EFFICIENCY IN ISLAMIC AND CONVENTIONAL BANKING: AN INTERNATIONAL COMPARISON

By
Mariani Abdul-Majid[a,b*], David S. Saal[a] and Giuliana Battisti[c]

RP 0811

[a]*Centre for Performance Measurement and Management*
Aston Business School
Aston University,
Birmingham, B4 7ET
United Kingdom

[b]*School of Economics,*
Faculty of Economics and Management
University Kebangsaan Malaysia
43600 UKM Bangi, Selangor
Malaysia

[c]*Nottingham University Business School*
Jubilee Campus, Wollaton Road, Nottingham NG8 1BB

**Corresponding author*
E-mail addresses:
D.S.Saal@aston.ac.uk (D.S.Saal),
mariani@ukm.my (M.Abdul-Majid),
giuliana.battisti@nottingham.ac.uk (G.Battisti)

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The Research Director, Aston Business School, Aston University,
Birmingham B4 7ET

Telephone No: (0121) 204 3000 Fax No: (0121) 204 3326 http://www.abs.aston.ac.uk/

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Abstract
The paper investigates the efficiency of a sample of Islamic and conventional banks in 10 countries that operate Islamic banking for the period 1996 to 2002, using an output distance function approach. We obtain measures of efficiency after allowing for environmental influences such as country macroeconomic conditions, accessibility of banking services and bank type. While these factors are assumed to directly influence the shape of the technology, we assume that country dummies directly influence technical inefficiency. The parameter estimates highlight that during the sample period, Islamic banking appear to be associated with higher input usage. Furthermore, by allowing for international differences in the underlying inefficiency distributions, we are also able to demonstrate statistically significant differences in efficiency across countries even after controlling for specific environmental characteristics and Islamic banking. Thus, for example, our results suggest that Sudan and Yemen have relatively higher inefficiency while Iran and Malaysia have lower estimated inefficiency. Except for Sudan, where banks exhibits relatively strong returns to scale, most sample banks exhibit very slight returns to scale, although Islamic banks are found to have moderately higher returns to scale than conventional banks. However while this suggests that Islamic banks may benefit from increased scale, we would emphasize that our results suggest that identifying and overcoming the factors that cause Islamic banks to have relatively high input requirements will be the key challenge for Islamic banking in the coming decades.

Keywords: Islamic Banking, international efficiency comparison, output distance function

1. INTRODUCTION

The emergence of Islamic banking has been driven by the increasing number of Muslims who wish to lead their lives according to the *shariah*, the legal code of Islam. The establishment of Nasser Social Bank in Egypt in 1971 (Iqbal and Molyneux 2005), the Dubai Islamic Bank in the United Arab Emirates and the Islamic Development Bank (IDB) in 1975 paved the way for the creation of other Islamic financial institutions all over the world (Central Bank of Malaysia 1999). Some form of Islamic financial services is now available in at least 70 countries Husain (2005).

The salient features of Islamic banking are the prohibition of interest payment in transactions, and the prohibition of undertaking or financing anti-social and unethical behaviour such as gambling, prostitution, alcohol and narcotics. An Islamic bank is governed by *shariah*, as well as the regulations set in place by the host country. While some Islamic banks were purposely established to operate within *shariah*, some Islamic banks were converted from conventional banks. Thus, in Iran and Sudan, all conventional banks were converted to Islamic banks in order to conform with government legislation (Sundararajan and Errico 2002). However, it is more common for countries with large Muslim populations to operate Islamic banking systems alongside conventional banking systems, as is now the case in Malaysia, Bahrain, Pakistan, Saudi Arabia, and Egypt (Hassan 2003).

Previous studies using cost and/or profit functions to compare the efficiency of Islamic and conventional banks, have found Islamic banks to be similar (Abdul-Majid, Mohammed Nor, and Said 2005; Mokhtar, Abdullah, and Al-Habshi 2006) if not better (Alshammari 2003; Al-Jarrah and Molyneux 2005) than conventional banks. However, (Abdul-Majid, Saal, and Battisti 2007) and (Abdul-Majid 2008) demonstrated that after properly taking into account environmental variables in either a cost or output distance function, Malaysian Islamic banks are found to have higher input requirements. This finding of higher input requirements for Islamic banks in Malaysia is the main motivation for this study, as we wish to further investigate how Islamic banks perform relative to conventional banks internationally. Moreover, an international study will allow analysis of how, respectively, Islamic and conventional banks from various countries perform relative to other countries, and whether significant differences across countries exist. This would potentially provide relevant findings for policy makers in the sample countries who wish to judge the relative performance of their banking sector.

We also note that the design of this study results from careful consideration of how to effectively compare the efficiency of conventional and Islamic banks, while properly allowing for relative differences between these types of banks. Thus, following several previous studies that include both conventional and Islamic banks, we adopt an intermediation approach. This approach is most suitable for comparably defining the relationship between bank outputs and inputs because Islamic banks adopt an equity participation principle that effectively intermediates between savers (depositors) and investors (e.g., Al-Jarrah and Molyneux 2005; El-Gamal and Inanoglu 2005). However, we also extend this approach by including equity as an input, because of both its role in Islamic banking and because we believe this better reflects the fact that banks can and do raise funds through equity financing.

This study similarly innovates by adopting an output distance function approach to compare Islamic and conventional banks. This implies the assumption of an output oriented approach, and therefore measure efficiency by comparing actual output relative to potential output, given fixed inputs. This approach has the advantage of allowing the use of identifiable output and input quantities such as deposits, total operating expenses and equity, and therefore allows us to avoid the possible problem of input price endogeneity (Orea 2002). Given differences in accounting standards across countries, as well as differences in conventional and Islamic banking assets, we also believe that for this international study, the standard approach of employing accounting information to define output and/or input prices, is particularly likely to result in distorted and inaccurate price estimates, and hence distorted cost or profit efficiency estimates. Finally, but most significantly, we have also adopted the output distance function approach because it does not require strong behavioral assumptions such as those required with a cost minimization or profit maximization approach. This is because the dual objective of Islamic banks, which are both maximizing profit for shareholders as well as fulfilling potentially non-profit maximizing obligations, may result in managerial objectives that differ substantially from those of conventional banks. Therefore, given its fewer behavioral assumptions, the output distance function approach should allow a more accurate comparison of the productive efficiency of Islamic and conventional banks, even if their managers have considerably different objectives.

In sum, this study aims to measure efficiency of banks in countries that have Islamic banking in operation as well as relative efficiency between countries, and will particularly focus on the relative performance of Islamic banks as compared to conventional banks. More specifically, by deriving estimates of efficiency for banks in different countries after estimating an output distance function with stochastic frontier techniques, the analysis highlights the impact of operating characteristics, including Islamic banking and country-specific conditions on the relative outputs of banks. In particular, the efficiency estimates highlight that during the sample period, Islamic banking appear to be associated with higher input usage. Moreover, by allowing for international differences in the underlying inefficiency distributions, we are able to demonstrate statistically significant differences in efficiency across countries even after controlling for specific environmental characteristics and Islamic banking.

