

Toward An Optimal Capital Adequacy in Jordanian Traditional and Islamic Banks: An Empirical Comparative Study during the Period 2015 - 2019

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Abstract :

This study aims to determine the optimal size of capital adequacy ratio in banks, this ratio may increase as a result of greater risk control and capital raise, but capital represents redundant funds and consequently a lost cost in the economic sense. This paper therefore sought to determine the optimal size for this ratio using the two-stage data envelopment analysis, taking into account bank capabilities using its own inputs and outputs to reach this size. A sample of 15 Jordanian banks is used, including three Islamic and 12 traditional during the period 2015-2019, the study found that a small number of banks achieved the optimal size of this ratio, Islamic banks often made no difference between the actual and optimal ratios or that the actual is higher than the optimal, while the study finds the opposite for the traditional banks where the actual rate was often less than the optimal.

Keywords: Capital Adequacy; Optimization; Efficiency; Data Envelopment Analysis. Banks.

JEL Classification Codes : G21; E5; C67.

Introduction

Investigating the efficiency of the financial system and in particular, banks have gained a lot of popularity in recent times for several reasons. First, the efficiency of banks is directly linked to the productivity of the economy. Banking system assets comprise a substantial proportion of total output (Paul, Berger, & Humphrey, 1992). Moreover, banks are the backbone of the global economy, providing capital for innovation, infrastructure, job creation, and overall prosperity so; an improvement in banks' efficiency helps in increasing the chance of survival in deregulated and competitive markets.

Banks seek to adhere to the capital adequacy ratio, which is a minimum rate imposed by the country's regulatory and supervisory authorities, to protect these banks from the risks that may be incurred by depositors' funds as a result of investing their money in loans, securities, and various bank investments, because the bank's capital and private funds in general, despite their small size, constitute a safety margin for the protection of those funds, which has been defined traditionally, but in recent decades it has been calculated according to an agreed global standard in this field, which is Basel ratio.

Moreover, setting a minimum requirement for this ratio by supervisory authorities means alerting banks not to go below this limit, as this poses significant risks to the bank and depositors' funds as mentioned above. but maintaining a higher rate of this limit may theoretically appear in the bank's interest and protecting depositors' funds, while overtaking this threshold may not be in the bank's best interest, as it may result from good risk control, and may also result from retaining a larger volume of capital or equity, necessary to face the risks resulting from the lost cost of not investing those funds.

Accordingly, this paper seeks to examine the optimal volume of capital required to meet risks in light of banks' efficiency measurement, and on the basis that achieving efficiency is considered as an optimization achievement, furthermore, efficiency means in brief, achieving the best relationship between inputs and outputs, or minimizing inputs with the possibility of maximizing outputs to the fullest extent possible.

I-1- Problem Statement

In light of the foregoing, this research seeks to answer the following main question: How can an optimal size of banks capital adequacy be determined mathematically by using banks' inputs and outputs? And to what extent do Islamic and traditional banks achieve the optimal ratios estimated by the Data Envelopment Analyses (DEA) model?.

I-2- Study Hypotheses

To answer the main study question the following hypotheses are developed:

H₁: An Optimal Capital Adequacy Ratio is released through banks' full operational efficiency.

H₂: The actual capital adequacy ratios achieved by Islamic banks are more than the estimated optimal ratios.

H₃: The actual capital adequacy ratios achieved by traditional banks are less than the estimated optimal ratios.

I-3- Literature Review

(Yudistira, 2004) In his paper Efficiency in Islamic banking; empirical analysis of eighteen banks, the researcher uses the Technical, pure technical, and scale efficiency measures depending on the non-parametric technique, Data Envelopment Analysis. Moreover, the study reveals the following results; first, the overall efficiency results suggest that inefficiency across 18 Islamic banks is small at just over 10 percent, which is quite low compared to many conventional counterparts. Islamic banks in the sample suffered from the global crisis in 1998-1999 but performed very well after the difficult periods. The findings indicate that there are diseconomies of scale for small-to-medium Islamic banks which suggests that mergers should be encouraged.

(Chen & Zhu, 2004) in their study Measuring Information Technology's Indirect Impact on Firm Performance, they have been recognized that there is an indirect link between information technology (IT) investment and the performance of firms because of the interaction of some mediating and moderating variables. Traditional efficiency models, such as data envelopment analysis (DEA), can only measure the efficiency of one specific stage when a two-stage production process is present. They develop an efficiency model that identifies the efficient frontier of a two-stage production process linked by intermediate measures.

(Li, Chen, Chien, & Lee, 2016) conducted a study of optimal capital adequacy ratio, and aims to determine the effects of raising the capital adequacy ratio on the bank, and to answer this question and achieve the goal of the study the researchers work on a sample of 31 commercial banks in Taiwan during the period 2007-2009, to where they depend on banks' efficiency to determine the optimal rate of capital adequacy, the measurement of efficiency was done in two stages which requires three types of variables: inputs, intermediate variables, and outputs, to produce three competencies, the efficiency of the first phase and the efficiency of the second phase and the overall efficiency, these efficiencies determine the weights from which we can get the optimal capital adequacy ratio, however,

the capital adequacy ratio is considered as an intermediate variable and is used as an output at the first stage and as an input in the second stage, finally, the study reveals the following findings: Most studies have a capital adequacy ratio higher than the Basel II minimum (8%), while 6.5% of banks have capital adequacy ratios below the Basel II minimum. The presence of 11.8% of banks with the optimum capital adequacy ratios of less than 10.5% and therefore these banks may face challenges to apply Basel III, and then reach the limits of efficiency, and approximately 73% of these banks must raise the capital adequacy ratio to achieve the optimal ratios to achieve the minimum efficiency and thus higher profitability.

