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THE EFFICIENCY OF ISLAMIC BANKING INDUSTRY: A NON-PARAMETRIC ANALYSIS WITH NON-DISCRETIONARY INPUT VARIABLE

FADZLAN SUFIAN*

ABSTRACT

This paper investigates the performance of Malaysian Islamic banking sector during the period of 2001-2005. Several efficiency estimates of individual banks are evaluated using non-parametric Data Envelopment Analysis (DEA). Two different approaches have been employed to differentiate how efficiency scores vary with changes in inputs and outputs. To examine the impact of risk factor on Islamic bank efficiency, we have incorporated problem loans as a non-discretionary input variable in our analysis. The findings suggest that during the period of study, scale inefficiency dominates pure technical inefficiency in the Malaysian Islamic banking sector. We found that foreign banks have exhibited higher technical efficiency compared to their domestic peers. The inclusion of risk factors has mixed impact on Malaysian Islamic banks' efficiency. The results seems to suggest that while potential economies of scale may be overestimated when risk factors are excluded, pure technical efficiency estimates on the other hand, tend to be much more sensitive to the exclusion of risk factors. The empirical results from the Spearman and Pearson tests reinforce these findings.

1. INTRODUCTION

As a Muslim majority country, Malaysia is also affected by the Islamic finance resurgence that has taken place in the Middle East and rest of the world during the last three decades. In 1980, the Bumiputra Economic Congress had proposed to the Malaysian Government to allow the setting up of an Islamic bank in the country. Another effort was the setting up of the National Steering Committee in 1981 to undertake a study and make recommendations to the Government on all aspects of the setting up of Islamic banking operations in Malaysia, including the legal, religious, and operational aspects. The study concluded that the establishment of an

* Planning and Research Department (BCB), Department of Banking and Finance, Faculty of Business and Accountancy, University of Malaya (UM). E-mail: fadzlan.sufian@cimb.com; fadzlan14@gmail.com.

Islamic bank in Malaysia would be a viable project from the operation and profits point of views. The conclusion marked the establishment of the first Islamic bank in Malaysia, Bank Islam Malaysia Berhad (BIMB) in July 1983, with an initial paid up capital of RM80 million.

It has been the Malaysian government's aspiration to create a vibrant and comprehensive Islamic banking and finance system operating side-by-side with the conventional system. A single Islamic bank does not fit the definition of a system. An Islamic banking and finance system requires a large number of dynamic and pro-active players, a wide range of products and innovative instruments and a vibrant Islamic money market. The first step in realizing the vision was to disseminate Islamic banking on a nationwide basis with as many players as possible and within the shortest period possible. This was achieved through the introduction of *Skim Perbankan Islam* (SPI) in March 1993. SPI allows conventional banking institutions to offer Islamic banking products and services using their existing infrastructure, including staff and branches. The scheme was launched on 4 March 1993 on a pilot basis involving three banks. Following the successful implementation of the pilot-run, Bank Negara Malaysia (BNM) has allowed other commercial banks, finance companies, and merchant banks to operate the scheme in July 1993 subject to the specific guidelines issued by the central bank. From only three banks offering Islamic financing in March 1993, the number of commercial banks that offered Islamic financing has increased to 17 (of which 4 are foreign banks). These Islamic banking institutions offer a comprehensive and broad range of Islamic financial products and services ranging from savings, current and investment deposit products, to financing products i.e. property financing, working capital financing, project financing, etc.

Throughout the years, the Islamic banking sector has gained its significance, and has been on a progressive upward trend. Since 2000, the Islamic banking industry has been growing at an average rate of 19% per annum in terms of assets. As at end-2005, total assets of the Islamic banking sector has increased to RM111.8 billion, accounted for 11.7% of the banking system's total assets, while the market share of Islamic deposits and financing has increased to 11.7% and 12.1% of the banking sector's total deposits and financing respectively. The rapid progress of the domestic Islamic banking system, accentuated by the significant expansion and developments in Islamic banking and finance has become increasingly more important in meeting the changing requirements of the new economy (Bank Negara Malaysia, 2005). Today, Malaysia is among the first few nations to have succeeded in implementing a dual banking system with a full-

fledged Islamic banking system operating side-by side with the conventional banking system.[1]

Despite the Islamic banking sector's considerable development, empirical works on Islamic bank efficiency particularly in Malaysia is still in its infancy. Furthermore, studies on Islamic banks have generally focused on theoretical issues, and empirical work has relied mainly on the analysis of descriptive statistics rather than rigorous statistical estimation (El-Gamal and Inanoglu, 2004). The study therefore attempts to fill the gap in the literature by providing new empirical evidence on the relative operating performance of domestic and foreign conventional banks offering Islamic banking products and services by using a non-parametric frontier based Data Envelopment Analysis (DEA) approach. Although there are currently a few studies that have examined the performance of Islamic banks in Malaysia, we are not aware of any study that has analyzed the efficiency of Malaysian Islamic banks employing a non-parametric DEA method.

Since its introduction by Charnes *et al.* (1978), researchers have welcomed DEA as a methodology for performance evaluation (Gregoriou and Zhou, 2005). Amongst the strengths of the DEA is that, DEA is less data demanding as it works fine with small sample sizes. Because the number of participants in the Malaysian Islamic banking sector is small, the scope to undertake this study using standard econometric methods is somewhat limited. The small sample size is among other reasons, which leads us to DEA as the tool of choice for evaluating Malaysian Islamic banks' X-(in) efficiency. DEA uses linear programming and optimization to appraise the relative (in) efficiencies of peer decision making units (Islamic banks in this case) and provides units of measure using multiple inputs and outputs by generating a 'best practice frontier'. DEA can ameliorate the performance of existing in (efficient) banks by diminishing input or increasing output levels. Furthermore, DEA focuses on the yearly observations of individual banks and optimizes the performance measure of each bank. Constructing a separate frontier for each of the years under study is a critical issue in a dynamic business environment because a bank may be the most efficient in one year but the same situation may not be the same the following year. In the Malaysian context, it becomes all the more important, as there is an ongoing liberalization in the banking sector. A separate frontier will highlight the changes taking place in the sector induced by BNM's supervisory policies.

Secondly, it has long been argued in the literature that the incorporation of risk/loan quality is vitally important in studies of banking efficiency. Akhigbe and McNulty (2003), for example, utilizing a profit function approach, include equity

[1] The first country which enjoyed a dual banking system was the United Arab Emirates (UAE) where Dubai Islamic Bank was established in 1973 with a paid capital of US$14 million (Metwally, 1997).

capital "to control, in a very rough fashion, for the potential increased in cost of funds due to financial risk" (pp. 312). Altunbas *et al.* (2000) and Drake and Hall (2003) also find that the failure to adequately account for risk can have a significant impact on relative efficiency scores. We attempt to address this important issue, by specifying two different DEA models. In doing so, we will be able to analyze the sensitivity of the choice of input and output variables as well as to gauge potential impact of risk on Malaysian Islamic banks' efficiency.

Notwithstanding, the study also has important public policy implications, particularly with respect to the principal aim of the Malaysia's Financial Sector Master Plan (FSMP), a long-term development plan charting the future direction of the financial services industry in Malaysia to achieve a more competitive, resilient and efficient financial system (see BNM Financial Sector Masterplan, 2001). The study could thus help the regulatory authorities in determining the future course of action to be pursued to further strengthen the Malaysian banking sector, in particular the domestic incorporated Islamic banks, to meet the challenges of foreign banks entry from 2007 onwards[2].

The remainder of the paper is organized as follows: The following section presents the literature review. Section 3 describes the data, sources and model specifications, which is employed in the study. Empirical results are presented in section 4. Finally, we conclude in section 5.

2. REVIEW OF THE LITERATURE

While there has been extensive literature examining the efficiency features of US and European banking markets over recent years, the work on Islamic banking is still in its infancy. Typically, studies on Islamic bank efficiency have focused on theoretical issues and the empirical work has relied mainly on the analysis of descriptive statistics rather than rigorous statistical estimation (El-Gamal and Inanoglu, 2004). However, this is gradually changing as a number of recent studies have sought to apply the approaches outlined above to estimate bank efficiency using various frontier techniques.

