The study employed an evaluative approach to measure the efficiency of commercial banks in Algeria, relying on the Data Envelopment Analysis (DEA) method and using financial data included in the annual reports issued by these banks during the period (2018-2020). DEA analysis was performed using the Variable Returns to Scale (BCC-O) model with an output-oriented approach. This involved presenting efficiency scores, size gains, and benchmark units.

The study yielded several key findings, including the observation that most commercial banks in Algeria do not effectively combine input elements to achieve a certain output level. The results also highlighted the inefficient banks with surplus inputs and stagnant outputs and identified the benchmark banks for each inefficient bank.

The study recommended that bank managers whose banks have not achieved the required relative efficiency (inefficient banks) should study the reasons preventing them from doing so to identify the weaknesses in their inputs.

keywords: efficiency, banking efficiency, data envelope analysis, Volumetric Efficiency, Relative Efficiency.

1. Introduction:

The banking industry has witnessed significant changes and expanded competition, encompassing the global banking market. This has placed commercial banks in direct competition with giant banks, necessitating the need to enhance their efficiency and productivity. Banks play a crucial role in a country's economy, especially those that follow open economic policies. Undoubtedly, the efficiency of banking institutions is among the key requirements for economic growth. In response to the rapid changes facing these complex institutions, they have come under competitive pressures at both the local and global levels. Consequently, they seek alternative solutions to reduce the costs of their services by activating their production efficiency and utilizing both quantitative and qualitative aspects of these services.

Banking efficiency is considered a key indicator in assessing these banking institutions and the sector as a whole. Improving the efficiency of banks is an important aspect of their development, relying on several methods, including Data Envelopment Analysis (DEA), which is a non-parametric mathematical approach used to measure the efficiency of commercial banks using multiple inputs and outputs.

1.2. Research Problem:

Based on the aforementioned context, the main research problem can be highlighted through the following question:

What is the level of technical efficiency of Algerian commercial banks using the Data Envelopment Analysis (DEA) method?

1.3. Hypotheses of the Study:

- There is variation in the achieved efficiency levels among the sampled banks;
- There is potential to avoid waste in the resources of banks and increase their outputs by relying on the benchmark banks that are more efficient.
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1.4. Study Objectives:

- To understand the key concepts related to efficiency and its measurement methods ;
- To understand Data Envelopment Analysis (DEA) as a non-parametric method used to measure efficiency ;
- To identify efficient banks that make prudent choices regarding their inputs and outputs, as well as inefficient banks that have surplus inputs and stagnant outputs.

1.5. Research Methodology:

To address the main research problem and validate the hypotheses, we adopted a descriptive-analytical approach. We used the descriptive approach in the theoretical aspect of the subject and the analytical approach in the empirical study to investigate aspects related to banking efficiency using the Data Envelopment Analysis (DEA) method.

2. The theoretical study:

2.1. A Comprehensive Overview of Banking Efficiency:

Banking efficiency currently holds excellent importance among economists as it serves as a crucial indicator of a bank's success or failure. Efficiency metrics are used to evaluate the performance of banking institutions. Therefore, we aimed to provide a comprehensive understanding of efficiency, banking efficiency, and quantitative methods for measuring efficiency.

2.1.1. The Concept of Efficiency:

Economists, both in the past and present, have shown significant interest in the concept of efficiency due to its paramount importance to individuals, institutions, and society as a whole. Since the inception of humanity, individuals have sought to make the most of their limited resources to improve their quality of life and achieve a better standard of living. This pursuit is known in economics as "achieving the maximum possible output from available resources," which constitutes the fundamental principle in studying the concept of efficiency (Zainab, 2014, p: 108).

In general, the emergence of the term efficiency, or "الكفاءة" is closely linked to the fundamental economic problem of resource scarcity or limited resources. Efficiency is intertwined with rational and prudent production, consumption, and the equitable distribution of these scarce economic resources. The development of this term can be attributed to the economist Pareto, who extensively studied it and led to its association with "Pareto optimality." According to this thinker, efficiency refers to a state where resources are allocated in such a way that it becomes impossible to improve the well-being of one individual without causing harm to at least another (Bouzidi, 2015/2016, p: 33).