(AL Said, 2017), *Assessing the efficiency of Islamic banks in Arab countries using the data envelopment analysis method*. This study aimed to investigate the existence of economic efficiency in Islamic banks, and to achieve this goal the researcher studied the extent of economic efficiency in fourteen Islamic banks from nine Arab countries during the period 2005-2010, where he used the data envelopment analysis to measure economic efficiency using inputs (volume of assets, number of employees, deposits and short-term financing) and outputs (1. sale modes: Murabahah, salam, and Istisna, 2. participatory modes: Mudarabah and Musharakah and 3. Investments), the findings of the study can be summarized as follows: first, the more efficient the bank is, the higher the quality of banking services and competitive rates. Second, there is a difference in efficiency between countries as a result of the impact of efficiency on the bank's characteristics and the economic environment surrounding it. Third, the failure of most banks to achieve economic efficiency is due to the lack of technical efficiency, due to the misallocation of the available managerial resources

What distinguishes this research from the previous studies is its reliance on a variety of traditional and Islamic banks, all of which are subject to a single minimum capital adequacy ratio determined by the supervisory authority since the study was conducted on banks operating in Jordan, and this is despite the difference in the calculation method of the ratio between these two types of banks as the research is concerned with studying and analyzing the difference between the optimal and achieved ratios in each bank, with the application of the two-stage DEA model.

1- Theoretical Framework

Determining the optimal ratio of capital adequacy in banks is very important for them, as working to raise or reduce the capital adequacy ratio without limits regardless of the side effects of the bank, especially in terms of performance and risk, makes the decision to raise or reduce capital ineffective, as the issuing bodies of the criteria for determining capital adequacy in Islamic banks have set minimum requirements for this ratio, the

latest of which is Basel III for traditional banks and the equivalent of any IFSB15 standard for Islamic banks, where the minimum was in both. 10.5%, however, in practice, many banks, including Jordanian traditional and Islamic, achieve this minimum and sometimes much more, which may affect the efficiency and performance of these traditional and Islamic banks (Li, Chen, Chien, & Lee, 2016), that is why we are looking for an optimal percentage of capital adequacy in Jordanian banks to achieve the minimum requirement imposed by the Regulatory and supervisory authorities on the one hand, and achieve better efficiency and performance for these banks on the other. To determine the optimal capital adequacy ratios, we must first identify the adequacy of capital in banks, their optimization, and their relationship with banks' efficiency, and then the appropriate model of measurement.

1-1- Capital adequacy in banks

The capital adequacy is an important subject that concerned experts and interested in banking issues, especially during the second half of the 20th century because of the crises they have experienced, the capital adequacy concept means measuring the size of the bank's capital and its adequacy to be a margin of safety and coverage of depositors' funds to face many losses in Banks' investments, which are already derived from those deposits, and are calculated by the ratio of the bank's available capital to risk-weighted assets, a minimum of 8% is set in the First Basel Convention, which has been set at a minimum of 8% in the First Basel Convention issued in July 1988.

The calculation of capital adequacy knew several adjustments, first, it concerned the credit risk only, then market risks were added in Basel 1 amendments between 1996 and 1998, after that, the operating risks were included in Basel II in 2004, according to (Investopedia, 2019) As of 2020, under Basel III, a bank's tier 1 and tier 2 minimum capital adequacy ratio (including the capital conservation buffer) must be at least 12.5% of its risk-weighted assets RWA). That combines tier 1 and tier 2 requirements—the minimum tier 1 capital ratio is 10.5% and the minimum tier 2 is 2%. The capital conservation buffer recommendation is designed to build up banks' capital, which they could use in periods of stress.

1-2- Optimization concept and its relationship to efficiency

The concept of economic efficiency, as attributed to the Italian economist Vilfredo Pareto (1848-1923), is usually interpreted in broader sense. Pareto specified a condition of optimal or efficient allocation of resources which is referred to as a Pareto condition (KUPER & KUPER, 2003). An economy is in a Pareto Optimal state when no further changes in

the economy can make one person better without at the same time making another worse off.

Efficiency can also be defined as the ability to accomplish a task with least waste of time and effort. The economist Pareto has addressed the efficiency in the field of microeconomics to study economic well-being, which means improving one person's situation without harming another, and we can find optimization in the field of operating research or the corporate finance when we investigate the optimal efficiency, where it represents the best performance that can be achieved by the firm under the available resources.

Through these definitions of efficiency we conclude that they differ in terms of wording but are consistent in terms of content and objective. Accordingly, this study of the optimization of capital adequacy in Jordanian banks, which are economic institutions, addresses the institutions efficiency, and therefore we can define the optimal efficiency as the best performance under the specified constraints and resources, as well as it, can be said that optimization is the best combination of resources to achieve the best efficiency and effectiveness. In these definitions of optimization, it can be seen a term that accompanies the mostly optimal is efficiency, and therefore we have to recognize the relationship between optimization and efficiency.

Efficiency is defined as 'reaching the best relationship between inputs and outputs (Hosseini & Al Muayyad, 2003) and it can be also defined as the intention to reduce resources or to be able to maximize output from the lowest input. Through these two definitions, it can be concluded that it concerns the relationship between inputs and outputs since efficiency is the possibility of minimizing inputs with the possibility of maximizing outputs, so, we can conclude that optimization and efficiency are exchangeable terms in many cases, but some economists look to the optimization as the maximum efficiency that can be reached.

Moreover, (GADI, 2014) argues that efficiency and optimization seem to go hand in hand and they do. Efficiency is the driving force in reducing operational costs and optimization is the engine with which to achieve this goal. Accordingly, by explaining the relationship between the term optimization and efficiency, it can be said that achieving efficiency is an achievement of optimization.

2 –Methods and Materials

The study methods and materials are clarified in the following:

2-1- Study sample

Jordan's banking sector is one of the pillars of financial intermediation in the Jordanian economy, and despite the challenges faced by the global economy, Jordan has achieved positive growth as a result of

the positive indicators that characterized the Jordanian banking sector (Mouna & Ibn al-Din, 2017). The banking sector in Jordan consists of local and foreign banks, each comprising Islamic and traditional banks, 24 banks are operating in Jordan, including eight foreign banks and 16 local banks, where there are three Islamic banks and 13 traditional banks, whereas foreign banks include one Islamic bank and seven traditional banks. In this study, a sample of 15 Jordanian banks, including three Islamic banks and 12 traditional banks, was selected to be investigated during the period 2015-2019. The study sample was chosen according to the availability of the data during the study period, whether on the Amman Stock Exchange or at the banks' web sites. In this sample, it is clear that the oldest bank is the Jordan Ahli Bank and the newest bank is the Capital Bank.

