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MEASUREMENT AND SOURCES OF TECHNICAL INEFFICIENCY: SOME EVIDENCE FROM THE SUDANESE ISLAMIC BANKS

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ABSTRACT

The establishment of Islamic banks that started in many parts of the Muslim countries some years ago has become a fact. However, this phenomenon needs to be justified empirically. Sudan has adopted Islamic principles for its entire banking industry. This has put the spotlight on the performance of the Islamic banks in the Sudan. In this paper the stochastic cost frontier function with a time series of cross-section data on Sudanese Islamic banks is used. The error terms are decomposed into v and u, which represent random noise and technical inefficiency, respectively. The banks in the sample have been divided into three categories, namely national banks, private domestic banks, and foreign joint venture banks. The technical efficiency was measured and the sources of inefficiency were investigated. The results showed that all banks in these groups were technically inefficient. The results also reveal that the national banks and private domestic banks were more technically inefficient than the foreign joint venture banks. The sources of inefficiency are attributed to the ownership, lack of banking technologies, severe economic sanctions and the lack of managing the high risk of the Islamic financing modes. This result has very good policy implications for the recent Sudanese government privatization policy regarding its national banks.

ABSTRAK

Usaha untuk menubuhkan bank Islam di pelbagai pelusuk dunia Islam sejak beberapa tahun kebelakangan ini telah menjadi satu kenyataan. Namun, penilaian prestasi bank-bank tersebut perlu dibuat dan ianya memerlukan justifikasi empirikal. Dalam konteks ini, negara Sudan yang telah menukar sepenuhnya industri perbankan mengikut prinsip Islam dan sekaligus *meletakkannya di persada dunia, tentunya tidak terlepas daripada penilaian tersebut. Bagi tujuan menilai prestasi bank Islam di Sudan, kajian ini telah menggunakan kaedah "stochastic cost frontier function" yang dipadankan dengan data siri masa dan keratan lintang. Terma ralat (error terms) telah diurai kepada dua iaitu "v" yang mewakili gangguan rambang (random noise) dan "u" yang mewakili ketidakefisienan teknikal. Manakala bank-bank dalam pensampelan telah dipecahkan kepada tiga: bank milik-negara; bank swasta tempatan; dan, bank usaha sama antara bank tempatan dengan asing. Ukuran prestasi telah dilakukan terhadap ketidakefisienan teknikal dan sumber-sumber ketidakefisienan tersebut. Dari sudut teknikal, dapatan kajian menunjukkan bahawa semua bank dalam ketiga-tiga kategori adalah tidak efisien. Manakala secara perbandingan, bank milik-negara adalah paling tidak efisien diikuti oleh bank swasta dan bank usaha sama. Ketidakefisienan ini mungkin berpunca daripada penggunaan teknologi yang tidak canggih, sekatan ekonomi oleh Amerika Syarikat ke atas Sudan dan ketidakupayaan bank-bank tersebut untuk mengurus pembiayaan yang berisiko tinggi mengikut kaedah Islam. Dapatan kajian ini sekurang-kurangnya mempunyai satu implikasi polisi iaitu kerajaan wajar menswastakan bank milik-negara supaya ianya menjadi lebih efisien.*

INTRODUCTION

In recent years there has been a renewed interest in Islamic economics amongst the Muslim and non-Muslim economists, centred especially on Islamic banking. This can be seen from the number of studies that had been conducted to measure the performance of Islamic banks. While several studies employed the standard bank performance measures, such as financial ratios, others used a combination of financial ratios and econometric methods. To give but a few examples, Samad (1999) used financial ratios to evaluate the performance of Bank Islam Malaysia Berhad (BIMB). His study showed that BIMB is less efficient than its conventional counterparts. Despite that result, he concluded that BIMB performed better than the conventional banks in Malaysia in terms of loan recovery. Bashir (1999) on the other hand, used both financial ratios and econometric methods to measure the scale effect of the Sudanese Islamic banks. Using data from two banks he discovered that Islamic banks in Sudan became more efficient and profitable as they grew in size.

