Measuring the Efficiency of Sudanese Banks Using Data Envelopment Analysis Approach

Al Nema B.K. El Tom*
University of Khartoum , School of Management

Abstract :

This paper examines the efficiency of commercial banks operating in Sudan using Data Envelopment Analysis (DEA). The purpose of the study is to measure the technical efficiency and scale efficiency in 2012 and 2013.These two years are particularly important as the economy witnessed some major changes after the secession of South Sudan and the loss of more than two thirds of export earnings in oil revenue. Inputs included expenses, deposits and the total assets while outputs included net profits, loans, and investments. Results suggest that there is significant relation between Efficiency and Return on Assets (ROA), Loan to total asset ratio (LOANTA), while bank size effect on efficiency fluctuates between these two years .

Keywords:
Data Envelopment Analysis, Pure Technical Efficiency, Scale Efficiency, Sudanese Banks , Islamic Bank , input- out put .

* Alnima Bakri is a Lecturer at the School of Management Studies, University of Khartoum, Sudan. She specializes in accounting and finance and teaches various accounting and finance courses.

Introduction:

The banks are considered one of the most important players in the financial sector given their ability to attract savings and mobilize resources and employ the same investment loans that contribute in small scale to finance economic and social development. However, the performance of the banks and their ability to mobilize sufficient level of savings and deposits, provide credit facilities and other banking services are affected by various factors that may limit their capacity to finance the economic activities. Therefore, the sound performance and efficiency of the banking sector is closely linked to the performance of the economy at large since the former underscores the improved performance of the payment system and the effective implementation of monetary policies. Moreover, the efficiency of the banking sector is indicative of social welfare as the viable banking system is well-positioned to provide cost effective services to the public.

Since the 1980's the international banking arena has witnessed radical transformations due to technological advancement, rigorous restructurings and globalization. The banking sector in Sudan, by and large, was not insulated from such transformations and global trends. The operational environment of the banking sector has changed considerably and is now facing a fierce competition and swings in the behavior and expectations of the users of the banking services. This scenario has driven the banks to change their operational strategies to ensure improved performance and to achieve a sustained level of growth. In addition to that, pressures have compelled the commercial banks to cut their operational cost and at the same time maintain the quality of their services. As a matter of fact, given the economic openness and the speedy response of the markets, it has become imperative for the bank sector to operate with greater efficiency to achieve the desired level of quality in the provision of banking services in order to resist and adjust to the increased competition and meet the challenges of the changing market circumstances that caused major businesses and institutions to go bankrupt.

In fact, the level of efficiency reflects the bank's ability to compete with other banks and hence its success or failure rates. An efficient bank can produce the maximum amount of output with a given values of inputs compared to other banks. As Harvey Leibenstein-1966 suggested, the

performance of business institutions is hindered by various factors including the misallocation and mismanagement of resources. The efficiency of the banking sector and the measurement of efficiency are highly important for policymakers, customers, the management and other stakeholders and investors alike. For policymakers underperformance implies risk and the high potential of failure and bankruptcy with negative consequences on the overall economy. For customers efficiency means low-priced full range of quality services (Anderson et.al, 1998). For the management, it is quite evident that in view of the tough competition and the rapidly changing operating environment, only efficient banks can pull through and increase their market shares by allocating the resources and transforming them to outputs. For investors efficiency means achieving higher returns on their investments. In addition , efficiency will help the owners to exercise greater control on the management as well as facilitating the government oversight over the banking sector. This study is pretty much important if we consider the current financial crunches and globalization trend which calls for serious restructuring and reduction of costs.

1. Objectives of the Study

This study aims to determine the efficiency of commercial banks operating in Sudan through the evaluation of the Technical Efficiency and Pure Technical Efficiency using the data collected during the years 2008 and employing the Data Envelopment Analysis tool. The study tries specifically to answer the following questions:

Is there any relationship between the profit ratios as return on assets (ROA) and the level of efficiency?

Is there any relationship between debt ratios as loan over total assets (LOANTA) and the level of efficiency?

Is there any relationship between the size of the bank and the level of efficiency?

Do the Sudanese banks utilize their resources efficiently?

Before going further into the study, it is necessary to explain some of the concepts associated with pure technical efficiency and scale efficiency. In generic, technical efficiency could be defined as the ratio of minimum costs that could have expended to produce a given output bundle to the actual costs expended. It is a relative measurement about how to handle the inputs and use the same to produce the maximum amount of outputs. Indeed, the

efficiency of the bank is defined as its ability to transform the available resources into a bundle of multiple financial services and the measurement of technical efficiency under the assumption of constant return to scale is defined as the overall technical efficiency. It is a measurement or indicator that helps to determine the inefficiency resulting from the failure to manage inputs, outputs and deliverables of operations in a professional manner. Scale efficiency measures the bank's ability to determine or select the appropriate size that enables it to work at its optimal level of operation.

2.Literature Review:

Many previous studies were conducted on the subject of operational efficiency by using different quantitative tools; however, this study will present a brief literature review of some of the previous studies conducted about commercial banks.

