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THE INPUT REQUIREMENTS OF CONVENTIONAL AND SHARIAH-COMPLIANT BANKING[1]

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Abstract

Islamic banking activities are limited within the scope of *shari'ah* which is within the scope of socially responsible and ethical banking activities, different from that based on interest-based banking. This paper attempts to measure the input data required by *shari'ah*-compliant banking in comparison with conventional banking to estimate their relative efficiencies and economies of and returns to scale. Cost and output distance functions were estimated for a sample of banks in 10 countries which operate both types of banking. The results showed that shari'ah-compliant banking has higher input requirements relative to interest-based banking, but exhibit superior average efficiency only in Malaysia but inferior average efficiency in cross-country analysis. There is little evidence of differences in economies/returns to scale between shari'ah and conventional banks.

Keywords: Islamic Banking, Stochastic Frontier Analysis, Efficiency, Frontier Analysis, Conventional Banks.
JEL Classification: G21, G28.

1. Introduction

The development of modern Islamic banking arose from adherents to Islam becoming conscious about rejection of the interest element in conventional banking. Islamic banks which started to operate in the early 1960s were initially concentrated in the Middle East before spreading to other regions such as Asia and Europe, due to demand mainly from the Muslim communities. Banks

[1]Note from editors: This paper is one of three best papers selected by a review panel of three professors at a Symposium held in November, 26-28, 2008 in Melbourne, Australia. The Symposium was funded by the Australian Research Council grant, 2007-2009/10, for research on Islamic Banking and Finance.

started to offer this as a choice to bank customers. Although Islamic banking is sometimes perceived as a limiting choice, it is actually broadening the banking choice. Compared to conventional banking, Islamic banking activities are limited within the scope of shari'ah hence, the mechanism involved in Islamic banking is different from that on interest-based banking. This gives bank customers an alternative to interest-based banking. In addition, Islamic banking is not viewed as threatening the existing business. Instead, it opens opportunity for new business as its operation is within the scope of ethical banking activities (Wilson, 2007). Islamic banking services have now been offered by both full-fledged Islamic banks, as well as conventional banks that choose to operate Islamic banking windows, and they can either be foreign- or domestic-owned firms.

As Islamic banking has been in operation for over 47 years and is viewed as an alternative to interest-based banking, the performance of Islamic banking needs to be assessed. Moreover, as Islamic banking is part of a country's banking system, the performance of Islamic banks may affect the soundness and stability of the banking system. Furthermore, Islamic banking influences the performance of conventional banks, if they choose to operate Islamic banking windows in addition to conventional windows. Hence, determination of the relative performance of Islamic and conventional banks will help policy makers to devise policies in order to improve the performance of a country's banking system as well as to provide some guidelines for managers of conventional banks with Islamic banking windows to improve bank performance. In addition, the rising number of Islamic banks has increased the competition between full-fledged Islamic banks and conventional banks. Therefore, the determination of their relative performances will encourage both full-fledged Islamic and conventional bank managers to improve their performance in order to compete with each other.

Given the above issues, the aim of this paper is to measure the efficiency of Islamic banking and compare it with conventional banks, concentrating on the impact of operational characteristics. Specifically, the first objective is to compare the efficiency of Islamic banking relative to conventional banks in Malaysia, focussing on the impact of operating characteristics. The second objective of the paper is to compare the efficiency of Islamic banks relative to conventional banks in countries operating Islamic banking.

2. Methodology

A. The Econometric Specification

In achieving the first objective, translog cost and output distance functions were applied to study the commercial banks to measure their efficiency. The measured efficiency of a firm is calculated as the difference between its observed input and output levels and the corresponding optimal values (given a country's fitted frontier). Given that Islamic banks cannot charge or pay interest and are hence, likely to face higher capital costs[2] and meet objectives other than profit maximization, a cost function has been employed which allows the potential higher costs of capital faced by Islamic banks to be controlled. Furthermore, if the non-profit oriented activities of Islamic banks are carefully controlled for, it is reasonable to assume that Islamic banks will try to minimize their costs of operation. In specifying the model, the intermediation approach, which has been widely employed in most bank studies (Brown and Skully, 2003; Hassan, 2003; Saaid, Saiful, Mansor and Naziruddin., 2003, Yudistira, 2004), and Islamic and conventional bank studies (e.g., Alshammari, 2003; El-Gamal and Inanoglu, 2005) was employed in this paper: see Ariff, Badar, Shamser and Taufiq. (2008).

Given this discussion, stochastic frontier analysis (SFA) will be employed in order to estimate a total cost function for Malaysian commercial banks. A single-equation stochastic cost function model can be described as:

$$\text{In}C_{n,t} = f(Y_{n,t}, W_{n,t}, Z_{n,t}) + \varepsilon_{n,t} \qquad (1)$$

where $C_{n,t,}$, $Y_{n,t,}$, $W_{n,t}$, and $Z_{n,t}$ are the observed total cost of production for the n-th firm at time t, a vector of outputs is $Y_{n,t}$, an input price vector is $W_{n,t}$, and an exogenous factor vector is $Z_{n,t}$. The assumption of the composed error term is as below (Aigneret, Knox and Peter 1977),

$$\varepsilon_{n,t} = v_{n,t} + u_{n,t} \qquad (2)$$

where $v_{n,t}$ represents random uncontrollable error and is assumed to be normally distributed with zero mean and variance, and $\sigma_v^2 \cdot \; u_{n,t} \geq 0$ is drawn from a one-sided distribution that is assumed to capture inefficiency. Similar to many previous studies, $u_{n,t}$ is assumed to be drawn from a half-normal distribution with mean zero and variance (Berger and Mester, 1997, Mester, 1996). $v_{n,t}$ and $u_{n,t}$ are independently distributed. Given this assumption, the log likelihood for inefficiency is expressed in terms of the two variance parameters, $\sigma^2 = \sigma_v^2 + \sigma_u^2$ which captures the variance of composed error and, which is a measure of the amount of variation originating from inefficiency relative to statistical noise (Jondrow, Knox Lovell, Ivan and Peter, 1982).

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[2] As they cannot issue or hold interest-bearing loans or securities but use alternative contract arrangements such as musharaka (Karim, 2001). However, as the available investment avenues using contracts are very limited, and most of them concentrate on short term investments, they may yield lower returns. In contrast, interest-based banks have wide choice of both short- and long-term investments thus potentially yield higher returns.

Maximum-likelihood estimates (MLE) are obtained by estimating a translog cost function as below, after including environmental variables, imposing the standard assumption of homogeneity in input prices, and allowing for the composed error terms:

$$\begin{aligned}\ln \tilde{C}_{n,t} &= \varphi + \sum_{k=1}^{K-1} \alpha_k \ln P_{k,n,t} + 0.5 \sum_{k=1}^{K-1} \sum_{s=1}^{K-1} \alpha_{k,s} \ln P_{k,n,t} \ln P_{s,n,t} \\ &+ \sum_{m=1}^{M} \beta_m \ln Y_{m,n,t} + 0.5 \sum_{m=1}^{M} \sum_{j=1}^{M} \beta_{m,j} \ln Y_{m,n,t} \ln Y_{j,n,t} \\ &+ \sum_{k=1}^{K-1} \sum_{m=1}^{M} \theta_{k,m} \ln P_{k,n,t} \ln Y_{m,n,t} + \sum_{k=1}^{K-1} \delta_k \ln P_{k,n,t}\, t \\ &+ \sum_{m=1}^{M} \psi_m \ln Y_{m,n,t}\, t + \lambda_1 t + 0.5 \lambda_{11} t^2 \\ &+ \sum_{h=1}^{H} \xi_h Z_{h,n,t} + v_{n,t} + u_{n,t}\end{aligned} \quad (3)$$

