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Efficiency of Syrian Banks: A Nonparametric Frontier Approach

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Abstract

The objective of this study is to measure efficiency of Syrian private banks. The study utilizes a non-parametric approach, namely the Data Envelopment Analysis DEA, and uses input- orientated models to measure pure technical efficiency and scale efficiency. Five alternative models under two approaches have been applied to show the effect of changing inputs and outputs on the estimated efficiency scores. Cross- sectional data were chosen to estimate efficiency scores of Syrian private banks. The Software DEAP, version 2.1, has been used in the analysis and the obtained results were compared against traditional performance measures. Study results show that the overall average efficiency score is low due to the low average of scale efficiency.

JEL classification numbers: C14, D61, G21.
Keywords: Efficiency, Data Envelopment Analysis, Syrian Banks.

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1. Introduction

Over the four decades that preceded 1990s, the Syrian banking sector consisted only of state-owned banks and a central bank (the Central Bank of Syria) which was supervising the banking and financial sector without having an actual role in the economy (Barhoom & Varga, 2017) (Al-Jafari & Alchami, 2014). This banking system was in line with the country's political and economic orientations. Since the beginning of the 2000s, there have been great efforts to reform the Syrian financial and banking sector to conform with the new movement towards a social-market economy (Barhoom & Varga, 2017). This is demonstrated by introducing new laws and other legislations regarding banking and financial activities, such as Law No. 23 issued in 2002 reactivates the role of Central Bank of Syria and allow the creation of a board, the Money and Credit Board which is the highest monetary authority in Syria (Al-Jafari & Alchami, 2014). Another example is Law No. 28 for 2001 that opens the Syrian banking sector to private investments, this is resulted in substantial inflows of foreign capital between the years 2005 and 2011, especially from banks of the Arab Gulf countries (Barhoom & Varga, 2017) (Al-Jafari & Alchami, 2014). Other laws permit the establishment of Islamic banks (Law No. 35 for 2005); Micro-finance banks (Law No. 15 for 2007); and of investment banks (Law No. 56 for 2010) (Al Mashhour, et al., 2020).

The Reform process was unfortunately disrupted by the Unrest that began in Syria in early 2011 and has not ended yet. This, in turn, created a very challenging operating environment for Syrian banking sector. Inflation rates grew annually by over 20% between 2010 and 2018, a drop of over 50% in the real GDP by the end of 2018 to its 2010 level was reported by official data. The outflow of financial assets and capital, accompanied with deteriorating investment environment, has led to a significant decrease in investment and savings. Moreover, the collapse of economic activities caused a significant decline in bank credit to the economic sector (ESCWA, 2020) (World bank, 2017). Some financial indicators for the period 2010 – 2020 stress the financial difficulties of Syrian private banks. The total average of ROA during this period was 5.15% and total average ROE was 19.74%. This computation of ROA and ROE, however, were based on the net income after taxes. The net income of Syrian private banks includes a very relevant component which is unrealized gains from revaluation of the so called structural foreign currency. Should the effect of these unrealized gains be eliminated from income when calculating ROA and ROE, negative indicators could result. Moreover, Syrian private banks have decreased their lending activities during this period and increased significantly their cash holding. The average ratio of direct loans to total assets has declined from 42.05% in 2010 to only 13.89% in 2020, whereas the ratio of non-interest-bearing liquid assets to total assets has increased from 33.19% in 2010 to 61.20% in 2020. This local uncertain business environment is accompanied with external factors that add to the operating difficulties of Syrian private banks. Most of these banks have mentioned in their annual reports for the year 2020 that the financial crisis in Lebanon has negatively affected the Syrian banking sector, as

Syrian banks rely completely on Lebanese banks in their very limited transactions with the outside world.
Currently, and after a decade of unrest, 15 private banks (Table 1) are still operating in the Syrian banking sector together with the state-owned banks, three of them are Islamic banks and one is specialized in micro- financing (Al Mashhour, et al., 2020). These private banks with their branch networks and Automated teller machines (ATM), are still working. (World bank, 2017).

Table 1: Syrian private banks

Banks′ Name	Acronym	Started	Number of Branches
Islamic banks			
Cham Bank	CHB	2007	8
Syrian Islamic International bank	SIIB	2007	23
AL-Baraka Bank	BBSY	2010	9
Conventional banks			
Bank Bemo Saudi Fransi	BBSF	2004	41
Bank of Syria and Overseas	BSO	2004	27
International Bank for Trade and Finance	IBTF	2004	30
Bank Audi Syria		2005	27
Byblos Bank Syria	BASY	2005	11
Arab Bank Syria	BBS	2006	17
Syria Gulf Bank	ARBS	2007	12
Sharq Bank Syria	SGB	2008	4
Bank of Jordan Syria	SHRQ	2008	13
Fransa bank Syria	BOJS	2010	8
Quatar National Bank	FSBS	2010	15
Micro Finance banks			
Al Ibdaa Bank Syria. For Microfinances		2010	3

Source: (Aldeen, et al., 2020)

It is very hard for Syrian private banks in such a business environment to expand their lending activities with acceptable levels of risk or to make high profits from providing new financial services and products. Syrian private banks should therefore operate efficiently to cut their costs and reduce their losses. The question about the level of their efficiency and the efforts that private banks make to operate efficiently, is the main motivation for this study.
The article analyzed the efficiency of Syrian private banks using non-parametric frontier approach, the data envelopment analysis DEA, applied to the data for the year 2020. The reason for choosing DEA is the advantages of this technology in estimating efficiency comparing with other methods. These advantages might be the reason for the wide- spread of DEA-applications. Paradi et al. (2017), for example, accounts over 15000 academic papers and 100 books about DEA and

DEA-applications in almost all sectors and industries. A long list of reviews about DEA and its applications have been published since the initial publication of (Charnes, et al., 1978).[2] Banks′ efficiency is one of the main Application fields for DEA literature. Berger & Humphry (1997) present a survey and a critical review of 130 studies from 21 countries that analyze efficiency in the financial sector by utilizing frontier methods. Berger et al. (1993) summarize and analyze the research on efficiency of financial institutions and suggest future improvements. Paradi et al. (2017) provides a timeline of DEA – Applications in the banking sector that concludes many topics such as productivity, bank branch profitability, multi-country branch performance, cost efficiency, ranking the branches, bank mergers and acquisitions, efficiency of providing bank services.[3]
The remainder of this study is organized as follows: Section 2 provides a literature review for researches on efficiency and the different approaches and methods used to measure efficiency. Section 3 introduces the DEA-method and its mathematical foundation. The Data used in this article and the chosen inputs and outputs for the employed models are described in section 4. The results and conclusions are discussed in section 5 and 6, respectively.