The rest of the paper is organised as follows. Section 2 provides a brief literature review focused on the relative performance of banks across countries, and is followed by a description of the methodology in Section 3. Data and the empirical specification are discussed in Section 4. Section 5 reports the results which are comprised of the output distance function, efficiency, and returns to scale estimates. Finally, Section 6 offers some conclusions.

2. REVIEW OF THE LITERATURE AND THE MODELLING APPROACH

This study contributes to both the existing literature employing a parametric approach to measure cross-country bank efficiency as well as the literature considering the comparative efficiency of Islamic and conventional banks. As our approach to controlling for differences in operating environment will have a significant impact on estimated efficiency, it is necessary to carefully consider the impact of the chosen operating environment variables on measured efficiency. Moreover, as the choice of appropriate inputs and outputs will significantly influence estimated efficiency, we also consider previous definitions of the input output set in order to better model an appropriate common frontier for Islamic and conventional banks in a cross-country analysis. It is also necessary to carefully consider the influence of functional form on the measured efficiency of both conventional and Islamic banks in an international setting. Finally, we briefly take into account the findings of previous studies with regard to returns to scale in banking.

In estimating cross-country bank efficiency, while some studies (Allen and Rai 1996; Altunbas, Gardener, Molyneux, and Moore 2001; Maudos, Pastor, Pérez, and Quesada 2002) do not assume that any environmental conditions influence frontier estimation, and hence location of the frontier; other studies (Dietsch and Lozano-Vivas 2000; Bonin, Hasan, and Wachtel 2005; Carvallo and Kasman 2005) do control for these factors. The environmental conditions can be categorised into country-specific factors (Fries and Taci 2005; Williams and Nguyen 2005) or country dummy variables (Bonin, et al. 2005) and bank-specific factors. A common frontier without controls for country-specific factors is likely to be misspecified because each country may have a different banking technology as well as different environmental and regulatory conditions (Dietsch and Lozano-Vivas 2000), but the frontier assumes the same technology for all banks (Chaffai, Dietsch, and Lozano-Vivas 2001). Therefore, by controlling for these factors in a common frontier, efficiency rankings are more persistent (Fries and Taci 2005), efficiency estimates are improved (Dietsch and Lozano-Vivas 2000; Bonin, et al. 2005; Carvallo and Kasman 2005; Kasman 2005), and the estimates of efficiently more appropriately reflect the impact of less (or more) favourable country-specific conditions on estimated relative efficiency (Dietsch and Lozano-Vivas 2000). These country-specific factors can be broadly generalised into macroeconomic factors such as per capita income, density of demand, population density, banking concentration (Dietsch and Lozano-Vivas 2000; Carvallo and Kasman 2005; Williams and Nguyen 2005), bank structure and regulation such as bank branches per capita (Maudos and de Guevara 2007), intermediation ratio (Dietsch and Lozano-Vivas 2000), as well as accessibility of banking services, as measured with GDP growth (Kasman and Yildirim 2006) and density of bank branches (Dietsch and Lozano-Vivas 2000).

In this study, countries involved in the sample range from low to high income economies and significant differences exist in many characteristics including those related to politics, economics, social structure, and geography. Thus, for example Sudan is characterized by a culture of holding cash to hand, and is plagued by the effects of civil war, economic sanctions and drought, and these jointly influence the poorly developed

Sudanese banking sector (Bashir 1999; Hussein 2004). In contrast, due to its high level of economic development and its comprehensive regulatory framework, Bahrain has attracted confidence among investors (Iqbal and Molyneux 2005). These country specific differences in the background operating environment as well as significant differences in bank regulatory frameworks and financial reporting formats (Karim 2001) strongly suggest that controlling for country-specific effects appropriately will have an important impact on estimated efficiency in an international sample. Irrespective of controlling for country-specific factors in frontier estimation however, countries with bigger sample still show larger difference in the average efficiency scores relative to the small samples (Lozano-Vivas, Pastor, and Pastor 2002) and wide range of average inefficiency estimates exists across countries (Abd Karim 2001; Carvallo and Kasman 2005). Furthermore, Bonin, et al. (2005) found that country effects continue to play a significant part in explaining differences in efficiency measures even after they have been controlled in the frontier estimation.

As *shariah* compliant banking has different objectives and modus operandi from conventional banking, it may also have different operational characteristics from conventional banking and potentially influence the operating output. Therefore, it is appropriate to control for this bank-specific factor in the frontier estimation. Some previous SFA cross-country studies (e.g., Maudos, et al. 2002; e.g., Fries and Taci 2005; Williams and Nguyen 2005; Kasman and Yildirim 2006) have either controlled for bank output quality and/or equity in the frontier estimation. Bank output quality[1] (Fries and Taci 2005) or equity capital (Carvallo and Kasman 2005; Bos and Schmiedel 2007; Fitzpatrick and McQuinn 2007) has always before been treated as fully exogenous in the frontier estimation, although some studies have treated equity (Maudos, et al. 2002; Williams and Nguyen 2005; Kasman and Yildirim 2006) and even both loan quality and equity (Alshammari 2003) as "netputs"[2]. However, we would argue that even conventional banks employ equity capital as an input in addition to funds from deposits and inter-bank borrowings to finance loans (Bonaccorsi di Patti and Hardy 2005). Moreover, Islamic banks that apply the equity participation principle also depend

[1] If output quality is not controlled for, unmeasured differences in loan quality that are not captured by banking data may be mistakenly measured as inefficiency (Berger and Mester 1997).

[2] "Netputs" are operating characteristic variables that have been made fully interactive with inputs and outputs in the function.

significantly on equity as a source of funds (Metwally 1997). Therefore, while in the previous literature equity has generally been employed only as an environmental factor in frontier estimation, we strongly believe that a more appropriate modelling approach, which not only better specifies the input relationship for all banks but also allows a flexible specification that is more appropriate for comparing conventional and Islamic banks, is to directly include equity as an input.

Efficiency scores estimated using SFA have been correlated with environmental factors under investigation using two different methodologies. The first, which is a "one step" methodology simultaneously estimates the frontier and the impact of environmental factors on efficiency by using an inefficiency effects model, such as that proposed by Battese and Coelli (1995). These include both studies that assume no direct impact of environmental factors on the estimated frontier, and hence assume that they only influence efficiency (Abd Karim 2001; Alshammari 2003; Al-Jarrah and Molyneux 2005) and studies that control for these factors in estimating the frontier (Bonin, et al. 2005; Williams and Nguyen 2005; Fitzpatrick and McQuinn 2007). Within the former strand of literature, bank types dummy variables (Abd Karim 2001; Alshammari 2003; Al-Jarrah and Molyneux 2005), ownership, size (Abd Karim 2001), assets, liquidity and bank concentration ratios (Al-Jarrah and Molyneux 2005) have been assumed to directly influence inefficiency. In the later studies that assume environmental conditions to influence frontier estimation, country-specific factors such as size and governance-related factors (Williams and Nguyen 2005) and country dummy variables (Bonin, et al. 2005; Fitzpatrick and McQuinn 2007) have been controlled for.

