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EFFICIENCY OF ISLAMIC BANKING IN MALAYSIA: A STOCHASTIC FRONTIER APPROACH

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This study empirically investigates the efficiency of the full-fledged Islamic banks, Islamic windows and conventional banks in Malaysia. It finds that the Malaysian Islamic banking industry has, in terms of assets, deposits and financing base, grown very rapidly over the 1997-2003 period. The study then measures the technical and cost efficiency of these banks using the Stochastic Frontier Approach. The findings show that, on average, the efficiency of the overall Islamic banking industry has increased during the period of study while that of conventional banks remained stable over time. However, the efficiency level of Islamic banking is still lower than that of conventional banks. The study also reveals that full-fledged Islamic banks are more efficient than Islamic windows, while Islamic windows of foreign banks tend to be more efficient than those of domestic banks.

1. INTRODUCTION

Islamic banks today exist in all parts of the world and are looked upon as a viable alternative system which has many things to offer. While it was initially developed to fulfil the needs of Muslims, Islamic banking has now gained universal acceptance. In Malaysia, the first Islamic bank, Bank Islam Malaysia Berhad (BIMB), operated as the only Islamic bank for 10 years since July 1983 before the government allowed other conventional banks to offer Islamic banking services using their existing infrastructure and branches in 1993 [Bank Negara Malaysia (BNM), 1994 and 1999]. The government decided to allow the conventional banking institutions to offer Islamic banking services or "Islamic windows" because this was thought to be the most effective and efficient mode of increasing the number of institutions offering Islamic banking services at the lowest cost and within the shortest time frame (BNM,

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1994 and 1999). By so doing, it would also force the Malaysian banking industry to be more competitive, which would then lead to an improved performance and enhanced efficiency of the Islamic banking industry (Alias, Kamarulzaman and Bhupalan, 1994; Kaleem, 2000). However, with the facilities and incentives extended, especially by the Central Bank, to both the full-fledged Islamic banks and Islamic windows, one wonders whether they have, over the two-decade period (1980s-1990s), performed efficiently. Although this issue is very pertinent, only few studies have been undertaken to investigate it.

This study examines the efficiency of the Islamic banking industry in Malaysia from 1997 to 2003, by using the Stochastic Frontier Approach (SFA) technique. To the researcher's best knowledge, this is the first time this technique is being used to analyse both the technical and cost efficiencies of Malaysian full-fledged Islamic banks and Islamic windows. The results would provide us explicit indications as to whether the decision to allow Islamic windows to operate side-by-side with full-fledged Islamic banks is commensurate with the ultimate objective of creating a conducive environment for them to compete in an efficient manner. The efficiency measurement would also give an indication as to whether current Islamic banks in Malaysia are ready to face financial liberation. This being the case because under the Phase Three of the Financial Sector Master Plan, the Central Bank of Malaysia had issued full-fledged Islamic bank licenses to foreign banks as part of the financial liberalisation of Islamic banking in Malaysia (BNM, 2004).

The paper is divided into six parts. Following this introduction, section two presents the developments of Islamic banking in Malaysia. Section three reviews briefly the previous studies on bank frontier efficiency. Section four proceeds with the methodology and data used to carry out the efficiency analysis. Section five examines the empirical findings and section six concludes the paper.

2. DEVELOPMENT OF ISLAMIC BANKING IN MALAYSIA

Malaysia has emerged as the first country to implement a dual banking system where Islamic banking system operates side-by-side with the conventional banking system. The Malaysian model has been recognised by many Islamic countries as the model of the future and many countries have shown interest in adopting this system. In fact, delegates from various countries, mainly Muslim countries, have come to Malaysia, particularly to the Central Bank and Bank Islam Malaysia Berhad (BIMB), to study how the dual banking system works.

2.1. History of Islamic banking in Malaysia

The history of Islamic banking in Malaysia can be traced back to 1963 when Tabung Haji (the Pilgrims Management and Fund Board) was established by the government. It is a specialised financial institution that provides a systematic mobilisation of funds from Muslims to assist them perform pilgrimage in Makkah as well as encourage them to participate in investment opportunities and economic activities. In fact, due to its uniqueness, Tabung Haji is considered to be the first of its kind in the world (Mohammed Seidu, 2002).

