

Assessing the Efficiency of Financial Institutions through Bank Risk Management: A Case Study on Some Commercial Banks Using Data Envelopment Analysis (DEA)

قياس كفاءة المؤسسات المالية من خلال ادارة المخاطر المصرفية دراسة حالة على بعض البنوك التجارية باستخدام مغلف البيانات (DEA)

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Abstract:

This study aims to address the issues related to the efficiency of bank risk management in Algeria. We utilized Data Envelopment Analysis (DEA) as a tool to measure the efficiency of risk management in these banks, relying on the input-oriented approach. The study was conducted on fifteen banks operating in the Algerian market, including private, public, and Islamic banks, during the period from 2019 to 2021. The objective was to assess the efficiency of risk management before, during, and after adapting to the COVID-19 pandemic.

The results in the practical domain indicated that Islamic banks are more efficient than other commercial banks, followed by private banks, with public banks showing the lowest efficiency. It is also evident that the impact of the COVID-19 pandemic in 2021 led to a decrease in the efficiency of risk management across all banks compared to previous years, despite an increase in efficiency in most commercial banks in 2020 compared to the preceding year.

Keywords: Risk Management, Banking Risk Management, Liquidity Risks, Loan Risks, Economic Environment, Banking Efficiency.

JEL Classification Codes G32.4, G21, G32, G21, G33, G21, G33, E60, O10

ملخص:

تهدف هذه الدراسة إلى معالجة الإشكالية المتعلقة بكفاءة إدارة المخاطر البنكية في الجزائر؛ ولمعالجة هذه الإشكالية اعتمدنا على أحد هم الأساليب في قياس الكفاءة والمتمثل في مغلف البيانات (DEA) لتحديد كفاءة إدارة المخاطر لهذه البنوك، معتمدين على الأسلوب المدخلي؛ وأجريت الدراسة على خمسة عشر بنك ينشط على التراب الجزائري منها ما هو خاصة؛ عمومي وإسلامي، خلال الفترة الممتدة من 2019 إلى 2021 من أجل معرفة كفاءة إدارة المخاطر قبل واثناء وبعد التأقلم مع وباء كوفيد 19.

وقد أظهرت النتائج من خلال الجانب التطبيقي أن البنوك الإسلامية أكثر كفاءة من بقية البنوك التجارية وتليها البنوك الخاصة وتأتي في الأخير البنوك العمومية؛ وكما يظهر جليا أثر وباء كوفيد 19 خلال سنة 2021 وذلك بانخفاض كفاءة إدارة المخاطر لدى جميع البنوك مقارنة بسنوات السابقة رغم أن سنة 2020 قد ارتفعت كفاءة إدارة المخاطر في معظم البنوك التجارية مقارنة بالسنة الماضية.

الكلمات المفتاحية: إدارة المخاطر إدارة المخاطر البنكية -مخاطر السيولة - مخاطر القروض - البيئة الاقتصادية - الكفاءة البنكية

تصنيفات JEL: G32.4, G21, G33, G21, G32, G21, G33, E60, O10

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INTRODUCTION

The banking sector is considered one of the sensitive economic domains for any country, as it constitutes a fundamental pillar in the national economy. The banking sector is characterized by significant risks, requiring banks' risk management to be highly vigilant in order to mitigate the negative impacts of both internal and external business environments. Achieving this goal necessitates addressing the challenges faced by risk management in recent years, particularly the focus of this study on the emergence of the COVID-19 pandemic. This pandemic has created a volatile business environment for bank risk management, making it imperative for banks to enhance their capabilities in response to the risks threatening their stability. Thus, they bear the responsibility of confronting these risks, which were once considered unexpected and surprising.

Study problem:

Study problem:

The problem of this study can be formulated in the following main question:

To what extent is the efficiency of bank risk management in Algeria capable of facing economic environmental fluctuations amid the emergence of the COVID-19 pandemic?

Study Hypothesis:

This study proceeds from the following hypotheses:

- Algerian banks exhibit efficiency in managing banking risks.
- Islamic banks are more efficient in risk management than conventional banks.
- Public banks are less efficient in risk management.
- There is an impact of the COVID-19 pandemic on the efficiency of risk management for the studied banks.

Study Objectives:

- Understand the extent of banks' adaptation to changes in the banking economic environment.
- Measure the efficiency of risk management for Algerian commercial banks before, during, and after the COVID-19 pandemic and assess their adaptation to this unexpected threat.
- Measure the efficiency of Algerian bank risk management using Data Envelopment Analysis (DEA).

Methodology:

To address the study problem, the study will rely on the following methodologies:

- Descriptive methodology in the theoretical aspect to understand the nature of bank risk management.
- Quantitative analytical methodology in the applied aspect, employing the Data Envelopment Analysis (DEA) approach, using data from 15 banks operating in the Algerian market from 2019 to 2021.
-

I. The Theoretical Framework of the Study

1. Nature of Banking Efficiency

1.1 Definition of Efficiency

The term "efficiency," like many other terms in the humanities, lacks a unanimous definition among researchers and writers, as it is not uncommon for its concept to intersect with other terms in the same field. Therefore, its concept can be summarized as follows.

According to the Oxford Dictionary, efficiency is defined as follows: "Efficiency is the accomplishment or ability to accomplish a task with the least amount of time and effort." This is also expressed by Peter, who states, "Doing things the right way is efficiency" (Shawaqfeh, 2021, p. 496).

Additionally, there is a historical concept traced back to the Italian economist Filfridou Paritou, who developed a concept known as "Pareto Optimality." According to this concept, "any allocation of resources is either efficient or inefficient, and any inefficient allocation of resources indicates inefficiency" (Hussein & Ahmed, 2020, p. 93).

1.2 Banking Efficiency

It is the ability to create a synthesis of resources with the least cost to produce the maximum financial services. Efficient banks can withstand constraints and changes accompanying fluctuations in prices and increased competition (Khaznaji, 2018, p. 214).

To determine the true efficiency, it is advisable to compare the efficiency of the bank under study with a bank outside the country where the bank operates, especially in countries known for the strength of their banking system (Kent Matthews, 2010, p. 03).

