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THE X-EFFICIENCY IN ISLAMIC BANKS

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This paper investigates relative efficiency of the Islamic banking industry in the world by analyzing a panel of banks during the period of 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 correlated with conventional accounting measures of performance. The results indicate that, on 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 these efficiency measures are highly correlated with ROA and ROE, suggesting that the efficiency measures can be used concurrently with conventional accounting ratios in determining Islamic bank performance.

1. INTRODUCTION

Islamic banking is a worldwide phenomenon involving a variety of institutions and instruments. Islamic institutions and instruments have developed in many countries during the past few decades. In countries such as Iran, Sudan, and Pakistan, all or most financial intermediation conforms to Islamic Shari[ah as defined by local authorities. These countries also have banking authorities that govern the general level of charges and returns in the system. 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, Islamic banks have significantly expanded their network, and have been able to amass large amounts of deposits as well as promote many economic ventures. In addition, they play a major role in rendering banking

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services to poverty stricken households, who historically have been treated apathetically. Given the differential behavior of Islamic banks compared to traditional commercial banks, and their involvement in both social and economic activities, there has always been the question of long run sustainability of these banks. The diverse involvement of Islamic banks in social and economic activities indeed increases their operational costs, which many critics consider to be the major constraint for the long run sustainability of this newly introduced profit sharing banking system.

This paper employs both parametric (cost and profit efficiency) and non-parametric methods (DEA analysis and Malmquist productivity index) to study cost, profit and X-efficiency of 43 Islamic banks in 21 Muslim countries over the 1995-2001 period. First, it employs a stochastic cost frontier approach to compute the cost efficiency. Second, it employs alternative profit efficiency which considers both cost and revenue simultaneously to examine profit efficiency. Third, 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 management, allocative inefficiency is caused by regulation and may not be controlled by management. Finally, by 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 the cost-efficiency of Islamic banks, and under what conditions such institutions are sustainable.[1]

Regardless of a bank's underlying philosophy, its long run sustainability depends on 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. That is, if it equates the marginal value of product of each factor to its price. Such a study is important both from an operational as well as an 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 to how to improve cost efficiency. Third, it will suggest policy measures to improve price efficiency within the banking system. Finally, much less research has been done in the area of Islamic banking compared to the traditional commercial banking industry. Since Islamic banks differ from conventional banks

[1] There is a current debate on the objectives of Islamic banks. What do Islamic banks produce? Are they simply mimicking the conventional banking products, thus ignoring the spirit of Islamic banking? For a lively discussion on this issue, refer to El-Gamal (2003).

in their cost, profit and revenue structures, it is important for these banks to be studied independently.[2]

2. A BRIEF LITERATURE REVIEW

With various econometric methods, economies of scale and scope of commercial banks operating in the US have been extensively studied [Berger and Humphrey, 1997; Shaffer, 1988, Shaffer and David, 1986; Clark, 1988, 1996; Hunter, Timme and Yang, 1990; Evanoff and Isrilevich, 1990; Noulas, Miller and Ray, 1990; 1993; Humphrey, 1993; Rezvanian, Mehdian and Elyasiani, 1996; Mester, 1987; Thompson et al. 1997]. These studies illustrate 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 inconclusive, however.

The cost structure of foreign banks has not been studied as extensively as that of the US [Lang and Welzel (1996) for Germany; Drake and Weyman-Jones (1992) for United Kingdom; Hassan and Tufte (2001) 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 regarding scope economies are inconclusive.

