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IMPACT OF FINANCIAL CRISIS ON BANKING SECTOR EFFICIENCY IN THE ARAB WORLD

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This paper examines the impact of 2007 financial crisis on the efficiency of 49 banks listed in the Forbes top 100 companies in the Arab World, by applying Data Envelopment Analysis (DEA). The intermediation process was applied with net interest income and non-interest income as outputs and interest expense and non-interest expense as inputs. DEA is used to estimate the overall technical efficiency for each bank which is composed of two components: scale efficiency and pure technical efficiency. The empirical results suggest that during financial crisis banks suffered from lower technical efficiency as a result of deterioration in pure technical efficiency. The lower levels of both technical and pure technical efficiency can be attributed to the close bonds of the region with the international financial system. Also, DEA identified the interest expense as the most common source of inefficiency for the studied banks during the financial crisis period.

Keywords: banking sector, financial crisis, efficiency, data envelopment analysis

1. Introduction

The global financial had a significant impact on Arab countries economies, however, the magnitude of the impact varied across the region and economic sector according to each country's economic linkages with the global market and its trading activities. For instance, in case of non-oil producing countries, such as Lebanon, Morocco, Egypt, and Jordan, the effect of financial crisis was channeled by the reduction in external demand from European

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countries, alongside with the drop in financial flows from both tourism and remittances. IMF (2009a, 2009b) estimated that on average manufactured export of Arab countries declined by 16 percent in 2009. For oil producing countries, such as United Arab Emirates, Saudi Arabia, Bahrain, Oman, Qatar and Kuwait, the effect of financial crisis was through the dependence on oil prices to finance economic activity in such countries. Most energy-exporting countries on average experience 50–75 percent reduction in their export revenue on the 2007-2009 periods (Siddiqi, 2009). Moreover, a decline in the economic activity, negative investment sentiment, fear or panic attributed to financial crisis led loss of value of financial institutions and other financial assets and consequently impacted their performance. For instance, on average, the stock market indices of the Arab countries crashed by more than 50 percent over 2008-2009 periods, and also many banks in Dubai, Bahrain and Saudi Arabia were at risk of insolvency (IMF, 2009 & Brach and Loewe, 2010).

This paper seeks to assess the effects of financial crisis on the banks efficiency during and after financial crisis for several Arab countries including: Saudi Arabia, Bahrain, Morocco, Lebanon, Kuwait, Oman, Egypt, Jordan, Qatar and UAE, over the three sub-periods 2003–2006, 2007–2010 and 2011–2014. The empirical evidence on bank efficiency aims to compare the efficiency between banks operating in non-oil producing countries and banks operating in oil producing countries during and after financial crisis.

To do so, the bank level of efficiency would be computed and each bank would be assigned a numerical efficiency value to other banks. The efficiency measured in this paper would be the technical efficiency (TE), which measures the ability of a bank to obtain the maximum output using a certain level of inputs. Also, technical efficiency would be split into two components: scale efficiency (SE) and pure technical efficiency (PTE). For SE, it measures the bank optimal size of operations and any modification in its size would alter the firm efficiency. As for PTE, it measures the efficiency that devoid the impact of SE and reflects how effective the firm is in implementing production plan to convert inputs to outputs.

While there are a number of studies that examined the impact of global financial crisis on the banking sector, however, there is lack of consistent results. Moreover, results are mostly country or region specific. For instance, Forughi and De Zoysa (2012) and Moradi-Motlagh and Babacan (2015) noted adverse effect of financial crisis on Banking sector in Australia, Gulati and Kumar (2016) found adverse effect on Indian Banking sector,Matausek et.al (2015) noted adverse effect of global financial crisis in case of ‘old’ European and Eurozone countries. To best of our knowledge there is no extensive study that examined the impact of global financial crisis on banking sector efficiency in Arab countries over an extended period of time. Case study of Arab countries is unique for the following reasons: (1) global financial crisis hit Arab countries during the period these countries were experience above average economic growth; (2) non-oil exporting Arab countries are less vulnerable to financial crisis as they are only weakly integrated into international trade and capital markets; (3) most of the oil-exporting countries which were hard hit by financial crisis were able to weather the crisis because they had substantial financial reserves accumulated during the preceding booming years; (4) Banks in the

Arab countries are based on Islamic principles of finance (which states that all financial transaction must be trade-based and Asset linked) and some studies claim that this makes such Banks less vulnerable to financial crisis (Smolo and Mirakhor, 2010; Hidayat and Abduh, 2012).

The rest the paper is organized as follows: section two provides literature review. Section three discusses choice of variables and data sources and section four discusses choice of bank's inputs and outputs. Section five provides data description and section six discusses the empirical result. Section seven concludes the finding.

