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# Scale and Technical Efficiency of Islamic Banks in Sudan: Data Envelopment Analysis

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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. Our results indicate, among twelve banks included in our sample only two banks, (the largest bank in the group which is government owned, and middle sized, private bank), score technical efficiency level (i.e. scale and pure technical efficiency). While the smallest bank in the group (private owned), score pure technical efficiency (i.e., managerial efficiency), but scale inefficient. This result adds additional evidence to the existing literature that ownership (government versus private) is not a constraint of managerial and scale efficiency but bank's size is important factor for scale efficiency.**

## 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 capital[1]. The purpose of this study to examine the efficiency and nature of returns to scale of Islamic banks in Sudan during the period of 2007 and 2008. The banking system in Sudan is peculiar as 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 would operate according to Islamic banking system (interest-free), whereas the banks in the south operate

[1] 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.

according to conventional banking system (interest-based). The data included in this research covers 12 banks, operating according to Islamic banking system. 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 competitors[2].

In the past, DEA approach has been extensively employed in the banking efficiency literature. 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,

[2] 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 main differences of Islamic banking system from the Western style 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

A major distinguishing feature of Islamic financial system is the financial products which are based on prohibition of interest rate[3]. 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 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 enterprenurship,

[3] 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).

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 mudurabah 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

The data employed in our study includes input and output variables for twelve banks operating currently in Sudan. The input variables include salaries & wages, and deposits, while the output variables include loans and net incomes[4]. The sample period includes data from the latest financial statements of 2007 and 2008. Despite the banking sector in Sudan includes currently about thirty commercial banks, we included in our sample only those provided the needed data for the analysis. It should

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

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 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. In this paper we refer to the inefficiency case arising from such situation as regulatory inefficiency because caused mainly by regulatory constraints facing the inefficient banks, or DMUs.

The ranking of the major financial variables included in table (1), reveal that the smallest bank in the group in terms of deposits and loans in the year 2008, was Islamic Cooperative Development bank, with deposit and loan sizes reaching 469 million of Sudanese pounds (equivalent to 195 million US$) and 196 million of Sudanese pounds (82 million US$) respectively. The largest bank in terms of deposits and loans, for the same period, was Omdurman National bank, with 1173 million Sudanese pounds (489 million US$), and 34472 million Sudanese pounds (14363 million US$). It is important to note that Omdurman National bank is the only government owned bank in the group of banks included in our analysis. Thus, size and earning performance dominance of ONB could be due to the ownership factor as this is the only government owned bank in the group. To put our DEA efficiency performance analysis in fairer context, 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 (2008) | Deposits | Loans | Net Income |
|---|---|---|---|
| SIB | 5 | 8 | 6 |
| SHIB | 8 | 7 | 8 |
| BNMB | 6 | 6 | 5 |
| TIB | 4 | 9 | 4 |
| ICDB | 12 | 12 | 11 |
| KHB | 11 | 11 | 12 |
| FIB | 3 | 2 | 3 |
| SFB | 2 | 4 | 2 |
| ONB | 1 | 1 | 1 |
| UCB | 9 | 5 | 7 |
| SB | 10 | 3 | 10 |
| ARB | 7 | 10 | 9 |

Note: See appendix for key to acronyms for DMUs.

**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 in a way that maximizes both.

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 $\lambda = (\lambda_1, .. \lambda_n)^T$ of variables can be expressed as:

Minimize θ (1)

subject to:

$\theta x_0 - x\lambda \geq 0$ (2)

$Y\lambda \geq y_0$ (3)

$\lambda \geq 0$ (4)

Where $y_0$ and $x_0$ are respectively the output and the input levels related to the specific $DMU_0$ 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 in the equations (*1*- *4*) has a feasible solution at θ=1, $\lambda_0 = 1$, $\lambda_i = 0$ (j≠0). Hence the optimalθ, denoted by $\theta^*$, is not greater than 1. On the other hand, due to the nonzero assumption for the data (X and Y), the constraint (4) forces $\lambda$ 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:

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

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

With $S^- \geq 0$, $S^+ \geq 0$ for any feasible solution $(\theta, \lambda)$ of *$DLP_0$*.