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 et al. (1994). This methodology has been used in studies by Aly et al. (1990), Rangan et al. (1988), Ferrier and Lovell (1990), and Elyasiani and Mehdian (1990, 1992, 1995), Miller and Noulas (1996), Ferrier, Grosskopf, Hayes and Yaisawarng (1993), and Fixler and Zieschang (1993) for the US banking industry. The same methodology has been used for banks in predominantly industrial countries in studies by Drake and Weyman-Jones (1992) and Field (1990) for the UK

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[2] In this paper, we assume Islamic banks maximize profit within the constraints of Islamic prohibition of *riba*. Therefore, we can use duality principle to derive cost and profit functions and thus the econometric framework adopted in this paper will be consistent. However, El-Gamal (2005) argues that

> "Islamic finance is a prohibitions-driven industry, which aims primarily to circumvent the canonical Islamic prohibitions of *riba* and *gharar*. The concepts of *riba* and *gharar* may best be understood as unbundled sales of credit and risk, respectively. An obvious solution is to adopt mutual structures for financial intermediaries of credit (e.g. banks) and risk (e.g. insurance companies), as early experiments in Islamic finance had apparently done. However, growth in Islamic finance over the past three decades has been led by rent-seeking Shari[ah arbitrageurs, whose efforts continue to be focused on synthesizing contemporary financial products and services from classical nominate contracts, without regard to corporate structure of financial institutions." (abstract, El-Gamal, 2005).

banking industry; Grifell-Tatje and Lovell (1996) Grifell-Tatje and Lovell (1997) for the Spanish banking industry; Berg, Forsund, and Jansen (1991, 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 have been just a few papers written on the cost efficiency of 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 (2002a,b; 2003abc) for Turkey. The results of all these studies reveal that, in general, banking firms experience an average efficiency of 77% and a median efficiency of 82% (Berger and Humphrey, 1997). It should be noted; however, that these statistics are significantly different across countries.

However, there are a few studies (both parametric and non-parametric), which deal with the Islamic Banking sector. Only exceptions are Hassan and Hussein (2003), who examined Sudanese banking system, and Hassan (2003), who examined Pakistan, Iran and Sudanese banking system, and Yudistira (2004) analyzed the Malaysian banking system. Samad and Hassan (2000) deals with examines the Malaysian Islamic banks using only financial ratios. Hassan (1999) also examines the Islamic banks in Bangladesh by employing financial ratios. Yudistira (2004) uses a DEA method to examine the technical and scale efficiencies for 18 Islamic banks. Their results suggest that Islamic banks suffer from inefficiencies during the 1989-9 world-wide financial crisis. The efficiency measures in his sample appear to be driven by country specific factors. Hassan and Hossein (2003) investigate relative efficiency of the banking industry in Sudan by employing a panel of 17 banks for the years 1992 and 2000. They employ a variety of parametric (cost and profit efficiency) and non-parametric (data envelopment analysis) techniques to examine five efficiency measures (cost, allocative, technical, pure technical and scale efficiency scores). The average cost and profit efficiency over 1992-2000 are about 55% and 50%, respectively. The productivity decline (MI) of all banks in the system was 22% during 1992-2000 periods. They suggest that Sudanese banks should improve their X-efficiency by best managing and allocating their inputs. The bank management must be appointed based on the competence and expertise and not on the political or personal biases. The labor force in the banking sector must be well trained to deal with nature of the Islamic banking practices.

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. 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 a societal standpoint, firms that operate at constant returns to scale represent the socially efficient level of operation. Therefore, choosing a 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.

3. 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 mainly dependent upon the purpose of the study and 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, 2002b).[3]

3.1 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

[3] 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.

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.

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

$$\varepsilon_b = u_b + e_b \qquad (2)$$

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:

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

where, f is a functional form and ε_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. 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, $N(0,\sigma_u^2)$, 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, $\lambda = \frac{\sigma_u}{\sigma_e}$. 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:

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

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.

