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The Relative Efficiency of Jordanian Banks and its Determinants Using Data Envelopment Analysis

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Abstract

The purpose of this study is to measure the relative efficiency of banks in Jordan using DEA. Also, it investigated the determinants of such efficiency, in terms of bank size and capitalization. The duration of the measured performance of this sector is (2005-2008). The results indicate that average efficiency score of the sample banks is high and stable over time. Another important result is that the relative efficiency of larger banks significantly outperforms smaller and medium size banks, indicating that bank size is a determinant of efficiency. However, banks with higher capital adequacy ratio are less efficient. Thus, commercial banks in Jordan with higher capital adequacy ratio are risk-averse and managing safer and lower-earning portfolios.

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1 Introduction

Banks play an important role in the economy for their contribution in providing financial intermediation and representing the bulk of the nation's money stock. Evaluating the economic performance of banks is a complicated process in the light of the changing nature of the banking industry. In recent years, banks have experienced a dynamic, fast-paced, and competitive environment at a cross-border scale. These trends have made the evaluations of banks' performance more difficult, increasing the need for more flexible alternative forms of financial analysis.

Financial systems serve as an important channel for achieving economic growth through the mobilization of financial savings, putting them to productive use and transforming various risks. Strengthening financial systems has been one of the central issues facing emerging markets and developing economies [1]. Banking performance is important at the macro and micro levels since banking sector plays a key role in allocating the economy's financial resources. In addition, efficient banking system helps to increase the effectiveness of the macroeconomic policies. From a social perspective, bank efficiency is a socially optimal target since it reduces the average cost of financial transactions and therefore enhances the society's welfare. So, it is important to conduct a deep investigation of the special features of the banking sector in Jordan, especially in term of its efficiency using new and developed methodologies called Data Envelopment Analysis (DEA).

Literature distinguishes between two main approaches in measuring performance: a parametric and a non-parametric approach in which the

specification of a production cost function is required in both approaches. The parametric approach engages in the specification and econometric estimation of a statistical or parametric function, while the non-parametric method offers a linear boundary by enveloping the experimental data points, known as DEA [2].

The problem of this study is to measure whether Jordanian banks perform efficiently, and what is the effect of such factors, as size and capital adequacy ration, on the level of bank efficiency. Despite the considerable development of banking sector in Jordan, there are few studies focused on the relative efficiency of Jordanian bank, and, specifically, analyzing the variables which explain the variations in the level of bank efficiency. Therefore, this study will try to fill the gap in the literature. The remainder of the paper is organized as follows: Part II reviews the relevant literature. Part III presents the conceptual background of the study, including: performance measurement, banking efficiency, financial ratio, and DEA. The institutional background of the study will introduce the Jordanian banking sector in part IV. While part V is devoted to the data, methodology, empirical results and analysis of the findings. Finally, part VI concludes the study and provides some recommendations.

2 Literature Review

In recent years, the performance measurement concerns for financial institutions have attracted a great deal of attention. Given that the structures of financial service industries are changing rapidly, it is of considerable interest to measure the efficiency of evolving institutions. Performance analysis in the banking industry attracts more and more attention. This due to the fact that evaluating banks overall performance and monitoring their financial condition is important to depositors, owners, potential investors, managers and, of course, regulators. Many studies have attempted to analyze efficiency issues by using non-

parametric techniques. DEA, a non-parametric technique, is a linear programming technique initially developed by Charnes *et al*. [3] to evaluate the efficiency of public sector non-profit organizations. However, a large number of literatures have extended DEA in their applications [4].

