

Efficiency of Islamic Banks in Sudan: A non-parametric Approach¹

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Abstracts

This paper employs several efficiency measures and productivity changes using Data Envelopment Analysis (DEA) to investigate efficiency performance of Islamic banks in Sudan, using data from annual reports of 12 banks during the sample period 2007-2008⁴. The study results indicate, only two banks (the largest bank in the group, government owned and middle sized, private bank), scored technical efficiency level (i.e. scale and pure technical efficiency). While the smallest bank in the group (private owned), scored pure technical efficiency (i.e., managerial efficiency), but scale inefficient. These results add to the existing literature findings, that ownership is not a constraint of managerial and scale efficiency but bank's size is important factor for scale efficiency in Islamic banks.

JEL classification: G21

Keywords: DEA, Efficiency, Banks.

1. Introduction

Islamic banking system has a long history in Sudan, as it goes back to mid 1970, when two Islamic banks operated in the country for the first time, funded mainly by private Saudi capital⁵. The purpose of this study to examine the efficiency and nature

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⁴ Our focus on the sample period (2007 – 2008) is due to the fact that, since 2007 the Central bank of Sudan started implementation of restructuring and supervisory policy process including banking mergers to meet the minimum level of paid-up capital; engaging banks in micro-finance policy as part of a five year economic development plan (2007 – 2011); stepping up the efforts for reducing the non-performing loans of commercial banks to international standard level; and implementation of supervisory standards of the Islamic Financial Services Board (IFSB) and Basel 2 standards.

⁵ Only Pakistan, Iran and Sudan are the only countries with fully Shariya compliant banking system, while only Iran and Sudan have fully Shariya compliant stock markets.

of returns to scale of Islamic banks in Sudan during the period of 2007 and 2008. The comprehensive peace agreement, which ended the civil war between the North and the South of the country in 2006, stipulates that all banks in the North should operate according to Islamic banking system (interest-free), whereas the banks in the south operate according to conventional banking system (interest-based). The data included in this research covers 12 banks, operating according to Islamic banking system⁶. The methodology employed includes the Data Envelopment Analysis (DEA), a non-parametric mathematical programming technique that reveals efficiency and return to scale through construction of a best-practice frontier.

The DEA literature distinguishes two types of efficiency; technical efficiency and allocative efficiency. The technical efficiency refers to the ability of a decision-making unit (DMU) to produce as much output as possible at a given input level, or to produce a given level of output employing the least possible input levels, whereas allocative efficiency refers to cost-minimizing mix of inputs, at a given relative input prices. Therefore, technical efficiency focuses on minimization of input waste, to the extent that further reduction of inputs becomes infeasible. As a result, Data envelopment analysis (DEA) can enable banks to identify both sources of relative cost inefficiency - technical and allocative. Reducing excess inputs would increase technical efficiency, and selecting the cost-minimizing mix of inputs, given relative input prices, would lead to allocative efficiency. Banks that attain both types of efficiency gain an edge in the competition for private savings by competing more effectively with relatively cost-inefficient competitors⁷.

In the past, DEA approach has been extensively employed in the banking efficiency literature. Kamaruddin et al (2008) employed DEA approach and investigated efficiency of Islamic banks in Malaysia; Viverite and Skully (2007) used DEA to assess efficiency of Islamic banks in Africa, Asia and Middle East countries; Zubair (2007) investigated critically the optimization process of DEA efficiency measures and its conformity with Islamic banking principles; Elzahi et al (2003) used the x-efficiency approach to analyze efficiency of Islamic banks in Sudan. Miller and Noulas (1996) applied DEA methodology on North American region banking sector; Drake and Hall (2003), indicate size efficiency evidence on Japanese banks. Unlike the case of large banks in US and UK, which experience economies of scale,

⁶ While the total number of Islamic commercial banks operating in the country during 2007 and 2008, were 20 banks overall, in this paper we excluded eight banks from the list because either they are: specialized banks; operating as foreign branches with Islamic widows; or due to missing data problems.

⁷ It is important to realize that the efficiency concept in this analysis refers to cost efficiency rather than information efficiency which has to do with transparency and disclosure aspects. Since in reality Islamic banks are also profit maximizers (cost minimizers), they share the same goal of cost efficiency with conventional banks.