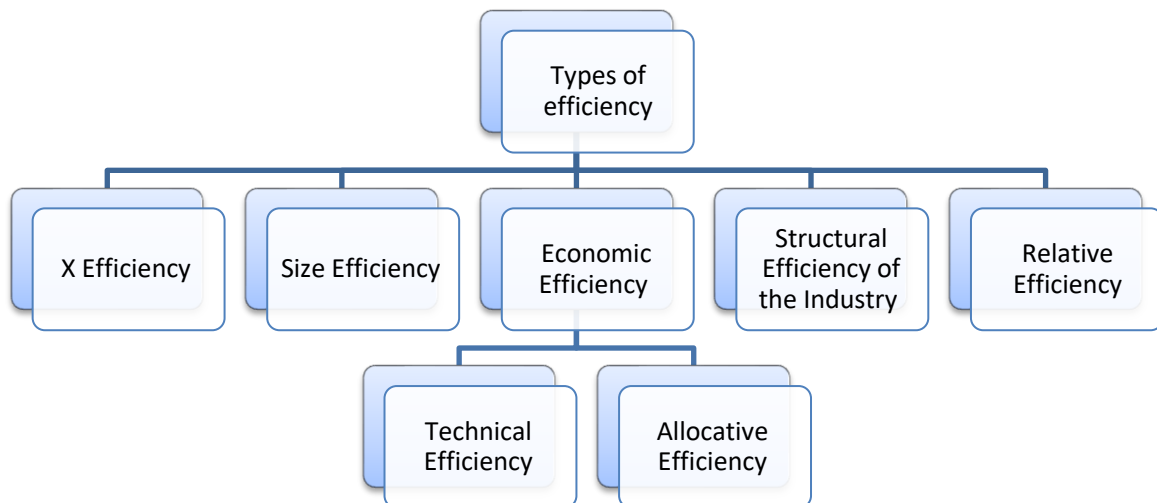
From the above definitions, it can be said that efficiency is the optimal utilization of resources to achieve the greatest return with the least costs.

1.3 Types of Banking Efficiency and their Fundamental Elements

Each institution is characterized by its specific size efficiency. If an institution operates at an optimal production scale, its size efficiencies increase. However, these efficiencies decrease when it fails to achieve maximum profit, resulting in its marginal cost being higher than the market price it operates in. Additionally, an institution may have goals that do not drive it to improve its size efficiency, such as government institutions (Imane, Safaa, & Mohammed, 2021, p. 351).

The types of efficiency can be summarized in the following diagram:

Figure 1 : types of efficiency



Source: Prepared by the researcher based on the study by (Ahlam & Ahmed, 2016)

1.3.1 Economic Efficiency

It is the harmonious relationship between inputs and outputs and is achieved when the marginal product of production factors equals the cost of labor, meaning efficiency in production and distribution. It is divided into two types :

- Technical Efficiency: The ability of a unit to obtain the maximum output using available inputs.
- Allocative Efficiency: Directly related to production techniques, involving the selection of inputs and outputs influenced by market prices, determining the optimal levels to achieve the economic goals of the institution.

1.3.2 Structural Efficiency of the Industry

Farrell (1957) introduced this concept when facing difficulties in comparing an industry with its counterparts in different regions. Structural efficiency represents the average technical efficiency scores weighted by output for each active institution. It helps assess how well an institution compares to the most efficient institutions (Bouamama, 2021, p. 42).

1.3.3 Relative Efficiency

Refers to institutions that have a relative advantage when compared to their counterparts. Improving inputs or outputs affects each other, measured by dividing the actual performance of the unit under evaluation by the best possible performance (Hussein & Ahmed, 2020, p. 93). It also evaluates homogeneous units relative to the best efficient institution (Ahlam & Ahmed, 2016, p. 316).

1.3.4 X Efficiency

Indicates that the level of efficiency of any institution is primarily due to the incentives provided to human resources, the efficiency of workers, and the administrative system for each unit. It is measured by the difference between the maximum efficiency for using available resources and their actual use (Ahlam & Ahmed, 2016, p. 316).

1.3.5 Size Efficiency

This type of efficiency is used to measure whether the institution operates at its optimal size. The institution can operate at increasing, decreasing, or constant size efficiency (Hussein & Ahmed, 2020, p. 93).

1.4 Methods of Measuring Banking Efficiency

1.4.1 First Classification of Methods for Measuring Banking Efficiency

- **Parametric Methods (Supervised):** These methods rely on estimating economic functions (production, cost, or profit) and deriving efficiency scores from residuals.
- **Non-Parametric Methods (Unsupervised):** These methods rely on linear programming of the objective function to maximize outputs or minimize inputs, using data from a group of units. The efficiency scores are obtained by comparing each unit's performance with that of the efficient unit (Bouamama, 2021).

1.4.2 Second Classification of Methods for Measuring Banking Efficiency

- **Financial Analysis Methods:** Given the limitations of financial statements in representing the true financial position of banks, financial analysis has emerged. It provides financial indicators to aid in planning, direction, and control strategies. Financial statements and financial ratios are analyzed using either vertical (static, stationary) analysis or horizontal (moving) analysis. Static analysis involves analyzing financial ratios in terms of increase or decrease at a specific date, while horizontal analysis involves studying or analyzing financial ratios in terms of increase or decrease over consecutive time periods to assess the changes that have occurred (Bachir, 2021).
- **Quantitative Methods for Measuring Banking Efficiency:** There are two types of quantitative methods for measuring banking efficiency—parametric methods developed by Aigner in 1977 and non-parametric methods developed by Charnes in 1978. The difference lies in the assumptions applied to the data, taking into account or not considering random errors. Parametric methods focus on cost efficiency, while non-parametric methods focus on the relationship between inputs and outputs. There are four methods for measuring banking efficiency :
 - **Stochastic Frontier Analysis (SFA):** It is a parametric method that considers random errors.
 - **Data Envelopment Analysis (DEA):** It is a non-parametric method that evaluates the relationship between inputs and outputs.
 - **Thick Frontier Analysis (TFA):** It is a method that combines features of both parametric and non-parametric methods.
 - **Free Distribution Analysis (DFA):** It is another non-parametric method used for measuring banking efficiency (Bachir, 2021, p. 85).

2. Risk Management in Banking:

2.1 Concept of Risk Management in Banking

During times of crisis, as seen during the economic recession of 2008, and the disruptions caused by the COVID-19 pandemic faced by governments, difficult decisions are made, particularly concerning the rescue of strategically important companies, large banks, and financial institutions (Latora, 2022, p. 1).

2.1.1 Definition of Risk

Risk is the possibility of something serious, unexpected, and undesirable happening. It refers to something that may occur or cause danger (Clash & Hullul Nour, 2021, p. 630). It is a situation in which exposure to hardships exists, or a condition where there is a possibility of deviation from the desired or expected outcome (Harelimana, 2017, p. 30).

2.1.2 Risk Management

Risk management is the process of identifying potential losses and choosing the most important methods to confront them (Harelimana, 2017). Risk management can be described as the management whose primary tasks include predicting future crises and preparing for them by developing strategic plans to prevent or minimize their negative effects.

