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The Cost, Profit and X-Efficiency of Islamic Banks

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1. Introduction

Islamic banking is a worldwide phenomenon involving a variety of institutions and Instruments. In the past few decades, Islamic institutions and instruments have developed in many countries. In certain countries—Iran and Sudan—all or most financial intermediation conforms to Islamic Shariah as defined by local authorities. All three of these countries also have banking authorities that govern the general level of charges and returns in the system and these are not usually market-governed systems. In most other countries, Islamic transactions and institutions make up a small part of the total and must compete with conventional financial institutions. Islamic instruments are simply a narrow group of familiar financing instruments.

During the last two decades, the Islamic banks have significantly expanded its network, and have been able to mobilize large amount of deposit, and promote many economic ventures. In addition, they have been playing major role in rendering social services to the generally ignored poverty stricken households from the banking services. Given the differential behavior of the Islamic banks from the traditional commercial banks and its involvement in both social and economic activities, there has always been question about the long run sustainability of the banks. The diversified involvement of the Islamic banks in social and economic activities indeed increases its operational costs, which many critics consider to be the major constraint for long run sustainability of this newly introduced profit sharing banking system.

This paper examines the cost, profit, revenue and X-efficiency of Islamic banks in the world. First, it employs a stochastic cost frontier approach to compute cost efficiency of a panel of Islamic banks over 1996-2003 period. Second, it employs profit efficiency which considers both cost and revenue simultaneously to examine profit efficiency. Third, it employs revenue efficiency model to ascertain whether Islamic banks are innovating products to enhance their revenue. Fourth, it employs a nonparametric data envelopment analysis (DEA), to calculate the overall, technical, pure technical, allocative and scale efficiencies. While technical inefficiency is caused and correctable by the management, allocative inefficiency is caused by regulation and may not be controlled by the management. Finally, applying a Malmquist DEA method to the panel data over time, Malmquist total factor productivity (TFP) indices are calculated. These indices will help us to examine the productivity improvement of Islamic banks over time in these countries. The results of this study will allow us to examine what factors are important in improving cost-efficiency of Islamic banks, and under what conditions such institutions are sustainable.

The long run sustainability of any bank regardless of the nature of the underlying banking philosophy, other things remaining constant, depends on the economic efficiency. A bank is economically efficient if it operates with both technical efficiency and price efficiency. A firm is said to be more technically efficient than another if it produces relatively larger output from the same set of inputs. A firm is price efficient if it maximizes profits i. e. equates the marginal value of product of each factor to its price. Such a study is important both from operational as well as academic point of view. First, such a study will exhibit the expansion potentials of Islamic bands in a mixed banking system. Second, it will have policy implications for Islamic banks and the banking system as how to improve cost efficiency. Third, it will suggest policy measures to improve price efficiency of the banking system of financial markets.

3. Literature Review

3.1. Parametric Frontier Studies:

With various econometric methods, economies of scale and scope of commercial banks operating in the U.S. have been extensively studied [Benston, Hanweck and Humphrey, 1982; Murray and White, 1983; Gilligan, Smirlock and Marshall, 1984; Kim, 1986; Berger, Hanweck and Humphrey, 1987; Shaffer, 1988, 1991; Clark, 1988; Hunter and Timme, 1986,1989; Hunter, Timme and Yang, 1990; Berger and Humphrey, 1991; Mester, 1987, 1992; Evanoff and Isrilevich, 1990; Noulas, Miller and Ray, 1990; 1993; Humphrey, 1990; Rezvanian, Elyasiani and Mehdian, 1996; Mehdian and Rezvanian, 1998]. These studies show that the average cost curve for banks is U shaped and economies of scale exist only for small banks. The findings of scope economies are, however, inconclusive. The cost structure of foreign banks has not been studied as extensively as that of the U.S. [Zardkoohi and Kolari (1990, 1994) for Finland; Dietsch (1993), Martin and Sassenou (1992) for France; Lang and Welzel (1994) for Germany; Rodriguez, Alvarez and Gomez (1993) for Spain; Drake and Weyman-Jones (1992) for United Kingdom; Hassan and Tufte (2000) for Bangladesh]. The findings of these studies generally show the presence of economies of scale only for financial institutions of small and medium size. The conclusions about scope economies are, however, inconclusive.

3.2. Non-Parametric Frontier Studies:

The nonparametric programming approach used in this paper to construct measures of overall, allocative and technical efficiency, and their changes over time is based upon the work of Farrell (1957) as well as extensions of it by Fare, Grosskopf and Lovell (1985) and Fare, Grosskopf, Norris and Zhang (1994). This methodology has been used in recent studies by Aly et. . al (1990), Rangan et. al (1988), Ferrier and Lovell (1990), and Elyasiani and Mehdian (1990, 1992, 1995), Sherman and Ladino (1995), Miller and Noulas (1986), Ferrier, Grosskopf, Hayes and Yaisawarng (1993), and Fixler and Zieschang (1993) for the U.S. banking industry. The same methodology has been used for banks in mainly industrial countries such as studies by Athanassopoulos (1995), Drake and Howcroft (1997), Drake and Weyman-Jones (1992) and Field (1990) for the U.K. banking industry; Lovell and Pastor (1997), Grifell-Tatje and Lovell (1997a,b) for the Spanish banking industry; Berg (1992), Berg, Forsund, and Jansen (1991) and Berg, Forsund, and Jansen (1992) for the Norwegian banking industry; Fukuyama (1993, 1995) for the Japanese banking industry; Favero and Papi (1995) for the Italian banking industry; Vassiloglou and Giokas (1990) for the Greek banking industry; Parkan (1987), and Schaffnit, Rosen, and Paradi (1997) for the Canadian banking industry. There are only a few papers written on the cost efficiency banks in the developing countries using the DEA method, such as Bhattacharya, Lovell and Sahay (1997) for India, Taylor, Thompson, Thrall, and Dharmapala (1997) for Mexico, Al-Faraj, Alidi, and Bu-Bshait (1993) for Saudi Arabia, Zaim (1995), Isik and Hassan (2000a,b) for Turkey. However, there is no DEA study, which deals with the Bahrain Banking sector. The results of all these studies reveal that, in general, banking firms experience an average efficiency of 77% and median of 82% (Berger and Humphrey, 1997), and these statistics are significantly different across countries.

The frontiers are constructed using cost, output, and input data for each bank. Linear programming techniques allow for the construction of best practice cost and production frontiers from these data and the performance of a particular branch is then judged relative to this frontier. The specific efficiency measures calculated can be given fairly simple interpretations. The technical efficiency measure gives the proportional reduction in input usage, which could have been achieved if the firm operated on the production frontier. The technical efficiency can be decomposed into the proportional reduction in input usage if inputs were not wasted (pure technical efficiency) and that reduction if there existed constant returns to scale (scale efficiency). As such, pure technical inefficiency reflects excess input levels for a given level of output. This inefficiency may be sustainable if competitive forces are weak. This inefficiency is unique in that it is caused by and correctable by management. From the society's standpoint, firms that operate at constant returns to scale represent the socially efficient level of operation. Therefore, choosing non-constant scale of operation also constitutes inefficiency.

The allocative efficiency measure gives the proportional reduction in costs if the optimal combination of inputs had been utilized. As such, allocative inefficiency reflects suboptimal proportions of factor inputs. Management cannot correct this inefficiency to the extent that it is due to regulation, such as the need to substitute service for interest payments on demand deposits. Overall efficiency measures the proportional reduction in costs which could have been achieved if firms had been both allocatively and technically efficient. The Malmquist-DEA technique allows us to decompose total factor productivity into changes in technical efficiency over time and shifts in technology over time. Improvements in technical efficiency change are considered to be evidence of moving close to the efficient frontier over time, whereas improvements in technological change are considered to be evidence of innovation.