Another significant methodology that has been employed in the literature employs a "two step" approach. Such studies have first estimated the frontier, followed by an OLS regression to find correlations between inefficiency scores and bank-specific factors (Allen and Rai 1996; Altunbas, et al. 2001; Maudos, et al. 2002). This category includes both studies that do not assume environmental conditions to influence frontier estimation and studies that control for these factors in estimating the frontier. Without controlling for any environmental conditions, the former (Allen and Rai 1996; Altunbas, et al. 2001; Maudos, et al. 2002) have subsequently correlated inefficiency with bank-specific factors such as ownership (Weill 2002), organisational structure (Boubakri, Cosset, Fischer, and Guedhami 2005), bank size, specialisation, profitability, risk and country-specific factors

(Maudos, et al. 2002). On the other hand, studies that control for these factors in estimating the frontier (e.g., Dietsch and Lozano-Vivas 2000; Carvallo and Kasman 2005) have subsequently correlated inefficiency with bank-specific factors such as loan quality, profitability, equity capital, non-interest income (Carvallo and Kasman 2005) and country-specific factors such as concentration ratio (Dietsch and Lozano-Vivas 2000). However, this "two-steps" procedure is associated with several anomalies and has been previously criticised (Coelli, Rao, and Battese 1998). We therefore employ a "one-step" procedure similar to Fries and Taci (2005) and Williams and Nguyen (2005). The present study will control for country-specific factors, and *shariah* compliant banking in the frontier estimation. It will also test for the significance of country dummy variables in the inefficiency effects model using Battese and Coelli (1995)'s model of "one-step" procedure.

With regard to the chosen functional form, most cross-country studies of banking efficiency have employed a cost function approach (Dietsch and Lozano-Vivas 2000; Abd Karim 2001; Carvallo and Kasman 2005; Fries and Taci 2005; Kasman 2005; Carbo Valverde, Humphrey, and Lopez del Paso 2007; Maudos and de Guevara 2007), or a profit function approach (Kasman and Yildirim 2006; Fitzpatrick and McQuinn 2007). Moreover, studies have increasingly simultaneously employed both cost and profit functions (Alshammari 2003; Hassan 2003; Al-Jarrah and Molyneux 2005; Bonin, et al. 2005; Hassan 2005; Kasman and Yildirim 2006; Bos and Schmiedel 2007). Nevertheless, with international comparisons of efficiency, one must note that international differences in accounting information might lead to distorted price estimates, thereby undermining the common use of both cost and profit functions for measuring bank efficiency. Moreover, as the moral underpinnings of Islamic banking may cause Islamic bank managers to pursue objectives that are less consistent with an assumption of cost or profit optimisation than those of conventional bank managers, the implicit behavioural assumptions of a cost/profit function approach may result in biased downward estimates of Islamic bank managerial efficiency. This study will therefore extend the approach of Cuesta and Orea (2002) and will measure the efficiency of banks internationally using an output distance function, which not only does not require price information, but also does not require any behavioural assumption such as cost minimisation or profit maximisation. This study will therefore join the limited number of studies using an output distance function approach to judge cross-country banking efficiency (Chaffai, et al. 2001; Olgu 2006), and, to our knowledge, is the first cross-country study of Islamic and conventional bank efficiency that has employed an output distance function approach.

Focussing briefly on returns to scale estimates in the previous literature, slight economies of scale are found in every production scale but are more pronounced in small banks in some studies (Abd Karim 2001; Altunbas, et al. 2001; Cavallo and Rossi 2001). However, other studies also find evidence of diseconomies of scale in large banks (Allen and Rai 1996; Carvallo and Kasman 2005), small and medium-sized Islamic banks (Yudistira 2004) and small banks (Kasman 2005). Irrespective of differences in the findings however, on average, returns to scale estimates are normally near one which indicates that on average, banks operate at almost constant returns to scale (e.g., Clark 1996; Cuesta and Orea 2002; Orea 2002; Carvallo and Kasman 2005). In addition, bank type (e.g. Islamic, conventional commercial or conventional merchant) is found to have little or no significant impact on estimated scale economies in GCC banks (Alshammari 2003). Given these limited previous findings, the model below will also investigate returns to scale of both Islamic and conventional banks internationally.

In sum, the discussion of the previous literature has demonstrated the importance of controlling for operating characteristics, and particularly country-specific environmental conditions, when estimating bank efficiency. In particular, it highlights that country effects play a significant part in explaining estimated efficiency differences across countries, and must therefore be carefully modelled. Moreover, in contrast to the previous literature, it has also been argued that equity should be modelled as an input because it is an important potential source of financing for conventional and particularly Islamic banks. In addition, this section has illustrated the advantage of employing an output distance function in an international study in which behavioural objectives may differ significantly between banks. The model below will therefore employ an output distance function and control for country-specific factors and *shariah* compliant banking directly in the estimated frontier as well as allowing for international differences in the underlying inefficiency distribution using Battese and Coelli (1995)'s model. Moreover, given the specification below it will be possible to test for statistically significant differences in the parameters that define each country's efficiency distribution. This study will therefore provide a useful methodology and therefore expand upon the existing literature that has analysed cross-country bank efficiency, in addition to providing a comparison between Islamic and conventional banks. Given this discussion, the following section further details the methodological approach employed,

3. METHODOLOGY

3.1 Output distance function

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, et al. 1998; Cuesta and Orea 2002). 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 by:

$$T = \{X,Y) : X \in R_+^K, Y \in R_+^M, X\ can\ produce\ Y\} \quad (1)$$

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:

$$P(X) = \{Y : (X,Y) \in T)\}. \quad (2)$$

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

$$D_o(X,Y) = \min . \left\{ \varpi > 0 : \left(\frac{Y}{\varpi} \right) \in P(X) \right\}. \quad (3)$$

The output distance function is non-decreasing, positively linearly homogeneous, increasing in Y, decreasing in X, and defined as the maximum feasible expansion of the output vector given the input vector (Fare and Primont 1995). Given the input vector X, the production possibility set is the area bounded by the production possibility frontier (PPF), which defines the maximum feasible output. If the output vector Y is an element of P(X), $D_o(X,Y) \leq 1$. However, if firms produce on the PPF, $D_0(X,Y) = \varpi = 1$, indicating technical efficiency. In contrast, for an inefficient firm operating within the area bounded by PPF, $D_0(X,Y) = \varpi < 1$, thereby indicating the ratio of actual output to potential output. Farrell's (1957) output-oriented measure of technical efficiency, defined as the maximum producible radial expansion of the output vector, can then be represented as:

$$OE_0 = 1 / D_0(X,Y) \quad (4)$$

3.2 The econometric specification

Following Fare and Primont (1995) and Cuesta and Orea (2002), and also allowing for exogenous factors, the general form of a stochastic output distance function can be shown as:

$$1 = D_o\left(Y_{n,t}, X_{n,t}, Z_{n,t}, \beta\right)\ h\left(\varepsilon_{n,t}\right) \quad (5)$$

where $h\left(\varepsilon_{n,t}\right) = \exp\ \left(u_{n,t} + v_{n,t}\right)$, $Y_{n,t}$ 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 of $v_{n,t}$ which represents random uncontrollable error that affects the n-th firm at time t, and $u_{n,t}$ is assumed to be attributable to technical inefficiency.