Mayo and Mathew clarify that efficiency involves the economic relationship between available resources and the outcomes achieved through maximizing outputs based on a given quantity of inputs. It also encompasses reducing the number of inputs used to attain a specific level of output. Thus, efficiency implies the absence of wasteful utilization of available material, financial, and human resources (Tarek, 2018/2019, p: 09).

From the previous definitions, it is evident that efficiency is about accomplishing more with less, i.e., reducing the use of resources, whether they are human, material, or financial. It also involves minimizing waste and disruptions in production efficiency (Aldouri, 2003, p: 227).

Efficiency is defined as achieving maximum outputs with minimal resources. This means using available resources in a rational and optimal manner. It involves selecting the optimal mix of production factors that minimize the organization's costs without affecting the quantity of production and choosing the optimal mix of production factors that increase the quantity or quality of production without affecting production costs (Al-Anizi, 2015, p. 113).

2.2. The Concept of Banking Efficiency:

Studies on banking efficiency have primarily focused on evaluating this efficiency within the framework of banks' operating costs and profitability. Concepts of economic efficiency have been applied to banks by measuring their technical and allocative efficiency. These studies often assess the efficiency of a specific bank or multiple banks (Saha, 2013, p: 94).

However, modern approaches aim to study the economics of banks within a broad and comprehensive framework by linking them to the central objectives of the economy at both the macro and micro levels. This involves defining the role of these banks in the economy and assessing their contribution to development. These studies have expanded beyond this scope to delve deeper into financial trends within the economy and measure the effectiveness of the banking system in meeting the needs of society, particularly for various business sectors. Therefore, the concept of banking efficiency is not an absolute one; instead, it is a relative concept that should be associated with the approach used in evaluating specific performance (Al-Zahraa, 2012, p: 60).

The concept of banking efficiency encompasses a wide range of meanings that cannot be confined to a narrow scope. Definitions discussing the concepts of banking efficiency have varied based on the viewpoints and opinions of researchers. The banking efficiency metric indicates whether a bank uses the minimum amount of inputs to produce a certain quantity of outputs or maximizes the quantity of outputs while keeping the level of inputs constant (Hasan, 2019, p: 121). A banking institution is considered efficient if it can allocate the available economic resources toward achieving the highest possible returns with minimal waste. This entails successful management of both its physical and human resources on the one hand, achieving optimal scale, and offering a wide range of financial products on the other (Nouai, 2016, p; 06).

2.3. Quantitative Methods for Measuring Banking Efficiency:

In the past, most studies focused on measuring banking efficiency using financial ratios. However, these studies faced criticism on several points, including the relative neglect of the importance of multiple inputs and outputs in banking operations. They also provided only a narrow and incomplete view of a bank's performance and did not offer a long-term perspective on banking efficiency (Faisal, February 23-24, 2011, p: 05). The diversity in the nature of banking activities and the various ways of measuring inputs and outputs in banking institutions have led to diversity in methods and tools for measuring banking efficiency.

The following quantitative methods for measuring banking efficiency can be distinguished (Khirnaji, December 2018, p. 2015):

- Data Envelopment Analysis (DEA) method.
- Stochastic Frontier Analysis (SFA) method.
- Thick Frontier method.
- Free Distribution method.

2.4. Generalities about Data Envelopment Analysis (DEA) Method:

2.4.1. The Concept of Data Envelopment Analysis (DEA)

In 1978, there was a significant development in the field of performance measurement when Charnes and his colleagues established the foundations for data envelopment analysis.

This work can be traced back to Farrell in 1957 when he demonstrated that Charnes et al.'s efficiency measure can be divided into two scales: "the pure technical efficiency scale and the scale of scale efficiency.

