



## **THE X-EFFICIENCY OF THE SUDANESE ISLAMIC BANKS**

Abd elrhman Elzahi Saaid,<sup>a</sup> Saiful Azhar Rosly,<sup>b</sup> Mansor H. Ibrahim,<sup>b</sup>  
and Naziruddin Abdullah<sup>c</sup>

<sup>a</sup>*Department of Banking and Export, College of Business Studies, Sudan University of Science and Technology, P. O. Box 407, Khartoum, Sudan. (e-mail: elzahi@yahoo.com)*

<sup>b</sup>*Professors, Department of Economics, Kulliyah of Economics & Management Sciences, International Islamic University Malaysia, Jalan Gombak 53100 Kuala Lumpur.*

<sup>c</sup>*Associate Professor, Department of Economics, Kulliyah of Economics & Management Sciences, International Islamic University Malaysia, Jalan Gombak 53100 Kuala Lumpur.*

---

### **ABSTRACT**

Important changes have taken place in the Sudanese banking industry since 1989. The transformation of the banking industry to conform to the Islamic principles has put the spotlight on the performance of the Islamic banks in Sudan. This study investigates the X-efficiency (technical and allocative) of these banks. The study used the basic Stochastic Frontier Approach (SFA). This is accomplished by decomposing the error term into two components, namely random noise ( $v_i$ ) and possible inefficiency ( $u_i$ ). The empirical results tend to suggest that banks in the sample had low levels of X-efficiency. This implied that the Sudanese Islamic banks were not optimizing their inputs usage. However, the results also showed that the inefficiency in the Sudanese Islamic banks could be more associated with inputs wasting (technical inefficiency) rather than choosing the incorrect input combinations (allocative inefficiency). The study has several important policy implications to offer, one of which is that it could be taken as a guideline for the Sudanese government to chart a policy on banking deregulation and mergers. Moreover, the study provides some information and identifies the source of X-inefficiency, which could, in turn, be used to assist banks' managements to overcome the problems of inefficiency.

JEL classification: G21

Key words: X-inefficiency, Islamic banks, Stochastic Frontier Approach

---

## 1. INTRODUCTION

Dramatic changes have taken place in the Sudanese Islamic banking industry in the last two decades of the 20th century. In 1989, all the banking practices in the country were made to conform to Islamic principles (*Sharfah*). Given these changes, one would like to know if there has been an improvement in the performance of the Sudanese Islamic banks. Historically, the Sudanese Islamic banks started their operations in 1979 which was the eve of the most difficult economic and political instability of the country. This had led to serious implications on the performance of Sudanese Islamic banks due to various factors.

These include deteriorating infrastructure, unstable economic policies, economic mismanagement in the public sector, drought, desertification, famine, disparate distribution of income and resources among the different districts of the country, and a continuous civil war. These factors have put severe economic pressures on Islamic banks leading to a high level of default with regard to the credit financing modes and non-performing equities modes of finance. Despite these difficulties, Islamic banks in Sudan grew rapidly in terms of assets and deposits size and have maintained considerable profit levels as shown by their respective balance sheets and income statements (Elzahi, 2002). These balance sheets also show the contributions of these banks in fulfilling their social responsibility and in the eradication of poverty in Sudan as reflected by the distribution of the large amount of *zakat* to the poor and needy.

Sudanese Islamic banks have mainly applied four types of contracts in their financial instruments namely, *musharakah*, *mu'arabah*, *murabahah*, and *salam*. While *musharakah* constitutes more than 50 percent of the total financing, *salam* is also a popular mode of finance in the Sudanese agricultural and livestock sectors (Elzahi, 2002). However, in using these instruments Sudanese banks have faced many challenges. Most of the financing was directed to the agricultural sector due to the Central Bank policies. Based on *salam* finance, the Islamic banks are supposed to receive the product in kind and not in currency. This requires the banks to maintain big warehouses to store these products before selling them locally. As a result, banks incur an additional cost plus the costs of inflation. In addition to the above problems, the Sudanese Islamic banks have difficulty in selling their products abroad due to the government's ideology and foreign policy. This have

adversely impacted on their revenue and caused an increase in their overhead costs due to the long storage period.

The recent wave of Islamization in the Sudan has put the spotlight on the efficiency implications of the Sudanese Islamic banks. If Islamization is successful in improving the efficiency of these banks, substantial benefits may accrue to their customers, shareholders, the economy and the Sudanese government.