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

$$D_o\left(Z, X, \frac{Y}{Y_M}\right) = \frac{D_o(Z, X, Y)}{Y_M} \quad (6)$$

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

$$\frac{1}{y_{M,n,t}} = D_o\left(Y^*_{n,t}, X_{n,t}, Z_{n,t}, \beta\right).\ h\left(\varepsilon_{n,t}\right) \quad (7)$$

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

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

$$+\frac{1}{2}\sum_{m=1}^{M-1}\sum_{j=1}^{M-1}\beta_{m,j}\ln Y^*_{m,n,t}\ln Y^*_{j,n,t} + \sum_{k=1}^{K}\sum_{m=1}^{M-1}\theta_{k,m}\ln X_{k,n,t}\ln Y^*_{m,n,t}$$

$$+\sum_{k=1}^{K}\tau_{k,t}\ln X_{k,n,t}t + \sum_{m=1}^{M-1}\psi_{m,t}\ln Y^*_{m,n,t}t + \lambda_1 t + 0.5\lambda_2 t^2 + \sum_{h=1}^{H}\xi_h Z_{h,n,t} + v_{n,t} + u_{n,t} \quad (8)$$

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 input; m=1,2,…M and j=1,2,..M are indices for output; h=1,2,…H is an index for the total of H environmental Z variables that are included to account for differences in operating environment discussed above, and the Greek letters (except *v* and *u*) represent unknown parameters to be estimated. Standard symmetry is imposed to the second order parameters by imposing the constraints $\alpha_{ks}=\alpha_{sk}$ and $\beta_{mj}=\beta_{jm}$.

We specify Battese and Coelli (1995)'s truncated normal SFA model with the mean of the truncated normal distribution made an explicit function of country dummy variables. This is illustrated in Equation 9, which follows the formulation of the model detailed in (Coelli 1996). Thus, $v_{n,t}$ is assumed to be normally distributed with zero mean and variance σ_v^2 and independently distributed of the $u_{n,t.}$ $u_{n,t} \geq 0$ is assumed to be drawn from a truncation (at zero) of the normal distribution with mean, $EM_{n,t}$ and variance σ_u^2 where δ_f is a parameter to be estimated, f=1,2..,F is an index for countries, and C is a country dummy . Therefore, given the absence of a constant in Equation 9, 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 8, 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

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

of the country specific inefficiency distributions (δ_f) specified in Equation 9 are estimated simultaneously using maximum likelihood estimation (MLE) techniques.

$$EM_{n,t} = \sum_{f=1}^{F} \delta_f C_{f,n,t} \tag{9}$$

Figure 1 illustrates the implication of the specification by demonstrating that because $\delta_B < \delta_A$ expected inefficiency for Country B is smaller than for Country A. Differences in δ_f, will therefore relate to differences in estimated average inefficiency across countries.

(Figure 1 about here)

Following from Equation 5, and given the model assumptions, an estimate of output distance can be derived as $D_o(Y_{n,t}, X_{n,t}, Z_{n,t}, \beta) = \exp(-\mu)$. Equivalently, an estimate of output oriented efficiency is obtainable as:

$$OE_{n,t} = \frac{1}{D_0\left(Y_{n,t}, X_{n,t}, Z_{n,t}, \beta\right)} = \exp(\mu_{n,t}) \tag{10}$$

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

$$E\left[\exp(u_{n,t}) \middle| \varepsilon_{n,t}\right] = \frac{\left\{\exp\left[(1-\gamma)m_{n,t} + \gamma\varepsilon_{n,t} + 0.5\left(\sigma_*^2\right)\right]\right\}\left\{\Phi\left[\left((1-\gamma)m_{n,t} + \gamma\varepsilon_{n,t} / \sigma_*\right) + \sigma_*\right]\right\}}{\Phi\left((1-\gamma)m_{n,t} + \gamma\varepsilon_{n,t} / \sigma_*\right)} \tag{11}$$

In the cross-country bank efficiency literature, the importance of specifying environmental variables so as to minimize bias in the efficiency model has been recognized. Dietsch and Lozano-Vivas (2000) argue that neglecting country-specific variables leads to misspecification of the common frontier and overestimates inefficiency. Thus, most previous studies have controlled for country-specific variables (e.g., Maudos and de Guevara 2007) and country dummy variables (Bonin, et al. 2005). Furthermore, certain studies have allowed exogenous factors to directly influence inefficiency effects by including country dummies, bank organisational structure controls such as an Islamic bank dummy (Alshammari 2003; Al-Jarrah and Molyneux 2005), assets, liquidity and concentration ratios (Al-Jarrah and Molyneux 2005). In a similar approach to ours, besides including country-specific variables in the estimated function, Williams and Nguyen (2005) also use the Battese and Coelli (1995)'s inefficiency effects model, to determine the effect of governance.

In the model, we have followed the recent practice of controlling for differences in economic and regulatory environments between countries that may explain 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 estimate how firms are ranked under the assumption that firms operate in an equivalent environment, while at the same time estimating how bank efficiency in one country differs from another. Moreover, by employing the parameter covariance matrix, we can also directly test whether the δ_f parameters and hence estimated inefficiency is significantly different across countries.

Given the estimated model, returns of scale for the banks in the sample can also be estimated, using the estimated scale elasticity. As in Cuesta and Orea (2002), scale elasticity can be calculated as the negative of the sum of the input elasticities:

$$SCALE_{n,t} = -\sum_{k=1}^{K} \frac{\partial \ln D_o\left(Y_{m,n,t}, X_{k,n,t}\right)}{\partial \ln X_{k,n,t}} \tag{12}$$

If $SCALE_{n,t} > 1$ a bank is operating at increasing returns to scale (IRS). If $SCALE_{n,t} < 1$, there is decreasing returns to scale (DRS) and constant returns to scale (CRS) are present if $SCALE_{n,t} = 1$.

4. THE DATA AND THE EMPIRICAL SPECIFICATIONS

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. Table 1 describes the sample of banks by type of bank for each country under study.

(Table 1 about here)

The selection of output and input variables follows the intermediation approach which has been widely employed in conventional bank studies (e.g., Maudos, et al. 2002; Carbo, Gardener, and Williams 2003), Islamic bank studies (e.g., Brown and Skully 2003; Hassan 2003; Yudistira 2004) and Islamic and conventional bank studies (e.g., Alshammari 2003; Al-Jarrah and Molyneux 2005). The intermediation approach focuses on a bank's role in intermediating savers and investors of funds, and is the most consistent with the concept of Islamic banking. This is because Islamic banking relies on profit-sharing contracts, which involve an equity participation principle[4] with depositors[5], and banks can therefore be seen as intermediating savers and investors by transforming deposits into earning assets, rather than as producers of services and loans.

Previous studies that employ the intermediation approach found that equity is significant in defining bank output but many (e.g., Girardone, Molyneux, and Gardener 2004; Kasman and Yildirim 2006) include it either as an environmental variable or a netput. Thus, it has not been employed as an input in single-country studies[6] (e.g., Mester 1996; e.g., Girardone, et al. 2004), and cross-country studies, nor in those using a profit function (Alshammari 2003; Al-Jarrah and Molyneux 2005; Kasman and Yildirim 2006) or a cost function (Carbo, et al. 2003; Al-Jarrah and Molyneux 2005; Kasman and Yildirim 2006).[7] 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

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[4] Some current Islamic banks also practice debt-like financing such as murabaha.