2.1.3 Banking Risks

Bank risk management involves protecting banks from unexpected or routine risks they face every day. Spending an hour on risk management usually leads to greater returns than an hour spent searching for new opportunities. This is because modern risk management in banking deals with factors that can be controlled, enabling better results (Haj, Abu, & Omar, 2019, p. 422).

2.2 Types of Banking Risks

Banking risks are diverse and can be summarized in the following table:

Table 1: Types of Banking Risks

Type of Risks	Calculation method
Credit Risks	$\frac{\text{Total Loans}}{\text{Net Loan Expenses}} \text{ or } \frac{\text{Provisions for Doubtful Debts}}{\text{Total Loans}} \text{ or } \frac{\text{Provisions for Doubtful Debts}}{\text{Loans Due and Unpaid}}$
Liquidity Risks	$\text{Cash Maturity Scale or } \frac{\text{Core Deposits}}{\text{Total Assets}} \text{ or } \frac{\text{Fluctuating Liabilities}}{\text{Total Assets}}$
Interest Rate Risks	$\frac{\text{Sensitive Assets} - \text{Sensitive Liabilities}}{\text{Liabilities Sensitive to Interest Rate}} \text{ or } \frac{\text{Assets Sensitive to Interest Rate}}{\text{Total Assets}}$
Exchange Rate Risks	$\frac{\text{Open position in each currency}}{\text{Capital adequacy ratio}} \text{ or } \frac{\text{Total open positions}}{\text{Capital adequacy ratio}}$
Operational Risks	$\frac{\text{Total assets}}{\text{Number of employees}} \text{ or } \frac{\text{Labor expenses}}{\text{Number of employees}}$
Capital Risks	$\frac{\text{Shareholders' equity}}{\text{Total assets}} \text{ or } \frac{\text{First tranche of capital}}{\text{Risk - weighted assets}} \text{ or } \frac{\text{Capital adequacy ratio}}{\text{Risk - weighted assets}}$

Source: (Aassas & Hourri, 2020)

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2.3 Risk Management Process Steps

The risk management process goes through several stages, summarized as follows (Clash & Hullul Nour, 2021, p. 440):

- **Preparation:** Involves planning for the process and mapping out the workflow.
- **Risk Identification:** Identifying significant and prioritized risks.
- **Assessment:** After listing the risks, they are assessed in terms of impact, classification, and ranking.
- **Dealing with Risks:** After identifying and ranking risks, the following steps are taken:
 - o **Transfer:** Utilizes means to accept risk from another party, often through contracts or insurance. Contracts may include formulations that transfer the risk to another party without committing to paying insurance premiums.
 - o **Avoidance:** Attempts to avoid actions that lead to a certain risk, such as avoiding investment in a specific area and preferring a less risky savings instrument.
 - o **Mitigation:** Involves methods to reduce the severity of resulting losses, such as software development companies following risk reduction methodologies in program development.
 - o **Acceptance (Retention):** Accepting losses when they occur. This method is considered an acceptable strategy in the case of small risks where the cost of insurance against the risk is higher than the total losses.
- **Plan Development:** Involves making decisions related to choosing a set of measures to deal with risks.
- **Execution:** In this stage, the plans established are followed to avoid risks by employing one of the methods (confrontation, transfer, etc.).
- **Plan Review and Evaluation:** After executing the plans, risk management evaluates the effectiveness of the adopted strategy and reviews it in case of any deviations.

II. Applied Field Study

Referring to studies in the field of banking efficiency measurement, there are two widely used methods: the SFA method and the non-parametric method Data Envelopment Analysis (DEA), which is the tool we will use for measurement in this study (Zakaria, 2017, p. 216).

1. General Overview of Data Envelopment Analysis (DEA)

The credit for developing the Data Envelopment Analysis (DEA) analysis method goes to a doctoral student, Edwardo Rhodes, in 1978. He was working on an educational program in the United States to compare the performance of a group of students in similar educational regions. The challenge faced by the researcher was to evaluate the technical efficiency of schools that include a set of inputs and outputs without information about their prices. To overcome this problem, the researcher and his supervisor (Cooper-Charnes) formulated a model later known

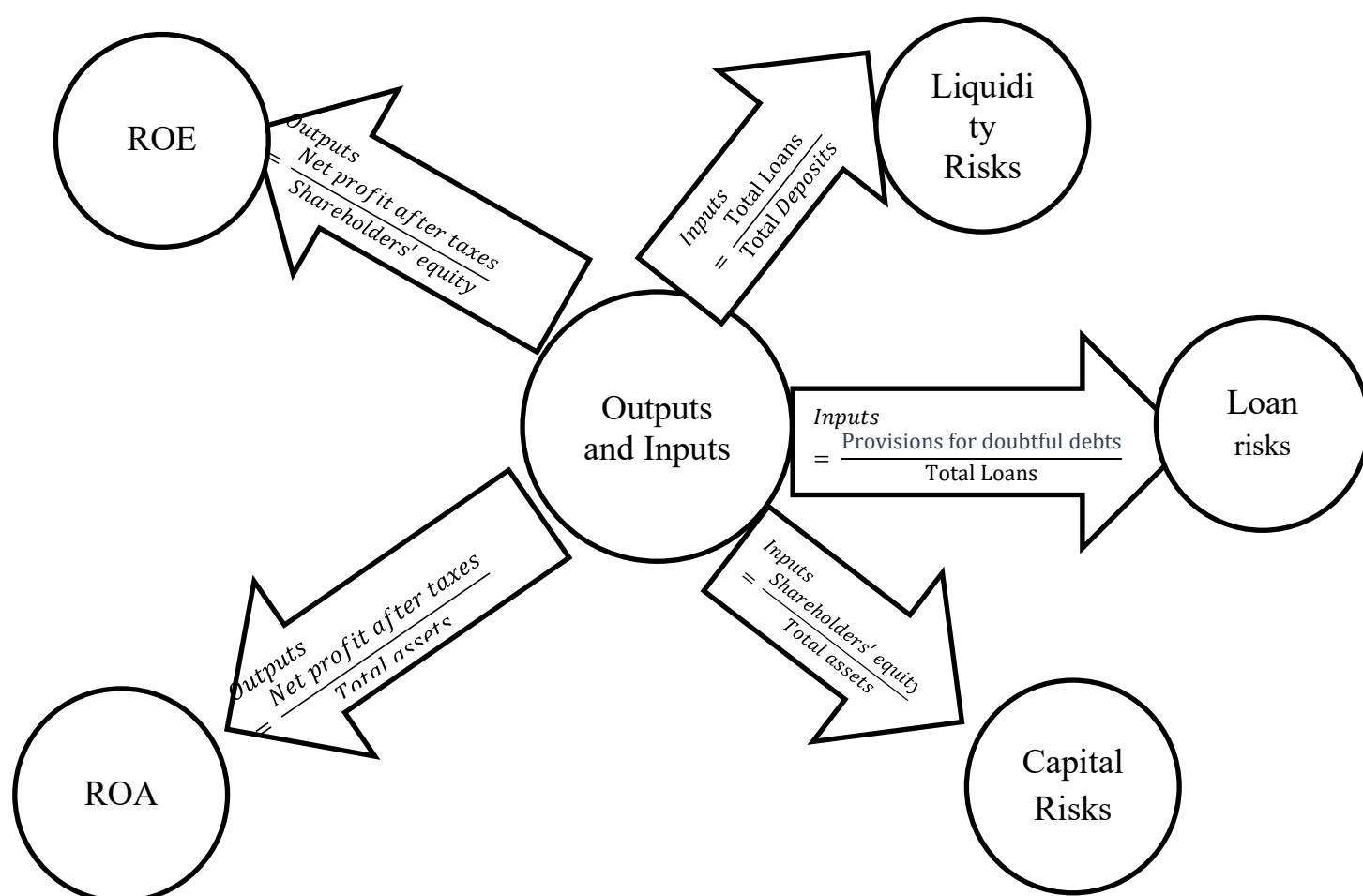
as the (CCR) model, named after (Rhodes-Cooper-Charnes). This model later became known as the Data Envelopment Analysis (DEA) method.

