Analysing Bank Efficiency Incorporating Internal and External Risks: A Case Of Jordan

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Abstract

The goal of this study is to estimate the efficiency of commercial and investment banks before, during, and after financial crises (2004 – 2013) in Jordan, including the internal and external variables through employing three stages Data Envelopment Analysis (DEA).To this end, the study aimed to investigate the efficiency of Jordan banks before, during, and after Global Financial Crisis and Arab spring and explain the impact of environmental variables on Jordan banks efficiency score level and the influence of Financial Soundness Indicators (FSIs) on Jordan banks efficiency score level. The study promotes a qualitative method adopting an empirical data in measuring banks efficiency in Jordan. Data are collected from INCIEF digital library and ASE database for 13 Jordanian banks over the period 2004-2013. Data are analyzed using super- SBM and SFA. The findings indicate that the overall Jordanian banks were found to be inefficient (2004- 2013). All the banks appeared to be inefficient before GFCS (2004-2006) and became even more inefficient during GFCS (2007-2009) while starting to recover but still inefficient after GFCs (2009-2013). Moreover, the soundness financial indicators and the environmental variables were found to be significant in all inputs.

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ANALYSING BANK EFFICIENCY INCORPORATING INTERNAL AND EXTERNAL RISKS: A CASE OF JORDAN:

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Abstract. The goal of this study is to estimate the efficiency of commercial and investment banks before, during, and after financial crises (2004 – 2013) in Jordan, including the internal and external variables through employing three stages Data Envelopment Analysis (DEA).To this end, the study aimed to investigate the efficiency of Jordan banks before, during, and after Global Financial Crisis and Arab spring and explain the impact of environmental variables on Jordan banks efficiency score level and the influence of Financial Soundness Indicators (FSIs) on Jordan banks efficiency score level. The study promotes a qualitative method adopting an empirical data in measuring banks efficiency in Jordan. Data are collected from INCIEF digital library and ASE database for 13 Jordanian banks over the period 2004-2013. Data are analysed using super- SBM and SFA. The findings indicate that the overall Jordanian banks were found to be inefficient (2004- 2013). All the banks appeared to be inefficient before GFCS (2004-2006) and became even more inefficient during GFCS (2007-2009) while starting to recover but still inefficient after GFCs (2009-2013). Moreover, the soundness financial indicators and the environmental variables were found to be significant in all inputs.

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1. Introduction

The last periods have witnessed many financial crisis and difficult macroeconomic situation effects of the global downturn and strike the world's economies, as well as individuals and institutions. The Global Financial Crisis (GFC) in 2009 deeply affected the whole world to the extent that it has been considered as one of the most harmful crises in the last decades.

Moreover, the GFC and the political crisis which is well known as Arab spring in 2008 had an economic and social impact in Arab world. In spite of huge efforts done to come out from these crises, there are still warnings of continued risks and challenges.

As a small open oil-importing emerging economy, Jordan is highly affected in the last ten years from severe shocks including global financial crisis and Arab Spring with the world

economy. In general, difficult regional environment as a conflict in Iraq and Syria is affecting Jordan through disruptions to trade routes, falling tourism receipts, weak investment and large inflows of refugees.

In light of the important role of financial system in facing GFCs and Arab spring. This study adopts the banking sector which is the main bulk in financial system as a case study with the aim to investigate bank efficiency in Jordan before, during, and after Global Financial Crisis and Arab spring from 2004 -2013.

To measure banks efficiency, the production theory provides two useful methods for measuring bank efficiency scores. These are the parametric method in regression representing the Stochastic Frontier Analysis model (SFA) (Aigner, et al.,1977; Meeusen and van Den Broeck, 1977) and nonparametric linear programming method like Data Envelopment Analysis (DEA) (Charnes, et al., 1978; Banker et al., 1984).

During the last decade, most of the literature on bank efficiency; especially those studies addressing DEA used traditional DEA with more attention toward 2- stage DEA (Cook et al., 2010; Simar and Wilson, 2011; Johnson and Kuosmanen, 2012; Li et al., 2012; Halkos et al., 2014). However, little of the literature studies focused on 3-stage DEA since its first introduction by Fried and Lovell in 1993 and its extension in focus in 1999 by Fried, Schmidt and Yaisawarng to account for estimating the environmental variables. Increasingly, fewer studies applied 3-stage DEA to explain the impact of external and internal variables (Lin et al., 2009; Yu et al, 2010; Shyu & Chiang, 2012).

