Measuring the banking efficiency in Algeria using Bootstrapped DEA Method (BDEA): a comparative study between Islamic and Conventional banks

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Abstract:

This study evaluates and compares the efficiency of Islamic banks in Algeria, despite their small size against conventional peers based on the non-parametric approach Bootstrapped Data envelopment analysis (BDEA) models during the period 2016-2019. Our findings concluded that all ten banks under evaluation are technically inefficient, while Islamic banks in average performed less efficiently than their conventional counterparts. Technically, results suggested the importance to removed input excess as a main source of banking inefficiency, with increasing Islamic banks size, which means Islamic windows should be encouraged as a strategy to improve the Algerian financial market.

Key Words: Technical efficiency; Islamic banks; conventional banks; Bootstrap; Data envelopment analysis**.**

JEL Classification:C14، G21 ،G28

1. Introduction

Comparative studies between Islamic and conventional banks (CBs) efficiency have been growing with interest after the last financial crisis which resulted the collapse of CBs. As a consequence, recent years have been characterized by an increased in Islamic finance entry in most developing countries (Miah & Uddin, 2017, p. 2). Developed countries have also begun a massive demand of Islamic financial products, meaning that Islamic banks (IBs) are now becoming more acceptedand has been moving into conventional financial systems. This huge demand may explain the fastest growing of Islamic finance, which was estimated to be worth US$2.4 trillion in 2017 and forecast to grow by 6% to reach US$3.8 trillion by 2023 (Islamic finance development, 2018). However, the competition among IBs with their commercial counterparts continues to accelerate, directly and through their own Islamic operations (Islamic windows (Hassan & Lewis, 2007, p. 5).

IBs have its own rules that make them different from the CBsin several important aspects. In Islamic banking model, the former is guided by Sharia' principles based on the interest-free and profit and loss sharing (PLS) in their financial activities as well asnet profits distribution.Due to these characteristics, Islamic financeis thought to have a positive implication on economic growth and sustainability, which have always been discussed with a view to their efficiency(Musa, et al., 2020, p. 31), despite the findings of numerous studies reported that IBs are less efficient as their conventional peers.

In Algeria, the total share of IBs is approximately 3% of the total banking industry, which is proportionally very small (Azzaoui & Bedrouni, 2020, p. 367). Since 1990, there are only two Islamic banks operate in Algeria, meaning that IBs are less growing and did not reveal a good progress in the financial market. According to Elhachemi (2018), these few numbers of IBs will undoubtedly give a help in evaluating the level of technical performance of Islamic banking segment. In view of this, we would be very interesting to investigate the efficiency of this crucial segment, while there have been a rich literature focusing on the issues concerned banking performance and very few studies about Islamic banking industry that take Algeria as a case study, but no empirical study found to be combined with them.

1.1 Problematic:

In light of above, we ask the following question: which are the most efficient banks operational style in Algeria between 2016 and 2019, and what is the main cause of inefficiency?

1.2 Hypothesis:

In order to answer our research question, the two main following assumptions are made:

H_1: Islamic banks in Algeria operate less efficiently than their conventional peers.

H_2: The main cause of Islamic inefficiency is scale inefficiency.

1.3 Study objectives:

The objective of this paper is to undertake an empirical investigation on evaluating and benchmarking thetechnical, pure, and scale efficiencies of IBs versusCBs in Algeria.Then, bootstrapping approach (Simar & Wilson 1998, procedure) is made to evaluate statistical properties of DEA estimators with their different assumptions (CRS-DEA, VRS-DEA), because the purpose here is to show how these assumptions influence the ranking study sample, which then avoids some econometric issues that can lead to a bias judgment.

1.4 Study Importance:

The topic of improving efficiency has always been a challenge against financial services industry. For that reason, by analyzing the efficiency components, the findings of our study will be very useful for many banks stakeholders in Algeria to show where they are in the competitiveness in the banking system at whole to will be able to determine the potential projections of weak aspects. Also, this will be important for regulators to formulate appropriate policy recommendations to improve the synergy between the benchmarked banks style in facilitating their role as intermediaries.

1.5 Study plan:

In order to answer our research question, this paper is organized as follows: section 1: includes some highlights and the hypothesis development concerning the debate of the efficiency of IBS versus CBs. Then, the literature on Algerian banking efficiency is viewed in order to simplify the findings comparison with previous studies. Section 2: includes a backgrounder of Algerian banking system concerning its structure, size, and regulations. Section 3: describes the data and discusses the methodology of DEA with SW (1998) bootstrap procedure. The discussions of empirical findings are found in section 4. Finally, section 5 summaries this paper and provides some implementations for future directions.