This study identifies two relevant literatures relating the Jordanian banking sector and one in insurance. Bdour and Al-khoury [5] investigate the efficiency pattern of Jordanian banks during the period between 1998 and 2004, using (DEA). The results show an increase in bank efficiency in the entire period except in 2003 and 2004 where a decrease in bank efficiency was shown for few banks in the sample. The total efficiency scores suggest that the liberalization programme has provided the anticipated efficiency gains. This conclusion is consistent with Maghayereh [6] who investigates the effect of 1990s financial liberalization on the efficiency of the Jordanian banks, for a panel data sample covering eight Jordanian commercial banks over the period (1984 – 2001), using DEA. The findings suggest that liberalization program was followed by an observable increase in efficiency. Another finding of the study is that large banks demonstrated the faster productivity growth during the liberalization. However, Ben-Khedhiri *et al.* [7] examine the effect of financial sector reform on bank performance in selected Middle Eastern and North African (MENA) countries during the period 1993-2006. They evaluate bank efficiency in Egypt, Jordan, Morocco and Tunisia, using DEA, and employ a meta-frontier approach to calculate efficiency scores in a cross country setting. They then employ a second-stage Tobit regression to investigate the impact of institutional, financial and bank specific variables on bank efficiency. Overall, the analysis shows that, despite similarities in the process of financial reforms undertaken in the four MENA countries, the observed efficiency levels of banks varies substantially across markets, with Morocco and Tunisia outperforming Egypt and Jordan. Differences in technology seem to be crucial in explaining efficiency differences.

On the other hand, Ajlouni and Tobaishat [8] measure the technical efficiency of insurance companies, using DEA, during the period (2000-2006), and further study the extent to which such efficiency will support the companies overall goal and how Amman Stock Exchange (ASE) value it. The results indicate that insurers' efficiency increased over time and ASE appreciating their stock prices.

Similar researches have investigated banks efficiency, using DEA, in developing countries. AlKhathlan and Abdul Malik [9] find that Saudi banks are relatively efficient in the management of their financial resources. Osman *et al.* [10] demonstrate DEA as an effective monitoring tool for central banks to track banks' efficiencies to maintain a sustainable growing sector and to provide early warning signals for a potentially at risk bank. Akhtar *et al.* [11] investigated the Pakistan banks and find that some banks are relatively efficient when its measured by constant return to scale, while more banks become efficient when its measured by variable return to scale. Sathye [12] shows how efficiency scores vary with change in inputs and outputs, and concludes that the efficiency of private sector commercial banks as a group is lower than that of public sector and foreign banks in India. Jackson and Fethi [13] investigate the determinants of efficiency of Turkish commercial banking sector, and find that larger and profitable banks are more likely to operate at higher levels of technical efficiency. Also the capital adequacy ratio has a statistically significant adverse impact on the performance of banks, which may reflect a risk-return tradeoff in the sector. Moreover, Gokgoz [14] reports that Turkish investment banks are more efficient than commercial ones. Finally, Chansarn [15] finds that the efficiency of Thai commercial banks via operation approach is very high and stable while the efficiency via intermediation approach is moderately high and somewhat volatile. Bank size and age are irrelevant factors in determining the relative efficiency via operation approach. However, small banks are the most efficient banks via intermediation approach.

Several studies have developed a strategy for identifying efficiency determinants. These include; factors external to the firm (i.e., competition [17]), characteristics of the bank (i.e., size [18] [19] [20] [21] [22], ownership [17] [23] [24] [25], location [18], traditional vs. Islamic [26] [27] [28] and bank type [26]). Nevertheless, Fethi and Pasiouras [16] present a comprehensive review of applications of operational research and artificial intelligence techniques in the assessment of bank performance, by discussing a total of 179 studies published between 1998 and 2008. The main conclusions are that (i) profit efficiency and capacity efficiency have received quite limited attention in DEA studies in banking, (ii) most studies that use a two-stage DEA do not employ appropriate bootstrapping techniques, and their results may be biased, and (iii) there is much diversity among studies with respect to the selection of input and outputs.

3 Theoretical Framework

Managers need to be concern with how performance will be measured. Robbins and Coulter [29] define performance as the accumulated end results of all the organization's work processes and activities (p.465). Performance means efficiency and effectiveness. Efficiency is concerns with the relationship between inputs and outputs. Whereas effectiveness is the degree to which the goals of an organization have met [30]. Mathematically, efficiency = output / input. It can be measured with respect to maximization of output, minimization of cost or maximization of profits [31].