2. Literature Review

It is not surprising that academic research in Syrian banks during the long-running unrest was not so rich and varied. One of the few studies about efficiency of Syrian private banks was introduced before the beginning of the unrest (Kaddaj, 2010). The study evaluated the efficiency of Syrian private banks during the period 2006 – 2009, utilizing the CCR model (explained hereafter). Kaddaj found that the majority of Syrian banks are relatively inefficient under the operating approach (the efficiency of a bank in managing costs and revenues), whereas most of them are relatively efficient on their intermediation role (the efficient use of bank's resources to transfer deposits into loans and investments). Al-Jafari & Alchami (2014) used data from public and private Syrian banks over a period 2004 - 2011 to determine the factors that most affect the profitability of Syrian banks. One of the determinants used in the study was management efficiency measured by the ratio of operational expenses to total assets and the return on average assets. The study utilized the Generalized Method of Moments technique and found a positive relationship between profitability and management efficiency. Aldeen et al. (2020) analyzed the performance of Islamic and conventional banks in Syria over the period of 2011-2017. The study covered the entire private banking sector and applied independent

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[2]Seiford (1996), for example, traced the development of DEA over the period from 1978 until 1995. A survey of DEA research for the first 30 years of DEA history (until the year 2007) were provided by (Emrouznejad, et al., 2008). By another survey presented by (Lampe & Hilgers, 2015), they account 4021 publications for DEA over the period 1987 to 2011

[3] The list of reviews presented in this article is only a selective presentation for some of the reviews to highlight the popularity of the DEA analysis. For more comprehensive review see for example (Gattoufi, et al., 2004); (Kaffash & Marra, 2017).

sample t-test and panel data regression on several financial ratios and macroeconomic variables. The ratio of total operating expenses to total operating revenues is used to evaluate efficiency. The study documents that both groups need more efforts to improve their efficiency and the conventional banks are less efficient than Islamic banks. Almuharrami (2015) compared the financial performance of 315 Arab banks during the period 1997 - 2010 by utilizing ratios analysis. Based on evaluating the Return on Average Asset, he found that the management teams of Syrian banks were inefficient in giving the best outcome from the used level of inputs. Farazi et al. (2013) explored the relationship between bank ownership and performance of 120 banks from nine countries (including Syria) for the period 2001-2008. They utilized multivariate panel regression analysis and enter the ratios of total overhead costs to total assets and the ratio of personnel costs to total assets as efficiency variables. They documented that listed banks (which are the private banks in Syria) have higher cost ratios than state owned banks and that this result is due to the higher wages paid by listed banks. However, the listed banks generate higher revenues and profits that compensate the higher cost ratios. The impact of regulation and ownership on the banks′ efficiency was studied by (Haque & Brown, 2017) using a sample of 132 commercial banks from 12 countries in the Middle East and North Africa (including Syria) over a period 2002 - 2012. They estimated cost and profit efficiency by using data envelopment analysis and after that utilized one-step maximum likelihood estimations to study the effect of ownership and regulation on bank efficiency. The study found in the first stage of the analysis that banks from the MENA region have very low cost efficiency scores with a mean of 0.38 and also a very low profit efficiency average of 43%. Syrian banks were among the banks that have the lowest cost and profit efficiency scores. The study found a positive effect of bank regulation on cost efficiency for the period after the global crisis and a positive influence of government ownership on cost efficiency in the pre-crisis period. Safiullah & Shamsuddin (2020) provided an additional comparative study of Islamic and conventional banks. They use a matched pair sample of 94 Islamic and 94 conventional banks from 28 countries (including Syria) and utilized a stochastic meta- frontier directional distance function model with undesirable output. They found that the average group-specific inefficiency score is 0.195 for conventional banks which means that conventional banks could decrease inputs usage and undesirable output and at the same time increase outputs by 19.5 %. They found also that the mean technological gap is 0.057 for conventional banks which means that conventional banks use production technology that is very close to the best available technology in the banking industry. Ratios analysis is used also in another study to compare Islamic and conventional banks in relation to their business model, efficiency and stability (Beck, et al., 2013). They used ratios to measure bank efficiency are the ratio of total operating costs to total assets and the ratio of overhead costs to gross revenues. The study analyzed data of 510 banks from 22 countries over the period 1995-2009 and shows that the cost to revenue ratio is only marginally higher for Islamic banks but the cost to assets ratio is significantly higher for this group of banks which means that conventional banks are more efficient than Islamic banks. Mobarek & Kalonov (2014) utilized two frontier approaches: DEA and SFA (explained hereafter) to estimate the efficiency scores of two groups of banks: Islamic and conventional banks with data from 18 counties (including Syria) over two periods: the pre- crisis period 2004-2006 and the crisis period 2007- 2009. The aim was to check whether there are significant differences between the efficiency scores of the two groups of banks. The study employed two DEA models: CCR and BCC Models and the chosen inputs and outputs are based on the intermediation approach. The study provided the average technical efficiency scores for each group of banks from each country separately over the years in the studied period. The average technical efficiency scores for Syrian conventional banks did not exceed the threshold 0.70 for the years until 2009. Eisazadeh & Shaeri (2012) used a stochastic frontier approach (SFA) to evaluate cost efficiency of banks from 19 Middle East and North Africa countries (including Syria) over the period 1995 - 2008. In a second stage of the analysis, they investigated the effect of some macro and bank-specific variables on efficiency. The study documented that banks from those countries are operational inefficient and could save up to 20% of their total costs if they were operating at the cost-frontier. The SFA efficiency-score for Syrian banks were 0.8883 relative of the estimated cost-frontier.