[5] In some Islamic banks, deposits or equity contributed by depositors are categorised under shareholders' funds, but some Islamic banks group them as deposits from customers, similar to conventional banks (Karim 2001).

[6] Some studies has treated equity capital as netput in the translog function (Berger and Mester 1997; Hasan and Marton 2003; Bonaccorsi di Patti and Hardy 2005; Kraft, Hofler, and Payne 2006).

[7] Dietsch and Lozano-Vivas (2000) and Kasman (2005) treat equity-to-assets ratio as a country-specific variable to proxy bank regulation.

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.

We therefore include 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)* loans and *(Y_2)* total other earning assets, and three inputs, *(X_1)* total operating expense, *(X_2)* deposits, measured by total deposits including customer funding and short term funding, and *(X_3)* equity, measured by total equity.

Table 2 presents the average values of bank outputs and inputs, expressed in constant 2000 US dollars for each country over the 1996-2002 period.[8, 9] While deposits on average represent 79-92 percent of banking inputs, equity on average represents 4-19 percent of all banking inputs for each country. Non-financial inputs are on average less than 10 percent of banking inputs. Differences in average input and output between countries are high, with Sudan and Iran, respectively having the smallest and largest average volume of bank loans. However, banks in Bangladesh and Jordan have similar average volumes of loans, other earning assets, operating expense, deposits and equity, when they are respectively compared to Yemen and Malaysia.

(Table 2 about here)

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 are 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.

[8] In the estimation, all variables are normalized around their means and the linear homogeneity in outputs is imposed using the output Y_2 as a numeraire.
[9] All data employed in this analysis is converted into constant international dollars according to the purchasing power parity hypothesis (Lozano-Vivas, et al. 2002).

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

(Table 3 about here)

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, we expect 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, and it is illustrated in Table 1. Inclusion of this variable will allow us 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 (e.g., Al-Jarrah and Molyneux 2005; El-Gamal and Inanoglu 2005; Mokhtar, et al. 2006) and none has assumed Islamic banking to influence potential bank output. We also note 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, we adopt 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.

Table 3 reports the average values of these environmental variables for each country over the 1996-2002 periods. The mean values exhibit significant variations in the macroeconomic conditions of banking activities across countries. In particular, Bahrain and Bangladesh have very high population density relative to other countries. Bahrain also has extremely high per capita income and deposits per kilometre squared. In contrast, Sudan has very low population density and very marginal deposits per kilometre squared. Furthermore, Bahrain, Iran and Jordan have relatively high concentration ratios. The banks in Sudan and Yemen stand out as they convert only 50 percent of their deposits into loans compared to 94 percent for the average country. This is possibly because banks in these countries face difficulties to make investments due to poor socio-economic conditions (Breitschopf 1999; Hussein 2004). The high cost of borrowing in Sudan and Sudanese culture of holding cash (Hussein 2004) as well as Yemeni culture of relying on micro-enterprise (Breitschopf 1999) may have contributed to the low loan-to-deposits ratio in banking. In contrast to Jordan which has all roads paved, Bangladesh and Yemen have about 10 percent of roads paved. Finally, as 24.7 telephone lines per 100 inhabitants is the maximum amount, this reflects the low development of electronic communications in most countries included in the sample. In sum, the descriptive statistics suggest that while Sudan and Yemen have the worst potential operating environments, Bahrain has the most favourable operating environment.

5. RESULTS

5.1 The output distance function estimates

The estimated output distance function parameters are reported in Table 4.[10] 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 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 into the model, thereby suggesting that these factors serve as proxies for cross country differences in bank efficiency, rather than legitimate determinants of potential output.[11]

(Table 4 about here)

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 percent 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.[12] 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

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

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

[12] 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).

(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 *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[13], 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.

Table 4 demonstrates that the country dummy variables illustrate systematic and significant 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[14] 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 4 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).[15] The δ_f parameters suggest a clear hierarchy of estimated efficiency across countries, with higher δ_f indicating greater inefficiency.

[13] All countries in the sample are developing economies except for Bahrain (World Bank 2007).
[14] Al-Jarrah and Molyneux (2005) also found that Bahrain is relatively efficient when compared to Jordanian banks.
[15] Even within Sudanese banks, wide inefficiency difference exists (Hussein 2004).

As the δ_f parameters are inversely related to expected inefficiency in each country, they can be directly employed to test for statistically significant differences in estimated inefficiency between any two countries in the sample. This is demonstrated in Table 5. Statistics above the diagonal report the difference in the estimated δ_f parameters for each country relative to the country on the first column, in the same row. Below the diagonal is the corresponding *t*-ratio for a test of the significance of the difference in the estimated δ_f parameters of each country relative to the country identified on the first row in the same column. For example, the first row demonstrates the estimated δ_f for Malaysian banks is 0.446 greater than that for Iranian banks, thereby suggesting that Iranian banks are on average more efficient. Nevertheless, the related t-statistic in the first column (0.754) demonstrates that this estimated difference is not statistically significant. Similarly, while Bahrain's δ_f parameter is 0.188 greater than Malaysia's, thereby suggesting greater average inefficiency in Bahrain, this difference is not statistically significantly different from zero based on a t-statistic of 1.481. However, all other countries have higher estimated inefficiency distributions compared to Malaysia and these differences are statistically significant. These results therefore suggest that Malaysian banks are significantly more efficient when compared to banks in other countries except for Iran and Bahrain.

Choosing Jordan as another example, the fifth row demonstrates that Yemeni and Indonesian banks' estimated inefficiency distributions are 0.459, and 0.259 higher than Jordanian banks, respectively. In contrast, Bahraini and Iranian banks' estimated inefficiency distributions are 0.306 and 0.940 lower than Jordanian banks, respectively. As the respective t-tests for these four statistics (4.222, 2.820, 1.833 and 1.653) are statistically significantly different from zero, this suggests that Yemeni and Indonesian banks are statistically less efficient, and Bahraini and Iranian banks are statistically more efficient than Jordanian banks. In contrast, the t-ratio of 1.506 as in the fifth column demonstrates that the estimated difference in the estimated inefficiency distributions for Lebanon is not statistically significant from zero implying that Lebanese banks are not significantly less efficient relative to Jordanian banks. In sum, analysis of various statistics reported in Table 5 suggest that Yemeni, Indonesian, Sudanese and Tunisian banks are significantly less efficient, while Bahraini, Iranian, Malaysian and Bangladeshi banks are significantly more efficient than Jordanian banks.

(Table 5 about here)

5.2 Efficiency estimates

Table 6 and Table 7 report the estimated efficiency of all, conventional and Islamic banks on average, and by country, respectively. The efficiency of all banks is on average 1.105, and ranges from 1.010 to 2.352. Moreover, as should be expected, the observed average efficiency hierarchy by country demonstrated in Table 7 is consistent with the estimated inefficiency distributions as previously detailed in Table 4 and 5. 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. However, this efficiency deterioration applies only in certain countries and especially in Sudan. 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. These deteriorations however, do not apply to all countries.