4. The Efficiency Methodology

While analyzing the performance of production units, researchers should decide on which economic efficiency concept to use. Actually, this basic decision is mostly dependent upon the purpose of the study or the question being investigated. There are two main efficiency concepts, cost and profit efficiencies, which are widely used in the literature. (See Isik and Hassan, 2001, 2002, 2003)[1]

4.1. Parametric cost efficiency

Cost efficiency is defined as a measure of how far a bank's cost is from the best practice bank's cost if they were to produce the same output under the same environmental conditions. One can obtain the cost efficiency of a bank by employing either a nonparametric or parametric approach. Nonparametric (non-stochastic) cost efficiency is calculated by employing linear mathematical programming techniques. Whereas, parametric (stochastic) cost efficiency is derived from a cost function in which variable costs depend on the input prices, quantities of variable outputs, random error, and inefficiency. Duality theory maintains that under certain conditions (e.g.; exogenous prices and optimal behavior of the producer), the properties of the production function (e.g.; scale and scope economies, i.e., sub-additivity) can be inferred indirectly either by utilizing cost or profit functions. Accordingly, Aigner et al. (1977) and Meeusen and Broeck (1977) define a firm's cost function as follows:

$$C_b = C(y_i, p_k, \varepsilon_b), \qquad b = 1, \ldots, n \qquad (1)$$

where, C_b stands for the bank's total operational costs, y_i represents the vector of quantities of the bank's variable outputs, p_k is the vector of prices of the bank's variable inputs, and ε_b is a composite error term, through which the cost function varies stochastically. The cost function provides an indirect representation of the feasible technology because it is mainly a specification for the minimum cost of producing the output vector, y, given the cost drivers, such as price vector, p, in the input market, managerial inefficiency, some exogenous economic factors, or just pure luck.

[1] Although revenue efficiency can be added to the list, although measuring virtually the same thing, profit efficiency is conceptually superior to revenue efficiency in reflecting the goal of the production units. Thus, addition of the revenue efficiency could be redundant.

The term ε_b can be partitioned into two parts as follows:

$$\boldsymbol{\varepsilon_b = u_b + e_b} \tag{2}$$

where, u_b refers to endogenous factors and e_b refers to exogenous factors, which impact the cost of the bank production. Thus the term u_b denotes a rise in the cost of bank production due to the inefficiency factor that may result from the mistakes of the management, such as non-optimal employment of the quantity or mix of inputs given their prices. Whereas, e_b represents a temporary rise or fall in the bank's costs due to the random factor that may stem from a data / measurement error, or unexpected / uncontrollable factors such as weather, luck, labor strikes, war, etc., that are not under the influence of the management.

To facilitate the measurement, u_b and e_b are assumed to be multiplicatively separable from the rest of the cost function and both sides of the equation (1) are represented in natural logs:

$$\boldsymbol{lnC_b = f(y_i, p_k) + \overbrace{ln u_b + ln e_b}^{\varepsilon_b}} \tag{3}$$

where, f is a functional form and $\varepsilon_b = ln\ u_b + ln\ e_b$ is the composite error term. Parametric and non-parametric efficiency techniques differ in how they disentangle the composed error term, ε_b. Non-parametric techniques assume that there is no error and attribute any deviation from the best practice bank's cost as inefficiency. Whereas parametric techniques assume that the inefficiencies follow an asymmetric distribution, mostly the half-normal, and random errors follow a symmetric distribution, mostly the standard normal. In other words, random factors, e_b, are assumed to be identically distributed as normal variates and the value of the error term in the cost function is equal to zero on the average. Thus, inefficiency scores are derived from a normal distribution, $\boldsymbol{N(0, \sigma_u^2)}$, but truncated below zero. The underlying reason for the truncated normal distribution assumption is that inefficiencies cannot be negative.

According to Jondrow et al. (1982), the relative efficiency of a firm can be estimated by means of the ratio, $\lambda = \dfrac{\sigma_u}{\sigma_e}$. If the inefficiency factor, which is under the control of management, dominates the random factor, which is beyond the control of management, the λ, attains large values. The u_b, inefficiency measure, of a firm can be formulated as follows:

$$\boldsymbol{u_b = [\sigma\lambda / (1 + \lambda^2)][-\phi(\varepsilon_b\lambda / \sigma) / \Phi(\varepsilon_b\lambda / \sigma) + (\varepsilon_b\lambda / \sigma)]} \tag{4}$$

where, $\sigma = [\sigma_u + \sigma_e]^2$, ϕ is the standard normal density function, Φ is the cumulative normal density function, and the rest of the terms are as defined above.

We first need to specify a relationship (function) between bank production and bank cost in order to estimate the inefficiency, u_b, and random, e_b, factors of the composite error term, ε_b. To that end, we specify banks as multi-product and multi-input firms and estimate the following translog cost function:

$$\begin{aligned} lnC_b = \alpha_0 + \sum_i^4 \beta_i \ln y_i + \frac{1}{2}\sum_i^4\sum_j^4 \beta_{ij} \ln y_i \ln y_j + \sum_k^3 \gamma_k \ln p_k \\ + \frac{1}{2}\sum_l^3\sum_m^3 \gamma_{lm} \ln p_l \ln p_m + \sum_i^4\sum_k^3 \rho_{ik} \ln y_i \ln p_k + \varepsilon_b \end{aligned} \quad (5)$$

where, *ln* is natural logarithm, C_b is the *b*'th bank's total (interest and noninterest) costs; y_i is the *i*'th output; *p* is the *k*'th input price, and ε_b is the composite error term. Cost and prices are written using p_2 (price of physical capital) as numeraire. Cost efficiency score attains values over (0,1]. A score of 0.6 for a bank implies that it is 60% cost efficient, or stated differently, it wastes 40% of its costs relative to a bank on the frontier facing similar conditions. Therefore, 1 refers to the best practice while 0 refers to the worst practice observed in the sample.

4.2. Alternative (non-standard) profit efficiency

DeYoung and Nolle (1996) indicate that cost-based models might misrepresent the nature and the extent of inefficiency in banks. For instance, banks might create more revenue by increasing costs. Thus, revenue efficiency might lead to cost inefficiency. If revenue efficiency overcomes cost inefficiency, banks will be more profitable. Berger and Mester (1999) and Berger DeYoung (2002) recommend profit maximization is superior to cost minimization for the study of firm performance because the profit function more completely addresses the economic goals of firms and their owners, who take revenue into account as well as costs. Profit efficiency is based on the economic goal of profit maximization, which requires the same amount of managerial attention to raise a managerial dollar of revenues as to reduce a managerial dollar of costs. Thus, profit efficiency may better capture the sources of efficiency gains, if any, associated with bank mergers.

There are two ways to estimate the profit efficiency; standard profit function and alternative profit function. Alternative profit efficiency measures how close a bank is to generating maximum profits given its output levels instead of output prices, unlike the standard profit efficiency concept. While the standard function is specified in terms of input prices and output prices, the alternative profit function is specified in terms of input prices and output quantities. Alternative profit efficiency is derived from a profit function with the same right-hand-side variable as the cost function and is estimated using the same functional form. As indicated by Berger and Mester (1997, 1999), alternative profit efficiency is particularly closer to reality when some of the standard assumptions of perfect markets do not hold.[2] They compare the two approaches and conclude that the alternative profit function is the better measurement. Berger and Mester (1997) report four conditions that alternative profit efficiency may provide better information. They are (i) substantial unmeasured differences in the quality of banking services, (ii) banks cannot achieve every output scale and product mix, (iii) output markets are not perfectly competitive, and (iv) output prices are not accurately measured. Since we estimate the efficiency for merging banks and for a relevant peer group of non-merging banks in the U.S, substantial differences in the bank's service quality exist. Not all banks can achieve every output scale and product mix. Under the regulation in the banking industry, we cannot say that the output markets are perfectly competitive. Output prices are not available to all sizes of the banks. Therefore, only alternative profit efficiency is estimated in this study.