2. Literature review and hypotheses development:

In the banking filed, the efficiency analysis is used to evaluate the sources of banking Performance, which decomposed into cost, technical, and allocative efficiency. An efficient bank is supposed to operate in the most efficient manner possible by generating its profits through effective utilization of resources rather than its exploitation of market power. In fact, bank managers can improve efficiency by adopting better technologies or, alternatively, enhance capital through improving profit efficiency.A strong literature frame work has been founded which provided conflicting evidence on the difference between IBs and CBs in terms of their efficiency, and divided into three hypotheses: IBs are less, more efficient, and no significant difference between the efficiency of both banks style as follow:

In the cost and profit efficiency terms, using a data for 83 different banks in 10 MENA countries, Olson and Zoubi (2011)found IBs to be more profitable than CBs despite their scale disadvantage, but are less cost efficient and not efficient when measured with accounting-based approach (financial ratios). According to the authors, the possible reason for the higher revenue efficiency are that IBs hold more profitable assets.Alqahtani et al.,(2017)estimated profit and cost efficiency of GCC banks during and after financial crisis (FC), using both DEA and Stochastic Frontier Analysis approach (SFA), the result showed that IBs were more cost and less profit efficient thanCBs during FC, which is consistent the previous findings of Olson and Zoubi (2011), Srairi (2010) and Johnes et al. (2014). Conversely, during the period subsequent to the FC, IBs suffered more than CBs in profit and lost their cost efficiency superiority.Nevertheless, Hassan et al., (2009) compared the efficiency of 40 banks in 11 Organization of Islamic Conference countries over the period of 1990-2005 using DEA model. The results found that there is no significant difference in mean cost, revenue, and profit efficiency scores between the different banks operational style.While in Europe, Batir et al., (2017) evaluated the technical, allocative, and cost efficinecy of 49 banks in Turkey over the period of 1990-2005 using DEA model. The empirical results showed the yearly average IBs efficiency is higher than the yearly average CBs efficiency. Musa et al., (2020) confirmed this conclusion, when they found the calculated DEA-efficiency scoresof IBs in a selected 1460 European banks were higher than traditional banks. The same result obtained in the the study of Erfani & Vasigh, (2018)usinga sample of 8 IBs and 11 CBscovered the period from 2006 to 2013, which revealed over the analyzed period, IBs managed to maintain their efficiency, while most CBs suffered a loss in their efficiency. Furthermore, they highlight that the FC did not have a significant impact on IBs profitability.

Using Malmquist productivity index, Abdul-Wahab & Haron (2017)analyzed the efficiency of the banking sector in Qatar modelling with 15 banks (comprising Islamic, conventional and foreign banks) for the period of 2007 to 2011. The conclusions indicated that Qatari banking sector inefficient in pure technical and scale efficiency. Besides, CBs are technically efficient (technical and pure technical efficiency), meanwhile, IBs are most efficient in terms of scale efficiency.Donsyah (2004) has measured technical, pure technical, and scale efficiency utilizing DEA method. The overall efficiency results suggested that inefficiency across 18 IBs is small at just over 10 %, which is low compared to conventional counterparts. The research findings indicated that there are diseconomies of scale for small-to-medium IBs, which suggested that mergers should be encouraged. In contrast, Pradiknas & Faturohman (2015) found that IBs are more efficient than CBs in the period of 2004-2013, using output-oriented VRS-DEA model with asset approach to measure efficiency. According to researchers, IBs have more allocation of their fund to the real sector than CBs.

The efficiency research in the context of the Algerian banking sector is very limited, in contrast of the other Arab countries, e.g., GCC banks which are the most researched. To the best of our knowledge, no previous studies to date have been devoted to evaluate and compare the efficiency of IBs against their commercial peers, but there are few studies (in English) investigated banks' efficiency within the Algerian Banking System will be discussed in this paper.

Table 1. Selected research on bank efficiency that takes Algeria as a case study (in English)

Reference	Type study	Sample and period study	Methodology		Efficiency measure	Bootstrap procedure	Comparison type
			Type	RTS			
Hacini &Dahou (2018a)	T	Algeria	-	-	-	-	-
Hacini & Dahou (2018b)	E	(2000-2012)	DEA	VRS CRS-	Technical Efficiency	No	ownership structure
Aouad & Benzai (2018)	E	14 banks (2003-2015)	SFA	-	Cost Efficiency	No	No
Ihaddaden & Bouhaba (2019)	E	14 banks in One-year 2015	DEA	VRS CRS-	Technical Efficiency	No	ownership structure
Anouze & Bouhamed (2019)	T+E	2 Algerian banks from sample (2008-2010)	2SDEA	VRS	Technical Efficiency	Yes	No

Source: developed by researcher

Notes: T: theoretical, E: empirical, RTS: returns to scale, VRS: variable returns to scale, CRS: constant returns to scale.

Hacini & Dahou (2018b) employed two DEA models (CRS and VRS) to compare the efficiency of foreign versus domestic banks in Algeria between 2000 and 2012. They suggested foreign banks to be more efficient than their domestic counterparts due to their superior scale efficiency. They also point out that the Algerian banking system could improve its technical efficiency by 23%. Using SFA method, Aouad & Benzai (2018)found mean cost efficiency of 14 Algerian banks has gradually declined over the period 2003-2015 meanwhile, state-owned banks are more cost efficient than private banks which reflects the importance of economies of scale in reducing costs. The authors stated the importance to improved banks efficiency by reducing 54, 25% of its potential resources during the production process.

Recently, Ihaddaden & Bouhaba (2019) compared 14 Algerian banks' performance according to their ownership structure (owned-state, mixed and private banks) using DEA model in 2015 (one year). Their results indicated the weak ability of public and mixed banks in terms of resource usage, while private banks mostly operate at a non-suitable size. Anouze & Bouhamed (2019) examined the performance of 151 banks from 17 MENA countries, two of them are algerian banks over the period 2008-2010 using variable returns of scale with input and output orientations (VRS-I ,VRS-O) and bootstrapped method. Results emphased the stability of the overall mean efficiency scores around 88% for all banks over the study period, namely, by adopting best practice MENA commercial banks can increase their output (keepnig their input constant) or decrease their input (without losing their output) by aproximately 11% to 13% in general.