The most common approaches to measure efficiency are: parametric approach using econometric techniques, such as the Stochastic Frontier Approach (SFA), the Thick Frontier Approach (TFA) and the Distribution Free Approach (DFA). While the nonparametric approach utilizing linear programming method, such as the Free Disposal Hull (FDH) and the Data Envelopment Analysis (DEA).

Parametric and nonparametric approaches mainly differ in how they handle the noise and their assumptions regarding the shape of the efficient frontier. However, each has its own strengths and weaknesses. The parametric approach has the advantage of allowing noise in the measurement of inefficiency. However, the approach needs to specify the functional form for the production, cost or profit function. Non-parametric is simple and easy to calculate as it does not require specification of functional form. However, it suffers from the drawback that all deviations from the best-practice frontier are attributed to inefficiency because it does not allow for random error to be taken into account [4].

Financial ratio analysis is the most known and common approach for measuring performance. Traditionally, analysts have analyzed the efficiency of organizations by focusing on certain simple ratios such as labor productivity (output per unit of labor employed) or capital intensification (Capital/Labor) [32]. In the first quarter of the 20th century, the DuPont firm introduced the return on investment (ROI) measure and the pyramid of financial ratios. Other models and methods have developed ever since, such as discounted cash flow (DCF), residual income (RI), economic value added (EVA) and cash flow return on investment (CFROI). Much of the work in the for-profit sector is concerned with financial measures of performance such as profitability, earnings per share and market share. Yeh [33] argues that the major demerit of ratio analysis is that its reliance on arbitrary and misleading benchmark ratios. Further, Sherman and Gold [34] note that financial ratios do not capture the long-term performance and aggregate many aspects of performance such as operations, marketing and financing. In recent years, there is a trend towards measuring bank performance using one of the frontier analysis methods. In frontier analysis, the institutions that perform better relative to a particular standard are separated from those that perform poorly. Such separation is done either by applying a non-parametric or parametric frontier analysis to firms within the financial services industry [35].

There are two types of efficiency used in the nonparametric measurement: (1) Technical efficiency, produce more outputs from a given set of inputs or use less input to produce a given level of output. (2) Allocative efficiency, which is divided into three types: (A) Cost efficiency, produces a given output at a minimum cost, and (B) Revenue efficiency, maximizes revenue from the utilization of given inputs, and (C) Profit efficiency, maximizes profit from the allocated inputs and outputs [31].

Sherman and Gold [34] were the first to apply DEA to banking. In the banking industry, there are two approaches for selecting the input and output variables. These are: the production approach and the intermediation approach. Under the production approach, banks are analyzed as institutions making use of various labor and capital resources to provide different products and services to customers. Thus, the resources being devoted such as labor and operating cost are considered as inputs while the products and the services such as loans and deposits are deemed as outputs of the banks. This model measures the cost efficiency of the banks [37]. Under the financial intermediation approach, banks are seen as financial intermediaries who collect deposits and other loanable funds from depositors and lend them as loans or other assets to others for profit. The different forms of funds that can be borrowed and the cost associated with performing the process of intermediation are considered as inputs. The forms in which the funds can be lent are outputs. This model measures the economic viability of the banks [18]. In practice, the intermediation approach is the most widely used in the banking literature [38]. In choosing the appropriate approach, Berger and Humphrey [2] suggest that the intermediation approach is the most appropriate for evaluating the entire bank because it is inclusive of interest expense (income paid to depositors), which often accounts for one-half to two-third of total costs. While the production approach is more appropriate for evaluating the efficiency of the bank's branches because branches process customer documents for the banks as a whole. Mokhtar *et al.* [39] summarize the main input and output variables used by

most researchers in measuring banking efficiency.

DEA is a linear programming technique initially developed by Charnes, Cooper and Rhodes [3] to evaluate the efficiency of public sector non-profit organizations. DEA calculates the relative efficiency scores of various Decision-Making Units (DMUs) in the particular sample. The DMUs could be banks or branches of a bank. DEA compares the efficiency of each of the DMU in that sample with the best practice in the sample. As an efficient frontier technique, DEA identifies the inefficiency in a particular DMU by comparing it to similar DMUs regarded as efficient.