More recently, Berger and DeYoung (2002) employ alternative profit function rather than the standard profit function to test the effects of geographic expansion on bank efficiency because of the data availability and better bank profit explanation. They report that output prices are difficult to measure accurately for banks, and because of output quantities are relatively fixed in the short-run and cannot respond quickly to changing prices as is assumed in the standard profit function, vary across banks more output prices and thus better explain differences in bank profits. In this study, we conduct the test by using the SFA approach to evaluate whether and how much bank mergers affect cost efficiency and profit efficiency. The type of profit efficiency method employed in this study is the alternative profit function.

In log form, alternative profit function can be written as follows:

$$\ln(\pi + a) = \ln C(Y, P, t, \beta) + u_\pi + v_\pi \tag{6}$$

Indeed, the alternative profit function employs the same independent variables as the cost function, as shown below:

$$\ln(\pi + a) = \alpha_0 + \sum_{i=1}^{4}\alpha_i \ln Y_{ist} + \sum_{i=1}^{3}\beta_i \ln P_{ist} + \frac{1}{2}\sum_{i=1}^{4}\sum_{j=1}^{4}\sigma_{ij} \ln Y_{ist} \ln Y_{jst} +$$

$$\frac{1}{2}\sum_{k=1}^{3}\sum_{l=1}^{3}\delta_{kl} \ln P_{kst} \ln P_{lst} + \sum_{k=1}^{3}\sum_{i=1}^{4}\mu_{ki} \ln P_{kst} \ln Y_{ist} + v_{st} + u_{st} \tag{7}$$

where, π represents net profits of the bank *b*; a is a constant added to the profits of each bank so that natural log is taken of a positive number since minimum profits are typically negative; and all other variables are as explained previously in the equation (3). Profit efficiency measures how close a bank is generating maximum profits given its output levels. A 70% profit efficiency score for a bank

[2] In the case of banking sector, whenever the assumption of perfect competition in pricing is questionable, or when there are differences of production quality among the banks in the sample.

suggests that it would earn about 30% more profits than what it is making now if it were operating on the efficient frontier.

4.3. The measure of the efficiency and productivity

The study of the efficient frontier began with Farrell (1957) who defined a simple measure of firm efficiency that could account for multiples inputs. He proposed that efficiency of any firm consist of two components: *technical efficiency* –the ability of the firm to maximize outputs from the given set of inputs– and *allocative efficiency* –the ability of the firm to use theses inputs in optimal proportion given their respective prices–. Combining these two measures provides a measure of productive efficiency.

Farrell illustrated his ideas using a simple example involving firms that use two inputs (x_1 and x_2) to produce a single output (y). If the isoquant of the benchmark efficient firm is known, the efficiency of any firm can be calculated. In Figure 1 the isoquant is represented by SS´. If a firm uses quantities of inputs defined by P to produce the output, the *technical inefficiency* is given by distance QP, which is the amount by which all inputs could be reduced without a reduction in outputs. This can be measured in percentage terms as QP/OP. Therefore the *technical efficiency* (TE) of the firm operating at P is measured by the ratio OQ/OP. A value of one in this ratio means that the firm is technically efficient.

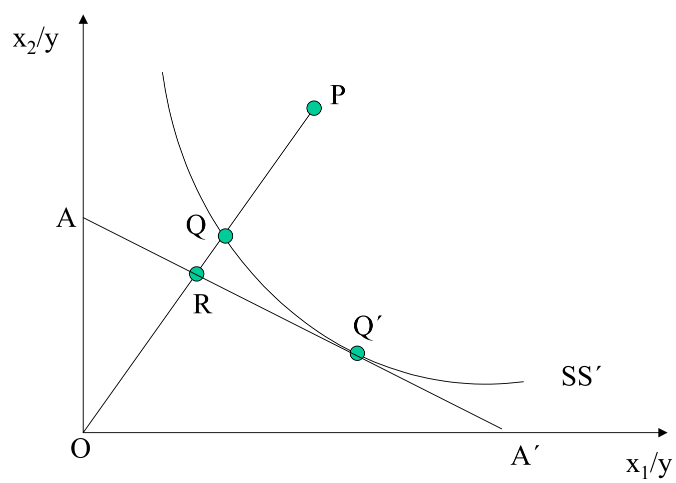

Figure 1. Technical and Allocative Efficiency

Source: Coelli (1996)

If the input price ratio is also known, the *allocative efficiency* may also be calculated. The allocative efficiency of the firm operating at P is the ratio OR/OQ, where RQ represents the reduction of the production costs that would occurs at the allocatively (and technically) efficient point Q´, instead of the allocatively inefficient point Q. Finally the *overall efficiency* (EE) is the ratio OR/OP, where RP is reduction of cost if firm at P moves to R (that it is technically impossible because is under the isoquant).

These efficiency measures assume that a production function of a benchmark efficient firm is know, but it is really unknown and therefore, it has to be estimated from a sample data. There are two approaches to approximate that production function: the parametric approach and the non-parametric approach. These approaches use different techniques to envelop the observed data and make different accommodations for random noise and for the flexibility in the structure of the production technology.

On one hand, the parametric (or econometric) approach specifies a production function and recognizes that deviation away from this given technology is given by two components, one represents statistical noises and the other inefficiency. The random term is due to events outside the control of the firm, e.g. uncontrollable factors directly related with the production function, or econometric error as misspecification of the production function or measure errors. This has led to the development of the "Stochastic Frontier Approach" (SFA), which seeks to take into account the external factors when estimating the efficiency of the firms.

On the other hand, the non-parametric approach does not require a production function to calculate the efficiency. It attempts to determinate the absolute economy efficient of the firm against some imposed benchmark trough mathematical programming. The most common version of this approach is Data Envelopment Analysis (DEA).

The advantage of the non-parametric approach, specifically DEA, is important in the studies of the efficiency in developing countries. In most of them, it is very difficult to obtain the input prices due to unavailability of data information (price data is necessary in order to perform econometric approach). Essentiality for that reason, this study uses the non-parametric approach to investigate the change in the productivity of the banks.

4.3.1. Data Envelopment Analysis

DEA is a linear programming technique that allows calculating relative efficiency of a business unit. DEA was developed by Charnes, Cooper and Rhodes (1978) in order to measure relative efficiency without knowing (*a priori)* what variables are more important, or what their relationship is.

Let's consider we want to evaluate *n* DMUs (decision making unit)[3], each one producing different outputs (**y**) and using different inputs (**x**). The efficiency of the DMU k (E_k) assuming constant return scale (CRS), is measured as follows:

$\text{Max}_{u,\, v}\ (\mathbf{u'y_i} / \mathbf{v'x_i})$ (1)

Subject to

$\mathbf{u'y_j} / \mathbf{v'x_j} \leq \mathbf{1}$ $\quad j = 1, 2, \ldots\ldots, N$

$\mathbf{u, v} > \square > \mathbf{0}$

Where:

- **x** is a vector of DMU inputs.
- **y** is a vector of DMU outputs given the inputs.
- **u** is the weighted relative vector associated to output
- **v** is the weighted relative vector associated to input.
- □ is a small positive number. (□ → 0)

The original mathematical formulation is not linear. To avoid it, one can impose the constrain $\mathbf{v'x} = 1$, which provides:

$$\text{Max}_{u,\, v}\ (\mathbf{u'y}_i) \qquad (2)$$

$$\text{st} \quad \mathbf{v'x}_i = 1,$$
$$\mathbf{u'y}_j - \mathbf{v'x}_j \leq 0,\ j = 1, \ldots. N$$
$$\mathbf{u, v} > 0$$

The dual form of the above problem as more used in the literature is:

$$\min_{\square,\square}\ \square \qquad (3)$$

$$\text{st} \quad -y_i + Y\square \geq 0$$
$$\square xi - X\square \geq 0$$
$$\square \geq 0$$

where X is m * n input matrix, Y s * n output matrix, □ is an n * 1 vector of constant and □ is a scalar.