This paper investigates the X-efficiency of Sudanese Islamic banks by using the Stochastic Frontier Approach (SFA). Although the studies of efficiency using frontier approach were introduced long ago, their application in evaluating the performance of banks did not start until Sherman and Gold (1985) initiated the study. They applied the frontier approach to the banking industry by focusing on the operating efficiency of the branches of a savings bank. Since then, numerous studies have been conducted using frontier approach to measure efficiency in banking. A recent survey found that 130 studies have applied frontier approach or frontier efficiency analysis to financial institutions in 21 countries worldwide (Berger and Humphrey, 1997).

The frontier approach is essential and very powerful. It requires very little institutional knowledge or experience to select the best bank practices within the industry. Thus, this study adopts this approach to measure the frontier efficiency of the Sudanese Islamic banking. Its objective is to investigate how close the Islamic financial institutions are to the “best-practice” frontier.

The literature search shows that up to 1997 only five studies out of the 130 were conducted on Islamic countries.<sup>1</sup> However, none of them apply to Islamic banks. Therefore, this study is the first of its kind as it focuses on Islamic banks using Sudanese banks’ data. It must be noted that there is more than one frontier approach used for the efficiency analysis. These approaches differ primarily in the assumptions imposed on the data in terms of:

- a. The functional form of the best practice frontier. Some functional forms are more restrictive compared to others,
- b. Whether or not random error is taken into account that may result in temporary increase or decrease in output, inputs, costs, or profits; and
- c. The treatment of random error, that is whether or not the probability distribution assumed for the (in)efficiency is used to distinguish the

(in)efficiencies from the random error.

According to the survey previously mentioned,<sup>2</sup> sixty-nine out of the 130 studies used a non-parametric approach, while 60 used parametric approaches. The non-parametric approaches, such as the Data Envelopment Analysis (DEA), are linear programming techniques in which the set of best-practice or frontier observations are those of which no other linear combinations of units has more of every input, given the amount of the output. Despite putting relatively little structure on the specifications of the best practices frontier, the main drawback of the DEA is with its assumption that there is no random error.

The parametric frontier approach, commonly referred to as the econometric frontier approach, is superior to the DEA in that it specifies a functional form for the cost, profit and, more importantly, allows for random error. Moreover, the parametric approaches such as the Stochastic Frontier Approach (SFA) decompose the error term into two components on the assumption that the inefficiency follows asymmetric distribution, usually half normal, while the random error follows standard normal distribution. The major limitation of these approaches is that they impose a particular form that presupposes the shape of the frontier. Hitherto, there is no clear-cut evidence on which approach dominates the others because in all cases the true level of efficiency is unknown.

Berger and Humphrey (1997) have proposed the only solution for the parametric and non-parametric approaches. They suggest adding more flexibility to parametric approaches and a degree of random error into the nonparametric approaches. Considering these limitations, this study adopts the econometric approach to measure the X-efficiency of the Sudanese Islamic banks from 1989 to 1998.

X-efficiency is found to be different from scale and scope economies because it takes the output bundle as given. On the other hand, scale and scope economies measure the least-cost scale and output mix to an output bundle, assuming that the firms are on the efficient frontier (Berger and Humphrey, 1993). Furthermore, X-efficiency dominates both scale and scope efficiency and is usually technical in nature (Berger and Humphrey, 1991). The cost or input X-efficiency of the bank refers to how close it is to the efficient cost frontier, where the bank's output bundle is produced at the minimum cost for the input prices it faces.

## 2. DATA AND VARIABLE SPECIFICATIONS

The data used to estimate the cost function were gathered from 12 Sudanese banks' annual reports for a 10 year period (1989-1998).<sup>3</sup> This period was chosen because it represents the transformation of the conventional Sudanese banks into fully-fledged Islamic banks. The definitions of the cost, prices, and output variables were determined on the basis of how and what banks produce (Mitchell and Onvural, 1996). There are two different views on the determination of input and output variables. They are the intermediate approach and the production approach (Berger and Humphrey, 1997).

The intermediate approach views banks as using deposits together with physical inputs to produce various types of bank assets as measured by their value. Total cost is defined as the interest expense of deposits plus the expense of physical inputs. The production approach, on the other hand, views banks as using only physical inputs such as labor and capital to produce deposits and other types of bank assets. Moreover, this approach defines the total cost as the cost of purchased inputs only.<sup>4</sup>

Berger and Humphrey (1997) suggest that the intermediate approach is best suited for evaluating firm-level efficiency, whereas the production approach is appropriate for evaluating the efficiency of the branches of financial institutions. This is because branches initially process customers' services for the whole institution and branch managers have little influence over the bank's funding and investment decisions.