The ability of the DEA to identify possible peers or role models as well as simple efficiency scores gives it an edge over other methods. DEA modeling allows the analyst to select inputs and outputs in accordance with a managerial focus. This is an advantage of DEA since it opens the door to what-if analysis. In addition, it works relatively well with small samples. Other advantages of DEA are that it does not require any assumptions to be made about the distribution of inefficiency and it does not require a particular functional form on the data in determining the most efficient DMU. However, DEA is also subject to few limitations [12]. Two of the best known shortcomings are that DEA assumes data to be free of measurement error, and that it is sensitive to outliers. Coelli *et al*. [40] also point out that: (i) having few observations and many inputs and/or outputs will result in many firms appearing on the DEA frontier, (ii) treating inputs/outputs as homogenous commodities when they are heterogeneous may bias the results, (iii) not accounting for differences in the environment may give misleading results, (iv) standard DEA does not control for multi-period optimization or risk managerial decision making.

4 Overview of Jordanian Banking System

The Jordanian banking system comprises of the Central Bank of Jordan (CBJ); 24 licensed banks, including 13 local, conventional banks and all are publicly traded on Amman Stock Exchange (ASE); 2 local Islamic banks, and 1 foreign Islamic bank; and 8 branches of foreign banks (5 of which are Arab banks). There are about 600 branches. As of 2008, the ratio of population/bank branch is about 10,300. Banks operating in Jordan are regulated and supervised by the CBJ subject to the CBJ Law No. 23 of 1971, the Banking Law No.28 of 2000, ASE laws, the Corporate Governance Code for Banks in Jordan issued by the CBJ in 2007 and the circulations and instructions issued by the CBJ. Banks are licensed by the CBJ as public shareholding companies with a minimum capital of JD 40 million. Foreign banks can obtain a license to operate in Jordan provided that they meet certain conditions. Minimum capital for foreign banks is half of that for Jordanian banks. Banks in Jordan are well capitalized according to Capital Adequacy Ratio, which equal to (17.6%) at the end of 2008.

Jordan has a very stable, but growing banking sector. The commercial banks are the dominate institution in the Jordanian banking system. They are completely private ownership and are the main source of funding for the industrial and commercial business. The Jordanian government announced and undertook a series of steps to liberalize the financial system in 1993. Additional reforms were implemented in 1997 to further liberalize the finance system: interest rates were further deregulated, greater autonomy was given to bank managements, increased capital adequate requirements, promoted bank mergers and acquisitions induced the inter-bank market, and further liberalization of foreign exchange transactions and foreign investment was undertaken. There have been also several important technological developments in the industry in recent years. Banks have computerized all of their operations and have introduced Automatic Teller Machines (ATMs), on-line system of communication and PC banking. Therefore,

This study select the period between 2005 and 2008 for studying the performance of Jordanian banking system in term of efficiency and effectiveness since the fundamental institutional changes will take its impacts clearly at this period of time. This section will provide a brief review of banks in Jordan performance during the period of the study (2005-2008) [41].

Banks in Jordan are relatively unaffected and insulated from the global financial crisis because of limited banking exposure to the International Toxic Assets; no securitization of mortgage loans in Jordan; real-estate loans regulated with a limit of 20% of deposits; real estate-related and consumer loans constitute of only 156% of banks' capital in Jordan, compared with 354% in USA; second mortgage and home equity lines of credit do not exist in Jordan; prudential regulations and supervision,; robust banks' risk management; no liquidity crisis, currently, excess reserves are well above $1.5 billion; recapitalization of banks; and deposit guarantee whereby 94% of depositors are fully guaranteed [41].

The consolidated balance sheets of licensed banks reveal that the total assets grew from $29.8 billion (US$1=Jordanian Dinar 0.708) in 2005 to $42.1 billion in 2008. Domestic assets increased from 74% of the total assets in 2005 to 81% in 2008. Credit facilities increased from $13.6 billion in 2005 to $23.9 in 2008. Of which 82.31% are loans and advances, 13.89% are bills discounted, and 3.79% are overdrafts. On the other side of the balance sheet, the total deposits grew from $13.7 billion in 2005 to $20.2 billion in 2008. The composite of deposits have changed during the period of the study. While demand and (saving) deposits declined from 28% (15%) of total deposits in 2005 to 25% (12%) in 2008, time deposit increased from 57% in 2005 to 63% in 2008. The ratio of performing loans to total loans is about 96% as of 2008 [42].