To summarize, data from Syrian private banks were used as part of cross- country studies to evaluate the relationship between efficiency or performance and some macro or bank-specific variables i.e. (Haque & Brown, 2017), (Farazi, et al., 2013) and (Eisazadeh & Shaeri, 2012), or to compare the performance (including efficiency) of Islamic and conventional banks i.e. (Beck, et al., 2013), (Safiullah & Shamsuddin, 2020) and (Mobarek & Kalonov, 2014), or even to compare efficiency of private banks across Arab countries i.e. (Al-Muharrami, 2015). However, these studies have not analyzed the efficiency of Syrian private banks in details and did not include any evaluation for the differences of efficiency between individual Syrian banks. Even studies that focused on the Syrian banking sector, have used efficiency analysis to compare the performance of public and private banks (Al-Jafari & Alchami, 2014) or to compare the performance of Islamic and conventional private banks (Aldeen, et al., 2020). Only one study has been traced that analyzed the efficiency of the private banking sector (Kaddaj, 2010). Nevertheless, this study was conducted before the beginning of unrest, and has measured only technical efficiency using CCR model (explained in details below).

This study contributes to the literature in many aspects. Firstly, the study differs from cross country studies as it sheds more light on the Syrian banking sector since it measures efficiency scores of each Syrian private bank separately and rank these banks with regard to their efficiency scores. Secondly, this study does not attempt to compare efficiency between groups of banks in the Syrian banking sector. Many differences could be detected in the study of (Kaddaj, 2010), where he analyzed the efficiency of private banks for the period 2006 - 2009 utilizing only CCR model under two aspects that influence the chosen inputs and outputs. In contrast, this study utilizes CCR and BRC models (explained hereafter) for the year 2020 using five models under two different approaches (production and intermediation approaches). Lastly, the results of the DEA-analysis are compared with the traditional analysis of efficiency (ratios analysis).

3. Methodology

DEA is one of the frontier methods, in which analyzing efficiency is based on constructing an efficiency- frontier and then estimating the individual efficiency scores relative to this frontier. Frontier methods are grouped usually into two main groups: parametric and non-parametric frontier methods (Berger & Humphrey, 1997). DEA and FDH (Free Disposal Hull) are examples of the non-parametric approaches that differ from each other primarily by the assumed production possibility set (Tulkens, 2006). The specified frontier by a non-parametric approach does not rely on a prior specified functional form for the relationship between inputs and outputs (Paradi, et al., 2017). Another advantage of non- parametric methods is the possibility of dealing with the case of multiple input- multiple output when measuring efficiency (Favero & Papi, 1995).[4] Those advantages should be weighed against some drawbacks of non- parametric approaches: The measured efficiency does not conclude measurement error and cannot be resulted by chance or biased by accounting rules that might not reflect accurately the economic inputs and outputs. Moreover, the error in the measured efficiency of a unit on the frontier could affect the results of inefficient units that are compared with this efficient unit (Berger & Humphrey, 1997).

In a parametric approach, in contrast, a technically efficient level of output is estimated with the help of a pre-specified functional form for the relationship between inputs and outputs. This estimated optimal level of output is compared then with the observed levels of outputs for the different Units. Deviations from this estimated optimal level of output are considered as a result of noise on the data or as a result of inefficiency of the unit under consideration (Favero & Papi, 1995).[5] The noise and inefficiency terms are assumed to be independent variables that follow a pre-specified distribution (Favero & Papi, 1995). The necessity to specify a functional form to describe the production technology and the need to specify a theoretical distribution for the technical efficiency term are considered as the major disadvantages of parametric approaches (Lovel & Schmidt, 1988).

DEA is not a single model but a set of models. The radial, additive and slack-based models are considered as the basic DEA-models (Paradi, et al., 2017). In a radial model, as DEA originally introduced (Charnes, et al., 1978), an efficiency score reflects the possible percentage decrease (increase) in inputs (outputs), where this decrease (increase) is proportional for all inputs (outputs) (Paradi, et al., 2017). Slack-based models deal with the possible additional efficiency gain that can be

[4] Parametric approaches, in contrast, can deal with the case of multiple inputs- single output, for more discussion of this issue see (Favero & Papi, 1995).

[5] Some parametric approaches do not account for noise in the data, for more details see (Paradi, et al., 2017).

achieved by additional decrease (increase) in one of the inputs (outputs) (Paradi, et al., 2017).[6]

As efficiency can be achieved either by decreasing the used inputs to produce a certain level of outputs or by increasing the produced outputs from a given level of inputs, the original DEA- model, also called CCR-model after Charnes, Cooper, and Rhodes, are proposed in two orientations: Input- and output- orientations. In the CCR- model, the production technology is assumed to exhibit constant return to scale (CRS) (Paradi, et al., 2017).

In the co called "ratio-form" of the CCR model, the relative efficiency of a DMU is measured by the ratio of its outputs to its inputs relative to the ratios of outputs to inputs of all other DMUs under consideration (Cooper, et al., 2011). The inputs and outputs of each DMU are weighted and added to a "virtually" single input and "virtually" single output. The ratio of this single virtual output to the single virtual input is the estimated efficiency score for this particular DMU. The only variables in this model are the weights that should be estimated as to maximize this ratio (Cooper, et al., 2011), symbolically.

$$max\, h_o(u, v) = \frac{\sum_r u_r y_{ro}}{\sum_i v_i x_{io}} \tag{1}$$

Subject to:

$$\frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{ij}} \leq 1 \text{ for j} = 1, \dots, \text{n},$$

$$u_r, v_i \geq 0 \text{ for all i and r}$$

$$r = 1, \dots, s; i = 1, \dots, m.$$

Where there are n- DMUs that use m different inputs to produce s different outputs. The first constraint ensures that the ratio of the virtual output to virtual input for every DMU is equal to or less than one (Cooper, et al., 2011).