Elsewhere, Elzahi (2002) used stochastic cost frontier functions to investigate the X-efficiency of the Sudanese Islamic banks for the period 1989-1998. With an estimated X-efficiency of less than one, he concluded that the Sudanese banks were not optimising their inputs-used and inputs-mixed. In another study, Abdullah and Elzahi (2003) used the same data to measure the Sudanese Islamic banks' TFP growth, scale efficiency and technological change using translog cost function. They found that, on average, the productivity growth of the Sudanese Islamic banks was 1.61%, of which 2.26% was contributed by the scale effect and the remaining (–) 0.65% was contributed by the technological change effect. Their empirical results point to the fact that the production technology of the Sudanese Islamic banks during the survey period was bound by increasing returns to scale, while the technological change effect contributed negatively to the TFP growth.

In the present study we concentrate on measuring and identifying the sources of technical inefficiency of 13 Sudanese Islamic banks for the period between 1991 and 1998. We note in passing that this study is distinctly different from Elzahi (2002) in that it divided the Sudanese Islamic bank into three discernible categories, namely, public banks, private banks, and foreign joint venture banks. All banks in the sample subscribed to Islamic banking practices.

Since, to date, no empirical studies using a translog cost function have been carried out to measure the technical inefficiency of the Sudanese Islamic banks owned by different groups, the present study offers a procedure to measure it using the said function. This function is preferred to the Cobb-Douglas function because its assumptions are less restrictive.

TYPES OF EFFICIENCY IN BANKING INDUSTRY: A SURVEY OF THE LITERATURE

Scale

Economies of scale are associated with firm size. Firms in an industry realize economies of scale if technology allows production costs to rise proportionately less than output when output increases. That is to say, economies of scale exist if per unit or average production costs decline as output rises. Conversely, if average costs rise with output, diseconomies of scale are present[1]. The earliest literature on scale efficiency suggests that medium-sized firms are slightly more scale efficient than either very large or very small firms[2]. In relation to this, Benston *et al.* (1982a, 1982b) and Allen and David (1993)[3] have conducted in-depth studies on how costs changed with size. They concluded that, *cateris paribus*, if banks doubled in their size they would have a reduction in average costs between 5 per cent and 8 per cent. This is applicable for all banks regardless of the size.

However, the results were later seen to have overstated the true economies of scale due largely to the shortcomings of the Cobb-Douglas production function used in the study. This is because the function itself constrained by the constant returns to scale production technology and could not concurrently show the average cost curve of three different sizes of banks. Another drawback of their study is that it did not differentiate between the economies of scale at the branch level and economies of scale at the level of the banking firm. This problem was, however, resolved by McAllister and McManus (1993) when they employed the translog cost function to measure scale efficiency in banking. They found that[4] small bank scale efficiency was found to be distinctly different from medium and large size banks.

Scope

Economies of scope relate to joint production of two or more products. Economies of scope arise if two or more products can be jointly produced at a lower cost than is incurred in their independent production. Diseconomies of scope, on the other hand, are present if joint production is more costly than independent production[5]. There are two major problems that have been recognized in the literature of scope efficiency (Allen *et al.*, 1993). The first problem that will likely be encountered when estimating the scope efficiency is that there are usually insufficient data on banks or specialized firms in general. The second problem is that the scope is always evaluated using data that are not on the frontier. Hence, Allen *et al.* (1993) concluded that due to these problems, the primary focus should be on banks that do not control costs rather than on those of a particular size or product mix[6]. This is because the competition arises not actually from improper product mix, but from banks with similar scope that are experiencing relatively low costs.

To sum up, the literature suggests that for future research researchers would do well to investigate and measure the optimal economies of scope[7] with particular attention given to defining and refining the concept itself.