Rezvanian and Mehdian (2002) show small and medium size commercial banks in Singapore enjoy economies of scale. Darrat et al (2002) employed DEA on a number of banks in Kuwait indicating evidence of technical inefficiency.

The remaining parts of the paper include five sections. Section two discusses the salient features of Islamic banking system. Section three describes the data of the research. Sections four and five respectively deal with the methodology and analysis of the results. The final section concludes the study.

2. Islamic Financial System

Since 1989, Sudanese banks were made to conform to Islamic principles that prohibit use of interest rates in all financial transactions. But the peace agreement accorded in 2007 with South Sudan part stipulated that banking system in the South is exempted from the Islamic banking system. As a result, the main financing modes of the banking system in the remaining parts of the country in the north comprises of Mudarabah (passive partnership), Musharakah (active partnership), Murabaha (sale contract at a profit markup), and Salam (forward sale contract)⁸. When utilizing these financial modes for income generation, northern Sudan banks use both fixed return modes such as Murabaha, and leasing and variable return modes such as Mudarabah and Musharakah. While on the liability side northern Sudan banks have made significant progress in using profit sharing, this is not the case on the asset side. The share of profit sharing modes in total financing provided by northern Sudan banks is very small as compared to Murabaha financing, which have the lion share in total finance resources.

In general, a major distinguishing feature of Islamic financial system is the financial products which are based on prohibition of interest rate⁹. Thus, central to Islamic financial product design is partnership and risk sharing, which is commonly referred to as the profit-and-loss sharing paradigm (Presely & Sessions, 1994). Another distinction of Islamic banking system includes, the nature of contracts traded among Islamic financial institutions are subject to behavioral norms which are different from those norms governing Western style financial institutions. More precisely, Islamic products are based on the principles of risk sharing between capital owner and entrepreneur, as opposed to interest rate based financing modes, inherent in the Western financial system. Also the common share in Islamic system differ from that of Western definition due to the way the contract addresses asymmetric information

⁸ Salam is a sale contract in which the price is paid in advance at the time of contracting, against delivery of the purchased good/services at a specified future date.

⁹ Most commonly employed Islamic products are Mudarabah, Musharaka, Murabaha, and Ijara, as well as Salam and Mugawla (for definitions of each of these and other products see [Aggarwal and Yousif, 2000](#)).

between the capital owner and the manager (Mannan, 1993; and Naughton & Naughton, 2000). The Islamic system views the equity contract as a form of Mudarabah, where one party provides the capital and the other one provides entrepreneurship, or management. Thus, the risk of asymmetric information is safeguarded by the very nature of Mudarabah contract which assign equal burden of risk and reward on parties, capital provider and manager. Since concerns related to asymmetric information in Islamic system are mitigated through adherence of all parties to Shariya principles, we can say that Islamic financial system follows self-regulatory model (El-Din, 2002). Also another distinction of Islamic financial system included in the managerial governance aspects of firms. In Islamic system corporate governance is heavily influenced the basic principle of partnership and mutual risk sharing based on mutual trust between the two parties, the principal and agent. Mannan (1993) point out that the longer term partnership nature of mudarabah contracts supports the presence of large block-shareholders, as opposed to smaller shareholders who are more likely interested in short term gains and socially less beneficial projects. As a result, corporate governance in Islamic system is more inclined towards board structure comprised of major block shareholders acting in a supervisory context over incumbent managers (Presley and Sessions, 1994).

3. Data analysis

Since Islamic banks manage their investment capital based on interest-free principle, their capital structure is believed to be dominated by shareholders' equity and investment deposits which mainly based on profit and loss sharing principle. In other words, the return on capital is determined by the return on the economic activity in which the funds are employed. Based on these distinctions the inputs and outputs in this paper determined based on the intermediation approach in which DEA model consist of two inputs and two outputs. The inputs include salaries & wage expenses, and total deposits. The outputs include total loans and net income. The specification of inputs as stated above is consistent with the intermediation approach in which capital and labor are used to produce loans and net earnings to shareholders¹⁰.