Based on the experience of Tabung Haji, the government of Malaysia then introduced a well-coordinated and systematic process of implementing the Islamic financial system. The process can be divided into three phases. The first phase is considered as the period of familiarisation (1983-1992). This was the period when BIMB was established and the Islamic banking operations were initiated in accordance with Shariah principles, and is also the period when Islamic Banking Act (IBA) was officially enacted. The second phase, from 1993 to 2003, was aimed at creating a more conducive environment for competition among the banks. At the same time, it was to give banks ample time to try to capture a larger market share. Lastly, while the intention was to create awareness among the public, especially the Muslims, of the benefits of the Islamic banking system, this was also the period when conventional banks were allowed to offer Islamic banking services by setting up "*Islamic windows*", as referred to in the "*Islamic banking scheme (IBS)*", in 1993. The third phase that commenced from 2004 was the period of further financial liberalisation (BNM, 2004). During that period, the Central Bank paved the way for new foreign Islamic banks to operate in Malaysia by issuing them licenses.

2.2. Islamic Banking System

The Islamic banking system comprises full-fledged Islamic banks and Islamic windows within the conventional banking institutions (commercial banks, finance companies and merchant banks). There are currently two full-fledged domestic Islamic banks operating in Malaysia. The first is Bank Islam Malaysia Berhad (Bank Islam) which was established in 1983, while the second is Bank Muamalat Malaysia Berhad (Bank Muamalat) which was established in 1999. There are also three new full-fledged foreign Islamic banks that were given licence to operate in Malaysia starting from the year 2004, namely Kuwait Finance House, Al-Rajhi Banking & Investment Corporation and the consortium led by Qatar Islamic Bank.

The commercial banks form the largest group of conventional banking institutions participating in the IBS. As indicated in Table 1, total assets as at the end of December 2003 amounted to RM 36.8 billion, while deposits and financing totalled RM 26.5 billion and RM 22.3 billion respectively. The second largest group of Islamic windows is finance companies, with total assets of RM 17.9 billion and deposits and financing amounting to RM 11.0 billion and RM 15.7 billion respectively. Finally, merchant banks are a relatively small group in the Islamic banking system. As at the end of December 2003, the total assets of IBS merchant banks amounted to RM 1.7 billion, while deposits and financing totalled RM 851.7 million and RM 780.8 million respectively.

The Malaysian Islamic banking industry, in terms of assets, deposits and financing base, has grown very rapidly over the seven-year period, as illustrated in Table 1. For example, the total assets accumulated by the industry (comprising Bank Islam, Bank Muamalat and Islamic windows) rose sharply from RM 17.8 billion in 1997 to RM 77.4 billion at the end of 2003. Total deposits mobilised by this industry increased tremendously from RM 9.9 billion in December 1997 to RM 55.9 billion in December 2003. On the financing side, the Islamic banking system has shown an impressive growth from RM 10.7 billion to RM 48.6 billion during the same period. However, it would be intriguing to investigate whether the growth achieved corresponded to a higher efficiency level.

3. LITERATURE REVIEW

3.1. The Bank Efficiency Study

The studies of efficiency using frontier approaches on banking did not start until Sherman and Gold (1985) initiated their own. They applied the frontier approach to the banking industry by focusing on the operating efficiency of the branches of a savings bank. Since then, numerous studies have been conducted using frontier approaches to measure banking efficiency. There have been extensive studies on bank efficiency done in the US and European countries and most of them focused on conventional banking (Berger and Humphrey, 1997; Goddard *et al.*, 2001). Only few efficiency studies on Islamic Banking can be found (Elzahi Saaid, 2002; Hussein, 2003).

A few interesting results were found in the study of Islamic banks in Pakistan, Iran and Sudan during the period of 1994-2001, realised by Hassan (2003). By employing both parametric and nonparametric techniques, he found that the major source of technical efficiency for Islamic banks is scale efficiency not technical efficiency, which is different from what Furukawa (1996) found in the study on Japanese credit associations. He also found that Islamic banks are relatively more efficient in containing cost but relatively inefficient in generating profit. The results obtained by Hassan (2003) showed that a larger bank size and greater profitability imply higher efficiency, which is consistent with the findings of Brown and Skully (2003). In another cross-country study on 35 Islamic banks, Brown and Skully (2003) had concluded that Iranian banks were found to be the largest and the most cost-efficient, whilst the Sudanese, which offer agriculture finances, the least cost-efficient. Using the non-parametric technique (DEA), they also found that the most cost-efficient banks were from the Middle East region.