Above comparative reviewed studies on efficiency between IBs and CBs, there are some studies focused on calculating technical efficiency, while the majority are concerned with profits and costs efficiency. Thus, the approach used for the estimation vary within accounting-based approach and frontier estimation methods such as DEA and SFA, which probably the main cause explains the difference in results. In addition, no study to date have been devoted to compare the efficiency of IBs against their commercial peers in Algeria, meanwhile, there have been some studies evaluated the IBs in Algeria theoretically. Our paper attempts to filling this gap. This is the first quantitative study which combines both the efficiency of Algerian banks and the Islamic context and uses BDEA approach.

3.A Backgrounder on the location of IBS in Algerian Banking System:

The essential features of IBs are the absence of interest payments, Shariah compliant regards interest as riba and forbidden it, money does not treat as a commodity, the prohibition ofuncertainty (Al gharar)(Johnes, Izzeldin, Pappas, & Alexakis, 2018, p. 3),the financing of projects in sectors lawful, the obligation of sharing of profits and losses, and finally the principle of affiliation investments to tangible assets of the real economy (Boudabbous & Elhaj-Ali, 2016, p. 1). In addition, IBs use its PLS modes to diversify their portfolios (Mudharabah and musharakah are the two main forms of this mode of financing). In this section, we are briefly discussing, the importance features of Islamic Finance in Algerian banking system including structure, size, and regulations.

3.1 Structure and size:

There is a major transformation in the banking sector after the large banking reforms started with Law on Money and Credit of 1990 as a first serious path to be taken by the Algerian government to remove the most barriers towards domestic and foreign banks. The law enabled both private banks and foreign banks to operate in parallel with state-owned banks as it allowed the creation of the first Islamic bank in Algeria.

Recently, the financial system in Algeria accounts 8 financial institutions and 20 banks, six of them are state-owned, 13 private banks and only 1 bank with mixed capital (Hacini & Dahou, 2018b, p. 156). Despite the superiority of the private banks in the number, State-owned banks have the big share in terms of banking activities due mainly to a numerous reason we will discusslater.

Table 2. Number of banks revolution in Algeria (1999-2019):

Bank's ownership	1999	2002	2008	2019
Owned-state	3	6	6	6
Private	4	7	13	13
Mixed	1	1	1	1
Total number of banks	8	14	20	20

Source: banks financial reports

At the beginning of 2019, we only have two IBs operate in Algeria. Namely, from the 20 banks in Algeria, only 2 banks are Islamic in their operational activities: "Al Baraka bank" with mixed capital and the private one "Al Salam Bank", which constitute about 2% to 3% of the overall turnover of the banking market and hold between 15% to 17% of the shares of private banks. In addition, the presence of the IBs on the market is relatively in their recent experience and they do not cover the whole territory (very few branches) (Azzaoui & Bedrouni, 2020, p. 376).

3.2 Regulations:

Despite Algeria is a Muslim country, Algerian market share of Islamic assets still marginally very small and the absence of real Islamic inter-bank market has constrained its activities, making Islamic products very limited (Benamraoui, 2008, p. 122). Probably, the main question is why only two Islamic banks operate in Algeria?

One from the main explanations is the Algerian targeting, which is the domestic savers rather than foreign investors (the previous rule of 51/49). Indeed, Algerian people distrust to deal with banks and keep large money at home in Algerian dinar or in foreign currency outside the banking sector.

In banking, the array of allowable activities is obviously constrained by regulation. This may preclude potential gains from the joint production of various financial services. In this context, Elhachemi (2018) suggested that the most critical factor in establishing a successful IBs is the legislation. In fact, the lack of a real legislation framework forms the primary barrier to establishingan Islamic banking segment in Algeria. IBs follow the principle of interest-free, and adopt profit and loss sharing (PLS) rule to distribute net profits and in performing their business as intermediaries, this why the legal environment on which Islamic financial institutions operate can have a direct effect on the Islamic finance industry's development, especially in countries which adopting a mixed legal system based on Common Law and Sharia Law. (Grassa & Gazdar, 2014, p. 159). As a results, the government entered two new reforms in order to hence Islamic finance in the last Finance Law, included the Regulations n° 18-02 and n° 02-20.

In the Regulation n° 02-18 of November 2018, which defined the exercise conditions of banking operations under Islamic window by naming it "crowdfunding window" as a department within a bank or a financial institution. Under this regulation, the four public banks, BDL, CNEP, BADR and BNA, are exclusively starting to provide Islamic services and products with last new conditions (Azzaoui & Bedrouni, 2020, p. 384).

The regulation n° 02-20 of March 2020, which defined banking operations related to Islamic banking and its practice rules concerning banks and financial institutions. In contrast, late regulation in its materials 5-12 explained the allowed Islamic banking operations on the level of Islamic windows, and added some new operations like deposit accounts. On the other hand, the new system pointed out the necessity of relying on a legitimate control authority whether it is related to the state of operations' compliance with Sharia provisions or monitoring it at the bank level, while the way it forms and works remains not clear yet (Benzakkoura, 2020, p. 11). Despite, recent regulations as 02-18 and 02-20 reflect the Algerian government’s intention to develop the current money market to improve Islamic banks liquidity, it is still not enough.