2. Literature Review

Data Envelopment Analysis (DEA) has been increasingly popular modeling tool to measure efficiency of banks over the years. A paper by Emrouznejad et al. (2008), have pointed out more than 4,000 studies by 2,500 authors using DEA to measure banks efficiency. The overwhelming majority of the empirical evidence comes from studies on banking industry in both the US and Europe due to easier widespread of data availability.

One of the earliest studies in measuring efficiency between different countries was a study by Berg el al. (1993) using DEA. The data set consisted of banks from Norway, Finland and Sweden for the year 1990 with labor and capital as inputs and total loans, total deposits and number of bank branches as outputs. Sweden banks had the highest technical efficiency, followed by Finland and Norway respectively.

Another study by Fecher and Pestieu (1993) looked at the efficiency on 11 OECD countries between 1971 and 1986. The inputs taken were number of employees and capital, while the outputs were aggregate value added. The results showed that efficiency ranges between 0.980 for Japan (the highest) and 0.670 for Denmark 9 (the lowest) with US banks to have the second lowest technical efficiency score of 0.710.

Another study conducted by Pastor (1997) who studied the technical and scale efficiency for 427 banks from eight countries that included United States, Spain, Germany, Italy, Austria, United Kingdom, France,and Belgium. The input variable included was non-interest expense and the output variables included were total deposits, total loans and investments. The results for technical efficiency showed the highest results for France at 0.950 level followed by Spain 0.822, Belgium 0.806, Italy 0.773, Germany 0.650, US 0.624 and UK 0.537. As for scale efficiency, France had the highest efficiency at 0.999 followed by UK 0.980, Spain 0.918, Belgium 0.872, US 0.769, Germany 0.694 and Austria 0.654.

A study by Casu and Molyneux (2003) investigated the efficiency of 750 European banks between 1993 and 1997 including five countries: France, Spain, UK, Italy, and Germany. Two inputs were included in this study: total costs and short term funding; while total loans and other earning assets are considered as outputs. The results obtained reflected low technical efficiency for all countries having minor improvements in technical efficiency throughout the period included in the study, except for Italy which had a case of decreased efficiency. The UK had the highest efficiency of 0.782 followed by Germany 0.720, France 0.623, Spain 0.570 and Italy 0.538.

Another study by Weill (2003) examined efficiency in 47 banks for the year 1997. The study tool into account 31 banks from Poland (19 domestic banks and 12 foreign banks) and 16 banks from Czech Republic (8 domestic banks and 8 foreign banks). The estimation for technical efficiency was carried out by using personnel expenses, interest expenses and non-interest expenses as inputs; whereas outputs were total loans and investment assets. The results obtained suggested that foreign banks were more efficient when compared to domestic banks in both Poland and Czech Republic. The average technical efficiency for foreign banks in both Poland and Czech was 0.704 when compared to domestic banks at 0.620.

A similar conclusion was obtained by Bonin el al (2005), who investigated the efficiency for 225 banks from Bulgaria, Czech Republic, Poland, Romania, Slovakia, Lithuania, Latvia, Hungary, Croatia, Estonia, and Slovenia. In the mentioned research, the input was capital and four outputs which were total loans, total deposits, liquid assets, and investments. The results revealed that foreign banks were more technically efficient than domestic banks.

A study undertaken by Grigorian and Manole (2006), which included 1,074 banks in 17 transitional economies measured technical efficiency for the period 1995-1998. They used two models A and B, with both models having the same inputs but different outputs. Labor, fixed assets and interest expenses were used as inputs in both models. As for outputs, model A used revenues, net loans, and liquid assets (including cash, balances with monetary authorities and holdings of T-Bills), while model B utilized total deposits, net loans, and liquid assets. The results obtained under model Ashowed that in majority of the countries, banks had improved technical efficiency over time, while in model B, the results revealed a decrease in technical efficiency for banks operating in five countries: Slovak Republic, Moldova, Romania, Ukraine, and Latvia.

A study by Attaullah et al. (2004) investigated the technical efficiency of banks in Pakistan and India over three periods: pre-liberalization period (1988–1991), transition period (1992–1994) and post-liberalization period (1995–1998). The research had two different models (A and B), but both used operating expense and interest expenses inputs. In terms of outputs, model A used total loans and investments and model B used interest and non-interest income. The results obtained reflected an increased overall technical efficiency following the financial liberalization in both Indian and Pakistani banks. Also, the results reflected a higher efficiency for banks using model A compared to model B.