2-2- Study Variables

To achieve the study objective, which is to measure the optimal size of capital adequacy in Jordanian banks, the operational efficiency of these banks is measured to get the optimal capital adequacy ratios, as operational efficiency is the efficiency that determines low-cost and unexploited opportunities or is the banking efficiency that has significant implications for the management capacity process to control costs and maximize profits, achieving capital adequacy ratio is significantly influenced by the bank's regulatory decisions, as capital raising is significantly affected by the bank's management decisions or by the regulatory and supervisory authorities, and risk-weighted assets are reduced through the bank's risk management policy. Thus, achieving this adequacy of capital has an impact on two contradictory aspects, the performance of banks on one side and the safety of deposits from asset risk on the other, achieving capital adequacy for good bank performance and good security of deposits from asset risk is realized through banks' operating efficiency.

Concerning the study variables, we find a difference among the researchers in determining them, and this difference is the result of the dependence of most studies that measure the efficiency of banks on the direct relationship between inputs and outputs such as the study (AL Said, 2017), and the study of (Yudistira, 2004),... Other studies that we find among them a difference in determining inputs and outputs to measure the efficiency of banks for both Islamic and traditional, where there is little difference between Islamic and traditional banks in determining the inputs and outputs of measuring the efficiency of the two types.

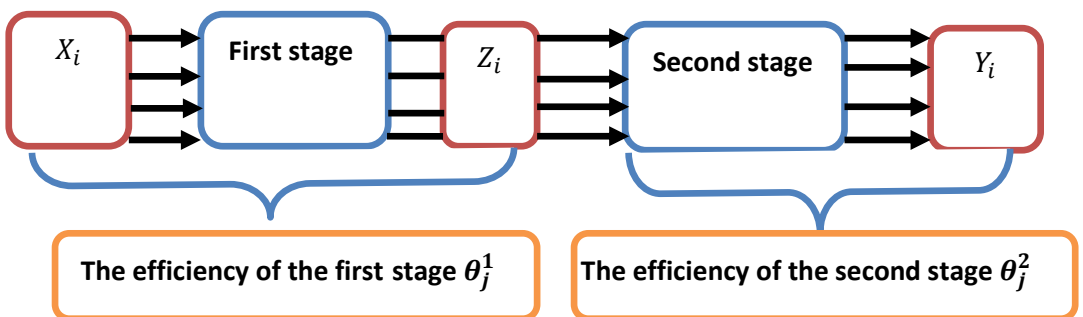
The difference among the previous studies in determining inputs and outputs is a result of the direct relationship between inputs and outputs lies in some variables that we find in some studies as inputs and in the others as outputs, for example, deposits found in some studies are considered as

inputs based on the mediation approach, and in others consider them as outputs based on the production approach.

Besides, the studies that consider loans and fixed investments as outcomes either in the production or in the mediation approach, a problem is posed: is the high investments and loans make the bank more efficient because the value of investments does not necessarily make the bank highly efficient, as this may affect the bank's performance, but for loans, the high value also does not necessarily make the bank high efficiency, because the bank may carry in its total loan portfolio a significant percentage of non-performing loans that may negatively affect the bank's performance. Therefore, the study of (Li, Chen, Chien, & Lee, 2016) (has made investments, loans, and capital adequacy ratios as intermediate variables linked to the optimal values of measuring efficiency in two phases, but the value of the non-performing loans is subtracted from the value of the total loans due to the implied risk in the denominator of the capital adequacy ratio.

Accordingly, the study variables can be identified and classified into three categories: inputs, intermediate variables, and outputs to measure banks' efficiency in two phases as described in Figure 1, where efficiency in two stages produces two efficiencies, the efficiency of the first phase resulting from inputs X_i and intermediate variables Z_i , and the efficiency of the second phase results from intermediate variables Z_i and outputs Y_i , and therefore the intermediate variables are considered as outputs for the first phase and inputs for the second phase, as described in figure1. Moreover, table 2 summarizes the study variables and their sources.

Figure number (1): Two-stage efficiency measurement



Source: Prepared by the researchers

The following table summarizes the study variables and their sources:

Table number (1): Study Variables

Symbol	Variable	Variable definition	Previous studies
Inputs			
X_1	Fixed assets	Real estate (land, buildings), equipment, bank-owned machinery plus equipment costs	<ul style="list-style-type: none"> - (Yudistira, 2004) - (Li, Chen, Chien, & Lee, 2016) - (Chen & Zhu, 2004) - (AL Said, 2017)
X_2	Operating expenses	Salaries, overtime wages, workers' wages taxes, rewards ...	<ul style="list-style-type: none"> - (Yudistira, 2004) - (Chen & Zhu, 2004) Some of the previous studies have used the employees' number as an output rather than the employees' expenses like the study of (AL Said, 2017)
Intermediate variables			
Z_1	Capital adequacy requirements	The bank' Capital adequacy ratio	(Li, Chen, Chien, & Lee, 2016)
Z_2	Total deposits (investments accounts)	Demand deposits, bank investments, term customers, current accounts, other client accounts. And so on.	- (Chen & Zhu, 2004) Yang-Li and others 2016
Z_3	Investments	Long and short-term investments including government, banks, and other financial institutions, in addition to financing or loans granted by the Bank	In the study of (Li, Chen, Chien, & Lee, 2016), the researchers separated the investments from loans (with ought the non-performing loans), in this study because of the unavailability of the data we some them as one variable.
Outputs			
Y_1	Return on assets (ROA)	Net income /total assets	Some of previous studies used the total income as outputs like the study of (Chen & Zhu, 2004) But others distinguished between the profits from interests and the profits from other activities like the study of Yang-Li and others 2016
Y_2	Return on equity (ROE)	Net income /total equity	

Source: Prepared by the researchers depending on the previous studies.