The DEA method is a non-parametric technique that uses linear programming to select the activity of a bank compared to another bank from the same sample (Ahlam & Ahmed, 2016, p. 323).

Data was collected from 15 nationally active banks. In this study, we focused on three years (2019, 2020, and 2021) due to their relevance before, during, and after the COVID-19 pandemic, which was an unexpected risk. In this study, we aim to understand the efficiency of banking risk management before the occurrence of this risk during the year 2019, during the occurrence of the risk in 2020, and after adapting to the risk in 2021.

The inputs, outputs, and measurement methods for each element can be summarized in the following chart (Yu Xiao & Wenqi, 2021, p. 5).

Figure 2: Inputs, Outputs, and Calculation Methods



Source: Prepared by the researcher

2. Results Analysis

After calculating the input and output values, Data Envelopment Analysis (DEA) software was utilized, and the results are presented in the following tables.

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Table 02: Reference Banks during the Year 2019

Reference Banks		BADR	ELBARAKA	ABC	ELSALAM	FRANSABANK
Number of References	CRS	/	13	7	/	/
	VRS	8	10	1	1	1

Source: Prepared by the researcher based on DEA outputs.

From the table, it is evident that there were two benchmark banks based on constant returns to scale: Elbaraka Bank (ELBARAKA) and ABC Bank. Elbaraka Bank was the more referenced bank, being referenced 13 times, while ABC Bank was referenced 7 times. Additionally, Elbaraka Bank was more referenced according to variable returns to scale, being referenced 10 times, followed by BADR Bank with 8 references. ABC Bank, ELSALAM Bank, and FRANSABANK were each referenced once in variable returns.

Table 03: Reference Banks during the Year 2020

Reference Banks		BEA	BADR	ELSALAM	TRUST	FRANSABANK
Number of References	CRS	11	/	3	/	3
	VRS	7	6	1	1	/

Source: Prepared by the researcher based on DEA outputs.

The table shows that three banks were benchmarks based on constant returns to scale. BEA Bank was the most referenced bank among efficient banks, being referenced 11 times. ELSALAM and FRANSABANK were referenced three times each. According to variable returns to scale, four banks were referenced, with BEA Bank being the most referenced seven times, followed by BADR Bank with six references, and ELSALAM and TRUST Banks referenced once each.

Table 04: Reference Banks during the Year 2020

Reference Banks		BEA	ELBARAKA	SG	TRUST
Number of References	CRS	10	2	/	2
	VRS	10	2	1	3

Source: Prepared by the researcher based on DEA outputs.

Through the table, it is evident that there are three banks that are considered reference banks based on fixed-size returns. The most referenced bank is BEA, cited ten times, followed by ELBARAKA and TRUST, both referenced twice. Similarly, based on variable-size returns, BEA is again the most referenced bank, with the same number of references as in the fixed-size returns (10 times). TRUST follows with three references, ELBARAKA with two, and finally, SG with one reference.

Table 05: Banking Efficiency Indicators for Algerian Banks in 2019

Banks	CRS	VRS	C/Size	Volume Effect
BEA	0.669	0.841	0.795	Increasing
BNA	0.133	0.56	0.237	Increasing
CPA	0.444	0.993	0.447	Increasing
BDL	0.071	0.894	0.079	Increasing
BADR	0.205	1	0.205	Increasing
ELBARAKA	1	1	1	Fixed
ABC	1	1	1	Fixed
HOUSING	0.12	0.462	0.26	Increasing
ELSALAM	0.95	1	0.95	Decreasing

NATIXIS	0.494	0.678	0.727	Increasing
SG	0.482	0.74	0.651	Increasing
HSBC	0.361	0.59	0.611	Increasing
BNP P	0.633	0.792	0.8	Increasing
TRUST	0.515	0.548	0.94	Decreasing
FRANSABANK	0.966	1	0.966	Decreasing
average	0.536	0.806	0.645	

Source: Prepared by the researcher based on DEA outputs.

Through the previous table related to the relative efficiency indicators for risk management in commercial banks in Algeria for the year 2019, regarding the efficiency measurement according to constant returns to scale (CRS), only two banks achieved complete efficiency: ELBARAKA Bank and ABC Bank. As for variable returns to scale (VRS), in addition to the previous two banks, three other banks also achieved complete efficiency: Banque de l'Agriculture et du Développement Rural (BADR Bank), Bank Al Salam, and Banque Française Commerciale (FRANSABANK). This indicates that these banks were able to minimize risks to the lowest possible level, making them the best practices in bank risk management in Algeria during this year.

It is also observed that the average relative efficiency was 0.536 and 0.806 for constant and variable returns to scale, respectively. These values are above average, indicating that commercial banks in Algeria to some extent control the management of risks related to liquidity, capital, and loans. This means that increasing inputs leads to an increase in outputs, or in other words, reducing liquidity, capital, and loan risks leads to an increase in Return on Equity (ROE) and Return on Assets (ROA).