Imperfect competition, constrain in finance, etc. may cause a DMU to be not operating at optimal scale, in this case the CRS assumption is not appropriate because it assumes that DMUs are

[3] Charnes, Cooper and Rhodes used the term DMU (decision making unit) because DEA can be used not only to measure efficiency of firms but also braches within a firm.

operating at optimal scale. If the CRS model is used when not all DMUs are operating at optimal level, the *technical efficiency* is confounded with *scale efficiency*. Banker, Charnes and Cooper (1984) suggested an extension of the above model to take into account the variable return to scale (VRS). They proposed to add the convexity constrain **1′**□ = 1 to the early model.

The technical efficiency obtained by CRS DEA model can be decomposed in two parts, one due to *scale efficiency,* and one due to *pure technical efficiency*. *Pure technical efficiency* refers to the firm's ability to avoid waste by producing as much output as input usage allows, or by using as little input as output production allows. Scale efficiency refers to the firm's ability to work at its optimal scale. It can be proved that:

$$TE_{CRS} = TE_{VRS} * SE \qquad (4)$$

Where TE_{CRS} is the technical efficiency, TE_{VRS} is the pure technical efficiency, and SE is the scale efficiency.

4.3.2. The Malmquist Productivity Index

In the presence of panel data, we can use DEA to calculate Malmquist index to measure productivity change and it can be decomposed in technological change and efficiency change. Caves et al. (1982) used developed a productivity index and used the concept of distance functions in Mailmquist's proportional scaling definition, without realizing the direct connection with Farrell efficiency measure (Fare et al., 1985). Fare et al. (1985) specify an output-based Malmquist productivity change index as:

$$M_0^{t+1}(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^t, y^t)} \right]^{1/2} \qquad (5)$$

This productivity index is the geometric mean of a pair of ratios of output distance function. The first ratio compares the performance of the data from period t to t +1 relative to production possibilities existing in period t, and the second compares the performance of the same data relative to production possibilities in period t+1.

The foregoing productivity index may be interpreted as an index of *total factor productivity*. It takes into account if firms are using the resources efficiently to produce goods and services, and if they are using the existing technology to produce goods and services. Values greater than one means increases in productivity, while values less than one indicate decreases in productivity over time.

Farrell et al (1992) decomposed this index into sub indexes measuring changes in efficiency and changes in technology:

$$M_0^{t+1}(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \left[\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})} \frac{D_0^{t+1}(x^t, y^t)}{D_0^{t+1}(x^t, y^t)} \right]^{1/2} \quad (6)$$

The first term of the equation is the change in technical efficiency; and the second term is the change in technology. Values greater than one means increases in output technical efficiency, values less than one means decrease and a value of one indicates no change. The second term is the technological change.

Färer at al. (1994) further decomposed the Malmquist index by rewriting equation (6) as:

$$\begin{aligned} M_0^{t+1}(x^{t+1}, y^{t+1}, x^t, y^t) = {} & \underbrace{\left[\frac{\Delta_0^{t+1}(x^{t+1}, y^{t+1}) / D_0^{t+1}(x^{t+1}, y^{t+1})}{\Delta_0^t(x^t, y^t) / D_0^t(x^t, y^t)} \right]}_{\Delta \text{ Scale Eff.}} \\ & * \underbrace{\left[\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})} * \frac{D_0^t(x^t, y^t)}{D_0^{t+1}(x^t, y^t)} \right]^{1/2}}_{\Delta \text{ Pure Tech. Eff.}} \qquad (7) \\ & * \underbrace{\left[\frac{\Delta_0^{t+1}(x^{t+1}, y^{t+1}) / D_0^t(x^{t+1}, y^{t+1})}{\Delta_0^{t+1}(x^{t+1}, y^{t+1}) / D_0^{t+1}(x^{t+1}, y^{t+1})} * \frac{\Delta_0^t(x^t, y^t) / D_0^t(x^t, y^t)}{\Delta_0^{t+1}(x^t, y^t) / D_0^{t+1}(x^t, y^t)} \right]^{1/2}}_{\Delta \text{ Technology}} \end{aligned}$$

Where □ Pure Tech. Eff. X □ Scale Eff. = □ Efficiency. Färe et al. refers the first term as a measure of change in scale efficiency and the second term as a measure of pure efficiency change. The last term is unchanged and it gives a measure of change in technology.

Any change in scale efficiency may be caused either by (i) changes in the shape of the technology, (ii) change in the location of the bank in the input/output space between t1 and t2, or a combination of (i) and (ii). Additionally, any change in the pure technical efficiency is caused by a movement of the bank relative to the existing technology. For each distance function is necessary to solve a DEA-VRS model.

5. Data and Definitions of Variables

To determine what constitutes inputs and outputs of banks, thus, one first should decide on the nature of banking technology. In the literature on the theory of banking, there are two main approaches competing with each other in this regard, production and intermediation approach (Sealey and Lindley, 1977). Like many studies on banking efficiency (Isik and Hassan, 2001, 2002 and 2003 and among others), we adopt intermediation approach in this paper[4]. Accordingly, we model Islamic banks as multi-product *firms,* producing three outputs employing three inputs. All variables except for the input factor labor are measured in millions of U.S. dollars. The input vectors include (1) labor, (2) fixed capital, and (3) customer and short-term funding funds. We measure the labor by staff costs, capital by cots on premises and fixed assets, and customer and short-term funds by the sum of deposit (demand and time) and non-deposit funds as of the end of the respective year.[5] Hence the total costs include both non-interest expenses and fees and operating costs and are proxied by the sum of labor, capital and customer and short-term fund expenditures. Obviously, all *input p*rices are calculated as flows over the year divided by these stocks: (1) price of labor is measured as total expenditures on employees such as salaries, employee benefits and reserves for retirement pay divided by customer and short-term funding, (2) price of capital is measured as total expenditures on premises and fixed assets divided by customer and short-term funds, and (3) price of customer and short-term funding is calculated as total interest expenses on deposit and non-deposit funds divided by customer and short-term funding. On the other hand, the *output vector* includes (1) total loan (2) other earning assets and (3) Off-balance sheet items.

The data used in this study are cross-country bank-level data, compiled from income statements and balance sheets of 43 Islamic banks in 21 countries for each year in the 1994-2001 period. Table 1 gives the country-wise and year-wise breakdown of these Islamic banks. The input and output variables are defined in Table 1 and their descriptive statistics year-wise are provided in Table 2. The main data source is BankScope database compiled by IBCA. In so far as possible, the BankScope database converts the data to common international standards to facilitate comparisons. Other data sources include International Monetary Fund's International Financial Statistics (IFS), world Development Indicator (2001), and Global Development Finance (2001).

6. Analysis of Results

DEA analysis

Table 4 reports sample statistics of the various efficiency scores of Islamic banks for the fiscal years 1995 (Panel 4.A), 1996 (Panel 4.B), 1997 (Panel 4.C), 1998 (Panel 4.D), 1999 (Panel 4.E), 2000 (Panel 4.F), 2001 (Panel 4.G), and overall (Panel 4.H). These results suggest that there is a downtrend in the cost efficiency of Islamic banks. The cost efficiency (inefficiency) was 91.7% (9%) in 1995,

[4] Humphrey (1985) presents an extended discussion of the alternative approaches over what a bank produces.

73.5% (36.1%) in 1996 and 1997.[6] This means that the average Islamic bank could have used only 91.7%, and 73.5% of the resources actually employed in 1995, 1996 and 1997, respectively, to produce the same level of output in these years. More evidently, while the average input waste was only 9% in 1995, it rose to 36.1% in 1995 and 1996. The 36.1% figure means that the average bank needed 36.1% more resources to produce the same output as the average efficient bank.[7]. Apparently, there was substantial room for significant cost savings if Islamic banks had utilized their productive inputs more efficiently. These inefficiency levels are notably higher than those typically estimated for developed countries. For example, Berger *et al*. (1993) report cost inefficiency at 20% for U.S. banks, and Altunbas *et al*. (1994) estimate it at about 5-10% for British banks. It is worth noting that cost efficiency decreased dramatically from 73.6% in 1997 to about 42% in 1998, 1999 and 2000. However, the cost efficiency climbed to 64.5% in 2001.