El-Gamal and Inanoglu (2004) used the stochastic frontier approach to estimate the cost efficiency of Turkish banks over the period 1990-2000. The study compared the cost efficiencies of 49 conventional banks with four Islamic special finance houses (SFHs). The Islamic firms comprised around 3% of the Turkish banking market. Overall, they found that the Islamic financial institutions to be the most efficient and this was explained by their emphasis on Islamic asset-based

[2] As part of Malaysia's World Trade Organization (WTO) commitment to further liberalized the banking sector and to give the foreign banks completely open access to the Malaysian markets by end-2006.

financing which led to lower non-performing loans ratios. It is worth mentioning that the SFH achieved high levels of efficiency despite being subjected to branching and other self-imposed constraints such as the inability to hold government bonds.

El-Gamal and Inanoglu (2005) substantially extend their earlier study by providing an alternative method for evaluating bank efficiency scores. Again they examine the cost efficiency of Turkish banks throughout the 1990s. They distinguish between groups of banks that have different production technologies. They find that the Islamic financial firms have different production technologies. They find that the Islamic financial firms have the same production technology as conventional banks (mainly domestic banks) and using standard stochastic cost frontier estimates they show that the Islamic firms are among the most efficient.

More recently, Hassan (2005) examined the relative cost, profit, X-efficiency, and productivity of the world Islamic banking industry. Employing a panel of banks during 1993-2001, he used both the parametric (Stochastic Frontier Approach) and non-parametric (Data Envelopment Analysis) techniques as tools to examine the efficiency of the sample banks. He calculated five DEA efficiency measures namely cost, allocative, technical, pure technical, and scale and further correlated the scores with the conventional accounting measures of bank performance. He found that the Islamic banks are more profit efficient, with an average profit efficiency score of 84% under the profit efficiency frontier compared to 74% under the stochastic cost frontier. He also found that the main source of inefficiency is allocative rather than technical. Similarly, his results suggest that the overall inefficiency was output related. The results suggest that, on average the Islamic banking industry is relatively less efficient compared to their conventional counterparts in other parts of the world. The results also show that all five efficiency measures are highly correlated with ROA and ROE, suggesting that these efficiency measures can be used concurrently with the conventional accounting ratios in determining Islamic bank performance.

Hussein (2003) provides an analysis of the cost efficiency features of Islamic banks in Sudan between 1990 and 2000. Using the stochastic cost frontier approach, he estimates cost efficiency for a sample of 17 banks over the period. The interesting contribution of this paper is that specific definitions of Islamic financial products are used as outputs. In addition, the analysis is also novel as Sudan has a banking system based entirely on Islamic banking principles. The results show large variations in the cost efficiency of Sudanese banks with the foreign owned banks being the most efficient. State owned banks are the most cost inefficient. The analysis is extended to examine the determinants of bank efficiency. Here, he finds that smaller banks are more efficient that their larger counterparts. In addition, banks that have higher proportion of *mush**a**rakah* and *mu**da**rabah* finance relative to total assets also have efficiency advantages. Overall,

the substantial variability in efficiency estimates is put down to various factors, not least the highly volatile economic environment under which Sudanese banks have had to operate over the last decade or so.

While the above outlines the literature that uses advanced modeling techniques to evaluate bank efficiency, one should also note that there is also a growing body of literature that covers the general performance features of Islamic banks. Such studies include those by Hassan and Bashir (2003) who look at the determinants of Islamic bank performance and show Islamic banks to be just as efficient as conventional banks if one uses standard accounting measure such as cost-to-income ratios. Other studies that take a similar approach are those by Sarker (1999) who looks at the performance and operational efficiency of Bangladeshi Islamic banks, while Bashir (1999) examines the risk and profitability of two Sudanese banks. Overall, the general finding from this literature is that Islamic banks are at least as efficient as their conventional bank counterparts and in most cases are more efficient.

Despite the considerable development of Islamic banking sector, there are still limited studies focusing on the efficiency of Islamic banks, particularly the Malaysian Islamic banking industry. Several studies that have been devoted to assess the performance of Islamic banks have generally examined the relationship between profitability and banking characteristics. Bashir (1999) and Bashir (2001) performed regression analyses to determine the underlying determinants of Islamic bank performance by employing bank level data in the Middle East. His results indicate that the performance of banks, in terms of profits, is mostly generated from overhead, customer short term funding, and non-interest earning assets. Furthermore, Bashir (2001) claimed that since deposits in Islamic banks are treated as shares, reserves held by banks propagate negative impacts such as reducing the amount of funds available for investment. Samad and Hassan (2000) applied financial ratio analysis to investigate the performance of a Malaysian Islamic bank over the period 1984-1997. Their results suggest that in general, the managements' lack of knowledge was the main reason for slow growth of loans under profit sharing. Despite that, the bank was found to perform better compared to their conventional counterparts in terms of liquidity and risk measurement (lower risks).

2.1 The Effects of Non-Performing Loans on Bank's Efficiency

For the past several years, most research conducted on explaining the causes of bank or thrift industry failures find that failing institutions carried a large proportion of non-performing loans in their books prior to failure (see among others Dermiguc-Kunt, 1989; Whalen, 1991; Barr and Siems, 1994). Berger and Humphrey (1992), Barr and Siems (1994) and Wheelock and Wilson (1995) found that banks approaching failure tend to have low cost efficiency and experiencing high ratios of problem loans and that failing banks tend to be located far from the

best practice frontiers. In addition, even among banks that do not fail, Kwan and Eisenbeis (1995), Resti (1997) and Barr *et al.* (2002) have found negative relationship between problem loans and bank efficiency.

Although the issue of controlling for risk in respect of bank efficiency analysis is still controversial, many studies have attempted to control for the exogenous impact of problem loans on bank efficiency. As noted by Berger and Humphrey (1997):

> "*Whether it is appropriate to include non-performing loans and loan losses as the bank's costs depends on the extent to which this variable are exogenous i.e. caused by negative economic shocks and endogenous i.e. either because the management is inefficient in managing its portfolio or because it has made a conscious decision to reduce short-run expenses by cutting back on loan origination and monitoring resources*".

Laeven and Majnoni (2003) argue that risk can be incorporated into efficiency studies via the inclusion of loan loss provisions. That is, "following the general consensus among risk agent analysts and practitioners, economic capital should be tailored to cope with unexpected losses and loan loss reserves should instead buffer the expected component of the loss distribution. Consistent with this interpretation, loan loss provisions required to build up loan loss reserves should be considered and treated as a cost; a cost that will be faced with certainty over time but that is uncertain as to when it will materialize" (pp. 181).

Among the earlier research that incorporated and studied the impact of non-performing loans on bank efficiency are those of by Hughes and Mester (1993, 1998), Hughes *et al.* (1996, 1999) and Mester (1997), who included the volume of non-performing loans as a control for loan quality in studies of U.S. banks. Berg *et al.* (1993) on the other hand included loan losses as an indicator of the quality of loan evaluations in DEA study of Norwegian bank productivity.

A recent study by Drake and Hall (2003) on Japanese banks using a DEA approach found that when risk factors are excluded, potential economies of scale may be overestimated, which is in line with Altunbas *et al.* (2000). They found that the mean pure technical efficiency level of all banks to increase significantly to 89.4% from 78.1% after controlling for problem loans. On the other hand, the mean scale efficiency level improved marginally from 92.8% to 96.6%. This has resulted in the mean overall efficiency to improve substantially to 86.3% from 72.4%. In contrast to Altunbas *et al.* (2000) who applied the Fourier Flexible Stochastic Cost Frontier in their studies, Drake and Hall (2003) found that the pure technical efficiency are much more sensitive when risk factors are excluded compared to the scale efficiency estimates.

3. METHODOLOGY

The term Data Envelopment Analysis (DEA) was first introduced by Charnes *et al*. (1978), (hereafter CCR), to measure the efficiency of each Decision Making Units (DMUs), that is obtained as a maximum of a ratio of weighted outputs to weighted inputs. This denotes that the more the output produced from given inputs, the more efficient is the production. The weights for the ratio are determined by a restriction that the similar ratios for every DMU have to be less than or equal to unity. This definition of efficiency measure allows multiple outputs and inputs without requiring pre-assigned weights. Multiple inputs and outputs are reduced to single 'virtual' input and single 'virtual' output by optimal weights. The efficiency measure is then a function of multipliers of the 'virtual' input-output combination.