There has been limited empirical evidence in the area of measuring banks' efficiency in Arab countries, apart from few attempts focusing on individual countries. One of the few studies focusing on different Arab countries was done by Mostafa (2007), whomeasured the relative efficiency for top 100 Arab banks for the year 2005. He employed two input and three output variables. The input variables included total assets and capital; while the output variables included net profit, rate on equity (ROE) and rate on assets (ROA). Of these banks, only Banque de Caire (Egypt), National Bank of UAQ (UAE), United Arab Bank (UAE) and Egyptian American Bank (Egypt) were technically efficient. On the other side, the study revealed that efficiency scores for Arab World banks were lower than the

banks in developed countries. Emrouznejad and Anouze (2009) used the same inputs and outputs as in Mostafa (2007) and reported that the results obtained by Mostafa (2007) were incorrect with Banque de Caire and Suez Canal Bank being ranked as highest in terms of efficiency, according to Mostafa (2007), while in the later research they were ranked as two poor performing banks, according to Emrouznejad and Anouze (2009).

Other studies examined efficiency per country such as a study by Al-Faraj et al. (1993), who focused on measuring the relative efficiency of 15 branches of one of the biggest banks in Saudi Arabia, using one year data with eight inputs and seven outputs. The results revealed out of the 15 branches, 12 were working at efficiently. Al-Shammari and Salimi (1998) examined the efficiency of 16 Jordanian banks over the 1991-1994 period and found that the majority of Jordanian banks were not efficient. The research revealed poor performance of all the banks in the sample in period between 1991 and 1992. Another study by Hassan et al. (2004) evaluated five efficiency measures: cost, allocative, technical, pure technical and scale efficiency for 31 banks operating in Bahrain for the period 1998-2000 and found that all banks had improved their efficiency levels in the analyzed period. A study implemented by Zreika et al. (2011) examined technical efficiency of 40 banks operating in Lebanon over two periods 2002–2006 and 2006–2009 and found that technical efficiency was higher in bigger banks when compared to smaller banks in terms of total assets.

Based on the above studies, there are very little empirical studies focusing on measuring efficiency for different Arab countries. The main aim of this paper is to fill the significant gap in literature review by measuring the efficiency of 49 largest banks from 10 different Arab countries for three sub periods 2003–2006, 2007–2010 and 2011–2014.

3. Choice of Variables and Data Sources

This study employed a non-parametric Data Envelopment Analysis (DEA) to analyze input-oriented technical efficiency of 49 largest Arab banks. DEA is a mathematical programing oriented model for evaluating the efficiency of set of banks called decision making units (DMUs), which convert multiple inputs to multiple outputs. DEA would allow us to indicate the relative efficiency from a population of observations, with the objective of extrapolating a discrete piecewise frontier determined by the set of Pareto-efficient decision-making units. When using traditional parametric methods, one assumes that the optimized regression applies to each decision-making unit, while DEA on the other hand optimizes the measure of performance for each individual decision making unit. The advantage of this approach is that the analyst is able to reveal greater understanding of each DMU instead of the depiction of a mythical average DMU. Perhaps one of the greatest advantages of any form of non-parametric analysis as compared to parametric analysis is that a parametric approach requires the imposition of a specific functional form – for example, linear regression, non-linear regression, or production function. Furthermore, the choice of functional form often requires the assumption of independently and identically normally distributed error terms. Data envelopment analysis does not require any assumptions regarding functional form as DEA calculates an optimal performance measure for each

DMU relative to all other decision making units contained within the observed population. However, it is important to note that the performance measure produced by DEA is a relative measure not an absolute one. This in turn means that the resulting measures are truly empirical and are sensitive to the population of observed DMUs used DEA produces a piecewise empirical external production surface which in economic terms represents the revealed best practice production frontier. That is, the frontier produced represents the maximum output empirically obtainable from any DMU contained within the observed population. The sole requirement of the DEA model is that each DMU lie on or below the external frontier. DEA has traditionally been used in microeconomic analysis to examine the performance of particular DMU's. For example, DEA has been used extensively to analyze the performance of public health and educational institutions (see Alfonso et. Al (2005) andSt. Aubyn, (2002, 2003)).

This paper adopts an input-orientated approach, which was initially adapted by Koopmans (1951) and Farrel (1957), where a firm uses two inputs (X1 and X2) and a single output Y (Fig. 1). Curve SS' represents the unit isoquant of fully efficient firms, which allows the measurement of technical efficiency. Any point on this curve would mean that the firm is technically efficient.