Furthermore, the majority of recent studies addressing DEA has been mostly conducted in USA, European countries and china (Périco et al, 2016; Andrieș & Ursu, 2016; Gallizo et al, 2016; Halkos et al, 2014; Shyu& Chiang, 2012; Avkiran, 2011). Few studies were conducted in the developing countries (Sufian et al,, 2016; Al-Gasaymeh, 2016; Abd Rahim, 2015; Bandaranayake & Jayasinghe, 2014; Mohamed Shahwan and Hassan, 2013; Jreisat, & Paul, 2010). Such studies which were conducted in the developing countries, including Jordan, has concentrated on traditional DEA with poor pinch mark (Hmedat, 2011; Hamiltona et al, 2010).

Despite of the plethora of research on banking efficiency, few studies has been conducted to combine both GFCs and political distress on banking efficiency. As such, this study incorporates both the external and internal variables to give a clear picture of Jordan banks efficiency scores during crisis periods.

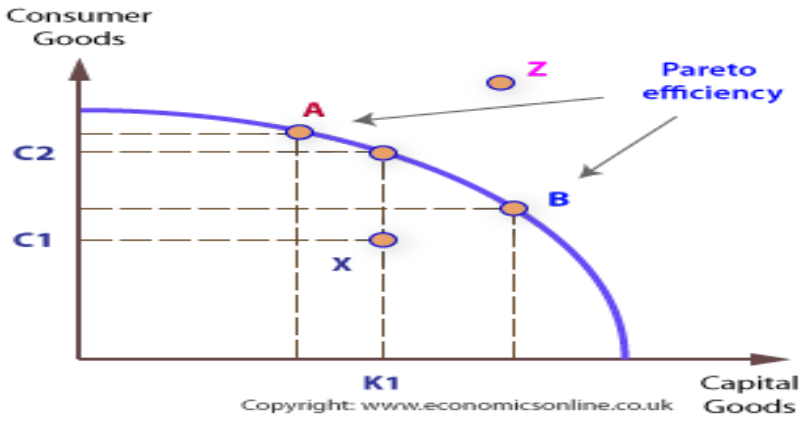
To achieve this target, this study seeks to apply the 3-stage DEA, where in the first stage the Super Slack Base Measurement (Super – SBM) will be used to estimate the efficiency in general without any risks included. In the second stage, the effect of external(the GDP, consumer pricing index and population) and internal(Financial Soundness Indicators (FSIs)) risks will be examined through applying stochastic frontier regression. The last stage; the super –SBM will be rerun to explore the effect of both the internal and external risks are included to measure and rank the banks.

2. Literature review

The initiation of the efficiency concept is traced back to the Pareto's criterion in 1906 where simply defined as choosing the best practices among the available sources without

making at least one individual worse off (Cooper et al, 2011; Cook & Seiford, 2009). An allocation is defined as "Pareto efficient" or "Pareto optimal" when no further Pareto improvements can be made (Barr, 2012).

Figure 1: Pareto efficiency, (cited in Barr, 1992).



The first study of banking efficiency measurement that used DEA was introduced by Sharman and Gold (1985). The operational efficiency of bank's branches were measured and evaluated and the results were compared with the accounting financial ratios. In which, the results highlight the advantage to DEA, because DEA is considered a useful approach in providing a clear vision to banking management to improve the productivity of branches and banks as whole.

Over than 30 years ago, DEA has been widely used to measure efficiency in various fields, including hospital and healthcare (Shulan et al., 2013; Ferrier & Trivitt, 2013), airlines (Wanke, 2013; Zhu, 2011), educational academies (Blackburn et al,2014; Sav, 2013), and banks (Wanke & Barros, 2014).

Multiple DEA additional models have been developed recently such as network and dynamic with slack based measurements (Fare & Grosskopf, 2000; Tone & Tsutsui, 2010; Tone &Tsutsui, 2014). In addition, DEA multistage models consists of two or more stages being introduced to involve both internal and external factors in efficiency measurement (Ebrahimnejad et al, 2014; Wang et al, 2014; Johnson & Kuosmanen, 2012; Estelle et al, 2010). The multistage DEA and the additive models are discussed in the following sections.