The classification of the study variables into three categories is due to two studies (Chen & Zhu, 2004) and (Li, Chen, Chien, & Lee, 2016), and we seek through this classification of the study variables to achieve the

main objective of the study which is to determine the optimal ratio of the capital adequacy that is considered as intermediate variables.

2-3- Model specification

Optimization is the maximum rate of efficiency that can be reached, through this concept it is clear that achieving optimization is done through the efficiency, in other word optimization measurement is reached through the efficiency measurement and this is proved in the study of (Cornuejols & Tutuncu, 2007) about the optimization measurement and the study of (ben Kheto, 2013) about the efficiency measurement.

The correlation is represented in the intermediate variables that are the outputs of one sub-process and at the same time input to another sub-process, in 1996 Färe and Grosskopf began to propose several network models for the production process analysis, but they provide only total efficiency with the inefficiency of partial operations, and in 2010 Fico Yama and Waber assessed the efficiency of Japanese banks using inefficient stagnation, while in 1999, (Lawrence & Zhu, 1999) tried to analyze banks' production processes into two stages, Profitability and market, where in the first phase the bank's ability to generate revenue and profitability is measured through the assets, business and equity, while in the second phase the bank's performance in the stock market is measured in terms of revenues and generated profitability, and this approach addresses the total production processes and partial processes independently, while it didn't deal with the contradictions between the two stages, which are the intermediate variables, which are the output of the first stage and the inputs of the second stage (Li, Chen, Chien, & Lee, 2016).

2-3-1- Specification of the two-stage data envelopment analysis model

DEA, which is a nonparametric, multifactor, productivity analysis tool, considers multiple input and output measurements in evaluating relative efficiencies of decision-making units (DMUs) such as banks (Barros, 2005).

The two-stage data envelopment analysis model is one of the best models that can achieve the objective of the study, where it can measure the efficiency of the bank and determine the optimal capital adequacy ratios at the same time, while the variables of the two-stage data envelopment analysis model are classified into three categories (1- inputs, 2- intermediate variables, 3- outputs), where efficiency is measured in the first and second stages, the efficiency of the first stage is measured through the inputs and intermediate variables, and the efficiency of the second stage is measured through the intermediate variables and outputs.

The two-stage data envelopment analysis model can be distinguished into several types and are often classified into four categories (Achi, 2016):

- Independent two-stage data envelopment analysis models;
- The dependent two-stage data envelopment analysis;
- Networked data envelopment analysis models;
- Continuous or interrelated two-stage data envelopment analysis models.

After reviewing the classifications of various models for the two-stage data envelopment analysis models, we found that the continuous two-stage data envelopment analysis model is the most appropriate model for the study, due to the lack of other models that prevent from reaching the objective of the study because, the interrelated two-stage DEA models overcome the shortcomings in the independent two-stage DEA models.

2-3-2- The mathematical formula of the two-stage DEA model

One of the most famous models of the interrelated two-stage data envelopment is the (Chen & Zhu, 2004) model, in this later the researchers developed the two-stage DEA, which is called the value chain model, it ensures the efficiency of the overall system in one case, which is the efficiency of each stage, and it is characterized by the matching degree of full efficiency in both the first and second phases and the efficiency of the variable volume model with input or output orientation, where if a specific resolution achieves full efficiency (1) in each of the first and second phases. Also in the variable returns model with output and input orientation. The mathematical formula of the model they proposed can be written as follows:

$$\left\{ \begin{array}{l}
 \min_{\alpha, \beta, \lambda_j, \mu_j, \tilde{z}} \quad w_1 \alpha - w_2 \beta \\
 \text{s.t} \\
 \text{(stage 1)} \\
 \sum_{j=1}^n \lambda_j x_{ij} \leq \alpha x_{io} \quad i = 1.2 \dots m \\
 \sum_{j=1}^n \lambda_j z_{dj} \geq \tilde{z}_{do} \quad d = 1.2 \dots D \\
 \sum_{j=1}^n \lambda_j = 1 \\
 d_j \geq 0, \quad j = 1.2.3 \dots n \\
 \text{(stage 2)} \\
 \sum_{j=1}^n \mu_j z_{dj} \leq \tilde{z}_{do} \quad d = 1.2 \dots D \\
 \sum_{j=1}^n \mu_j y_{ro} \geq \beta y_{ro} \quad r = 1.2 \dots S \\
 \sum_{j=1}^n \mu_j = 1 \\
 \mu_j \geq 0, \quad j = 1.2 \dots n
 \end{array} \right.$$

Where w_1 and w_2 are weights determined by the decision-maker according to the importance of each stage, and the symbol (\sim) refers to unknown variables. If $\alpha^* = \beta^* = 1$, then there is an optimal solution where

$\lambda_{jo}^* = \mu_{jo}^* = 1$. Also, the symbol (*) mentions the optimal solution for the model. Moreover, $\lambda_{jo}^* = \mu_{jo}^* = 1$ and $\alpha^* = \beta^* = 1$ and $\tilde{z}_{ajo}^* = z_{ajo}$ are the possible solutions for the model.

3- Results and discussion

The results of the study and their discussion are presented as follows:

3-1- Measurement of the optimal capital adequacy of Jordanian banks during the period 2015-2019

Based on the optimization concept, which is efficiency at its highest level, we will try in this section to measure efficiency first and then move on to determine the optimal values of capital adequacy in the selected sample of Jordanian banks.

3-1-1- Efficiency Measurement of the Selected Banks

The use of the interrelated two-stage data envelopment analysis generates three types of efficiency: 1- The efficiency of the first stage resulting from Xi inputs and Zi intermediate variables, 2- The efficiency of the second stage resulting from the intermediate variables Zi and Yi outputs, 3- overall efficiency resulting from Xi inputs and Yi outputs. In table 2 we explain the three efficiencies during the study period.