Additionally, the table shows that Banque El Baraka and Banque de l'Entreprise Arabe Algérienne achieved complete scale efficiency. It is advisable for them to maintain this level of risk management. As for the remaining commercial banks, they need to work on improving risk management. It is also evident that the scale of 10 banks is increasing, so they should consider expanding their activities. This is because the rate of increase in inputs is less than the rate of increase in outputs. For three banks, the scale is decreasing, indicating that the rate of increase in inputs is greater than the rate of increase in outputs, so it is advisable for them not to expand their activities.

Table 6: Banking Efficiency Indicators for Algerian Banks for the Year 2020

Banks	CRS	VRS	C/Size	Volume Effect
BEA	1	1	1	Fixed
BNA	0.206	0.606	0.339	Increasing
CPA	0.371	0.955	0.388	Increasing
BDL	0.104	0.95	0.109	Increasing
BADR	0.167	1	0.167	Increasing
ELBARAKA	1	1	1	Fixed
ABC	0.42	0.803	0.523	Decreasing
HOUSING	0.346	0.415	0.833	Increasing
ELSALAM	1	1	1	Fixed
NATIXIS	0.508	0.679	0.748	Increasing
SG	0.464	0.882	0.526	Increasing
HSBC	0.9	1	0.9	Decreasing
BNP P	0.35	0.728	0.481	Increasing

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TRUST	0.549	1	0.549	Increasing
FRANSABANK	1	1	1	Fixed
average	0.559	0.868	0.638	

Source: Prepared by the researcher based on DEA outputs.

The table related to the relative efficiency indicators for risk management in commercial banks in Algeria for the year 2020 reveals that, for efficiency measurement through constant returns to scale, four banks were efficient: Algerian Foreign Bank, El Baraka Bank, Salam Bank, and French Bank. Similarly, using variable returns to scale, the same banks, in addition to Agricultural and Rural Development Bank, HSBC, and TRUST, demonstrated efficiency. This indicates that these banks were able to minimize risks to the maximum extent, representing the best-performing banks in efficient bank risk management in Algeria.

The average relative efficiency was 0.559 and 0.868 for constant and variable returns to scale, respectively. These values are above average, suggesting that commercial banks in Algeria control risk management related to liquidity, capital, and loans to some extent.

The Algerian Foreign Bank, El Baraka Bank, Salam Bank, and French Bank achieved complete scale efficiency. Therefore, it is advisable for them to maintain this level of risk management. As for the remaining commercial banks, they need to work on improving risk management. Additionally, eight banks had increasing scale effects, suggesting that they should consider expanding their activities since the rate of increase in inputs is less than the rate of increase in outputs. For two banks, scale effects were decreasing, indicating that the rate of increase in inputs is greater than the rate of increase in outputs; therefore, it is advisable for them not to expand their activities.

Table 7: Banking Efficiency Indicators for Algerian Banks for the Year 2021

Banks	CRS	VRS	C/Size	Volume Effect
BEA	1	1	1	Fixed
BNA	0.324	0.551	0.588	Increasing
CPA	0.544	0.925	0.588	Increasing
BDL	0.165	0.935	0.176	Increasing
BADR	0.222	0.945	0.235	Increasing
ELBARAKA	1	1	1	Fixed
ABC	0.311	0.369	0.842	Decreasing
HOUSING	0.34	0.361	0.941	Increasing
ELSALAM	0	0.815	0	Increasing
NATIXIS	0.533	0.647	0.824	Increasing
SG	0.745	1	0.745	Decreasing
HSBC	0.713	0.714	0.999	Increasing
BNP P	0.422	0.652	0.647	Increasing
TRUST	1	1	1	Fixed
FRANSABANK	0.444	0.636	0.698	Increasing
average	0.518	0.77	0.686	

Source: Prepared by the researcher based on DEA outputs.

The table related to the relative efficiency indicators for risk management in commercial banks in Algeria for the year 2021 shows that, for efficiency measurement through constant returns to scale, three banks were efficient: Algerian Foreign Bank, El Baraka Bank, and Trust Bank.

Using variable returns to scale, the same banks, in addition to SG Bank, demonstrated efficiency. This suggests that these banks were able to minimize risks to the maximum extent, representing the best-performing banks in efficient bank risk management.

The average relative efficiency was 0.518 and 0.770 for constant and variable returns to scale, respectively. These values are above average, indicating that commercial banks in Algeria control risk management related to liquidity, capital, and loans to some extent.

The Algerian Foreign Bank, El Baraka Bank, and Trust Bank achieved complete scale efficiency. Therefore, it is advisable for them to maintain this level of risk management. As for the remaining commercial banks, they need to work on improving risk management. Additionally, ten banks had increasing scale effects, suggesting that they should consider expanding their activities since the rate of increase in inputs is less than the rate of increase in outputs. For two banks, scale effects were decreasing, indicating that the rate of increase in inputs is greater than the rate of increase in outputs; therefore, it is advisable for them not to expand their activities.

To achieve efficiency, banks can implement several improvements by reducing inputs and increasing outputs. The percentage of improvements is calculated according to the ratio:

$$\frac{\text{Target Value} / \text{Actual Value}}{\text{Actual Value}} \times 100$$

Table 8: Required Improvements for the Year 2019

		Inputs			Outputs	
		Liquidity Risks	Credit Risks	Capital Risks	ROE	ROA
BEA	Actual Value	0.012		0.135	0,142	0.019
	Targeted Value	0.005	0.006	0.09	0.168	0.019
	Improvement point	-58%	-40%	-33%	18%	0%
BNA	Actual Value	0.034	0.035	0.179	0.03	0.005
	Targeted Value	0.001	0.002	0.024	0.044	0.005
	Improvement point	-97%	-94%	-87%	47%	0%
CPA	Actual Value	0.017	0.018	0.103	0.085	0.009
	Targeted Value	0.002	0.003	0.046	0.085	0.009
	Improvement point	88%	-83%	-55%	%	0%
BDL	Actual Value	0.026	0.027	0.106	0.014	0.001
	Targeted Value	0	0.001	0.007	0.014	0.002
	Improvement point	-100%	-96%	-93%	0%	100%
BADR	Actual Value	0.026	0.029	0.089	0.034	0.003
	Targeted Value	0.001	0.001	0.018	0.034	0.004
	Improvement point	-96%	-97%	-80%	0%	33%
ELBARAKA	Actual Value	0.006	0.008	0.114	0.212	0.024
	Targeted Value	0.006	0.008	0.114	0.212	0.024
	Improvement point	0%	0%	0%	0%	0%
ABC	Actual Value	0.003	0.003	0.262	0.07	0.018
	Targeted Value	0.003	0.003	0.262	0.07	0.018
	Improvement point	0%	0%	0%	0%	0%
HOUSING	Actual Value	0.056	0.083	0.198	0.026	0.005
	Targeted Value	0.001	0.002	0.024	0.044	0.005
	Improvement point	-98%	98%	-88%	69%	0%
ELSALAM	Actual Value	0.011	0.012	0.155	0.197	0.031