The CCR model presupposes that there is no significant relationship between the scale of operations and efficiency by assuming constant returns to scale (CRS) and it delivers the overall technical efficiency (OTE). The CRS assumption is only justifiable when all DMUs are operating at an optimal scale. However, firms or DMUs in practice might face either economies or diseconomies of scale. Thus, if one makes the CRS assumption when not all DMUs are operating at the optimal scale, the computed measures of technical efficiency will be contaminated with scale efficiencies.

Banker *et al*. (1984) extended the CCR model by relaxing the CRS assumption. The resulting "BCC" model was used to assess the efficiency of DMUs characterized by variable returns to scale (VRS). The VRS assumption provides the measurement of pure technical efficiency (PTE), which is the measurement of technical efficiency devoid of the scale efficiency (SE) effects. If there appears to be a difference between the TE and PTE scores of a particular DMU, then it indicates the existence of scale inefficiency.

The input oriented DEA model with VRS technologies can be represented by the following linear programming problem:

$$
\begin{aligned}
& \min_{\varphi, \lambda,} \varphi \\
\text{subject to } & -\varphi y_i, + Y\lambda, \geq 0 \\
& x_i - X\lambda \geq 0 \\
& N1' \lambda = 1 \\
\text{and } & \lambda \geq 0
\end{aligned} \qquad (1)
$$

where λ is an N x 1 intensity vector of constants and φ is a scalar ($1 \geq \varphi \leq \infty$). $N1$ is an N x 1 vector of ones. For N number of firms, y_i and x_i are the M x N and K

x *N* output and input vectors, respectively. *Y* comprises the data for all the N firms. Given a fixed level of inputs for the *i*th firm, the proportional increase in outputs to be achieved the firm indicated by $\varphi - 1$. Note that without the convexity constraint $N1' \lambda = 1$, equation (1) becomes a DEA model with CRS technology. The convexity constraint implies that an inefficient firm is benchmarked against firms of a similar size and therefore the projected point of that firm on the DEA frontier will be a convex combination of observed firms. In other words, each firm would produce on or to the right of the convex production possibility frontier. If TE scores for a particular firm with or without the convexity constraint imposed are the same, then the firm is operating under CRS. If these scores are different, the firm operates under VRS technology. However, in such a case, it would be necessary to identify whether the firm or the DMU operates with IRS or DRS. To do this, assumption of non-increasing returns to scale (NIRS) is imposed in (1) and the convexity constraint $N1' \lambda = 1$ is substituted with $N1' \lambda \leq 1$. This is given as follows:

$$
\begin{aligned}
& min_{\varphi, \lambda,} \varphi \\
\text{subject to } & -y_i, - Y\lambda, \geq 0, \\
& \varphi x_i - X\lambda \geq 0, \\
& N1' \lambda \leq 1 \\
& \lambda \geq 0
\end{aligned}
\qquad (2)
$$

Solution of the equation (2) reveals the nature of scale efficiencies. IRS exists if TE score obtained with NIRS technology differs from the TE estimates with VRS technology. If both of these efficiency scores are equal, then the corresponding firm operates with DRS.

Because the number of participants in the Malaysian Islamic banking sector is small, the scope to undertake this study using standard econometric methods is somewhat limited. Amongst the strengths of the DEA is that, DEA is less data demanding as it works fine with small sample size (Canhoto and Dermine, 2003). The small sample size is among other reasons, which leads us to DEA as the tool of choice for evaluating Malaysian Islamic banks' X-(in) efficiency. Furthermore, DEA does not require a preconceived structure or specific functional form to be imposed on the data in identifying and determining the efficient frontier, error, and inefficiency structures of the DMUs[3] (Evanoff and Israelvich, 1991, Grifell-Tatje and Lovell, 1997, Bauer *et al*., 1998). Hababou (2002) adds that it is better to adopt the DEA technique when it has been shown that a commonly agreed functional form relating inputs to outputs is difficult to prove or find. Such specific functional

[3] Hababou (2002) and Avkiran (1999) provide a relatively thorough discussion of the merits and limits of the DEA.

form is truly difficult to show for financial services entities. Avkiran (1999) acknowledges the edge of the DEA by stating that this technique allows the researchers to choose any kind of input and output of managerial interest, regardless of different measurement units. There is no need for standardization.

Three useful features of DEA are first, each DMU is assigned a single efficiency score, hence allowing ranking amongst the DMUs in the sample. Second, it highlights the areas of improvement for each single DMU. For example, since a DMU is compared to a set of efficient DMUs with similar input-output configurations, the DMU in question is able to identify whether it has used input excessively or its output has been under-produced. Finally, there is possibility of making inferences on the DMUs general profile. We should be aware that the technique used here is a comparison between the production performances of each DMU to a set of efficient DMUs. The set of efficient DMUs is called the reference set. The owners of the DMUs may be interested to know which DMU frequently appears in this set. A DMU that appears more than others in this set is called the global leader. Clearly, this information gives huge benefits to the DMU owner, especially in positioning its entity in the market.

The main weakness of DEA is that it assumes data are free from measurement errors. Furthermore, since efficiency is measured in a relative way, its analysis is confined to the sample set used. This means that an efficient DMU found in the analysis cannot be compared with other DMUs outside of the sample. The reason is simple. Each sample, separated, let us say, by year, represents a single frontier, which is constructed on the assumption of same technology. Therefore, comparing the efficiency measures of a DMU across time cannot be interpreted as technical progress but rather has to be taken as changes in efficiency (Canhoto and Dermine, 2003).

DEA can be used to derive measures of scale efficiency by using the variable returns to scale (VRS), or the BCC model, alongside the constant returns to scale (CRS), or the CCR model. Coelli *et al.* (1998) noted that the BCC model have been most commonly used since the beginning of the 1990s. A DEA model can be constructed either to minimize inputs or to maximize outputs. An input orientation aims at reducing the input amounts as much as possible while keeping at least the present output levels, while an output orientation aims at maximizing output levels without increasing use of inputs (Cooper *et al.*, 2000). The focus on costs in banking and the fact that outputs are inclined to be demand determined means that input-oriented models are most commonly used (Kumbhakar and Lozano Vivas, 2005).

The standard approach to measuring scale effects using DEA is to run models on both a CRS and VRS basis. Scale efficiency is then found by dividing the efficiency score from the CRS model by the efficiency score from the VRS model.

Because the data points are enveloped more tightly under the VRS model, the VRS efficiency scores will be higher and the scale efficiency measures will therefore be in the range 0 to 1. A useful feature of VRS model as compared to the CRS model is that it reports whether a decision-making unit (DMUs) is operating at increasing, constant, or decreasing returns to scale. Constant returns to scale will apply when CRS and VRS efficiency frontiers are tangential with each other; in other words, when the slope of the efficiency frontier is equal to the ratio of inputs to outputs (Cooper *et al*., 2000). Increasing returns to scale must apply below that level, as the slope of the efficient frontier, which reflects the marginal rate of transformation of inputs to outputs will be greater than the average rate of conversion. Likewise, decreasing returns to scale must apply above the zone in which constant returns to scale apply. DMUs not on the efficient frontier must first be projected onto the efficient frontier before their returns to scale status can be assessed.

3.1 Inputs and Outputs Definition and the Choice of Variables

The definition and measurement of inputs and outputs in the banking function remains a contentious issue among researchers. Banks are typically multi-input and multi-output firms. As a result, defining what constitutes 'input' and 'output' is fraught with difficulties, since many of the financial services are jointly produced and prices are typically assigned to a bundle of financial services. Additionally, banks may not be homogeneous with respect to the types of outputs actually produced. To determine what constitutes inputs and outputs of banks, one should first decide on the nature of banking technology. In the banking theory literature, there are two main approaches competing with each other in this regard: the production and intermediation approaches (Sealey and Lindley, 1977).

Under the production approach, a financial institution is defined as a producer of services for account holders, that is, they perform transactions on deposit accounts and process documents such as loans. Hence, according to this approach, the number of accounts or its related transactions is the best measures for output, while the number of employees and physical capital is considered as inputs. Previous studies that adopted this approach are among others by Sherman and Gold (1985), Ferrier and Lovell (1990) and Fried *et al.* (1993).

The intermediation approach on the other hand assumes that financial firms act as an intermediary between savers and borrowers and posits total loans and securities as outputs, whereas deposits along with labor and physical capital are defined as inputs. Previous banking efficiency studies research that adopted this approach are among others Charnes *et al.* (1990), Bhattacharyya *et al.* (1997) and Sathye (2001).