5 Data and Analysis

This study presents an analysis of the efficiency of the commercial banks in Jordan during the period (2005–2008). The population of the study is presented in the previous section. The sample of 11 commercial banks listed in ASE was selected for achieving the study purposes. Two banks were excluded because of missing information. Data is collected from the annual reports of these banks downloaded from ASE database [43].

One of the most important features of DEA is its ability to manage the multiple characteristics of a bank, which use several inputs and outputs. The analysis is carried out employing the intermediation approach which takes commercial banks as entities using labor and capital to transform deposits into loans and securities. Following Chansarn [15] in the intermediation approach, two inputs and two outputs are chosen for each commercial bank. These are:

Input 1 (x_1) = Total deposits

Input 2 (x_2) = Total expense (Interest and non-interest expenses)

Output 1 (y_1) = Total loans

Output 2 (y_2) = Net investments

Table 1 provides some relevant statistics of key variables in the sample.

Table 1: Average Statistics of Inputs and Outputs of Commercial Bank in Jordan for the Period (2005-2008)

Bank Name (in Million JD)	INPUTS		OUTPUTS	
	Total Deposits	Total Expense	Total Loans	Net Investment
ARAB BANK	7,311.1	337.5	8,821.2	957.0
THE HOUSING BANK FOR TRADE AND FINANCE	1,655.7	79.2	1,782.6	385.6
JORDAN NATIONAL BANK	724.5	59.0	702.7	87.7

JORDAN KUWAIT BANK	591.7	30.3	1,003.7	44.8
BANK OF JORDAN	576.6	39.4	690.4	156.3
UNION BANK	328.8	3.8	456.2	7.6
CAPITAL BANK	246.9	17.2	491.2	39.7
ARAB JORDAN INVESTMENT BANK	228.4	10.5	206.3	9.4
ARAB BANKING CORPORATION /(JORDAN)	186.4	12.6	245.3	0.5
JORDAN COMMERCIAL BANK	186.3	13.8	283.4	53.7
SOCIETE GENERALE DE BANQUE - JORDANIE	68.6	5.9	95.6	8.6
Average	1,100.4	55.4	1,343.5	159.2

5.1 Analysis of Efficiency Scores

The efficiency of each DMU can then measured by comparing it to the 'frontier' firms, which are nearest to it. Assume there are n decision making units (DMU), denoted by subscript i [44]:

$$\text{Maximize } E_k = \sum_{i=1}^{m} Vj_k \, Y_{jk}$$

Subject to the constraints:

1) $\sum_{i=1}^{m} U_{ik} \, X_{ik} = 1,$

2) $\sum_{j=1}^{n} V_{jk} \, Y_{jk} - \sum_{i=1}^{m} U_{ik} \, X_{ik} \leq 0$

3) $U_{ik} \geq 0, \quad i = 1, 2, \ldots, m$

4) $V_{jk} \geq 0, \quad j = 1, 2, \ldots, n$

5) $\sum_{i=1}^{m} U_{ik} = \sum_{j=1}^{n} V_{jk}$

Where,

V_{jk} = the weight placed on jth output (Yj) of the kth DMU.

U_{ik} = the weight placed on ith input (Xi) of the kth DMU.

X_{ik} = the ith input parameter (X) of the kth DMU.

Y_{jk} = the jth output parameter (Y) of the kth DMU.

E_k = the relative efficiency score of kth DMU.