Depending on table 1, the researchers analyze the results of measuring the three efficiencies: overall efficiency (input-oriented, output-oriented), stage1 efficiency, and stage 2 efficiency, each year as follows:

Table number (1): banks’ efficiencies during the period 2015-2018

Banks	2015				2016			
	VRS Efficiency		E-stage-1	E-stage-2	VRS Efficiency		E-stage-1	E-stage-2
	I-Oriented	O-Oriented			I-Oriented	O-Oriented		
Safwa Islamic Bank (SIB)	0,846	3,017	0,846	4,009	0,813	1,952	0,813	2,496
Jordan Islamic Bank (JIB)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Islamic International Arab Bank (IIAB)	1,000	1,000	0,884	1,000	1,000	1,000	1,000	1,000
Union Bank (UB)	0,495	1,242	0,453	1,080	0,435	1,324	0,431	1,263
Société Générale – Jordan (SGJ)	1,000	1,000	1,000	1,247	1,000	1,000	1,000	1,369
Investment Bank (IB)	1,000	1,000	0,664	1,011	1,000	1,000	0,636	1,022
Arab Jordan Investment Bank (AJIB)	0,786	1,067	0,452	1,000	0,704	1,150	0,340	1,068
Housing Bank for Trade and Finance (HBTF)	0,338	1,059	0,214	1,037	1,000	1,000	1,000	1,000
National Bank of Jordan	0,251	1,799	0,414	1,761	0,281	6,603	0,610	6,569

(NBJ)												
Jordan Kuwait Bank (JKB)	0,493	1,258	0,492	1,173	0,474	1,567	0,474	1,507				
Commercial Bank of Jordan	1,000	1,000	0,781	1,000	0,618	1,854	0,717	1,909				
Capital Bank (CB)	0,489	33,22	0,939	35,96	0,465	2,070	0,465	2,028				
Cairo Amman Bank (CAB)	1,000	1,000	0,752	1,000	0,453	1,148	0,349	1,066				
Bank of Jordan (BOJ)	1,000	1,000	0,789	1,000	1,000	1,000	0,808	1,000				
ABC Bank/Jordan (ABCJ)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,143				
banks	2017				2018				2019			
	VRS Efficiency		E-stage -1	E-stage -2	VRS Efficiency		E-stage -1	E-stage -2	VRS Efficiency		E-stage -1	E-stage -2
	I-Oriented	O-Oriented			I-Oriented	O-Oriented			I-Oriented	O-Oriented		
	SIB	0,809	2,471	1,000	3,200	0,889	1,274	0,894	1,927	1,000	1,000	1,000
JIB	0,446	1,142	0,483	1,142	0,400	1,255	0,467	1,242	1,000	1,000	1,000	1,000
IIAB	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
UB	0,268	1,940	0,458	1,940	0,329	1,443	0,311	1,368	0,332	1,422	0,316	1,230
SGJ	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,406	1,000	1,000	1,000	1,000
IB	0,683	1,513	0,810	1,575	1,000	1,000	0,711	1,024	1,000	1,000	0,798	1,012
AJIB	0,522	1,803	0,477	1,506	0,644	1,486	0,583	1,568	0,620	1,271	0,673	1,223
HBTF	0,171	1,427	0,234	1,427	0,182	1,359	0,145	1,269	0,152	1,410	0,164	1,275
NBJ	0,281	3,774	0,466	3,774	0,278	2,006	0,318	1,919	0,290	1,637	0,409	1,236
JKB	0,478	2,827	0,709	2,827	1,000	1,000	0,813	1,000	0,788	1,190	0,711	1,000
CBJ	0,646	5,294	1,000	5,969	0,748	3,177	1,000	3,892	1,000	1,000	1,000	1,000
CB	0,477	2,033	0,785	2,033	1,000	1,000	0,622	1,000	0,849	1,028	0,560	1,230
CAB	0,345	1,820	0,476	1,820	0,407	1,516	0,423	1,444	0,470	1,337	0,457	1,000
BOJ	0,470	1,507	0,599	1,507	1,000	1,000	0,712	1,000	1,000	1,000	0,600	1,012
ABCBJ	1,000	1,000	1,000	1,189	1,000	1,000	1,000	1,527	1,000	1,000	1,000	1,223

Source: Prepared by researchers based on DEA software outputs.

In 2015: in this year it is obvious that two banks of 15 are fully efficient in the three categories: the overall efficiency and efficiency of the first and the second stage, this banks are The Jordan Islamic Bank and The Arab Banking corporation /Jordan, the first is an Islamic bank while the second is a traditional one, moreover, seven banks achieve the overall efficiency but do not achieve either the first stage and the second stage efficiency. Of these seven banks, only, one bank which is the Arab Islamic Bank achieves the overall efficiency and the efficiency of the second stage but doesn't achieve the efficiency of the first stage.

In 2016: it can be concluded that three banks are fully efficient in the three categories of efficiency, two are Islamic banks: the Jordan Islamic Bank and the Islamic International Arab Bank and one is a traditional Bank:

Housing Bank for Trade and Finance, also, five traditional banks achieve the overall efficiency but do not achieve the efficiency of the first stage or the efficiency of the second stage.

In 2017: two banks achieve the three efficiencies, an Islamic bank (Islamic International Arab Bank) and a traditional bank (Societe Generale-Jordan). Whereas, the Arab banking corporation /Jordan achieves the overall efficiency and the efficiency of the first stage but doesn't achieve the efficiency of the second stage.

In 2018: just one bank achieves the overall efficiency of the three categories; this bank is the Islamic International Arab Bank. Furthermore, seven traditional banks achieve the overall efficiency but do not achieve the efficiency of the first stage or the efficiency of the second stage.

In 2019: it is obvious that three banks achieve the three efficiencies: the overall efficiency, the efficiency of the first stage, and the second stage efficiency, these banks are the Islamic Bank of Jordan, the Islamic International Arab Bank, and the of Societe Generale Bank, where the first and second are Islamic banks, and the third is a traditional one, additionally, it can be seen that eight banks achieve the overall efficiency but do not the efficiency of the first stage or the efficiency of the second stage, for these banks, there is just one Islamic bank which is Safwa Islamic bank.