As the results in Panel I of Table 4 indicate, over the years under study, the average technical is about 84%, where the average allocative efficiency is is about 73%. Also, in each year, technical efficiency of Islamic banks is consistently higher than allocative over the estimation period. This finding suggests that the dominant source of cost inefficiency is allocative (regulatory) rather than technical (managerial). Moreover, these results imply that Islamic banks do a better job employing available inputs than choosing the proper input mix given the prices. Hence, overall inefficiency in Islamic banks may be attributed to choosing the incorrect input mix rather than wasting of resources.

Furthermore, the decomposition of total technical efficiency (TE) into its components reveals that scale inefficiency for Islamic banks is also persistently higher than pure technical inefficiency. Pure technical efficiency is simply technical efficiency devoid of scale effects, i.e., the difference between technical efficiency and pure technical efficiency represents the cost operating at an incorrect scale. The results show that scale inefficiency is about 13%, while pure technical inefficiency is about 5%, suggesting that the major source of total technical inefficiency for Islamic banks is scale inefficiency (output related) and not pure technical inefficiency (input related). This finding is consistent with results reported in some studies for other countries.[8]

Productivity Progress

Table 5 reports results from measuring productivity progress of Islamic banks. The results there indicate that these banks have experienced only 3% productivity growth over the sample period. It is worth mentioning that productivity changes reflect the product of changes in technical and

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[5] Non-deposits funds include borrowed funds from interbank, central bank, domestic banks, abroad and others as well as funds raised by issuing securities.

[6] The relation between efficiency (*E*) and inefficiency (*IE*) is *IE* = (1-*E*) / *E*. Thus, the 73.5% efficiency implies 36.1% inefficiency, not 26.5%.

[7] Bank operates on the frontier.

technological efficiency. According to our findings, Islamic banks have been able to achieve such productivity improvement from becoming more technologically advanced (2.4%), than from being more technically efficient (only .01%).

The results further suggest that Islamic banks have achieved productivity growth of 21% between 1998-1998, 6% between 1998-1999, and 12% between 2000 and 20001.On the other hand, those banks have registered productivity loss of 4% between 1995-1996, 21% between 1996-1997, and 10% between 1999-2000.

Correlation of efficiency measures with financial performance:

In order to complement the results of efficiency measures, we correlated various accounting measures of bank performance with various efficiency scores. ROA (Net Income/Total Assets), and ROE (Net Income/Total Equity). We calculated both rank-order Spearman correlation coefficients to examine the possible relationship among the X-efficiency measures and accounting measures of performance. The Spearman correlation coefficients are presented in Table 6. The null hypothesis is that correlation coefficient between two variables is zero. As the results indicate, the Spearman correlation coefficients are all significantly different from zero, indicating that there is a strong association among the X-efficiency measures and proxy measures of performance. Cost efficiency (CE) is highly positively and statistically significantly associated with other X-efficiency measures, namely, AE, TE, PTE, and SE ($\rho_{CE,AE}$=0.670, $\rho_{CE,TE}$=0.532, $\rho_{CE,PTE}$=0.427,$\rho_{CE,SE}$=0.329, respectively). TE is more related to SE than to PTE ($\rho_{TE,SE}$=0.702 versus $\rho_{TE,PTE}$=0.688*),* confirming the dominant effect of scale efficiency in determining the technical efficiency of the Islamic banks, which we stated earlier. Both ROA and ROE are positively and statistically significantly correlated with all five efficiency measures. Overall, the statistically and significantly different from zero correlation coefficients discussed above suggest that various measures of efficiency are strongly associated with conventional accounting measures of performance, i.e., they are robust and are not ‘meaningless’ artifacts of our sophisticated techniques.

Cost and Profit efficiency

Table 7 reports the stochastic cost and profit efficiency estimations of the Islamic banks for the years under study.[9] Table 8 presents estimates of cost and profit efficiency functions. The average cost and profit efficiency over the years studies are about 74% and 84%, respectively. This implies that during the period (1995-2001), Islamic banks would have needed only 74% of the resources they

[8] See Aly et al. (1990) for the US banking and Fukuyama (1993) for the Japanese banking).
[9] We convert the inefficiency scores (IE) into efficiency scores (E) by first taking the anti-logs of inefficiencies and then using the following transformation: E= 1/ (1+IE).

used to produce services they generated, while earning about 84% of their potential profits on average. It seems that Islamic banks are relatively better at generating profits than controlling costs. It is worth noting that Islamic banks have achieved higher profit efficiency level than other banking sectors in other countries. On average, profit efficiency is reported to be only 64% for U.S. banks (Berger and Humphrey, 1997) and 72% for Spanish banks (Lozano, 1995).

The inter-temporal comparison of the scores suggests that although cost efficiencies of the Islamic banks were practically stable between 1995 and 1997, they dramatically fell between 1997 and 2001. Results indicate that cost efficiency in 2001 is much less than those in 1995 and 1996. On the other hand, profit efficiencies were stable between 1995 and 2001.

Second-Stage Regression

In order to determine which factors can affect the efficiency scores, we examine some aspects of banks' structure is related to efficiency estimates. For this purpose, efficiency scores are regressed on a set of common explanatory variables. We use the following variables: banks size (measured by the value of total assets), profitability (measured by operating income to total assets) and the loan ratio (loan to total assets).

Table 9 reports the results of the regression estimation. It is important to note that dependent variables are the DEA efficiency scores. A positive coefficient implies efficiency increase whereas a negative coefficient means an association with an efficiency decline. The results suggest that bank size has significant positive influence efficiency, implying that larger banks tend to be more efficient. The positive sign o the ROA and ROE coefficients signals that higher efficiency is correlated with higher profitability. Consistent with Isik and Hassan (2000), our results suggest that the loan ratio exerts an insignificant impact upon all efficiency scores except with scale efficiency. loan ratio has a significant positive relation with scale efficiency, indicating that output mix is favorable influencing scale efficiency.

6. Summary and Concluding Remarks

The paper investigates relative efficiency of the Islamic banking industry in the world by employing a panel of banks during 1995-2001. Both parametric (cost and profit efficiency) and nonparametric (data envelopment analysis) techniques are used to examine efficiency of these banks. Five DEA efficiency measures such as cost, allocative, technical, pure technical and scale efficiency scores are calculated and have been correlated with conventional accounting measures of performance. The results show that, on the average, the Islamic banking industry is relatively less efficient compared to their conventional counterparts in other parts of the world. The results also show that all five efficiency measures are highly correlated with ROA and ROE, suggesting that these efficiency measures can be used concurrently with conventional accounting ratios in determining Islamic bank performance.

The average cost efficiency (stochastic cost frontier) is 74%, whereas the average profit efficiency (profit efficiency frontier) is 84%. Although Islamic banks are relatively less efficient in containing cost, they are relatively efficient in generating profit. The average allocative efficiency is 74%, whereas the average technical efficiency is about 84%. This means that the dominant source of inefficiency is due to allocative inefficiency rather than technical inefficiency. These results are consistent with the fact that the Islamic banks operate in overall regulatory environments which are not very supportive of their operations. Hassan (2003) found when Islamic banks operate in countries in countries such as Iran and Sudan where the entire banking system operate under Islamic Shariah, the banks become more allocatively efficient. Average scale efficiency is about 89%, and average pure technical efficiency is about 95%, suggesting that the major source of the total technical inefficiency for Islamic banks is not pure technical inefficiency (input related) but scale inefficiency (output related). Our results indicate that there has been moderate increase in productivity growth over the years. Productivity increase in Islamic banking industry is mainly driven by technological change (opening up and penetrating in other markets) not technical efficiency change (efforts of inefficient banks to catch up with the efficient ones). The results show that larger bank size and greater profitability are associated with higher efficiency. These results indirectly support the economies of scale arguments in Islamic banking industry. Most of the Islamic banks are of smaller size compared to the conventional counterparts. It is imperative that Islamic banks be allowed to merge to obtain an optimal size in order to be more technically efficient and compete with their conventional counterparts.