Data Envelopment Analysis is defined as a "mathematical method that uses linear programming to measure the relative efficiency of a number of administrative units by

determining the optimal mix of inputs and outputs based on their actual performance" (Moftah, 2017/2018, p: 94).

The DEA methodology eliminates the need for some assumptions and constraints imposed on the traditional efficiency measurement process. It is typically used when input and output prices and decision-making units are unavailable. DEA is a multi-factor production model for measuring the relative efficiency of a homogeneous group of decision-making units. It accommodates multiple inputs and outputs simultaneously and can also include external environmental variables.

This method allows each decision-making unit to choose its weights for inputs and outputs to maximize its efficiency score. DEA calculates the efficiency score and determines the relative weights of inputs and outputs, as well as inefficient decision-making units (Elias, 2014, p: 45).

2.4.2. Determinants of Using the Data Envelopment Analysis (DEA) Method

The study conducted by Cooper and a group of researchers in 2006, which resulted in a set of instructions ensuring the successful use of the DEA method, can be summarized by achieving one of the following three rules:

- a. The first rule: The sample size must be greater than or equal to the product of the number of inputs and the number of outputs; otherwise, the model will lose its discriminatory power between efficient and inefficient units.

$$Ss \geq I \times O$$

Where:

- Ss: Decision-Making Units (DMUs).
- I: Inputs.
- O: Outputs.

- b. The second rule: The sample size must be greater than or equal to three times the product of the sum of inputs and outputs (Kerim, 2009/2010, p. 118):

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

- c. The third rule is known as the "one-third rule." It ensures the model's quality in the results obtained, where the number of fully efficient units (100%) should not exceed one-third of the studied sample (Tarek, 2018/2019, p: 42):

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

2.4.3. Indicators of the Data Envelopment Analysis (DEA) Method

Data envelopment analysis contributes to identifying important indicators when evaluating the performance of a group of business institutions, including the following (Kaydi, p. 29):

- Identifying benchmark institutions.
- Identifying fully efficient institutions.
- Establishing planning objectives.
- Allocating resources.

3. Empirical Study:

In this section, we aim to apply the Data Envelopment Analysis (DEA) model to a sample of Algerian banks from 2018 to 2020 to measure bank efficiency.

3.1. Data, Tools, and Study Variables

The sample for this study was selected based on the data available in bank reports. The study includes a financial dataset for eight Algerian banks during the period (2018-2020).

A well-executed application of the DEA analysis method requires optimal input and output variables selection, which significantly affects the interpretation of the results. The variables in the model estimated in this study are as follows:

Inputs: Input 1: Fixed Assets. Input 2: Deposits & Short-term Funding.

Outputs: Output 1: Loans. Output 2: Other Earning Assets.

We utilized the DEAP software (version 2.1) to estimate the technical efficiency of the commercial banks within the studied sample. This was achieved by applying the Variable Returns to Scale (BCC) output-oriented model. The analysis includes efficiency scores, scale elasticity, benchmark units, an attempt to interpret the results, and finally, the necessary improvements for inefficient units.

3.2. Results of Measuring Banking Efficiency for Algerian Commercial Banks Using the BCC Model for 2018

Table 01: Banking Efficiency Indicators for Algerian Commercial Banks Using the BCC Model for the Year 2018.

Banks	Variable Returns to Scale (VRS) Efficiency Indicators	Constant Returns to Scale (CRS) Efficiency Indicators	Scale Efficiency Indicators VRS	Benchmark Units
Baraka Bank	0.689	0.679	0.985	3-7-2
AlSalam Bank	1.000	1.000	1.000	2
Arab Bank	1.000	1.000	1.000	3
Banque de Développement Local BDL	1.000	0.985	0.985	4
BADR Banque	0.869	0.839	0.973	3-7-6
Banque Extérieure d'Algérie BEA	1.000	1.000	1.000	6
Banque Nationale d'Algérie BNA	1.000	1.000	1.000	7
Crédit Populaire d'Algérie CPA	0.985	0.875	0.888	7-6-3