where, $P_{k,n,t} = W_{k,n,t} / W_{k,n,t}$ and $\tilde{C}_{n,t} = C_{n,t} / W_{K,n,t}$

k=1,…,K, and s=1,…,K are indices for input prices; m=1,…M and j=1,…,M are indices for output prices; h=1,…,H is an index for environmental variables; while the Greek letters (except *v* and *u*) represent unknown parameters to be estimated. Output and input variables follows the existing literature (Allen and Rai, 1996; Casu and Girardone, 2002; Mester, 1996), are normalized around their means and the values are in real 2000 MYR. Total costs (C) are defined as operating and financial costs and are calculated as the sum of labour expenses, physical capital expenses, and either income paid to depositors for Islamic banks or interest expense for conventional banks. Input prices W1, W2, and W3 are the price of labour, price of financial capital and price of physical capital, respectively. W1 is labour expenses divided by the number of full time workers, W2 is the amount of income paid to depositors divided by total deposits, and W3 is the physical capital expenses divided by the fixed assets. Bank outputs, are defined as the sum of total loans (Y1), and total other earning assets (Y2). The latter comprise deposits with other banks, securities and equity investments. Standard symmetry is imposed to the second order parameters: and $\alpha_{ks} = \alpha_{sk}$ and $\beta_{mj} = \beta_{jm}$.

Given the above model specification and assumptions, a measure of cost efficiency can be derived as the ratio of observed costs to predicted efficient costs, which is theoretically equivalent to:

$$CE_{n,t} = \exp(u_{n,t}) \quad (4)$$

These relative efficiency measures range from one to infinity with a score of one indicating full efficiency. However, $CE_{n,t}$ relies on the unobservable inefficiency, $u_{n,t}$. Following Jondrow, et al. (1982), the conditional expectation of $u_{n,t}$ given the observed value of the overall composed error term, $\varepsilon_{n,t}$, can be expressed as:

$$E\left(u_{n,t} \middle| \varepsilon_{n,t}\right) = \frac{\sigma\lambda}{1+\lambda^2}\left[\frac{\phi\left(\varepsilon_{n,t}\lambda/\sigma\right)}{1-\Phi\left(\varepsilon_{n,t}\lambda/\sigma\right)} + \left(\frac{\varepsilon_{n,t}\lambda}{\sigma}\right)\right] \quad (5)$$

where, Φ is the standard normal cumulative distribution function and ø is the standard normal density function.

Failure to account for differences between bank groups may yield inappropriate conclusions about bank performance (Bos and Kool, 2006). Therefore, differences in operating characteristics that may affect the efficient level of costs or output in this paper have been controlled for, by including environmental factors directly in the function, hence the resulting efficiency scores are net of the impact of environmental influences on efficient input requirements. As a result, these efficiency measures permit one to predict the ranking of firms under the assumption that firms operate in an equivalent environment. However, these exogenous factors are possibly an indicator of differences in efficiency rather than differences in efficient costs or outputs.

The estimated economies of scale enable banks to identify potential costs savings if they change the operation scale which can be obtained by first calculating the M output elasticities:

$$\varsigma_{m,n,t} = \frac{\partial \ln \tilde{C}_{n,t}}{\partial \ln Y_{m,n,t}} = \beta_m + \sum_{j=1}^{M}\beta_{m,j}\ln Y_{j,n,t} + \sum_{k=1}^{K-1}\theta_{k,m}\ln P_{k,n,t} + \psi_m t \quad (6)$$

From which a scale elasticity can be calculated as:

$$\varsigma_{Scale,n,t} = \left(\sum_{i=1}^{M}\varsigma_{m,n,t}\right)^{-1}. \quad (7)$$

$\varsigma_{Scale,n,t} > 1$, $\varsigma_{Scale,n,t} = 1$, $\varsigma_{Scale,n,t} < 1$, indicates economies of scale, constant returns to scale and diseconomies of scale respectively. Banks that produce at constant returns to scale realise the lowest average costs in which any increase (decrease) in output will increase (decrease) costs proportionately.

Cost efficiency, as mentioned above, measures how efficient banks minimise inputs, given outputs. As efficiency estimates obtained from different approaches should generate consistent estimates of efficiency and efficiency rankings, as well as give consistent results over time, an alternative method employing an output-oriented distance function, which estimates how efficient banks transform inputs into outputs, is also applied. By using this function, the paper has also the benefit of employing a quantity measure to identify bank inputs and outputs, thus avoiding possible problems leading to distorted and inaccurate price estimates that might occur given divergences in asset classification among Islamic and conventional banks, hence, potentially resulting in unreliable estimates of cost efficiency. Moreover, this function does not call for the strong behavioural assumptions of a profit maximisation or cost minimisation approach and is therefore appropriate for Islamic banks as they have dual objectives of fulfilling non-profit obligations for the society and profit or revenue maximisation for the depositors and shareholders. Moreover, if behavioural objectives between Islamic and conventional banks differ, the weaker behavioural assumptions of the output distance function approach may allow more consistent estimates of relative efficiency.

A production technology that transforms inputs into outputs can be represented by the technology set, which is the technically feasible combination of inputs and outputs (Coelli, Prasada and George, 1998; Cuesta and Orea, 2002; Fare and Primont, 1957). If the vector of K inputs, indexed by *k* is denoted by $X=(X_1,X_2,\ldots,X_K)$ and the vector of M outputs, indexed by m , is denoted by $Y=(Y_1,Y_2,\ldots,Y_M)$, the technology set can be defined as:

$$T = \{X,Y) : X \in R_+^K, Y \in R_+^M, X \text{ can produce } Y\} \qquad (8)$$

where R_+^K and R_+^M are the sets of non-negative, real K and M-tuples respectively. For each input vector, X, let P(X) be the set of producible output vectors, Y, that are obtainable from the input vector X:

$$P(X) = \{Y: (X,Y) \in T)\} \qquad (9)$$

The output distance function can then be defined in terms of the output set, P(X) as:

$$D_o(X,Y) = \min.\left\{\varpi > 0 : \left(\frac{Y}{\varpi}\right) \in P(X)\right\}. \qquad (10)$$

The output distance function is defined as the maximum feasible expansion of the output vector given the input vector which is non-decreasing, positively linearly homogeneous and increasing in Y, and decreasing in X (Cuesta and Orea, 2002). Given an output distance function with two outputs and a given input vector, X, the production possibility set is the area bounded by the production possibility frontier (PPF), which indicates the maximum feasible output given X, and the Y_1 and Y_2 axes. If the output vector, Y, is an element of the feasible production set, P(X), $Do(X,Y) \leq 1$, firms which produce on the PPF, $D_0(X,Y) = \varpi = 1$, thereby indicating technical efficiency. In contrast, for a firm operating inside the PPF, $D_0(X,Y) = \varpi = \frac{OA}{OB} < 1$, thereby indicating the proportion by which output is below potential output.

This also illustrates that Farrell is (1957) output-oriented measure of technical efficiency, defined as the maximum producible radial expansion of the output vector, and can be represented as:

$$OE_0 = 1/\, D_0\,(X,Y) \qquad (11)$$

OE_0 increases with inefficiency and lies between one and infinity. If Y is located on the outer boundary of the production possibility set, $OE_0 = 1$, indicating efficiency. On the other hand, if Y is in the interior of the production possibility set, $OE_0 > 1$ indicating inefficiency.