The population of banks in this study include twelve Islamic banks operating currently in Sudan. The data of the study gathered from the annual reports of 12 banks covering the sample period 2007-2008 (see footnotes 1 and 3). It should be noted that the efficiency (inefficiency) concepts in DEA models, based on the above named input and output variables not necessarily imply efficiency (inefficiency) of risk management. Inefficiency of a DMU here implies falling short of best practice cost minimizing DMUs in the group (so-called efficiency frontier). To clarify this point further suppose, there are two banks with equal input sizes - deposits and

¹⁰ Other studies define inputs as total expenses on labor (salaries & wages), capital (book value of fixed assets) and deposits (demand and saving deposits).

operating expenses. Then the bank which allocates more loans out of its total deposits, while maintaining higher net earnings to shareholders is regarded more efficient, even if this condition is achieved under imperfect competition due to monopoly power, or special privileged status gained by government ownership.

Table (1) include the ranking of the twelve banks based on average values of deposits, loans, and net income during the sample period. Results in the table indicate the smallest bank in the group in terms of deposits and loans was Islamic Cooperative Development bank, and the largest bank was Omdurman National bank (ONB), which is the only government owned bank in the group. Thus, size and earning performance dominance of ONB could be due to the government ownership factor. To mitigate the size and ownership effect on efficiency performance of banks, in this paper we explored the efficiency analysis with and without ONB, to see how efficiency performance of other banks in the group is influenced.

Table (1): Ranking leading indicators

DMU	Deposits	Loans	Net Income
SIB	5	8	6
SHIB	7	7	8
BNMB	6	6	5
TIB	4	9	3
ICDB	11	11	10
KHB	10	10	11
FIB	3	2	4
SFB	2	4	2
ONB	1	1	1
UCB	8	3	7

Note1: See appendix for key to acronyms for DMUs.

Note2: The rankings are based on the mean values of 2007-2008.

4. Methodology

Several alternative DEA models have been employed in banks efficiency literature. The DEA models differ according to difference in the shape of the efficient frontier. In this paper we employed three alternative DEA models. We use the CCR (Charnes, Cooper, and Rohdes, 1978), BCC (Banker, Charnes, and Cooper, 1984), and the additive model (Charnes, Cooper, Golaney, Seiford, and Stutz, 1985). The main objective of a DEA study is to project the inefficient DMUs onto the most efficient frontiers of the DMUs in the sample, under the assumptions of change in return to scale and constant return to scale. There are three directions, input-oriented approach

that aims at reducing the input amounts by as much as possible at a given level of output; the output-oriented, approach that maximizes output levels at a given input level; and the additive model that deals with the input excesses and output shortfalls simultaneously.

It should be noted that the additive and BCC models may give different results when inefficiencies are present. The CCR and BCC models differ in that the former evaluates scale as well as technical inefficiencies simultaneously, whereas the latter evaluates the two in a separately identified fashion (Charnes et al 1994). In the following we illustrate briefly each of these models.

4.1: Basic DEA models:

In vector-matrix notation the input-oriented CCR model, with a real variable θ and a non-negative vector $\lambda = (\lambda_1, \dots, \lambda_n)^T$ of variables can be expressed as:

$$(LP_\theta) \min \theta \quad (1)$$

subject to:

$$\theta x_0 - X\lambda \geq 0 \quad (2)$$

$$Y\lambda \geq y_0 \quad (3)$$

$$\lambda \geq 0 \quad (4)$$

Where y_0 and x_0 are respectively the output and the input levels related to the specific DMU₀ under investigation, and Y and X are matrices constituting all output and input variables. The objective function in equation (1) minimizes the input level, whereas the constraints in equations (2) and (3) constrain the minimization of input within feasible region, and equation (4) stipulates non-negativity constraint the input and output weights.

The problem (LP_θ) has a feasible solution at $\theta=1$, $\lambda_0 = 1$, $\lambda_i = 0$ ($i \neq 0$). Hence the optimal θ , denoted by θ^* , is not greater than 1. On the other hand, due to the nonzero assumption for the data (X and Y), the constraint (4) forces λ to be nonzero because $y_0 > 0$. Putting all this together, we have $0 < \theta^* \leq 1$. The input excesses S^- and the output shortfalls S^+ can be identified as:

$$S^- = \theta x_0 - X\lambda \quad (5)$$

$$S^+ = Y\lambda - y_0 \quad (6)$$

With $S^- \geq 0$, $S^+ \geq 0$ for any feasible solution (θ, λ) of DLP_θ .