Many studies found that the results of applying SFA and DEA lack consistency, even when using same variables and data (Charnes et al, 2013; Paradi& Zhu, 2013; Thoraneenitiyan & Avkiran, 2009; Avkiran and Rowlands, 2008; Jacobs et al, 2006; Xu& Shi, 2006; Weill, 2004; Chen, 2002; Bauer et al, 1998). More recent studies found that SFA efficiency scores are generally higher compared to DEA scores (Bazrkar & Khalilpour, 2013; Zhou et al, 2013; Erkoc, 2012).

The multi-period DMUs has been currently solved through the network DEA which was proposed by Fare & Grosskopf (2000). Moreover, the solution of the heterogeneity of input – output was solved through augmenting DEA with Cluster Analysis (CA) and Neural Networks (NN) by Samoilenko & Osei-Bryson (2010).

In 1996, three stage DEA was introduced by Fried and Lovell (1996) then Fried, Schmidt and Yaisawarng (1999) extended three-stage DEA and focused on estimating the external environmental variables which influence the input slacks variables. Furthermore, a comparison between traditional DEA and three- stage DEA was held (Liu et al, 2013; Shyu& Chiang, 2012; Lee, 2008; Pastor, 2002; Fried et al, 2002). The results of those studies gave the three-stage advantage over traditional DEA.

Thanassoulis (1999), Tone (2002), and Lovell and Rouse (2003) used super -SBM to solve the infeasible problem. In addition, Chen et al (2010) and Spaho & Mitre (2015) used super –SBM to provide a comprehensive discussion about various models to solve the efficiency score.

Generally, there is no consensus amongst researchers to select of inputs and outputs in measuring efficiency. There are two principal schools of thought on bank behavior; namely, production and intermediation approach. Under the production approach, the objective of a firm is to minimize the consumption of resources in providing various products and services, or maximize products and services for given levels of resources.

As in the most recent studies, the intermediation approach is the most widely used in the banking literature (e.g, Sufian et al, 2016; Al-Gasaymeh, 2016; Zhao & Kang, 2015; Spaho &Mitre, 2015; Echchabi et al, 2015…etc). This study adopts the intermediation approach.

In this study, the inputs used are fixed assets, deposit and total interest expense and the outputs adopted are securities, loans and net interest revenue. This study follows the input and output by (Al-Gasaymeh, 2016; Zhao & Kang, 2015; Ab Rahim, 2015; Zimková, 2014; Akhtar, 2013; Hmedat, 2011; Chen et al, 2010).

From the literature, the determinants of bank efficiency are often had identified as a function of bank-specific and environment factors. Previous studies focused on banks' size, age, location, loan quality as bank-specific. The environment factors are variant according to the aim of each case study as GDP, inflation rate, exchange interest rate, Consumer Price Index (Sufian et al, 2016; Abu Orabi et al, Al-Gasaymeh, 2016; 2016; Echchabi et al (2015); Rozzani & Abdul Rahman, 2013; Shyu & Chiang, 2012; chen et al , 2010; Lee, 2008).

From the existing literature, this study had identified that bank-specific variables such as size, age and credit risk (Sufian et al, 2016; Al-Gasaymeh, 2016; Alber, 2015; Rozzani & Abdul Rahman, 2013; Liu et al, 2013; Shyu & Chiang, 2012; Hmedat, 2011; Chiu & Chen, 2009).

Andries & Ursu (2016) investigated the influence of GFCs on banks efficiency of 27 member countries in European Union. The sample consists of 783 banks from 2004 to 2010. The SFA model by Battese and Coelli (1995) and multi-product by Andrieș and Căpraru (2014) were used to estimate two sets of alternative models; cost and profit efficiency under intermediation approach.

By reviewing bank efficiency studies, the foundation of the majority studies conducted on efficiency has been conducted in USA, European countries and china (Halkos et al, 2014; Shyu& Chiang, 2012; Avkiran, 2011).Quite, few studies were conducted in developing

countries (Mohamed Shahwanand Hassan, 2013; Jreisat, & Paul, 2010). As such, this study incorporates both the external and internal variables to give a clear picture of Jordan banks efficiency scores during crisis periods.