4. Methodology (model specification):

The empirical part of this paper utilizes a non-parametric approach in order toanswer the research question by applying bootstrap DEA method to estimate and compare technical efficiency of banks in Algeria in the period of 2016- 2019.

4.1 Data envelopment analysis (DEA) model: a review

DEA has been widely used in the efficiency analysis literature, because of its specific properties, as it is a non-parametric technique uses linear programming techniques to solved their equations, it does not need a special functional form; free from assumptions regarding the distribution of variables (normality of variables), namely, assumptions that are difficult to fulfill in the finance area.

The basis of DEA approach has been back in the recent series of discussions started by Charnes, Cooper, & Rhodes (1978). As mentioned, DEA has been employed for assessing the relative efficiency of a set of homogeneous firms, usually called as the decision-making units (DMUs), which consume a variety of identical inputs to produce a variety of identical outputs. In addition, DEA method provides non-parametric efficiency estimators of each bank compared to the efficiency frontier constructed by the best-performing banks which has been intimately linked to efficiency measurement proposed by Farrell (1957).

The initial DEA models consider constant return to scale (CRS) which does not take the operating at different scalesin consideration. In other words, CRS is not the realitycase, and the efficiency of unit changes when their size changes. To overcome this limitation point, Banker et al. (1984) developed variable returns to scale (VRS) model in which each bank is only benchmarked against banks of similar size (Coelli, 1996, pp. 9-10).In fact, the first model (CRS-DEA) measure Technical Efficiency (TE), also called overall efficiency, while the second model (VRS-DEA) identifies Pure Technical Efficiency (PTE) related only to administrative and managerial capabilities. Scale Efficiency (SE), which is linked to the operating scale leveland, calculated by the ratio of TE to PTE. By using both models, we achieve a better understanding the inefficiency causes of banks under analysis(Henriques, 2018, p. 158).

In our paper, different assumptions regarding returns to scale (CRS-DEA and VRS-DEA) are made to determine the efficiencies of banks sample with input orientation, since banks usually have no control over the levels of service demanded by their customers. The VRS input-oriented model, can be formulated mathematically where we consider n banks ($j= 1, 2, ..., n$) use m inputs ($x_{ij}= 1, 2, ..., m$) for producing s outputs ($y_{kj}= 1, 2, ..., s$), the efficiency of the bank jo is the optimal value of θ as:

$$Min\theta$$

Subject to …………… (1)

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{io}, \quad i = 1, \dots\dots, m$$

$$\sum_{j=1}^{n} \lambda_j y_{kj} \geq y_{ko}, \quad k = 1, \dots\dots, s$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j \geq 0; \quad \forall j, \quad \theta\ free$$

The objective function θ refers to the value of bank efficiency j, its value bounded from 0 to a unity ($0 \leq \theta \leq 1$). The value "1" indicates that bank lies on the efficiency frontier, and technical efficiency of all other units less than one must be maximized. $\lambda_j$represents the associated weighting of input and output vectors of bank j, and the restriction $\sum_{j=1}^{n} \lambda_j = 1$ represents variable returns to scale assumption on the reference technology. So, we can reach the CCR-I model by removing $\sum_{j=1}^{n} \lambda_j = 1$ constraint from the above models (Cook, Tone, & Zhu, 2014, p. 3).

As shown in VRS and CRS models formulations, DEA does not take the error term in consideration when assumes the distance between the observations and efficiency frontier reflects only the inefficiency, then some difficulties in selecting input and outputs based on classical approaches (Simar & Wilson, 2000, p. 780) . Most studies have been performed these limitations that might lead to a bias efficiency estimator, especially Simar and Wilson (1998) who proposed to adopt bootstrapping technique as a post-stage in order to minimize above weaknesses.

4.2 Statistical inference by bootstrapping DEA

The bootstrap was introduced first time in statistics by Efron (1979), while in DEA area, Simar & Wilson (1998)were the first who suggested the use of bootstrap for more consistent results as an advanced model called later BDEA. This new technique allows to estimate confidence intervals, as well as to obtain bias-corrected technical efficiency scores (extract the sensitivity of efficiency scores) resultedofinefficiency distribution(Panagiotis, 2012, p. 5).

Bootstrapping could be defined as a procedure of drawing with replacement from a sample, mimicking the data generating process of the true model and producing many estimates can be used for statistical inference (Panagiotis, 2012, p. 3). We can say that bootstrap is a computer-based method that re-samples the original data in order to assign statistical properties. One of its most important uses is to test hypotheses and resampling, within the framework of the bootstrap relates to re-distributing the assumed randomness of the model among observations. This randomness is reflected in the deviations of the model's variables from their expected values, as estimated by the model. The higher the variance of the residuals, the wider the constructed bootstrap confidence intervals will be in hypothesis testing (Panagiotis, 2012, p. 3) .

In this paper, we follow the bootstrap procedure of Simar and Wilson (1998) to correct the bias- efficiency scores and estimate confidence intervals. The estimation algorithm found in Simar and Wilson (1998) with 11 steps, we can be summarized in the following 5 steps (for the abbreviation purposes):

Steps 1: from the original data set, we use DEA to compute efficiency scores.

Steps 2: Draw with replacement from the empirical distribution of efficiency scores. Simar and Wilson (1998) suggest that smoothing the empirical distribution provides more consistent results.