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	Targeted Value	0.008	0.01	0.147	0.274	0.031
	Improvement point	-27%	-17%	-5%	39%	0%
NATIXIS	Actual Value	0.028	0.038	0.154	0.102	0.016
	Targeted Value	0.004	0.005	0.076	0.141	0.016
	Improvement point	-86%	-87%	-51%	38%	0%
	Actual Value	0.047	0.058	0.138	0.104	0.014
SG	Targeted Value	0.003	0.004	0.066	0.123	0.014
	Improvement point	-4%	-5%	-7%	2%	0%
	Actual Value	0.01	0.012	0.239	0.059	0.014
	Targeted Value	0.003	0.004	0.086	0.114	0.014
HSBC	Improvement point	-70%	-67%	-64%	93%	0%
	Actual Value	0.032	0.043	0.135	0.132	0.018
BNP_P	Targeted Value	0.004	0.006	0.085	0.159	0.018
	Improvement point	-88%	-86%	-37%	20%	0%
	Actual Value	0.021	0.017	0.227	0.098	0.027
	Targeted Value	0.007	0.009	0.143	0.231	0.027
TRUST	Improvement point	-67%	-47%	-37%	136%	0%
	Actual Value	0.007	0.007	0.269	0.1	0.027
FRANSABANK	Targeted Value	0.006	0.007	0.26	0.172	0.027
	Improvement point	-14%	0%	-3%	72%	0%

ROE = Return on Equity, ROA = Return on Assets

Source: Prepared by the researcher based on DEA outputs.

The table reveals that the reduction rates in inputs, or rather the reduction percentages in inputs, were higher in liquidity risks, except for three banks: SG, BADR, and NATIXIS. However, with a 1% rate, it came after the reduction rates for loan risks. It is also evident that the reduction rates in the two inputs vary from one bank to another. Ten banks aimed to improve their outputs by reducing inputs by over 50% in liquidity and loan risks. These are high percentages. For capital risks, the reduction rates came with the lowest percentages. Seven banks achieved reduction rates exceeding 50%, and the reduction rates are very low compared to liquidity and loan risks.

As for the improvement rates in outputs, or in other words, the required increase percentages to achieve efficiency in outputs, they varied from one bank to another. Regarding the ROE output, four banks achieved an increase rate exceeding 50%, and there is a bank with an increase rate exceeding 100%, which is TRUST. It needs to increase this output by 136% to achieve efficiency. As for the ROA output, the increase rates are much lower compared to ROE. Only two banks require increases to achieve efficiency, BDL and BADR, with improvement rates of 33% and 100%, respectively. The rest have improvement rates of 0%.

Table 9: Required Improvements for the Year 2020

		Inputs			Outputs	
		Liquidity Risks	Credit Risks	Capital Risks	ROE	ROA
BEA	Actual Value	0.015	0.014	0.104	0.21	0.022
	Targeted Value	0.015	0.014	0.104	0.21	0.022
	Improvement point	0%	0%	0%	0%	0%
BNA	Actual Value	0.022	0.021	0.0187	0.036	0.007
	Targeted Value	0.005	0.004	0.038	0.064	0.007

	Improvement point	-77%	-81%	-103%	78%	0%
CPA	Actual Value	0.02	0.021	0.102	0.075	0.008
	Targeted Value	0.006	0.005	0.038	0.076	0.008
	Improvement point	-70%	-76%	-63%	1%	0%
BDL	Actual Value	0.023	0.023	0.1	0.021	0.002
	Targeted Value	0.002	0.001	0.01	0.021	0.002
	Improvement point	-91%	-96%	-90%	0%	0%
BADR	Actual Value	0.02	0.021	0.095	0.032	0.003
	Targeted Value	0.003	0.002	0.016	0.032	0.003
	Improvement point	-85%	-90%	-83%	0%	0%
ELBARAKA	Actual Value	0.009	0.014	0.113	0.139	0.016
	Targeted Value	0.009	0.014	0.113	0.139	0.016
	Improvement point	0%	0%	0%	0%	0%
ABC	Actual Value	0.051	0.04	0.27	0.09	0.024
	Targeted Value	0.016	0.015	0.113	0.229	0.024
	Improvement point	-69%	-63%	-58%	154%	0%
HOUSING	Actual Value	0.097	0.155	0.246	0.072	0.018
	Targeted Value	0.012	0.011	0.085	0.172	0.018
	Improvement point	-88%	-93%	-65%	139%	0%
ELSALAM	Actual Value	0.008	0.011	0.126	0.126	0.016
	Targeted Value	0.008	0.011	0.126	0.126	0.016
	Improvement point	0%	0%	0%	0%	0%
NATIXIS	Actual Value	0.036	0.064	0.149	0.107	0.016
	Targeted Value	0.011	0.01	0.076	0.153	0.016
	Improvement point	-69%	-84%	-49%	43%	0%
SG	Actual Value	0.068	0.099	0.112	0.099	0.011
	Targeted Value	0.008	0.007	0.052	0.105	0.011
	Improvement point	-88%	-93%	-54%	6%	0%
HSBC	Actual Value	0.01	0.01	0.339	0.072	0.025
	Targeted Value	0.009	0.009	0.305	0.127	0.025
	Improvement point	-10%	-10%	-10%	76%	0%
BNP_P	Actual Value	0.049	0.07	0.135	0.076	0.01
	Targeted Value	0.007	0.006	0.047	0.095	0.01
	Improvement point	-86%	-91%	-65%	25%	0%
TRUST	Actual Value	0.021	0.022	0.781	0.044	0.034
	Targeted Value	0.012	0.012	0.429	0.165	0.034
	Improvement point	-43%	-45%	-45%	275%	0%
FRANSABANK	Actual Value	0.005	0.005	0.255	0.07	0.018
	Targeted Value	0.005	0.005	0.255	0.07	0.018
	Improvement point	0%	0%	0%	0%	0%

Source: Prepared by the researcher based on DEA outputs.