The intermediate approach, on the other hand, is best suited to measure efficiency at the firm level because of its inclusiveness of the interest expenses, which are almost one-half to two-thirds of the total costs in the conventional financial institutions. Secondly, the intermediate approach is superior for measuring the importance of frontier efficiency to the profitability of the financial institution since the minimization of total costs, not just production costs, is needed to maximize profit.<sup>5</sup>

It is for the above reasons that this study follows the intermediate approach to measure the X-efficiency of the Sudanese Islamic banks. In this study, a transcendental logarithmic, or for brevity translog cost function is used. The advantages of this function lie in the fact that:

- a. It allows homogeneity of degree one via sample parameter restriction;
- b. It does not have a finite representation if one or more of the sample banks only produces a subset of the output vector, i.e., if any output has a zero value (Jagtiani and Khanthavit, 1996);
- c. The translog cost function offers less restrictive assumptions compared to the Cobb-Douglas function; and
- d. It has never been applied to measure X-efficiency of Sudanese Islamic banks, which means that introducing this function would provide a new dimension to the evaluation of this sector.

This paper uses one output variable and three variable inputs to measure the Sudanese banks' X-efficiency. Since during the period of investigation loans that were given on the basis of interest-bearing financing were forbidden by the Islamic government, all Sudanese banks practiced only equity financing. As a result, the only output available was investments ( $Y$ ).<sup>6</sup> While labor ( $X_1$ ), fixed assets ( $X_2$ ) and core deposits<sup>7</sup> ( $X_3$ ) are factor inputs, salaries and wages divided by the number of employees ( $W_1$ ), total expenses on furniture, equipment and premises divided by their book value ( $W_2$ ), and rate of return on deposits divided by the total deposits ( $W_3$ ) are the prices of  $X_1$ ,  $X_2$  and  $X_3$ , respectively.

### 3. METHODOLOGY

Following Kaparakis, Miller and Noulas (1994) outputs are taken to be a function of a large number of inputs. The outputs may deviate from the optimum due to the availability of the observable inputs, but such deviations must be random. If this deviation comes as a result of misuse or misallocation of inputs, we call it X-inefficiency. This study adopts the same procedure to analyze the X-efficiency of Sudanese banks. In addition, similar to Kaparakis, Miller, and Noulas (1994), we identify and estimate the error model and then decompose it into a one-side error term and asymmetric error term. Here we will follow the Stochastic Cost Frontier approach to measure X-efficiency.

Many studies that apply DEA have used small cross-sectional samples to measure efficiency of the production unit. The use of such samples may have resulted in findings of high levels of efficiency of the production unit under investigation. This is because, according to

Esho (2001), a large proportion of the sample is efficient by default.

In fact, we believe that the main reason why the study undertaken by Worthington (1996) found a high level of efficiency (approximately 99 percent) was that his study employed a small cross-sectional sample (he investigated a small sample of 63 Australian credit unions). A shortcoming of this kind of study is commonly associated with a large number of non-identifiers. In order to avoid Worthington's technical error (1996) we will utilize an econometric model, known as a Stochastic Cost Frontier, described in section 4.

#### 4. THE STOCHASTIC COST FRONTIER MODEL

The basic Stochastic Cost Frontier model states that a firm's observed cost will deviate from the cost frontier due to random noise,  $v_i$ , and possible inefficiency,  $\mu_i$ , thus, the cost function may be written as,

$$(1) \quad \ln TC = f(y_i, w_i) + \varepsilon$$

where  $TC$  is the observed cost of firm  $i$ ,  $y_i$  and  $w_i$  are the vectors of output levels and input prices, respectively. The function  $f(y_i, w_i)$  is the predicted natural log cost function of a cost-minimizing firm operating at output level  $y_i$  and input prices  $w_i$ . Once the model is estimated, inefficiency measures are calculated using the residuals. Thus, the technical efficiency ( $TE$ ) can be captured by decomposing the error term into two parts as follows,

$$(2) \quad \varepsilon_i = v_i + \mu_i$$

where the first component,  $v_i$ , is a normal error term with  $v_i \sim N(0, \sigma_v^2)$  representing pure randomness, and  $\mu_i$  is a non-positive error term exponentially or half normally distributed which represents technical inefficiency (Jondrow et al., 1982). The non-positive  $\mu_i$  reflects the fact that each firm's cost must lie on or below its frontier. Any such deviation is the result of factors under the firm's control such as technical inefficiency.