The above model is a linear fractional programming problem that can be transformed into an equivalent linear programming problem with a change of variables from (u, v) to (μ, v) as a result of this transformation (Charnes, et al., 1978). Moreover, the above ratio has infinite number of solutions; if (u*, v*) is a solution, then (αu*, αv*) is also a solution for all α >0. The solution that has been chosen is

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[6] The issue of determining the best mix of inputs and/or outputs that minimize costs and/or maximize Revenues (the allocative efficiency) is addressed in the additive models. The additive models required additional information about input- and output prices is required (Paradi, et al., 2017).

the solution (u, v) for which $\sum_{i=1}^{m} v_i x_{io} = 1$ (Cooper, et al., 2011). The resulting model is the so-called "multiplier- form" of the CCR model (Cooper, et al., 2011).

$$\max z = \sum_{r=1}^{s} \mu_r y_{ro} \tag{2}$$

Subject to:

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

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

$$\mu_r, \boldsymbol{v_i} \geq \mathbf{0}$$

The linear programming dual of this ordinary linear programming problem is as follows (Paradi, et al., 2017).

$$\theta^* = \min \theta \tag{3}$$

Subject to:

$$\sum_{j=1}^{n} x_{ij} \lambda_j \leq \theta x_{io} \quad i = 1,2, \dots, m;$$

$$\sum_{j=1}^{n} y_{rj} \lambda_j \geq y_{ro} \quad r = 1,2, \dots, s;$$

$$\lambda_j \geq 0 \quad j = 1,2, \dots, n$$

The efficiency evaluation resulted from the above model is a radial optimization, a further improvement in the efficiency measurement is possible through a non-proportional decrease in the input-usage or a non-proportional increase in the produced outputs (Paradi, et al., 2017). This additional non-proportional increase (decrease) in one of the inputs (outputs), called slack, can be estimated by introducing a second stage of the DEA model (Paradi, et al., 2017).

$$\max \sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+ \qquad (4)$$

Subject to:

$$\sum_{j=1}^{n} x_{ij}\,\lambda_j + s_i^- = \theta^* x_{io} \quad i = 1,2,\dots,m;$$

$$\sum_{j=1}^{n} y_{rj}\lambda_j - s_r^+ = y_{ro} \quad r = 1,2,\dots,s;$$

$$\lambda_j, s_i^-, s_r^+ \geq 0 \forall i,j,r$$

Where θ^* is the calculated value from the first stage; the presence of slacks has no effect on this value.
A DMU is considered fully efficient (DEA- efficiency) if only both terms:
(1) $\theta^*=1$
and (2) $s_i^{-*} = s_r^{+*} = 0,$ are satisfied.
A DMU is weakly efficient (weakly DEA-efficiency) if:
(1) $\theta^*=1$
and (2) $s_i^{-*} \neq 0 \frac{\text{and}}{\text{or } s_r^{+*}} \neq 0$
for some I or r in some alternate optima (Cooper, et al., 2011).
The input- and output- oriented versions of the CCR model give the same results, as the production technology is assumed to exhibit a constant return to scale. This is not the case for the DEA models developed under the assumption of variable return to scale (VRS) (Cooper, et al., 2011). Banker, Charnes, and Cooper added an additional constraint to account for variable return to scale (Banker, et al., 1984).

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

By this additional constraint, a DMU is compared only with the DMUs that have almost the same operational scale as this unit. This constraint can be adjusted to be less than or equal to one to account for a non-increasing return to scale (constant or decreasing return to scale), or it could be altered to be greater than or equal to one allowing for a non-decreasing return to scale (Paradi, et al., 2017).
The ratio of the CRS- technical efficiency score to the VRS- technical efficiency score is a measure of the DMUs′ scale efficiency (operating at the optimal scale) (Paradi, et al., 2017).
This article utilizes the CCR model and the BCC model to measure technical and scale efficiencies of Syrian banks. The input-oriented version is chosen as it is

assumed that bank managers have more control over inputs than over outputs (Fethi & Pasiouras, 2010).

4. Data

Measuring Banks' efficiency requires the specification of inputs and outputs in the banking industry. This issue was and is the subject of longstanding debate about what are the services that (commercial) banks really produce and what do they use to produce these services. Until the earliest years of the 70th decade, it was accepted that different purposes of analyzing the activity and functions of banks can lead to different output- specifications (Mackara, 1975); (Benston, 1972). Sealey & Lindely (1977) analyzed carefully the production and cost conditions of financial firms (banks), grouped the early works of different researchers to identify the inputs and outputs of banks under the concept of the so- called technical production of a financial firm (the production approach), and developed a model to specify the inputs and outputs. This model is built on the concept of so -called economic production (explained hereafter) (Sealey Jr. & Lindley, 1977). Berger & Humphrey (1992) provide for three additional alternative approaches to choose bank outputs without any efforts to combine those methods with the early work of Sealey and Lindley. To summarize, five different approaches to specify the inputs and outputs of (commercial) banks can be identified: The production approach (PA), the intermediation approach (IA), the asset approach (AA), the user cost approach (UCA) and the value-added approach (Favero & Papi, 1995).

According to the PA approach, banks use capital (in the physical sense), labor and materials (the inputs) to produce services to the banks′ creditors (depositors) and borrowers (the outputs) (Sealey Jr. & Lindley, 1977). The number of transactions or documents processed over a given period of time is a measure of the level of banks' output (Berger & Humphrey, 1997); (Heffernan, 2005). Since information about the number of transactions is usually not available, the balances of loans or deposits are used as a proxy for the level of processed documents or transactions (Berger & Humphrey, 1997). In this approach, the financial liabilities and the associated costs (interest costs) are not considered as part of the production process (Sealey Jr. & Lindley, 1977). In the IA, the concept of production in banks is related directly to incurred costs and generated profits from a bank. Banks need physical capital, labor, materials, and incur additionally financial costs (interest costs) to produce deposits that are considered as intermediate products. Loanable funds from deposits, capital, labor and materials are used then to produce earning assets that generate profits (the final outputs of banks) (Sealey Jr. & Lindley, 1977). The AA approach could be viewed as a special case of the IA, as inputs are strictly defined by the liability side and outputs are the assets: Banks are treated as intermediary between liability holders and receivers of bank funds (Favero & Papi, 1995). In the UCA approach, there is no pre specification of bank′s inputs and outputs based on a prior theoretical analysis of the bank′s functions. Instead, any (financial) asset is an output if the returns of the assets exceed the opportunity cost of funding the asset, and any liability could be considered as output if its financial costs are less than the opportunity cost. Inputs are the financial instruments that cannot be considered as outputs (Berger & Humphrey, 1992). In the value-added approach, also a pragmatic approach, the criterion to identify a financial item as an (important) output is its contribution to the value added; the contribution to the value added is measured by the amount of physical inputs that the production of this item requires. Other items are regarded either as unimportant outputs, intermediate products, or as inputs (Berger & Humphrey, 1992). The last two approaches do not consider the macroeconomic functions carried out by banks (Favero & Papi, 1995).