3.2 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 (1997) recommends that 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 profit efficiency: the standard profit function and the alternative profit function. 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. Unlike the standard profit efficiency concept, alternative profit efficiency measures how close a bank is to generating maximum profits given its output levels rather than output prices. 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), alternative profit efficiency is particularly closer to reality when some of the standard assumptions of perfect markets do not hold.[4] They compare the two approaches and conclude that the alternative profit function is the better measurement. Berger and Mester (1997) report four conditions under which 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. Not all Islamic banks can achieve every output scale and product mix. Under various regulations that exist in Muslim countries regarding the activities of Islamic banks, we cannot say that the output markets are perfectly competitive. Output prices are not available to all sizes of the banks. In addition, because output quantities are relatively fixed in the short-run and cannot respond quickly to changing prices as is assumed in the standard profit function, the alternative profit function is preferable to analyze differences in bank profits. Therefore, only alternative profit efficiency is estimated in this study. 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:

[4] 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.

$$\ln(\pi + a) = \alpha_0 + \sum_{i=1}^{4} \alpha_i \ln Y_{ist} + \sum_{i=1}^{3} \beta_i \ln P_{ist} + \frac{1}{2}\sum_{i=1}^{4}\sum_{j=1}^{4} \sigma_{ij} \ln Y_{ist} \ln Y_{jst} +$$
$$\frac{1}{2}\sum_{k=1}^{3}\sum_{l=1}^{3} \delta_{kl} \ln P_{kst} \ln P_{lst} + \sum_{k=1}^{3}\sum_{i=1}^{4} \mu_{ki} \ln P_{kst} \ln Y_{ist} + v_{st} + u_{st} \qquad (7)$$

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 (5). Profit efficiency measures how close a bank is generating maximum profits given its output levels. A 70% profit efficiency score for a bank suggests that it would earn about 30% more profits than what it is making now if it were operating on the efficient frontier.

3.3 Data Envelopment Analysis and the Malmquist Productivity Index

This study utilizes a nonparametric data envelopment analysis (DEA) to calculate five efficiency measures. These are cost, allocative, technology, pure technology and scale efficiencies. 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. In addition, a Malmquist DEA method is applied to the panel data and Malmquist total factor productivity (TFP) indices are calculated. Productivity growth is measured by the Malmquist index (MI) that is the product of two elements: the technical efficiency (ΔTE), which is how much closer a bank gets to the efficient frontier (*catching up effect or falling behind*), and technological change (ΔTC), which is how much the benchmark production frontier shifts at each bank's observed input mix (technical innovation or shock). MI >1 indicates a productivity gain and MI <1 indicates productivity loss. (Hassan, Al-Sharkas and Samad, 2005; Isik and Hassan, 2003c)[5]

4. DATA AND DEFINITIONS OF VARIABLES

To determine what constitutes inputs and outputs of banks, one should first decide on the nature of banking technology. In theory of banking literature there are two main competing approaches in this regard: production and intermediation (Sealey and Lindley, 1977). Like many studies on banking efficiency (Isik and Hassan, 2002ab, 2003abc and among others), we adopt the intermediation

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[5] For a thorough explanation of DEA analysis and TFP calculations, see Coelli, T.J., Prasada Rao, D.S., and Battese, G.E. (1998), *An Introduction to Efficiency and Productivity Analysis*, Kluwer Academic Publishers, Boston, pp.271.

approach in this paper.[6] 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 US 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.[7] 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 non-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[8] (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 periods. Table 1 gives the country-wise and year-wise breakdown of these Islamic banks. We have banks from a variety of countries with different banking laws and regulations. Only Sudan and Iran have Islamic banking system, where all financial transactions are done according to Islamic Shariah. Other countries such as Malaysia and Jordan, for example, have specific Islamic banking laws and Islamic banks operate side by side with conventional banks. In other countries (for example, Bangladesh), Islamic banks operate on the laws based on conventional banks (either through promulgations or central bank circulars).[9] The input and output variables are defined in Table 2 and their descriptive statistics year-wise are provided in Table 3. The mean and standard deviations of all input,

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[6] Humphrey (1985) presents an extended discussion of the alternative approaches over what a bank produces. There is no standard in the literature about the numbers and types of input and output variables. It all depends on the availability of data. BankScope allows us to use three inputs and outputs for Islamic banks in this paper.

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

[8] BankScope defines a uniform term loans for both Islamic and conventional banks. Fro Islamic banks, it means mostly murabaha types of transactions.