The information obtained from efficiency studies can be used to help bank managers, government regulators and investors. Managerial performance can be improved by identifying "best practice" and "worst practice" associated with high and low efficiency firms, respectively. Success in competitive markets demands achieving the highest levels of performance through continuous improvement and learning. Frontier efficiency analyses can identify best practice banks and provide a numerical efficiency score and ranking for each bank that can be useful to policy makers, market analysts, and managers of competing banks.

Islamic banking emerged as a response to both religious and economic exigencies. While religious exigency calls for avoiding any transaction based on interest, economic exigencies, on the other hand, provide a new outlook to the role of banking in promoting investment/productive activities, influencing distribution of income and adding stability to the economy. Islamic banking is thus perceived as an improved system in all dimensions. However, in order to sustain in the long-run, the Islamic banking system has to be internally efficient and technologically advanced in order to compete with its conventional counterparts.

References

Al-Faraj, T.N., A.S. Alidi, K.A. Bu-Bshait, "Evaluation of Bank Branches by Means of Data Envelopment Analysis," International Journal of Operations and Production Management, 13 (1993): 45-52.

Ali, A.A., and L.M. Seiford, "The Mathematical Programming Approach to efficiency Analysis, in Fried, H.O., C.A.K. Lovell, and S.S. Schmidt, The Measurement of Productive Efficiency: Theory and Applications, New York, Oxford University Press, 1993, pp. 120-160.

Aly, Hassan Y., Richard Grabowski, Carl Pasurka, and Nanda Rangan,"Technical, Scale, and Allocative Efficiencies in U.S. Banking: an Empirical investigation", The Review of Economics and Statistics, 72, 1990, pp.211-218.

Athanassopoulos, A.D. "Service Quality and Operating Efficiency Synergies for Management Control in the Provision of Financial Services," European Journal of Operational Research, 1997.

Bauer, P.W., A.N. Berger and D.B. Humphrey, "Efficiency and Productivity Growth in U.S. Banking", in H.O. Fried. C.A.K. Lovell and S.S. Schmidt, eds., The Measurement of Productive Efficiency: Techniques and Applications, Oxford University Press, Oxford 1993, pp.386-413.

Berg, S.A., F. Forsund and E. Jansen," Technical Efficiency of Norwegian Banks: a Nonparametric Approach to Efficiency Measurement", Journal of Productivity Analysis 2, 1991, pp.127-142.

Berger, A.N., W.C. Hunter, and S.G. Timme, "The Efficiency of Financial Institutions: a Review and Preview of Research Past, Present, and Future", Journal of Banking and Finance, vol. 17, No.2-3, April 1993, pp.221-250.

Bhattacharya, A., C.A.K. Lovell, and P. Sahay. "The Impact of Liberalization on the Productive Efficiency of Indian Commercial Banks," European Journal of Operations Research, 1997.

Chaffai, M. "Estimating Input-Specific Technical Inefficiency: The Case of the Tunisian Banking Industry," European Journal of Operational Research, 1997.

Charnes, A., W.W. Cooper, Z.M. Huang, and D.B. Sun," Polyhedral Cone-Ratio Dea Models with an Illustrative Application to Large Commercial Banks," Journal of Econometrics 46, 1990, pp.73-91.

Drake, L., and B. Howcroft. "A Study of the Relative Efficiency in U.K. Building Societies," Journal of Banking and Finance, (Forthcoming).

Drake, L. and T. Weyman-Jones, "Technical and Scale Efficiency in U.K. Building Societies," Applied Financial Economics, 2(1992): 1-9.

Elyasiani, E., and Seyed M. Mehdian,"A Nonparametric Approach to Measurement of Efficiency and Technological Change: The Case of Large U.S. Commercial Banks", Journal of Financial Services Research, July 1990a, pp. 157-68.

Elyasiani, E. and S.M. Mehdian, "Productive Efficiency Performance of Minority and Non-Minority-Owned Banks: A Nonparametric Approach," Journal of Banking and Finance, 16(1992): 933-48.

Elyasiani, E. and S. M. Mehdian, "The Comparative Efficiency Performance of Small and Large U.S. Commercial Banks in the Pre- and Post-Deregulation Eras," Applied Economics, 27 (November 1995): 1069-79.

Elyasiani, E., S.M. Mehdian, and R. Rezvanian, "An Empirical Test of Association between Production and Financial Performance," Applied Financial Economics, 4 (1994): 55-9.

Evanoff, Douglas D., and Philip R. Israilevich,"Relative Efficiency, Technical Change, and Economies of Scale for Large Commercial Banks", Journal of Regulatory Economics, 2, 1990, pp. 281-298.

Färe, R.J., and Shawna Grosskopf, and C.A. Knox Lovell, The Measurement of Efficiency of Production, Boston, Kluwer Academic Publishers, 1985.

Farrell, M.J.,"The Measurement of Productive Efficiency", Journal of the Royal Statistical Society, A 120, 1957, 253-281.

Favero, C. and L. Papi, "Technical Efficiency and Scale Efficiency in the Italian Banking Sector: A Nonparametric Approach," Applied Economics, 27 (1995): 385-95.

Ferrier, G.D. and C.A.K. Lovell, Measuring Cost Efficiency in Banking: Econometric and Linear Programming Evidence, Journal of Econometrics 46, 1990, pp.229-245.

Ferrier, G.D., S. Grosskopf, K. Hayes and S. Yaisawarng,"Economies of Diversification in the Banking Industry: A Frontier Approach", Journal of Monetary Economics, 31 (1993): 229-49.

Fried, H.O., C.A.K. Lovell, and S.S. Schmidt, eds. The Measurement of Productive Efficiency: Techniques and Applications, New York, Oxford University Press, 1993.

Field, K. "Production Efficiency of British Building Societies," Applied Economics, 22 (1990): 415-26.

Fixler, D. and K. Zeischang, "An Index Number Approach to Measuring Bank Efficiency: An Application to Mergers," Journal of Banking and Finance, 17(1993): 437-50.

Fukuyama, H. "Technical and Scale Efficiency of Japanese Commercial Banks: A Nonparametric Approach," Applied Economics, 25 (1993): 1101-12.

Fukuyama, H., "Measuring Efficiency and Productivity Growth in Japanese Banking: A Nonparametric Frontier Approach," Applied Financial Economics, 5(1995): 95-117.

Grifell-Tatje, E. and C.A.K. Lovell, "The Sources of Productivity Change in Spanish Banking," European Journal of Operational Research (1997).

Grifell-Tatje, E. and C.A.K. Lovell, "Deregulation and Productivity Decline: The Case of Spanish Savings Banks," European Economic Review (Forthcoming). (1997).

Hassan, M. Kabir, Abdus Samad and Adel Al-Sharkas. "An Empirical Study of Relative Efficiency of the Banking Industry in Bahrain," 2003. Studies in Economics and Finance (Under Review).

Hassan, M. Kabir, Abdus Samad and Mazhar M. Islam. "The Performance Evaluation of the Bahraini Banking System," University of New Orleans Working Paper 2003.

Hassan, M. Kabir and David R. Tufte. "The X-Efficiency of a Group-Based Lending Institution: The Case of Grameen Bank," World Development, Volume 29, Number 6, June 2001: 1071-1082.

Hassan, M. Kabir. "Islamic Banking in Theory and Practice: The Experience of Bangladesh," Managerial Finance. (Published from the U.K) Volume 25, Number 5, 1999: 60-113.