Through this analysis, we conclude that if the Bank achieves total overall efficiency, it is not necessary to achieve overall efficiency in the first and second stage, and vice versa, since if the Bank achieves an overall efficiency in the first and the second stage, it necessary to achieve an overall efficiency, both in input-oriented and output-oriented, this means that the H_1 : is accepted, another conclusion is that Islamic international Arab Bank has maintained its full efficiency in the three categories for the three years of the study period (2016-2017and 2018), The Jordan Islamic Bank maintained its full efficiency in the three categories for only two years of study (2015-2016), while the traditional banks achieve a full efficiency in the three categories and just one year of the study period: Société Générale/Jordan in 2017, Housing Bank for Trade and Finance in 2016 and Arab banking corporation /Jordan in 2015.

3-1-2- Measurement of banks' optimal ratio of capital adequacy

To measure the efficiency of the first stage and the efficiency of the second stage the researchers rely on three types of variables: inputs, intermediate variables, and outputs, where the intermediate variables are considered as the outputs of the efficiency of the first stage and at the same time the inputs of the efficiency of the second phase, in the first stage, is maximized and in the second stage is reduced as described in model 1, through which the optimal values of the intermediate variables can be

computed and it allows for reaching the efficiency of the first and the second stage at the same time.

Table 3: Optimal capital adequacy ratios for Jordanian banks

Bank	2015	2016	2017	2018	2019	المتوسط
SIB	21,34757	17,39199	16,02130	17,35782	18,40278	18,10429
JIB	21,11000	22,02000	16,50372	18,59711	24,33000	20,51216
IIAB	20,12654	16,21000	16,50000	18,90000	20,38000	18,42331
UB	20,99392	16,98248	16,52458	17,37716	18,73098	18,12182
SGJ	21,55000	17,11594	19,39000	15,00000	14,22000	17,45519
IB	21,34174	18,19039	16,12519	18,11708	17,10423	18,17573
AJIB	20,63007	16,96071	15,81017	17,15438	17,20744	17,55255
HBTF	20,23081	17,02000	16,54070	17,27357	18,50792	17,91460
NBJ	19,45825	19,98693	16,52293	17,62881	19,07795	18,53497
JKB	20,99920	18,03530	16,56566	18,13140	19,02216	18,55075
CBJ	20,53126	16,88012	16,29646	18,09669	17,46765	17,85444
CB	17,98137	17,96224	16,56968	16,25000	18,08418	17,36949
CAB	18,71999	17,18561	16,52794	19,05835	18,78227	18,05483
BOJ	18,21000	20,82000	16,56546	17,44324	17,07000	18,02174
ABCBJ	20,87000	17,57578	15,41877	19,60000	17,10818	18,11455

Source: Prepared by the researchers based on DEA software outputs

According to Table 3, it can be noted that the optimal ratios (to be achieved) for Jordanian banks, whether Islamic or traditional, during the study period are above the minimum capital adequacy ratio set by the supervisory authorities (Central Bank of Jordan) which is 12%, where the lowest optimal capital adequacy ratio is 14.22% this later is reached by the Societe Generale/Jordan bank in 2019, and the highest capital adequacy ratio is 24.33% reached by the Jordan Islamic Banking 2019, the analysis of the optimal capital adequacy ratios are presented as follows:

In 2015: the lowest optimal capital adequacy ratio is achieved by the Capital Bank (traditional bank) and is equal to 17.98%, while the highest optimal capital adequacy ratio is reached by the Societe Generale/ Jordan and equals to 21.55%, moreover, no clear differences found between Islamic and traditional banks concerning the optimal capital adequacy ratio.

In 2016: The lowest optimal capital adequacy ratio is reached by the Jordan Arab Islamic Bank at 16.21%. However, the highest optimal capital adequacy ratio is realized by The Islamic International Arab Bank and it is equal to 22.02%, and there are no obvious differences between Islamic and traditional banks in the optimal size of capital adequacy ratios.

In 2017: the lowest optimal capital adequacy ratio is found at Arab Banking Corporation /Jordan (a traditional bank) at 15.41%, and the highest optimal capital adequacy ratio is associated with the Societe Generale/Jordan (a traditional bank) at 19.39%, and there are no significant

differences between Islamic and traditional banks in the optimal capital adequacy ratios.

In 2018: the lowest optimal capital adequacy ratio is reached by the Societe Generale/Jordan (a traditional bank) and it equals 15% and the highest optimal capital adequacy ratio is allocated to the Arab Banking Corporation/ Jordan at 19.6%, and there are no important differences between Islamic and traditional banks in the optimal capital adequacy ratio.

In 2019: the lowest optimal capital adequacy ratio is achieved by the Societe Generale/Jordan (a traditional bank) at 14.22% and the highest optimal capital adequacy ratio is found at The Jordan Islamic Bank at 24.33%, and there are no clear differences between Islamic and traditional banks in the size of optimal capital adequacy ratios.

Concerning the average optimal capital adequacy ratios during the study period 2015-2019, it is found that the lowest average is reached by the Bank of Jordan at 17.36% and the highest average is found at the Jordan Islamic Bank by 20.51%. This means, economically and financially, that the specified capital adequacy ratio determined by the supervisory authorities in Jordan, which is estimated at 12%, is still below the required level and must be raised, the results of the sample can be generalized to the rest of banks, given that the sample includes most of the banks operating in Jordan.

3-2- the extents to which Jordanian banks achieve optimal capital adequacy ratios

After determining the optimal capital adequacy ratios to be achieved by the Jordanian banks to reach the minimum requirements of full efficiency (1) in the first and second stages, the optimal ratios can be compared with the actual ratios achieved during the study period 2015-2018 through determining the difference between the optimal and actual ratios shown in the following table.