The technical efficiency will be estimated by decomposing the error term based on the random effects model so that its estimation by generalized least squares (GLS) is possible. GLS is consistent with the

model as  $N \rightarrow \infty$  without the assumption of normality of the  $v_i$  and without an assumption of a specific distribution for the  $\mu_i$ .

In this approach, one-sided random deviations are allowed in order to characterize inefficiencies. The estimated efficiency can be obtained directly if the following procedures are pursued.

To begin with, let  $\bar{\varepsilon} = \sum \hat{\varepsilon}_i$  where  $\hat{\varepsilon}_i$  is the residual obtained from equation (1) (see Simar, 1992, for details). Then we define  $\hat{\xi}_i = \max$  where the maximum is introduced in order to provide positive value of the  $\hat{\xi}_i$ 's. Hence the estimation of the efficiency of the  $i$ th bank is given by:

$$(3)$$

The Sudanese Islamic banks are assumed to be technically efficient if  $\exp(-\xi_i) = 1$ . Thus, the optimal value of  $\exp(-\xi_i)$  provides a measure of technical efficiency (*TE*).

If  $\exp(-\xi_i)$  is positive but less than 1, it implies that the production unit under investigation is technically inefficient or not efficient at the 100 percent level. The overall efficiency level (*OE*) may be obtained by averaging of the  $\xi_i$ . Alternatively, the *OE* is measured by the cost ratios, as the deviation of a bank's total costs from stochastic frontier. Hence the Farrell-type measure of efficiency can be then calculated (Vennet, 1996) as:

$$(4) \quad OE = C / C^* = e^{-\theta_i}$$

where *OE* = overall efficiency, *C* = observable cost, *C\** = estimated cost.

Finally, the solutions to equations (3) and (4) are used to derive the allocative efficiency (*AE*) (see Sengupta, 2000) as follows;

$$(5) \quad AE = OE/TE$$

where technical (in)efficiency (*TE*) in this context means excessive usage of factor inputs while the allocative (in)efficiency (*AE*) implies an incorrect input combination.



## 5. ECONOMETRIC SPECIFICATION

The following translog cost function is used to estimate equation (1):

$$(6) \quad \ln TC = \alpha_0 + \sum_{i=1}^3 \alpha_i \ln w_i + \frac{1}{2} \sum_{i=1}^3 \sum_{j=1}^3 \gamma_{ij} \ln w_i w_j \\ + \sum_{i=1}^3 \delta_{iy} \ln w_i \ln y + \beta_y \ln y + \frac{1}{2} \beta_{yy} (\ln y)^2 + \varepsilon$$

where  $TC$  = total cost  
 $y$  = investment assets  
 $w_1$  = price of labor  
 $w_2$  = price of fixed capital  
 $w_3$  = price of deposits

We note that the dual condition that must be satisfied by the cost function implies that it must be concave in input prices and monotonically non-decreasing in input prices and output (Jagtiani and Khanthavit, 1996). To ensure that the monotonicity condition holds the symmetry and linear homogeneity<sup>8</sup> conditions are imposed prior to estimations. The cost shares equation is derived using Shephard's lemma as follows:<sup>9</sup>

$$(7) \quad S_i = \alpha_i + \sum_{j=1}^3 \gamma_{ij} \ln w_j + \delta_{iy} \ln y$$

where  $S_i$  represents the share<sup>10</sup> of input  $i$  in total cost,  $TC$ . The share equations are included because evidence has shown that it helps to improve estimation efficiency in a small sample (Clark, 1996). Because  $\sum_{i=1}^3 S_i = 1$ , the share equations are not linearly independent and one of the share equations must be dropped prior to estimation.

## 6. THE EMPIRICAL RESULTS

Table 1 shows the data summary and its statistical descriptions of the 12 Sudanese banks. This table also shows the cost shares of labor ( $S_1$ ), capital ( $S_2$ ) and deposits ( $S_3$ ). From the table, it is obvious that the cost

shares of deposits and capital are significantly higher than that of labor. The improper allocation of these costs will be used as a good indicator for the existence of the X-inefficiency in the following sections.

Table 2 presents the estimated results of the translog cost function using the GLS method. The  $R^2$  for the cost function and the two<sup>11</sup> cost-share equations, namely, capital and deposits, were 0.85, 0.56 and 0.94, respectively, indicating a fairly good measurement of goodness of fit for the model. Table 2 also shows that 10 out of the 11 estimated parameters were significant either at the 5 percent or 10 percent level. The parameters that measure the output and the interaction between the output and input prices are also generally significant. The estimated cost elasticity equation of labor, physical capital and deposit inputs were 0.09, 0.42 and 0.49 respectively. The absolute summation of the inputs' coefficients are equal to one. This shows that the model satisfies the symmetry and linear homogeneity conditions that were imposed prior to the estimation.