Following Fare and Primont (1957) and Cuesta and Orea (2002), and allowing for exogenous factors, the general form of a stochastic output distance function can be shown as follows:

$$1 = D_0\,(Y_{n,t}, X_{n,t}, Z_{n,t}, \beta)\,h(\varepsilon_{n,t}) \tag{12}$$

where $h(\varepsilon_{n,t}) = \exp\,(u_{n,t} + v_{n,t})$, $Y_{n,t}$ is a vector of outputs, $X_{n,t}$ is an input vector, $Z_{n,t}$ is an exogenous factor vector and β is a vector of parameters. Inefficiency is accommodated in the specification of h (.) as $\varepsilon_{n,t}$ is a composed error term comprised $v_{n,t}$ which represents random uncontrollable error that affects the n-th firm at time t, and $u_{n,t}$, which is assumed to be attributable to technical inefficiency.

In order to facilitate estimation, the author followed the standard practice of imposing homogeneity of degree one in outputs on the distance function, which implies that $D_0\,(Z,X,Y) = \pi D_0\,(Z,X,Y)$, $\pi > 0$. By arbitrarily choosing the M-th output, the author can then define $\pi = \frac{1}{Y_M}$ and write:

$$D_o\left(Z, X, \frac{Y}{Y_M}\right) = \frac{D_o(Z, X, Y)}{Y_M} \tag{13}$$

From Equation 13 and after assuming $Y^*_{n,t} = (Y_{1,n,t}/Y_{M,n,t}, Y_{2,n,t}/Y_{M,n,t}, \ldots, Y_{M-1,n,t}/Y_{M,n,t})$. and rearranging terms yields the general form:

$$\frac{1}{y_{M,n,t}} = D_o\left(Y^*_{n,t}, X_{n,t}, Z_{n,t}, \beta\right).\ h\left(\varepsilon_{n,t}\right) \tag{14}$$

Finally after assuming the standard translog functional form[3] to represent the technology, the output distance can be represented as:

$$-\ln Y_{M,n,t} = \varphi_o + \sum_{k=1}^{K} \alpha_k \ln X_{k,n,t} + \sum_{m=1}^{M-1} \beta_m \ln Y^*_{m,n,t} + 0.5 \sum_{k=1}^{K} \sum_{s=1}^{K} \alpha_{k,s} \ln X_{k,n,t} \ln X_{s,n,t}$$

$$+ 0.5 \sum_{m=1}^{M-1} \sum_{j=1}^{M-1} \beta_{m,j} \ln Y^*_{m,n,t} \ln Y^*_{j,n,t} + \sum_{k=1}^{K} \sum_{m=1}^{M-1} \theta_{k,m} \ln X_{k,n,t} \ln Y^*_{m,n,t} \tag{15}$$

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[3] In the literature, the translog function is preferred in estimating a parametric distance function because it is flexible, easy to calculate and permits the imposition of homogeneity (Fuentes, Emili and Sergio, 2001).

where, $Y^*_{m,n,t} = Y_{m,n,t} / Y_{M,n,t}$, k=1,2,..K and s=1,2,..K are indices for inputs; m=1,2,…M and j=1,2,..M are indices for output. The selection of the input and output variables follows the existing literature (Cuesta and Orea, 2002; Cuesta and Zofío, 2005; Iqbal, Kizhanathan, and Aigbe, 1999). The outputs Y_1, Y_2 are loans and total other earning assets, and the inputs X_1, X_2, X_3 are labour deposits and capital (fixed assets), respectively. X_1 is the number of full time workers, X_2 is total deposits including customer funding and short term funding, and X_3 is the total expenses on fixed assets. It is noted that linear homogeneity in outputs is imposed using Y_2 as a numeraire and these variables have been mean-corrected prior to estimation. The approach of Jondrow, Lovell, Materov, and Schmidt (1982) is followed to derive the log likelihood which is expressed in terms of the two variance parameters, $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2 / \sigma_v^2 + \sigma_u^2$.

Following from Equation 12, and given current model assumptions, an estimate of output distance can be derived as $D_0\,(Y_{n,t}, X_{n,t}, Z_{n,t}, \beta) = \exp(-\mu)$. Equivalently an estimate of Farrell output oriented efficiency is obtainable as:

$$OE_{n,t} = \frac{1}{D_0\left(Y_{n,t}, X_{n,t}, Z_{n,t}, \beta\right)} = \exp(\mu) \tag{16}$$

However, $OE_{n,t}$ relies on the unobservable inefficiency, $u_{n,t}$,. Following Jondrow et al. (1982), the conditional expectation of $u_{n,t}$ given the observed value of overall composed error term, $\varepsilon_{n,t}$ can be expressed as:

$$E\left(u_{n,t} \middle| \varepsilon_{n,t}\right) = \sigma_A\left[\frac{\phi\left(\gamma\varepsilon_{n,t}/\sigma_A\right)}{1-\Phi\left(-\gamma\varepsilon_{n,t}/\sigma_A\right)} + \left(\frac{\gamma\varepsilon_{n,t}}{\sigma_A}\right)\right] \tag{17}$$

where, $\sigma_A = \sqrt{\gamma(1-\gamma)\sigma^2}$ Φ (.) is the standard normal cumulative distribution function and ϕ (.) is the standard normal density function.

Given the estimated model, estimated scale elasticity can be calculated as the negative of the sum of the input elasticities (Cuesta and Orea, 2002):

$$SCALE_{n,t} = -\sum_{k=1}^{K} \frac{\partial \ln D_o\left(Y_{m,n,t}, X_{k,n,t}\right)}{\partial \ln X_{k,n,t}} \tag{18}$$

$SCALE_{n,t} > 1$, $SCALE_{n,t} < 1$, and $SCALE_{n,t} = 1$, are when a bank is operating with increasing returns to scale (IRS), decreasing returns to scale (DRS) and constant returns to scale (CRS) respectively.

The second objective of how Islamic banks perform relative to conventional banks internationally is examined by employing a translog output distance function. The relative efficiency and returns to scale of Islamic and conventional banks have been investigated in countries that operate Islamic banking namely Malaysia, Sudan, Bangladesh, Tunisia, Jordan, Lebanon, Yemen, Indonesia, Bahrain and Iran. Except for Sudan and Iran which only operate Islamic banking, banks from other countries operate both Islamic and conventional banking. A common frontier with country-specific environmental variables is estimated after allowing for country specific differences in estimated inefficiency and the analysis puts emphasis on the impact of operating characteristics, including Islamic banking and country-specific conditions on the relative outputs of banks.

The frontier is controlled for variations in economic and regulatory environments between countries that may justify differences in efficiency, by including country-specific variables directly in the distance function, and also allowed country dummies to directly influence output inefficiency. These country dummy variables simultaneously capture other country-specific environmental conditions and determine relative efficiency between countries. This implies that the resulting efficiency scores are net of the impact of controlled for environmental influences on efficient input requirement, and the differences in these scores are directly influenced by country-specific inefficiency distributions. As a result, these efficiency measures enable one to determine how firms are ranked under the assumption that firms operate in an equivalent environment, while at the same time measuring how bank efficiency in one country differs from another.