If an optimal solution $(\theta^*, \lambda^*, S^{-*}, S^{+*})$ above satisfies $\theta^*=1$ and is zero-slack ($S^{-*} = 0, S^{+*} = 0$), then the $DMU_0$ is called CCR-efficient. Otherwise, the $DMU_0$ 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 if 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,...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)**

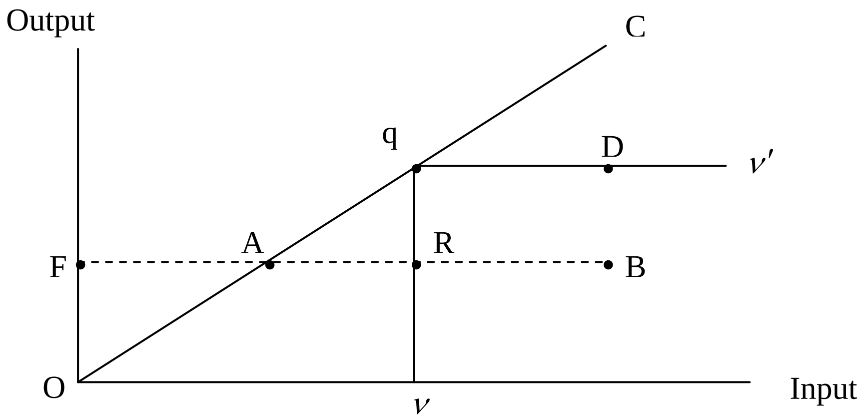



Figure 1, exhibits 5 $DMU_s$, A, R, B, q, and D each with one output and one input. The efficient frontier of the CCR model is the line (OAC), that passes through the origin. The frontier of the BCC model consists of the lines connecting v, R, q and D. The production possibility set is the area enclosing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

maximize $Z = eS^- + eS^+$ (7)

subject to:

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

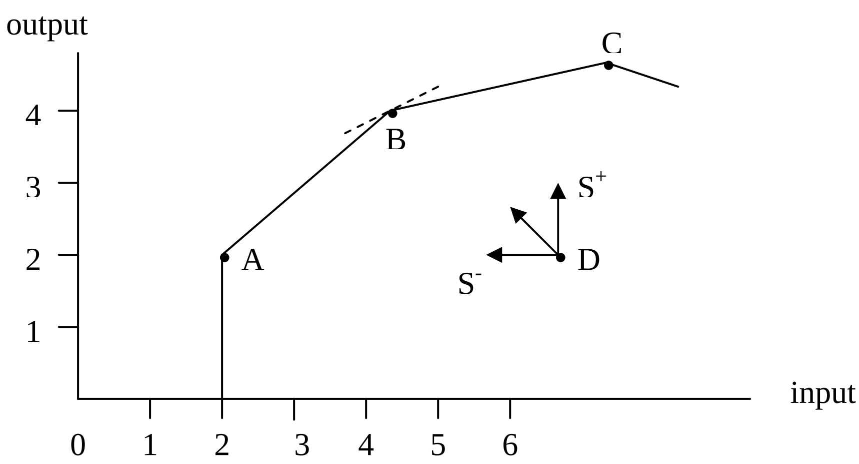
$$X\lambda - S^{+} = y_0 \qquad (9)$$

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

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

To outline the main features of this model we use the figure below, where four DMU$_s$, A, B, C and D, each with one input and one output, are depicted. Since by (8) – (10), the model (equations (7 - 9)) 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, $t_{z1}$,..T. From t to t+1, $DMU_0$'s efficiency may change or (and) the frontier may shift. Malmquist productivity index is defined as:

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

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 $DMU_0$ 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 $DMU_0$.

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

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

$\left[\frac{\theta_0^t(X_0^t, Y_0^t)}{\theta_0^{t+1}(X_0^{t+1}, Y_0^{t+1})}\right] \begin{smallmatrix} < \\ = \\ > \end{smallmatrix} 1$ 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

Since Islamic banks manage their investment capital based on interest-free principal, their capital structure is believed to be dominated by shareholders' equity and investment deposits which mainly based on profit and loss sharing principal. 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 shareholders. More specifically, capital input is represented by total deposits, and labor input represented by salary & wage expenses. The efficiency performance of Sudanese banks in the sample indicate that 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 while 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 privilege 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, UCB, and SB. The technical efficient group also rises to three banks, including ICDB, KHB, and FIB. The remaining banks, SHIP,TIB, SFB, and ARB, appear to have scale and technical inefficiency problems. The high efficiency scores for most banks in the group could be due to recapitalization of banks and the nonperforming loans clean-up policy urged by the central bank in 2005. As a result of the recapitalization efforts, lower provisions were charged for loan losses and there were also higher loan recoveries. Some banks may have 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, represented by the term outside the bracket in equation (12) of Malmquist index. The results in column (2) indicate considerable variation across banks and across time. Only ONB remained unchanged in its efficiency status for both periods. For all other banks their efficiency status improved in 2008 as all numbers in column (2) are non-zero positive. Results in column (3) reveal changes in the best-practice frontier from period 2007 to 2008. As all numbers in this column are positive all banks experience improvement in their technical progress. Column (1) includes results of Malmquist index, indicating a positive productivity change during 2008 compared to the year before. This may reveal the recapitalization of banks capital and the clean-up of non-performing loans policy adopted by the central bank in 2005, which may have influenced banks inputs and outputs. One important direction of future research on this issue is to include sensitivity analysis. In DEA models each Decision Making Unit (DMU) is classified either as efficient or inefficient. Change in inputs or outputs constraints for any DMU can alter the efficiency decisions, i.e., an efficient DMU can become inefficient and vice versa. 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. Thus, efficiency of DMU is viewed as robust the more insensitive efficiency of a DMU to changes in inputs or outputs. This implies that efficiency status of a DMU remains unchanged even when inputs and outputs change within wider range of variation.