For the purpose of this study, a variation of the intermediation approach or asset approach originally developed by Sealey and Lindley (1977) will be adopted in the

definition of inputs and outputs used[4]. According to Berger and Humphrey (1997), the production approach might be more suitable for branch efficiency studies, as at most times bank branches basically process customer documents and bank funding, while investment decisions are mostly not under the control of branches.

The aim in the choice of variables for this study is to provide a parsimonious model and to avoid the use of unnecessary variables that may reduce the degree of freedom[5]. Data for the empirical analysis is sourced from individual bank's Islamic Banking Scheme's (IBS) annual balance sheet and income statements[6]. All variables are measured in million of Malaysian Ringgit (RM). Given the sensitivity of efficiency estimates to the specification of outputs and inputs, we have estimated two alternative models. In DEA Model A, we model Malaysian Islamic banks as multi-product firms, producing two outputs by employing one input. Accordingly, *Total Deposits* (*x1*), which include deposits from customers and other banks, is used as an input vector to produce *Total Loans* (*y1*), which include loans to customers and other banks and *Investments* (*y2*), which include investment securities held for trading, investment securities available for sale (AFS), and investment securities held to maturity. To assess the importance of risk and lending quality problems in explaining the efficiency of Malaysian Islamic banks, following the approach by Drake and Hall (2003) and Charnes *et al.* (1990), *Loan Loss Provisions* (*x2*) is incorporated as an input variable in DEA Model B.

As we are looking at relative (in)-efficiency, it is important that the DMUs should be sufficiently similar, so that comparisons are meaningful. This is particularly the case with DEA, where Dyson *et al.* (2001) have developed what they describe as a series of homogeneity assumptions. The first of these is that the DMUs the performance of which is being compared should be undertaking similar activities and producing comparable products and services so that a common set of outputs can be defined. The second homogeneity assumption is that a similar range of resources is available to all the units and they operate in a similar environment.

In the spirit of maintaining homogeneity, only banks that offered Islamic banking services are included in the analysis. The annual balance sheet and income statement used to construct the variables for the empirical analysis were taken from published balance sheet and income statement information in annual reports of

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

[5] For a detailed discussion on the optimal number of inputs and outputs in DEA, see Avkiran (2002).

[6] Only data from Islamic Banking Scheme (IBS) accounts are used. Malaysian conventional banks offering Islamic banking window services are required to maintain a separate IBS account. Hence, the data used are not contaminated with the conventional banking operations.

each individual bank. During the period of study, there were a total of 17 banks offering Islamic banking services in Malaysia, four of which were foreign incorporated banks.

Table 1: Summary Statistics of the Variables Employed in the DEA Model (in billion of Ringgit)

	Domestic		Foreign	
	Mean	**S.D.**	**Mean**	**S.D.**
Outputs				
2001				
Total Loans (y1)	1,967,986.73	1,976,784.14	126,262.25	75,286.80
Investments (y2)	1,092,748.09	804,200.13	260,398.25	453,683.63
2002				
Total Loans (y1)	2,525,162.64	2,471,994.80	152,367.00	94,030.16
Investments (y2)	1,788,555.64	1,711,153.96	206,365.00	359,831.82
2003				
Total Loans (y1)	3,297,960.55	3,500,591.92	305,565.50	306,106.83
Investments (y2)	1,547,236.91	1,308,132.42	512,945.75	556,976.22
2004				
Total Loans (y1)	3,958,634.27	4,204,438.27	717,941.75	795,103.21
Investments (y2)	1,142,359.00	1,140,943.73	737,046.25	291,378.52
2005				
Total Loans (y1)	4,559,123.18	473,2843.20	1,161,446.50	1,262,479.59
Investments (y2)	1,162,148.73	1,267,558.66	662,793.25	313,357.54
Inputs				
2001				
Total Deposits (x1)	3,408,836.36	3,076,784.90	212,426.5	177,647.60
Non-Performing Loans (x2)	27,935.18	25,979.92	1,005.50	848.29
2002				
Total Deposits (x1)	1,3215,032.64	31,531,022.91	354,919.75	458,261.93
Non-Performing Loans (x2)	31,580.00	34,379.41	1,544.25	1,666.60
2003				
Total Deposits (x1)	4,850,946.00	4,256,388.72	633,900.00	682,829.75
Non-Performing Loans (x2)	45,907.27	55,987.38	5,644.00	10,198.84
2004				
Total Deposits (x1)	5,385,656.73	4,819,090.13	1,200,215.75	638,321.87
Non-Performing Loans (x2)	65,172.18	89,503.00	10,931.50	10,568.67
2005				
Total Deposits (x1)	6,275,245.55	5,894,714.12	1,827,051.75	1,450,907.66
Non-Performing Loans (x2)	92,155.45	189,858.41	8,939.25	8,742.78

Source: Banks Annual Reports.

Table 1 presents summary statistics of the output and input variables used in the DEA models, measured in million of RM. It is apparent that during the period of study, there has been increasing awareness among Malaysian public about Islamic banking and finance products and services substantiated by the growth in total loans (financing) to the domestic economy. During the years (2001-2005), total loans and deposits grew by 132% and 52% for the domestic and foreign banks respectively. Likewise, total deposits from the Malaysian public increased by 84% for the domestic banks, while the rate is significantly higher for the foreign banks, which recorded more than sevenfold increase. Table 1 also demonstrates the persistence of risk factors in the Malaysian Islamic banking sector. During the period of study, while problems loans due at the domestic banks has more than doubled, the five year period has witnessed more than sevenfold increase in problem loans at the foreign banks. This has further strengthened and validated our reason to investigate this important issue within the context of the Malaysian Islamic banking industry.

4. RESULTS

In this section, we will discuss the technical efficiency change (TE) of the Malaysian Islamic banking sector, measured by the DEA method and its decomposition into pure technical efficiency (PTE) and scale efficiency (SE) components. In the event of the existence of scale inefficiency, we will attempt to provide evidence on the nature of returns to scale of the Malaysian Islamic banks. The efficiency of Malaysian Islamic banks was first examined by applying the DEA method for each year under investigation by employing the traditional input-output variables. We extend the analysis to examine the domestic and foreign banks' efficiency results derived from an alternative model, which incorporates a non-discretionary input variable.

4.1 Efficiency of the Malaysian Islamic Banking Sector

Table 2 presents mean efficiency scores of Malaysian Islamic banks for the years 2001 (Panel A), 2002 (Panel B), 2003 (Panel C), 2004 (Panel D), 2005 (Panel E), Domestic Banks (Panel F) and Foreign Banks (Panel G). The results from DEA Model A seems to suggest that Malaysian Islamic banks mean technical efficiency has been on a declining trend during the earlier part of the studies, before increasing again during the latter years. The decomposition of overall efficiency into its pure technical and scale efficiency components suggest that scale inefficiency dominates pure technical inefficiency of Malaysian Islamic banks during all years except for the year 2002 when scale efficiency was higher compared to pure technical efficiency. Overall the results imply that during the period of study, Malaysian Islamic banks have been operating at the wrong scale of operations. If anything could be delved from the results, during the period of study

the findings suggest that the Malaysian Islamic banking sector were either too large to be scale efficient or too small to reap the benefits of economies of scale.

Table 2: Summary Statistics of Efficiency Scores (DEA Model A)

Banks	Mean	Minimum	Maximum	Std. Dev.
Panel A: **All Banks 2001**				
Technical Efficiency	0.608	0.414	1.000	0.186
Pure Technical Efficiency	0.889	0.593	1.000	0.140
Scale Efficiency	0.685	0.431	1.000	0.161
Panel B: **All Banks 2002**				
Technical Efficiency	0.573	0.049	1.000	0.283
Pure Technical Efficiency	0.701	0.075	1.000	0.312
Scale Efficiency	0.817	0.443	1.000	0.153
Panel C: **All Banks 2003**				
Technical Efficiency	0.583	0.299	1.000	0.224
Pure Technical Efficiency	0.813	0.383	1.000	0.214
Scale Efficiency	0.740	0.327	1.000	0.234
Panel D: **All Banks 2004**				
Technical Efficiency	0.789	0.445	1.000	0.163
Pure Technical Efficiency	0.916	0.665	1.000	0.126
Scale Efficiency	0.861	0.660	1.000	0.131
Panel E: **All Banks 2005**				
Technical Efficiency	0.783	0.290	1.000	0.186
Pure Technical Efficiency	0.931	0.709	1.000	0.094
Scale Efficiency	0.847	0.290	1.000	0.200
Panel F: **Domestic Banks Only**				
Technical Efficiency	0.597	0.049	1.000	0.196
Pure Technical Efficiency	0.819	0.075	1.000	0.216
Scale Efficiency	0.740	0.290	1.000	0.169
Panel G: **Foreign Banks Only**				
Technical Efficiency	0.777	0.314	1.000	0.256
Pure Technical Efficiency	0.911	0.344	1.000	0.196
Scale Efficiency	0.859	0.351	1.000	0.207

Note: Detailed results are available from the authors upon request.