This study utilizes the PA and the IA for determining the inputs and outputs of banks because these two approaches are based on a theoretical analysis for the functions of a bank and because they are considered as the main approaches in identifying the functions of a bank (Berger & Humphrey, 1997).

Another problem that should be addressed in choosing the inputs and outputs of banks is the total number of inputs and outputs that should be used in the DEA-analysis, relative to the number of investigated DMUs. If there are only few observations, then only few inputs and outputs can be analyzed; this procedure reduces actually the usefulness of DEA as a method that can deal with the multiple input- multiple output case, but it is a necessary step to have meaningful results (Paradi, et al., 2011). A possible solution for this problem is to use more than one model with fewer total number of inputs and outputs (variables) (Paradi, et al., 2011). A rule of thumb is presented in (Paradi, et al., 2017).

$$n \geq max\{m \times s, 3(m + s)\}$$

Where n, m, and s are the numbers of DMUs, inputs, and outputs respectively. As the study compare the efficiency of 10 DMUs, the number of total variables is 3.

Table 2: The different input- and output-models used in the analysis

Model	Inputs	Outputs
Model 1	Labor expenses Fixed assets (premises and equipment)	Total loans
Model 2	Labor expenses Fixed assets (premises and equipment)	(retail) deposits
Model 3	Deposits Labor expenses	Loans
Model 4	Interest cost Labor expenses	Interest income
Model 5	Interest cost Labor expenses and other operating expenses	Interest income

The sample used in this research consists of the eleven Syrian private banks listed at Damascus Securities Exchange, after excluding Islamic banks for their special business model.[7] The bank of micro-finance is also excluded from the study as this bank is specialized in giving micro-loans and does not provide the services of traditional banks.[8] The data used in the analysis are extracted manually from the published annual financial reports for the financial year ending at 31/12/2020, available at the website of the Damascus Securities Exchange.

Model 1 and Model 2 (Table 2) should reflect the production approach where only physical inputs are needed for the production process. Following the literature, two inputs are taken into account: Labor and capital (Berger & Humphrey, 1997); (Sealey Jr. & Lindley, 1977). The level of labor input is proxied by the labor expenses since data on the number of employees are not available.[9] The level of fixed assets should serve as a proxy for the cost of physical capital (Heffernan, 2005); (Drake & Hall, 2003). The total amount of loans or deposits are used as a proxy for the level of outputs as the level of loans or deposits should be proportional to the number of transactions and documents processed during a period (Berger & Humphrey, 1992); (Sealey Jr. & Lindley, 1977); (Pastor, et al., 1997).

Models 3, 4, and 5 should reflect the intermediation approach where an additional input (or an intermediate product) is needed for the production process: deposits or its costs (Sealey Jr. & Lindley, 1977); (Berger & Humphrey, 1997); (Paradi, et al., 2017). The outputs of banks are proxied by the value of loans and other earning assets (Paradi, et al., 2017); (Drake & Hall, 2003).[10] As efficiency is a measure of the level of produced outputs from the level of used inputs during a period, it is argued that flow measures instead of stock measures should be used in measuring efficiency.[11] In Model 5, only flow measures are used in the analysis.

One of the debated points in efficiency literature is the necessitate to control for bad loans as an undesirable output when analyzing efficiency. (Berger & Humphrey, 1997) argue that this problem could be solved by searching for the potential cause of these bad loans. If bad loans were resulted from exogenous circumstances, then there is a need to control for bad loans to eliminate their possible effect on estimated efficiency scores. But if bad loans resulted from "bad management", then bad loans are one of the indicators for the inefficient management and there is no need to control for them (Berger & Humphrey, 1997) (Drake & Hall, 2003). This study

[7] For more discussion of Islamic banks and their special business models see for example (Heffernan, 2005).

[8] More information is available at the website of the bank: https://www.ibdaabanksyria.com.sy/.

[9] For more discussion of this issue see (Pastor, et al., 1997); (Paradi, et al., 2017); (Drake & Hall, 2003).

[10] It should be noted that loans in the intermediation approach is a reflection of the banks′ ability to generate profits whereas in the production process they serve as a proxy for the level of transactions or documents processed during a period.

[11] For more discussion of this issue see (Berger & Humphrey, 1992). Sealey and Lindley contested this argument and asserted that level of loans, deposits…at a specific date are the results of efforts during a whole period (Sealey Jr. & Lindley, 1977).

ignores controlling for bad loans for two reasons: first, the sample in the analysis contains ten DMUs and this allows the use of three variables (the total number of inputs and outputs) by the rule of thumb mentioned earlier. As bad loans cannot be taken as the only product of a bank, a model with one input and two outputs should be utilized. Such model neglects the input-side because only one input is considered.[12] Second, it is still controversary if bad loans should be taken into account when measuring efficiency or if they can be ignored.[13]

5. Results

Descriptive statistics of the five models are presented in Table 3. The overall mean efficiency scores (technical and scale) range from 0.326 (model 1) to 0.58 (Model 5). This significant overall inefficiency of private banks is mainly the result of scale inefficiency. As it can be seen from Figure 1, the mean of scale efficiency in all models is lower than the mean of pure technical efficiency. All banks (with the exception of bank Bemo) are operating with increasing return to scale.