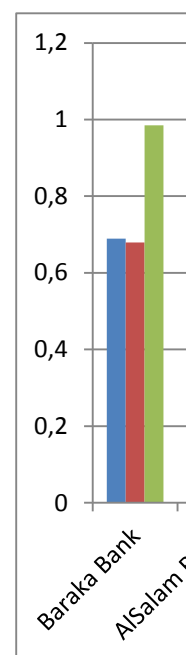
Source: DEAP Model Outputs

We can conclude that Banque El Baraka, Banque de l'Agriculture et du Développement Rural (BADR Banque), and Crédit Populaire National (CPA) did not achieve full relative efficiency in both the Variable Returns to Scale (VRS) and Constant Returns to Scale (CRS) models. Their scale efficiency scores were 98.5%, 97.3%, and 98.5%, respectively. This means that there is a need to expand by 1.5%, 2.7%, and 1.5%, respectively, to reach the optimal scale.

As for Banque de Développement Local (BDL), it achieved full relative efficiency in the VRS model but did not achieve relative efficiency in the CRS returns model. Its scale efficiency was 98.5%, indicating a need for expansion by 1.5% to reach the optimal scale.

The remaining banks achieved full relative efficiency in the output-oriented direction in both the CRS and VRS models, meaning they achieved the best possible outputs given their inputs.

Figure 01: Banking Efficiency Indicators for Algerian Commercial Banks According to the BCC Model for the Year 2018.



Source: Prepared by the researcher based on the outputs of the DEAP model.

The above figure represents the efficiency results according to the BCC output-oriented model. The results showed that only four (04) banks achieved a perfect efficiency rate of 100%, indicating the excellence of these banks over others in operating at maximum capacity to increase their output.

Table 02: Surplus Inputs and Slack Outputs According to the BCC Model for the year 2018

Banks	Loans	Profitable Other Assets	Fixed Assets	Short-Term Deposits and Financing
Baraka Bank	0.000	15601122	0.000	0.000
AlSalam Bank	0.000	0.000	0.000	0.000
Arab Bank	0.000	0.000	0.000	0.000
Banque de Développement Local BDL	0.000	0.000	0.000	0.000
BADR Banque	0.000	0.000	1531911	0.000
Banque Extérieure d'Algérie BEA	0.000	0.000	0.000	0.000
Banque Nationale d'Algérie BNA	0.000	0.000	0.000	0.000
Crédit Populaire d'Algérie CPA	0.000	0.000	0.000	980657

Source: Prepared by the researcher based on the outputs of the DEAP model.

Based on the table, the following observations can be made:

a. Banque Baraka (Baraka Bank) has idle outputs in the Profitable Other Assets category with a value of 15,601,122 Algerian Dinars.

b. Banque de l'Agriculture et du Développement Rural (BADR) has surplus inputs in the Fixed Assets category with a value of 1,531,911 Algerian Dinars.

- c. **Crédit Populaire d'Algérie (CPA)** also has surplus inputs in the Short-Term Deposits and Financing category with a value of 980,657 Algerian Dinars.
- d. The rest of the banks do not have surplus inputs or idle outputs.

Table 03: Banking Efficiency Indicators for Algerian Commercial Banks According to the BCC Model for the Year 2019