3. Objectives of the study:

This study aims to:

1. Investigate the efficiency of Jordan banks before, during, and after Global Financial Crisis and Arab spring.

2. Explain the impact of environmental variables on Jordan banks efficiency score level.

3. Explain the influence of Financial Soundness Indicators (FSIs) on Jordan banks efficiency score level.

4. Data source and construction of the model:

Super SBM VRS will be applied to estimate bank efficiency by Tone (2002) will be used in order to avoid the shortcoming of the BCC models. However, the evaluating the radial efficiency do not include non-zero slacks in BCC models. The super SBM VRS deals with the input excesses and output shortfalls and uses the additive models to give a scalar measure of all the inefficiencies.

The VRS super-SBM model can solve the efficiency ranking problem and the infeasible problem caused by the AP model. When the performances of the decision-making unit get closer, then using the Super-SBM model is a better option (Chen et al, 2010).

The sample will be ranked according to the objective of the study where the efficiency score will be estimated for whole period of the study 2004-2013, then the efficiency scores was investigated for 3 main period which are before GFCs (2004-2006), after GFCs (2007-2009) and Arab spring (2010-2013).

Then, a frontier regression model (SFA) will be employed once for estimating the environmental variables and one more time to estimate FSIs on bank efficiency. In order to identify the influence of these variables on bank efficiency for whole period 2004-2013, the dependent variable in the frontier regression model were the slacks for each input.

In this step the Battese and Coelli (1992) functional form of the econometric model will be employed. Frontier version 4.1 was built by Tim Coelli to estimate stochastic frontier production function models as Battese and Coelli (1992). According to Battese and Coelli (1992) the function estimated as following:

$$S_{ij} = f(Z_j; B_i) + \mathcal{E}_{ij} \,,\ \mathcal{E}_{ij} = V_{ij} + u_{ij} \qquad i = 1,.....,m;\ j = 1,.....,n. \qquad (6.1)$$

Sij: the j-th bank of the i-th input slack.

$f(\ )I$: the feasible slack function.

Z_j : $Z_j = [Z_{1j}, Z_{2j}, ..., Z_{kj}]$ is the k-th environmental factors of the j-th bank

B: the estimated parameters

Vij: error term, V~N (0, δ_{vi})

U_{ij} = managerial inefficiency, U_{ij} ~N+ (U_i, $\delta_{ui)}$, V_{ij} and U_{ij} are independent here,

This study assumes V_{ij} is normal distribution, and u_{ij} is a truncated normal distribution. In stochastic frontier analysis the maximum likelihood method used to solve the above equation interpreted the relationship of dependent and independent variables. The linearity of the equation (6.1) was imposed by logarithmic for slacks variables.

In this stage also includes four independent variables (external or environmental) representing the factors likely to impact a bank's efficiency which are specific –bank (size and age) and environmental variables (GDP, consumer pricing index and population). The specific –bank and environmental variable is consistent to the studies of Al-Gasaymeh (2016) and Shyu & Chiang (2012) respectively.

The SFA run again under new dependent variable which are (internal) FSIs namely; tier 1 ratio, liquidity assets, non-performing loans, ROAA and ROAE. This is considered as new contribution in the internal variables set as Sufian et al (2016) used Z-score as dependent variables and Kutum & Al-Jaberi (2016) adopted Basel III ratios.

The purpose of the second stage is to explain the variance in the first stage in terms of a vector of observable environment variables and FSIs. In addition, two stage approaches obtains estimating of the impact of internal or external variables on efficiency scores.

After applying SFA in the second stage, the impact of environment factors on efficiency is initiated then from SFA error term will be eliminated to adjust the input in order to reuse them in Super-SBM to measure bank efficiency with the existence of these factors.