A study on the efficiency of the Turkish commercial banks concluded that there is a variation in the pure technical efficiency and the scale efficiency between the Turkish commercial banks and that the banking sector has failed to achieve sustainable efficiency –Yildirim (2000). In the European Union, a study conducted by Casu and Molyneux (2003) confirmed that the level of efficiency of the European banking systems have improved significantly as a result of the creation of the Single Internal Market. In a study conducted by Krishnasamy (2003) about the Malaysian banking sector, it was concluded that the productivity growth of the commercial banks was mainly attributable to technological advancement rather than technical efficiency change. In another study on the Taiwanese banking industry, Lo and Lu (2006) suggested that the major contribution to efficiency was the size of the economic entities and large and well-capitalized banks are more efficient than small banks. An earlier study by Seaford and Zhu (1999) about the top 55 US banks came to the same conclusion.

A study conducted by Sufian (2007) to evaluate the efficiency of Islamic banks and conventional banks (local and foreign) in Malaysia, suggested that the domestic Islamic are more efficient than the foreign Islamic banks and this conclusion was further confirmed by Mukhar et al (2008) but they argued that the banks operating under purely Islamic principles are more

efficient than conventional banks, more or less, compliant with Islamic principles. Moreover, a study by Hassan et al (2009) about the efficiency of the banks in the countries of the Muslim World League during the period 1990-2005 concluded that despite the fact conventional banks are ahead of Islamic banks as far as efficiency is concerned but the difference is not statistically significant. In a similar study conducted by Sufian and Noor (2009) Islamic banks in the Middle East exhibited high technical efficiency compared to their peers in Asia. In a study about the relative efficiency of the Algerian banks Mansoori and Akasha (xxxxx) stated that there is a variance in the cost efficiency index and that the local banks are underperforming compared to foreign banks and they proposed a relook into the size of the banks. The study also concluded that there is no significant relationship between the financial indices of the banks and their cost efficiency indices.

Sufian and Abdul Majeed (2008) launched a comparative analysis for local and foreign Islamic banks in Malaysia to determine the difference in efficiency results upon changing inputs and outputs. The study attributed the change in efficiency indices to numerous variables including the size of the bank, ownership structure, the capital, non-performing loans and the competence of the management. The results revealed the prevalence of pure technical inefficiency in the Malaysian banking sector and that the foreign banks have a higher average technical efficiency than the local banks. The empirical results of multivariable Tobit Model revealed technically large and well-capitalized banks with extensive loan activities and reduced levels of default. A study conducted by Mohamed Mustafa (2011) intended to measure the relative efficiency of the largest Islamic banks by using the Data Envelopment Analysis and concluded that many of these banks suffer from distortions that created inefficiencies but still there is a high potential for improvement. The study used various criteria to determine the necessary decrease in inputs to achieve the desired level of efficiency.

In the Arab region, few studies were conducted to measure the efficiency of commercial banks by using the Data Envelopment Analysis notably among them was the study launched by Al Saqqa (2008) and highlighted the inefficiency of the Kuwaiti banks compared to their peers in the GCC countries. A similar study by Al Imam (2003) concluded that the Saudi and Bahraini banks are the most efficient among the banks in the Gulf region. In

a recent study by Onour and Abdullah (2012) it was pointed out that the banking sector in the GCC countries performed satisfactorily well during 2007 but slipped back in 2008 due to the regress in pure technical efficiency and scale efficiency. The study conducted by Al Obaidan (2008) discussed the impact of the off-balance sheet activities on the efficiency of the Kuwaiti commercial banks. He used advanced models of mathematical economics for prudent quantitative analysis of the relationship between the off-balance sheet activities and the economic viability of commercial banks. Moreover, he touched on the Basel requirements including the capital adequacy establishing rules to make sure that the banks hold enough capital to ensure continuation of a safe and efficient market and be able to withstand any foreseeable problems. The researcher concluded that an off-balance sheet activity is a double-edged sword that will increase the technical efficiency, on the one hand and decrease the overall economic efficiency, on the other hand.

In Sudan, Onour and Abdullah (2011) have conducted study to measure and analyze the efficiency of 12 sample banks relying on the financial statements for the period 2007-2008. The authors used the Data Envelopment Analysis to evaluate the efficiency and change in productivity and concluded that only two banks have succeeded to achieve technical efficiency and pure technical efficiency – the largest bank among the group (State-owned) and a medium-sized bank (private) while the smallest bank in the group achieved the pure technical efficiency. The study found out that the ownership structure has nothing to do with pure technical efficiency or the scale efficiency and that the bank size is a crucial factor in relation to the scale efficiency.

3. Research Methodology:

The study relied on the secondary data gathered from annual reports, financial statements and notes to financial statements circulated by the banks during the fiscal years 2008-2013. It was collected from the Central Bank of Sudan. The study applied the DEA technique segmenting the data into inputs and outputs. Inputs included the total assets, expenses and the deposits while outputs included profit besides loans and investments .