Steps 3: Divide the original efficient input levels by the pseudo-efficiency scores drawn from the (smoothed) empirical distribution to obtain a bootstrap set of pseudo-inputs.

Steps 4: Apply DEA using the new set of pseudo-inputs and the same set of outputs and calculate the bootstrapped efficiency scores.

Steps 5: Repeat steps 2 and 4 B times and use bootstrapped scores for statistical inference and hypothesis testing. Confidence intervals are then constructed for the regression parameters as well as for the efficiency scores (For more detail see, Simar & Wilson, 2000, pp. 788-789).

4.3Input-output selection and data description:

In our paper, it seems more appropriate to use technical efficiency instead of cost or profit efficiency for the comparisons. Furthermore, cost and profit efficiencies need more information on input and output prices, which are not available for most banks sample. For that reason, technical efficiency is estimated in this study. From the issues that needs to be clarified before using DEA is the balance of the number of inputs and outputs. In view of this, we follow the 'rule of thumb' proposed by Cooper et al., (2006)based on which the number of DMUs must be higher than three times the sum of inputs and outputs. According to the authors, if this rule does not achieve, then the lack of degrees of freedom is tend to decrease the discrimination power of the model. As a results, in our case, weselect two inputs and only one output to measure the efficiency of ten (10) banks, two of them are Islamic over the period of 2016-2019.

Table 3. Banks study structure

Code	Bank name	Operational style	Ownership
ABC	Arab Banking corporation	-	private
AGB	Algerian Gulf Bank	-	private
BNA	Banque nationale d'Algérie	Islamic	Owned-state
BRK	Baraka Bank		Mix-capital
CPA	Crédit populaire d'Algérie		Owned-state
BNP	BNP Paribas	-	private
FRB	FRANS Bank	-	private
SLM	Salam Bank	Islamic	private
SGA	Société générale	-	private
TRB	Trust Bank	-	private

Source: banks' financial reports

The selections of inputs and outputs in banking is an issue not settled in an econometrical debate only (number of inputs and outputs), but it is also theoretical within a banking context (studies). The main approaches that address banking efficiency are intermediation and production approaches, while there is no consensus among researchers about the perfect approach to modeling bank behavior (Avkiran, 2006, p. 284). Following the comparison studies between conventional and IBs, we adopt the intermediation as a commonly accepted approach suggested by Sealey & Lindley (1977), which views banks as intermediaries employ labor and deposits to produce different types of loans and income. However, data on labor is unavailable for some banks, especially for owned-state banks. Considering the sample size and following the other studies with the same situation (Sun and Chang, 2011; Kaffush et al., 2019; and others). We consider deposits and total operating expenses as inputs and the total loans as bank output. The data for our study is obtained from the bank's financial reports. After that, (Simar & Wilson, 1998) bootstrap approach applied to determine whether there is a difference in efficiency of IBs and CBs, which have been conducted by using *Benchmarking* Package, developed by Bogetoft and Otto (2010) in the *R* software.

Table 4. Statistical descriptive of Inputs and output (millions DZD)

code	Variables	Mean	Std. dev	Islamic	Commercial
	Inputs				
X1	Total deposits	503 414 573,2	7.67e+08	1 087 802 104	19 048 780 824
X2	Total operating expenses	6 565 124	6 467 282	20 374 647	242 230 313
	Output				
Y1	Total loans	460 702 848,4	7.28e+08	809 053 733	17 619 060 204

Source: developed by the researcher using Excel

Some important issues can be drawn from the table.4 above, which provides inputs and output summary statistic used in this study. Over the four-year period, the total deposit, total operating expenses, and loans of IBs are about 5.40%, 8.41%, 4.591% which is still significantly very small than CBs. High financing to deposits ratio reflects banks contribution to real sector, while this ratio considering study sample is 74.37% and 92.49% for IBs and their peers respectively, representing its expansion in activities. While, table 5 represents the correlation coefficient matrix between inputs and output. All the correlation coefficients are significant, which shows that selected variablesare reasonable for the estimation.

Table 5. Correlation coefficient matrix between inputs and output

	Total deposits	Total deposits	Total loans
Total deposits	1		
Total operating expenses	0.959544**	1	
Total loans	0.994134**	0.939630**	1

Notes: ** significant at 5%

5. Results and discussion

The CRS and VRS results are presented in this section. As mentioned earlier, DEA efficiency estimators are decomposed into technical, pure technical and scale efficiencies, which is valuable for our empirical setting, since it provides insight on the inefficiency sources.

5.1 Study sample efficiency components before and after bootstrapping

As the table.6 exhibits, there is a significant difference before and after bootstrap in the mean of Technical and Pure technical efficiency in the study period. Indeed, the size of the confidence interval for the bias-corrected DEA scores in our case is 0.05, and the number of bootstrap replications used in the loop of the SW (1998) algorithm is B=2000 (the bootstrap results are presented in the appendix). usually, practitioners extract valuable information from evaluating the original DEA scores, rather than the bootstrapped ones, which lead into bias results then bias judgments.