Contrary to the year 2019, the table shows that the reduction rates during this year to achieve efficiency were higher for the loan risks input. The reduction rates in this input were higher than others, except for ABC Bank, where the reduction rate in liquidity risks was higher than that in loan risks. There are only two banks that came with a reduction rate of less than 50%, which are TRUST and HSBC, and they are the same in liquidity risks, where the reduction rates

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are more than 50%. As for capital risks, it came last, as in 2019, but compared to the previous year, the reduction rates increased. BNA Bank came with the highest reduction rate at 103%. Regarding the improvement rates in outputs, the increase rates in the ROE output were higher compared to the year 2019. There are banks that need an increase in this output by more than 100%, namely TRUST, HOUSING, and ABC, while the increase rates for BDL and BADR are negligible (0%). As for the ROA output, all banks do not need an increase in this output to achieve efficiency.

Table 10: Improvement Ratios for the Year 2021

		Inputs			Outputs	
		Liquidity Risks	Credit Risks	Capital Risks	ROE	ROA
BEA	Actual Value	0.007	0.009	0.086	0.201	0.017
	Targeted Value	0.007	0.009	0.086	0.201	0.017
	Improvement point	0%	0%	0%	0%	0%
BNA	Actual Value	0.018	0.018	0.156	0.067	0.01
	Targeted Value	0.007	0.009	0.086	0.201	0.017
	Improvement point	-61%	-50%	-45%	200%	70%
CPA	Actual Value	0.014	0.016	0.093	0.105	0.01
	Targeted Value	0.007	0.009	0.086	0.201	0.017
	Improvement point	-50%	-44%	-8%	91%	70%
BDL	Actual Value	0.015	0.017	0.092	0.032	0.003
	Targeted Value	0.007	0.009	0.086	0.201	0.017
	Improvement point	-53%	-47%	-7%	528%	467%
BADR	Actual Value	0.019	0.021	0.091	0.043	0.004
	Targeted Value	0.007	0.009	0.086	0.201	0.017
	Improvement point	-63%	-57%	-5%	367%	325%
ELBARAKA	Actual Value	0.005	0.009	0.109	0.136	0.015
	Targeted Value	0.005	0.009	0.109	0.136	0.015
	Improvement point	0%	0%	0%	0%	0%
ABC	Actual Value	0.043	0.038	0.293	0.061	0.018
	Targeted Value	0.013	0.014	0.108	0.189	0.018
	Improvement point	-70%	-63%	-63%	210%	0%
HOUSING	Actual Value	0.032	0.055	0.238	0.067	0.016
	Targeted Value	0.007	0.009	0.086	0.201	0.017
	Improvement point	-78%	-84%	-64%	200%	6%
ELSALAM	Actual Value	0.008	0.011	0.115	0	0
	Targeted Value	0.006	0.009	0.094	0	0
	Improvement point	-25%	-18%	-18%	0	0
NATIXIS	Actual Value	0.018	0.034	0.133	0.108	0.014
	Targeted Value	0.007	0.009	0.086	0.201	0.017
	Improvement point	-61%	-74%	-35%	86%	21%
SG	Actual Value	0.056	0.052	0.129	0.151	0.019
	Targeted Value	0.056	0.052	0.129	0.151	0.019
	Improvement point	0%	0%	0%	0%	0%
HSBC	Actual Value	0.009	0.013	0.29	0.069	0.02
	Targeted Value	0.006	0.007	0.205	0.12	0.02

	Improvement point	-33%	-46%	-29%	74%	0%
BNP_P	Actual Value	0.037	0.054	0.132	0.085	0.011
	Targeted Value	0.007	0.009	0.086	0.201	0.017
	Improvement point	-81%	-83%	-35%	136%	55%
TRUST	Actual Value	0.011	0	0.512	0.071	0.036
	Targeted Value	0.011	0	0.512	0.071	0.036
	Improvement point	0%	0%	0%	0%	0%
FRANSABANK	Actual Value	0.01	0.012	0.259	0.05	0.013
	Targeted Value	0.006	0.008	0.165	0.141	0.019
	Improvement point	-40%	-33%	-36%	182%	46%

Source: Prepared by the researcher based on DEA outputs.

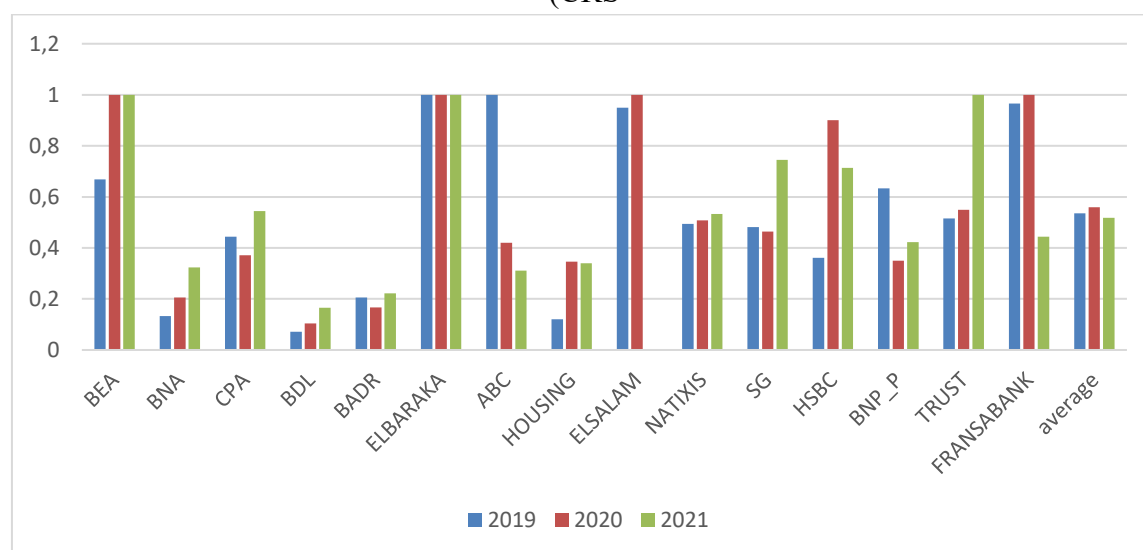
Through the table, unlike the two previous years, the required reduction percentages for inefficient banks to achieve efficiency were close between liquidity risks and loan risks. Banks such as BNA, CPA, BDL, ABC, ELSALAM, and FRANSABANK had higher reduction percentages in liquidity risks. As for the remaining inefficient banks, the higher reduction percentages were in loan risks. Similar to previous years, loan risks came last in reduction percentages and were comparable to the previous year.