The program selects weights so that the ratio of outputs to inputs for all DMUs is less than or equal to one. However, it selects those weights in order to make the output to input ratio for one particular DMU (the DMU in the objective function) as high as possible. If the ratio for that particular DMU is less than one, then, with the same weights, one or more other DMUs must equal one. Thus, those other DMUs are more efficient. The resultant ratio for DMU is a measure of distance from the production possibilities frontier. A ratio of 1 or 100% indicates DMU lies squarely on the frontier and operations on the frontier, hence and full efficiency. A ratio of less than 1 or 100% reflects operations below the frontier. The lower the ratio, the further the DMU lies from the frontier, hence inefficient [8]. Thus, the first hypothesis can be expressed as follows:

H1: Commercial banks in Jordan are efficient.

The result for the analysis via operating approach is presented in Table 2.

According toTable 2, the average efficiency of banks in Jordan during the period (2005–2008) is high and ranges between (84%) and (95%). The geometric mean of the relative efficiency of all banks over the sample period is 89%. This result is consistent with Maghayereh [6] and Bdour and Al-Khoury [5]. However, Maghayereh [6] covers the period (1984-2001) whereas Bdour and Al-Khoury [5] cover the period (1998-2004). This leads to indicate that the efficiency of banks in Jordan is stable over time. In addition, this efficiency is to some extent similar to those found in developed countries but higher than that in some developing countries, as reported in the literature reviewed above. For example, the overall

relative efficiency of Japanese, Germany, Italian, U.S., and Australian are found to be around of 94%, 92%, 90%, 95%, and 88%, respectively. However, these of Indian, Mexican, Tunisian, Kuwaiti and Turkish banks are about 79%, 75%, 72%, 86% and 89%, respectively.

Table 2: The Relative Efficiency of Selected Commercial Banks in Jordan During the Period (2005-2008)

Bank Name	2005	2006	2007	2008	Average
ARAB BANK	1.00	1.00	1.00	1.00	1.00
THE HOUSING BANK FOR TRADE AND FINANCE	1.00	1.00	1.00	1.00	1.00
JORDAN NATIONAL BANK	0.55	0.65	0.95	1.00	0.79
JORDAN KUWAIT BANK	0.91	0.92	1.00	0.96	0.95
BANK OF JORDAN	0.95	1.00	1.00	1.00	0.99
UNION BANK	0.82	0.79	0.83	0.90	0.84
CAPITAL BANK	0.78	0.90	0.79	1.00	0.86
ARAB JORDAN INVESTMENT BANK	0.78	0.69	0.67	0.73	0.72
ARAB BANKING CORPORATION /(JORDAN)	0.80	0.86	0.89	0.93	0.87
JORDAN COMMERCIAL BANK	0.65	0.86	0.82	0.90	0.81
SOCIETE GENERALE DE BANQUE - JORDANIE	0.99	1.00	1.00	1.00	1.00
Average	0.84	0.88	0.90	0.95	0.89

In 2005, the average efficiency of banks in Jordan is 84%. Two banks are considered to be completely efficient, with a score of 100%, implying that they had produced their output on the efficiency frontier. However, other banks have not been that efficient in utilizing their resources. In 2006, the average efficiency

increased by 4.7% to 88%. Now three banks are considered to be completely efficient. Once again, the average efficiency increased in 2007 to 90%, with five banks achieved complete efficiency. Furthermore, the average efficiency increased in 2008 to 95% with six banks accomplished complete efficiency. In summary, we can say that commercial banks in Jordan are efficient. They utilize their resources to some extent in an efficient manner. Therefore, we can accept the first hypothesis of this study.

5.2 Analysis of Efficiency Determinants

Literatures investigate the factors that influence the efficiency of banks. Some studies examine only bank-specific factors and others examine both bank-specific attributes and environmental determinants. This study will examine only two bank-specific variables (bank size and bank capital adequacy).

The impact of bank size can be investigated as follow: based on the market shares of total assets of commercial banks in Jordan, we classify banks as large banks, medium banks, and small banks. Large banks include commercial banks with market share of total assets not less than 10%, such as Arab Bank and the Housing Bank for Trade and Finance; medium banks include commercial banks with market share of total assets between 9% and 3%, such as Jordan Kuwait Bank, Jordan National Bank, and Bank of Jordan; and small banks include commercial banks with market share of total assets less than 3%, includes the remaining banks listed in Table 1.