### 6.1 X-EFFICIENCY

The present study estimates the technical and allocative efficiencies (X-efficiency) of the Sudanese Islamic banks. This is in line with the traditional cost regressions that are normally interpreted on the hypothesis that all banks operate at the lower frontier of the cost function. This behavior, however, is not found in practice because the banks, which incur higher costs than the minimum at a given scale and scope due to allocative inefficiency or technical inefficiency, are behaving less efficiently than theoretically assumed (Shaffer, 1993). In this study, the Stochastic Cost Frontier approach is used to evaluate the Sudanese Islamic banks' X-efficiency. The concept of frontier is consistent with the theory of optimization and allows a bank to customize and adjust its objectives if its efficiency deviates from the frontier.

The results obtained from our application of the parametric approach (random effects model) to the Sudanese Islamic banking industry, as presented in Table 3, show that on average the banks have used their inputs inefficiently. This can be seen from the estimated technical efficiency, which registered a value of 86 percent which is less than

TABLE 1  
Data Summary of 12 Sudanese Islamic Banks (1989-1998)

Variable	No. of Observations	Mean	Maximum	Minimum	Std. Dev.
$Y$	120	9644909	137000000	1971.49	20674338
$X_1$	120	1006	7099	17	1279
$X_2$	120	2682402	16140186	1769.72	4132545
$X_3$	120	24893232	891000000	2154.36	85561647
$W_1$	120	0.9483	60.4606	0.01858	5.49927
$W_2$	120	0.9295	0.9952	0.6650	0.0556
$W_3$	120	1.04089	9.6145	0.3539	0.7933
$S_1$	120	0.055	0.944	0.0043	0.0952
$S_2$	120	0.155	0.710	0.0127	0.1381
$S_3$	120	0.7896	0.9804	0.0406	0.1697
$TC$	120	2876032	909000000	18079.35	88852153

**Note:**  $Y$  = Investments,  $X_1$  = Labor,  $X_2$  = Capital,  $X_3$  = Deposits,  $W_1$  = Price of labor,  $W_2$  = Price of capital,  $W_3$  = Price of deposits,  $S_1$  = Share of labor,  $S_2$  = Share of capital,  $S_3$  = Share of deposits. All variables are measured in millions Sudanese pounds except  $X_1$ , which is in terms of number of employees.  $TC$  = Total Cost of the three inputs.

100. This implies that the Sudanese Islamic banks can reduce their total costs by 16 percent if they are technically efficient. To put it differently, the Islamic banks in Sudan were 16 percent technically inefficient in the period from 1989 to 1998 (see Table 4). The technical inefficiency results are consistent with the results in Berger, Hunter and Timme (1993).

The model also estimates the allocative efficiency ( $AE$ ) which measures the way in which the inputs are managed and is expressed in terms of the ratio of the marginal productivity of inputs to respective input prices. Specifically, if banks are allocatively inefficient, the costs are not minimized because the ratios of marginal productivity of inputs to the respective input price are not equal to 1. Table 3 shows the result of the allocative efficiency was 91 percent. This suggests that the Sudanese Islamic banks were 10 percent (see Table 4) away from the optimum cost frontier, that is, the Sudanese Islamic banks' managements might not have allocated the inputs in an efficient way.

TABLE 2  
GLS Parameter Estimates of 12 Sudanese Islamic Banks

Coefficients	Estimate	<i>t</i> -statistic	<i>p</i> -value
$\alpha_0$	0.435	-1.854	0.081
$\alpha_1$	0.090*	2.085	0.039
$\alpha_2$	0.420	-3.060	0.003
$\alpha_3$	0.490	9.212	0.000
$\beta_y$	0.620	3.462	0.000
$\beta_{yy}$	0.113	4.669	0.000
$\gamma_{12}$	-0.003	-1.700	0.094
$\gamma_{13}$	-5.560	-1.221	0.225
$\gamma_{23}$	0.003	1.959	0.053
$\delta_{1y}$	-0.016	2.961	0.004
$\delta_{2y}$	-0.068	-8.014	0.000
$\delta_{3y}$	-0.009	-1.904	0.059
			$R^2$
Cost function			0.85
Capital share equation			0.56
Deposit share equation			0.94

**Note:** The coefficient for labor was obtained using parameter restrictions of linear homogeneity. Method used: Generalized Least Squares (GLS): Total panel observations: 120.