(Table 6 about here)

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 percent lower output associated with Islamic banking, potential output of conventional banks is only 8.2 percent higher than actual output, while for Islamic banks this difference is 21.5 percent. In contrast to this aggregate result, Table 7 shows little variation in estimated efficiency between Islamic and conventional banks within most countries. It is therefore clear that the substantially lower cross-country average estimated efficiency for Islamic banks relative to conventional banks reported in Table 6 can only be attributed to country effects. Thus, 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 percent decrease in potential output attributable to Islamic banking, the further particularly poor performance of Islamic banks in Sudan and Yemen must be attributed to country specific banking inefficiency.

(Table 7 about here)

We finally emphasize 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 *shariah*. Therefore, as argued by (Coelli, Perelman, and Romano 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 do not allow for exogenous variables in either the frontier or as influence on inefficiency: Islamic banks are found to be no different from conventional banks in Malaysia (Abdul-Majid, et al. 2005; Mokhtar, et al. 2006), and equally if not more cost efficient in Turkey (El-Gamal and Inanoglu 2005). Modelling for bank types of 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 that may influence relative efficiency.[16]

5.3 Returns to scale

Table 8 and 9 provide firm specific returns to scale estimates for all, conventional and Islamic banks on average, and by country. Estimated returns to scale averages 1.034 for all banks, ranges between 0.945 and 1.128, and is consistent with the previous literature (e.g., Abd Karim 2001; Cavallo and Rossi 2001; Carvallo and Kasman 2005). 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.[17] 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 as demonstrated in Table 2. This is consistent with Kasman (2005) which found economies of scale in small-sized banks in Poland and the Czech Republic.

(Table 8 about here)

While there is evidence for some variations in returns to scale across countries and across bank types, as summarized in Table 9, the country specific results are still consistent with the overall finding of very moderate returns to scale and a slight downward trend in estimated returns to scale. Thus, most banks in the sample appear to operate at or near constant returns to scale, and the results provide little evidence for strong returns to scale in banking.

[16] 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.

[17] 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.

(Table 9 about here)

6. CONCLUSION AND POLICY IMPLICATIONS

This study employs an output distance function to examine the efficiency and returns to scale of Islamic banks relative to conventional banks in countries that have Islamic banks, namely Malaysia, Sudan, Bangladesh, Tunisia, Jordan, Lebanon, Yemen, Indonesia, Bahrain and Iran for the period 1996-2002. A common frontier with country-specific environmental variables has been estimated for a panel of 111 banks after allowing for country specific differences in estimated inefficiency. The resulting model enables better understanding of difference between Islamic and conventional banks and across different countries.

As we have modelled bank compliance with *shariah* under the assumption that this is a true exogenous factor that influences potential output, the results suggest that *ceteris paribus*, Islamic banks have 14.1 percent lower outputs. Nevertheless, it is equally plausible that the reduced potential output of Islamic banks is evidence of systematic inefficiency. Moreover, we would argue that ultimately one's interpretation of the reduced potential output associated with Islamic banking will be influenced by one's beliefs. If one believes that the tenets of *shariah* are legitimate, then this result can be properly interpreted as the result of legitimate differences in the nature of the banking product that reduces potential output. In contrast, if one does not accept the legitimacy of *shariah*, the reduced output for compliance with *shariah* is more likely to be interpreted as inefficiency. Thus, while the results provide evidence to answer the positive query of whether Islamic banking is associated with reduced potential outputs, ultimately the interpretation of these results is a normative matter influenced by the values of the interpreter.

Turning to the actual efficiency estimates, the results suggest that for all banks, average potential output exceeds actual output by 10.5 percent, while the corresponding averages for all conventional and Islamic banks are respectively 8.2 percent and 21.5 percent. However, as these efficiency scores already net out the measured impact of Islamic banking, the lower average performance of Islamic banks must be attributed to the low country-specific efficiency scores for Sudanese and Yemeni banks. Thus, the model clearly demonstrates that even after controlling for differences in operating environment, large systematic differences in efficiency across countries exist. Moreover, the results indicate a wide range of output efficiencies across countries, ranging from 1.014 for Iran to 1.724 for Sudan, which are notably the only two countries in the sample that legally mandate Islamic banking.

Therefore, similar to Bonin et. al (2005), this study shows that country effects play a significant part in explaining efficiency distributions between countries, even after controlling for country-specific environment conditions, including Islamic banking. However, this study goes further, as we have tested for statistically significant differences in the parameters that define each country's efficiency distribution. The results therefore provide statistically validated evidence that suggests that banks in Iran, Malaysia, Bahrain and Bangladesh have achieved relatively high levels of efficiency compared to other countries in the sample. In contrast, while the efficiency of banks in Jordan, Lebanon, Tunisia, and Indonesia falls into a middle category, banks in Yemen and Sudan can be classified as highly inefficient.

We finally note that on average, the banks in each of the 10 sample countries exhibit moderate returns to scale. However, the average estimated returns to scale for conventional banks are lower than those for Islamic banks, with the exception of Malaysia and Jordan. However, while this result suggests that Islamic banks will benefit more from increased scale than conventional banks, the average scale economy estimate of 1.052 for all Islamic banks indicates that only moderate gains will be achieved even if Islamic banks strive to increase their scale size. This therefore suggests that while growth may allow Islamic banks to improve their scale efficiency, identifying and overcoming the factors that cause Islamic banks to have relatively high input requirements will be the key challenge for Islamic banking in the coming decades.

Table 1
Sample of banks, 1996-2002

Country	Islamic		Conventional		Total	
	Number	Observations	Number	Observations	Number	Observations
Malaysia	2	10	34	188	36[a]	198
Sudan	3	16	0	0	3	16
Bangladesh	3	10	13	84	16	94
Tunisia	1	4	8	29	9	33
Jordan	1	5	4	26	5	31
Lebanon	1	3	12	64	13	67
Yemen [d]	2	8	0	0	2	8
Indonesia	1	7	11	41	12[b]	48
Bahrain	6	23	6	31	12[c]	54
Iran	3	9	0	0	3	9
Total	*23*	*95*	*88*	*463*	*111*	*558*

Notes:
[a] 11 mergers occurred during the sample period.
[b] 1 merger occurred during the sample period.
[c] 2 mergers occurred during the sample period.
[d] Bank scope data on conventional banks are incomplete although Yemen has both types of banks.