Employing the output distance function approach, the cross-country analysis specifies Battese and Coelli's (1995) truncated normal SFA model with the mean of the truncated normal distribution made an explicit function of country dummy variables. The illustration is in Equation 18 and the formulation of the model detailed in (Coelli, 1996) is followed. Previous studies that employ the intermediation approach found that equity is significant in defining bank output but many (Girardone, Philip and Edward, 2004; Kasman and Yildirim, 2006) include it either as an environmental variable or a netput (fully interactive with input and output). Nevertheless, in financing the operation of banks, equity capital is an alternative to deposits and inter-bank borrowings (Bonaccorsi di Patti and Hardy, 2005). Furthermore, Islamic banks that apply an equity participation principle rely heavily on their equity to finance loans (Metwally, 1997). Therefore, it is appropriate that equity is considered as part of bank inputs for studies employing the intermediation approach. The author therefore, included equity as an input, because of both its role in Islamic banking and because all banks can potentially raise funds to finance their loans through equity, rather than deposits. The specification therefore extends the standard intermediation model by including two outputs, Y_1, Y_2 representing loans and total other earning assets, and three inputs, X_1, X_2, X_3 representing total operating expense, deposits, measured by total deposits including customer funding and short term funding, and equity, measured by total equity.

Thus, $v_{n,t}$ is assumed to be normally distributed with zero mean and variance σ_v^2 and independently distributed of the $u_{n,t}$, where $u_{n,t} \geq 0$ is assumed to be drawn from a truncation (at zero) of the normal distribution with mean, $EM_{n,t}$ and variance σ_u^2 , δ_f is a parameter to be estimated, f=1,2...,F is an index for countries, and C is a country dummy. Hence, given the absence of a constant in Equation 18, each country f is estimated to have inefficiency drawn from a distribution with mean δ_f, that is truncated at zero. The parameters in the translog function as defined in Equation 14, the composed error parameters $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2 / \sigma_v^2 + \sigma_u^2$, and the estimated means of the country specific inefficiency distributions (δ_f) specified in Equation 18 are estimated simultaneously using maximum likelihood estimation (MLE) techniques.

$$EM_{n,t} = \sum_{f=1}^{F} \delta_f C_{f,n,t} \tag{18}$$

Given the model assumptions and following Equation 18, an estimate of output distance can be derived as $D_0\,(Y_{n,t}, X_{n,t}, Z_{n,t}, \beta) = \exp(-\mu)$. Equivalently, an estimate of Farrell (1957)'s output oriented efficiency is obtainable as:

$$OE_{n,t} = \frac{1}{D_0\left(Y_{n,t}, X_{n,t}, Z_{n,t}, \beta\right)} = \exp(\mu_{n,t}) \tag{19}$$

$OE_{n,t}$ relies on the unobservable inefficiency, $u_{n,t}$, hence following the approach of Battese and Coelli (1995) and Frame and Coelli (2001) to estimate the unobservable inefficiency, $u_{n,t}$, the conditional expectation of $u_{n,t}$ given the observed value of the overall composed error term, $\varepsilon_{n,t}$, can be expressed as:

$$E\left[\exp\left(u_{n,t}\right)\varepsilon_{n,t}\right] = \frac{\left\{\exp\left[(1-\gamma)m_{n,t} + \gamma\varepsilon_{n,t} + 0.5\left(\sigma_*^2\right)\right]\right\}\left\{\Phi\left[\left((1-\gamma)m_{n,t} + \gamma\varepsilon_{n,t}/\sigma_*\right) + \sigma_*\right]\right\}}{\Phi\left((1-\gamma)m_{n,t} + \gamma\varepsilon_{n,t}/\sigma_*\right)} \tag{20}$$

Following Cuesta and Orea (2002), returns of scale for the banks in the sample can be estimated using the estimated scale elasticity which is calculated as the negative of the sum of the input elasticities:

$$SCALE_{n,t} = -\sum_{k=1}^{K} \frac{\partial \ln D_o\left(Y_{m,n,t}, X_{k,n,t}\right)}{\partial \ln X_{k,n,t}} \tag{21}$$

where if $SCALE_{n,t} > 1$, and $SCALE_{n,t} < 1$, $SCALE_{n,t} = 1$, when a bank is operating at IRS, DRS and CRS respectively.

B. Data and Input Variables

For Malaysian banks, data on 33 banks were drawn from Bureau van Dijk's (BvD's) BankScope database for the period 1996-2002 and were verified against the banks' annual reports. The data are expressed in Malaysian Ringgit (MYR) and are adjusted for inflation using the Malaysion GDP Deflator, which was extracted from IMF (2004). The number of full-time workers and ownership information is taken from the Central Bank of Malaysia (2002) and Association of Banks in Malaysia (Various Years). As some banks have incomplete information, this has resulted in an unbalanced panel of 168 observations.

Mergers during the sample period have caused a marked reduction in the number of Malaysian commercial banks. Over this period, ten mergers and acquisitions took place: two in 1999, one in 2000, six in 2001 (involving 14 banks) and one in 2002. Given these trends, each pre-merger commercial bank is included as a separate bank and these banks are assumed to have merged into one of the pre-merger banks.

For cross-country analysis, data on 23 Islamic and 88 conventional banks from 10 countries that operate Islamic banking were drawn from the BankScope database for the period 1996-2002 resulting in an unbalanced panel of 558 observations expressed in constant 2000 US dollars.[4,5]

C. Environmental environments

Focussing on Malaysian banks while applying the cost function, the first operating environment variable is an indicator of loan quality, and is proxied by the ratio of the non-performing loans (NPL)-to-total loans (Berger and Mester, 1997; Clark, 1996, Girardone et al., 2004; Mester, 1996; Williams and Nguyen, 2005). The second operating environment variable is measured by the equity-to-total assets ratio (Berger and Mester, 1997; Clark, 1996; Girardone, et al., 2004; Mester, 1996; Williams and Nguyen, 2005).

The remaining environmental variables are dummy variables that are designed to capture potential differences in bank characteristics, and operating environment that may influence costs. The dummy variable indicating full-fledged Islamic banks, is to control for the potential impact of full-fledged Islamic banking on bank costs. As changes in bank scale should be captured through the impact of output growth on estimated costs, the impact of mergers will be net of the impact of changes in bank scale attributable to the merger. A dummy for observations in 1998 is included to control for the East Asian financial crisis. The author considered including a foreign-owned dummy, for banks with more than 50% foreign ownership. However, while almost all domestic banks operate an IBS window relatively few foreign banks do. The author therefore, chose to interact a foreign dummy variable with a dummy variable for conventional banks that operate IBS windows and include the resulting set of dummy variables. Therefore, the model includes dummy variables for foreign banks without IBS, foreign banks with IBS, domestic banks with IBS, and leaves domestic banks

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[4]In the estimation, all input and output variables were normalized around their means and the linear homogeneity in outputs was imposed using the output Y2 as a numeraire.
[5]All data employed in this analysis were converted into constant international dollars according to the purchasing power parity hypothesis (Lozano-Vivas, Jesus and Jose, 2002).

without IBS as the base case measured in the constant.[6] Finally, Z_9 provides a dummy variable indicating public ownership, and is expected to have a positive sign indicating higher costs.[7]

Turning to the operating environments for Malaysian banks employing output distance function, the first operating environment variable is loan quality, the dummy variable indicating full-fledged Islamic banks is to control for the potential impact of full-fledged Islamic banking on bank output. The model also includes a dummy variable for foreign banks, foreign banks with IBS and all banks with IBS, leaving conventional domestic banks without IBS as the base case measured in the constant, where banks with IBS are conventional banks offering Islamic banking products through a separate Islamic banking window. A dummy variable for observations in 1998 is included to control for the East Asian financial crisis. Finally, given that some banks have gone through mergers, one can control for this effect by using a merger dummy variable. The author also tests for the potential effects of individual mergers, finding that the dummy is significant for three individual mergers, namely merger 1, merger 2 and merger 3.[8]

For cross-country analysis, in order to identify a common frontier, variables describing distinctive features of the economy, the banking industry as well as the geography of each country were identified. These variables are grouped into three categories. The first category includes macroeconomic conditions, and consists of a measure of population density, per capita income, density of demand (deposits per kilometer squared) and real GDP growth. These indicators explain the macro conditions under which banks operate. Population density is measured by the ratio of inhabitants per square kilometre, and it is expected that with high population density, the retail distribution of banking services becomes less costly. High per capita income, measured by Gross National Income (GNI) per inhabitant, is usually associated with countries having a mature banking environment, and thus, competitive interest rates and profit margins which lower banking costs and increase bank outputs. Density of demand is measured as total deposits per square kilometre. A less concentrated demand for banking services is costly because demand is more dispersed. As a result, bank customers are less

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[6]As all Islamic banks in the sample are domestically owned, and by definition are not conventional banks, the impact of Islamic banking on costs is also relative to the base case of a domestic bank that does not operate IBS.