According to Chiu &Chen (2009) the adjusted input factors dataset the following equations:

$$X_{\_ij}^{\hat{}adj}=X_{\_ij}+\lfloor \max\{Z_{\_(j)}\,\beta^{i}\}-Z_{\_j}\,\beta^{i}\rfloor+\lfloor [\![\max]\!]_{(j)}\{V_{\_ij}\}-V_{\_ij}\rfloor \quad .....(5.2)$$

i=1,.....,m j=1,.....,n

$$V_{IJ}\,\hat{E}\{V_{ij} \mid V_{(ij)}+U_{ij}\}=S_{ij}-Z_{(j)}\,\beta^{i}-\hat{E}\{U_{ij} \mid V_{ij}+U_{ij}\} \quad .....(5.3)$$

i=1,.....,m j=1,.....,n

Among these, the decision making unit j (j=1,...,n) uses i(i=1,...,m) to adjust. The adjusted input is X_{ij}^{adj}.

After that, super SBM model reruns the adjusted data. The super SBM model is including internal and external variables including in the adjusting slacks. See appendix 4 clarify the three stage DEA model.

A comparison between the bank efficiency score in the first and third stages is initiated in order to find which of them is the most efficient as if the efficiency score in the third stage is better than the first stage then the variables are affecting positively the efficiency and vise versa.

Finally, the bank efficiency have to be calculated as a multiple of efficiency and effectiveness and ranked all the DMUs (banks) according to their efficiency from 2004-2013. See appendices 3 & 4 for selecting input – output and 3- stage DEA.

5. Data chosen and empirical results

5.1. Participants and sample:

The population in this study is all commercial and investment banks in Jordan (13) banks from the fiscal year 2004-2013, the banks as whole not branches. In which Jordan and the region faced by economic and political challenges initiated from the Arab Spring and global financial crisis.

where the latest study measuring bank efficiency in Jordan was by Abu Orabi et al (2016) used correlation coefficient test, and simple regression to test the effect of GFCs in 6 commercial banks from 2007-2009,Ramadan(2016) used the statistical software SIAD for 16 banks in 2014, Hmedat (2011) which used traditional DEA during the period (2005 – 2008).

5.2. Data collection and the chosen outputs –inputs and variables

This study promotes quantitative method adopted an empirical data in measuring banks efficiency in Jordan. This study tries to investigate the main difficulties that still facing non-parametric approach users in selecting variables, correlation analysis on variables, and the classifications of these variables into input and output.

In this study, the intermediation approach is selected according to Berger and Humphrey (1997) findings there are difficulties in collecting the detailed transaction flow information required in the production approach. As a result, the intermediation approach is the one favored in the banking literatures (Repkova, 2014; Yilmaz, 2013; Avkiran, 2011; Tahir& Bakar, 2009).

In this study, the inputs used are fixed assets, deposit and total interest expense and the outputs adopted are securities, loans and net interest revenue. This study follows the input and output by (Al-Gasaymeh, 2016;Gulati & kumar,2016; Zhao & Kang, 2015; Ab Rahim, 2015; Zimková, 2014; Akhtar, 2013; Hmedat, 2011; Chen et al, 2010).

From previous literature, the determinants of bank efficiency are often had identified as a function of bank-specific and environment factors. Previous studies focused on banks` size, age as bank-specific. Whether, the environment factors are varying according to the aim of each case study as GDP, inflation rate, exchange interest rate, Consumer Price Index (Sufian et al, 2016; Abu Orabi et al, Al-Gasaymeh, 2016; 2016; Echchabi et al (2015); Rozzani & Abdul Rahman, 2013; Shyu & Chiang, 2012; chen et al , 2010; Lee, 2008).

Meanwhile the FSIs namely; tier 1 ratio, liquidity assets, non-performing loans, ROAA and ROAE. This is considered as new contribution in the internal variables set as Sufian et al (2016) used Z-score as dependent variables and Kutum & Al-Jaberi (2016) adopted Basel III ratios.

5.3. The empirical results

5.3.1 The first stage

The efficiency of Jordanian banks is examined before, during and after Global Financial Crisis and Arab spring as one grand- frontier is computed for all 13 banks during the study period from 2004 to 2013. The crisis period of the study is divided into three periods: before 2004 to 2006, during 2007 to 2009 and after 2010 to 2013 which indicate it covers Global Financial Crisis and Arab spring.

the efficiency scores and rankings of 13 commercial banks is analyzed through using super SBM VRS—first stage for the period before GFC from 2004 to 2006. Table 1 illustrates the efficiency scores and rankings of 13 Jordanian commercial banks before GFC period (2006 – 2004).