During the period of study, the results seem to suggest that the domestic Malaysian Islamic banks (Panel F) have exhibited mean technical efficiency of 59.7%, suggesting mean input waste of 40.3%. In other words, the domestic banks could have produced the same amount of outputs by only using 59.7% of the amount of inputs it uses. From Table 2 (Panel F) it is also clear that scale inefficiency dominates pure technical inefficiency of the domestic Malaysian Islamic banks. On the other hand, our results from Table 2 (Panel G) suggest that foreign banks that offered Islamic banking services in Malaysia have exhibited higher mean technical efficiency of 77.7% compared to their domestic banks counterparts. Likewise, our results also suggest that the foreign banks' inefficiency were mainly attributed to scale rather than pure technical albeit at a lower degree of 14.1% (domestic banks – 26.0%). The foreign banks also seem to have exhibited higher pure technical efficiency of 91.1% (domestic banks – 81.9%). Overall the results suggest that foreign banks were more managerially efficient in controlling their costs and have been operating at a relatively more optimal scale of operations compared to their domestic counterparts.

Our findings are interesting in that, although the foreign banks were relatively small compared to their domestic banks peers, have limited capabilities to expand their operations (number of branches, ATMs, etc.), and have limited knowledge on the local markets, they seems to have exhibit higher efficiency compared to their domestic counterparts. Our results thus support the divisibility theory, which holds that there will be no such operational advantage accruing to large banks, if the technology is divisible, that is, small scale banks can produce financial services at costs per unit output comparable to those of large banks, suggesting no or possibly negative association between size and performance. This was made possible as advances in technology reduced the size and cost of automated equipment, thus significantly enhance small banks' ability to purchase expensive technologies, implying more divisibility in the banking industry's technologies (Kolari and Zardkoohi, 1987).

Our results are in line with earlier evidences on other developing countries in that foreign owned banks are more efficient compared to their domestic peers (e.g. Sathye, 2003 on Indian banks, Hassan and Marton, 2003 on Hungarian banks and Isik and Hassan, 2003 on Turkish banks). As suggested by Berger *et al.* (2003), foreign owned banks may have better access to capital markets, superior ability to diversify risks, and the ability to offer some services to multinational clients, not easily provided by domestically owned banks. They also pointed that foreign owned banks from developed nations in developing countries also have access to superior technologies, particularly information technologies for collecting and assessing "hard" quantitative information.

Table 3: Composition of Production Frontiers (DEA Model A)

Bank	Type	2001	2002	2003	2004	2005	Count
Affin Bank	Domestic	DRS	DRS	DRS	IRS	IRS	0
Alliance Bank	Domestic	IRS	IRS	IRS	IRS	IRS	0
Arab-Malaysian Bank	Domestic	DRS	DRS	DRS	IRS		0
EON Bank	Domestic	DRS	CRS	DRS	CRS	IRS	2
Hong Leong Bank	Domestic	DRS	DRS	DRS	IRS	DRS	0
Maybank	Domestic	DRS	DRS	DRS	DRS	DRS	0
Public Bank	Domestic	DRS	DRS	DRS	DRS	CRS	1
RHB Bank	Domestic	DRS	DRS	DRS	DRS		0
Southern Bank	Domestic	DRS	DRS	DRS	IRS	IRS	0
Bank Islam Malaysia	Domestic	DRS	DRS	DRS	DRS	DRS	0
Bank Muamalat	Domestic	DRS	DRS	DRS	DRS	DRS	0
RHB Islamic Bank Berhad	Domestic					DRS	0
Commerce TIJARI Bank Berhad	Domestic					IRS	0
Citibank	Foreign	DRS	CRS	CRS	IRS	CRS	3
Hong Kong Bank	Foreign	CRS	DRS	CRS	CRS	DRS	3
OCBC	Foreign	CRS	IRS	IRS	IRS	IRS	1
Standard Chartered Bank	Foreign	IRS	IRS	IRS	CRS	IRS	1
Number of Banks	**n = 17**	**2**	**2**	**2**	**3**	**2**	

Notes: CRS – (Constant Returns to Scale); DRS – (Decreasing Returns to Scale); IRS – (Increasing Returns to Scale); The banks corresponds to the shaded regions have not been efficient in any year in the sample period (2001-2005) compared to the other banks in the sample.

Since the dominant source of the total technical X- (in) efficiency in the Malaysian Islamic banking sector seems to be scale related it is worth investigating the composition of the efficiency frontier. Table 3 shows banks that lie on the efficiency frontier under DEA Model A. The composition of the efficiency frontier for DEA Model A suggests the number of 100% efficient banks varies between two to three banks. During the period of study, foreign banks seem to have dominated the efficiency frontier for DEA Model A and all foreign banks have appeared at least once on the frontier. It is also clear from the results, two foreign banks namely, Citibank and HSBC have appeared the most times on the efficiency frontier. On the other hand, the results seem to suggest that only two domestic banks have managed to appear on the frontier. Meanwhile, 11 domestic banks have never made it to the efficiency frontier throughout the period of study.

4.2 Non-Performing Loans and the Gap between the Two DEA Models

Having established the basic DEA model, we now analyze the potential impact

of risk and problem loans on Malaysian Islamic banks' efficiency. As indicated previously, these results are obtained by modifying the initial DEA model to incorporate an additional, non-discretionary input variable, in the form of provisions of loans losses. The results are presented in Table 4 and Figures 1 – 3. It is apparent that controlling for problem loans has resulted in higher mean technical efficiency of Malaysian Islamic banks during all years. The impact of the inclusion of loan loss provisions towards Malaysian Islamic banks seems to be mixed. In line with the findings by Drake and Hall (2003) and Altunbas *et al.* (2000), the results suggest that potential economies of scale may well be overestimated when risk factors are excluded. Likewise, it is clear that the inclusion of loan loss provisions has resulted in higher mean pure technical efficiency during 2002 and 2003. The results support earlier findings by Drake and Hall (2003) whom suggests that the mean pure technical efficiency estimate is much more sensitive that the mean scale efficiency estimate to the exclusion of risk factors.

Table 4: Summary Statistics of Efficiency Scores (DEA Model B)

Banks	Mean	Minimum	Maximum	Std. Dev.
Panel A: **All Banks 2001**				
Technical Efficiency	0.736	0.452	1.000	0.208
Pure Technical Efficiency	0.950	0.593	1.000	0.114
Scale Efficiency	0.773	0.474	1.000	0.184
Panel B: **All Banks 2002**				
Technical Efficiency	0.685	0.245	1.000	0.236
Pure Technical Efficiency	0.927	0.698	1.000	0.111
Scale Efficiency	0.737	0.245	1.000	0.222
Panel C: **All Banks 2003**				
Technical Efficiency	0.828	0.516	1.000	0.155
Pure Technical Efficiency	0.949	0.559	1.000	0.126
Scale Efficiency	0.875	0.622	1.000	0.122
Panel D: **All Banks 2004**				
Technical Efficiency	0.840	0.452	1.000	0.169
Pure Technical Efficiency	0.937	0.665	1.000	0.117
Scale Efficiency	0.893	0.660	1.000	0.123
Panel E: **All Banks 2005**				
Technical Efficiency	0.851	0.564	1.000	0.130
Pure Technical Efficiency	0.956	0.731	1.000	0.089
Scale Efficiency	0.893	0.564	1.000	0.129
Panel F: **Domestic Banks Only**				
Technical Efficiency	0.745	0.245	1.000	0.192
Pure Technical Efficiency	0.934	0.559	1.000	0.122
Scale Efficiency	0.799	0.245	1.000	0.173
Panel G: **Foreign Banks Only**				
Technical Efficiency	0.900	0.541	1.000	0.141
Pure Technical Efficiency	0.975	0.790	1.000	0.059
Scale Efficiency	0.922	0.541	1.000	0.127