Isik, Ihsan and M. Kabir Hassan, "Technical, Scale and Allocative Efficiencies of Turkish Banking Industry," Journal of Banking and Finance, Volume 26, Number 4, 2002: 719-766.

Isik, Ihsan and M. Kabir Hassan. "Cost and Profit Efficiency of the Turkish Banking Industry: An Empirical Investigation," The Financial Review, Volume 37, Number 2, May 2002: 257-280.

Isik, Ihsan and and M. Kabir Hassan. "Financial disruption and bank productivity: The 1994 experience of Turkish banks" Quarterly Review of Economics and Finance, Volume 43, No. 2, Summer 2003.

Isik, Ihsan and M. Kabir Hassan. "Financial Deregulation and Total Factor Productivity Change: An Empirical Study of Turkish Commercial Banks," 2003, Journal of Banking and Finance.

Ihsan Isik and M. Kabir Hassan, "Governance, Corporate Control and Efficiency of the Turkish Banking Industry" Journal of Business Finance and Accounting, (Forthcoming).

Hermalin, B.E. and N.E. Wallace, "The Determinants of Efficiency and Solvency in Savings and Loans," Rand Journal of Economics, 25 (Autumn 1994): 361-81.

Lovell, C.A.,"Production Frontiers and Productive Efficiency", in Fried, H.O., C.A.K. Lovell, and S.S. Schmidt, The Measurement of Productive Efficiency: Techniques and Applications, New York: Oxford University Press, 1993, pp.3-67.

Miller, S.M. and A. G. Noulas, "The Technical Efficiency of Large Bank Production," Journal of Banking and Finance," 20 (April 1996): 495-509.

Parkan, C. "Measuring the Efficiency of Service Operation: An Application to Bank Branches", Engineering Costs and Production Economics 12 (1987): 237-242.

Samad, Abdus and M. Kabir Hassan. "The Performance of Malaysian Islamic Bank During 1984-1997: An Exploratory Study," Thoughts on Economics, Volume 10, Number 1-2, January-June, 2000: 7-26.

Schaffnit, C., D. Rosen, and J.C. Paradi, "Best Practice Analysis of Bank Branches: An Application of DEA in a Large Canadian Bank," European Journal of Operational Research, (1997).

Sealey, C. and James T. Lindley, "Inputs, Outputs, and a Theory of Production Cost a Depository Financial Institutions", Journal of Finance 32, September 1977, 1251-66.

Seiford, L.M., and R.M. Thrall," Recent Development in DEA: The Mathematical Programming Approach to Frontier Analysis", Journal of Econometrics 46, 1990, pp.7-38.

Sherman, H.D. and F.Gold, "Bank Branch Operating Efficiency: Evaluation with Data Envelopment Analysis", Journal of Banking and Finance 9 (1985): 297-315.

Taylor, W.M., R.G. Thompson, R.M. Thrall, and P.S. Dharmapala, "DEA/AR Efficiency and Probability of Mexican Banks: A Total Income Model," European Journal of Operational Research (1997).

Thompson, R.G., P.S. Dharmapala, J. Diaz, M.D. Gonzalez-Lima, and R.M. Thrall,' DEA/AR Profit-Ratios and Sensitivity of 100 Largest U.S. Commercial Banks," European Journal of Operational Research (1997).

Tarek Zaher and M. Kabir Hassan. "A Comparative Literature Survey of Islamic Finance and Banking," Financial Markets, Institutions and Instruments, Volume 10, Number 4, 2001: 155-199.

Zaim, O. "The Effect of Financial Liberalization on the Efficiency of Turkish Commercial Banks," Applied Financial Economics, 5 (1995): 257-64.

Table 1: Number of Banks by Country and By Year

Country \ Year	1993	1994	1995	1996	1997	1998	1999	2000	2001
ALGERIA			1	1	1	1	1	1	1
BAHAMAS						1	1	1	1
BAHRAIN		3	3	3	4	5	5	4	4
BANGLADESH		1	1	1	1	1	1	1	2
BRUNEI DARUSSALAM	1	2	2	2	3	3	3	3	
EGYPT	1	1	2	2	2	2	2	2	1
GAMBIA					1	1	1	1	
INDONESIA				1	1	1	1	1	
IRAN	1	1	1		3	3	3	3	
JORDAN		1	1	1	1	2	2	2	2
KUWAIT		1	1	1	1	1	1	1	1
LEBANON	1	1	1	1	1	1	1		
MALAYSIA			2	2	2	3	3	3	3
MAURITANIA						1	1	1	
QATAR		1	2	2	2	2	2	2	2
SAUDI ARABIA		1	1	1	1	1	1	1	
SUDAN	1	2	2	3	3	3	3	1	1
TUNISIA	1	1	1	1	1	1	1	1	
UNITED ARAB EMIRATES		1	1	1	1	2	2	2	2
UNITED KINGDOM	1	1	1	1	1	1	1	1	
YEMEN				1	1	2	2	2	2
Total	**7**	**18**	**23**	**25**	**31**	**39**	**39**	**34**	**22**

Source: Bank Scope Data Base (2002)

Table 2: Variable Definitions banks' inputs and outputs for Islamic Banks

Variables	Description
Cost	Total cost (includes profit shares, Personnel expense, Commission expense, Fee expense, Trading expense, other operating expense) (US$).
P1	Price of funds (%) (total non-interest expenses/ total customer deposits (demand, saving and time deposits)).
P2	Price of labor (%) (total personnel expense/total assets).
P3	Price of physical capital (Non-interest expense/Average assets).
Y1	The US $ value of total aggregate loans (all types of loans) (US$).
Y2	The US $ value of total aggregate other earning assets (short-term investment, equity and other investment and public sector securities (US$ millions)).
Y3	The US $ value of the off-balance sheet activities (nominal values, US$).
X1	Customer and Short-term Funding
X2	Labor
X3	Fixed Assets

Source: Bankscope (2002)

Table 3: Sample statistics of variables: outputs, inputs and input prices (millions of U.S. dollars)

Year	1995		1996		1997	
	Mean	Std.	Mean	Std.	Mean	Std.
Profit	6258.333	4508.315	7222.400	6172.419	2678.889	33462.33
Cost	29603.222	34698.443	30737.200	33792.127	225864.11	444564.972
Outputs						
Y1	363380.67	416207.770	412084.40	441364.787	1648745.4	3224360.045
Y2	134647.00	108220.778	96415.300	120543.414	1128565.8	2333976.217
Y3	106241.00	94786.531	100588.70	103549.155	1263827.7	2976931.5394
Inputs						
X1	7737.444	7735.966	7851.100	7959.844	159140.83	366874.654
X2	454050.89	480617.134	462242.60	526835.467	2226842.8	4056351.811
X3	5000.667	4050.213	5381.00	4547.858	41789.889	87829.478
Input Prices						
P1	1.183	1.109	3.005	4.299	2.699	6.172
P2	2.387	2.5204	6.884	13.244	1.940	1.983
P3	3.153	8.500	3.513	7.707	8.169	23.491
Year	1998		1999		2000	
Profit	5725.778	57732.936	31860.053	67163.317	11981.33	14432.755
Cost	165979.67	463536.221	323393.21	716128.054	236274.44	800742.031
Outputs						
Y1	1299686.4	3832482.99	2744720.6	5697788.39	2049386.6	6104788.650
Y2	696861.89	2231765.06	1626221.3	3441330.11	1035670.0	3603348.633
Y3	712457.06	2590192.30	1527818.9	3398934.34	349634.61	1105074.584
Inputs						
X1	92594.889	338940.862	171311.84	414820.64	107599.61	405800.829
X2	1246109.6	3516006.04	3219820.2	7191911.68	2869455.1	9095176.956
X3	29612.111	87913.320	63166.89	143341.26	58208.88	204600.909