3.2. Malaysian Bank Efficiency Studies

A few efficiency studies have been done on Malaysian banks and most of them focused on conventional banking (Katib, 1999; Abdul Majid *et al.*, 2003; Mat Nor and Hisham, 2003). Katib (1999) studied the technical efficiency of Malaysian commercial banks from 1989 to 1995 and the results showed that, on average, the banks did not efficiently combine their inputs. The findings suggested that over the period of observation, technical efficiency ranged from 68 to 80%. Katib (1999) also found that banks with a higher level of technical efficiency have lower costs of labour. In other words, banks that are more efficient are more cost-conscious than less efficient ones.

Two recent seminal papers on Malaysian commercial banks are those of Abdul Majid *et al.* (2003) and Mat Nor and Hisham (2003). The former studies the impact of a crisis on efficiency and the latter the effect of mergers on efficiency. Using the stochastic frontier cost function, Abdul Majid *et al.* (2003) examines the cost efficiency of Malaysian commercial banks over the period 1993-2000 to compare the efficiency before and after the financial crisis. The findings show that the efficiency of Malaysian banks before and after the crisis was not significantly different. The study also finds that foreign-owned banks are more efficient than local-owned ones. Mat Nor and Hisham (2003) attempt to find the effects of mergers on the technical efficiency of commercial banks using the Data Envelopment Analysis (DEA) for the years 2000 and 2001. They find that mergers did not lead to any changes in efficiency. However, it might be too early to conclude that mergers had no impact on efficiency since the study was based on only two years. In another seminal paper, Batchelor and Mokhtarul Wadud (2003) attempt to study the technical efficiency of Islamic banking operations in Malaysia over the period 2000-2001 by using the non-parametric method DEA. The results show that full-fledged Islamic banks are less efficient than commercial banks that offer Islamic banking products. Their study, however, was confined to only two years and did not cover the allocative efficiency.

4. METHODOLOGY

4.1. Stochastic Frontier Approach

There are several econometric (parametric) and linear programming (nonparametric) techniques used to measure efficiency, as surveyed by Berger *et al*. (1993) and Berger and Humphrey (1997). The parametric approach has the advantage of allowing noise in the measurement of inefficiency. However, the approach needs to specify the functional form for production, cost or profit. The non-parametric approach is simple and easy to calculate since it does not require the specification of the functional form (Coelli, 2004). However, it suffers from the drawback that all deviations from the best-practice frontier are attributed to inefficiency since it does not allow for noise to be taken into account. Common parametric methods are the stochastic frontier approach, the thick frontier approach and the distribution-free approach, while the common non-parametric techniques are the free disposal hull analysis and data envelopment analysis.

The present study uses the Stochastic Frontier Approach (SFA) to compute the technical and cost efficiencies. Figure 1 summarises the SFA modelling framework of the study, which will be explained in this section. First, following the Bhattacharyya *et al.* (1997) approach, the study constructs a single "grand frontier" which envelops the pooled input-output data of all banks for the entire study period. This approach gives us a few advantages. First, it provides a single benchmark against which we can gauge the performance of other banks over a specific period. Second, using this approach, it is possible for us to compare the relative efficiency for each bank in each year while at the same time observing the change in the performance of all banks during the period. Third, this grand frontier approach can also alleviate the problem related to unbalanced panel data. Finally, by pooling all the data into a single grand frontier, it gives reliable results, as the number of banks grows.

4.1.1. Efficiency Concepts and their Function

In analysing the efficiency of financial institutions using the SFA, it is important to consider which concepts to use. The two concepts used for this study are technical efficiency and cost efficiency.

Technical efficiency (TE) has two types of measure. If it is an output-oriented measure, TE is a bank's ability to achieve maximum output given its sets of inputs. An input-oriented TE measure, however, reflects the degree to which a bank could minimise its inputs used in the production of given outputs. A value of 1 indicates full efficiency and operations on the production frontier. A value of less than 1 reflects operations below the frontier. The wedge between 1 and the value observed measures the technical efficiency. The technical efficiency of the bank can be calculated by using either nonparametric or parametric techniques. Nonparametric technical efficiency can be calculated by using the linear mathematical programming technique. On the other hand, for a parametric approach, technical efficiency is derived from a production function. The production function which was first proposed by Aigner, Lovell and Schmidt (1977) and Meusen and Van Den Broeck (1977), can be written in a natural logarithm form as follows:

$$\ln y = f(x) + \ln U_t - \ln V_t \qquad \textbf{\textit{(1)}}$$

where $\ln y$ represents observed outputs, f denotes some functional form, x is the vector of inputs, U_t is the inefficiency error term, and V_t is the random error term which accounts for measurement error or other errors such as effects of weather, strike or luck on the value of output. The production function above describes the relationship between the output variables with quantities of input variables plus the inefficiency and random error.