Tab 1: efficiency scores and rankings of Jordanian banks before GFC period (2006 – 2004)

Bank	2006		2005		2004		No. of efficient
	Super-SBM-V	Rank	Super-SBM-V	Rank	Super-SBM-V	Rank	
Arab bank	1.0000	19	0.9709	23	1.0000	19	2
Jordan Ahli Bank	0.5822	37	0.7779	31	0.4520	39	0
Bank of Jordan	1.0451	15	1.0563	13	1.0000	19	3
Cairo Amman Bank	1.0020	18	0.9595	24	1.0030	17	2
Housing Bank for Trade & Finance	1.1915	3	1.0759	9	1.1862	4	3
Jordan commercial Bank	0.7983	29	1.1106	8	1.2741	2	2
Arab Jordan Investment Bank	0.8297	27	0.8364	26	1.0558	14	1
Arab Banking Corporation	0.6327	36	0.6984	35	0.7816	30	0
Invest Bank	1.1502	5	1.0631	12	0.5312	38	2
Bank al Etihad	0.8126	28	1.0309	16	0.8453	25	1
Société générale de Banque-Jordanie	1.0729	10	1.1410	6	1.0000	19	3
Capital Bank of Jordan	1.0633	11	1.1119	7	1.5900	1	3
Jordan Kuwait Bank	0.7233	34	0.7764	32	0.7425	33	0
Average of scores	0.9480						

No. of efficient banks	7		7		8		22

As noticed from table 1, the efficiency score of 13 Jordanian banks is measured for the period 2004-2006 is 0.948.the tackles the number of efficient banks in 2004 as they are slightly different than in 2005 and 2006.

Table 2 illustrates the findings of efficiency scores and rankings of Jordanian commercial banks under super SBM VRS—first stage during the GFC period and Arab spring (2009-2007).

Tab.2 the efficiency scores and rankings of banks during GFC period (2009-2007)

Bank	2009		2008		2007		No. of efficient
	Super-SBM-V	Rank	Super-SBM-V	Rank	Super-SBM-V	Rank	
Arab bank	1.0000	17	1.0000	17	1.0293	9	3
Jordan Ahli Bank	0.6567	35	0.6558	36	0.6029	38	0
Bank of Jordan	0.8135	27	1.0066	14	0.9862	19	1
Cairo Amman Bank	0.8578	24	1.0015	16	0.7949	29	1
Housing Bank for Trade & Finance	1.0130	12	1.1080	3	0.9560	20	2
Jordan commercial Bank	1.0102	13	1.0397	7	0.8684	23	2
Arab Jordan Investment Bank	1.0342	8	0.7690	31	0.6682	34	1
Arab Banking Corporation	1.0148	11	1.0033	15	0.6410	37	2
Invest Bank	1.0157	10	0.5568	39	0.6866	33	1
Bank al Etihad	0.8264	26	0.9228	22	0.7342	32	0
Société générale de Banque-Jordanie	1.6335	1	1.1008	4	1.1228	2	3

Capital Bank of Jordan	0.7965	28	1.0810	5	1.0530	6	2
Jordan Kuwait Bank	0.8359	25	0.9784	21	0.7714	30	0
Over all mean	0.914023						
No. of efficient banks	7		8		3		18

As noticed from table 2, the findings clearly indicate that the mean efficiency is 0.9140 which is lower than the previous period by 3.4%. As noticed, the number of efficient banks found to be 18 out of 39 banks. It is also interesting to note that the most inefficient banks are in 2007. The findings indicate that nearly 50% of Jordanian commercial banks found to be inefficient during GFC and Arab spring specifically in 2007.

Table 3 illustrates the efficiency scores and rankings of banks under super SBM VRS—first stage after Arab spring period and GFC for the period (2013-2010). The findings indicate that the number of efficient banks found to be 26 and inefficient banks found to be 26.