[9] There is a great deal of heterogeneity in Islamic banking technology in the sample. Sudan and Malaysia are polar opposites while GCC countries are in the middle. The constructed efficiency scores should be interpreted cautiously as divergent Islamic banks are pooled in the same sample.

output and price variables show considerable variation, which is expected as the sample is drawn from 21 countries.

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 and all financial information is reported both in local currency and in US dollar. We use US dollar data which makes the comparison across country consistent. Other data sources include International Monetary Fund's International Financial Statistics (IFS), world Development Indicator (2001), and Global Development Finance (2001).

5. ANALYSIS OF RESULTS

5.1 Analysis of Non-Parametric DEA Efficiency Scores in Islamic Banks

In Table 4 we report the 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 downward trend in the cost efficiency of Islamic banks. The cost efficiency (inefficiency) was 91.7% (9%) in 1995, and 73.5% (36.1%) in 1996.[10] This means that the average Islamic bank could have used only 91.7% and 73.5% of the resources actually employed in 1995 and 1996 respectively in order 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 1996. The 36.1% figure means that the average Islamic bank in the sample needed 36.1% more resources to produce the same output as the average efficient Islamic bank in the sample.[11] Apparently, there was substantial room for significant cost savings if Islamic banks had utilized their productive inputs more efficiently.[12] 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 US banks, and Altunbas *et al*. (1996) estimate it at about 5-

[10] The relation between efficiency (E) and inefficiency (IE) is $IE = (1\text{-}E) / E$. Thus, the 73.5% efficiency implies 36.1% inefficiency, not 26.5%.

[11] Bank operates on the frontier.

[12] It is argued whether Islamic banks use a different production technology than conventional banks or simply use the same production technology as conventional banks inefficiently. Such inefficiency may be due to non-profit maximizing objectives of Islamic banks (as argued by El-Gamal) or allocatively due to using a restricted set of instruments. Allocative inefficiency may not only be due to regulatory restrictions because many of such allocative distortions are self-imposed by the Islamic banking industry. If all Islamic banks in the sample are inefficient, then the constructed efficiency scores (whether they increase or decrease) may be uninformative. Anectodal evidence, however, suggests that Islamic banks per se are not inefficient vis-à-vis conventional banks, and therefore this DEA method is not simply forcing all Islamic banks to be equally inefficient.

10% for British banks. It is worth noting that cost efficiency decreased dramatically from 73.6% in 1997 to about 41.8% in 1998, 47.2% in 1999 and 39.4% in 2000. However, the cost efficiency climbed to 64.5% in 2001.

As the results in Panel I of Table 4 indicate, the average technical efficiency is approximately 84% during the period studied whereas the average allocative efficiency is approximately 73% during the same period. In addition, technical efficiency of Islamic banks is consistently higher than allocative efficiency for each year during 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 of 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 the wasting of resources.

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 indicate that scale inefficiency is approximately 13%, while pure technical inefficiency is approximately 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.[13]

5.2 Analysis of DEA-Type Malmquist Productivity Growth in Islamic Banks

In Table 5 we report the results from measuring productivity progress of Islamic banks. The results indicate that these banks have experienced only 3.1% productivity growth over the sample period. It is worth mentioning that productivity changes reflect the product of changes in technical and technological efficiency. According to our findings, Islamic banks have been able to achieve such productivity improvement by becoming more technologically advanced (2.4%) rather than from being more technically efficient (only .006%).

The results further suggest that Islamic banks achieved productivity growth of 21.4% during 1997-1998, 6% during 1998-1999, and 12% during 2000-2001. On the other hand, those same banks registered productivity loss of 4.6% during 1995-1996, 21.4% during 1996-1997, and 10.6% during 1999-2000.

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[13] See Aly et al. (1990) for the US banking and Fukuyama (1993) for the Japanese banking.