Recent years have seen a great variety of applications of DEA (Data Envelopment Analysis) in evaluating the performances of many different kinds of entities engaged in different activities in many different contexts in different countries. One reason is that DEA has opened up possibilities for use in cases which have been resistant to other approaches because of the complex (often unknown) nature of the relations between the multiple inputs and multiple outputs involved in many of these activities (which are often reported in non-commeasurable units). These kinds of applications extend to evaluating the performances of cities, regions, and countries various inputs and outputs. These include "social" and "safety-net" expenditures as inputs and various "quality-of-life" dimensions as outputs. DEA has also been used to supply new insights into activities (and entities) that have previously been evaluated by other methods. For instance, studies of benchmarking practices with DEA have identified numerous sources of inefficiency in some of the most profitable firms – firms that served as benchmarks by reference to their (profitability only) criterion. DEA studies of the efficiency of different firms as in "stock" insurance companies have shown that previous studies had fallen short in their attempts to evaluate the potentials of these firms.

3.1 THE BASIC CCR MODEI

Charnes , Cooper, and Rhodes (1978) initially proposed The CCR model. For each Decision Making Unit (DMU), virtual input and output is formed by (yet unknown) weights (vi) and (ur):

Virtual input = vix10 + …+ umxmo
Virtual output = uiy10 + …+ usyso.

To determine the weight using linear programming in order to maximize the ratio, we have;
Virtual output/Virtual input
The optimal weights may (and generally will) vary from one DMU to another. Thus, "weights" in DEA are derived from the data instead of being fixed in advance. Each DMU is assigned a best set of weights with values that may vary from one DMU to another.

3.2 THE CCR MODEL

Given the data, the efficiency of each DMU is measured once, and hence n optimizations are needed, one for each DMUj to be evaluated. Let the DMUj to be evaluated on any trial be designated as DMUo where o ranges over 1, 2 , …, n. The following fractional programming problem is solved to obtain values for the input "weights" (vi) (i=1 ,…m) and the output "weights" (ur) (r = 1, …, s) as variables.

$$(FP_0)\ \theta = \frac{u_1 y_{10} + u_2 y_{20} + ...u_s y_{so}}{u_1 x_{10} + u_2 x_{20} + ... + u_m x_{mo}} \qquad (1)$$

$$\textit{subject to} \quad \frac{u_1 y_{1j} + ... + u_s y_{sj}}{u_1 x_{1j} + ... + u_m x_{mj}} \le 1 (j = 1,..., n) (2)$$

$$u_1, u_2, ..., u_m \ge 0 \ (3)$$

$$u_1, u_2, ..., u_s \ge 0. \ (4)$$

The constraints mean that the ratio of "virtual output" to "virtual input" should not exceed 1 for every DMU. The goal is to obtain weights (ui) and (ur) that maximize the ratio of DMU0, the DMU being evaluated. By virtue of the constraints, the optimal objective value θ^* is at most 1. Mathematically, the non negativity constraint (3) is not sufficient for the fractional terms in (2) to have a positive value. This assumption will not be treated in explicit mathematical form at this time. As an alternative we put this in managerial terms by assuming that all outputs and inputs have some nonzero worth and this is to be reflected in the weights ur and ui being assigned some positive value.

3.3 FROM A FRACTIONAL TO A LINEAR PROGRAM

In this part of the analysis, we will replace the above fractional program (FP0) by the following linear program (LP0),

$$(LP_0) \qquad \max \theta = \mu_1 y_{10} + ... + \mu_s y_{so} \qquad (5)$$

$$\textit{subject to} \quad v_1 x_{10} + ... + u_m x_{mo} = 1 \qquad (6)$$

$$\mu_1 y_{1j} + ... + \mu_s y_{sj} \le v_1 x_{1j} + v_m x_{mj} \qquad (7)$$

$$(j = 1, ..., n)$$

$$v_1, v_2, ..., v_m \ge 0 \qquad (8)$$

$$\mu_1, \mu_2, ..., \mu_s \ge 0. \qquad (9)$$

The fractional program (FP0) is equivalent to (LP0).
Under the nonzero assumption of u and X > 0, the denominator of the constraint of (FP0) is positive for every j, and hence we obtain (3) by multiplying both sides of (2) by the denominator. The fractional number is invariant under multiplication of both numerator and denominator by the same nonzero number. The denominators of (3) equal to 1, move it to a constraint, as is done in (6), and maximize the numerator, resulting in (LP0).

Let an optimal solution of (LP0) be $(v = v^*, \mu = \mu^*)$ and the optimal objective value θ^*. The solution $(u = v^*, u = \mu^*)$ is also optimal for (FP0), since the above transformation is reversible under the assumptions above. (FP0) and (LP0) therefore have the same optimal objective value θ^*
The measures of efficiency we are "units invariant" – i.e., they are independent of the units of measurement used in the sense that multiplication of each input by a constant $\delta_r > 0$, r = 1… m, and each output by a constant pr > 0, r = 1… s, does not change the obtained solution.

The optimal values of mar $\theta = \theta^*$ in (3) and (5) are independent of the units in which the inputs and outputs are measured provided these units are the same for every DMU.
The (LP0) can be solved by the simplex method of linear programming. The optimal solution can be more easily obtained by dealing with the dual side of (LP0).

4. Analysis and Findings :

We used DEA-Solver Program to analyze and assess the technical efficiency of the sample banks using expenses, total assets and deposits as inputs and the profits, loans and investments as outputs. Both CCR and BCC input-oriented models were used to estimate the pure technical efficiency and scale efficiency.