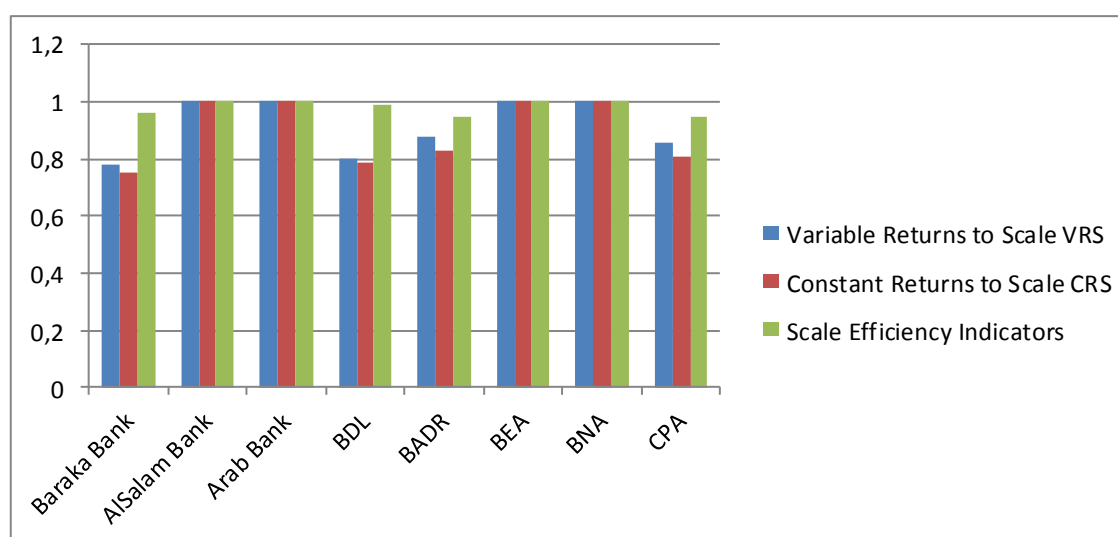
Banks	Variable Returns to Scale (VRS) Efficiency Indicators	Constant Returns to Scale (CRS) Efficiency Indicators	Scale Efficiency Indicators VRS	Benchmark Units
Baraka Bank	0.783	0.752	0.961	7-2
AlSalam Bank	1.000	1.000	1.000	2
Arab Bank	1.000	1.000	1.000	3
Banque de Développement Local BDL	0.798	0.788	0.987	7-2-3
BADR Banque	0.875	0.828	0.946	6-7-3
Banque Extérieure d'Algérie BEA	1.000	1.000	1.000	6
Banque Nationale d'Algérie BNA	1.000	1.000	1.000	7
Crédit Populaire d'Algérie CPA	0.854	0.809	0.888	7-6-3

Source: DEAP Model Outputs

It can be deduced that Banque Baraka, Banque de Développement Local (BDL), Banque de l'Agriculture et du Développement Rural (BADR), and Crédit Populaire d'Algérie (CPA) did not achieve full relative efficiency in both the Variable Returns to Scale (VRS) and Constant Returns to Scale (CRS) models. Their volumetric efficiency percentages were 96.1%, 98.7%, 94.6%, and 94.8%, respectively. This indicates that there is a need to expand by 3.8%, 1.3%, 5.4%, and 5.2%, respectively, in order to reach optimal volume efficiency.

As for the remaining banks, they achieved full relative efficiency with an output-oriented approach in both the Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) models. This means that they have achieved the best possible outputs given their inputs.

Figure 02: Banking Efficiency Indicators for Algerian Commercial Banks According to the BCC Model for the Year 2019



Source: Prepared by the researcher based on the outputs of the DEAP model.

The above figure represents the efficiency results according to the BCC output-oriented model. The results show that there are only four (04) banks with a perfect efficiency ratio of 100%, indicating the excellence of these banks in operating at maximum capacity to increase their output.

Additionally, there are four (04) banks with a 100% efficiency ratio according to the variable returns to scale model and four (04) banks with a 100% efficiency ratio according to the constant returns to scale model.

Table (04): Surplus Inputs and Slack Outputs According to the BCC Model for the Year 2019

Banks	Loans	Profitable Other Assets	Fixed Assets	Short-Term Deposits and Financing
Baraka Bank	0.000	8457473	501257	0.000
AlSalam Bank	0.000	0.000	0.000	0.000
Arab Bank	0.000	0.000	0.000	0.000
Banque de Développement Local BDL	0.000	0.000	1178287	0.000
BADR Banque	0.000	0.000	2505477	0.000
Banque Extérieure d'Algérie BEA	0.000	0.000	0.000	0.000
Banque Nationale d'Algérie BNA	0.000	0.000	0.000	0.000
Crédit Populaire d'Algérie CPA	0.000	0.000	2554614	0.000

Source: Prepared by the researcher based on the outputs of the DEAP model.