Table number (4): The optimal and the actual capital adequacy ratios in Jordanian banks during the period 2015-2018

Bank name	2015	2016	2017	2018	2019
Safwa Islamic Bank	25,92	23,82	14,87	8,16	0,96
Jordan Islamic Bank	0,00	0,00	6,50	4,18	0,00
Islamic International Arab Bank	-2,54	0,00	0,00	0,00	0,00
Union Bank	-6,19	-3,39	-1,82	-3,26	-5,28
Société Générale - Jordan	0,00	5,49	0,00	0,00	0,00
Investment Bank	-3,13	-0,83	-0,86	-2,57	0,01
Arab Jordan Investment Bank	-4,69	-0,71	0,14	-1,25	-1,83
Housing Bank for Trade and Finance	-3,20	0,00	0,57	-1,14	-1,26
National Bank of Jordan	-3,17	-6,66	-2,48	-2,90	-3,42
Jordan Kuwait Bank	-2,77	0,97	1,73	-1,06	0,43
Commercial Bank of Jordan	-5,92	-1,55	-2,60	-6,60	-6,37

Capital bank	0,32	-4,09	-1,45	0,00	0,33
Cairo Amman Bank	-2,93	-0,72	-1,49	-3,85	-0,77
Bank of Jordan	0,00	0,00	2,51	-0,63	0,00
ABC Bank/Jordan	0,00	2,19	3,46	0,00	2,99

Source: Prepared by researchers based on appendix 1

Through table 5 it can be concluded that there are negative, positive and zero differences, negative differences indicate that the actual capital adequacy ratio is lower than the optimal capital adequacy ratio, otherwise, these banks have to increase their capital adequacy ratio by the difference to reach the efficient boundaries, but the positive differences indicate that the actual ratio of capital adequacy is higher than the optimal ratio, accordingly, these banks have to reduce their capital adequacy ratios by the difference to reach the efficient boundaries. The zero differences are indicative of the equality between the actual and optimal capital adequacy ratios; this means that these banks have to maintain their capital adequacy ratios, which are considered optimal. More analyses are presented as follows:

In 2015: four banks have achieved the optimal capital adequacy ratios, since; the difference between the optimal and actual capital adequacy ratios is zero. From these banks, there is one Islamic bank the Jordan Islamic bank, and three conventional banks (Societe Generale/Jordan Bank, Bank of Jordan, Arab Banking Corporation Bank/Jordan. However, two banks have achieved a positive difference where the actual capital adequacy ratio is higher than the optimal, from these banks there is one Islamic bank (Safwa Islamic Bank) which had the highest negative difference during the study period, in 2015 by more than 25%, finally, a positive difference also exists at Capital Bank by more than 0.32%, and for the rest of banks achieve a negative difference where the actual adequacy ratios are less than the optimal ratios, as well as the largest difference is found at the Union Bank by 6% and the lowest difference at The Islamic International Arab Bank by 2.53%.

In 2016: the researchers find that four banks achieve optimal capital adequacy ratios, and the difference between the optimal and actual capital adequacy ratios is zero. From these banks, there are two Islamic banks (Jordan Islamic bank and The Islamic International Arab Bank), and two traditional banks (bank of Jordan and housing banks for trade and financing). Whereas, four banks have achieved a positive difference, on Islamic bank (Safwa Islamic banks) and three traditional banks (Societe Generale/Jordan, Jordan Kuwait Bank, and the ABC/Jordan)

The highest positive difference in 2016 was more than 23%, and we also find the positive difference at three traditional banks (Societe Generale/Jordan, Jordan Bank, ABC/Jordan), and the rest of the banks,

which are negatively ingested by any actual capital adequacy ratios below the ideal where we find the highest difference at The National Bank of Jordan by 6% and the lowest difference at The Arab Investment Bank of Jordan by 0.71%. The rest of the banks achieve a negative difference, where the actual capital adequacy ratios are less than the optimal, and the highest deference goes to the National Bank of Jordan by 6% and the lowest difference is found at Arab Jordan Investment Bank by 0.71%.

In 2017: two banks achieve optimal capital adequacy ratios since, the difference between the optimal and actual capital adequacy ratios is zero: Islamic International Arab Bank and Societe General bank/Jordan, while seven banks achieve a positive difference since, the actual capital adequacy ratios are higher than optimal, two banks are Islamic: Safwa Islamic Bank, which has the highest positive difference during 2017 by more than 14% and Islamic International Arab Bank by 6%, other banks traditional achieved a positive difference ranged between 0.16% and 3.46%. The rest of the banks achieve a negative difference, the actual capital adequacy ratios are below the optimal where the highest difference is found at the Commercial Bank of Jordan at 2.59% and the lowest difference at the Investment Bank by 0.85%.

In 2018: We note that four banks achieve optimal capital adequacy ratios, that is, the difference between the optimal and actual capital adequacy ratios is null. For the banks achieving this case, we find one Islamic bank (Arab International Islamic Bank) and three conventional banks (Societe Generale Bank / Jordan, Capital Bank, Arab Banking Corporation / Jordan). however, for the banks that achieve a positive difference, where, their actual capital adequacy ratios are higher than the optimal, from these banks there are two Islamic banks (Safwah Islamic Bank), which had a higher positive difference during the 2018 study period by 8%, and the Jordan Islamic Bank by more than 4%, and the rest of the banks have achieved a negative difference, since, the actual capital adequacy ratios are less than the optimal, and the highest difference is found at the Jordan Commercial Bank by more than 6% and the lowest difference at Bank of Jordan at 0.63%.

In 2019: the researchers find that four banks achieve optimal capital adequacy ratios, that is, the difference between the optimal and actual capital adequacy ratios is zero. For the banks achieving this case, they find two Islamic banks (the Jordan Islamic Bank and the International Islamic Arab Bank) and two conventional banks (Societe Bank General / Jordan, and Bank of Jordan). As for the banks that achieve a positive difference, means that the actual capital adequacy ratios are higher than the optimal, are found at (Safwa Islamic Bank) with a positive difference of approximately

1% and the lowest difference at the investment bank by 0.01% and the highest positive difference at ABC Bank by 2.99%. Moreover, a negative difference, where the actual capital adequacy ratios are less than optimal is found at six conventional banks, the lowest at Cairo Amman Bank by 0.77% and the highest at Jordan Commercial Bank by 6.37.