According to the analysis for year 2013, out of thirty six banks, nine banks satisfied Scale and pure technical efficiency. Seven banks satisfied scale efficiency while Pure Technical Inefficient. (See table 1)

Table (1)
Efficient banks year 2013

Banks satisfy scale and pure technical efficiency	Banks satisfy Scale efficiency while pure technical inefficient
Alsalam Bank	Alrwoad Bank for Development and Investment
National Bank of Sudan	Qatar Islamic Bank
Family Bank	Faisal Islamic Bank
National Bank of EGYPT (Khartoum)	Bank of Khartoum
Blue Nile Mashreq Bank	Omdurman National Bank
Qatar National Bank	Agricultural Bank Sudan
Tadamon Islamic Bank	Ivory Bank
Industrial Development Bank	-
Farmer's Commercial Bank	

* Technically efficient banks satisfy 1.0 technical efficient index
* The efficiency index result appended in appendix (A 1)

The nine banks satisfying scale efficiency are banks that allocated resources to the optimum level of operations, i.e. the size of bank capital is matching its operation level.

Six banks are scale efficient while pure technical inefficient. This result indicates that these banks may have used more inputs than needed (input waste). Alternatively, pure technical inefficiency can be caused by

inefficient implementation of the production plan in converting inputs to outputs (managerial inefficiency).

The result shows that out of thirty six banks, twenty seven were technical inefficient. This implies that their operations and capital utilization is not properly managed. Out of these twenty seven banks, four banks exhibit Decreasing Return to Scale (DRS). This implies that these banks are over utilizing their resources, and therefore their returns are decreasing when expansion policy is adopted. Twenty three banks are showing increasing return to scale (IRS) which implies that more operation may add to the overall return of the bank. As a result, it is advisable to expand operations when a bank is under increasing return to scale.

The fraction of output loss due to scale inefficiency (fall of scale operations below optimum level) can be calculated according to the formula (1CCR/BCC). For the year 2013 the average output loss is 0.10. See appendix (A1) for the individual banks output loss.

For year 2012, results obtained from the analysis are quite comparable to year 2013. This can be attributed to the similar economic conditions (post secession of the South). Out of thirty one banks under study, seven satisfied scale and pure technical efficiency. It can be noted that four banks sustained efficiency from 2012 to 2013. Five banks Satisfied Scale Efficiency while Pure Technical Inefficient. See table 2

Table (2)
Efficient banks year 2012

Banks satisfy Scale and Pure Technical Efficiency	Banks satisfy Scale Efficiency while Pure Technical Inefficient
Omdurman National Bank	Tadamon Islamic Bank
Alsalam Bank	Bank of Khartoum
Al -Shamal Islamic Bank	Agricultural Bank Sudan
Blue Nile Mashreq Bank	United Capital Bank
Industrial Development Bank.	African Bank for Trade and Development
Ivory Bank	-
Family Bank	

* Technically efficient banks satisfy 1.0 technical efficient index
* The efficiency index result appended in appendix (A2)

Analysis also shows that fifteen banks should increase their operation level while nine banks should decrease their operations to achieve efficiency. Average output loss has been calculated for the year 2012 to 0.31, which is three times higher than the year 2013 which explains the significant effect of secession of South Sudan in 2011 has on the banking sector. See Appendix (A 2). After Regression Results we ran the xl stat program to find relations between Return on Assets (ROA), Loans-To- Total Assets Ratio (LOANTA), Size of the bank and bank efficiency using CCR model.

CCR MODEL Regression Result:

$EC\iota = \propto \iota + C1\ SIZE + C2\ ROA + C3\ LOANTA + e\iota$

ι =1, 2, 3……N

Table (3)
Regression Result for years 2013- 2012

2013				2012			
	COFFICIENT	T stat	P value		COFFICIENT	T stat	P value
intercept^{xxx}	0.41	5.02	0.00	intercept^{xxx}	0.23	3.10	0.00
Size^{x}	1.43	1.64	0.10	Size	-0.16	-0.24	0.80
ROA^{x}	2.81	1.72	0.09	ROA^{xxx}	3.01	3.21	0.00
LOANTA^{x}	0.3	2.72	0.10	LOANTA^{xxx}	0.90	6.68	0.00
R^2	0.341			R^2	0.667		

^{x} is Significant at 10% significant level.
^{xx} Significant at 5% significant level.
^{xxx} Significant at 1% significant level.

Results in table 3 reveal the association of the efficiency scores of CCR as dependent variable and the size of the bank as measured by the deposit ratio (bank deposits over total sectored deposits), ROA, the ratio of profit to total assets, and LOANTA (Loan divided Total Assets).

The cross-sectional regression results indicate that the three independent variables for the year 2013 are all significant at the 10% significance level. The size coefficient is positive which indicates an increase in the deposits as represented by the size, stimulate the efficiency positively at 1.43.
ROA is shown to be the most effective variable in influencing the efficiency level of banks, since its coefficient is recorded as 2.81 indicates 1 percent increase in profit will increase the efficiency score by 2.81 percent. This reflects that profitability is a major stimulus to the efficiency performance of banking sector. It also implies that the recent measures adopted by the central bank with regards to restrictions on banks loans and curbing profitable opportunities, for commercial banks, is expected to have negative impact on the efficiency score in the coming years.