Table 6.TE, PTE, SE efficiency mean before and after bootstrap

year	TE		PTE		SE	
	$\hat{\theta}$	$\hat{\theta}^*$	$\hat{\theta}$	$\hat{\theta}^*$	$\hat{\theta}$	$\hat{\theta}^*$
2016	0,60115	0,55517	0,72202	0,64883	0.83469	0.85564
2017	0,62876	0,58489	0,71981	0,65368	0.87350	0.89476
2018	0,70810	0,63221	0,76337	0,68282	0.92759	0.92588
2019	0,63856	0,58390	0,70490	0,63086	0.90588	0.92556
Mean	**0,64414**	**0,58904**	**0,72752**	**0,65405**	**0.88539**	**0,89082**

source: R software and Excel outputs

Notes: TE: technical efficiency, PTE: pure technical efficiency, SE: scale efficiency, $\hat{\theta}^*$: bootstrap efficiency scores ,$\hat{\theta}$:original efficiency scores, Mean: includes all banks in the study

As a first observation, when taking bias-corrected efficiency estimates in consideration, mean efficiency decreases (indicating high level of inefficiency) by 5.51%, 7.34% than original technical, pure technical efficiency scores respectively, which lead to an increased in scale efficiency by 0.54%. Overall, theaverage technical efficiency range between 58.90% as a minimum to 65.40% as maximum side, it can be said that the sample of our study is technically inefficient. While, scale efficiency is bounded from 85.56% to 92.58% indicating diseconomies of scale.

Precisely, by tracing the development path in the mean of TE, PTE, and SE efficiencies, it can be seen a decline but was known to be almost stable, while the tangible development begins rise and reached its peak in 2018 estimated at 63.22%, 68.28%, 92.58% compared to previous and the recent decline in 2019. This positive improvement due to banks adaptation and increased in competition, and might be attributed for new financial technology entry relies on the financial access, and the increase in banks branches number, which were important in this period for banks to exploit their internal recourses. During the analysis of the above table which indicates the mean technical, pure technical, and scale efficiencies of the banks sample during the period 2016-2019, we find that the efficiency of the Algerian banking system is low and bounded from 59% to 66% with a mean of 58.90 %. These values reflex the inefficiency in utilizing banks resources, which indicate the need to improve the overall efficiency by reducing inputs by 40% which is a significant improvement potential. Our results are close to those obtained by Hacini and Dahou (2018a) who observed that Algerian banks are wasting 54, 25% of potential resources which could be saved during the production process, and Ihaddaden & Bouhaba (2019) who suggested an improvement of 30% in terms of technical efficiency.

5.2 The efficiency decomposition for each bank individually

Nevertheless, as we show in table.7 which represents mean technical, pure technical, and scale efficiencies for each banks' and its ranking, no bank is fully efficient in managing its resources and operate at the optimal scale during study period, except some banks in some years (see the appendix). From efficiency ranking, how ever,the owned-state banks, BNA and CPA technically are the best banks with a score of 83.26%, 79.35%, 100%, and78.80%, 80.32%, 98.10% in technical, pure technical, and scale efficiencies respectively. Meanwhile, the most inefficient banks are the private banks: ABC and PNB in the nine and last rank with a score of 51.74% and 46.96% respectively. In this case, the main inefficiency causes in these banks are back to PTE rather than SE, which indicate the needs to reduce the access slack in deposits and total operating expenses (keeping loans constants) by 48.26% and 53.04% respectively.

From the previous findings, we can say that state ownership has a significant influence on the banking efficiency level, especially on scale efficiency. This implies that while state-owned banks are used by the government to implement its social mandate as well as financing it in times of need, they are compensated by other benefits such as cheaper rents and large public servant accounts. Another possible reason is that state (co-)owned banks are well positioned and, despite their possible social mandate towards sociality, they can manage their cost and compete in the market in terms of generating profit as much as their privately owned peers. (Alqahtani, Mayes, & Brown, 2017, p. 70)

Table 7. Efficiencies mean of individual bank and its ranking in the period 2016-2019

Banks	TE	Ranking	PTE	Ranking	SE	
ABC	0,51745	9	0,58573	7	0,88341	5
AGB	0,56565	3	0,66098	4	0,85576	8
BNA	0,83267	1	0,79356	2	1,00000	1
BRK	0,54109	6	0,57602	10	0,93935	3
CPA	0,78805	2	0,80325	1	0,98107	2
FRB	0,55911	4	0,71284	3	0,78433	10
PNB	0,46964	10	0,58564	8	0,80192	9
SLM	0,53401	7	0,60972	6	0,87581	7
SGA	0,55607	5	0,63096	5	0,88130	6
TRB	0,52670	8	0,58178	9	0,90532	4
Mean	**0,58904**	**-**	**0,65405**	**-**	**0,89082**	**-**

source: R software and Excel outputs

Note: Mean represents all study period 2016-2019

Further, ranking of IBs El Baraka and Al Salam bank reveals a slight result under different returns of scale (constant and variable). In contrast, the mean technical efficiency for both banks are approximately coordinate than SE. The variance in SE between two banks due to appreciation of the El Baraka bank to its capital by 5000000 million DA in the year of 2017 to reached 15000000 million DA, versus 10000000 million DA as a capital for Al Salam bank. Our data results indicated that the main inefficiency causes are back to PTE and SE, which means they suffer from a lower scale and operate efficiency in comparison to CBs that operate in average almost at a middle.

5.3 The efficiency decomposition for each bank operational style

Despite the analysis of table above suggested the increase in IBs technical efficiency from 47.50% in 2016 to 58.12% in 2019, they represent the less successful banks in terms of their resource minimization. With an average in technical efficiency of 53.75% versus 60.19%, it's obvious that IBs operate less efficiently than commercial peers. Indeed, for the last four years, mean of TE of IBs is ranging from 48% to 59%, which indicates that Islamic banks were utilizing half of their financial resources during study period. However, the trend of our findings signs that Islamic banks are less growing and did not reveal a good progress in the Algerianfinancial market.