For analyzing the relative efficiency of banks in Jordan categorized by size, the mean values of inputs (total deposits and total expenses), and outputs (total loans and net investments) of large, medium and small banks are calculated and used for the analysis via the DEA approach. Hence, the second hypothesis can be articulated as follows:

H2: There is a significant difference between the efficiency of Banks in Jordan due to their size (Market Share of Total Assets).

Table 3 presents the result of the analysis of the relative efficiency of banks in Jordan categorized by size via the operating approach.

Table 3: The Relative Efficiency of Selected Commercial Banks in Jordan Categorized by Size during the Period (2005-2008)

Bank Size	2005	2006	2007	2008	Average
Large Banks *	1.00	1.00	1.00	1.00	1.00
Medium Banks**	0.97	1.00	0.95	1.00	0.98
Small Banks ***	0.73	0.78	0.82	0.86	0.80

* Large bank (2): Arab Bank and the Housing Bank for Trade and Finance.
** Medium banks (3): Jordan Kuwait Bank, Jordan National Bank, and Bank of Jordan.
***Small banks (6): Societe Generale de Banque Jordan, Jordan Commercial Bank, Arab Jordan Investment Bank, Union Bank, Capital Bank, and Arab Banking Corporation/Jordan.

According to table 3, it is reasonable to conclude that, on average, large banks are the most efficient banks and have the efficiency scores of 100% in every year during (2005–2008). However, medium banks are considered to be efficient only in 2006 and 2008. Unlike medium banks, small banks are considered to be inefficient in every single year during the period of the study.

The above result implying that large banks could perform the role of financial intermediaries, using labors and capitals to transfer deposits into loans and investments, more efficiently than small and medium ones. This is not a surprising result, because revenues of commercial banks come from two major sources which are interest incomes and non-interest incomes. However, large banks are normally superior to small and medium banks in several aspects such as

amount of capital, number of labors and reputation, generating non-interest incomes from other sources such as investment banking services, money transfer services, foreign exchange services or insurance services. Consequently, it is easier to obtain loans from large banks than small and medium banks. In addition, the liberalization has a significant impact on largest banks in Jordan which encourage them to starting to use high technology such as establishing ATM networks, associating to the SWIFT system and using on-line computer systems. Because these transfers were mostly to largest banks, they appear to have benefited more from this diffusion than smallest banks. That is why large banks are more efficient than small and medium banks. Hence, the second hypothesis of the study is accepted.

On the other hand, the impact of banks' capital adequacy on the efficiency of commercial banks in Jordan can be investigated as follow: Capital adequacy can be proxy by the ratio of equity to total assets (EQ/TA). EQ/TA indicates capital strength or bank safety and soundness. Banks in Jordan will be classified according to the capital adequacy ratio into two groups: banks meeting the CBJ minimum requirement of 12%, as regulated by CBJ, and those do not meet this requirement. Therefore, the third hypothesis can be stated as follows:

H3: There is a significant difference between the efficiency of anks in Jordan due to their capital adequacy (the ratio of Equity to Total Assets).

Table 4 shows the calculated EQ/TA ratio for each bank in the sample.

As shown in the Table 4, only three banks of the sample did not meet the minimum capital adequacy ratio of 12%, while the remaining eight banks met such requirement. However, all banks in Jordan met the minimum capital adequacy ratio level of Basel, which is 8%.

The result of the analysis of the relative efficiency of banks in Jordan categorized by capital adequacy ratio via the operating approach is exhibited in Table 5.