TABLE 3  
Efficiency Scores of Sudanese Islamic Banks, 1989-1998

Efficiency	Scores	No. of Banks
<i>TE</i>	0.86	12
<i>AE</i>	0.91	12
<i>OE</i>	0.78	12

**Note:** *TE* = Technical Efficiency, *AE* = Allocative Efficiency, *OE* = Overall Efficiency, such that  $AE = OE/TE$ .

TABLE 4  
Inefficiency Scores of Sudanese Islamic Banks, 1989-1998

Inefficiency	Scores	No. of Banks
<i>TIE</i>	0.16	12
<i>AIE</i>	0.10	12
<i>OIE</i>	0.28	12

**Note:** *TIE* = Technical Inefficiency, *AIE* = Allocative Inefficiency, *OIE* = Overall Inefficiency, calculated using  $(1-E)/E$ .

As we have seen in Table 2, the coefficients of the input variables such as capital and deposits were high and the coefficient of labor was low. This indicates that the Sudanese Islamic banks were not allocating factor inputs in the right proportion.

Table 3 also shows that the overall efficiency (*OE*) was 78 percent. This means 28 percent out of the investigated Sudanese banks cost was inefficiently used when these banks were on the efficient frontier (see Table 4). Alternatively, we can say that the *OE* suggests that the Sudanese Islamic banks were 28 percent away from the optimum cost frontier. Although the investigation reflects that Sudanese Islamic banks were X-inefficient, the results indicate that the main source of overall inefficiency was the technical component. Hence, we can conclude that the inefficiency in Sudanese Islamic banks can be attributed more to input wastage (technical inefficiency) rather than selecting the incorrect input combinations (allocative inefficiency). This conclusion is consistent with the results in English et al. (1993).

## 7. CONCLUSION AND POLICY IMPLICATIONS

In this study, a Stochastic Frontier Approach (SFA) is used with the usual linear homogeneity and symmetry conditions imposed to arrive at the allocative and technical efficiency of the Sudanese banking sector. Given relative input prices, and output level and mix, Sudanese Islamic banks are assumed to choose inputs so as to minimize total production costs. This study sought to contribute new evidence on the cost

efficiency of Sudanese Islamic banks by calculating X-efficiency.

The result of the study shows that on average the Sudanese Islamic banks did not use their inputs efficiently. The estimated technical efficiency (*TE*) being only 86 percent, implies that the Sudanese Islamic banks were not using their total costs properly when they were on the frontier. In other words, the operations of the Islamic banks in Sudan were 16 percent technically inefficient. This technical inefficiency occurred due to the over-utilization of physical inputs and deposits and the under-utilization of labor. This means that the Sudanese Islamic banks rely heavily on financing using deposits and capital and less on labor. The over-utilization of deposits may imply that the banks use a high share of deposits in financing and keep insufficient reserve as required by the central bank. This is well reflected by many cases in which some banks were unable to pay their demand deposits on time. The over-utilization of capital input indicates that the banks expanded operations by setting up new branches. This strategy must have diverted their capital to unproductive fixed assets in the less profitable branches. The Sudanese Islamic banks may have chosen this approach given that they were not able to exploit new technologies such as automated teller machines (ATM) and banking solutions due to the economic sanctions imposed by the United States and the United Nations.

The economic sanctions may have also adversely impacted the Sudanese banking performance in other ways. Being unable to import new technologies also means the inability to train and upgrade banking personnel skills and expertise to a higher level of banking operations. This may have caused the under-utilization of labor in the Sudanese Islamic banks. Another reason could be the appointment or recruitment policy of the Sudanese Islamic banks where employment is based on political and religious connections and merit. Hence, the appointed bank officers might not be the best ones to execute their job most efficiently.

The study also estimates the allocative efficiency (*AE*) of Sudanese Islamic banks, which measures the way in which the inputs are allocated. The result shows the allocative efficiency was 91 percent which means that the Sudanese Islamic banks were 10 percent allocative inefficient. This implies that the Sudanese Islamic banks might not have allocated their inputs in the right proportion. This allocative inefficiency could be due to internal factors such as lack of managerial expertise as well as external factors such as the economic sanctions that were

imposed during the nineties as mentioned earlier.