The analysis of table. 8 suggests that the decline in Islamic technical efficiency compared to CBs attributes to the PTE and/or SE. Note that for CBs, PTE lower than the SE, meaning that the most important inefficiencyis on the Pure technical efficiency side rather than the scale side.

Table 8.TE, PTE, and SE efficiency during the period of 2016-2019.

	Technical Efficiency		Pure Technical Efficiency		Scale Efficiency	
year	Islamic	conventional	Islamic	conventional	Islamic	conventional
2016	0,47509	0,57519	0,57472	0,66736	0,82663	0,86189
2017	0,53240	0,59801	0,61048	0,66448	0,87209	0,89996
2018	0,56144	0,64990	0,5996	0,70361	0,93623	0,92366
2019	0,58127	0,58456	0,58661	0,64192	0,99090	0,91063
Mean	**0,53755**	**0,60192**	**0,59287**	**0,66934**	**0,90668**	**0,89926**

Source: R software and Excel outputs

Conversely, IBs most important source of inefficiencyis mainly on the scale side, which negatively affects their pure technical efficiency. IBs often make up a relatively small segment in Algerian banking sector as not exceed 3% the total banking assets, putting pressure on them to produce financial products and generates incomes that conform to conventional banking. As a results of small size, IBs find more difficulties dealing with external factors, such as competition than do CBs, than controlling the utilization of internal resources. In other side, Islamic products characterized by its high costs due mainly to diseconomies of scale. This suggests that strong and prompt policy actions are needed to address these variables and recapitalize bank assets and costs to be more efficient.In summary, results of the tables.7 and 8 show that the efficiency of Islamic banking different from the efficiency of CBs, we can say that IBs statistically significant less efficient than CBs over study period. Our results close to the previous literature that could consensus on this hypothesis (Alqahtani, Mayes, & Brown, 2017 ; Miah & Uddin, 2017 ; Pradiknas & Faturohman, 2015 ; and others).

6.Conclusion

In the present study we have empirically compared the banking performance according to their operational style banks based on a sample of 10 banks during the period 2016-2019. In terms of the results, the bias-corrected efficiency scores calculated through a time period analysis provides solid indications that IBs operate in average less than CBs over study period. In this since, we accept the hypothesis that say technical efficiency of IBs is less than their conventional counterparts.

Namely, with decomposing the overall technical efficiency into their components, results show that the most important inefficiencies are rely on the Pure technical efficiency side rather than the scale side. Whereas, the most important source of IBs inefficiency is mainly on the scale side, which negatively affects their pure technical efficiency. IBs often make up a relatively small segment of the banking sector in Algeria in comparison with the total banking assets, putting pressure on them to produce financial products and generates incomes that conform to conventional banking. On the other hand, IBs operate in average almost at a middle, consequently they are mainly advised to focus on calibrating their inputs to the quantity of services provided, which means they suffer from a lower scale efficiency in comparison to CBs. As a results, IBs find more difficulties dealing with external factors, than controlling the utilization of internal resources, which means the acceptance of the second hypothesis indicated the main causes of Islamic inefficiency are scale inefficiency.Most importantly, the ownership is also found to magnify the effect banking efficiency through size, which positively impact the efficiency of owned-state banks.

The problem in the case of actual banking system is only two IBs operate in Algeria. According to Pradiknas & Faturohman (2015), the growth of Islamic banking not only showed by number of operating IBs, but also can showed by the growth of Islamic banks total assets. Unfortunately, the total the share of IB is approximately 3% of the total banking industry, we can say it is earlier to speak on an Islamic banking segment in Algeria, which make our comparison relative, but that do not negate our findings.

From our findings despite the limitations of this research, we suggest a number of recommendations as follow:

-The findings suggest that smaller banks, especially IBs as they are significantly smaller than CBs, should seek to grow in size, as scale was found to be negatively related to efficiency, in which means IBs should monitor their level of capital to avoid high costs risk.

-They should also develop more innovating risk management tools; as better-quality assets hence efficiency levels.

-The size of the IBs matters in Algeria. Consequently, the window banks should be encouraged to convert to subsidiaries or full branches apart from their parent CBs, this strategy could improve their scale and overall efficiencies.

- The government could give incentives to legal framework in which IBs operate, without forgetting, human resources development role by providing a good training for the Islamic bank officers.

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Appendices

Table 9.bootstrapping VRS-CRS DEA efficiency estimators and its confidence intervals