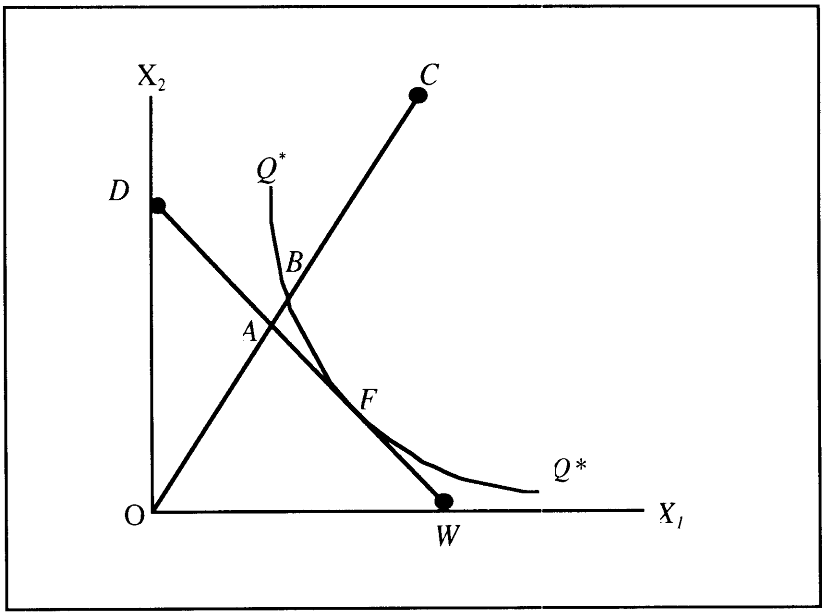
X-Efficiency

Farrel (1957) divided the measurement of productive efficiency into three different components[8]. The components are technical efficiency (*TE*), allocative efficiency (*AE*) and the overall efficiency (*OE*). The term

X-efficiency is widely used to describe all technical (the use of inputs) and allocative (mix of inputs) efficiencies of the firm(s). The concept of the *TE*, *AE*, *OE* and X-efficiency is illustrated in Figure 1. Specifically, Figure 1 represents a firm that employed two factors of production, capital (K) and labor (L), in production of a single output, Y. For simplicity, constant returns to scale are assumed in order to avoid frontiers at each level of output[9]. The isoquant QQ^* shows the possible combinations of factor inputs the firm can produce if it is perfectly efficient. The slope DW represents the prices of inputs. If the firm's production is efficient, it should occur at point F, which indicates cost minimization. This point referred to as the optimal point or overall efficiency (OE) is measured by the ratio of *OA/OC*. Farrell suggested that *OE* could be separated into technical efficiency (TE) and allocative efficiency (AE). If the firm is not producing on the isoquant, it is technically inefficient, which is calculated as *OB/OC*. Likewise, producing at point C also indicates that the firm has made an incorrect choice in combining its factor inputs at the given prices and thus incurs more cost than if it had produced at point *F*. This incorrect input choice is called allocative inefficiency and is measured by *OA/OB*. Thus, *OE* is the multiplication of *TE* by *AE* or mathematically:

$$OE = TE^*AE = (OB/OC)^*(OA/OB)$$

Figure 1
Farrell Measure of Efficiency



The cost or input X-efficiency (*TE* and *AE*) of a bank/firm refers to how close the bank/firm is to the efficient cost frontier, at which the bank's/firm's output bundle is produced at the minimum cost for the input prices it faces. X-efficiency differs from scale and scope economies as it takes the output bundle as given, while scale and scope economies try to determine the least-cost scale and mix of the output bundle, taking as given that the firm/bank is on the efficient frontier (Allen & David, 1993)[10].

Allen *et al.* (1993) also used the term X-efficiency to describe all technical (the use of inputs) and allocative (mix of inputs) efficiencies of individual firms[11]. Most X-efficiencies are operational in nature, involving the usage and correct allocation of inputs. Allen and David (1991) claimed that technical inefficiencies (proportionate overuse of all inputs) dominate allocative inefficiencies (improper mix of inputs). Their study showed that X-efficiency differences across banks are relatively large and dominate the scale and scope efficiency[12]. Allen *et al.* (1993) concluded that on average, banks appear to lose about one-half of their potential profits to X-inefficiencies and that larger banks are more X-efficient on average than smaller banks[13].

In another study, English *et al.* (1993) investigated whether individual banks are operating efficiently in terms of technical and allocative efficiency[14]. They used 1982 data from the Federal Reserve's Functional Cost Analysis (FCA) program to measure X-efficiency. In their study, they assumed that the bank attempted to minimize costs and that managerial mistakes are committed in input usage. From the findings, they concluded that the banks in their sample were inefficient.

Recently, Sathye (2000) conducted a study to investigate the X-efficiency in a sample of 29 Australian banks[15]. He found banks in the sample had a low level of overall efficiency compared with banks in Europe and the U.S. He also found the source of overall inefficiency in the technical component was more than in the allocative component. This result implies that the inefficiency in Australian banks could be attributed to inputs wasting (technical inefficiency) rather than choosing incorrect input combinations (allocative inefficiency).