Note: Detailed results are available from the authors upon request

Figure 1: Malaysian Islamic Banks Technical Efficiency

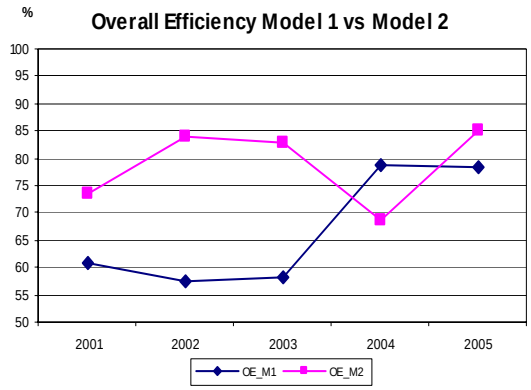


Figure 2: Malaysian Islamic Banks Pure Technical Efficiency

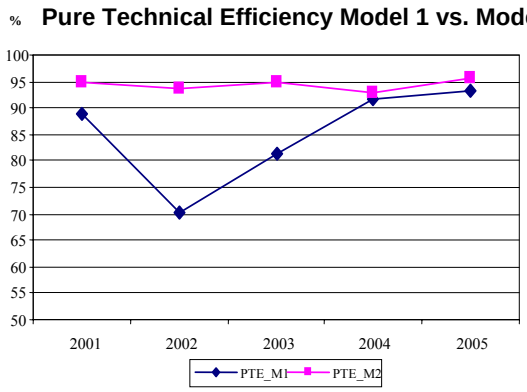
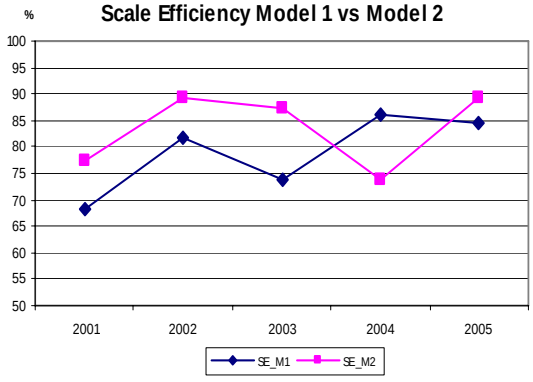


Figure 3: Malaysian Islamic Banks Scale Efficiency



We now turn to discuss the impact of the inclusion of loan loss provisions on the evolution of the domestic and foreign banks' technical efficiency. The results from Table 5 (Panel F and G) suggest that the inclusion of risk factors has resulted in higher domestic and foreign banks' technical efficiency. It is also apparent that the inclusion of loan loss provisions has had greater positive impact on both domestic and foreign banks pure technical efficiency. A closer look at the results, it seems that while the magnitude of the increase in the domestic banks' pure technical efficiency is higher compared to their foreign counterparts, on the other hand, the foreign banks magnitude of increase in scale efficiency is higher compared to the domestic banks.

Table 5: Composition of Production Frontiers (DEA Model B)

Bank	Type	2001	2002	2003	2004	2005	Count
Affin Bank	Domestic	DRS	DRS	DRS	IRS	IRS	0
Alliance Bank	Domestic	IRS	CRS	CRS	IRS	IRS	2
Arab-Malaysian Bank	Domestic	CRS	DRS	DRS	IRS		1
EON Bank	Domestic	DRS	CRS	DRS	CRS	IRS	2
Hong Leong Bank	Domestic	DRS	DRS	DRS	DRS	DRS	0
Maybank	Domestic	DRS	DRS	DRS	DRS	DRS	0
Public Bank	Domestic	DRS	DRS	DRS	CRS	CRS	2
RHB Bank	Domestic	DRS	DRS	DRS	DRS		0
Southern Bank	Domestic	DRS	DRS	DRS	CRS	IRS	1
Bank Islam Malaysia	Domestic	DRS	DRS	DRS	DRS	DRS	0
Bank Muamalat	Domestic	DRS	DRS	DRS	DRS	DRS	0
RHB Islamic Bank Berhad	Domestic					CRS	1
Commerce TIJARI Bank Berhad	Domestic					IRS	0
Citibank	Foreign	CRS	CRS	CRS	IRS	CRS	4
Hong Kong Bank	Foreign	CRS	DRS	CRS	CRS	DRS	3
OCBC	Foreign	CRS	DRS	CRS	IRS	IRS	2
Standard Chartered Bank	Foreign	CRS	IRS	IRS	CRS	IRS	2
Number of Banks	**n = 17**	**5**	**3**	**4**	**5**	**3**	

Notes: CRS – (Constant Returns to Scale); DRS – (Decreasing Returns to Scale); IRS – (Increasing Returns to Scale); The banks corresponds to the shaded regions have not been efficient in any year in the sample period (2001-2005) compared to the other banks in the sample.

The composition of the efficiency frontier and the nature of the returns to scale are discussed next. Table 6 presents the results on the nature of returns to scale in Malaysian Islamic banking sector derived from DEA Model B. Unlike the results from DEA Model A, the composition of the efficiency frontier for DEA Model B suggests that the number of 100% efficient banks has almost doubled to between 3

and 5 banks. The results from DEA Model B are very much similar to the results from DEA Model A, where foreign banks seem to dominate the efficiency frontier. Similar to the results from DEA Model A, Citibank and HSBC have appeared the most times on the efficiency frontier. Unlike DEA Model A, the results from DEA Model B suggest that 6 domestic banks have managed to appear on the efficiency frontier, while there were only 5 domestic banks that have never made it to the efficiency frontier throughout the period of study.

Table 6: Efficiency Gap between Domestic and Foreign Islamic Banks (DEA Model A and B)

	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency
2001			
DEA Model A	0.608	0.889	0.685
DEA Model B	0.736	0.950	0.773
Efficiency Gap	**0.128**	**0.061**	**0.088**
2002			
DEA Model A	0.573	0.701	0.817
DEA Model B	0.685	0.927	0.737
Efficiency Gap	**0.112**	**0.226**	**-0.08**
2003			
DEA Model A	0.583	0.813	0.740
DEA Model B	0.828	0.949	0.875
Efficiency Gap	**0.245**	**0.136**	**0.135**
2004			
DEA Model A	0.789	0.916	0.861
DEA Model B	0.840	0.937	0.893
Efficiency Gap	**0.051**	**0.051**	**0.032**
2005			
DEA Model A	0.783	0.931	0.847
DEA Model B	0.851	0.956	0.893
Efficiency Gap	**0.068**	**0.025**	**0.046**
Domestic Banks			
DEA Model A	0.597	0.819	0.740
DEA Model B	0.745	0.934	0.799
Efficiency Gap	**0.148**	**0.115**	**0.059**
Foreign Banks			
DEA Model A	0.777	0.911	0.859
DEA Model B	0.900	0.975	0.922
Efficiency Gap	**0.123**	**0.064**	**0.063**

Notes: Min = 0; Max = 1; Efficiency-Gap = DEA Model A – DEA Model B.

Since the efficiency gap between the domestic and foreign banks seems large, our next step is to test the significance of the difference between the foreign and domestic banks' efficiency. Foreign banks could have quite different goals from domestic banks, as they may be inclined to trade-off between efficiency and market share in order to penetrate a local market (Isik and Hassan, 2002). Further, foreign banks may have relied heavily on purchased funds in the inter-bank market, which is costlier. Alternatively, foreign banks might possess some distinct advantages, stemming mainly from their asset portfolios. Relative to domestic banks, foreign banks' asset portfolios are more skewed to investment securities, whose administrative and transactional costs are much lower than loans. Also, lack of exposure in a lesser-known market may manifest itself in the form of extra information gathering costs for clients.

We have performed several parametric (*t*-test) and non-parametric (Mann-Whitney [Wilcoxon Rank-Sum] and Kruskall-Wallis) univariate tests. The results are reported in Table 7. The results seem to suggest that foreign banks are relatively more technically efficient (significant at the 5% level of significance) compared to their domestic banks counterparts. This is mainly due to higher scale efficiency (significant at the 5% level of significance). The findings also suggest that foreign banks are more managerially efficient compared to their domestic peers, although not significant at any conventional level.