[7]Publicly-owned banks are defined as banks with more than 50 percent government ownership through its agencies such as the Employees Provident Fund (EPF) and Permodalan Nasional Berhad (PNB). By definition, no foreign banks are included in the publicly owned category.

[8]Merger 1, 2, 3 refer to mergers between Oriental Bank and EON Bank, between Chung Khiaw Bank and UOB Bank, and between International Bank Malaysia, Sabah Bank and Multi-Purpose Bank respectively.

informed and banks tend to achieve lower output.[9] Finally, real GDP growth is expected to increase bank outputs due to increasing economic activities.

The second group of environmental variables identifies differences in banking structure and therefore provides measures of both banking concentration and the intermediation ratio. The concentration ratio is defined as the ratio of the total assets of the first three largest banks in a country to total banking assets. Higher concentration may be associated with higher or lower output. If higher concentration of banks is a result of market power, then the banks may become inefficient in producing outputs (Leibenstein, 1966). On the other hand, if higher concentration is a result of efficiency, then bank costs are reduced and bank outputs increase (Demsetz, 1973). In order to control for differences in regulation or allow factors that may affect the ability to convert deposits to loans among banking industries, the intermediation ratio, as measured by the loan-to-deposits ratio is employed. It is expected that the higher the intermediation ratio, the higher bank outputs will be. Thus, the first two groups of variables follow closely those of Dietsch and Lozano-Vivas (2000), and Carvallo and Kasman (2005).

The final group of environmental variables includes proxies for accessibility of banking services. The proxy variables are roads paved and telephone lines per 100 inhabitants. Roads paved is the percentage of road being paved in total roads, and is expected to positively impact bank outputs. Finally, the author expects that easier access to telephone lines will also increase potential bank outputs.

One final control variable is a dummy variable indicating whether a bank is an Islamic bank. Inclusion of this variable allows the author to test whether full-fledged Islamic banks have a different operating environment from conventional banks. Therefore, a dummy variable is included in the model to capture for this difference, but no a priori assumption is made due to mixed results in the literature on the direction of the influences of Islamic banking on inefficiency (Al-Jarrah and Molyneux, 2005; El-Gamal and Inanoglu, 2005; Mokhtar, Naziruddin and Syed M. Al-Habshi, 2006) and none has assumed Islamic banking to influence potential bank output. The author also noted that while this modelling assumption maintains the assumption that adherence to *shariah* causes a shift in potential output obtainable from given inputs, it could also be argued that any difference in output between conventional and Islamic banks is evidence of differences in efficiency. However, the author adopts this approach because it is believed that the restrictions imposed by *shariah* require Islamic banks to operate a modified banking technology that is not equivalent to that of conventional banks.

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[9]Countries with population concentrated in small habitable area(s) warrant careful judgement with regard to these results.

3. Results and Interpretation

A. Eficiency

Table 1

Maximum Likelihood Estimates for Parameters of the Environmental Factors:1996-2002

Coefficient	Parameters	Estimated value [a]	Std. Error
A. Costs function for Malaysian banks			
ζ_1	Loan Quality	0.309***	0.103
ζ_2	Equity/Asset Ratio	-0.736***	0.229
ζ_3	**Islamic Bank**	**0.150*** **	**0.041**
Z_4	Foreign without IBS	-0.218***	0.028
ζ_5	Financial Crisis	-0.048**	0.023
ζ_6	Merged Bank	0.108***	0.026
λ	Lambda	1.501***	0.439
Σ	Sigma	0.096***	0.014
B. Output distance function for Malaysian banks			
ζ_1	Loan Quality	0.380***	0.048
ζ_2	**Islamic Bank**	**0.066*** **	**0.021**
ζ_3	Foreign Owned Bank	-0.140***	0.027
ζ_4	Foreign with IBS	0.118***	0.031
ζ_5	Financial Crisis	-0.027***	0.012
ζ_6	Merged Bank 1	0.083***	0.035
ζ_7	Merged Bank 2	0.097***	0.034
ζ_8	Merged Bank 3	0.063*	0.038
Σ_2	Sigma-squared	0.005	0.001
Γ	Gamma	0.826***	0.143

(continued)

Table 1

Maximum Likelihood Estimates for Parameters of the Environmental Factors:1996-2002

Coefficient	Parameters	Estimated value [a]	Std. Error
C. Output distance function for banks internationally			
ζ_1	**Islamic Bank**	**0.141*****	**0.022**
ζ_2	Density of Population	$2.82\text{x}10^{-4}$***	$7.83\text{x}10^{-5}$
ζ_3	Density of Demand	-0.035***	0.008
ζ_4	Telephone lines	0.015***	0.003
δ_1	Malaysia	-0.541***	0.096
δ_2	Sudan	0.537***	0.082
δ_3	Bangladesh	-0.366***	0.097
δ_4	Tunisia	0.210***	0.047
δ_5	Jordan	-0.047	0.095
δ_6	Lebanon	0.112***	0.041
δ_7	Yemen	0.412***	0.083
δ_8	Indonesia	0.212***	0.053
δ_9	Bahrain	-0.353***	0.121
δ_{10}	Iran	-0.987*	0.555
σ^2	Sigma-squared	0.029***	0.002
γ	Gamma	0.491***	0.076

a *,**,*** Significance at 90, 95 and 99% confidence levels, respectively.
Source: Extracted from (Abdul-Majid, 2008)

For Malaysian banks employing cost function, recalling that $\lambda=\sigma_u/\sigma_v$, Table 1 shows the highly significant estimate of 1.501 implies that estimated deviation from the frontier is due mainly to inefficiency rather than statistical noise. Loan quality (Z_1) is positive as predicted and indicates that the lower output quality (higher the NPL-to-loan ratio), the higher the cost incurred by banks, which may reflect higher monitoring costs. The equity-to-asset ratio (Z_2) has a negative relationship with costs, indicating that as the equity-to-asset ratio increases, costs are lower relative to those banks that depend more on deposits.

The positive coefficient for the Islamic bank dummy (Z_3) indicates that full-fledged Islamic banks are found to have costs that *ceteris paribus* are 15.0% higher than for other banks. This may result from constrained opportunities in terms of investments and limited expertise in Islamic banking. Merged banks

(Z_4) are found to have costs that are 10.8 percent higher, after controlling for other variables.[10] The dummy variable for the financial crisis (Z_5) is positive, indicating that costs fell by 4.8% in 1998 after controlling for other variables. Finally, foreign banks without IBS windows (Z_6) are found to have costs that are 21.8% lower than the combined group of all domestic banks, publicly owned banks, and foreign owned banks with IBS windows.