**Table (2 ): Efficiency Scores**

| DMU | CCR $\theta^*$ | BCC $\theta^*$ | 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 full names of DMUs. $S_1^{-*}$ and $S_2^{-*}$ are input slacks, and $S_3^{**}$ and $S_4^{+*}$ are output slacks; (+) denotes a positive number.

**Table (3): Efficiency scores without ONB**

| DMU | CCR $\theta^*$ | BCC $\theta^*$ | 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 positive number.

**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 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 attain scale and pure technical efficiency scores, the smallest bank in the group which is Islamic Cooperative Development Bank (ICDB), scored pure technical efficiency level, but 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 owned banks, banks ownership is not instrumental factor for managerial efficiency (pure technical efficiency) performance, and also banks sizes is not a necessary requirement for managerial efficiency.

Since DEA efficiency scoring mechanism determined based on best performing benchmark DMUs, and given that ONB is the only government-owned bank in the group, that enjoys special status in terms of government deposits, we also run the efficiency test without ONB to reduce the sample constituents into more homogenous decision making units. Results in table (3) show the number of DMUs which are scale and technical efficient, when ONB excluded from sample, increases to three banks including BNMB, UCB, and SB. The technical efficient group also rises to three banks, including ICDB, KHB, and FIB. The remaining banks, SHIP, TIB, SFB, and ARB, appear to have scale and technical inefficiency problems.

Results of productivity changes, implied by Malmquist index show that the two banks (ONB, and BNMB) which scored technical efficiency have shown productivity improvement during 2007 and 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.

**References**

Aggarwal, R., and Yousif, T., (2000) "Islamic Banks and Investment Financing" Journal of Money, Credit and Banking, 32/1, pp.93-120.

Banker, R.D; Charnes A.; Cooper, W., (1984) "Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis" Management Science, 30, pp.1078 – 1092.

Charnes A.; Cooper W; and Rhodes E., (1978) "Measuring the Efficiency of Decision Making Units" European Journal of Operation Research, 2, pp.429-444.

Charnes A.; Cooper W.; Lewin A.; and Seiford L. (Eds.), 1994: Data Envelopment Analysis: Theory, Methodology, and Application, Kluwer Academic Publishers, Boston, MA.

Charnes, A.; Cooper W.; Golany B; Seiford L.; Stutz J. (1985) "Foundations of Data Envelopment Analysis for Pareto-Coopmans Efficient Empirical Production Functions" Journal of Econometrics, 30 (1-2),pp.91-107.

Darrat A.; Topuz C.; and Yousef T., (2002) "Assessing Cost and Technical Efficiency of Banks in Kuwait" Economic Research Forum, 8th annual conference, Cairo.

Drake, L.; and Hall, M. (2003) "Efficiency in Japanese Banking: An Empirical Analysis" Journal and Banking and Finance, 27, pp.891-917.

EL-Din, S. I., (2002) "Towards an Islamic Model of Stock Markets" Journal of King Abdulaziz University: Islamic Economics, 14, pp.3-29.

Miller S, and Noulas A., (1996) “The Technical Efficiency of Large Bank Production, Journal of Banking and Finance, 20, pp. 495 – 509.

Mannan, M. A., (1993). Understanding Islamic Finance: A Study of the Securities Market Framework. Islamic Development Bank, Saudi Arabia, Islamic research and Training Institute, Research paper No.18.

Naughton, T., and Naughton S., (2000) "Religion, Ethics and Stock Trading: The Case of an Islamic Equities Market" Journal of Business Ethics, 23/2, pp.145-159.

Presley, J.R., and Sessions J. G.(1994) "Islamic Economics: The Emergence of a New Paradigm" The Economic Journal, 104/424, pp.584-596.

Rezvanian R.; and Mehadian S., (2002) “An Examination of Cost Structure and Production Performance of Commercial Banks in Singapore” Journal of Banking and Finance, 26, pp.78-98.

**Appendix: Key to acronyms**

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|---|---|
| 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 |