Table 3: Summary statistics of models 1 to 5

Models		Mean	Median	SD	Min	Max
Model 1	Overall tech. Eff.	0.3256	0.2845	0.2599	0.0550	1
	Pure tech. Eff	0.6967	0.6735	0.2889	0.2480	1
	Scale Eff.	0.4720	0.4090	0.2796	0.1880	1
Model 2	Overall tech. Eff.	0.5535	0.4800	0.2023	0.3630	1
	Pure tech. Eff	0.8105	0.9290	0.2418	0.4460	1
	Scale Eff.	0.7108	0.7385	0.2069	0.4340	1
Model 3	Overall tech. Eff.	0.4456	0.3995	0.2587	0.0930	1
	Pure tech. Eff.	0.7243	0.6665	0.2629	0.2290	1
	Scale Eff.	0.6046	0.5835	0.2497	0.2910	1
Model 4	Overall tech. Eff.	0.5457	0.4760	0.1949	0.3580	1
	Pure tech. Eff.	0.8250	0.8175	0.1756	0.5300	1
	Scale Eff.	0.1614	0.6485	0.2125	0.3580	1
Model 5	Overall tech. Eff.	0.5868	0.5480	0.1882	0.3740	1
	Pure tech. Eff.	0.8497	0.8830	0.1624	0.5300	1
	Scale Eff.	0.7049	0.6990	0.2053	0.3740	1

[12] In the empirical analysis, a model with two inputs and two outputs is applied but the result was that most DMUs from the sample are VRS-efficient. This problem is known in the literature, see for example (Fethi & Pasiouras, 2010). The model and the results could be sent under request.

[13] For more information about bad loans and their possible effect on efficiency measures see (Berger & Humphrey, 1997); (Drake & Hall, 2003).

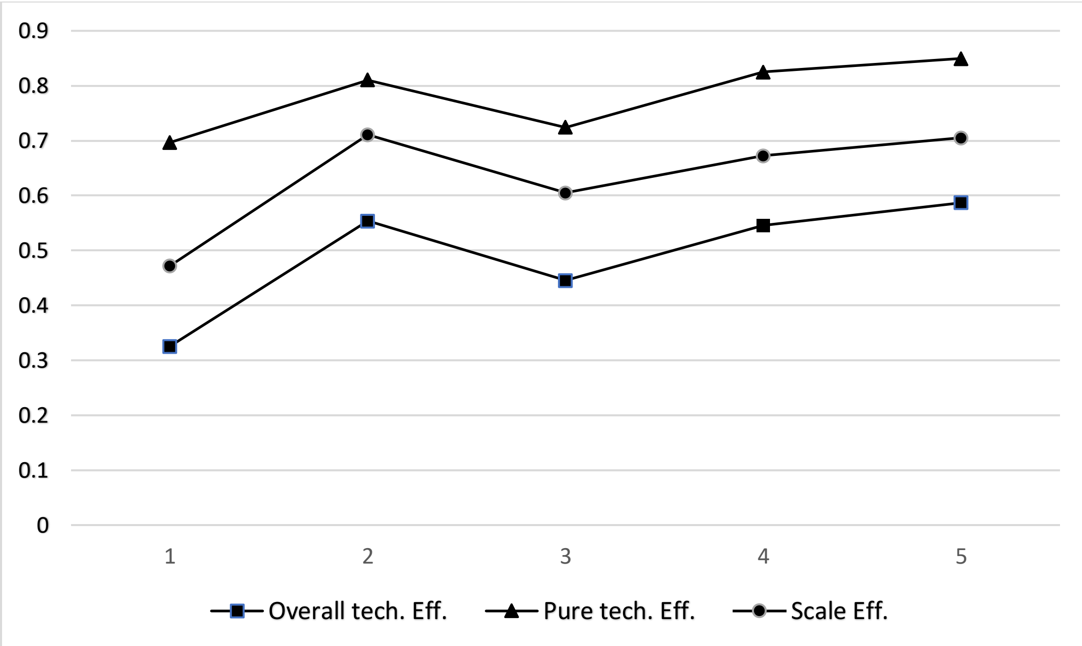

Figure 1: The mean scores of overall technical, pure technical and Scale efficiencies from the five models

Table 4: Overall technical efficiency scores

Bank	Model 1	Model 2	Model 3	Model 4	Model 5
Syria Gulf Bank	1	0.799	1	0.423	0.459
The international Bank for Trade & Finance	0.396	1	0.396	0.651	0.764
Bank of Jordan Syria	0.379	0.437	0.665	0.358	0.374
Fransabank Syria	0.315	0.377	0.569	0.383	0.587
Bank Alsharq	0.312	0.563	0.377	0.467	0.509
Qatar National Bank- Syria	0.257	0.434	0.403	1	1
Byblos Bank Syria	0.221	0.363	0.486	0.485	0.485
Banque Bemo Saudi Fransi	0.188	0.486	0.291	0.417	0.417
Arab Bank- Syria	0.133	0.602	0.176	0.588	0.588
Bank of Syria and Overseas	0.055	0.474	0.093	0.685	0.685

The reason for the low scale efficiency scores could be ascribed to the deliberate reduction in lending activities by private banks as a reaction to the uncertain business environments and the close of branches in some areas. Private banks suffer also from technical inefficiency as the average of pure technical efficiency scores does not exceed the threshold of 80 % in all five models. This means that Syrian private banks could reduce their input-usage by over 20% and have the same level of outputs. This result is in line with the results of (Safiullah & Shamsuddin, 2020) were they found that private banks could reduce their input-usage by 19.5%. Also, the study of (Haque & Brown, 2017) found that Syrian private banks suffer from cost inefficiency. However, the level of inefficiency scores from (Haque & Brown, 2017) or from (Safiullah & Shamsuddin, 2020) cannot be compared directly with the level of inefficiency scores from this study since the DEA is a technic that estimates efficiency of a group of banks by comparing banks from the group with each other. It seems that the inefficiency of Syrian private banks documented in the studies of (Kaddaj, 2010), (Mobarek & Kalonov, 2014), and (Al-Muharrami, 2015) for the years until 2010 (before the beginning of unrest) continued during the years of unrest, as it is observed by the study of (Aldeen, et al., 2020) for the years 2011 until 2017, and as it is reported by this study for the year 2020.