If an optimal solution $(\theta^*, \lambda^*, S^{-*}, S^{+*})$ above satisfies $\theta^* = 1$ and is zero- slack

($S^{-*} = 0$, $S^{+*} = 0$), then the DMU₀ is called CCR-efficient. Otherwise, the DMU₀ is called CCR-inefficient. Thus, full CCR-efficiency needs to satisfy:

- (i) $\theta^*=1$
- (ii) All slacks are zero.

The first of these two conditions is referred to as “radial efficiency”. It is also referred to as “technical efficiency” because a value of $\theta^* < 1$ means that all inputs can be simultaneously reduced without altering the proportion in which they are utilized. Because $(1-\theta^*)$ is the maximal proportionate reduction allowed by the production possibility set, any further reductions associated with nonzero slacks will necessarily change the input proportions. Hence the inefficiencies associated with any nonzero slack identified in the above two phase procedure are referred to as “mix inefficiencies”. “Weak efficiency” is sometime used when attention is restricted to (i) in definition 2. The conditions (i) and (ii) taken together describe what is also called “Pareto-Koopmans” efficiency. The weak efficiency also called “Farrell efficiency” because nonzero slack, when present in any input or output, can be used to effect additional improvements without worsening any other input or output. On the other hand CCR-efficiency refers to satisfaction of both (i) and (ii) conditions.

The input-oriented BCC model evaluates the efficiency of DMU_0 ($0=1, \dots, n$) by adding to the constraints in (2) – (4), the new constraint $e\lambda = 1$, and solving for the minimum objective function in equation (1).

It is clear that difference between CCR and BCC models is present in the free variable u_0 , which is the dual variable associated with the constraint which also does not appear in the CCR model.

If BBC_0 satisfies $\theta_b^*=1$ and has no slack ($S^{-*} = 0, S^{+*} = 0$) then the DMU_0 is called BCC-efficient, otherwise it is BCC-inefficient.

Figure -1.

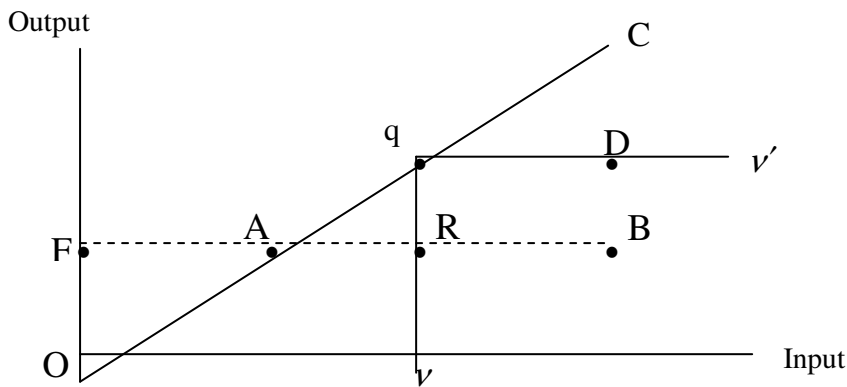


Figure 1, exhibits 5 DMU_s , A, R, B, q, and D each with one output and one input. The efficient frontier of the CCR model is the line (OAC), that passes through the origin. The frontier of the BCC model consists of the lines connecting v, R, q and D. The

production possibility set is the area enclosing the frontier lines. At point B, a DMU is CCR and BCC inefficient. But at point q, a DMU is CCR and BCC efficient. Generally, the CCR-efficiency does not exceed BCC-efficiency. The inefficiency score of the point B inside the frontier according to CCR model is computed as ratio FA/FB (reflecting how close point B would be to point A, along the radial line OC). Thus, according to CCR model a DMU should reduce its inputs by $(1 - \theta_i)$ in order to be at the efficiency frontier at point A. However, when the BCC model is taken into account, the overall technical efficiency includes the pure technical efficiency, which is given by the ratio $FR/FB = \sigma_i$, and the scale efficiency which is $\pi_i = \theta_i / \sigma_i$. Thus, the fraction of output lost due to scale inefficiency can be computed as $(1 - \pi_i)$. Scale efficiency equals 1 at any point along the CCR frontier line OC, at which production technology exhibits constant return to scale. Scale inefficiency can arise due to variable (increasing or decreasing) return to scale. On the other hand, pure technical inefficiency occurs because a DMU uses more inputs than needed (input waste), whereas scale inefficiency occurs due to reasons that DMU is not operating at constant return to scale. To account for variable return to scale we employ BCC model, so that at scale efficiency $\theta^* = 1$, for both CCR and BCC models, but for $\theta < 1$, for CCR, and $\theta^* = 1$ for BCC, indication of scale inefficiency but pure technical efficiency. Pure technical inefficiency can be due to inefficient implementation of the production plan in converting inputs to outputs (managerial inefficiency). However scale inefficiency could be due to divergence of DMU from the most productive scale size. Therefore decomposing technical efficiency into pure technical and scale efficiencies allows us to gain insight into the main source of inefficiency in Sudanese banks.