Table 2
Average values of outputs and inputs by country, 1996-2002 (Int'l $ mil)[a]

Countries	Output		Input		
	Loans	Other earning assets	Operating expense	Deposits	Equity
Malaysia	5,480.7	3,148.0	134.6	7,113.8	740.4
Sudan	61.2	91.9	17.7	175.5	27.0
Bangladesh	176.7	13.1	4.5	218.5	13.8
Tunisia	1,871.3	498.0	44.8	1,967.5	262.0
Jordan	4,478.4	5,912.8	173.4	8,094.2	762.8
Lebanon	171.5	281.1	12.2	486.9	30.1
Yemen	115.4	51.8	3.6	173.9	21.7
Indonesia	397.2	250.2	15.9	459.4	108.6
Bahrain	993.9	941.0	28.6	1,559.8	223.8
Iran	15,391.5	10,311.9	753.6	20,960.2	812.1
Average bank	*2,736.6*	*1,793.2*	*79.1*	*3,721.6*	*371.7*

[a] Constant 2000 USD

Table 3
Environmental characteristics by country (1992-1996) [a]

Countries	Macroeconomic conditions				Bank structures		Accessibility of banking services	
	Density of population :inhabitant/ km^2	Per capita income: GNI per inhabitant (int $)[a]	Density of demand: deposits per km^2 (Int $) [a]	Real GDP growth (%)	Concentration ratio (%)	Intermediation ratio: loan/ deposits	Road paved (% of total roads)	Telephone lines per 100 inhabitants
Malaysia	68	8,032	680,322.3	4.7	0.46	1.36	76	19.6
Sudan	13	1,413	1.4	5.1	0.70	0.45	36	0.9
Bangladesh	879	1,727	388,542.8	5.0	0.59	1.15	9	0.4
Tunisia	57	5,607	142,283.6	5.2	0.51	1.36	70	8.6
Jordan	54	3,848	174,378.9	2.6	0.90	1.03	100	11.0
Lebanon	335	5,816	2,883.7	2.4	0.34	0.92	90	16.9
Yemen	33	726	3,681.6	4.7	0.77	0.50	10	1.9
Indonesia	109	2,696	158.7	1.6	0.55	1.03	46	3.1
Bahrain	984	15,057	10,691,990.7	5.2	0.90	0.83	77	24.9
Iran	40	5,807	87.9	2.2	0.92	0.81	56	11.6
Average	257.2	5,072.9	1208433.2	3.9	0.66	0.94	57	9.9

Notes:
[a] in constant 2000 USD
Sources: Bank Scope, International Financial Statistic, Euromonitor, World Bank, own calculations.

Table 4
Maximum likelihood estimates for parameters of the output distance function: 1996-2002

Parameters	Coefficient[a]	Estimated value[b]	Standard error
φ_0	Constant	-0.268***	0.058
$\acute{\alpha}_1$	ln X_1	-0.069***	0.019
$\acute{\alpha}_2$	ln X_2	-0.760***	0.021
$\acute{\alpha}_3$	ln X_3	-0.206***	0.014
$\acute{\alpha}_{1,1}$	$(\ln X_1)^2$	-0.046	0.031
$\acute{\alpha}_{2,2}$	$(\ln X_2)^2$	-0.066***	0.022
$\acute{\alpha}_{3,3}$	$(\ln X_3)^2$	-0.127***	0.014
$\acute{\alpha}_{1,2}$	ln X_1 ln X_2	0.003	0.021
$\acute{\alpha}_{1,3}$	ln X_1 ln X_3	0.020	0.019
$\acute{\alpha}_{2,3}$	ln X_2 ln X_3	0.095***	0.015
β_1	ln Y_1	0.590***	0.011
$\beta_{1,1}$	$(\ln Y_1)^2$	0.187***	0.008
$\theta_{1,1}$	ln X_1 ln Y_1	0.025**	0.011
$\theta_{2,1}$	ln X_2 ln Y_1	-0.011	0.010
$\theta_{3,1}$	ln X_3 ln Y_1	-0.021*	0.011
λ_1	t	0.007	0.004
λ_{11}	t^2	-0.002	0.004
τ_1	ln X_1 t	-0.011	0.007
τ_2	ln X_2 t	0.002	0.006
τ_3	ln X_3 t	0.014***	0.005
Ω_1	ln Y_1 t	0.001	0.004
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
Log Likelihood			288.120

Notes:
[a] X_1, X_2, X_3, Y_1, Y_2, t refer to total operating expense, deposits, equity, loans, other earning assets and year.
[b] *,**,*** Significant at 90, 95 and 99 percent confidence level.

Table 5

Relative difference in country's estimated mean of inefficiency distribution and *t*-ratio test

	Malaysia	Sudan	Bangladesh	Tunisia	Jordan	Lebanon	Yemen	Indonesia	Bahrain	Iran
Malaysia		*-1.078*	*-0.175*	*-0.752*	*-0.494*	*-0.653*	*-0.954*	*-0.753*	-0.188	0.446
Sudan	*7.167*		*0.903*	*0.326*	*0.584*	*0.425*	0.124	*0.325*	*0.890*	*1.524*
Bangladesh	*1.799*	*5.985*		*-0.577*	*-0.319*	*-0.478*	*-0.779*	*-0.578*	-0.013	0.621
Tunisia	*6.273*	*4.241*	*4.734*		*0.258*	0.099	*-0.202*	-0.002	*0.564*	*1.198*
Jordan	*3.120*	*5.684*	*2.047*	*2.746*		-0.159	*-0.459*	*-0.259*	*0.306*	*0.940*
Lebanon	*6.792*	*4.527*	*5.077*	1.365	1.506		*-0.301*	-0.101	*0.465*	*1.099*
Yemen	*6.538*	1.437	*5.305*	*2.626*	*4.222*	*3.039*		*0.200*	*0.765*	*1.400*
Indonesia	*5.872*	*4.875*	*4.456*	0.033	*2.820*	1.337	*2.800*		*0.565*	*1.199*
Bahrain	1.481	*5.414*	0.101	*3.882*	*1.833*	*3.912*	*4.641*	*3.722*		0.634
Iran	0.754	*2.707*	1.093	*2.144*	*1.653*	*1.997*	*2.481*	*2.124*	1.129	

Notes:

Above the diagonal reports the difference in the estimated inefficiency distributions of each country relative to country identified on the first column, in the same row.

Below the diagonal shows *t*-ratio for the test of significance on the difference in the estimated inefficiency distributions of each country relative to country identified on the first row in the same column.

Table 6

Average efficiency estimates for all banks, by bank types

	1996	1997	1998	1999	2000	2001	2002	All Years
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 by bank types								
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