From the table, we can observe the following:

- **Banque El Baraka:** This bank has slack outputs on the profit asset side with a value of 8,457,473 Algerian Dinars and surplus inputs on the fixed asset side with a value of 501,257 Algerian Dinars.
- **Banque de Développement Local (BDL):** This bank has a surplus on the fixed asset side with a value of 1,178,287 Algerian Dinars.
- **BADR Banque:** This bank has surplus inputs on the fixed asset side with a value of 2,505,477 Algerian Dinars.
- **Crédit Populaire d'Algérie (CPA):** This bank also has surplus inputs on the fixed asset side with a value of 2,554,614 Algerian Dinars.

As for the remaining banks, they neither have surplus inputs nor slack outputs.

Table (05): Banking Efficiency Indicators for Algerian Commercial Banks According to the BCC Model for the Year 2020

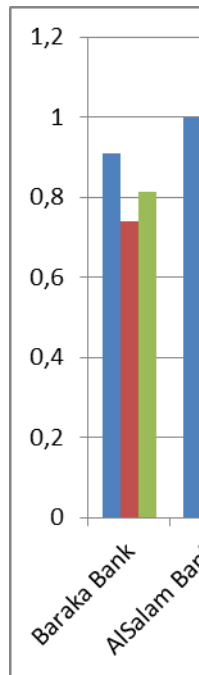
Banks	Variable Returns to Scale (VRS) Efficiency Indicators	Constant Returns to Scale (CRS) Efficiency Indicators	Scale Efficiency Indicators VRS	Benchmark Units
Baraka Bank	0.909	0.740	0.814	3-4
AlSalam Bank	1.000	0.964	0.964	2
Arab Bank	1.000	1.000	1.000	3
Banque de Développement Local BDL	1.000	0.988	0.988	4
BADR Banque	0.916	0.850	0.928	7-4
Banque Extérieure d'Algérie BEA	1.000	1.000	1.000	6
Banque Nationale d'Algérie BNA	1.000	1.000	1.000	7
Crédit Populaire d'Algérie CPA	0.981	0.979	0.997	3-7-4

Source: DEAP Model Outputs

From the information provided, we can draw the following conclusions regarding the efficiency of Algerian commercial banks according to the BCC model for the year 2020:

- a. **Banque El Baraka, BADR Banque, and Crédit Populaire d'Algérie CPA:** These banks did not achieve perfect relative efficiency in either the Variable Returns to Scale (VRS) or Constant Returns to Scale (CRS) models. Their scale efficiency percentages were 81.4%, 92.8%, and 99.7%, respectively. This implies a need to expand their operations by 18.6%, 7.2%, and 0.3%, respectively, to reach optimal size.
- b. **Banque de Développement Local (BDL):** This bank achieved perfect relative efficiency in the VRS model but did not achieve relative efficiency in the CRS model. Its scale efficiency percentage was 98.8%, meaning it needs to expand its operations by 1.2% to reach optimal size in the CRS model.
- c. **Remaining Banks:** The remaining banks achieved perfect relative efficiency in the output-oriented approach for both the CRS and VRS models, meaning they have optimized their outputs given their inputs.

Figure No. (03): Banking Efficiency Indicators for Algerian Commercial Banks According to the BCC Model for the Year 2020.



Source: Prepared by the researcher based on the outputs of the DEAP model.

The figure above represents the efficiency results according to the BCC output-oriented model. The results show that there are only three (03) banks with a perfect efficiency ratio of 100%, indicating the excellence of these banks in operating at maximum capacity to increase their output.

Additionally, five (05) banks have a 100% efficiency ratio according to the variable returns to scale model and three banks with a 100% efficiency ratio according to the constant returns to scale model.