The preceding models required us to distinguish between input-oriented and output oriented specifications. The additive model combines both orientations in a single model:

$$(ADD_0) \max \quad Z = eS^- + eS^+ \quad (7)$$

subject to:

$$X\lambda + S^- = x_0 \quad (8)$$

$$X\lambda - S^+ = y_0 \quad (9)$$

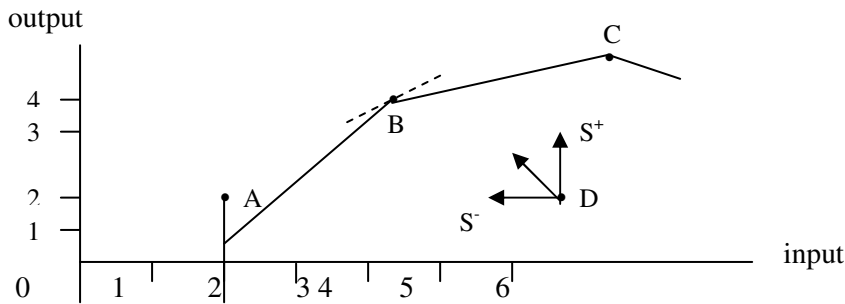
$$e\lambda = 1 \quad (10)$$

$$\lambda \geq 0, s^- \geq 0, s^+ \geq 0$$

To outline the main features of this model we use the figure below, where four DMUs, A, B, C and D, each with one input and one output, are depicted. Since by (8) – (10), the model (ADD₀) has the same production possibility set as the BCC model,

the efficient frontier, which consist of the line segment \overline{AB} and \overline{BC} . Now consider how DMU D might be evaluated. A feasible replacement of D with S^- and S^+ is denoted by the arrows S^- and S^+ in the figure. As shown by the dotted line, the maximal value of $S^+ + S^-$ is attained at B. It is clear that the model considers the input excess and the output shortfall simultaneously in arriving at a point on the efficient frontier which is most distant from D.

The Additive Model



Another useful analytical tool within the DEA technique is the Malmquist index, which measures the change in technical efficiency within two periods. To explain how Malmquist index can computed within DEA framework, suppose each DMU_j(j=1,...n) produces: a vector of outputs $Y_j^t = (Y_{1j}^t, .., Y_{sj}^t)$ by using a vector inputs $X_j^t = (X_{1j}^t, .., X_{mj}^t)$ of each time period t, $t_1, .., T$. From t to t+1, DMU₀'s efficiency may change or (and) the frontier may shift. Malmquist productivity index is defined as:

$$m_0 = \left[\frac{\theta_0^t(X_0^t, Y_0^t)}{\theta_0^t(X_0^{t+1}, Y_0^{t+1})} \frac{\theta_0^{t+1}(X_0^t, Y_0^t)}{\theta_0^{t+1}(X_0^{t+1}, Y_0^{t+1})} \right] \quad (11)$$

Where $X_0^t = (X_{10}^t, .., X_{m0}^t)$ and $Y_0^t = (Y_{10}^t, .., Y_{s0}^t)$ are the input and output vectors of DMU₀ among others, and $\theta_0^t(X_0^t, Y_0^t)$ is the minimum cost values. Then m_0 measures the productivity change between periods t and t+1.

Productivity declines if $m_0 > 1$, remains unchanged if $m_0 = 1$, and improves if $m_0 < 1$.