The application of Islamic contracts requires banks to assume a higher degree of risk-taking in facilities such as *mushÙarakah*, *murÙbaÙah*, *muÙÙrabah* and *salam*. The experience in Sudan has shown that defaults were on the high side with *murÙbaÙah* at 30 percent, *salam* at 27 percent, non-performing *mushÙarakah*<sup>12</sup> at 62 percent, and *muÙÙrabah* at 56 percent. In this case, the over-utilization of deposits does not always mean profitability.

The study as a whole shows 78 percent overall efficiency (*OE*), meaning that 28 percent of the Sudanese Islamic banks' total cost was inefficiently used when banks were on the efficient frontier. The study has found that the main source of this overall inefficiency is the technical component. This can be largely attributed to the Sudanese policy on agriculture where banks were directed by the government to inject most of their funds into the agricultural sector via *salam* financing. Although *salam* financing, as applied by the Sudanese Islamic banks has embraced Islamic principles, the banks were unable to provide the necessary infrastructure to expedite the marketing of agricultural products. The lack of transport and warehousing facilities has impacted on *salam* financing in a negative way, thus increasing costs and reducing banks' revenues. To make matters worse, the economic sanctions made it more difficult for the banks to sell their agricultural products abroad.

The Sudanese banks are also highly concentrated,<sup>13</sup> and this market power may have reduced the banks' efficiency. Previous studies have demonstrated that in a highly concentrated market, uncertainty avoidance or risk aversion rather than profitability and efficiency become the objectives of some banks (Edwards and Heggstad, (1973)). The mergers between the major Sudanese public banks during the study period may have also raised costs if a decline in their X-efficiency from the reduced competition due to merging outweighs the scale cost efficiencies from their increased size.

Several implications can be drawn from this study. The study addresses the question of whether the Sudanese Islamic banks are X-efficient or not. The empirical results of this study find the Sudanese Islamic banks across the industry to be both technically and allocatively inefficient. The overall inefficiency amounting to 28 percent is quite worrisome since it shows that the Islamic banks in Sudan performed suboptimally during the period under study. This means that the Sudanese

Islamic banks have not been able to minimize their total costs by managing their riskiest financial operations to the best effect.

It is hoped that the finding in this study will help both the banks' shareholders and the government to further understand the problems of the banking business in Sudan. The study provides very important Islamic banks to assign suitable strategies to avoid further inefficient use of inputs and to improve their managerial performance. This is critical as the cost incurred due to X-inefficiency is likely to be serious. The Sudanese banks should improve their X-efficiency by better managing and allocating their inputs. The bank management must be appointed based on competence and expertise and not on the political or personal biases. The labor force in the banking sector must be well-trained to deal with the nature of the Islamic banking practices without depending on the past conventional experience.

The application of risky contracts such as *mushārakah*, *murābahah*, *salam* and *muḥārabah* demands professional and well-disciplined risk-management strategies in Islamic banks. This is to minimize the high risk that may erode the bank's profitability. Islamic instruments should not be treated like conventional loans. They require greater supervision and monitoring operations. In this regard, the staff should be trained to ensure that the Islamic operations succeed as planned.

The spread of banks' branches must be well-planned and ATMs should be used to reduce banking costs. Flexible financial policies are needed to permit banks to differentiate their products and practice good diversification strategies. The Sudanese Islamic banks need to build stronger internal control mechanisms, as some of the problems are caused by internal factors. The banks need to study the experiences of other Islamic banks in Muslims countries (for example, the Bank Islam Malaysia Berhad) in using banking technology. The government must reduce intervention and the imposition of many unwise national policies on commercial banking operations.

#### ENDNOTES

1. Berger and Humphrey (1997).
2. If we add the 69 non-parametric studies to the 60 parametric studies, the



result is less than 130. The authors did not mention which approach the remaining study followed.

3. The twelve surveyed banks include the Faisal Islamic Bank of Sudan, the Bank of Khartoum, El-Nillein Industrial Development Bank, Sudanese French Bank, Tadamon Islamic Bank, Islamic Co-operative Development Bank, Sudanese Islamic Bank, Sudanese Saving Bank, Al-Baraka Bank of Sudan, Islamic Bank for Western Sudan, Workers' National Bank and Mashreq Bank.