Table 7: Summary of Parametric and Non-Parametric Tests

	Test Groups					
	Parametric Test		**Non-Parametric Test**			
Individual Tests	*t*-test		Mann-Whitney [Wilcoxon Rank-Sum] test		Kruskall-Wallis Equality of Populations test	
Hypotheses			$Median_{db} = Median_{fb}$			
Test Statistics	*t* (Prb > *t*)		*z* (Prb > *z*)		χ^2 (Prb > χ^2)	
	Mean	*t*	Mean Rank	*z*	Mean Rank	χ^2
Technical Efficiency (TE)						
Domestic Banks	0.6363	-1.986***	35.11	-1.908***	35.11	3.640***
Foreign Banks	0.7527		45.95		45.95	
Pure Technical Efficiency (PTE)						
Domestic Banks	0.8368	-0.928	36.29	-1.177	36.29	1.386
Foreign Banks	0.8870		42.70		42.70	
Scale Efficiency (SE)						
Domestic Banks	0.7663	-1.853***	34.40	-2.376***	34.40	5.646***
Foreign Banks	0.8555		47.90		47.90	

Note: Test methodology follows among others, Aly *et al.* (1990), Elyasiani and Mehdian (1992) and Isik and Hassan (2002).
*** indicates significant at the 0.05% level

4.3 Correlates of the DEA Efficiency Measures

As suggested by Bauer *et al.* (1998), for the frontier based efficiency scores to be useful, the estimated scores should be correlated with the traditional non-frontier based measures of performance used by regulators, managers, and industry consultants. Bauer *et al.* (1998) stated that positive rank order correlations with these measures would give assurance that the frontier measures are not simply artificial products of the assumptions made regarding the underlying optimization concept.

In the spirit of Bauer *et al.* (1998), in order to complement the results of the efficiency measures, we have further correlated various commonly used accounting based measures of financial institutions performance with efficiency scores derived from the two DEA models. We have used *ROA* (Net Income divided by Total Assets) as a proxy measure of bank's profitability, while *NIE/TA* (Non-Interest Expense divided by Total Assets) is used as a proxy of bank management quality in controlling costs. *LOGASS* (Natural log of Total Assets) is a proxy of bank size and *LOGLOANS* (Natural Log of Total Loans) is a proxy measure of bank market share. To measure the association between risk and Malaysian Islamic banks' efficiency, *LLP/TL* is used as a proxy measure for risk. *EQUITY/TA* is also included because, as noted, domestic and foreign banks use different degrees of leverage. Furthermore, as Berger and Mester (1997) point out, it is an important control variable used to account for differences in risk among banking institutions. Dummy variables *FORB* (dummy variable that takes a value of 1 if a bank is a foreign bank, 0 otherwise), and *FFIB* (dummy variable that takes a value of 1 if a bank is a full-fledged Islamic bank, 0 otherwise) are included in the analysis to examine the relationship between bank ownership and efficiency.

Following among others, Isik and Hassan (2002), we have calculated both the rank-order Spearman and the parametric Pearson correlation coefficients to examine the possible relationship between the X- in (efficiency) and accounting measures of bank performance. Both the Spearman and Pearson correlation coefficient results are presented in Table 8. The null hypothesis is that the correlation coefficient between two variables is zero.

Table 8: Spearman Rho Rank Order [*s*] and Parametric Pearson [*p*] Correlation Coefficients among Efficiency Estimates and Proxy-Measures of Performance

Variables	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency	ROA	NIE/TA	EQUITY/TA	LOGASS	LOGDEPO	LLP/TL	DUMFORB	DUMFFIB
TE											
[*s*]	1.000	0.580***	0.715***	0.260**	-0.117	0.333***	-0.064	-0.138	0.105	0.222*	-0.239**
[*p*]	1.000	0.645***	0.681***	0.258**	-0.235**	0.245**	-0.082	-0.142	0.111	0.226*	-0.262**
PTE											
[*s*]	0.580***	1.000	-0.001	0.082	0.179	0.283**	-0.005	-0.056	0.102	0.137	0.068
[*p*]	0.645***	1.000	-0.108	0.058	0.078	0.283**	-0.068	-0.105	0.127	0.108	0.009
SE											
[*s*]	0.715***	-0.001	1.000	0.196*	-0.286**	0.191	-0.167	-0.229**	-0.084	0.276**	-0.333***
[*p*]	0.681***	-0.108	1.000	0.282**	-0.386***	0.044	-0.065	-0.105	0.016	0.212*	-0.375***
ROA											
[*s*]	0.260**	0.082	0.196*	1.000	0.031	0.466***	-0.223*	-0.195*	-0.282**	0.047	-0.398***
[*p*]	0.258**	0.058	0.282**	1.000	0.007	0.465***	-0.274**	-0.264**	-0.151	0.160	-0.304***
NIE/TA											
[*s*]	-0.117	0.179	-0.286**	0.031	1.000	0.396***	-0.084	-0.061	0.036	-0.038	0.493***
[*p*]	-0.235**	0.078	-0.386***	0.007	1.000	0.450***	-0.113	-0.092	0.320***	0.048	0.464***
EQUITY/ TA	0.333***	0.283**	0.191	0.466***	0.396***	1.000	-0.215*	-0.225*	-0.060	0.070	0.014
[*s*]	0.245***	0.283**	0.044	0.465***	0.450***	1.000	-0.529***	-0.537***	-0.086	0.178	0.105
[*p*]											
LOGASS											
[*s*]	-0.064	-0.005	-0.167	-0.223*	-0.084	-0.215*	1.000	0.986***	0.175	-0.478***	0.214*
[*p*]	-0.082	-0.068	-0.065	-0.274**	-0.113	-0.529***	1.000	0.992***	0.159	-0.472***	0.141
LOGDEPO											
[*s*]	-0.138	-0.056	-0.229**	-0.195*	-0.061	-0.225*	0.986***	1.000	0.155	-0.533***	0.229**
[*p*]	-0.142	-0.105	-0.105	-0.264**	-0.092	-0.537***	-0.992***	1.000	0.146	-0.511***	0.159

Variables	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency	ROA	NIE/TA	EQUITY/TA	LOGASS	LOGDEPO	LLP/TL	DUMFORB	DUMFFIB
LLP/TL											
[*s*]	0.105	0.102	-0.084	-0.282**	0.036	-0.060	0.175	0.155	1.000	-0.091	0.050
[*p*]	0.111	0.127	0.016	0.151	0.320***	-0.086	0.159	0.146	1.000	0.029	0.052
DUMFO											
RB	0.222*	0.137	0.276**	0.047	-0.038	0.070	-0.478***	-0.533***	-0.091	1.000	-0.314***
[*s*]	0.226*	0.108	0.212*	0.160	0.048	0.178	-0.472***	-0.511***	0.029	1.000	-0.314***
[*p*]											
DUMFFI											
B	-0.239**	0.068	-0.333***	-0.398***	0.493***	0.014	0.214	0.229**	0.050	-0.314***	1.000
[*s*]	-0.262**	0.009	-0.375***	-0.304***	0.464***	0.105	0.141	0.159	0.052	-0.314***	1.000
[*p*]											

Note: ROA is return on assets; NIE/TA is non-interest expense on total assets; EQUITY/TA is shareholders equity on total assets; LOGASS is natural log of total assets; LOGDEPO is natural log of total deposits; LLP/TL is loan loss provisions on total loans; DUMFORB is a dummy variable that takes a value of 1 if a bank is a foreign bank and 0 otherwise; DUMFFIB is a dummy variable that takes a value of 1 if a bank is a full fledged Islamic bank and 0 otherwise.

Spearman [*s*] correlation coefficient – first row of each cell

Parametric Pearson [*p*] correlation coefficient – second row of each cell

*** indicates significant at the 0.01% level (2-tailed)

** indicates significant at the 0.05% level (2-tailed)

* indicates significant at the 0.10% level (2-tailed)

Table 8 shows the Spearman [*s*] and the Pearson [*p*] correlation coefficients between the DEA results and a set of common banking efficiency ratios. Levels of significance are also shown. As the results indicate, the Spearman [*s*] and the Pearson [*p*] correlation coefficients are all significantly different from zero, indicating that there is a strong association among the X-efficiency measures and accounting measures of bank performance. Generally, the Pearson coefficient results have confirmed all the relationships found with the Spearman in the direction (positive or negative) and significance[7]. The results from the Spearman correlation coefficients shows that technical efficiency is highly positively and statistically significantly associated with other X-efficiency measures namely, PTE and SE (ρ TE – PTE = 0.580, ρ TE – SE = 0.715). The results also suggest that SE is more related to TE than PTE, confirming the dominant effect of scale efficiency in determining the technical (in) efficiency of Malaysian Islamic banks.