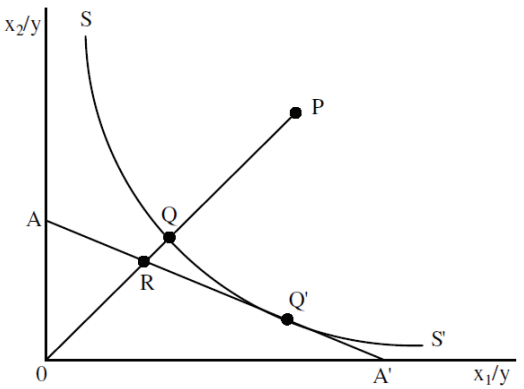

Figure 1: Technical and allocative efficiency.
Source: Coelli*et al*. (1998)

The value for technical efficiency would vary between zero to one, where zero means the firm is fully technically inefficient and one means that the firm is fully technically efficient. This means at point Q, the firm will be technically efficient but allocatively inefficient. In order to be allocatively efficient, the production cost should decrease by the distance RQ, so the production take place at the technically and allocatively efficient point Q'.

Overall efficiency, technical efficiency and allocative efficiency are restricted to numbers between one and Zero. When measuring the three kinds of efficiencies, the subscript "*i*" is used to indicate that it is an input-oriented or input-minimizing measure. An input minimizing measure concentrates on how much would be the reduction in input quantity with no change in the output produced. Whereas, an output-maximizing measure focuses on how much the output can be increased with no reduction in the input levels used.

Initially, using the assumption of constant returns to scale, for each DMU_j ($j = 1, 2,\ldots N$) we would like to obtain a measure of the relation of all outputs over all inputs, such as ($U'Y_i$)/$V'X_i$ where U is an mx1 vector of output weights and V is a k*1 vector of input weights. The optimum weights are selected by specifying the mathematical programming problem:

$$\begin{aligned} & \max_{(U,V)} (U'Y_i)/V'X_i), \\ \text{subject to:} \quad & (U'Y_j)/V'X_j \leq 1 \\ & U,V \geq 0 \qquad j = 1, 2,\ldots N \end{aligned}$$

This involves finding values of U and V that maximize the efficiency measure of the ith DMU subject to the constraint that all efficiency measures are less than 1. This particular formulation has the potential for an infinite number of solutions. To avoid this, one can impose the constraint $V'X_i = 1$:

$$\begin{aligned} & \max_{(U,V)} (U'Y_i) \\ \text{subject to:} \quad & V'X_j = 1 \\ & \mu,V \geq 0 \qquad j = 1, 2,\ldots N \end{aligned}$$

The transformation is reflected in the change of notation from U and V to μ and V. This is known as the multiplier form of the linear programming problem. Using the duality in linear programming, one can derive an equivalent envelopment form of this problem:

$$\begin{aligned} & \min_{(\theta,\lambda)}\theta \\ \text{subject to:} \quad & -Y_i + Y\lambda \geq 0 \\ & \theta X_i - X\lambda \geq 0 \\ & \lambda \geq 0 \end{aligned}$$

where θ is a scalar and λ is a Nx1 vector of constants. The envelopment form is generally preferred over the multiplier form as it involves fewer constraints. From the envelopment form, θ will be the efficiency score for the DMU. The efficiency score can be less than or equal to one where an efficiency score of one indicates a point on the frontier and hence a technically efficient DMU. It is important to note that the efficiencies measures produced by DEA are a relative measure not an absolute one. This in turn means that the resulting measures are truly empirical and sensitive to the number of banks included. In this study, DEA will be applied to calculate technical efficiency, pure technical efficiency and scale efficiency.

4. Choice of Bank's Inputs and Outputs

The choice of banks' inputs and outputs variables required for estimating relative efficiency remain an argumentative issue among researchers, mainly because of financial intermediaries' functions. In efficiency literature, there are four approaches used which are: intermediation, production, value added and user cost. For intermediation approach, the banks are considered as financial intermediaries between savers and investors. Under intermediation approach most commonly used output variables are net loans, net interest income and non-interest income. As for input variables, four inputs are commonly used, which are staff numbers, deposits, interest expense and non-interest expense. As for

production approach, banks would be considered as production centers of services to customers with labor, capital and funds as outputs and short term loans, long term loans and other earning assets as inputs. Under the value added approach, value creating activities would be considered such as loans and deposits for outputs and physical capital, labor and purchased funds as inputs (Wheelock and Wilson, 1995). Under user-cost approach, banks are considered as financial services' producers, where every asset and liability would be considered either an input or output depending whether the asset or liability is higher or lower than the opportunity cost (Hancock, 1991).