The following modification of m_0 makes it possible to measure the change in technical efficiency and the movement of the frontier in terms of specific DMU₀.

$$m_0 = \frac{\theta_0^t(X_0^t, Y_0^t)}{\theta_0^{t+1}(X_0^{t+1}, Y_0^{t+1})} \left[\frac{\theta_0^{t+1}(X_0^{t+1}, Y_0^{t+1}) \cdot \theta_0^{t+1}(X_0^t, Y_0^t)}{\theta_0^t(X_0^{t+1}, Y_0^{t+1}) \cdot \theta_0^t(X_0^t, Y_0^t)} \right]^{1/2} \quad (12)$$

The first term on the RHS measures the magnitude of technical efficiency change between periods t and t+1. Obviously

$$\left[\frac{\theta_0^t(X_0^t, Y_0^t)}{\theta_0^{t+1}(X_0^{t+1}, Y_0^{t+1})} \right] \begin{matrix} < \\ = \\ > \end{matrix} 1 \text{ Indicates the technical efficiency improves, remains, or}$$

declines. The second term measures the shift in the EPF between periods t and t+1.

5. Results and analysis

The efficiency performance of Sudanese banks in the sample indicate Omdurman National Bank (ONB) and Blue Nile Mashriq Bank (BNMB) satisfy scale and pure technical efficiency, whereas Islamic Cooperative Development Bank (ICDB), the smallest in the group in terms of deposits and loans, satisfy pure technical efficiency even though it is scale inefficient. Given that DEA efficiency scoring mechanism determined based on a benchmark DMU, and given that ONB is the only government-owned bank in the group, that enjoys preference status in terms of government deposits, we performed the efficiency test scores in the second round excluding ONB from the group to see how well performs the remaining group when a new benchmark DMU introduced. Results in table (3) reveal that the number of DMUs which are scale and technical efficient, when ONB excluded from sample, increases to three banks which includes BNMB, United Capital Bank (UCB), and Alsalam Bank (SB). The number of technical efficient banks also rises to three banks, including ICDB, Khartoum Bank (KHB), and Fisal Islamic Bank (FIB). The remaining banks in the sample appear to suffer from scale and technical inefficiency problems. The high efficiency scores for most banks in the group could be due to recapitalization of banks and the non-performing loans clean-up policy implemented from 2007. As a result of the recapitalization efforts, lower provisions were charged for loan losses, and more effective loan recovery plans implemented. Some banks adopted stricter provisioning and classification policies for non-performing loans to further strengthen their balance sheets.

Results in table (4) display changes in efficiency for each individual bank during 2007 and 2008, as indicated by the term outside the bracket in equation (12) of Malmquist index. Results in column (2) of the table, indicate considerable variation in efficiency across banks during the sample period. Unlike the case of other banks only ONB remained unchanged in its efficiency level in the two periods. Results of Malmquist index, indicate a positive productivity change during 2008 compared to the year before. This may reveal the impact of recapitalization policy and more stringent stands included in the Central Bank directives of 2007. Results in column (3) reveal changes in the best-practice frontier from period 2007 to 2008. Since all numbers in this column are positive all banks experience improvement in their technical progress. One important direction of future research on this issue is inclusion of sensitivity analysis to assess sensitivity of efficiency scores to changes in output and input constraints included in equations (2) and (3). Thus, sensitivity analysis allows us to identify the extent to which the efficiency status of an efficient

DMU is sensitive to changes in inputs and outputs constraints. Efficiency of a DMU is viewed as more robust as efficiency status of a DMU remains unchanged when inputs and outputs change within a wide range of variation.

Table (2): Mean efficiency scores*

DMU	CCR θ^*	BCC θ^*	Additive Model			
			S_1^{-*}	S_2^{-*}	S_3^{+*}	S_4^{+*}
SIB	0.41	0.41	0.00	(+)	(+)	0.00
SHIB	0.37	0.37	(+)	0.00	(+)	0.00
BNMB	1.00	1.00	0.00	0.00	0.02	0.00
TIB	0.48	0.83	0.00	(+)	(+)	0.00
ICDB	0.21	1.00	0.00	0.00	0.00	0.00
KHB	0.12	0.57	0.00	(+)	(+)	(+)
FIB	0.44	0.82	0.00	(+)	(+)	0.00
SFB	0.32	0.96	0.00	(+)	(+)	0.00
ONB	1.00	1.00	0.00	0.00	0.00	0.00
UCB	0.83	0.83	0.00	(+)	(+)	0.00
SB	0.26	0.27	0.00	(+)	(+)	(+)
ARB	0.25	0.25	0.00	(+)	(+)	(+)

Note: See appendix for the acronyms under DMUs. S_1^{-*} and S_1^{-*} are input slacks, and S_3^{+*} and S_4^{+*} are output slacks; (+) denotes a positive number.