On the other hand, cost efficiency (CE) is a measure of how far a bank's cost is from the best practice bank's cost if both were to produce the same output bundle under the same market conditions (Berger & Mester, 1997; Vander Vennet, 2002). Thus, if the measured cost efficiency of a bank is 0.80, it implies that it is about 80 per cent cost-efficient or it has wasted 20 per cent of its cost relative to a best practice bank. In this case, the bank should use its inputs as efficiently as possible in order to gain a reduction of 20 per cent in its costs so that it reaches the minimum cost of the best practice bank.

The parametric cost efficiency is derived from a cost function. According to Berger and Mester (1997), the cost function can be written in a natural logarithm form as the follows:

$$\ln TC = f(\mathbf{Y}, W) + \ln U_c + \ln V_c \qquad \textbf{\textit{(2)}}$$

where $\ln TC$ is the total cost variable, f denotes some functional form, $\mathbf{Y}$ is the vector of output variables, W is the vector of prices of input variables, $\ln U_c$ is the inefficiency factor that may raise cost above the best-practice optimal cost and $\ln V_c$ is the random error incorporated to capture the measurement error and luck, which may temporarily increase or decrease a bank's costs. Basically, the cost function above describes the relationship between the cost variables with prices of input variables, quantities of output variables plus the inefficiency and random error.

4.1.2. Distributional Assumptions

After deciding on the economic concept to be used, this section focuses on the distributional assumptions for the inefficiency and random error components. As discussed in the earlier Stochastic Frontier Approach section, non-parametric techniques assume that there is no error and deviation from the best practice banks attributed to inefficiency. However, for parametric techniques, the inefficiency and random error components of the composite error term are disentangled by making explicit assumptions about their distributions. Following Aigner, Lovell and Schmidt (1977), this study assumes the distribution of the error term or statistical noise, V_i, to **be a two-sided normal distribution** while the inefficiency term, U_i, is assumed to be **one sided (*half normal distributed*)**.

Information gathered from the literature review reveal that other types of distribution assumptions are also used for estimating inefficiency. Aigner, Lovell and Schmidt (1977) provide two ways of estimating inefficiency. Specifically, they assume that the distribution of the inefficiency term takes a half-normal distribution in one estimation and an exponential distribution in another. Whereas Meusen and Broeck (1977) consider inefficiency to take only the exponential distribution, Cebenoyan, Cooperman, Register and Hudgins (1993) and Berger and DeYoung (1997) use the truncated normal distribution, while the Gamma distribution is considered by Stevenson (1980) and Greene (1990). However, Bauer (1990) and Greene (1990) note that the half-normal distribution has become a standard choice. Berger, Hunter and Timme (1993) and Bauer *et al.* (1998) confirm this view in their detailed literature review on banking efficiency.

Although, there is no consensus on the type of distribution one should choose to arrive at the inefficiency measures, most of the works that are available in the literature suggest that different distributional assumptions tend to yield similar efficiency scores. Based on the Aigner *et al.* (1977) analysis, little difference in inefficiency scores is found when different assumptions are used for the inefficiency term. Greene (1990) also suggests that distributional assumptions do not have much impact on the efficiency results. Altunbaş and Molyneux (1994) also do not find much difference in efficiency estimates when comparing four different distribution assumptions (half-normal, truncated normal, exponential and gamma distribution), while Bauer *et al.* (1998) suggest that the efficiency ranking for the banks are in the same order although different distributional assumptions are used.