Table 7
Average efficiency estimates for banks, by country, by bank types

	1996	1997	1998	1999	2000	2001	2002	All Years
Malaysia								
All Banks	1.025	1.025	1.024	1.026	1.024	1.025	1.025	1.025
Conventional banks	1.025	1.025	1.024	1.026	1.024	1.025	1.025	1.025
Islamic banks	1.024	1.022	1.025	1.024	1.022	1.022	1.022	1.023
Sudan								
Islamic banks	1.543	1.728	1.966	1.745	1.710	1.691	1.703	1.724
Bangladesh								
All Banks	1.035	1.035	1.036	1.030	1.033	1.036	1.036	1.034
Conventional banks	1.035	1.035	1.034	1.030	1.033	1.035	1.036	1.034
Islamic banks	1.029	1.039	1.056	1.030	1.034	1.039	1.037	1.038
Tunisia								
All Banks	1.258	1.251	1.274	1.250	1.215	1.218	1.219	1.246
Conventional banks	1.258	1.251	1.290	1.267	1.228	1.244	1.219	1.255
Islamic banks	n.a.	n.a.	1.196	1.183	1.177	1.166	n.a.	1.181
Jordan								
All Banks	1.085	1.087	1.086	1.079	1.073	1.067	1.072	1.079
Conventional banks	1.085	1.085	1.084	1.075	1.072	1.066	1.072	1.078
Islamic banks	n.a.	1.096	1.094	1.094	1.080	1.072	n.a.	1.087
Lebanon								
All Banks	1.125	1.163	1.143	1.151	1.153	1.188	1.152	1.152
Conventional banks	1.125	1.150	1.146	1.156	1.153	1.188	1.152	1.151
Islamic banks	n.a.	1.293	1.111	1.106	n.a.	n.a.	n.a.	1.170
Yemen								
Islamic banks	n.a.	1.379	1.366	1.552	1.569	1.445	1.365	1.475
Indonesia								
All Banks	1.261	1.232	1.229	1.269	1.211	1.278	1.274	1.255
Conventional banks	1.252	1.202	1.247	1.241	1.216	1.286	1.282	1.255
Islamic banks	1.290	1.352	1.141	1.434	1.184	1.211	1.203	1.260
Bahrain								
All Banks	1.030	1.031	1.034	1.036	1.035	1.038	1.036	1.034
Conventional banks	1.032	1.031	1.034	1.038	1.034	1.037	1.037	1.034
Islamic banks	1.025	1.031	1.034	1.034	1.035	1.040	1.035	1.034
Iran								
Islamic banks	1.018	n.a.	1.012	1.013	1.014	1.014	n.a.	1.014

Notes:
n.a. data not available

Table 8

Average return to scale for all banks, by bank types

	1996	1997	1998	1999	2000	2001	2002	All Years
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 by bank types								
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

Table 9
Average return to scale for all banks, by country, and by bank types

	1996	1997	1998	1999	2000	2001	2002	All Years
Malaysia								
All Banks	1.048	1.041	1.041	1.029	1.026	1.026	1.024	1.035
Conventional banks	1.049	1.042	1.041	1.029	1.028	1.027	1.026	1.035
Islamic banks	1.042	1.035	1.058	1.035	1.012	1.013	1.007	1.023
Sudan								
Islamic banks	1.062	1.073	1.064	1.058	1.061	1.086	1.070	1.069
Bangladesh								
All Banks	1.016	1.017	1.013	1.005	1.004	1.000	0.999	1.007
Conventional banks	1.012	1.012	1.010	1.001	1.001	0.996	0.994	1.004
Islamic banks	1.062	1.047	1.053	1.049	1.047	1.023	1.023	1.040
Tunisia								
All Banks	1.064	1.058	1.045	1.039	1.034	1.029	1.022	1.045
Conventional banks	1.064	1.058	1.043	1.036	1.032	1.027	1.022	1.045
Islamic banks	n.a.	n.a.	1.059	1.052	1.039	1.035	n.a.	1.046
Jordan								
All Banks	1.052	1.044	1.041	1.036	1.029	1.027	1.025	1.037
Conventional banks	1.052	1.044	1.041	1.038	1.031	1.032	1.025	1.038
Islamic banks	n.a.	1.044	1.039	1.029	1.018	1.011	n.a.	1.028
Lebanon								
All Banks	1.044	1.050	1.038	1.035	1.019	1.006	1.003	1.031
Conventional banks	1.044	1.048	1.033	1.031	1.019	1.006	1.003	1.029
Islamic banks	n.a.	1.072	1.090	1.081	n.a.	n.a.	n.a.	1.081
Yemen								
Islamic banks	n.a.	1.059	1.049	1.043	1.037	1.008	0.995	1.034
Indonesia								
All Banks	1.064	1.068	1.054	1.048	1.035	1.033	1.037	1.045
Conventional banks	1.058	1.063	1.045	1.042	1.030	1.031	1.036	1.041
Islamic banks	1.080	1.088	1.098	1.086	1.060	1.053	1.045	1.073
Bahrain								
All Banks	1.049	1.054	1.054	1.049	1.041	1.035	1.035	1.047
Conventional banks	1.043	1.041	1.036	1.035	1.030	1.024	1.018	1.034
Islamic banks	1.064	1.094	1.076	1.061	1.056	1.046	1.052	1.064
Iran								
Islamic banks	1.052	n.a.	1.044	1.041	1.027	1.032	n.a.	1.039

Notes:
If return to scale >,< or =1, there are increasing returns to scale; decreasing returns to scale or constant returns to scale respectively.
n.a. data not available

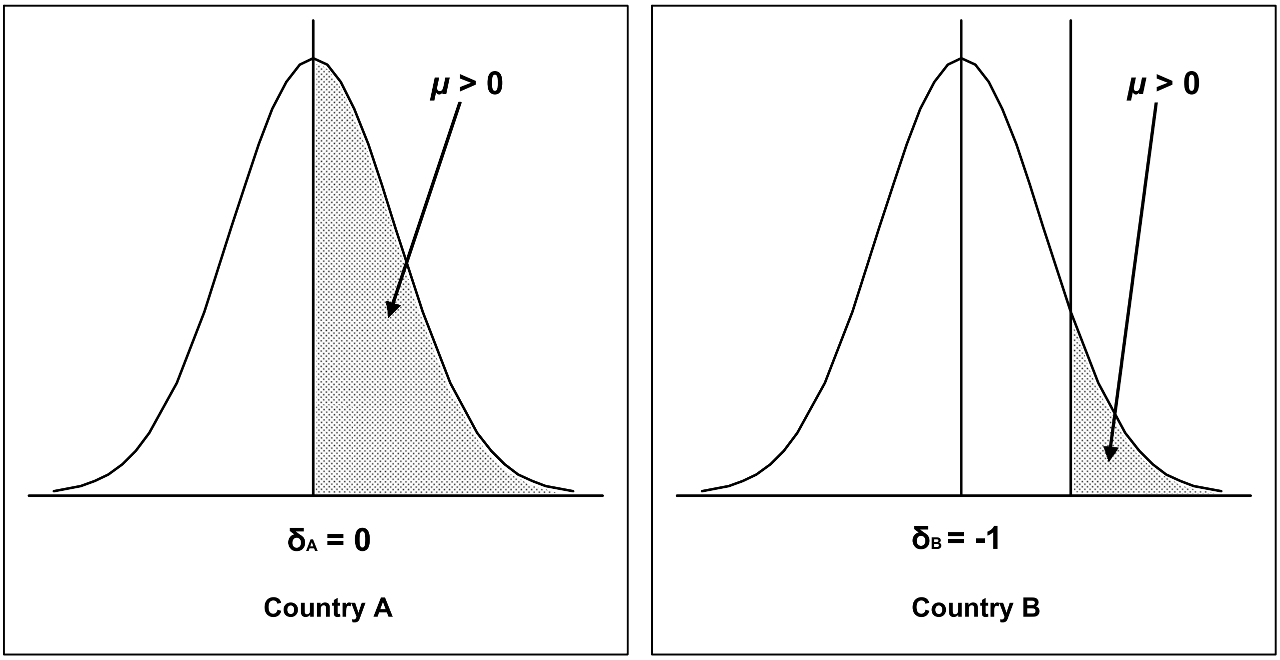

Figure 1
Truncated normal inefficiency distributions for different countries

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