Banks	year	$\hat{\theta}_{VRS}$	$\hat{\theta}_{CRS}$	$bias_{VRS}$	$bias_{CRS}$	$\hat{\theta}^*_{VRS}$	$\hat{\theta}^*_{CRS}$	confidence intervals			
								L_{VRS}	U_{VRS}	L_{CRS}	U_{CRS}
ABC	2016	0.6288	0.5515	0.0481	0.0380	0.5806	0.5134	0.5210	0.6221	0.4647	0.5475
	2017	0.6782	0.5939	0.0426	0.0270	0.6356	0.5669	0.5735	0.6729	0.5209	0.5917
	2018	0.6498	0.5694	0.0476	0.0366	0.6021	0.5327	0.5407	0.6431	0.4816	0.5664
	2019	0.5670	0.4889	0.0425	0.0322	0.5244	0.4566	0.4678	0.5614	0.4131	0.4858
AGB	2016	0.6836	0.5584	0.0316	0.0265	0.6520	0.5318	0.6054	0.6782	0.4879	0.5553
	2017	0.6302	0.5661	0.0384	0.0249	0.5918	0.5411	0.5418	0.6242	0.4952	0.5630
	2018	0.7647	0.6535	0.0390	0.0284	0.7256	0.6251	0.6615	0.7615	0.5731	0.6504
	2019	0.7071	0.5896	0.0327	0.0251	0.6744	0.5644	0.6232	0.7042	0.5181	0.5865
BNA	2016	0.7929	0.7663	0.0888	0.0697	0.7040	0.6965	0.6067	0.7847	0.5967	0.7573
	2017	1.0000	1.0000	0.1507	0.1048	0.8492	0.8951	0.7373	0.9833	0.7583	0.9875
	2018	1.0000	0.9998	0.1605	0.1202	0.8394	0.8796	0.7294	0.9896	0.7365	0.9932
	2019	1.0000	0.9973	0.2184	0.1379	0.7815	0.8593	0.6817	0.9832	0.7221	0.9893
BRK	2016	0.5925	0.5382	0.0408	0.0346	0.5517	0.5035	0.5096	0.5856	0.4451	0.5345
	2017	0.6332	0.5851	0.0469	0.0436	0.5862	0.5414	0.5377	0.6268	0.4720	0.5803
	2018	0.6370	0.6036	0.0428	0.0439	0.5941	0.5597	0.5419	0.6311	0.4884	0.5990
	2019	0.6153	0.5978	0.0433	0.0382	0.5719	0.5595	0.5163	0.6080	0.4949	0.5940
CPA	2016	0.8909	0.8893	0.0823	0.1055	0.8086	0.7837	0.6971	0.8848	0.6566	0.8844
	2017	0.8251	0.8238	0.0788	0.1001	0.7463	0.7236	0.6433	0.8170	0.6055	0.8167
	2018	0.9526	0.9521	0.1309	0.1467	0.8216	0.8054	0.7143	0.9393	0.6780	0.9416

	2019	1.0000	1.0000	0.1636	0.1606	0.8363	0.8393	0.7371	0.9831	0.7079	0.9781
FRB	2016	1.0000	0.5901	0.1816	0.0331	0.8183	0.5570	0.7241	0.9827	0.5067	0.5859
	2017	0.7698	0.4833	0.1201	0.0239	0.6496	0.4593	0.5698	0.7622	0.4208	0.4806
	2018	1.0000	1.0000	0.2163	0.2714	0.7836	0.7285	0.6853	0.9831	0.6403	0.9778
	2019	0.6579	0.5186	0.0582	0.0271	0.5996	0.4914	0.5335	0.6501	0.4487	0.5152
PNB	2016	0.5838	0.4834	0.0266	0.0211	0.5571	0.4622	0.5184	0.5802	0.4245	0.4805
	2017	0.6184	0.4926	0.0262	0.0220	0.5921	0.4705	0.5493	0.6166	0.4323	0.4905
	2018	0.6051	0.4838	0.0258	0.0216	0.5793	0.4622	0.5376	0.6031	0.4246	0.4817
	2019	0.6412	0.5061	0.0273	0.0225	0.6139	0.4835	0.5673	0.6394	0.4442	0.5039
SLM	2016	0.6983	0.4859	0.1006	0.0393	0.5977	0.4465	0.5266	0.6949	0.4029	0.4811
	2017	0.6986	0.5468	0.0639	0.0234	0.6346	0.5233	0.5712	0.6878	0.4799	0.5438
	2018	0.6437	0.5883	0.0385	0.0252	0.6052	0.5631	0.5513	0.6356	0.5175	0.5853
	2019	0.6525	0.6305	0.0513	0.0275	0.6012	0.6029	0.5537	0.6399	0.5524	0.6273
SGA	2016	0.6642	0.6019	0.0420	0.0286	0.6222	0.5733	0.5700	0.6580	0.5230	0.5977
	2017	0.6380	0.5802	0.0421	0.0293	0.5958	0.5508	0.5426	0.6321	0.4998	0.5764
	2018	0.7269	0.6162	0.0457	0.0283	0.6811	0.5878	0.6169	0.7194	0.5375	0.6126
	2019	0.6641	0.5352	0.0395	0.0229	0.6245	0.5122	0.5661	0.6573	0.4706	0.5324
TRB	2016	0.6848	0.5461	0.0891	0.0629	0.5957	0.4832	0.5234	0.6753	0.4323	0.5394
	2017	0.7062	0.6157	0.0511	0.0391	0.6551	0.5765	0.5865	0.6989	0.5211	0.6123
	2018	0.6535	0.6138	0.0577	0.0361	0.5958	0.5776	0.5460	0.6424	0.5235	0.6101
	2019	0.5435	0.5213	0.0631	0.0519	0.4804	0.4694	0.4410	0.5330	0.4212	0.5167

Source: R software and Excel outputs

Notes:$\hat{\theta}$: original DEA estimators, $\hat{\theta}^{*}$: bias-corrected efficiency estimators, bias: bias value, 95% confidence intervals, L: lower bound, U: upper bound