Tai-Hsin Huang (2000) examined the X-efficiency of the Taiwanese banking sector[16]. He used panel data of 22 of Taiwan's domestic banks over the period 1981 to 1995. The study discovered that the large banks tend to be more technically efficient than the small ones. Mohamed (1997) estimated input-specific technical inefficiency for the Tunisian banking industry[17]. His results showed that technical efficiency of labor and capital inputs decrease over time. Labor input was used more inefficiently than capital input.

In summary, the literature cited above points to the fact that frontier analyses have been widely used to analyze and measure conventional financial industry performance, notably efficiency. This approach, however, has not been applied to the Islamic banks. All studies that have been undertaken to measure the Islamic banks' performance have instead used either financial ratios or descriptive analysis. Therefore, a study that can make full use of available tools to investigate Islamic banking efficiency, of which frontier analysis is one, is badly needed. The lack of studies conducted to measure the performance of the Islamic banking sector using recently established methods has motivated us to undertake such study. Perhaps, by so doing some light on how the Islamic banks fared compared with their counterparts, the conventional banks can be shed.

It is also worth mentioning at this juncture that the latest methods are considered best because they permit individuals with very little institutional knowledge or experience in firms to select the most efficient firms in the industry, assign numerical efficiency values and identify the areas of input overuse and/or output underproduction. At the same time, for those who are well-versed in this area, frontier analysis permits management to identify the areas of best practice within complex services operations, which is not always possible using the traditional benchmarking techniques due to lack of a powerful optimizing methodology[18].

SOURCES OF INEFFICIENCY: THE CASE OF THE SUDANESE ISLAMIC BANKS

This paper intends to measure the technical inefficiency of 13 Sudanese Islamic banks. This is actually in line with the interest of policymakers and firms managers whose main task is to distinguish between efficient and inefficient firms. In fact, this exercise is also very helpful for those who are interested in determining whether inefficient banks shared among themselves a similar set of characteristics. In order to explicitly show and evaluate the sources of inefficiency among the Sudanese Islamic banks we divide the banks into three categories, namely: national banks, domestic private banks and foreign joint venture banks.

Theoretically, a source of inefficiency that may directly be attributed to the Sudanese Islamic banks is the lack of banking technology, such as Automotive Teller Machines (ATM) and banking solutions. The banks, constrained by this, may adopt a labour-intensive technique at the expense of technical efficiency. This was proven to be the case when Elzahi (2002), in his empirical study, found that due to lack of recently invented technology adoption, the Sudanese Islamic banks spread widely in unprofitable branches, which in turn caused them to misallocate their physical capital.

Another source of inefficiency is output heterogeneity, which is driven by the process of competition among the firms through product differentiation. Since inefficiency is a relative term it should be measured using homogeneous firms that use the same level of technology and input mix to produce similar outputs. Hence the measurement of a firm's inefficiency should treat all firms as homogeneous even though they may not give satisfactory results. In this study this problem is resolved because it is assumed that all Sudanese banks, regardless of their ownership, shared the same level of technology.

Inefficiency may also be linked to the age of the firm. Long operating firms may be more efficient because of their long operational experience. Likewise, younger firms may be more efficient by adopting the more recent technological advances, which older firms may not have adopted. In the case of the Sudanese Islamic banks the problem related to this is overcome given the fact that most of the banks in the sample began subscribing to the Islamic mode of transactions more or less in the same period.

Lastly, apart from the above-mentioned factors, the inefficiency of the firms may be due to the inability of management to control costs. This is commonly referred to as technical inefficiency, which means the degree of ineffectiveness in utilising inputs. The reason is that different firm managements have different management skills, different capabilities, and different bargaining power. Since these aspects of inefficiency have never been measured before for the Sudanese Islamic banks, they will be undertaken in this paper.

DATA AND VARIABLE SPECIFICATIONS

The data used to estimate the cost function were gathered from 13 Sudanese bank annual reports for the years 1991-1998[19]. The definitions of the cost, prices, and output variables were made based on how and what banks produce[20]. There are two different views on the determination of input and output variables. They are the production approach and the intermediate approach (Allen & David, 1997).

The production approach considers banks as users of physical inputs such as labor and capital from which deposits and other types of bank assets are produced. It defines the total cost as the cost of purchased inputs only[21]. This approach is appropriate for evaluating the efficiency of the branches of financial institutions for the simple reason that branches initially process customer services for the whole institution and branch managers have little influence over the bank's funding and investment decisions.