Table (06): Surplus Inputs and Slack Outputs According to the BCC Model for the Year 2020

Banks	Loans	Profitable Other Assets	Fixed Assets	Short-Term Deposits and Financing
Baraka Bank	0.000	16741999	1172627	0.000
AlSalam Bank	0.000	0.000	0.000	0.000
Arab Bank	0.000	0.000	0.000	0.000
Banque de Développement Local BDL	0.000	0.000	0.000	0.000
BADR Banque	0.000	0.000	2033918	0.000
Banque Extérieure d'Algérie BEA	0.000	0.000	0.000	0.000
Banque Nationale d'Algérie BNA	0.000	0.000	0.000	0.000
Crédit Populaire d'Algérie CPA	0.000	0.000	0.000	0.000

Source: Prepared by the researcher based on the outputs of the DEAP model.

Through the table, we observe the following:

- Regarding Banque Baraka, it has stagnant outputs on the Profitable Assets side, amounting to 16,741,999 Algerian Dinars, and surplus inputs on the Fixed Assets side, totaling 1,172,627 Algerian Dinars.
- Banque de l'Agriculture et du Développement Rural has surplus inputs on the Fixed Assets side amounting to 1,531,911 Algerian Dinars.
- For the rest of the banks, neither surplus inputs nor stagnant outputs are present.

4. Conclusion

This research has addressed a significant research issue related to the development of performance evaluation methods for financial institutions using an approach that circumvents many of the challenges faced by traditional methods, which primarily rely on accounting data and financial ratios.

This objective was achieved by utilizing of the Data Envelopment Analysis (DEA) model to measure and improve the efficiency of eight Algerian banks. Data for inputs and outputs were collected from the financial statements and annual reports published by these Algerian banks for 2018, 2019, and 2020, respectively.

The following conclusions have been drawn from the study:

4.1. Results:

- Most Algerian commercial banks do not effectively combine input elements (such as fixed assets, deposits, and short-term financing) to achieve a specific level of outputs (loans and other profitable assets). This suggests that they are technically or internally inefficient units;
- In Variable Returns to Scale (VRS) efficiency, the average efficiency of the studied banks was 93%, 91.4%, and 98.1% in 2018, 2019, and 2020, respectively. Four banks consistently achieved efficiency scores ranging from 60% to 100% during these three years: Banque Baraka, Banque Arabi, Banque de l'Agriculture et du Développement Rural, and Banque Populaire Nationale. The rest of the banks achieved perfect relative efficiency;
- In Constant Returns to Scale (CRS) efficiency, the average efficiency of the studied banks was 92.2%, 89.7%, and 97.9% in 2018, 2019, and 2020, respectively. Four banks consistently achieved a perfect relative efficiency of 100% during these three

years: Banque Salam, Banque Arabi, Banque Algérienne Extérieure, and Banque Nationale Populaire. The rest of the banks had efficiency scores ranging from 60% to 80% during these three years;

- The study identified efficient banks and inefficient banks with surplus inputs and stagnant outputs;
- Reference banks were determined for each inefficient bank. These reference units achieved efficiency despite operating in the same conditions and environment;
- This study highlighted the various advantages of using the Data Envelopment Analysis (DEA) method as non-parametric tool with a high discriminatory power and a simple methodology for analyzing the performance of different institutions.

We therefore propose the following recommendations:

4.2. Recommendations:

- Utilize the efficiency indicators and improvement levels obtained from input-oriented and output-oriented models in the case of both Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) for banks that did not achieve 100% efficiency;
- Bank managers whose banks did not achieve the required relative efficiency (inefficient banks) should study the reasons hindering this to identify areas of weakness in inputs and outputs. This will enable them to utilize available resources effectively. Additionally, they should analyze the factors that led reference banks to achieve relative efficiency and consider these results as goals to strive for.
- Banks should consider organizing specialized training programs in the field of Data Envelopment Analysis (DEA) applications. It's important to note that DEA is not a replacement for traditional performance metrics (e.g., profitability ratios) but rather a complementary tool in the analysis process;
- Bank management should focus on internal planning processes to enhance the ability to efficiently utilize resources, thus supporting improved performance efficiency;
- Relevant professional organizations in Algeria should propose standards related to preparing and reviewing of banks' financial statements, focusing on enhancing disclosure in these statements. DEA can provide decision-makers with additional information to supplement traditional accounting inputs.