4.1.3. Functional Forms

In this section, the cost and profit functional forms, F, are discussed in estimating economic efficiency. Three widely used functional forms are the Cobb-Douglas, Fourier Flexible and Translog Functional. This study uses **the translog functional form** as described by Mester (1997); Bauer *et al.* (1998); Roger (1998); and Işık and Hassan (2002). The translog model is a flexible functional form and is expanded by a second order Taylor series. As mentioned earlier, the flexibility of the translog model is demonstrated in its usefulness for approximating the second-order effect of an unknown functional form (Berndt and Christensen, 1973). In other words, it does not impose any restrictions on the first and second-order effects (Kaparakis *et al.*, 1994). This flexibility serves as an advantage for banking efficiency studies because it is difficult to identify exactly the functional form that fits the production and cost functions (Kaparakis *et al.*, 1994). Furthermore, the translog model allows homogeneity of degree one by simply imposing restrictions on the translog model parameter (McAllister and McManus, 1993).

To start building the translog functional form for this study we first recall the technical (equation *1*) and cost (equation *2*) efficiency functions discussed earlier in the section on efficiency concepts. Those functions are rewritten as:

$$\ln y = \alpha_o + \sum_{i=1}^{n} \alpha_i \ln x_i + E_t \quad \text{is the production function,} \quad \textbf{(3)}$$

$$\ln TC = \alpha_o + \sum_{i=1}^{n} \alpha_i \ln Y_i + \sum_{i=1}^{n} \alpha_i \ln W_j + E_c \quad \text{is the cost function.} \quad \textbf{(4)}$$

where TC is the cost variable for the cost function, y is the output variable for the production function, x_i is the vector of quantities of variable inputs, Y_i is the vector of quantities of variable outputs, W_j is the vector of prices of variable inputs, E_i is the stochastic error term where $E_t = U_t - V_t$ is for the production function and $E_c = U_c + V_c$ is for the cost function. To avoid repetition, we show the construction of our model using the cost function. Similar to Rogers (1998) and Işık and Hassan (2002), a translog cost function for this study is shown as:

$$\ln TC = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln Y_i + \sum_{j=1}^{n} \beta_j \ln W_j + \frac{1}{2}[\sum_{i=1}^{n}\sum_{j=1}^{n} \delta_{ij} \ln Y_i \ln Y_j + \sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} \ln W_i \ln W_j] + \sum_{i=1}^{n}\sum_{j=1}^{n} \rho_{ij} \ln Y_i \ln W_j + E_i \qquad \textbf{\textit{(5)}}$$

where, $\ln TC$= the natural logarithm of total costs; $\ln Y$= the natural logarithm of output quantities; $\ln W$= the natural logarithm of input prices; $E_i = V + U$ is as defined in equation (2) and (4); $\alpha, \beta, \delta, \gamma$ and ρ are coefficients to be estimated.

4.2. Choice of banks' input and output variables

Most of the frontier studies in banking have adopted the intermediation approach and only a few have used the production approach (Ferrier and Lovell, 1990; Wheelok and Wilson, 1995). Berger and Humphrey (1997) suggest that the intermediation approach is the best for evaluating the entire bank because it is inclusive of interest expense (income paid to depositors), which often accounts for one half to two thirds of total costs.

This study employs the intermediation approach for four reasons: First, it will be evaluating the bank's efficiency as a whole; second, this approach is widely used (Kwan, 2001); third, the financial institutions normally employ labour, physical capital and deposits as their inputs to produce earning assets (Sealey and Lindley, 1977); and fourth, the main principle of the Islamic banking itself. The principle of the Islamic financial system is based on equity participation, i.e. employing funds on the basis of Profit and Loss sharing. This, by all means, implies the importance of the intermediary activities that Islamic banks perform.

For the choice of input and output variables, the study uses two input variables and one output variable. The first input variable, denoted by **X1,** is *total deposits* which include the deposits from customers and other banks. The second input variable, denoted by **X2,** is *total overhead expenses* which include the personnel and other operating expenses. This represents the resources expended in converting deposits to financing[4] and other earning assets.

The output is *total earning assets*, denoted by **Y1**, which include financing, dealing securities, investment securities and placements with other banks. In the calculation of cost efficiency, apart from the input and output variables, two input prices are added: prices of labour and physical capital, denoted by **W1,** and prices of deposits, denoted by **W2**. **W1** is calculated using personnel and other overhead expenses divided by total assets, which is similar to the Hassan and Marton (2003) and Fries and Taci (2005) approaches, while **W2** is defined as the income paid to depositors[5] divided by total deposits.