The intermediate approach, on other hand, views banks as using deposits together with physical inputs to produce various types of bank assets as measured by their currency value. In the case of conventional banks, total cost is defined as the interest expense of deposits plus the expense of physical inputs. Following Islamic principles, we note, however, that the Islamic banking system is expected to replace interest with return on deposits.

As pointed out by Allen and David (1997) and owing to the inclusiveness of the interest (or return on deposits as in Islamic banks) expenses, which is almost one-half to two thirds of the total costs in conventional financial institutions, the present paper will employ the intermediate approach to evaluate Sudanese Islamic banks. The transcendental logarithmic (or translog) cost function is used to measure the technical efficiency of the said banks. The advantage of this function compared to the Cobb-Douglas function is that it allows homogeneity of degree one via sample parameter restriction. Furthermore, it does not have a finite representation if one or more sample banks only produce a subset of the output vector, i.e., if any output has a zero value[22].

We note here that the present study uses one output variable and three-variable inputs to measure the three categories of Sudanese Islamic bank technical efficiency, namely, public banks, private banks and foreign joint venture banks. Since our sample represents purely Islamic banks in which interest bearing loans were forbidden as all bank practices conformed to Islamic principles, the only output used in this investigation is total investments (Y). Meanwhile, labor (X_1), fixed assets (X_2) and core deposits (X_3) are factor inputs, and salaries and wages divided by 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.

MODEL SPECIFICATION

Since outputs are taken to be the function of a large number of inputs they may deviate from the optimum due to the availability of observable inputs. Such deviations must be random. If this deviation comes as a result of the excessive use of inputs, we call it technical inefficiency. In this study, the standard procedure (see Emmanuel *et al.*, 1994, for more details) is adopted to identify and estimate an error term and then decompose it into two components: a one-side error term and an asymmetric error-term. Here we will follow the stochastic econometrics cost frontier approach to measure technical efficiency.

Although another approach, namely the data envelopment analysis (DEA), can also be used to measure the technical efficiency of Sudanese banks, Worthington (1996) found that a high level of efficiency (approximately 99 per cent) would occur when a small cross-sectional sample is utilized. To avoid committing the same technical error, as we have about the same sample size, we will adopt the stochastic econometric cost frontier, to be described in Section 6.

STOCHASTIC ECONOMETRICS COST FRONTIER MODEL

The basic stochastic econometrics 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, μ_i, and thus, the cost function may be written as:

$$\text{In } TC = f(y_i, w_i) + \varepsilon \qquad (1)$$

Where TC is the observed cost of the firm, 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:

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

The first component v_i is a normal error term with $v \approx N(0, \sigma_v^2)$ representing pure randomness and μ_i is a non-positive error term exponential or half normally distributed[23] representing technical inefficiency. The non-positive μ_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 ---- ∞ without the assumption of normality of the v_i and without the assumption of a specific distribution for the μ_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 $\bar{\varepsilon}_i = \Sigma\hat{\varepsilon}_i$ where $\hat{\varepsilon}_i$ the obtained residual from equation (1) (see Simar, 1991 for details). Then we define $\hat{\zeta}_i$ = max $\bar{\varepsilon}_i$ - $\bar{\varepsilon}_i$ where the maximum is introduced in order to provide positive value of the estimation of the $\hat{\zeta}_i$'s. Hence the estimation of the efficiency of the bank is given by:

$$TE = eff_i = exp\ (-\hat{\zeta}_i) \qquad (3)$$

Sudanese Islamic banks are assumed to be technically efficient if exp $(-\hat{\zeta}_i) = 1$. Thus the optimal value of exp $(-\hat{\zeta}_i)$ provides a measure of technical efficiency (*TE*). If exp $(-\hat{\zeta}_i)$ is positive but les than 1, it implies that the pruduction unit under investigation is technically inefficient or not efficient at the 100 per cent level.

ECONOMETRICS SPECIFICATION

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

$$\ln TC = \alpha_0 + \Sigma^3_{i=1}\, \alpha_i \ln w_i + 1/2\, \Sigma^3_{i=1}\Sigma^3_{j=j}\, \gamma_i \ln w_i w_j + \Sigma^3_{i=1}\, \delta_i \ln w_i \ln y + \beta_i \ln y + 1/2\, \beta_{yy} (\ln y)^2 + \varepsilon$$

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 outputs (Jagtiani *et al.*, 1995).