Tab.3 the efficiency scores and rankings of banks after GFC and Arab spring period (2013-2010)

Bank	2013		2012		2011		2010		No. of efficient
	Super-SBM-V	Rank	Super-SBM-V	Rank	Super-SBM-V	Rank	Super-SBM-V	Rank	
Arab bank	1.0000	26	0.9578	28	1.0335	11	1.0482	9	3
Jordan Ahli Bank	1.0675	8	1.0252	13	0.7765	40	0.6620	52	2
Bank of Jordan	1.1549	2	0.9971	27	1.0182	16	0.8205	35	2
Cairo Amman Bank	1.0816	5	1.0038	23	1.0208	15	0.8982	30	3
Housing Bank for Trade & Finance	1.0996	4	1.0158	18	1.0032	24	0.8767	31	3
Jordan commercial Bank	0.6643	51	0.7304	47	0.8084	38	0.8996	29	0
Arab Jordan Investment Bank	0.8197	36	0.7247	49	1.0086	20	0.7626	41	1

Arab Banking Corporation	1.0249	14	1.0736	7	1.0763	6	1.0111	19	4
Invest Bank	0.7573	43	1.0164	17	1.0038	22	0.7358	46	2
Bank al Etihad	1.0063	21	0.8122	37	0.8419	34	0.8508	33	1
Société générale de Banque-Jordanie	1.1270	3	0.7554	44	1.0311	12	3.3379	1	3
Capital Bank of Jordan	1.0336	10	1.0018	25	0.7489	45	0.8752	32	2
Jordan Kuwait Bank	0.7256	48	0.7584	42	0.8017	39	0.6774	50	0
Over all mean	0.962772								
No. of efficient banks	9		6		8		3		26

As noticed from table 3, the findings indicate that the mean of efficiency scores is 0.9628.

Tab. 4 summary of the first stage

		2013 – 2004	Period (after)2013 – 2010	Period (during)2009 -2007	Period (befor) 2006 – 2004
Mean of Efficiency score		0.8464	0.9628	0.9140	0.9480
Max efficiency	Score	1.5072	3.3379	1.6335	1.5900
	Bank name	Société générale de Banque-Jordanie -2010	Société générale de Banque-Jordanie in 2010	Société générale de Banque-Jordanie_2009	Capital Bank of Jordan_2004
Min efficiency	Score	0.3935	0.6619	0.5568	0.4520
	Bank name	Jordan Ahli Bank-2004	Jordan Ahli Bank in 2010	Invest Bank_2008	Jordan Ahli Bank_2004
Percentage of number of efficient bank		33%	50%	46%	56%
Sample size		130	52	39	39

The findings of this study indicate that Jordanian commercial banks faced the worst efficiency score during GFCs period (2007-2009) then slightly improved after GFCs period (2010-2014) to reach the highest mean efficiency score (0.9628).

5.3.2 The Second Stage

Table .5 illustrates the stochastic frontier analysis results of the second stage that are related to environmental variables.

Tab.5 Stochastic frontier analysis results- second stage with environmental variables.

	Fixed Assets slack		**Deposit slack**		**T.I. Expenses slack**	
	Parameter	**Standard error**	**Parameter**	**Standard error**	**Parameter**	**Standard error**
Constant	193.57	1.097	- 0.0003	0.010	107.36	0.998
Age	0.32	0.061	0.029	0.966	0.185	0.081
Size	-0.008	0.002	1.537	0.004	0.003	0.003
GDP	0.044	0.001	- 0.054	0.029	- 0.002	0.001
CPI	-0.680	0.462	0.018	0.001	0.146	0.595
Pop	-0.031	0.006	0.596	0.172	0.022	0.814
Log likehood	-461.41		-889.37		-495.938	
Significant at the 5% level						

The environmental variables are classified and categorized according to SFA , it could be deduced that both bank specific determinants variables age and size have a significant relation with all inputs. The age affected inputs rather than size. Meanwhile the findings indicate a significant relation with all inputs (GDP, CPI and POP), CPI found to be the most effective compared to others (POP, GDP). The second effective variable found to be population with negative impact.

The second stage regression analysis can be conducted with SFA according to Battese and Coelli (1992) model which is applied to estimate the relationship between input slacks and internal (FSIs) as summarized below. While Table 6 illustrates stochastic frontier analysis results in the second stage (FSIs variables).