Finally, total costs, denoted by **TC,** include the income paid to depositors/interest expense, personnel expenses and other operating expenses (linear homogeneity restrictions are imposed by normalising the total cost and input price of labor and capital by the price of deposits). Tables 2 and 3 present the descriptive statistics of the bank's input and output variables from 1997 to 2003 for the Malaysian Islamic Banking and conventional banking respectively.

4.3. Data

The study uses 288 panel data from the annual reports of 20 Islamic windows, 2 full-fledged Islamic banks and 20 conventional banks from 1997 to 2003. These were individually obtained from each bank. Some of the information was also obtained from the Bank Negara Malaysia reports. The samples are selected on the basis that the bank has Islamic banking operations within the period of the study and also on the basis of data availability. The conventional banks included are the parent banks of Islamic windows. Table 4 shows the list of the banks.

5. EMPIRICAL FINDINGS AND RESULTS

The computer programme FRONTIER Version 4.1, developed by Coelli, has been used to obtain the maximum likelihood estimates of parameters in estimating the technical and cost efficiency (Coelli, 1996 and Coelli *et al.*, 1998). The programme can accommodate cross

[4] The term financing is for Islamic banks, which is equivalent to loans for conventional banks.
[5] For conventional banks, it refers to interest expense.

sectional and panel data; cost and production function; half-normal and truncated normal distributions; time-varying and invariant efficiencies; and functional forms which have a dependent variable in logged or original units. These features of what Frontier 4.1 can and cannot do are not exhaustive, but provide an indication of its capabilities.

5.1. Average Bank Efficiency Over Time

The overall trend of efficiency estimates, derived from our Stochastic Frontier Analysis (SFA) model, are summarised in Table 5. Tables 6 and 7 present the maximum likelihood estimates for the production (technical efficiency) and cost (cost efficiency) functions.

Overall, the average technical and cost efficiencies of the conventional banks are higher than those of the Islamic banking system. The average technical and cost efficiencies for Islamic banking are respectively 80.1% and 86.0%; whilst conventional banks show technical and cost efficiencies of 83.5% and 87.6%. The efficiency results of conventional banking and Islamic banking reflect the years the banks have been established in which Islamic banking is still considered at an early development stage. By any standards, 20 years of Islamic banking is an extremely short period of time if we were to compare it with conventional banking which has a history of more than a 100 years.

Whereas the trend shows that the average technical and cost efficiencies of Islamic banking tended to increase over the seven year-period, the efficiency of the conventional banks did not change much, on average, over the same period. The trend results provide useful information to the policy maker regarding the positive impacts of the introduction of Islamic windows on the Malaysian Islamic banking industry.

5.2. Average Bank Efficiency by Type

Referring to Tables 8 and 9, the full-fledged Islamic banks are found to outperform the Islamic windows across the board. The average technical efficiency based on bank type for the Islamic banking system ranged from 78.9% for the Islamic windows of the commercial banks to 83.8% for the full-fledged Islamic banks; whilst the average cost efficiency ranged from 85.4% for the former to 87.7% for the latter. For the conventional banks, technical efficiency ranged from 81.6% for finance companies to 84.8% for merchant banks; whilst cost efficiency ranged from 87.4% for the former to 87.8% for the latter.

Next, in order to test whether the bank type implies different levels of efficiency, we performed the ANOVA statistical test as shown in Tables 10a and 10b. Three categories of banks are Islamic windows, full-fledged Islamic banks and conventional banks. Imbedded in ANOVA are the following alternative hypotheses:

H1= There is a significant difference in the technical and cost efficiency scores for at least two different types of banks.

Based on the ANOVA test, H1 is supported (technical efficiency: F=4.921, df=2,285, p=0.008; cost efficiency: F=3.807, df=2,285, p=0.023). Therefore, we can conclude that the bank type exerts an influence on technical and cost efficiencies by resulting in a significantly different level of efficiency scores for at least two of the three types of bank.

In order to examine further the relationship between bank types and efficiency, we run a post hoc comparison. Tables 11a and 11b of the Tamhane's T2 show that the full-fledged Islamic banks are significantly more efficient than the Islamic windows which are significantly less efficient than their parent banks. However, the difference between the full-fledged Islamic banks and conventional banks is not statistically significant.