			5		9	
Input Prices						
P1	1.426	1.081	1.280	0.834	1.485	1.094
P2	2.059	2.595	2.112	2.929	2.134	2.385
P3	6.909	16.735	9.445	24.693	17.328	36.268
Year	2001					
Profit	209781.13	156632.755				
Cost	256275.00	710742.031				
Outputs						
Y1	2249386.6	5204788.15				
Y2	114670.0	3813348.42				
Y3	569634.61	1205074.08				
Inputs						
X1	117580.61	426800.823				
X2	2939455.1	9115176.22				
X3	68217.669	213600.114				
Input Prices						
P1	1.958	1.188				
P2	2.665	2.962				
P3	18.091	38.345				

Table 4. Summary Statistics of Efficiency Measures of (1995-2001)

Efficiency Measure	Mean	Minimum	Maximum
Panel A: 1995			
(CE)a	0.917	0.828	1.000
(AE)a	0.953	0.853	1.000
(TE)a	0.961	0.893	1.000
(PTE)a	0.990	0.923	1.000
(SE)a	0.971	0.894	1.000
Panel B: 1996			
(CE)	0.735	0.588	1.000
(AE)	0.771	0.664	1.000
(TE)	0.951	0.825	1.000
(PTE)	0.992	0.940	1.000
(SE)	0.959	0.829	1.000
Panel C: 1997			
(CE)	0.736	0.397	1.000
(AE)	0.865	0.604	1.000
(TE)	0.861	0.417	1.000
(PTE)	0.936	0.434	1.000
(SE)	0.922	0.558	1.000
Panel D: 1998			
(CE)	0.418	0.103	1.000
(AE)	0.477	0.135	1.000
(TE)	0.827	0.335	1.000
(PTE)	0.921	0.484	1.000
(SE)	0.897	0.335	1.000
Panel E: 1999			
(CE)	0.472	0.072	1.000
(AE)	0.594	0.108	1.000
(TE)	0.801	0.477	1.000
(PTE)	0.918	0.508	1.000
(SE)	0.877	0.477	1.000
Panel F: 2000			
(CE)	0.394	0.182	1.000
(AE)	0.444	0.197	1.000
(TE)	0.900	0.723	1.000
(PTE)	0.970	0.800	1.000
(SE)	0.927	0.613	1.000
Panel G: 2001			
(CE)	0.645	0.263	1.000
(AE)	0.703	0.263	1.000
(TE)	0.936	0.614	1.000
(PTE)	0.945	0.633	1.000
(SE)	0.990	0.970	1.000
Panel H: All b			
(CE)	0.620	0.082	1.000
(AE)	0.733	0.074	1.000
(TE)	0.843	0.109	1.000
(PTE)	0.950	0.311	1.000
(SE)	0.891	0.266	1.000

a. (CE) = Cost Efficiency, (AE) : Allocative Efficiency, (TE) : Technical Efficiency, (PTE) : Pure Technical Efficiency, (SE) : Scale Efficiency, **b.** *Panel D: All* gives the summary statistics for the pooled sample of (1995-2001) efficiency measures combined).

Table 5. Summary Statistics of Productivity and Efficiency Changes for (1995-2001)

Period	MI	TE	TC	PTE	SE
1995-96	0.954	1.002	0.952	1.005	0.998
1996-97	0.786	0.846	0.929	0.899	0.941
1997-98	1.214	0.939	1.294	0.976	1.214
1998-99	1.060	0.950	1.116	0.984	1.060
1999-2000	0.894	1.183	1.030	0.845	0.877
2000-2001	1.120	1.038	1.079	0.964	1.076
Average(1995-2001)	1.031	1.006	1.024	0.998	1.008

Note: MI: Change in productivity (Malmquist index of productivity); TE: Change in technical efficiency; TC: Technological change; PTE: Change in pure technical efficiency, and SE: Change in scale efficiency

Table 6: Spearman rank order(s) correlation coefficients among efficiency estimates and proxy-measured of performance

	CE	AE	TE	PTE	SE	ROA
AE	0.670**					
TE	0.532*	-0.398				
PTE	0.427	-0.205	0.688***			
SE	0.329*	-0.336	0.702**	-0.114		
ROA	0.024	0.334*	0.341**	-.670**	0.139	
ROE	0.100	0.212***	0.181*	-0.457	0.212	0.627**

a: Spearman correlation coefficient of tests for zero correlation. AVCR is average cost (Total cost / Total assets). ROA is return on assets (Net income / Total assets). REQ is return on equity (Net income / equity). : CE: Cost efficiency, AE: Allocative efficiency, TE: Technical efficiency, PTE: pure technical efficiency, SE: Scale efficiency.

*** Significant at the 0.01 level.

** Significant at the 0.05 level.

* Significant at the 0.10 level

Table 7. Summary statistics for the stochastic cost and profit efficiency

	Cost efficiency		Profit efficiency	
	Mean	Std. Dev.	Mean	Std. Dev.
1995	0.921	0.011	0.825	0.125
1996	0.907	0.008	0.864	0.206
1997	0.856	0.001	0.749	0.033
1998	0.768	0.172	0.783	0.039
1999	0.725	0.239	0.819	0.017
2000	0.711	0.030	0.858	0.116
20001	0.682	0.124	0.890	0.060
All	0.735	0.056	0.844	0.130

Table 8: The ML cost and profit frontier parameter estimates

	Cost function	*Profit function*
Coefficient		
a_0	*12.291***	*11.383**
a_{y1}	*0.553*	*0.447*
a_{y2}	*0.199*	*-0.228*
a_{y3}	*0.324*	*-0.512*
β_{p1}	*-0.135*	*0.287***
β_{p2}	*-3.095*	*-2.564*
β_{p3}	*0.123*	*-0.114*
$a_{y1,y1}$	*0.169*	*0.124*
$a_{y2,y2}$	*-0.149*	*-0.196*
$a_{y3,y3}$	*0.321*	*-0.135*
$a_{y1,y2}$	*0.157*	*-0.271*
$a_{y1,y3}$	*0.457***	*0.167*
$a_{y2,y3}$	*-0.259*	*0.377-0.793**
$\beta_{p1,p1}$	*0.563*	*-0.277***
$\beta_{p3,p3}$	*0.708*	*0.669***
$\beta_{p1,p3}$	*0.199***	*0.134**
$\mu_{y1,p1}$	*-0.750*	*0.201*

$\mu_{y1,p3}$	*-0.217**	*-2.902*
$\mu_{y2,p1}$	*-.172*	*0.587*
$\mu_{y2,p3}$	*0.411*	*0.152*
$\mu_{y3,p3}$	*-0.268*	*0.469***

Table 9: Second-Stage Regression Results

Variable	CE	TE	AE	PTE	SE
Constant	0.564***	0.680***	0.865***	1.078***	0.606***
	(2.352)	(3.082)	(4.328)	(6.526)	(3.951)
TA	1.1	2.133	-3.460	7.945**	2.990*
	(0.162)	(0.341)	(-.061)	(7.10)	(1.689)
ROA	4.10	7.55**	3.45**	6.129**	1.669**
	(1.919)**	(1.837)	(1.927)	(1.994)	(2.585)
ROE	4.322	4.689	4.409**	-3.691	8.427
	(0.164)	(0.193)	(2.02	(-0.203)	(0.499)
LOGLOAN	3.975	4.77	-7.478	-1.031	5.746**
	(0.850)	(1.110)	(-0.192)	(-0.320)	(1.921)
R Square	0.319	0.539	0.339	0.676	0.538

Note: ROA is return on assets (Net income / Total assets). REQ is return on equity (Net income / equity). : CE: Cost efficiency, AE: Allocative efficiency, TE: Technical efficiency, PTE: pure technical efficiency, SE: Scale efficiency.
*** Significant at the 0.01 level.
** Significant at the 0.05 level.
* Significant at the 0.10 level