Table 4: Capital Adequacy (EQ/TA) Average Ratio for Selected Commercial Banks in Jordan for the Period (2005-2008)

Bank Name (in Million JD)	Total Assets	Total Equity	EQ/TA %
ARAB BANK	19,806.7	3,020.4	15.25
THE HOUSING BANK FOR TRADE AND FINANCE	4,435.8	725.3	16.35
JORDAN NATIONAL BANK	1,874.5	197.2	10.52
JORDAN KUWAIT BANK	1,784.4	186.7	10.46
BANK OF JORDAN	1,425.9	150.7	10.57
UNION BANK	936.7	160.4	17.12
CAPITAL BANK	869.5	160.2	18.42
ARAB JORDAN INVESTMENT BANK	590.3	91.1	15.44
ARAB BANKING CORPORATION /(JORDAN)	529.2	70.3	13.28
JORDAN COMMERCIAL BANK	513.4	77.8	15.15
SOCIETE GENERALE DE BANQUE - JORDANIE	207.1	30.7	14.84
Average	32,973.5	442.8	14.77

Table 5: The Relative Efficiency of Selected Commercial Banks in Jordan Categorized by EQ/TA Ratio during the Period (2005-2008)

Bank Name	2005	2006	2007	2008	Average
Meeting minimum requirement *	0.79	0.89	0.76	0.80	0.81
Not meeting minimum requriment **	1.00	0.92	0.96	1.00	0.97
Average	0.89	0.90	0.86	0.90	0.89

* These banks are: Arab Bank, the Housing Bank for Trade and Finance, Societe Generale de Banque-Jordan, Jordan commercial Bank, Arab Jordan Investment Bank, Union Bank, Capital Bank, and Arab Banking Corporation/Jordan.

** These banks are: Jordan Kuwait Bank, Jordan National Bank, and Bank of Jordan.

On the contrary of bank size, capital adequacy ratio could not be considered as a determinant of efficiency of banks in Jordan. Table 5 illustrates that, on average, banks meeting the minimum EQ/TA ratio are less efficient than those do not. The latter banks have the highest efficiency scores in every year during (2005–2008), implying that they are efficient and had produced their outputs on the efficiency frontier. This implies that commercial banks in Jordan with higher capital adequacy ratio are risk-averse and prefer safer and lower-earning portfolios.

5 Conclusion

This study uses a non-parametric mathematical programming model (DEA) to measure whether banks in Jordan are efficient, during the period (2005-2008). In addition, the study investigates the determinants of such efficiency, specifically, the effect of bank size and the degree of capitalization on banks' efficiency. The results indicate that the average efficiency of banks in Jordan during the period (2005–2008) is high and ranges between (84%) to (95%). The average of the relative efficiency of the sample banks over the study period is 89%. The results are consistent with Maghayereh [6] and Bdour and Al-Khoury [5]. This leads to signify that the efficiency of banks in Jordan is stable over time. Moreover, the average efficiency score of banks in Jordan compares well the efficiency score of banks in developed countries. On the other hand, the analysis shows that large banks strongly outperform small and medium banks in terms of efficiency. This leads to conclude that bank size is a determinant of efficiency. However, the results concerning capital adequacy ratio in explaining efficiency implies that banks with higher capital adequacy ratios are less efficient. This is inconsistent with pervious studies, such as Isik and Hassan [45], Kaparakis *et al*. [46], Elyasiani *et al*. [47], Mester [48] and [49] and Casu *et al*. [50], which reported a positive correlation between capital adequacy and bank efficiency This

inconsistency implies that commercial banks in Jordan with higher capital adequacy ratio are risk-averse and managing safer and lower-earning portfolios.

Based on the results of the study, it is recommended that inefficient commercial banks need to improve their efficiency and performance, by either (1) increasing their loans or net investment, and/or (2) promote resources utilization efficiency by better handing their total expenses. Efficiency determinants identified in this study can aid banks and policy makers in devising suitable strategies. Central Bank of Jordan needs to make a review to the minimum capital adequacy ratio by making it nearest to Basel one, because of the inverse impact of this ratio on banks efficiency in Jordan.

Since Data envelopment Analysis (DEA), can be used to evaluate the performance of organizations regardless of their types and seeks to address the limitations of the financial ratio analysis, the researcher recommend the company managements and the researchers to use this technique in assessing and measuring performance. However, more research employing advanced DEA modeling should be devoted to analyze the impact of other regulatory-specific and bank-specific variables on banks efficiency such as bank loan quality. Improvements in the legal system and in the regulatory and supervisory bodies would help to upgrade efficiency.

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