The intermediation and production approaches are among most widely used approaches. Their main difference is in the specification of banking activities where banks are considered as financial intermediaries under intermediation approach and as production centers under production approach (Denizer et al, 2000). This study adopts the intermediation approach, since it has fewer problems with the needed data when compared to other approaches (Heffernan 2005). Another major reason behind using the intermediation approach is other approaches ignore interest expenses and off-balance sheet activities, which are considered to account for one-half to two-thirds of total costs (Berger and Humphrey, 1997). The present study will specify two outputs: net interest income (proxy for net loans) and non-interest income (proxy for other banking activities). The two chosen inputs are interest expense (proxy for deposits) and non-interest expense (proxy for expenses not attributable to income from deposits).

5. Data

In this paper, the data for inputs and outputs variables was extracted from Thomson Reuter's database for the periods between 2003 till 2014 (please refer to Table 1 for the complete list of banks included). The study included 49 banks: three from Bahrain, one from Egypt, two from Jordan, five from Kuwait, four from Lebanon, three from Morocco, one from Oman, eight from Qatar, 12 from Saudi Arabia and 10 from UAE. Due to DEA data requirements, we have excluded three banks for period 2007-2010 and five banks for period 2003-2006 due to either missing some financial information or they have negative financial data which is defined as "positivity" requirement of DEA.

Table 1: List of banks included in the study

Name	Country	Name	Country
Abu Dhabi Commercial Bank	U.A.E.	Commercial Bank of Kuwait	Kuwait
Abu Dhabi Islamic Bank	U.A.E.	Commercial Bank of Qatar	Qatar
Ahli Bank Qatar	Qatar	Commercial International Bank	Egypt
Ahli United Bank	Bahrain	Doha Bank	Qatar
Al Ahli Bank Of Kuwait	Kuwait	Dubai Islamic Bank	U.A.E.
Al Baraka Banking Group	Bahrain	Emirates NBD	U.A.E.
Al Khalij Commercial Bank	Qatar	First Gulf Bank	U.A.E.
Al Rajhi Bank	Saudi Arabia	Gulf Bank	Kuwait

Name	Country	Name	Country
Alinma Bank	Saudi Arabia	Housing Bank	Jordan
Arab Bank	Jordan	Kuwait Finance House	Kuwait
Arab Banking Corporation	Bahrain	Mashreq Bank	U.A.E.
Arab National Bank	Saudi Arabia	Masraf Al Rayan	Qatar
Attijariwafa Bank	Morocco	National Bank of Abu Dhabi	U.A.E.
Bank Albilad	Saudi Arabia	National Bank of Kuwait	Kuwait
Bank AlJazira	Saudi Arabia	National Commercial Bank	Saudi Arabia
Bank Audi	Lebanon	Qatar International Islamic Bank	Qatar
Bank Muscat	Oman	Qatar Islamic Bank	Qatar
Bank Of Beirut	Lebanon	Qatar National Bank	Qatar
Banque Centrale Populaire	Morocco	RAKBANK	U.A.E.
BanqueMarocaine du Commerce Extérieur (BMCE)	Morocco	Riyad Bank	Saudi Arabia
		Samba Financial Group	Saudi Arabia
Banque Saudi Fransi	Saudi Arabia	Saudi British Bank	Saudi Arabia
BLOM Bank	Lebanon	Saudi Hollandi Bank	Saudi Arabia
Byblos Bank	Lebanon	Saudi Investment Bank	Saudi Arabia
Commercial Bank of Dubai	U.A.E.	Union National Bank	U.A.E.

For DEA, it is important to decide on the sample size due to relative sensitivity for the efficiency measure of each bank. This means if the sample size decreased to certain magnitude, it would affect the number of units that are identified as efficient. According to previous studies, there are two answers regarding the sample size offered by two researchers Dyson et al. (1998) and Sinuany-Stern et al. (1994). For Dyson et al. (1998), they assumed that the minimum accepted sample size should exceed the product number of outputs and inputs used in the study. As for Sinuany-Stern et al. (1994), the assumed the minimum number should be at least three times larger than the sum of number of inputs and outputs used. In this paper, the sample data exceeds the minimum number assumed for both Dyson and Sinuany-Stern. Table 2 portrays the descriptive statistics for inputs and outputs variables adopted in this study for the three periods.

Table 2: Descriptive statistics of inputs and outputs

Period 1: 2003–2006

Variable	No of Banks	Mean	SD	Min	Max
Net-interest Income	44	278.26	263.86	18.70	278.26
Non-Interest Income	44	192.34	172.28	5.00	192.34
Non-Interest Expense	44	164.54	138.82	12.90	164.54
Interest Expense	44	231.11	207.98	0.20	231.11