Focussing on Table 2, the cost efficiency of Malaysian commercial banks is on average 1.066, and ranges from 1.019 to 1.217. The yearly average as well as the range of the efficiency scores has increased. The trend in efficiency suggests a decline in average efficiency over the sample period, but also the presence of a group of firms that were steadily slipping further away from the cost frontier. Thus, average efficiency deteriorated from 1.064 in 1996 to 1.075 in 2002 and the maximum efficiency score increased from 1.142 in 1996 to 1.206 in 2002. This may indicate that there are high gains achieved by best-practice banks but declines in efficiency as other banks struggle to keep up with best practice. The efficiency scores is judged against an efficient frontier, which for example allows full-fledged Islamic banks to have 15% higher costs and requires foreign banks without IBS windows to have 21.8% lower costs. These results can be compared to the previous literature: Islamic banks are found to have no difference with conventional banks in Malaysia (Abdul-Majid, Mariani and Fathin, 2005; Mokhtar, et al., 2006), but are equall if not more efficient in Turkey (El-Gamal and Inanoglu, 2005), are more efficient in Arabian countries (Al-Jarrah and Molyneux, 2005) and in GCC countries (Alshammari, 2003), when compared to conventional banks. These differences may potentially be due to the absence of environmental variables in some previous studies employing the intermediation approach, different input and output specifications, and cross-country differences in Islamic banking that may influence relative cost efficiency.[11]

Concentrating on the estimated output distance function parameters for Malaysian banks as reported in Table 1B, recalling that $\gamma = \sigma_u^2 / \sigma_v^2 + \sigma_u^2$, the highly significant estimate of 0.826 for this parameter suggests that the portion of technical inefficiency in total variance is high. Thus, the estimated deviation from the frontier is mainly due to inefficiency rather than statistical noise. The estimated coefficients of all variables have the expected signs. Loan quality ($\zeta 1$) is positive as predicted, and indicates that lower output quality (higher NPL-to-loan ratio) reduces output, thereby reflecting the higher input requirement needed to monitor default loans.

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[10]Berger and Humphrey (1997) noted that some mergers improve cost efficiency whereas others worsen their performance. Orea (2002) found that merged banks have negative efficiency change in contrast to the unmerged banks in the initial period of merger activities.

[11]For example, Islamic banks in other countries may employ more equity-based financing rather than debt-like financing which is more common in Malaysia.

Table 2

Efficiency Estimates for Banks and by Types, 1996-2002

	1996	1997	1998	1999	2000	2001	2002	All Years
A. Malaysian banks using cost function								
Descriptive Statistics: All Banks								
Average	1.064	1.057	1.064	1.071	1.075	1.056	1.075	1.066
Standard Deviation	0.029	0.026	0.033	0.039	0.048	0.036	0.041	0.037
Minimum	1.033	1.022	1.025	1.026	1.02	1.019	1.024	1.019
Maximum	1.142	1.124	1.155	1.181	1.217	1.157	1.206	1.217
Average efficiency of conventional, conventional with IBS and Islamic banks								
All Banks	1.064	1.057	1.064	1.071	1.075	1.056	1.075	1.066
Without IBS	1.071	1.057	1.066	1.082	1.078	1.057	1.083	1.071
With IBS	1.061	1.057	1.062	1.068	1.076	1.057	1.072	1.065
Islamic	1.058	1.056	1.072	1.061	1.062	1.042	1.059	1.057
B. Malaysian banks using output distance function								
Descriptive Statistics: All Banks								
Average	1.042	1.061	1.054	1.052	1.060	1.050	1.060	1.055
Standard Deviation	0.023	0.027	0.034	0.026	0.052	0.037	0.044	0.036
Minimum	1.016	1.015	1.014	1.015	1.011	1.015	1.015	1.011
Maximum	1.104	1.109	1.161	1.123	1.220	1.144	1.211	1.220
Average efficiency of conventional, conventional with IBS and Islamic banks								
All Banks	1.042	1.061	1.054	1.052	1.060	1.050	1.060	1.055
Without IBS	1.043	1.062	1.056	1.055	1.069	1.063	1.069	1.060
With IBS	1.041	1.060	1.055	1.052	1.054	1.041	1.052	1.052
Islamic	1.037	1.066	1.017	1.028	1.061	1.062	1.086	1.057
C. Banks in 10 countries using output distance function								
Descriptive Statistics: All Banks								
Average	1.087	1.106	1.102	1.106	1.102	1.120	1.112	1.105
Standard Deviation	0.121	0.158	0.173	0.159	0.151	0.173	0.167	0.158
Minimum	1.014	1.012	1.011	1.010	1.014	1.014	1.019	1.010
Maximum	1.756	1.949	2.352	1.918	1.743	1.882	2.114	2.352
Average Efficiency of conventional and Islamic banks								
Conventional banks	1.076	1.076	1.081	1.081	1.076	1.096	1.094	1.082
Islamic banks	1.187	1.289	1.195	1.204	1.214	1.215	1.200	1.215

Source: Extracted from (Abdul-Majid, 2008).

The positive estimate for ζ2 implies that full-fledged Islamic banks are found to have outputs that *ceteris paribus* are 6.6% lower than other banks and this may be due to constrained opportunities in terms of investments and limited expertise in Islamic banking. The coefficient for foreign-owned banks is negative, indicating that output increases by 14.0% relative to domestic banks. However, foreign-owned banks with IBS (Z_4) are found to have potential output that is 11.8% lower than foreign banks without IBS. The coefficient for the financial crisis dummy variable (Z_5) is negative, indicating that output increased by 2.7% in 1998 after controlling for other variables. This finding is consistent with the reactions of banks towards the financial crisis, which was to lay off substantial number of workers and to cut other operating expenses. The individual mergers (Z_6, Z_7, Z_8) are found to be associated with output that is 8.3%, 9.7% and 6.3% lower respectively, after controlling for other variables.

The efficiency estimates of Malaysian commercial banks using output distance function as shown in Table 2B is on average 1.055, and ranges from 1.011 to 1.220, hence on average, banks only produce 94.8%[12] of the output they could produce if they operated on the efficient frontier. The efficiency scores demonstrate that while there is little variation in the estimated efficiency once differences in the environmental variables are controlled for. In other words, if efficiency is judged against an efficient frontier, which for example, allows full-fledged Islamic banks to have 6.6 percent lower output, it should be expected that the resulting efficiency scores exhibit small difference across bank types. The yearly average and the range of the efficiency scores have risen and it implies a deteriorating in average efficiency over the sample period, but also the existence of a group of banks that were steadily deviating from the output frontier. Hence, average efficiency worsened from 1.042 in 1996 to 1.060 in 2002 and the maximum efficiency score deteriorated from 1.104 in 1996 to 1.211 in 2002.

The author finally compares the output distance function with the results the cost function in order to check the consistency of results. With the cost function approach, slightly higher average inefficiency estimates of 1.066 percent are found as compared to 1.055 when using an output distance function. On balance however, the author believes that an output distance function approach is a better method because the behavioural assumptions being made with the output distance function are less likely to create biases when jointly evaluating Islamic and conventional banks, and this approach also allows the author to avoid the further potential pitfall associated with price endogeneity.

Concentrating on the estimated output distance function parameters for cross-country analysis as reported in Table 1C,[13] recalling that, $\gamma = \sigma_u^2 / \sigma_v^2 + \sigma_u^2$, the highly significant estimate of 0.491 for this parameter, suggests that the

[12]OE=(1/ 1.055)100.