The results from the Spearman and Pearson correlation coefficients suggest that LOGASS as a proxy for size and LOGDEPO as a proxy of market share to be negatively related to TE. It is also interesting to note that the negative relationship is more prevalent towards SE, implying that the larger banks with greater market share tend to be less efficient resulting from operating at a non-optimal scale. As expected, the results from the Spearman and Pearson correlation coefficients suggest that NIE/TA, which is a proxy measure for management quality in controlling costs, is negatively and significantly related to TE and SE (ρ NIE/TA – TE = 0.117, ρ NIE/TA – SE = 0.286). The results imply that a more efficient bank is also one that is efficient in controlling their costs.

From Table 8 it is also apparent that EQUITY/TA as a proxy measure of bank capitalization is positively associated with all efficiency measures, suggesting that a better capitalized bank tend to be more efficient. The results seem to suggest that LLP/TL, a proxy measure of bank risk, have positive relationships with TE and PTE. A possible explanation is that banks with higher amount of non-performing loans would allocate a higher amount of resources to manage this problem. The results have also confirmed the sensitivity of PTE with the exclusion of risk factor in DEA estimations, while SE tends to be overestimated when risk measures are excluded.

As expected the results from Table 8 suggest that both TE and SE are positively and significantly related to FORB, implying that the foreign banks are relatively more efficient compared to their domestic counterparts. On the other hand, TE and

[7] In the case that the relationship found significant with the Spearman rank correlation and is not supported by the Pearson correlation, the results obtained by the Spearman correlation should be used, as the results obtained by Spearman correlation coefficients are more credible due to the less stringent assumptions required (Isik and Hassan, 2002). The difference could be attributed to the assumptions underlying each method.

SE seem to have a negative relationship with the full-fledged Islamic banks. Further, the results also seem to suggest that the full-fledged Islamic banks have relatively lower management quality, measured by NIE/TA as a proxy. The results also suggest that, foreign banks are smaller in size and have lower market share. On the other hand, the full-fledged Islamic banks are larger and have a bigger slice of the market share. It is also apparent that while LLP/TL is negatively related to FORB (in the case of Spearman correlation), it seems to have a positive relationship with the full-fledged Islamic banks, suggesting that problem loans are more prevalent at the full-fledged Islamic banks.

Finally, there is also statistically strong positive relationship between profitability ratio (ROA) and all efficiency measures. The results from the Spearman correlation coefficients suggest that ROA is positively and significantly correlated with TE and SE (ρ ROA – TE = 0.260, ρ ROA – SE = 0.196) at the 5% and 10% levels of significance, respectively. Again, the results from the Spearman correlation coefficients are further confirmed by the Pearson correlation coefficients albeit at different levels of significance. The findings support among others, Miller and Noulas (1996), Hasan and Marton (2003) and Isik and Hassan (2002) in that the more efficient banks tend to be more profitable.

In sum, the statistically and significantly different from zero correlation coefficients suggest that our X-efficiency measures are strongly associated with conventional proxy measures of performance, i.e. they are robust and are not 'meaningless' of the technique used.

5. CONCLUSIONS, DISCUSSIONS, AND DIRECTIONS FOR FUTURE RESEARCH

The paper investigates the performance of Malaysian Islamic banking sector during the period of 2001-2005. Several efficiency estimates of individual banks are evaluated using non-parametric Data Envelopment Analysis (DEA) approach. This was a time in which all local banks were undergoing massive changes in face of the imminent competition from globalization. Two different models have been employed to differentiate how efficiency scores vary with changes in inputs and outputs. To examine the impact of risk factor on Islamic banks' efficiency, we have incorporated problem loans as a non-discretionary input variable in our analysis.

The results suggest that during the period of study, scale inefficiency dominates pure technical inefficiency in the Malaysian Islamic banking sector. We found that foreign banks have exhibited higher technical efficiency compared to their domestic peers attributed to higher scale efficiency. The findings are validated by a series of parametric and non-parametric tests. The inclusion of risk factors has mixed impact on Malaysian Islamic banks' efficiency. The results seem to suggest

that while potential economies of scale may be overestimated when risk factors are excluded, pure technical efficiency estimates on the other hand tend to be much more sensitive to the exclusion of risk factors.

To further complement the results of the efficiency measures, we have correlated various accounting measures of bank performance with the efficiency scores derived from the DEA model. The results from both the Spearman and the Pearson correlation coefficients suggest that technical efficiency is positively and significantly associated with scale and pure technical efficiency measures. The results have also confirmed the dominant effect of scale efficiency over pure technical efficiency in determining Malaysian Islamic banks' technical efficiency during the period of study. We found that bank size and market share have negative effect on Malaysian Islamic banks' efficiency. During the period of study, the results suggest that the foreign banks were smaller, have lower market share and have relatively lower problem loans. On the other hand, the domestic banks were larger, have bigger market share, and have higher amount of non-performing loans. The results suggest that the foreign banks were more efficient compared to their domestic peers. Finally, our results also suggest that the more efficient banks tend to be more profitable.

The general conclusion provided from the findings is that in recent years, the window based Islamic banking operations performed better than the full-fledged Islamic banks, which appear to have under performed their window-based Islamic banks mainly due to sub-optimal scale of operations. The principal findings for the period under study indicates that technical efficiency scores are improving more for the conventional banks offering Islamic banking products and services than for the full-fledged Islamic bank. This appears mainly due to operations under DRS. Thus, the results suggest that for the full-fledged Islamic bank to be efficient, they need to minimize their size. The results are generally consistent with earlier studies, which have generally found that the larger banks tend to be less efficient.

The emergence of two foreign banks i.e. Citibank and Hong Kong Bank, as the "global leaders" by appearing the most times on the efficiency frontier for both models, may be mainly explained by 1) advantages stemming from their expertise on the Malaysian banking environment gained from long-term involvement in the country 2) their ability as a foreign bank with wide international presence, to mobilize Islamic banking funds from the Middle East, 3) engagement in less risky operations evidenced by the comparatively lower loan loss provisions and 4) dynamism and innovativeness in introducing and promoting new Islamic banking and finance products, to cater for the domestic market's needs. Foreign banks were also considered to possess inherent economies of scale, as a direct extension of their other international operations and so were capable of competing with the incumbent domestic banks. From the policy making perspective, the results may imply that the opening up of the Islamic banking sector to the entry of foreign

banks as important in the on-going process of efficiency improvement and innovation, as well as increasing globalization of the Malaysian financial system.

Our findings on the scale efficiency of Islamic banking operations is consistent with similar DEA study on US banks performed by among others Miller and Noulas (1996) who found that the larger banks are more likely to operate at decreasing returns to scale (DRS) and constant returns to scale (CRS) at best, while the small banks tend to operate at increasing returns to scale (IRS). Thus, from the public policy point of view, from the scale efficiency perspective, banks that were found to operate at IRS may raise their efficiency by expanding, while the larger banks which were operating at DRS may need to scale down their operations by managing and controlling their existing costs more efficiently. However, as pointed by Avkiran (2000), overcoming inefficiency due to scale may be more time consuming with in market mergers and business collaborations, compared to addressing pure technical inefficiency in the short-term by 'experimenting with new combinations of inputs and outputs observed from the operations of efficient peers' within the sample.

Due to its limitations the paper could be extended in a variety of ways. Future research into the efficiency of Malaysian Islamic banks in particular and Islamic banks in general could also consider the production function along with the intermediation function. Investigation of changes in productivity over time as a result of technical change or technological progress or regress by employing the Malmquist Total Factor Productivity Index could yet be another extension to the paper. Future research into the efficiency and productivity of Malaysian Islamic banks could also consider the production function along with the intermediation function.

Despite these limitations, the findings of this study are expected to contribute significantly to the existing knowledge on the operating performance of the Malaysian Islamic banking industry. Nevertheless, the study have also provide further insight to bank specific management as well as the policymakers with regard to attaining optimal utilization of capacities, improvement in managerial expertise, efficient allocation of scarce resources and most productive scale of operation of the banks in the industry. This may facilitate directions for sustainable competitiveness of future Islamic banking operations in Malaysia.

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