5.3. Average Bank Efficiency by Ownership Status

Another dimension to look at banks is to look at their ownership status, which is illustrated in Tables 12 and 13. One distinctive feature of this study is that the efficiency analysis is extended to the extent that it allows us to make a comparison between foreign and domestic banks' performance. It appears from Tables 12 and 13 that the Islamic windows of foreign banks have a higher average technical and cost efficiency scores than the Islamic windows of domestic banks. This finding is consistent with the previous studies, including Zaim (1995) and Hussein (2003), who find that foreign banks are the most cost-efficient banks.

The differences observed in Tables 12 and 13 must be tested for statistical significance. The alternative hypotheses posit the following:

H1: There is a difference in the technical and cost efficiencies of foreign and domestic Islamic windows.

The T-test in Tables 14 and 15 shows that the gap in relative efficiency between the two groups is statistically significant. The mean technical efficiency (Table 14) and cost efficiency (Table 15) for domestic and foreign Islamic windows are significantly different at $p=0.0001$ and $p=0.012$ respectively. This finding suggests that there is a difference in the efficiency of the two groups. For the conventional banks, foreign banks also appear to be slightly better than domestic ones. However, the difference between the means is statistically insignificant.

5.4. Efficiency of Individual Banks

Tables 16 and 17 report the average efficiency scores of each bank from 1997 to 2003. The results could provide an insight to the relative efficiencies between Islamic windows with the country's two full-fledged Islamic banks as well as their parent banks.

The review in Table 16 shows that most of the bank rankings are the same for both the technical and cost efficiencies of the Islamic banking system. First, the Islamic window of Maybank Berhad is the most technical and cost-efficient among domestic commercial banks with an average efficiency score of 84.1% and 86.8% respectively. Second, the results indicate that the Islamic window of the HSBC Bank (M) Berhad is the most technical and cost-efficient among foreign commercial banks with the average efficiency score of 88.7% and 88.7% respectively. Third, the Islamic window of Am Merchant Bank is the most technical and cost-efficient among merchant banks. However, there is a difference in rankings between the technical and cost efficiencies of finance companies. We find that the Islamic window of the Maybank Finance Berhad is the most technically efficient among finance companies with an average efficiency score of 85.8% while the Islamic window of the Public Finance Berhad is the most cost-efficient among finance companies with an average efficiency score of 88.3%. The study also reveals that the Bank Islam (M) Berhad is respectively the most technical (84.3%) and cost efficient (87.9%) full-fledged Islamic bank. The other interesting finding is that the most efficient Islamic window of foreign banks, HSBC Bank, is surpassing other categories of most efficient banks including the Bank Islam.

For the conventional banks, Table 17 shows that both the Maybank Berhad and RHB Berhad have relatively higher average technical and cost efficiency scores as compared to the other domestic commercial bank (Maybank has average technical and cost efficiencies of 86.6% and 88.3%, whilst RHB has technical and cost efficiency scores of 87.8% and 88.4% respectively). Whereas OCBC Bank (M) Berhad is the most efficient foreign commercial bank with both technical and cost efficiency average scores of 88.5%. For the finance companies, Maybank Finance Berhad is the most efficient finance company with an average technical and cost efficiency score of 84.8% and 87.8% respectively. Furthermore, Am Merchant Bank is the most technical (88.0%) and cost (88.2%) efficient merchant bank. The finding also reveals that the OCBC Bank, being a foreign bank, is the most efficient bank among all categories of most efficient banks. The finding is in line with the argument that foreign banks are superior as they normally have advanced technology and skills; sophisticated services and broader international networks (Levine, 1996; Unite and Sullivan, 2003).

6. CONCLUSION

Studies on Islamic banking efficiency using the frontier method are still lacking although several studies have been realised on conventional banking, particularly in the US and Europe (Berger & Humphrey, 1997; Goddard *et al.*, 2001). This study would fill the lack of study on the efficiency of Islamic banks. It applies the Stochastic Frontier Approach (SFA) in evaluating the efficiency of Islamic banks. To the researcher's best knowledge, this is the first time a technique is being used to analyse both the technical and cost efficiencies of Malaysian full-fledged Islamic banks and Islamic windows.