[13]The author notes that a log likelihood ratio test for the joint significance of the 6 parameters related to equity is 17.98, thus the author can reject the null hypothesis that these parameters are jointly insignificant at the 99 percent confidence level.

estimated deviation from the frontier is equally due to both inefficiency and statistical noise. Besides the statistically significant Islamic bank dummy variable, the only significant country-specific environmental variables are density of population, density of demand, and telephone lines per 100 inhabitants. Many country-specific variables become insignificant when country dummy variables are included in the model, thereby suggesting that these factors serve as proxies for cross country differences in bank efficiency, rather than legitimate determinants of potential output.[14]

The Islamic bank dummy (Z_1) has a positive coefficient, indicating that full-fledged Islamic banks are found to have potential efficient outputs that ceteris paribus are 14.1 % lower than other banks. Therefore the results suggest a systematic reduction in potential output that can be attributed to Islamic banking, which may result from constrained opportunities in terms of investments and limited expertise in Islamic banking. However, because the estimated model effectively assumes that the reduced outputs associated with Islamic banking result from legitimate differences in operating environment that reduce potential output, the efficiency scores reported below for Islamic banks must be carefully interpreted as they net out this impact.

In contrast to expectations, the sign of the coefficient of the population density variable (Z_2) is positive indicating that, *ceteris paribus* countries with high population density have lower bank output.[15] A possible explanation for this finding is that in non-price bank competition, banks may open branches in large cities, in which real estate and labour costs are high, for strategic reasons, and thereby reduce their potential outputs (Dietsch and Lozano-Vivas, 2000). As expected, lower density of demand (Z_3), tends to increase expenses thereby, limiting potential output. The finding of reducing potential output is consistent with (Dietsch and Lozano-Vivas, 2000) and (Carvallo and Kasman, 2005), which found that lower density of demand raises bank costs, and hence reduces efficiency. Finally, in contrast to the a priori assumption, the positive sign of telephone lines per 100 inhabitants' variable (Z_4) indicates that greater availability of telephone lines decreases bank outputs. This is possibly because most countries in the sample are developing economies[16] in which electronic communications including phone- and internet-banking are not fully developed. Hence, telephone usage may raise relative bank costs within the sample of countries.

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[14]Bank specific loan quality and merger dummy variables were also found to be statistically insignificant when they were included in the distance function.

[15]The finding is consistent with cost function studies in which higher population density contributes to an increase in banking costs in France and Spain (Dietsch and Lozano-Vivas, 2000), and Latin American and Caribbean countries (Carvallo and Kasman, 2005).

[16]All countries in the sample are developing economies except for Bahrain (World Bank, 2007).

Table 1C demonstrates that the country dummy variables illustrate systematic and significantly differences in the relative inefficiency of banks across countries. Thus, for example, δ_{Jordan} is found to be insignificantly different from zero, thereby suggesting that inefficiency for Jordanian banks is drawn from a standard half-normal distribution. However, banks in Malaysia, Bangladesh, Bahrain[17] and Iran are found to have δ_f<0 and hence, inefficiency in these countries is estimated as being drawn from truncated normal distributions with lower expected inefficiency than in a half normal distribution. In contrast, Sudan, Tunisia, Lebanon, Yemen, and Indonesia all have δ_f>0, and hence are estimated to have higher expected inefficiency than that drawn from a half-normal distribution, with given variance σ_u^2 . Furthermore, Table 1C suggests that while Iranian banks have on average the best output performance, Sudanese banks experience the worst output performance. This is consistent with two previous DEA studies, which find that Iranian banks are among the most efficient banks (Brown, 2003; Brown and Skully, 2003) and Sudanese banks are among the least efficient banks (Brown, 2003).[18] The parameters suggest a clear hierarchy of estimated efficiency across countries, with higher indicating greater inefficiency.

Table 2C reports the estimated efficiency of all, conventional and Islamic banks on average for cross country analysis, respectively. The efficiency of all banks is on average 1.105, and ranges from 1.010 to 2.352. The yearly average as well as the range of the average efficiency scores, has only slightly increased over time. Thus, average efficiency deteriorated from 1.087 in 1996 to 1.112 in 2002. The trend in both conventional and Islamic banks suggests only a slight decline in average efficiency over the sample period. Hence, the conventional bank average efficiency score increased from 1.076 in 1996 to 1.094 in 2002 and the Islamic bank average efficiency score increased from 1.187 in 1996 to 1.200 in 2002.

Across all countries, the average conventional and Islamic bank efficiency measures are 1.082 and 1.215, respectively. This suggests that on average, even after having netting out the 14.1% lower output associated with Islamic banking, potential output of conventional banks is only 8.2 % higher than actual output, while for Islamic banks this difference is 21.5%. Sudan and Yemen, which have only Islamic banks in the sample, have extremely low average estimated efficiency, even after netting out the impact of the statistically significant environmental characteristics and Islamic banking. Put differently, while the results do clearly demonstrate a significant 14.1% decrease in potential output attributable to Islamic banking, the further particularly poor performance

[17] Al-Jarrah and Molyneux (2005) also found that Bahrain is relatively efficient when compared to Jordanian banks.
[18] Even within Sudanese banks, wide inefficiency difference exists (Hussein, 2004).

of Islamic banks in Sudan and Yemen must be attributed to country specific banking inefficiency.[19]

The author finally emphasized that because the methodology assumes that differences in operating environment influence potential output rather than efficiency, the resulting efficiency estimates should in principle be interpreted as allowing for legitimate difference in potential output associated with compliance with *shari'ah*. Therefore, as argued by (Coelli, Sergio and Elliot, 1999), as this approach nets out the impact of operating environments, it provides a measure of managerial efficiency. Thus, based on this argument, Islamic banks are substantially more efficient in Tunisia and marginally more efficient in Malaysia, but less efficient in all other countries where both Islamic and conventional banks operate. However, this interpretation is dependent on the assumption that all of the reduced output of Islamic banks is attributable to differences in technology rather than systematically greater inefficiency amongst Islamic banks.

These results can be compared to the previous literature that does not allow for exogenous variables in either the frontier or as an influence on inefficiency: Islamic banks are found to be no different with conventional banks in Malaysia (Abdul-Majid, Mariani, Nor Ghani and Fathin, 2005; Mokhtar, et al., 2006), and equally if not more cost efficient in Turkey (El-Gamal and Inanoglu, 2005). Modelling for bank types of the Islamic bank, commercial, investment banks, country dummy, assets, liquidity, concentration ratio, and market share to directly influence inefficiency effects in Arabian countries, Islamic banks are found to be more cost efficient (Al-Jarrah and Molyneux, 2005). Controlling for loan quality and capital in the function and modelling for bank type, country dummy, assets, liquidity, concentration ratio, and market share to directly influence inefficiency effects in Arabian countries using profit function, Islamic banks are also more efficient (Al-Jarrah and Molyneux, 2005). Alshammari (2003) also found relatively efficient Islamic banks in GCC countries when loan quality and capital are included in the function, and bank type and country dummies are assumed to directly influence inefficiency. The differences in results may potentially be due to different environmental variables in the function, different input and output specifications, and cross-country differences in Islamic banking operation that may influence relative efficiency.[20]

B. Returns to scale

Table 3 provides firm specific scale economy estimates for all banks and by bank types using the three methodology. Using cost function, Table 3A demonstrates the range of the estimated scale economies is between 0.911 and 1.218 and this is consistent with the previous literature (Carvallo and Kasman, 2005; Orea, 2002). On average, these estimated scale economies have declined from 1.066

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[19]Efficiency estimates by country is available from the author by request.
[20]For example, Islamic banks in countries other than Malaysia may have a higher percentage of equity-based financing which has been controlled for in this study.