To ensure the monotonocity condition holds the symmetry and linear homogeneity[24] conditions are imposed prior to estimations. The cost shares equation is derived using Shepherd's Lemma as follows[25]:

$$S_i = \alpha_i \Sigma^3_{j=1} \gamma_i \ln w_j + \delta_{iy} \ln y \quad (5)$$

Where S_i represents the share[26] 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[27]. Because $\Sigma S_i = 1$ the share equations are not linearly independent and one of the share equations must be dropped prior to estimation.

EMPIRICAL RESULTS

Table 1 shows the data summary and statistical descriptions of the 13 Sudanese banks for the period 1991-1998. Table 2 presents the estimation results of the translog costs function using the *GLS* method. The R^2 for the cost function, which is 99%, indicates a fairly good measurement of goodness of fit for the model. Table 2 also shows that 11 out of the 12 estimated parameters were significant either at the 1 per cent or 5 per cent 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 labour, physical capital and deposit inputs were 0.36, 0.04 and 0.6 respectively. The absolute summations of the input coefficients are equal to one. This shows that the model satisfies the symmetry and linear homogeneity conditions that were imposed prior to estimation.

Table 1
Data Summary

Variables	Observations	Mean	Maximum	Minimum	Std.Dev.
Y	104	11474478	137000000	10000	21903812
X_1	104	3146607	16140186	3154.990	4275932
X_2	104	1215	7099	120	1371
X_3	104	37727868	891000000	2154.36	10600000
W_1	104	0.881	0.995	-0.246	0.202
W_2	104	1341	13566	0.6022	2476.55
W_3	104	0.623	1.173	-34.586	3.486
S_1	104	0.150	0.700	0.004	0.145
S_2	104	0.050	0.420	0.000	0.054
S_3	104	0.800	0.990	0.117	0.164
TC	104	4227868	909000000	18359	10900000

Investments (Y), Capital (X_1), Labour (X_2), Deposits (X_3), Price of capital (W_1), Price of labor (W_2), Price of deposits (W_3), (S_1) share of capital, (S_2) share of labor, (S_3) share of deposits. All variables are measured in thousands Sudanese pounds except X_2, which is in terms of number of employees. The numbers of the cross sections are 13 banks. TC = total cost of the three inputs.

Table 2
GLS Parameter Estimates for Cross-section of Sudanese Banks

Coefficients	Estimate	t-statistic	Prob.
α	0.14	16.8	0.0000
α_1	0.04	5.14	0.0000
α_2	0.36*	5.90	0.0000
α_3	0.60	5.10	0.0000
β_y	0.80	3.40	0.0011
β_{yy}	0.18	-3.89	0.0002
γ_{w12}	0.06	-0.11	0.9095
γ_{w13}	0.79	4.73	0.0000
γ_{w23}	0.24	-2.87	0.0051
δ_{w1y}	0.26	5.30	0.0000
δ_{w2y}	-0.19	-6.50	0.0000
δ_{w3y}	-0.21	-6.70	0.0000
F = 5632			S.E = 1.532
			R^2=0.99

Method General Lest Squares *(GLS):* Total Panel Observations are 104.
*Note: Coefficient for labor was obtained using parameter restrictions of linear homogeneity.

The present study also estimates the technical efficiency of the 13 Sudanese Islamic banks. This is consistent with traditional cost regressions that are normally interpreted on the hypothesis that all banks operate at the minimum 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 the technical inefficiency are behaving less efficiently than theoretically assumed[28]. In this study, the stochastic econometrics cost frontier approach is used to evaluate the Sudanese Islamic bank technical efficiency.

The banks in the sample have been divided into three categories, namely national banks (Group A), private banks (Group B) and foreign joint venture banks (Group C). When we apply the parametric approach (random effects model) to all three categories of Islamic banks, the results, as presented in Table 3, show that, on average, the banks in all the groups used their inputs inefficiently. This can be seen from the estimated technical efficiency, which registered a value of less than 1. An estimated technical efficiency of 65%, 71.3% and 79% for group A, Group B and Group C, respectively, implies that the Sudanese national banks were more technically inefficient than the private and foreign joint venture banks. To put it differently, the foreign joint venture banks in Sudan were more technically efficient in the period from 1991 to 1998 than the Sudanese national and private banks. Overall, the results tend to suggest that despite the fact that all the groups of these Islamic banks overused their physical inputs, national banks are the worst.