As it can be seen from Figure 2, the Qatar National Bank- Syria is in Models 1, 2, and 3 pure technically efficient with efficient scores of 0.971, 1, and 0.971 respectively but the Bank is scale inefficient with scale efficiency scores of 0.264 IRS, 0.434 IRS, and 0.415 IRS respectively. These results indicate to possible additional efficiency gains by the Qatar National Bank- Syria through raising the level of its operations. This scale inefficiency disappears in Models 4 and 5 (output: interest income, Inputs: labor expenses, interest cost, labor expenses and other operating expenses), and the Bank is pure technically and scale efficient. The Qatar National Bank- Syria is the best practice bank in the sample. These results are consistent with the results of traditional analysis of banks′ performance: The return on asset of the Qatar National Bank- Syria is the highest among the private banks (1.8 after excluding the unrealized gains from revaluation of the so called structural foreign currency from net income). The ratio of interest income to interest cost for Qatar National Bank- Syria is 6 to 1, whereas this ratio does not exceed the threshold of 4 to 1 for all other private banks. This high ratio of interest income to interest cost cannot be explained by intensive lending as the amount of loans is one of the lowest amounts among private banks (only about 12 billion SP, comparing with 97 billion SP for Banque Bemo Saudi Fransi). A possible explanation of this high ratio is the high level of investment in Securities (about 36 billion SP, comparing with 8.85 billion SP for Banque Bemo).

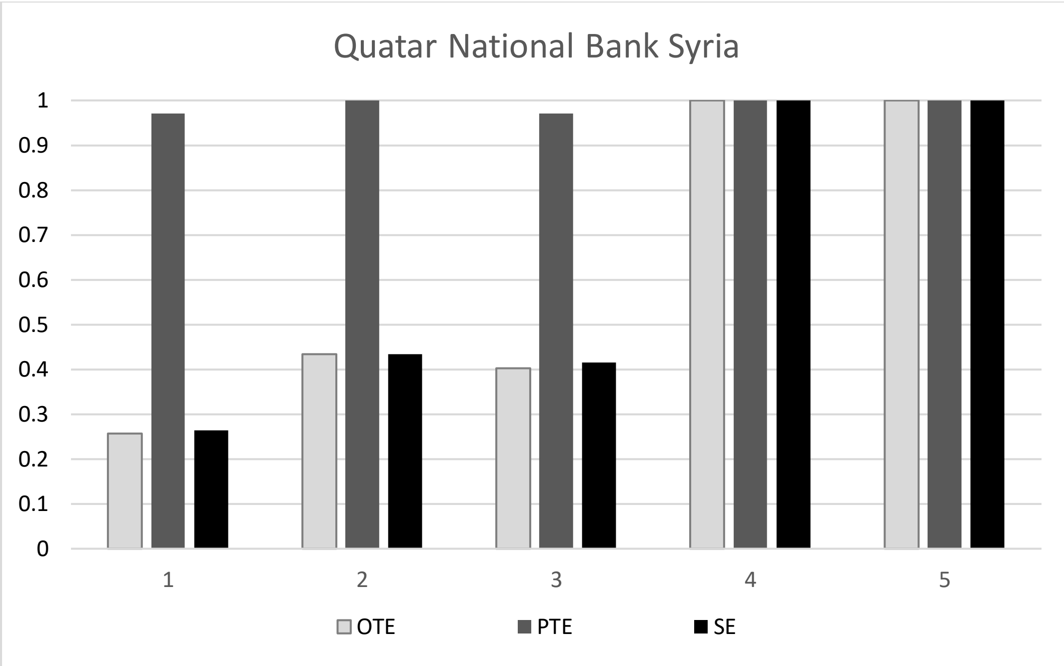

Figure 2: The efficiency scores of Qatar National Bank Syria from the five models

The results of Banque Bemo Saudi Fransi are very interesting as the bank has very low scale efficiency scores in all models (ranking in places 10, 8, 10, 9, 9 respectively, with decreasing return to scale), but the bank is pure technically efficient in all models. Figure 3 shows the efficiency scores of Banque Bemo from the five models. The bank does not exhibit X-inefficiency (represented by technical efficiency), this means that the overall inefficiency is only the result of scale-inefficiency. By taking a look to the amount of loans (97 billion SP), deposits (533 billion SP), interest income (19 billion SP), interest cost (7 billion SP), Labor expenses (9 billion SP), and other operating expenses (3 billion SP); they are the highest amounts among private Syrian banks. This high level of operations is not associated with better Performance: ROA is only 0.15, the loan loss provision of 24 billion SP is much higher than the provisions of other banks (the next highest amount is 7 billion SP). These results suggest a necessaire reduction in the level of its lending activities.