The findings in table 3 also reflect that the loan ratio (LOANTA) is the least effective to efficiency score of the banking sector, with a coefficient of 0.3, an indication of a limited effect of loans on the outputs (including investment and profit).

In 2012 the cross-sectional regression results show that the ROA and LOANTA are both significant at 1% significance level and the coefficients are positive, while the size is not significant at any significance level. The size coefficient is negative (0.16), an indication that 1 percent increase in deposits result in a decrease of efficiency score by 16 percent. Some of the deposits couldn't be used to generate profit opportunities due to the restrictions imposed by the Central Bank. During the years that followed the secession of South Sudan, banks were skeptical as the economy witnessed a great shock in addition to the increase of in the reserve ratio that banks were required to keep from 11% to 13%. The response from policy makers as the crisis unveiled was probably in line with the perception that banks are too-big-to-fail subsides. As a result, banks were unstable in funding, and vulnerable to involve in risky market based activities and suffer from terrible corporate governance.

ROA is shown to be the most effective variable influencing the efficiency level of banks with a coefficient of 3.01. This indicates an increase in profit stimulate efficiency positively at 3.01. LOANTA positive relation to efficiency with a coefficient of 0.09, less than one third of the ROA coefficient, an indication; of the importance of facilitating loans to the private sector to increase bank efficiency performance.

BCC MODEL Regression Result:

$E\beta\iota = \propto \iota + \beta 1\ SIZE + \beta 2\ ROA + \beta 3\ LOANTA + e\iota$

$\iota = 1, 2, 3 \ldots\ldots\ldots N$

Table 4

BCC MODEL Regression Result for 2013 – 2012

	2013				2012		
	COFFICIENT	**T sta**	**P valu**		**COFFICIENT**	**T sta**	**P value**
intercept^{xxx}	0.60	6.99	0.00	**intercept**^{xxx}	0.49	5.09	0.00
Size^{x}	1.56	1.73	0.09	**Size**	-0.77	-0.87	0.39
ROA	1.63	.97	0.34	**ROA**	1.92	1.59	0.12
LOANTA^{x}	0.28	1.67	0.10	**LOANTA**^{xxx}	0.59	3.40	0.00
R²	0.202			**R²**	0.351		

^{x} is Significant at 10% significant level.

^{xx} Significant at 5% significant level.

^{xxx} Significant at 1% significant level.

Results in table 4 reveal the association of the efficiency scores of BCC as dependent variable and the size of the bank as measured by the deposit (banks deposit over total sect oral deposits), and ROA, the ratio of profit to total assets, and LOANTA (Loans divided Total Assets).
The cross-sectional regression results for 2013 indicate that **SIZE** and **LOANTA** are significant at 10% significance level. **ROA** was insignificant at all levels. All 3 variables, i.e.; SIZE, ROA, and LOANTA, show positive coefficients.

ROA is shown to be the most effective variable in influencing the efficiency level of banks, since its coefficient is recorded as 1.63 indicates 1 percent increase in profit increase the efficiency score by 1.63 percent. This reflects that profitability is a major stimulus to the efficiency performance of banking sector. This also implies that the recent measures adopted by the central bank with regards to restrictions on banks loans and curbing profitable opportunities, for commercial banks, is expected to have negative impact on the efficiency score in the coming years.

Size coefficient is positive which indicates an increase in the deposits as represented by the size, stimulate the efficiency positively at 1.56 Results also reflect that the loan ratio (LOANTA) is the least effective to the efficiency score of the banking sector, with a coefficient of 0.28, an indication of limitation effect of loans on the outputs, which also includes investments and profit.

In 2012 the Cross-sectional regression results show that the LOANTA is significant at 1% while SIZE and ROA are both insignificant. The negative coefficient for SIZE is a further proof of the negative relation between **size** and **efficiency** for this year obtained according to the CCR MODEL. In other words, increase in deposits by 1% result in a decrease in efficiency by 77%, an indication of unused deposits (frozen deposits) by banks in the years that followed the secession of South Sudan. Banks were skeptical as the economy witnessed a great shock in addition to the increase of deposit reserve ratio that banks were required to keep from 11% to 13%
ROA is shown to be the most effective variable influencing the efficiency level of banks with a coefficient of 1.92. This indicates an increase in profit stimulate efficiency positively at 1.92. LOANTA shows positive relation to

efficiency with a coefficient of 0.59, an indication of the importance of facilitating loans to the private sector to increase bank efficiency performance.

5.Conclusion and Recommendations:

This study aims to measure the efficiency of Sudanese Banks through the evaluation of the Scale Efficiency and Technical Efficiency using the data collected during the years 2013, 2012 employing the Data Envelopment Analysis (DEA). DEA is receiving increasing importance as a tool of evaluating and improving the performance and efficiency of manufacturing and service industries. Two types of efficiency analyses have been employed CCR model and BCC model. The relation between Efficiency, ROA, LOANTA, and Bank size is then tested

The study results showed that some banks did satisfy pure technical efficiency and scale efficiency while others fell short in satisfying either of these efficiencies. Results to banks efficiency throughout the period of study were somewhat sporadic. This could be attributed to the turbulence the economic and political situation Sudan underwent in this period. Investors were skeptical during the years immediately preceding the referendum that was followed by the secession of Southern Sudan. Another factor is the frequent changes in policies implemented by Sudan Central Bank. For example, the ratio that banks are required to keep as a reserve on deposits had changed almost annually, in 2012 the `ratio of reserve on deposits is 13% and it increased to 18% in 2013.