Table 3
The Technical Efficiency (TE)

GROUP A (NATIONAL BANKS)	
	TE
BKH (Bank of Khartoum)	51%
EIDB (El Neillien Industrial Development Bank)	78%
SSB (Sudanese Saving Bank)	65%
AVERAGE	**65%**
GROUP B (PRIVATE BANKS)	
TIB (Tadamon Islamic Bank)	65%
ICDB (Islamic Co-operative Development Bank)	75%
SIB (Sudanese Islamic Bank)	78%
WNB (Workers' National Bank)	87%
IBWS (Islamic Bank for Western Sudan)	61%
SHIB (Shamal Islamic Bank)	62%
AVERAGE	**71.3%**
GROUP C (JOINT VENTURE BANKS)	
FIBS (Faisal Islamic Bank of Sudan)	76%
SFB (Sudanese French Bank)	73%
BIBS (Al- Baraka Islamic Bank of Sudan)	97%
SUSB (Saudi Sudanese Bank)	70%
AVERAGE	**79%**

CONCLUSION

In this paper, the stochastic cost frontier function with a time series of cross-sections data on Sudanese Islamic banks is used. The error terms are decomposed into v and u, which represent the random noise and technical inefficiency, respectively. The banks in the sample have been divided into three categories, the national banks, private domestic banks and foreign joint venture banks. The empirical results showed that all banks in our groups were technically inefficient with a mean level of efficiency less than one. Specifically, the average technical efficiency for national banks, private domestic banks, and foreign joint venture banks were 65%, 71.3% and 79% respectively for the period 1991 to1998. Since national banks and private domestics banks were more technically inefficient than foreign joint venture banks, ownership could be one of the sources of inefficiency in the Sudanese banking industry. Other sources of inefficiency may be the lack of banking technologies, which forced Islamic banks in Sudan to follow labour-intensive techniques at the expense of technical efficiency. Finally, due to an unfavourable environment and the economics sanctions that were imposed on Sudan during the 1990s, coupled with the Sudanese government's agriculture financing policy to attain self-sufficiency in foodstuffs, the banks were exposed to high risks. Preoccupied with these problems, the Islamic banks management in Sudan had very little choice but to concentrate on minimizing the risks rather than optimizing their physical inputs. The results of this study provide a good reason for the Sudanese government to undertake a privatization policy, that is, to privatize its national banks.

ENDNOTES

1. Jeffrey A. Clark, 1996, Economic Cost, Scale Efficiency, and Competitive Viability in Banking, *Journal of Money, Credit and Banking*, Vol. 28, No. 3.pp.22
2. Allen N. Berger, William C. Hunter and Stephen G. Timme, 1993, The efficiency of financial institutions: A review and preview of past, present, and future, *Journal of Banking and Finance* 17, pp. 221-249.
3. As quoted by Allen N. Berger & David B. Humphrey (1993), ibid.
4. McAllister, P.H. & D.A. McManus (1993), Resolving the scale efficiency puzzle in banking, *Journal of Banking and Finance*, 17, pp. 389-405