4. Mitchell and Onvural (1996).

5. Berger and Humphrey (1997).

6. Investment consists of *mush'Erakah*, *mur'Ebau'ah*, *mu'Erabah* and *salam*.

7. Core deposits constitute current deposits and saving deposits.

8. The symmetry and linear homogeneity conditions imposed are  $\sum_{i=1}^3 \alpha_i = 1$ ,

$$\sum_{i=1}^3 \gamma_{ij} = \sum_{j=1}^3 \gamma_{ji} = 0, \quad \sum_{j=1}^3 \delta_{yj} = 0.$$

9. Applying Shephard's lemma to (6)  $\sum_{i=1}^3 \partial \ln C / \partial \ln w_i = \sum_{i=1}^3 S_{i=1} = 1$ .

10.  $S_i = w_i x_i / TC$ , where  $i = 1, 2, 3$

11. One cost share equation, namely labor, was dropped prior to the estimation.

12. Regarding *al-mush'Erakah*, we can say non-performing *mush'Erakah* in a state of default.

13. The majority of Sudanese Islamic banks and all headquarters are concentrated in the state of Khartoum. There are 25 other states in Sudan.

## REFERENCES

- Berger, A. N., W. C. Hunter, and S. G. Timme. "The Efficiency of Financial Institutions: A Review and Preview of Past, Present, and Future." *Journal of Banking and Finance* 17, no. 2 & 3 (1993): 221-49.
- Berger, A. N., and D. B. Humphrey. "The Dominance of Inefficiencies over Scale and Product Mix Economies in Banking." *Journal of*

*Monetary Economics* 28, no. 1 (1991): 117-48.

- . “Efficiency of Financial Institutions: International Survey and Directions for Future Research.” *European Journal of Operational Research* 98 (1997): 175-212.
- . “Bank Scale Economies, Mergers, Concentration, and Efficiency: The U.S Experience.” *Revue Economique Financiere* 27 (1993): 123-54.
- Clark, J. “Economic Cost, Scale Efficiency, and Competitive Viability in Banking.” *Journal of Money, Credit and Banking* 28, no. 3 (1996): 342-64.
- Elzahi, A. “The X-efficiency of the Sudanese Islamic Banks.” Unpublished Doctoral Thesis. International Islamic University Malaysia, 2002.
- Edwards, F. R., and A. A. Heggestad. “Uncertainty, Market Structure and Performance: The Galbraith-Caves Hypothesis and Managerial Motives in Banking.” *Quarterly Journal of Economics* 87, no. 3 (1973): 455-73.
- English, M., S. Grosskopf, K. Hayes, and S. Yaisawarnng. “Output Allocative and Technical Efficiency of Banks.” *Journal of Banking and Finance* 17, no. 2 & 3 (1993): 349-66.
- Esho, N. “The Determinant of Cost Efficiency in Cooperative Financial Institutions: Australian Evidence.” *Journal of Banking and Finance* 25, no. 5 (2001): 941-64.
- Jagtiani, J., and A. Khanthavit. “Scale and Scope Economies at Large Banks: Including Off-Balance Sheet Products and Regulatory Effects.” *Journal of Banking and Finance* 20, no. 7 (1996): 1271-87.
- Jondrow, J., Lovell, C. A. Knox, I. S. Materov, and Schmidt. “On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model.” *Journal of Econometrics* 19, no. 2 & 3 (1982): 233-8.
- Kaparakis, E., S. Miller, and A. Noulas. “Short-run Cost Inefficiency of Commercial Banks: A Flexible Stochastic Frontier Approach.” *Journal of Money, Credit and Banking* 26, no. 4 (1994): 875-93.
- Mitchell, K., and N. M. Onvural. “Economies of Scale and Scope at Large Commercial Banks: Evidence from the Fourier Flexible Functional Form.” *Journal of Money, Credit and Banking* 28, no. 2 (1996): 178-99.

- Shaffer, S. "Can Mega Mergers Improve Bank Efficiency?" *Journal of Banking and Finance* 17, no. 2 & 3 (1993): 423-36.
- Sherman H. D., and F. Gold. "Bank Branch Operating Efficiency: Evaluation with Data Envelopment Analysis." *Journal of Banking and Finance* 9, no. 2 (1985): 297-315.
- Simar, L. "Estimating Efficiencies from Frontier Model with Panel Data: A Comparison of Parametric, Non-parametric and Semi-parametric Methods with Bootstrapping." *Journal of Productivity Analysis* 3, no. 1 & 2 (1992): 171-203.
- Vennet, R. V. "The Effect of Mergers and Acquisitions on the Efficiency and Profitability of EC Credit Institutions." *Journal of Banking and Finance* 20, no. 9 (1996): 1531-58.
- Worthington, A.C. "A Comparison of Financial Ratio and DEA Efficiency Measures in Assessing Co-Operative Financial Institutions Performance: Evidence Using the Australian Credit Union Industry." *Working Paper*. School of Economics and Finance. Queensland University of Technology, Australia, 1996.