We feel it is quite safe to conclude that ROA and LOANTA have positive effect on Efficiency while Bank Size effect on Efficiency fluctuates between years. In 2012, the year after the secession of South Sudan, the relation is negative. In 2013, results show a positive and significant relation between Bank Size and Efficiency.

This study recommends Sudanese banks adopt new evaluation methods like DEA model in order to get a new insights on their efficiency, strength, and weaknesses. We feel that, by doing so, it will help policy makers in putting up proper policies and strategies for banks. And recommends banks working in Sudan (especially those with several branches) to adopt the DEA

approach for measuring the relative efficiency of the branches. The results will be more impressive and accurate and will enrich the top management with a lot of relevant information needed for monitoring and evaluation system and for strategic planning as well.

References:

- Ahmad, N.H.bt., Noor, M.A.N.M., and Sufian, F. (2010). The efficiency of Islamic banks: empirical evidence from the Asian countries Islamic banking sectors. *J. International*
- Business and Entrepreneurship Development, 5 (2), 154–166.
- Berger, A.N., Kashyap, A.K. and Scalise, J.M. (1995), 'The Transformation of the U.S.
- Banking Industry: What a Long, Strange Trip It's Been,' *Brookings Papers on Economic Activity* 2, 55-218.
- Cooper, W.W., Seiford, L. M. and Tone, K. (2000) *Data Envelopment Analysis.* Boston: Kluwer Academic Publishers.
- Eljelly Abuzar M. A. " Internal and External Determinants Of Profitability Of Islamic Banks in Sudan: Evidence From Panel Data" *Afro-Asian J. of Finance and Accounting, Vol. 3, No3, 222-240.*

- Hassan, M.K and Hussein, K.A. (2003) Static and Dynamic Efficiency in the Sudanese Banking System, *Review of Islamic Economics* 14, 5-48.
- Isik, I. and Hassan, M.K. (2002), Technical, Scale and Allocative Efficiencies of Turkish
- Banking Industry, *Journal of Banking and Finance* 26 (4), 719-766.
- Onour Ibrahim A, and Abdalla. Abdelgadir M.A "Efficiency of Islamic banks in sudan: A non- parametric Approach" journal of Islamic Economics, banking and finance lslamic bank Training and Research Academy. Vol 7. No 4.2011, – 93 .
- Onour. Ibrahim A, and Aballa. Abdelgadir M.A " Technical Efficiency Analysis of banks in Major Oil Exporting Middle East Countries' Khartoum University Journal of Management Studies , 5,1,2011, 44 –71 .
- Hassan , T . Mohamed s. and Bader, M ,"Efficiency of Conventional versus Islamic Banks : evidence from the Middle East''

,International Journal of Islamic and Middle Eastern Finance and Management ,2, 2009 ,46 – 65 .

- Seiford , L .and Zhu ,J. "Profitability and marketability of the Top 55 US Commercial Banks", Management Science , 45 ,1999 ,1270 -88 .
- Sufian , F . and Noor , M ."The Determinants of Islamic banks " Efficiency Changes Empirical evidence from Mena and Asian banking sectors'' International Journal of Islamic and Middle Eastern Finance and Management , 2, 2009 ,120 – 38 .

Appendix:

A1. DEA Results for the year 2013

DMU No.	DMU Name	CCR	RTS	BCC	Output loss (1-CCR/BCC)
1	Abu Dhabi National Bank	0.34503	Increasing	0.37426	0.08
2	Sudanese Islamic Bank	0.80331	Increasing	0.80339	0.00
3	Alsalam Bank	1.00000	Constant	1.00000	0.00
4	National Bank of Sudan	1.00000	Constant	1.00000	0.00
5	Abu Dhabi Islamic Bank	0.31312	Increasing	0.45916	0.32
6	Al -Shamal Islamic Bank	0.22300	Increasing	0.22549	0.01
7	Savings and Social Development Bank	0.64328	Increasing	0.64328	0.00
8	Byblos Bank (Africa)	0.47937	Increasing	0.49940	0.04
9	Family Bank	1.00000	Constant	1.00000	0.00
10	National Bank of EGYPT	1.00000	Constant	1.00000	0.00
11	Workers' National Bank	0.56721	Increasing	0.61522	0.08
12	Blue Nile Mashreq Bank	1.00000	Constant	1.00000	0.00
13	Ivory Bank	0.39108	Increasing	1.00000	0.61
14	Alrwoad Bank	0.58516	Increasing	1.00000	0.41
15	Baraka Bank	0.61204	Increasing	0.61208	0.00
16	Qatar National Bank	1.00000	Constant	1.00000	0.00
17	Arab Sudanese Bank	0.35832	Increasing	0.63511	0.44
18	Qatar Islamic l Bank	0.45712	Increasing	1.00000	0.54
19	Tadamon Islamic Bank	1.00000	Constant	1.00000	0.00
20	Faisal Islamic Bank	0.74829	Decreasing	1.00000	0.25
21	Farmer's Commercial Bank	1.00000	Constant	1.00000	0.00
22	African Bank for Trade and Development	0.67387	Increasing	0.75614	0.11
23	United Capital Bank	0.86275	Increasing	0.87428	0.01