*average efficiency scores for 2007 and 2008.

Table (3): Mean efficiency scores without ONB*

DMU	CCR θ^*	BCC θ^*	Additive Model			
			S_1^{-*}	S_2^{-*}	S_3^{+*}	S_4^{+*}
SIB	0.23	0.23	+	+	+	0.00
SHIB	0.66	0.66	+	0.00	+	0.00
BNMB	1.00	1.00	0.00	0.00	0.00	0.00
TIB	0.16	0.16	+	0.00	+	0.00
ICDB	0.22	1.00	0.00	0.00	0.00	0.00
KHB	0.65	1.00	0.00	0.00	0.00	0.00
FIB	0.22	1.00	0.00	0.00	0.00	0.00
SFB	0.14	0.17	0.00	0.00	0.00	0.00
ONB	--	--	--	--	--	--
UCB	1.00	1.00	0.00	0.00	0.00	0.00
SB	1.00	1.00	0.00	0.00	0.00	0.00
ARB	0.13	0.13	+	+	+	0.00

Note: See appendix for the acronyms under DMUs. S_1^{-*} and S_1^{-*} are input slacks, and S_3^{+*} and S_4^{+*} are output slacks; (+) denotes a nonzero positive number.

*average efficiency scores for 2007 and 2008.

Table (4): Malmquist index and productivity change

DMU	Malmquist Index*	Efficiency changes	Frontier shift
SIB	1.21	12.08	0.10
SHIB	1.01	9.01	0.11
BNMB	0.76	6.82	0.11
TIB	1.27	13.64	0.093
ICDB	1.24	12.64	0.098
KHB	0.92	8.47	0.10
FIB	0.72	6.00	0.12
SFB	1.04	9.50	0.10
ONB	0.098	1.00	0.09
UCB	0.55	5.55	0.09
SB	1.36	7.39	0.18
ARB	1.19	11.07	0.10

*Input-oriented CRS Malmquist index.

6. Concluding remarks

To measure efficiency performance of Islamic banks in Sudan we employed DEA approach using the intermediation approach of banking services, which entails banks produce financial services using inputs. The DEA models employed in this paper test technical efficiency of twelve Islamic banks in Sudan. Technical efficiency can be divided into pure technical efficiency (i.e. efficient implementation of production plan in converting inputs into outputs) and scale efficiency (divergence of decision making units from the most productive scale size).

The efficiency performance of Sudanese banks in the sample indicate the largest bank in the group, Omdurman National Bank (ONB) and middle sized, Blue Nile Mashriq Bank (BNMB) are the only two banks performed scale and pure technical efficiency scores; but the smallest bank in the group which is Islamic Cooperative Development Bank (ICDB), scored pure technical efficiency level, even though scale inefficient.

These results imply, since ONB is the only government owned and the largest bank in the group in terms of deposit and loan sizes, and BNMB and ICDB are private sector

owned banks, bank size and ownership are not important factors for managerial efficiency (pure technical efficiency) performance.

Results of productivity changes, implied by Malmquist index show that recapitalization and nonperforming loan policies implemented by the banking sector since 2007, resulted in productivity improvement in 2008. This result is consistent with the stricter provisioning and classification policies adopted by these banks, aimed at clean-up of nonperforming loans to further strengthen their balance sheets.

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Appendix: Key to acronyms

SIB	Sudan Islamic Bank
SHIB	Alshamal Islamic Bank
BNMB	Blue Nile Mushrig Bank
TIB	Tadamon Islamic Bank
ICDB	Islamic Cooperative Development Bank
KHB	Khartoum Bank
FIB	Fisal Islamic Bank
SFB	Sudanese French Bank
ONB	Omdurman National Bank
UCB	United Capital Bank
SB	Alsalam Bank
ARB	Animal Resource Bank