5. Jeffrey A. Clark, 1996, *ibid.*
6. Allen N. Berger & David B. Humphrey (1991). The dominance of inefficiencies over scale and product mix economies in banking, *Journal of Monetary Economics* 28 (1991) pp. 117-148.
7. Allen N. Berger *et al. (1993), ibid.*
8. Farrel, M.J. (1957) The measurement of productive efficiency, *Journal of the Royal Statistical Society* A, 120, 253-281.
9. Mayes, D. and Lansbury, M., *Inefficiency in Industry*, Published (1994) by Harvester Wheatsheaf Campus 400.
10. Allen N. Berger and David B. Humphrey, Bank Scale Economies, Mergers, Concentration, and Efficiency: the U.S Experience, *Revue Economique Financiere*, 27 (Winter 1993): This paper was translated into English by Wharton School, University of Pennsylvania.
11. *Ibid.*
12. See Allen N. Berger and David B. Humphrey, (1991), *ibid*, Allen N. Berger *et al., (1993), ibid., and* Allen N. Berger and David B. Humphrey (1993) *ibid.*
13. Allen N. Berger *et al. (1993), ibid.*
14. M. English, S. Grosskopf, K. Hayes, and S. Yaisawarng, 1993, output allocative and technical efficiency of banks, *Journal of Banking and Finance* 17, pp. 349-366.
15. Millind Sathye, 2000, X-efficiency in Australian banking: An empirical investigation, *Journal of Banking and Finance* 25, pp. 613-630.
16. Tai-Hsin Huang, 2000, Estimating X-efficiency in Taiwanese Banking Using a Translog Shadow Profit Function, *Journal of Productivity Analysis*, 14, pp. 225-245.
17. Mohamed E. Chaffai, Estimating input-specific technical inefficiency: The case of the Tunisian banking industry, European *Journal of Operational Research* 98 (1997) pp. 314-331.
18. Allen N. Berger and David B. Humphrey, Efficiency of financial: International Survey and directions for future research, European *Journal of Operational Research* 98 1997, pp. 175-212.
18. see Table 1 for more explanation.
19. Karlyn Mitchell and Nur M. Onvural, 1996, Economies of Scale and Scope at Large Commercial Banks: Evidence from the Fourier Flexible Functional Form, *Journal of Money, Credit and Banking*, Vol. 28, No. 2.pp.178-199.
20. Karlyn Mitchell and Nur M. Onvural, 1996, *ibid.*
21. Julapa J. and Anya K., 1996, Scale and Scope economies at large banks: Including off-balance sheet products and regulatory

effects (1984-1991), *Journal of Banking and Finance* 20, pp.1271-1287.

22. Jondrow, J. *et al*. 1982, On the Estimation of Technical Inefficiency in the stochastic Frontier Production Function Model, *Journal of Econometrics* 19, pp. 233-238.
23. The symmetry and linear homogeneity conditions imposed are $\Sigma^3_{j=1} \alpha_i = 1$, $\Sigma^3_{i=1} \gamma_{ij} i =$, $\Sigma^3_{j=1} \gamma_{ji} = 0$, $\Sigma^3_{j=1} \beta_{jy} = 0$
24. Applying Shephard's lemma to(6) $\Sigma^3_{j=1} \partial In\ C/\partial In = \Sigma^3_{j=1} x_i w_i / C = \Sigma^3_{j=1} S_{i=1} = 1$
26. $S_i = w_i x_i/TC$ Where $i = 1,2,3$
27. Jeffrey A. Clark (1996), *Journal of Money, Credit and Banking ibid.*
28. Sherrill Shaffer, 1993, Can mega mergers improve bank efficiency? *Journal of Banking and Finance* 17, pp. 423-436.

REFERENCES

Abdullah, N. & Elzahi, A. (2003). A decomposition analysis of the Sudanese Islamic Banks TFP growth into its source components, *Tafakkur* [Journal issued by Gazira University, Sudan (No. 2, Vol. 5)].

Allen, N.B. & David, B.H. (1991). The dominance of inefficiencies over scale and product mix economies in banking. *Journal of Monetary Economics,* 28.

Allen, N.B. & David, B.H. (1997). Efficiency of financial: international survey and directions for future research. *European Journal of Operational Research,* 98.

Allen, N.B., William, C.H. & Stephen, G.T. (1993). The efficiency of financial institutions: a review and preview of past, present, and future. *Journal of Banking and Finance,*17.

Bashir, A.H. (1999). Risk and profirability measures in Islamic banking: the case of two Sudanese banks. *Islamic Economic Studies,* 6 (2).

Elzahi, Abdelrhman. (2002). The X-efficiency of Sudanese Islamic banks, Unpublished doctoral dissertation, Kulliyah of Economics and Management Sciences, IIUM.

Farrel, M.J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society,* 120, 253-281.

McAllister, P.H. & McManus, D.A. (1993). Resolving the scale efficiency puzzle in banking. *Journal of Banking and Finance,* 17.

Mohamed, E.C. (1997). Estimating input-specific technical inefficiency: the case of the Tunisian banking industry. *European Journal of Operational Research,* 98.

Samad, A. (1999). Comparative efficiency of Islamic banks vs

conventional banks in Malaysia. *IIUM Journal of Economics and Management*, 7(1).
Sathye, M. (2000). X-efficiency in Australian banking: an empirical investigation. *Journal of Banking and Finance*, 25.
Tai-Hsin Huang (2000). Estimating X-efficiency in Taiwanese banking using a translog shadow Profit Function. *Journal of Productivity Analysis*, 14.