24	Sudanese Egyptian Bank	0.93789	Increasing	0.93802	0.00
25	Sudanese French Bank	0.63714	Increasing	0.63716	0.00
26	Aljazeera Sudanese Jordanian Bank	0.59944	Increasing	0.61111	0.02
27	El -Nilien Bank	0.84206	Increasing	0.84206	0.00
28	Bank of Khartoum	0.86470	Decreasing	1.00000	0.14
29	Real Estates Commercial Bank	0.85604	Increasing	0.85646	0.00
30	Al Nile Bank For ommerce and Development	0.89303	Increasing	0.89307	0.00
31	Omdurman National Bank	0.82660	Decreasing	1.00000	0.17
32	Industrial Development Bank	1.00000	Constant	1.00000	0.00
33	Saudi Sudanese Bank	0.51780	Increasing	0.51789	0.00
34	Agricultural Bank Sudan	0.70433	Decreasing	1.00000	0.30
35	Animal Resources' Bank	0.47819	Increasing	0.52482	0.09
36	Export Development Bank	0.70030	Increasing	0.70039	0.00

A 2 DEA Results for the year 2012.

DU No.	DMU Name	CCR	RTS	BCC	1CCR/BCC
1	National Bank of Sudan	0.76786	Decreasing	0.8755	0.122947
2	Savings and Social Development Bank	0.65084	Decreasing	0.65095	0.000169
3	Sudanese Islamic Bank	0.70722	Decreasing	0.70738	0.000226
4	Baraka Bank	0.75375	Decreasing	0.75412	0.000491
5	Tadamon Islamic Bank	0.88099	Decreasing	1	0.119010
6	Bank of Khartoum	0.95002	Decreasing	1	0.049980
7	Agricultural Bank Sudan	0.72438	Decreasing	1	0.275620
8	Saudi Sudanese Bank	0.89878	Decreasing	0.89947	0.000767
9	Alsalam Bank	1	Constant	1	0.000000

10	Sudanese Egyptian Bank	0.74972	Increasing	0.77224	0.029162
11	Al -Shamal Islamic Bank	1	Constant	1	0.000000
12	Workers' National Bank	0.68447	Increasing	0.80752	0.152380
13	Sudanese French Bank	0.55006	Decreasing	0.55022	0.000291
14	United Capital Bank	0.197	Increasing	1	0.803000
15	Farmer's Commercial Bank	0.82248	Increasing	0.82348	0.001214
16	Blue Nile Mashreq Bank	1	Constant	1	0.000000
17	Omdurman National Bank	1	Constant	1	0.000000
18	Byblos Bank (Africa)	0.28576	Increasing	0.36003	0.206288
19	Faisal Islamic Bank	0.08896	Increasing	0.10387	0.143545
20	Industrial Development Bank	1	Constant	1	0.000000
21	Animal Resources' Bank	0.71181	Increasing	0.73351	0.029584
22	Real Estates Commercial Bank	0.77189	Increasing	0.87691	0.119761
23	El -Nilien Bank	0.89744	Increasing	0.89759	0.000167
24	African Bank for Trade and Development	0.83146	Increasing	1	0.168540
25	Abu Dhabi National Bank	0.39227	Increasing	0.46901	0.163621
26	Qatar National Bank	0.72493	Increasing	0.77355	0.062853
27	Aljazeera Sudanese Jordanian Bank	0.43628	Increasing	0.56026	0.221290
28	Arab Sudanese Bank	0.55311	Increasing	0.63064	0.122939
29	Ivory Bank	1	Constant	1	0.000000
30	Al Nile Bank	0.30506	Increasing	0.3251	0.061643
31	Family Bank	1	Constant	1	0.000000

A 3 Statistical Results 2013.

DMU Name	Size	ROA	LOANTA	CCR	BCC
National Bank of Sudan	0.003217	0.05675	0.337480	1.00000	1.00000
Savings and Social Development Bank	0.018611	0.04020	0.471611	0.64328	0.64328
Sudanese Islamic Bank	0.018969	0.01966	0.657005	0.80331	0.80339
Baraka Bank	0.022203	0.02690	0.486051	0.61204	0.61208
Tadamon Islamic Bank	0.054687	0.00002	0.000218	1.00000	1.00000
Bank of Khartoum	0.135517	0.01865	0.631406	0.86470	1.00000
Agricultural Bank Sudan	0.035990	0.00714	0.536010	0.70433	1.00000
Saudi Sudanese Bank	0.014151	0.00981	0.423495	0.51780	0.51789
Alsalam Bank	0.018196	0.03413	0.817869	1.00000	1.00000
Sudanese Egyptian Bank	0.009317	0.06956	0.308143	0.93789	0.93802
Al -Shamal Islamic Bank	0.019930	0.01698	0.159749	0.22300	0.22549
Workers' National Bank	0.008575	0.03893	0.411667	0.56721	0.61522
Sudanese French Bank	0.027529	0.02505	0.496415	0.63714	0.63716
United Capital Bank	0.021276	0.03578	0.683390	0.86275	0.87428
ا Farmer's Commercial Bank	0.031978	0.01353	0.667513	1.00000	1.00000
Blue Nile Mashreq Bank	0.024088	0.09145	0.679370	1.00000	1.00000
Omdurman National Bank	0.171383	0.01577	0.613909	0.82660	1.00000
Byblos Bank (Africa)	0.022044	0.02308	0.375831	0.47937	0.49940
Faisal Islamic Bank	0.118972	0.03183	0.590015	0.74829	1.00000
Industrial Development Bank	0.004319	0.00227	0.628777	1.00000	1.00000
Animal Resources' Bank	0.006959	0.00877	0.030667	0.47819	0.52482
Real Estates Commercial Bank	0.005645	0.00526	0.700131	0.85604	0.85646
El -Nilien Bank	0.023348	0.01514	0.684340	0.84206	0.84206
African Bank for Trade and Development	0.001762	0.01281	0.305016	0.67387	0.75614