Variable	No of Banks	Mean	SD	Min	Max
Period 2: 2007–2010					
Net-interest Income	46	603.56	495.54	53.70	2505.10
Non-Interest Income	46	328.32	274.22	0.80	1281.70
Non-Interest Expense	46	356.07	307.76	16.50	2345.40
Interest Expense	46	474.56	361.55	0.60	1770.60
Period 3: 2011–2014					
Net-interest Income	49	809.07	404.23	16.50	1759.00
Non-Interest Income	49	442.33	404.23	8.70	3157.10
Non-Interest Expense	49	493.11	412.44	16.50	3266.60
Interest Expense	49	363.51	309.40	5.60	1759.00

Source: Data collected from Thomson Reuters (values are in US million Dollars)

6. Empirical Results

DEA involves the use of linear programming methods to construct a non-parametric surface over the given data set which optimizes each bank's observation. This would measure the relative efficiency of each bank with similar resources (inputs) to achieve gain or similar (outputs) (Perez el al., 1988). DEA results classify DMU into efficient and inefficient, with the most efficient scoring one. A DMU is considered technically inefficient if it scores less than one, which means that the DMU (or the bank in this case) can achieve the same level of output using less amount of inputs or would increase the level of output using the same level of inputs. The DEA approach was applied to 565 observations to construct the efficient frontier and predict the estimates of technical efficiency, pure technical efficiency and scale efficiency over the three periods. The DEA efficiency scores would range between 0 and 100%, where 100% denotes a fully efficient bank. The results in Table 2 demonstrate the average annual rates of efficiencies for all banks. The negative impact of the financial crisis on banks was apparent with a significant decrease in both technical efficiency and pure technical efficiency, where both the average technical efficiency and pure technical efficiency have decreased by 1.28% and 3.99% compared to the previous period (2003-2006). After the financial crisis, technical efficiency and pure technical efficiency have both increased by 20.19% and 14.49% respectively.

Table 3: Average annual efficiency

Period	Average Rate of TE	Average Rate of PTE	Average Rate of SE
All Banks			
2003–2006	0.622	0.726	0.865
2007–2010	0.614	0.697	0.891
2011–2014	0.738	0.798	0.929

Source: Authors' calculations. Note: TE denotes Technical Efficiency, PTE Pure Technical Efficiency and SE Scale Efficiency

During the period of 2003–2006, the average technical efficiency for the studied banks had an average of 0.622 with Al Rajhi Bank (Saudi Arabia), Bank Al Bilad (Saudi Arabia), Commercial Bank of Kuwait (Kuwait) and Bank Al Jazira (Saudi Arabia) are found to be operating at optimal scale. During financial crisis period, the average technical efficiency have decreased to 0.614 with Masraf Al Rayyan (Qatar) to be the only bank to be fully efficient in that period. A technical efficiency of 0.614 means that an average bank to be considered efficient would have needed 61.4% of the current inputs used; which suggest that inputs can be reduced by 38.6% on average, relative to the most efficient banks during that period. Furthermore, the decrease in technical efficiency during financial crisis could be attributed to deterioration in pure technical efficiency which have been reduced by 3.99% during the same period as seen in Table 3. However, the average technical efficiency have substantially increased to 0.738, and Al Rajhi Bank (Saudi Arabia), Bank Al Bilad (Saudi Arabia), and Samba Financial Group (Saudi Arabia) were found to be operating at optimal scale. Banks at optimal scale are maximizing their outputs at same level of inputs. Two banks from Saudi Arabia (Al Rajhi Bank and Bank Al Bilad) have dominated in terms of technical efficiency during all the three periods except during the financial crisis period where both banks were not operating at optimal scale. The only bank that operated at optimal scale during financial crisis was Masraf Al Rayyan (Qatar).

Pure technical efficiency measures how efficient the bank is in transforming their inputs into outputs disregarding the scale efficiency from the analysis. The average pure technical efficiency during 2003-2006 period was 0.726, which declined to 0.697 during the crisis period. The decline in pure technical efficiency during that period can be attributed to banks such as BMCE (Morocco) decreased by 48.01%, Abu Dhabi Commercial Bank (UAE) decreased by 35.19%, Bank Al Jazeera (Saudi Arabia) decreased by 30.93%. As per results shown in Table 3, the average pure technical efficiency have increased by 14.49%, to 0.798 due to the increase in pure technical efficiency for the majority of the banks during that period. For example, Byblos Bank (Lebanon) increased pure technical efficiency to 94.09%, BLOM Bank (Lebanon) to 74.48%, Abu Dhabi Commercial Bank (U.A.E.) to 62.51% and Bank AUDI (Lebanon) to 61.88%.