Finally, through the preceding analysis, it can be concluded that Islamic banks for four years achieve a nil or positive difference between their actual and optimal capital adequacy ratios except in one year (2015), accordingly H_2 : is accepted. Thus, the International Islamic Arab Bank has made a negative difference, but in the remaining years of the study, it made a nil difference. Moreover, Safwa Islamic Bank during the entire study period has made a positive difference due to the high proportions of capital adequacy, we also note that whenever the actual capital adequacy ratio decreases, the difference decreases with the optimal capital adequacy ratios. As for the Jordan Islamic Bank, it was observed to maintain the optimal capital adequacy ratios during the years 2015, 2016, 2019, and for the rest of the years, the difference was positive between its actual and optimal capital adequacy ratios.

Concerning conventional banks, it is noted that most of them achieve capital adequacy ratios less than their optimal ratios during the study period this means that H_3 : is accepted, where the ratio is found to be higher than 50% of several conventional banks in 2017 and 2019, and higher than 60% of many conventional banks in the 2015-2016 And more than 70% of some conventional banks in 2018, making a negative difference between the optimal and actual capital adequacy ratios, so they must raise their capital adequacy ratios to reach efficient boundaries.

As an economic and financial explanation of these results, the foregoing can be explained by the fact that Islamic banks are subjected to greater risks than conventional banks (the same risks that conventional banks are exposed to, in addition to risks related to Islamic banking), accordingly, they seek to increase the capital adequacy ratios to face these risks, which makes Islamic banks achieve the optimal ratio, unlike traditional banks.

Conclusion

The main aim of this study is to determine the optimal efficiency ratios in banks. To do this a sample of 15 banks operating in Jordan were chosen for the period 2015-2019. To reach the study objective the continuous two-stage data envelopment analysis model is used since this model is considered among the best models that achieve both objectives; measuring

efficiency and measuring optimal values of the intermediate variables. After performing the analysis the following results have been achieved:

- A few numbers of Jordanian banks have achieved optimal capital adequacy ratios during the study period, while in 2017 we find only two banks reach a rate of 12.5%, while in the rest of the years we find four banks reach 25%.
- Safwa Islamic bank achieve high capital adequacy ratios during the study period, which moves it away from its optimal capital adequacy ratios and therefore it doesn't reach the full efficiency during the study period;
- Islamic banks within five years achieved a zero or a positive difference between their actual and optimal capital adequacy ratios, excluding that in 2015 we note that the International Arab Islamic Bank has made a negative difference, but in the rest of the study period it has made a nil difference.
- Most traditional banks achieve lower capital adequacy ratios than their optimal rates during the study period, where we find that the ratio is equal to or more than 50% of the number of traditional banks and sometimes more than 60% and 70% of them, however, the difference is not large, ranging between 0.71% and 6%.

Bibliography

- Achi, A. (2016). Improving the efficiency of health institutions using two methods of data envelope analysis and hierarchical analysis - a field study in Batna, unpublished doctoral thesis. Algeria.: University of Batna.
- AL Said, A. (2017). Assessing the efficiency of Islamic banks in Arab countries using the data envelopment analysis method. *The Jordanian Journal of Economic Sciences*, 4 (1).
- Barros, C. (2005). 'Measuring performance in defense-sector companies in a small NATO member country. *Journal of Economic Studies*, 31 (2).
- ben Keto, F. (2013). Measuring the profitability and efficiency of banking institutions; A case study of Algerian banks during the period 2005-2011, unpublished doctoral dissertation. - Ouargla, Algeria.: Kasadi Merbah University.
- Chen, Y., & Zhu, J. (2004). *Measuring Information Technology's Indirect Impact on Firm Performance*. Kluwer Academic Publishers, Information Technology and Management.
- Cornuejols, G., & Tutuncu, R. (2007). *Optimization Methods In Finance*. Cambridge University Press.
- Gadi, E. (2014). Efficiency and Optimisation. Retrieved 07 2020, 08, from available on <https://www.realisedatasystems.com/efficiency-and-optimisation>.
- Hosseini, h. F., & Al Muayyad, A. a.-R. (2003). (2003). *Bank management Contemporary quantitative and strategic approach*. Wael Publishing House.
- Investopedia. (2019). Retrieved 07 2020, 2020, from What Is the Minimum Capital Adequacy Ratio Under Basel III?: Available on

- <https://www.investopedia.com/ask/answers/062515/what-minimum-capital-adequacy-ratio-must-be-attained-under-basel-iii.asp>.
- Kuper, A., & Kuper, J. (2003). *The Social Science Encyclopedia* (2 ed.). US: Routledge Taylor Francis group.
- Lawrence, S., & Zhu, J. (1999). Profitability and Marketability of the Top 55 U.S. Commercial Banks. *Management Science, Institute for Operations Research and the Management Sciences*, 45 (9).
- Li, Y., Chen, Y.-K., Chien, F. S., & Lee, w. C. (2016). Study of optimal capital adequacy ratio. (Springer, Ed.) *journal of productivity analysis*, 45 (3).
- Mouna, Y., & Ibn al-Din, M. (2017). The importance of capital adequacy in Islamic banks compared to conventional banks; A study of the effect of the transition of some Jordanian Islamic banks from the Basel II application to the implementation OF THE IFSB2 standard. (A. D. University, Ed.) *Al-Haqiqa Magazine*, (43).
- Paul, B., Berger, A., & Humphrey, D. (1992). Efficiency and Productivity Growth in US Banking” in *The Measurement of Productivity Efficiency; Techniques and Applications*, edited by HO Fried, C.A.K Lovell, and P.Schmidt. Oxford University Press, 3.
- Yudistira, D. (2004). Efficiency in Islamic banking: an empirical analysis of eighteen banks *Islamic economics studies. Islamic Research and Training Institute*, 12 (1).