5. References:

- Amina Ben Khernaji. (December 2018). **Using Data Envelopment Analysis Method to Measure the Efficiency of Algerian Banks**. Journal of Economics, Finance, and Business, Volume 3, Issue 2, University of El-Oued, Algeria.
- Tarek Ben Kesemi. (2018/2019). **Attempting to Build a Model for Measuring Utilization Efficiency in Industrial Enterprises**. Doctoral Thesis, Department of Higher Studies, Mohamed Khider University, Biskra.
- Elias Boumaaraf. (2014). **Measuring Bank Efficiency Using Data Envelopment Analysis Method**. The Economic Researcher Journal, Issue 1, University of Setif.

- Raïs Hadda, Noui Fatima-Zahra. (2012). **Measuring Banking Efficiency Using the Random Cost Frontier Model: A Case Study of Algeria**. Al-Quds Open University Journal for Research and Studies, Issue 26.
- Hassan Mfatah. (2017/2018). **The Impact of Market Structure on Banking Efficiency: A Sample Study of Algerian Banks**. Doctoral Thesis, Department of Economic Sciences, Mohamed Khider University, Biskra.
- Khalida Ali, Zainab Amarawi. (2014). **Measuring Efficiency of Arab Banks Using Data Envelopment Analysis Technique**. Al-Badeel Economic Journal, Issue 108.
- Khamissi Qaidi. (No date). **Measuring the Efficiency of Commercial Banks in Algeria Using Data Envelopment Analysis Method**. Journal of Law and Humanities - Economic Studies, Volume 25(2), University of Ziane Achour, Djelfa.
- Sayeda Ahmed Ahmed Hassan. (2019). **Measuring the Efficiency of Commercial Banks Listed on the Egyptian Stock Exchange Using Data Envelopment Analysis**. Scientific Journal of Economics and Commerce.
- Issam Bouzidi. (2015/2016). **An Attempt to Test the Efficiency of the Islamic Finance System in Facing Financial Crises**. Doctoral Thesis, University of Kasdi Merbah, Ouargla.
- Ali Ben Saha. (2013). **Measuring the Banking Efficiency of Algerian Private Banks in the Context of Financial Liberalization**. Al-Wahat Journal for Research and Studies, Issue 18.
- Fatima-Zahra Noui. (2016). **Evaluating the Performance of Algerian Banks Using Financial Ratios and the Random Cost Frontier Model**. Doctoral Thesis, Department of Financial and Banking Sciences, Yarmouk University, Jordan.
- Lahcen Al-Hassani, Mouayyad Al-Douri. (2003). **Bank Management: A Quantitative and Strategic Approach**. Wael Printing, Publishing, and Distribution House.
- Abdelkarim Mansouri. (2009/2010). **Attempt to Measure the Efficiency of Commercial Banks Using the Data Envelopment Analysis Approach**. Doctoral Thesis, Economic Analysis Specialization, University of Tlemcen.
- Huwari Maerag, Faisal Shiad. (February 23-24, 2011). **Measuring the Efficiency of Islamic and Conventional Banks in Algeria**. The First International Conference on Islamic Economics: Current Situation and Future Challenges, University Center of Ghardaia.
- Wisam Hussein Ali Al-Anizi. (2015). **Measuring the Efficiency of the Private Banking Sector in Iraq Using the Random Frontier Analysis Model**. Al-Azzy Journal of Economic and Administrative Sciences, Volume 12, Issue 35.