The scale efficiency presented an upward trend during and after financial crisis, with 3% increase during financial crisis and 4.26% increase after financial crisis. This could be attributed to the continuous restructuring efforts made by the banks to increase the use of the internet and electronic banking in parallel with decreasing the banks cost via limited increase in numbers for both branches and staff employed. Banks working at efficiency level of the most productive scale size (MPSS) would be maximizing their outputs for the inputs expended. Instead, banks working at decreasing return to scale(DRS)would experience an increase in inputs that is accompanied by a less proportionate rise in outputs. That is, banks operating at DRS could increase their efficiency levels downsizing their scale of operations. Banks working at increasing return to scale (IRS) would have increase in inputs higher in comparison to the increase in the outputs, which means that such banks could increase their efficiency by expanding their scale of operations. The estimates for scale efficiency over the studied period are presented in Table 4, among which it seems

Table 4: DEA Estimates of Nature of Returns to Scale, 2003 - 2014

Bank name	Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Abu Dhabi Commercial Bank	UAE	IRS	IRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS
Abu Dhabi Islamic Bank	UAE	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	DRS	DRS	DRS	IRS
Ahli Bank Qatar	Qatar	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS
Ahli United Bank	Bahrain	IRS	DRS	IRS	IRS	DRS	IRS	DRS	IRS	IRS	DRS	IRS	IRS
Al Ahli Bank Of Kuwait	Kuwait	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS
Al Baraka Banking Group	Bahrain	DRS	DRS	DRS	IRS	DRS	MPSS	IRS	IRS	IRS	DRS	IRS	IRS
Al Khalij Commercial Bank	Qatar					MPSS	IRS	IRS	IRS	IRS	IRS	IRS	IRS
Al Rajhi Bank	Saudi Arabia		MPSS	MPSS	MPSS	DRS	MPSS	MPSS	MPSS	MPSS	MPSS	MPSS	MPSS
Alinma Bank	Saudi Arabia							MPSS	IRS	IRS	IRS	IRS	IRS
Arab Bank	Jordan	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS
Arab Banking Corporation	Bahrain	DRS	DRS	IRS	IRS	DRS	IRS	IRS	IRS	IRS	DRS	IRS	IRS
Arab National Bank	Saudi Arabia	DRS	DRS	DRS	DRS	DRS	DRS	MPSS	IRS	IRS	DRS	IRS	IRS
Attijariwafa Bank	Morocco	DRS	DRS	DRS	DRS	DRS	DRS	MPSS	DRS	DRS	DRS	DRS	DRS
Bank Albilad	Saudi Arabia			MPSS	MPSS	IRS	MPSS	MPSS	MPSS	MPSS	MPSS	MPSS	MPSS
Bank AlJazira	Saudi Arabia	DRS	MPSS	MPSS	MPSS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS
Bank Audi	Lebanon	IRS	DRS	IRS	IRS	IRS	IRS	IRS	DRS	IRS	DRS	IRS	IRS
Bank Muscat	Oman	DRS	IRS	IRS	IRS	IRS	IRS	DRS	IRS	IRS	DRS	DRS	IRS
Bank Of Beirut	Lebanon	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS
Banque Centrale Populaire	Morocco	IRS	DRS	DRS	IRS	DRS	IRS	IRS	DRS	IRS	DRS	IRS	IRS
Banque Saudi Fransi	Saudi Arabia	DRS	DRS	DRS	DRS	DRS	DRS	DRS	IRS	IRS	DRS	IRS	DRS
BLOM Bank	Lebanon	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	DRS	IRS	IRS
BMCE Bank	Morocco	DRS	DRS	IRS	DRS	IRS	IRS	DRS	IRS	IRS	DRS	IRS	IRS
Byblos Bank	Lebanon	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS
Commercial Bank of Dubai	UAE	MPSS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS
Commercial Bank of Kuwait	Kuwait	MPSS	MPSS	MPSS	MPSS	MPSS	MPSS	MPSS	IRS	IRS	MPSS	MPSS	IRS