Table 6 Stochastic frontier analysis results – second stage (FSIs variables)

	Fixed Assets slack		**Deposit slack**		**T.I. Expenses slack**	
	Parameter	**Standard error**	**Parameter**	**Standard error**	**Parameter**	**Standard error**
Constant	16.116	6.499	1718.208	1453.427	11.264	3.096
TR	-0.564	0.143	- 2.542	4.455	-0.223	-1.611
LA	17.565	0.069	500.593	31.000	29.316	23.449
NPL/GL	0.262	0.109	- 4.058	3.349	-0.109	-0.732
ROAA	-1.516	0.015	-79.342	45.996	-3.860	-1.912
ROAE	-0.301	0.158	2.722	4.701	-0.049	-0.238
Log likehood	-457.516		-903.061		-499.031	
Sig 5% level						

All the variables (TR, LA, NPL, ROAA and ROAE) are classified and categorized in table 6.10. All the variables found to be significant and have impact on all inputs. The most significant

variable that has impact on inputs found to be LA with negative impact followed by ROAA with positive impact. Deposit found to be the most input that is affected by FSIs (LA, ROAA, NPL/GL, ROAE and TR) from highest to lowest impact respectively.

5.3.3 The Third Stage

From the adjusted inputs analysis in the previous step, the input Slack will be attained as it will be adjusted by the impact of the environment variables and then the impact of financial soundness indicators. Through the adjusted input slack, DEA-Solver-PRO (Professional version 3.0) will be used again to estimate the banks' super-efficiency of the super SBM VRS model. Table 7 illustrates a comparison between the first and third stage related to Jordanian commercial banks efficiency.

Table 7 comparison between the first and third stage

		2004-2013	Env	FSIs
Mean of Efficiency score		0.8464	0.954359779	0.846735
Max efficiency	Score	1.5072	1.532156	1.32632
	Bank name	Société générale de Banque-Jordanie -2010	Capital Bank of Jordan_2013	Société générale de Banque-Jordanie -2013
Min efficiency	Score	0.3935	0.118267	0.134115
	Bank name	Jordan Ahli Bank-2004	Arab bank_2007	Jordan Ahli Bank
Percentage of number of efficient bank		33%	60%	42%
Sample size		130	130	130

As noticed from the table 7, the findings indicate clearly that the mean of efficiency score for all the banks from 2004 to 2013 without environmental variables and FSIs interference have approximately the same efficiency score with only 0.01%. This finding indicates that the Jordanian banking system is stable as CBJ regulations serve the sustainability of the banking system as well as the banks are committed in applying CBJ regulations strongly.

Conclusion

This study considers not only the impact of the global financial crisis and Arab spring on (13) Jordanian banks efficiency before, during and after theses crises (20042013). But also the effect of internal (FSIs) and (external or environmental) representing the factors likely to impact a bank's efficiency which are specific bank (size and age) and environmental variables (GDP, consumer pricing index and population).

The sample ranked according to the objective of the study where the efficiency score will be estimated for whole period of the study 2004-2013, then the efficiency scores was investigated for 3 main period which are before GFCs (2004-2006), after GFCs (2007-2009) and Arab spring (2010-2013).

Then, a frontier regression model (SFA) will be employed once for estimating the environmental variables and one more time to estimate FSIs on bank efficiency. In order to identify the influence of these variables on bank efficiency for whole period 2004-2013, the dependent variable in the frontier regression model were the slacks for each input. After that, super SBM model reruns the adjusted data. The super SBM model is including internal and external variables including in the adjusting slacks.

The results are as follows:

1. This result reflects the effects of the global financial crisis which has significantly affected the banks; the majority of Jordanian banks recovers and becomes more efficient after the crisis (2010-2013). The efficiency of Jordanians banks is even higher before the crisis (2004-2006) than during it (2007-2009).
2. The age affected inputs rather than size. Meanwhile the findings indicate a significant relation with all inputs (GDP, CPI and POP), CPI found to be the most effective compared to others (POP, GDP). The second effective variable found to be population with negative impact. Deposit found to be the most input that is affected by FSIs (LA, ROAA, NPL/GL, ROAE and TR) from highest to lowest impact respectively.
3. The mean of efficiency score for all the banks from 2004 to 2013 without environmental variables and FSIs interference have approximately the same efficiency score with only 0.01%

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