Regarding the outputs, the results were contradictory; they were very high compared to the previous two years, highlighting the clear impact of the COVID-19 pandemic. Seven banks need to increase ROE outputs by more than 100% to achieve efficiency. These banks are BNA, BNP_P, HOUSING, ABC, BADR, BDL, and FRANSABANK. Concerning ROA, BADR Bank had the highest required increase percentage to achieve efficiency, which is 325%.

Analyzing the data from the three tables for the three study years, it becomes evident that the year 2021 requires more improvement in risk management for banks operating in Algeria to achieve optimal efficiency. This is also explained by the impact of the COVID-19 pandemic. In general, Algerian banks, especially public ones, have a long way to go in the field of risk management.

2. Evolution of Banking Risk Management Efficiency during the Years 2019-2020-2021 According to the Fixed and Variable Returns Model

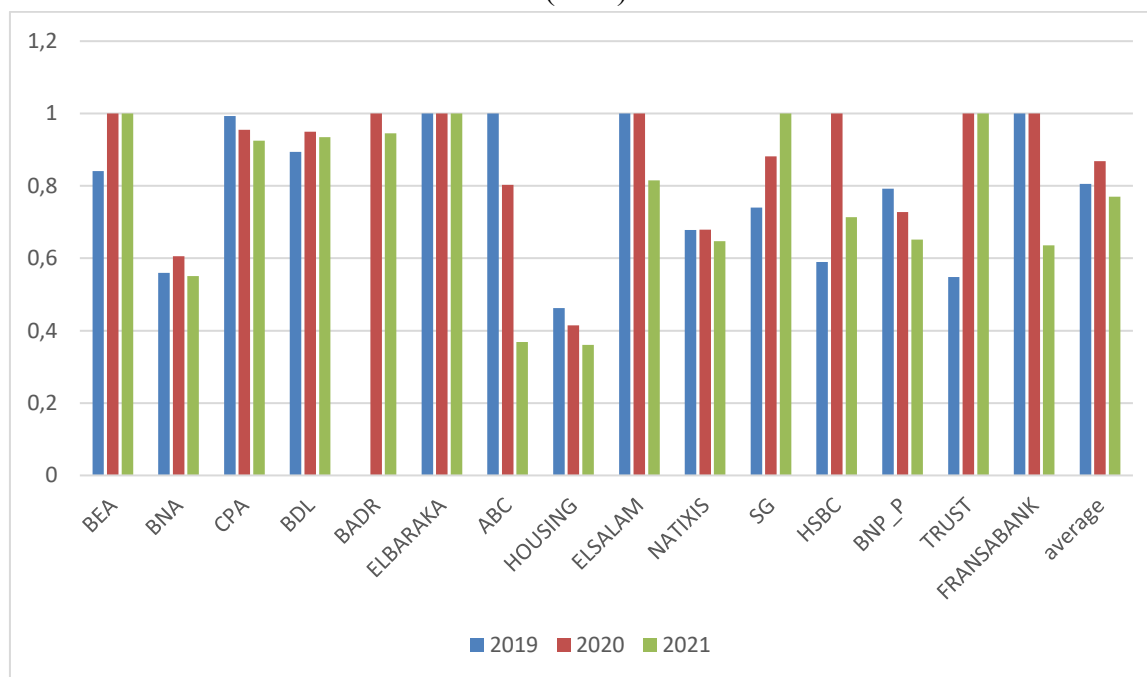
Figure 3: Comparison of Relative Efficiency According to the Fixed Size Returns Model (CRS)



Source: Prepared by the researcher based on DEA outputs.

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Figure 4: Comparison of Relative Efficiency According to the Variable Size Returns Model (VRS)



Source: Prepared by the researcher based on DEA outputs.

From the figure, it is evident that El Baraka Bank was the most efficient in risk management, relying on both fixed and variable returns during the three years. This explains that Islamic banks are more efficient than other banks, attributed to their risk management relying on a clear and consistent policy. It may also be attributed to the lower risks they face, primarily dealing with profit-sharing formulas, which are relatively secure.

Moreover, the independent banks follow Islamic banks in the efficiency of banking risk management. This is due to these banks relying entirely on their revenues, apart from government support, resulting in a constant struggle for survival. However, they are characterized by more banking risks than Islamic banks. Hence, risk management in these banks needs improvement.

As for banks considered public, they showed lower efficiency in risk management. This can be explained by the lack of independent risk management, as they are subject to government authority, mostly aligning with government directives.

In general, the year 2020 witnessed the highest efficiency in risk management for the fifteen Algerian banks. This is interpreted as risk management being required to enhance its efficiency to cope with the repercussions and aftermath of COVID-19. However, during the year 2021, the efficiency of banking risk management in Algeria decreased, indicating the impact of the COVID-19 pandemic on this management.

CONCLUSION

Efficiency is the optimal use of available resources, involving minimizing inputs and maximizing outputs. Banking efficiency comes in various types (e.g., volumetric, relative) and can be measured through financial analysis and quantitative methods.

Bank risk management involves predicting future risks, preparing plans, and developing strategies to mitigate their negative impacts. The risk management process goes through several stages to make appropriate decisions and face potential risks.

The measurement of efficiency in commercial banks significantly impacts banking risk management. Assessing banking efficiency clarifies the position of the institution compared to others in the market, identifying competitive and financially similar institutions.

Hypothesis Testing:

- **First Hypothesis:** Accepted. However, it's not a reliable indicator as real risk management efficiency should be compared with banks outside the study.
- **Second Hypothesis:** Accepted with reservation. Islamic banks' reliance on murabaha, a relatively risk-free method, may explain their efficiency.
- **Third Hypothesis:** Rejected. State intervention can be positive for liquidity risk but negative for other risks due to potential rejection of risk management decisions.
- **Fourth Hypothesis:** Accepted. The negative impact of COVID-19 on risk management efficiency is evident, but superior banks can use this challenge to improve risk management methods.

Study Results:

- Islamic banks, particularly Bank Al Baraka, demonstrated greater risk management efficiency over the three years.
- Independent banks followed Islamic banks in risk management efficiency, while public banks ranked the lowest.
- The efficiency of risk management in traditional banks is less due to susceptibility to economic fluctuations.
- Public banks are less efficient, as their risk management aligns with governmental objectives rather than being independent.
- On average, the risk management efficiency of commercial banks in Algeria is above average, indicating a certain level of control.
- The negative impact of COVID-19 on risk management efficiency in commercial banks is evident, particularly in 2021, signaling the beginning of the pandemic's adverse effects on banking risk management.
- Bank Al Baraka was the only bank to consistently achieve risk management efficiency over the three years.

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