5.3 How Financial Measures of Efficiency Scores are related with DEA Efficiency Scores?

In order to complement the results of efficiency measures, we correlated various accounting measures of bank performance such as ROA (Net Income/Total Assets) and ROE (Net Income/Total Equity) with various efficiency scores. 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 the 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 positive and statistically significant when 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*)*. While ROA is significantly positively correlated with AE, TE and PTE, ROE is positively and statistically significantly correlated with AE and TE. 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. This strongly suggests that various efficiency measures calculated from non-parametric methods can easily be used in substitute of conventional accounting measures of performance. Although not widely followed by the industry, such non-parametric measures can be adopted along with financial ratios to make comparisons of performance more robust.[14]

5.4 Analysis of Parametric Cost and Profit Efficiency in Islamic Banks

In Table 7 we report the stochastic cost and profit efficiency estimations of the Islamic banks for the years under study.[15] The average cost and profit efficiency over the years are approximately 73.5% and 84.4%, respectively. This implies that during the period (1995-2001), Islamic banks would have needed only 73.5% of the resources they used to produce services they generated, while earning about 84.4% of their potential profits on average. It seems that Islamic banks are relatively better at generating profits than controlling costs. It is worth noting,

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[14] A correlation of 20% is considered to be an indication of co-linearity problem in statistical analysis. Table 6 only gives the statistically significant Spear rank order correlation coefficients. Efficiency ratios can be used concurrently or in substitute of financial performance ratios because they are highly correlated. These are only correlations, not causations which are examined in second stage regression analysis (Table 8).

[15] 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).

however, that Islamic banks have achieved higher profit efficiency levels than other banking sectors in other countries. On average, profit efficiency is reported to be only 64% for US banks (Berger and Humphrey, 1997).

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

The average DEA cost efficiency is 62% (Table 4) while the parametric cost efficiency is 74% and profit efficiency is 84% (Table 7). We have used pooled data in our estimation as suggested by the referee, and found no mistake. There are heterogeneous types of banks in the pooled data, and there could be large variation of efficiency estimates. It is not necessarily true that DEA (non-parametric method) efficiency estimates would be larger than cost and profit efficiency (parametric methods) estimates. There are many studies where DEA scores are greater than parametric efficiency scores. For example, the average DEA cost efficiency of 139 pooled Turkish banking data over 1988-1996 is 72% (Isik and Hassan, 2002a); the average see the following two articles. The average parametric cost efficiency of 139 pooled Turkish banking data is 90% (Isik and Hassan, 2002b).[16]

5.5 Determinants of DEA Efficiency Measures in Islamic Banks

In order to determine which factors affect efficiency scores, we examine some aspects of banks' structure as related to efficiency estimates. The generally accepted methodology is to obtain the efficiency measures for each bank (first stage), and then regress the resultant efficiency scores on a set of explanatory variables (second stage) that explain the efficiency scores. For this purpose, efficiency scores are regressed on a set of common explanatory variables. We use the following variables: bank size (measured by the value of total assets), profitability (measured by ROA and ROE) and the loan ratio (loan to total assets). These variables have also been used by Yudistira (2004).

In Table 8 we report the results of the regression estimation. ROA is a significant determinant for all five measures of efficiency- CE, TE, AE, PTE and SE. The higher the profitability, the greater the efficiency scores. We find that ROE is the only significant determinant of AE. The positive sign of ROA and ROE coefficients signal that higher efficiency is correlated with higher profitability.

[16] It is again not necessarily true that profit efficiency scores will be lower than cost efficiency scores (The referee also refers that the alternative might be true under specific circumstances). We find the Islamic banks are mostly more profitable than their conventional counterparts, but they are yet to reach the level of cost efficiency enjoyed by conventional banks.