Abu Dhabi National Bank	0.021405	0.00755	0.282191	0.34503	0.37426
Qatar National Bank	0.097264	0.00002	0.000131	1.00000	1.00000
Aljazeera Sudanese Jordanian Bank	0.011004	0.03907	0.437483	0.59944	0.61111
Arab Sudanese Bank	0.000015	0.01876	0.277269	0.35832	0.63511
Ivory Bank	0.000717	0.01617	0.107612	0.39108	1.00000
Al Nile Bank	0.024620	0.00805	0.730381	0.89303	0.89307
Family Bank	0.000861	0.02279	0.704467	1.00000	1.00000
Abu Dhabi Islamic Bank	0.003162	0.00000	0.251415	0.31312	0.45916
National Bank of EGYPT	0.002442	0.07539	0.520534	1.00000	1.00000
Alrwoad Bank	0.001276	0.02496	0.422401	0.58516	1.00000
Qatar Islamic Bank	0.000001	0.00000	0.291747	0.45712	1.00000
Export Development Bank	0.018569	0.00542	0.572750	0.70030	0.70039

A 4 Statistical Results 2012

DMU Name	Size	ROA	LOANTA	CCR	BCC
National Bank of Sudan	0.0039345	0.06361	0.330599	0.76786	0.87550
Savings and Social Development Bank	0.0213612	0.01514	0.500032	0.65084	0.65095
Sudanese Islamic Bank	0.0270814	0.00482	0.543380	0.70722	0.70738
Baraka Bank	0.0284226	0.01334	0.579227	0.75375	0.75412
Tadamon Islamic Bank	0.0633810	0.02512	0.418659	0.88099	1.00000
Bank of Khartoum	0.1406396	0.02425	0.720559	0.95002	1.00000
Agricultural Bank Sudan	0.0354880	0.00109	0.522547	0.72438	1.00000
Saudi Sudanese Bank	0.0151035	0.01263	0.691083	0.89878	0.89947
Alsalam Bank	0.0226720	0.10274	0.767918	1.00000	1.00000
Sudanese Egyptian Bank	0.0183237	0.06956	0.308143	0.74972	0.77224

Al -Shamal Islamic Bank	0.0023178	0.01494	0.608523	1.00000	1.00000
Workers' National Bank	0.0097228	0.04736	0.525771	0.68447	0.80752
Sudanese French Bank	0.0466674	0.01395	0.422578	0.55006	0.55022
United Capital Bank	0.0000254	0.00005	0.000486	0.19700	1.00000
Farmer's Commercial Bank	0.0357137	0.01143	0.624856	0.82248	0.82348
Blue Nile Mashreq Bank	0.0265048	0.12027	0.545689	1.00000	1.00000
Omdurman National Bank	0.1840324	0.01116	0.645019	1.00000	1.00000
Byblos Bank (Africa)	0.0277996	0.01477	0.219454	0.28576	0.36003
Faisal Islamic Bank	0.1275230	0.00003	0.068319	0.08896	0.10387
Industrial Development Bank	0.0030963	0.00198	0.627945	1.00000	1.00000
Animal Resources' Bank	0.0125384	0.00828	0.546922	0.71181	0.73351
Real Estates Commercial Bank	0.0067346	0.00644	0.593172	0.77189	0.87691
El -Nilien Bank	0.0241836	0.01440	0.685805	0.89744	0.89759
African Bank for Trade and Development	0.0031736	0.04492	0.266183	0.83146	1.00000
Abu Dhabi National Bank	0.0282541	0.01617	0.188994	0.39227	0.46901
Qatar National Bank	0.0266991	0.02901	0.230644	0.72493	0.77355
Aljazeera Sudanese Jordanian Bank	0.0111849	0.02438	0.329758	0.43628	0.56026
Arab Sudanese Bank	0.0136628	0.06583	0.310636	0.55311	0.63064
Ivory Bank	0.0006335	0.08416	0.116352	1.00000	1.00000
Al Nile Bank	0.0296529	0.01351	0.230049	0.30506	0.32510
Family Bank	0.0034716	0.00837	0.769173	1.00000	1.00000