Bank name	Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Commercial Bank of Qatar	Qatar	DRS	IRS	DRS	IRS	DRS	DRS	MPSS	IRS	IRS	DRS	IRS	IRS
Commercial International Bank	Egypt	IRS	IRS	IRS	IRS	IRS	IRS	DRS	IRS	IRS	DRS	IRS	IRS
Doha Bank	Qatar	MPSS	IRS	DRS	IRS	IRS	IRS	MPSS	IRS	IRS	IRS	IRS	IRS
Dubai Islamic Bank	UAE	IRS	IRS	DRS	DRS	DRS	MPSS	DRS		IRS	DRS	IRS	DRS
Emirates NBD	UAE	DRS	DRS	IRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS
FGB	UAE	IRS	IRS	IRS	DRS	DRS	DRS	MPSS	MPSS	DRS	DRS	MPSS	MPSS
Gulf Bank	Kuwait	IRS	MPSS	IRS	IRS	DRS		IRS	IRS	IRS	DRS	IRS	IRS
Housing Bank	Jordan	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS
Kuwait Finance House	Kuwait	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS
Mashreq Bank	UAE	DRS	DRS	MPSS	DRS	DRS	DRS	MPSS	DRS	DRS	DRS	DRS	DRS
Masraf Al Rayan	Qatar					MPSS	MPSS	MPSS	MPSS	MPSS	IRS	MPSS	MPSS
National Bank of Abu Dhabi	UAE	IRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS
National Bank of Kuwait	Kuwait	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	MPSS	DRS	DRS	DRS
National Commercial Bank	Saudi Arabia					DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS
Qatar International Islamic Bank	Qatar	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS
Qatar Islamic Bank	Qatar	IRS	IRS	MPSS	MPSS	MPSS	MPSS	IRS	IRS	IRS	DRS	IRS	IRS
QNB	Qatar	IRS	IRS	DRS	DRS	DRS	DRS	DRS	DRS	MPSS	MPSS	DRS	DRS
RAKBANK	UAE	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS
Riyad Bank	Saudi Arabia	DRS	DRS	DRS	DRS	DRS	DRS	DRS	IRS	MPSS	DRS	DRS	DRS
Samba Financial Group	Saudi Arabia	DRS	DRS	DRS	DRS	DRS	DRS	DRS	MPSS	MPSS	DRS	MPSS	MPSS
Saudi British Bank	Saudi Arabia	DRS	DRS	DRS	DRS	DRS	DRS	DRS	IRS	MPSS	DRS	MPSS	MPSS
Saudi Hollandi Bank	Saudi Arabia	DRS	MPSS	DRS	IRS	IRS	IRS	IRS	IRS	IRS	DRS	IRS	IRS
Saudi Investment Bank	Saudi Arabia	IRS	IRS	IRS	DRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS
Union National Bank	UAE	IRS	IRS	IRS	IRS					DRS	IRS	IRS	IRS

Source: Author's Calculations. Note: IRS denotes Increasing Return to Scale, DRS Decreasing Returns to Scale and MPSS Most Productive Scale Size.

that First Gulf Bank (U.A.E.), Saudi British Bank (Saudi Arabia), Al Rajhi Bank (Saudi Arabia), Bank Al Bilad (Saudi Arabia), Masraf Al Rayyan (Qatar), and Samba Financial Bank (Saudi Arabia) are found to be fully technically efficient and operating at the MPSS for the most recent year of 2014. In addition, Al Rajhi Bank (Saudi Arabia) and Bank Al Bilad (Saudi Arabia) were operating at MPSS during the whole period of study, except for the year 2007,when both banks experienced deterioration in scale efficiency due to the strong negative impact of financial crisis.

In order to detect the sources of inefficiencies, DEA allows us to track the main inefficiency sources for each bank and recommend potential efficiency improvements by detecting the slacks for each bank's inputs and outputs. Slacks determine the amount of inputs reduction or outputs increase, as a potential improvement to achieve the full technical efficiency. This would help in detecting the areas where the financial crisis hit most. Additionally, it would help banks to engineer their future policy recommendations based on previous implemented actions and their effects on efficiency. The inefficiencies experienced by the studied banks during the financial crisis can be attributed mainly to the interest expense as the main source of inefficiency. Such inefficiency in interest expense could be the result of falling interest rates with increased competition on deposit rates. After the period of financial crisis, most of the banks were able to reduce their interest expense which was reflected clearly with an increase in technical efficiency.

7. Conclusion

The main aim of this paper is to investigate the effects of financial crisis on the efficiency of top 49 banks listed in the Forbes 100 top companies in the Arab countries. The efficiency measures (technical, pure, and scale) were computed using a non-parametric technique, DEA. DEA results classify DMUs into efficient and inefficient, with the most efficient scoring one. A DMU is considered technically inefficient if it scores less than one, which means that the DMU (or the bank in this case) can achieve the same level of output using less amount of inputs or would increase the level of output using the same level of inputs. The DEA intermediation approach have been adopted with net interest income and non-interest income as outputs and interest expense and non-interest expense as inputs. The empirical results showed that banks have suffered from lower pure and technical efficiency during the financial crisis period (2007-2010), but were able to recover and performed at higher efficiency during the period 2011-2013. This means that banks were not able to produce equal amount of outputs using equal amount of inputs or less during financial crisis periods with technical efficiency decreasing on average during financial crisis due to deterioration in pure technical efficiency which have been reduced by 3.99% during the same period. This would reflect the close tides of the region with the international financial system, which was reflected clearly with lower levels of both technical and pure efficiency. The analysis further suggests that such inefficiency was mainly attributed to the interest expense.

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