SIZE is only significant in PTE and SE, but LOGLOAN is only significant for SE. Consistent with Isik and Hassan (2002a), our results suggest that loan ratio exerts an insignificant impact upon all efficiency scores except scale efficiency. ROE is ROA amplified by leverage ratio. The fact that ROE is only significant in SE, and similarly LOGLOAN is significantly positive in SE, supports our argument that the inefficiency that exists in the Islamic banking industry has more to do with scale inefficiency than with technical efficiency. The lack of well-defined Islamic banking regulations prevents these banks from optimal usage of labor and input as well as the ability to operate at the optimal size. The fact that SIZE is positively correlated with SE (scale efficiency) suggests the possibility of attaining higher levels of scale efficiency by increasing their size of operations either through mergers or acquisitions (smaller banks being acquired by larger banks and or smaller banks merging to become larger). Such mergers and acquisitions may also include cross-border banks. Islamic banks may also form strategic partnerships with other Islamic or conventional banks. It is also possible to build bridges by bringing together both Islamic and conventional banks who commit to do their businesses along the lines of Islamic Shariah either through an Islamic banking branch or an Islamic banking window.

6. SUMMARY AND CONCLUDING REMARKS

This paper investigates relative efficiency of the Islamic banking industry in the world by analyzing a panel of banks during the period of 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 correlated with conventional accounting measures of performance. The results indicate that, on 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 these efficiency measures are highly correlated with ROA and ROE, suggesting that the efficiency measures can be used concurrently with conventional accounting ratios in determining Islamic bank performance.

The average cost efficiency (stochastic cost frontier) is 73.5%, whereas the average profit efficiency (profit efficiency frontier) is 84.4%. Although Islamic banks are relatively inefficient in containing costs, they are relatively efficient in generating profit. The average allocative efficiency is 73.3%, whereas the average technical efficiency is approximately 84.3%. 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 Islamic banks operate in overall regulatory environments that are not very supportive of their operations.

Hassan (2003b) found that when Islamic banks operate in countries such as Iran and Sudan, where the entire banking system operates under Islamic Shariah, the banks become more allocatively efficient. Average scale efficiency is approximately 89.1%, and average pure technical efficiency is approximately 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 have been moderate increases in productivity growth over the years. Productivity increases in the Islamic banking industry is mainly driven by technological change (opening up and penetrating other markets) not technical efficiency change (efforts of inefficient banks to catch up with those that are efficient). The results indicate that larger bank size is associated with higher scale efficiency. These results indirectly support the economies of scale arguments in the Islamic banking industry.

Most of the Islamic banks are of smaller size compared to their conventional counterparts. It is imperative that Islamic banks be allowed to merge to obtain an optimal size in order to become more technically efficient and compete with their conventional counterparts. Multinational conventional banks which engage in Islamic banking have a size advantage over smaller Islamic banks. The only way for Islamic banks to be competitive with multinationals is to bring products and services in conformity with the true spirit of Islamic prohibition of interest, utilize modern technology and expand the score and scale of their operations.

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. In addition, success in competitive markets demands achieving the highest levels of performance through continuous improvement and learning. Finally, frontier efficiency analyses can identify best practice banks and provide numerical efficiency scores and rankings which can be quite useful to policy makers, market analysts, and managers of competing banks.

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Table 1: Number of Banks by Country and by Year in the Sample Data

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: Islamic Bank Input, Output and Output Price Definitions

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). These definitions of inputs, input prices and outputs are standard in literature. BankScope Data source uses one universal definition of loans for both conventional and Islamic banks. The loans for Islamic banks represent short-term cost-plus *murabahah* type of financings only.

Table 3: Descriptive Statistics of outputs, inputs and input prices (denominated in millions of U.S. dollars)