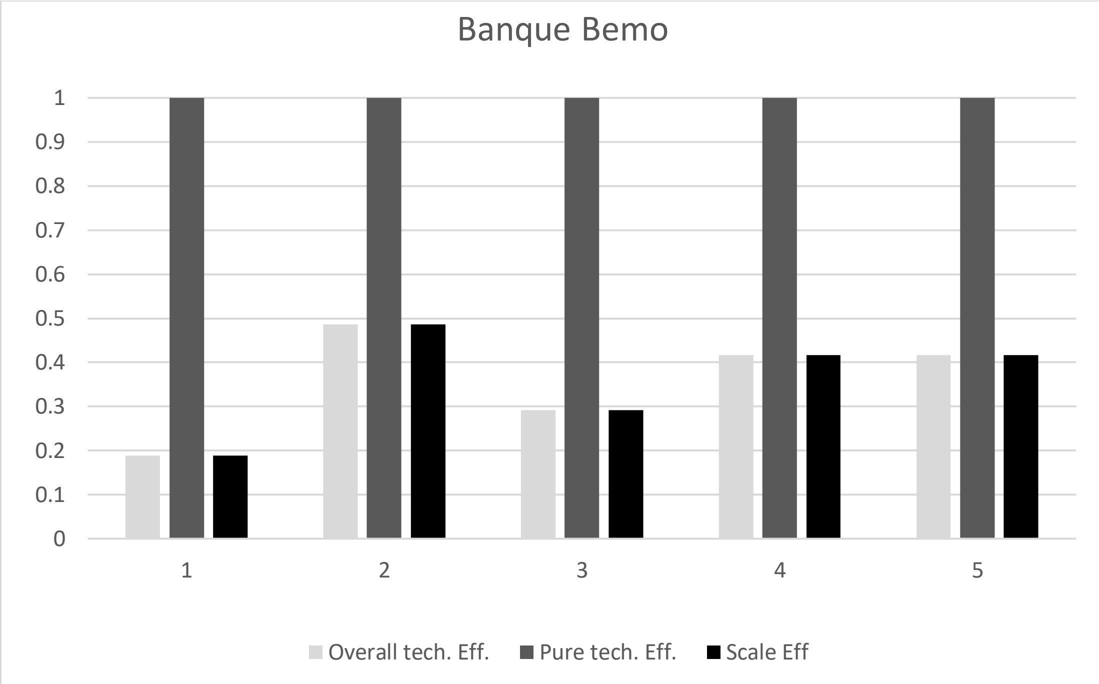

Figure 3: The efficiency scores of Banque Bemo from the five models

Syria Gulf Bank is an efficient bank, if the amount of loans or deposits are considered as outputs (Models 1, 2, and 3), but if the ability of the bank to generate revenues (interest income) are taken into account when measuring efficiency, the bank is technically and scale inefficient. The bank has direct loans to customer in an amount of 69 billion SP with interest income of 3.7 billion SP. In contrast, the Qatar National Bank- Syria has direct loans in an amount of 12.5 billion SP with interest income of 6.5 billion SP. These differences could be explained only through the interest income from investment in securities at amortized costs: 36 billion SP vs. zero for Syria Gulf Bank.

Bank of Jordan Syria has very low overall inefficiency scores. As the bank is pure technically efficient in all models, this inefficiency is the result of scale inefficiency. A first look for net income could show a contradiction with the efficiency scores from DEA analysis as the bank reports net income of 19543426141 for the fiscal year ending 31/12/2020, but if unrealized gains from revaluation of structural foreign currency are excluded from net income, the bank occur a loss of over 1 billion Sy. Pound. Losses are reported over most of the fiscal years during the period of 2010 until 2020 (with exception of two fiscal years). The lowest level of direct loans, customer deposits, labor expenses among private banks and the very low scale efficiency scores indicate efforts from the management's side to decrease the scale of operations.

Bank Syria and Oversee is pure technically and scale inefficient, as the results from the five investigated model reveal. The bank has the lowest ratio of loans to customer deposits in year 2020 (the ratio is 5.8%) and suffers from losses, if the

unrealized gains excluded from the net income. The financial report of the bank for year 2020 did not include any comments of the managements' side about the modest financial indicators or the efforts that the bank will follow to correct this situation.
Inefficiency scores are also observed for Bank Alsharq, Arab Bank- Syria, Fransabank Syria. The low efficiency scores and the modest financial indicators raise the question about the management efforts to improve their financial and operating results. The financial reports of the Syrian private banks for the year 2020 and other disclosures have been manual checked to answer this question. Most banks plan to expand their lending activities for commercial purposes which are in nature short-term lending. There are also plans to open new branches and to provide new financial services. Only one bank, Qatar National Bank- Syria, refers to the importance of operational efficiency and the necessitate to cut costs to improve financial performance; this is the bank that has the highest efficiency scores in the five models and also it has the best financial indicators between Syrian private banks.
Berger et al. (1993) have argued that the chosen inputs and outputs influence the estimated efficiency scores even without changing the measurement method. To investigate the sensitivity of DEA- results to the chosen inputs and outputs, the rank correlations between the five models are calculated and the results are presented in Table 5. Model 1 vs Model 3 and Model 4 vs Model 5 show high level of rank correlation in the overall efficiency scores (0.81 and 0.78 respectively). This high level of rank correlation is expected from the similarity in inputs and outputs of these models. A very low positive rank correlation or even a moderate negative rank correlation could be observed between the pairwise comparisons of Models 1, 2, and 3 from one side and Models 4, and 5 from the other side. This confirms the possible effect of the chosen inputs and outputs on the efficiency scores and the efficiency rank of the UDMs.[14]

Table 5: Spearman correlation between the ranking of overall technical efficiency scores from the different models

Models	1	2	3	4	5
1	1				
2	0.2848	1			
3	0.8061	-0.2242	1		
4	-0.3818	0.1636	-0.5151	1	
5	-0.1515	0.0667	-0.3454	0.7818	1

[14] For more discussion of the effect of different methods and models on the efficiency scores and ranking see (Berger, et al., 1993).

6. Conclusion

In this study, the efficiency of Syrian private banks was analyzed. To achieve this purpose, a non-parametric frontier approach (DEA) has been applied and five models were used that reflect the two main approaches about the nature of the banks′ production process. An input- oriented version is chosen, as managers have more control over their inputs.

Pure technical efficiency scores and scale scores were estimated from current cross-sectional data using the DEAP software Version 2.1. The results of these models were compared with the results of the traditional analysis of performance to investigate the consistency of the results. The rank correlation for the overall efficiency scores from the five models were calculated to study the sensitivity of the efficiency scores and ranks for change in the chosen inputs and/ or outputs.

The results showed that most private banks operate with increasing return to scale. It is hard to believe that banks should increase their level of operations by increasing their lending activities. The experience of Banque Bemo confirms this conclusion, as the bank has the highest amount of loans (about 97 bill. SP) but also it has the highest loan loss provisions (24 bill. SP).[15]Syrian private banks should search for other investment opportunities, maybe outside Syria.

The mean scores of the pure technical efficiency (between 0.6967 from Model 1 and 0.8497 from model 5) suggest a possible gain of efficiency by additional cost reduction through decreasing the input-usage. The number of employees, branches and the amount of deposits (as they cause costs for banks) should be reviewed and reduced if necessary.

In this study, only current cross-sectional data are used. Further researches on efficiency that take into account data over years are also needed.[16]DEA- approach can alternatively be applied on cross sectional data over years to shed more light over the changes of efficiency of the individual DMUs over years or in comparisons with other DMUs. It is questionable, if it is possible to apply a parametric approach to measure efficiency of Syrian private banks as there are only 11 private banks.

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[15]Private banks prefer to hold cash than to increase their lending activities. For example, Banque Bemo has an amount of cash, balances with the central bank of Syria, and balance with other banks of about 490 bill. SP. whereas the amount of loans is only about 97 bill. SP. Other banks have also very high levels of cash holding.

[16] The windows analysis approach can for example be used, for more details about the approach see (Paradi, et al., 2017).

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