Table 3

Return to Scale for all, Islamic and Conventional Banks

	1996	1997	1998	1999	2000	2001	2002	All Years
A. Malaysian banks using cost function								
Descriptive Statistics: All Banks								
Average	1.066	1.061	1.059	1.042	1.026	1.026	1.025	1.043
Standard Deviation	0.036	0.042	0.041	0.040	0.053	0.039	0.049	0.048
Minimum	0.990	0.973	0.965	0.944	0.925	0.936	0.911	0.911
Maximum	1.115	1.140	1.150	1.166	1.218	1.084	1.104	1.218
Average return to scale of conventional, conventional with IBS and Islamic banks								
All banks	1.066	1.061	1.059	1.042	1.026	1.026	1.025	1.043
Without IBS	1.070	1.080	1.073	1.054	1.032	1.013	1.015	1.045
With IBS	1.064	1.056	1.054	1.038	1.027	1.038	1.038	1.045
Islamic	1.051	1.045	1.056	1.023	0.992	0.992	0.980	1.010
B. Malaysian banks using output distance function								
Descriptive Statistics: All Banks								
Average	1.018	1.017	1.004	0.989	0.974	0.969	0.967	0.990
Standard Deviation	0.035	0.032	0.038	0.035	0.047	0.040	0.046	0.044
Minimum	0.943	0.945	0.912	0.894	0.869	0.880	0.856	0.856
Maximum	1.062	1.061	1.081	1.067	1.092	1.034	1.051	1.092
Average return to scale of conventional, conventional with IBS and Islamic banks								
All Banks	1.018	1.017	1.004	0.989	0.974	0.969	0.967	0.990
Without IBS	1.015	1.030	1.006	0.988	0.968	0.957	0.957	0.985
With IBS	1.020	1.012	1.003	0.990	0.978	0.977	0.975	0.993
Islamic	1.016	1.013	1.004	0.989	0.972	0.963	0.945	0.978
C. Banks in 10 countries using output distance function								
Descriptive statistics: All Banks								
Average	1.045	1.044	1.040	1.032	1.025	1.023	1.022	1.034
Standard Deviation	0.021	0.022	0.023	0.025	0.020	0.023	0.023	0.024
Minimum	0.989	0.995	0.996	0.945	0.983	0.984	0.981	0.945
Maximum	1.093	1.117	1.128	1.106	1.097	1.103	1.096	1.128
Average return to scale of conventional and Islamic banks								
Conventional banks	1.044	1.040	1.035	1.027	1.021	1.018	1.019	1.030
Islamic banks	1.061	1.066	1.065	1.054	1.040	1.040	1.036	1.052

Note:
a: No mergers between Islamic banks have occurred during the sample period.
If return to scale >,< or =1, there are increasing return to scale; decreasing return to scale or constant returns to scale respectively.
Source: Extracted from (Abdul-Majid, 2008)

in 1996 to 1.025 in 2002. Similarly, within all of the bank types summarized, very moderate economies of scale and a slight downward trend in estimated scale economies is evident. Thus, there is little evidence for a difference in scale economies across the groups identified in Table 3A. Moreover, even though full-fledged Islamic banks are the only type with average economies of scale less than one in any year, this result is also consistent with the broader finding that most banks in the sample appear to operate at or near CRS.[21]

Table 3B illustrates the average estimated return to scale is 0.990 for Malaysian banks using output distance function, thereby indicating the presence of mild decreasing return to scale. The range of estimated returns to scale is between 0.856 and 1.092, and is consistent with the previous output-oriented literature (Cuesta and Orea, 2002). On average, this estimated scale elasticity has decreased from 1.018 in 1996 to 0.967 in 2002. Likewise, within all bank categories summarised in Table 3B, very mild decreasing returns to scale and a slight downward trend in estimates is observed. Thus, there is little evidence for a difference in returns to scale across the bank types identified in Table 3B.[22] Using both methods however, banks experience almost constant returns to scale.

Table 3C provides firm specific returns to scale estimates cross –country analysis for all, conventional and Islamic banks on average. Estimated returns to scale averages 1.034 for all banks, ranges between 0.945 and 1.128, and is consistent with the previous literature (Abd Karim, 2001; Carvallo and Kasman, 2005; Cavallo and Rossi, 2001). On average, these estimated returns to scale have declined from 1.045 in 1996 to 1.022 in 2002. The average estimated returns to scale for conventional banks is lower (1.030) than for Islamic banks (1.052) and this applies to all countries except for Malaysia and Jordan. This suggests that generally a larger scale of operation will be useful if Islamic banks wish to eliminate disadvantages attributable to their relatively small size. However, there is little evidence of substantial returns to scale to be gained, nor is there substantial difference in potential returns to scale between conventional and Islamic banks.[23] The trend for both conventional and Islamic banks also suggests a decline in average returns to scale over the sample period. Hence, conventional bank average returns to scale declined from 1.044 in 1996 to 1.019 in 2002 and Islamic bank average returns to scale declined from 1.061 in 1996 to 1.036 in 2002. Compared to other countries, Sudanese banks exhibit relatively strong returns to scale, which is consistent with the very small bank size in this country. This is consistent with Kasman (2005) who found economies of scale in small-sized banks in Poland and the Czech Republic.

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[21]Yudistira (2004) found that small and medium-sized Islamic banks in most countries have diseconomies of scale but Alshammari (2003) found that bank type has no effect of economies of scale in GCC countries.
[22]Yudistira (2004) found that small and medium-sized Islamic banks in most countries have diseconomies of scale but Alshammari (2003) found that bank type has no effect of economies of scale in GCC countries.
[23]Alshammari (2003) found almost constant returns to scale in banks (including Islamic banks) in GCC countries and no difference across bank types. However, Yudistira (2004) found that small and medium-sized Islamic banks in most countries have diseconomies of scale.

4. Conclusions

The aim of this paper is to examine the efficiency and economies of scale of Islamic banks relative to conventional banks using SFA. Operating characteristics such as *shari'ah* compliant banking could capture validated differences in costs or systematic differences in efficiency. Similar to cost function approach, using output distance function on Malaysian banks, higher input requirements for full-fledged Islamic banks relative to average banks have been found. In cross-country analysis, having netted out the 14.1 % lower output, the potential output of conventional banks is only 8.2 % higher than actual output, while for Islamic banks this difference is 21.5 %. However, as these efficiency estimates are net of the measured effect of Islamic banking, the inferior average performance of Islamic banks must be in part attributed to the low country-specific efficiency scores for certain countries. Furthermore, it has demonstrated that country effects play a significant role in explaining efficiency distributions between countries, even after controlling for country-specific environment conditions, including Islamic banking. The paper has however concluded that bank compliance with *shari'ah* which operates ethical banking activities has higher input requirements and it is possible that the reduced potential output is proof of systematic inefficiency.

Although studies on Malaysian banks found banks to operate at almost constant return to scale, the cross-country analysis demonstrates that the average estimated returns to scale for conventional banks are lower than those for Islamic banks, with the exception of Malaysia and Jordan. Therefore, moderate benefits will be realized even if Islamic banks attempt to increase their scale size.

Finally, the main conclusion derived from the paper, in which Islamic banks have relatively higher input requirements compared to conventional banks should however, motivate policy makers involved in Islamic banking and Islamic bank managers to identify and overcome factors leading to these higher input requirements. In addition, they should aggressively work to create a more encouraging banking environment for Islamic banking, if they plan to further expand Islamic banking.

In order to expand our knowledge and understanding concerning the investigated issues, more research especially applying advanced techniques needs to be carried out in different time and country settings and the investigation should also extend to foreign-owned Islamic banks.

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