Year	1995		1996		1997		1998		1999		2000		2001	
	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
Profit	6,258	4,508	7,222	6,172	2,679	33,462	5,726	57,733	31,860	67,163	11,981	14,433	209,781	156,633
Cost	29,603	34,698	30,737	33,792	225,864	444,565	165,980	463,536	323,393	716,128	236,274	800,742	256,275	710,742
Outputs														
Y1	363,381	416,208	412,084	441,365	1,648,745	3,224,360	1,299,686	3,832,483	2,744,721	5,697,788	2,049,387	6,104,789	2,249,387	5,204,788
Y2	134,647	108,221	96,415	120,543	1,128,566	2,333,976	696,862	2,231,765	1,626,221	3,441,330	1,035,670	3,603,349	114,670	3,813,348
Y3	106,241	94,787	100,589	103,549	1,263,828	2,976,932	712,457	2,590,192	1,527,819	3,398,934	349,635	1,105,075	569,635	1,205,074
Inputs														
X1	7,737	7,736	7,851	7,960	159,141	366,875	92,595	338,941	171,312	414,821	107,600	405,801	117,581	426,801
X2	454,051	480,617	462,243	526,835	2,226,843	4,056,352	1,246,110	3,516,006	3,219,820	7,191,912	2,869,455	9,095,177	2,939,455	9,115,176
X3	5,001	4,050	5,381	4,548	41,790	87,829	29,612	87,913	63,167	143,341	58,209	204,601	68,218	213,600
Input Prices														
P1	1.183	1.109	3.005	4.299	2.699	6.172	1.426	1.081	1.280	0.834	1.485	1.094	1.958	1.188
P2	2.387	2.520	6.884	13.244	1.940	1.983	2.059	2.595	2.112	2.929	2.134	2.385	2.665	2.962
P3	3.153	8.500	3.513	7.707	8.169	23.491	6.909	16.735	9.445	24.693	17.328	36.268	18.091	38.345

Source: The sample of banks are collected from BankScope (2002).

Table 4: Data Envelopment Analysis Measures of Five Efficiency Scores: 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). *Cost efficiency (CE)* arises if banks do not waste resources as a result of allocative or technical inefficiency in production of services. *Allocative efficiency (AE)* is related to the ability of a bank to choose the optimum mix of inputs given their prices. *Technical efficiency (TE)* measure indicates whether a bank employs minimum amount of inputs to produce a given amount outputs, or whether a bank produces maximum level of outputs given a fixed amount of inputs, as compared to a bank operating on the efficient frontier. *"Pure" technical efficiency (PTE)* is simply technical efficiency devoid of scale effects, which indicates a proportional reduction in input usage if inputs are not wasted given the current production level that may be scale inefficient. *Scale efficiency (SE)* refers to a proportional reduction in input usage if the bank can attain the optimum production level where there are constant returns to scale, i.e. long run average cost is minimum. The efficiency measures take values between 0 and 1 for the least and the most efficient units in the sample, respectively (Isik and Hassan, 2003a).

Table 5: Malmquist DEA-Type Total Factor Productivity Change over 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. Total factor productivity change contains two mutually exclusive and exhaustive components: *change in efficiency* (catching-up or falling behind) and *change in technology* (innovation or shock). Change in efficiency is further decomposed into two mutually exclusive sources: *pure technical efficiency change* (improvement in management) and *scale efficiency change* (improvement towards optimal size). This technique allows to investigate efficiency improvement in Islamic banking industry over a time period.

Table 6: Correlations among Financial Measures of Efficiency and DEA measures of efficiency

	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. ROA is return on assets (Net income/Total assets). ROE 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
B: This table helps us to examine the relationships among traditional financial measures of efficiency scores and the DEA measures of efficiency scores, therefore, validating the usefulness of DEA scores in managerial decision making.

Table 7: Descriptive Statistics of Parametric Cost and Profit Efficiency Measures

	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
2001	0.682	0.124	0.890	0.060
All	0.735	0.056	0.844	0.130

Source: Bank Scope (2002). Cost and profit efficiency are parametric measures of 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. Profit efficiency measures how close a bank is to generating maximum profits given its output levels instead of output prices. Both cost and profit efficiency measures are parametric measures of efficiency scores.

Table 8: Determinants of Non-Parametric Efficiency Scores

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: a. ROA is return on assets (Net income/Total assets). ROE is return on equity (Net income/equity). TA is log of total assets. LOGLOAN is log of total loans. 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

b. These regression equations examine how on-balance financial measures of efficiency impact DEA measures of efficiency scores.