This study has been set out to provide empirical evidence of Islamic banks in Malaysia from 1997 to 2003. This is the period when Islamic windows were introduced and before the period of further financial liberalisation on Islamic banks. The yearly annual reports of 2 full-fledged Islamic banks, 20 Islamic windows and 20 conventional banks were used. The findings show that the average efficiency of the overall Islamic banking industry has increased during the period of study while the efficiency trend for conventional banks has been stable over time. However, the efficiency level of Islamic banking is still less efficient than that of conventional banks. The study also reveals that full-fledged Islamic banks are more efficient than Islamic windows. Foreign banks are also found to be more efficient than domestic ones.

As shown by this study, the Malaysian Islamic banking industry, in terms of assets, deposits and financing base, has grown very rapidly between 1997 and 2003. Islamic banks in Malaysia are now facing ever-increasing competition with the issuance of three new foreign full-fledged Islamic banks. The competition from conventional banks is also expected to increase further in the near future due to globalisation. The findings of this study, revealing technical and cost efficiencies in Malaysian Islamic banks, are expected to provide significant insights to management and policy-makers with regard to the optimal utilisation of capacities and allocation of scarce resources in various banks. This would also facilitate directions for the efficiency improvement of future Islamic banking operations in Malaysia. We also hope that the findings will open a fruitful avenue for future research in the area of Islamic banking efficiency.

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APPENDIX

TABLE 1:
Total Assets, Total Deposits and Total Financing of Islamic Banking (RM' million)

	As at end of						
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Total Assets	**17,881.3**	**21,183.1**	**33,558.7**	**42,725.3**	**55,605.4**	**63,321.9**	**77,390.6**
Full-fledged Islamic Bank							
Islamic Windows:	5,202.1	5,698.4	11,724.2	14,008.9	17,404.8	20,159.6	20,929.7
Commercial Bank							
Finance Company	9,078.0	11,385.2	15,589.1	20,058.5	27,026.1	29,109.8	36,830.0
Merchant Bank	2,924.4	3,321.4	4,806.1	7,149.9	9,821.6	12,622.9	17,915.1
	676.8	778.1	1,439.3	1,508.0	1,352.9	1,429.6	1,715.8
Total Deposits	**9,895.2**	**15,172.1**	**23,695.7**	**33,650.7**	**44,743.8**	**49,553.9**	**55,919.7**
Full-fledged Islamic Bank							
Islamic Windows:	3,223.4	4,039.7	9,685.2	11,301.6	14,375.6	16,421.2	17,583.7
Commercial Bank							
Finance Company	5,153.2	8,415.2	10,576.0	16,089.4	22,031.0	23,353.9	26,518.7
Merchant Bank	1,170.2	2,110.7	3,033.1	5,392.6	7,663.7	9,094.6	10,965.6
	348.4	606.5	401.4	867.1	673.5	684.2	851.7
Total Financing	**10,749.4**	**10,461.1**	**13,723.7**	**20,816.1**	**28,317.6**	**36,717.7**	**48,615.4**
Full-fledged Islamic Bank							
Islamic Windows:	3,350.7	3,471.4	5,029.5	6,423.4	7,671.0	9,158.2	9,764.5
Commercial Bank							
Finance Company	4,705.8	4,702.8	4,920.5	8,533.6	12,257.6	16,706.4	22,324.3
Merchant Bank	2,189.9	1,878.4	2,995.5	5,089.8	7,617.4	10,049.6	15,745.8
	503.0	408.5	778.2	769.3	771.6	803.5	780.8

* Sources: BNM Annual Report (various years).

TABLE 2:
Input and Output Variables of Islamic Banks

Variables	Description	Mean (RM' 000)	Std. Dev. (RM' 000)
TC	Total Costs	54,008.8	83,571.0
X1	Total Deposits	1,485,690.6	2,250,944.0
X2	Total Overhead expenses	12,263.8	33,096.8
Y1	Total Earning assets	1,465,188.6	2,336,290.5
W1	Price of labor & physical capital (%)	0.0050	0.0053
W2	Price of deposits (%)	0.0365	0.0245

TABLE 3:
Input and Output Variables of Conventional Banks

Variables	Description	Mean (RM million)	Std. Dev. (RM million)
TC	Total Costs	1,078.6	961.8
X1	Total Deposits	17,807.215	16,766.796
X2	Total Overhead expenses	304.865	283.253
Y1	Total Earning assets	18,254.799	17589.748
W1	Price of labor & physical capital (%)	0.014	0.005
W2	Price of deposits (%)	0.048	0.022

TABLE 4:
List of Islamic Windows, Full-fledged Islamic Banks and Conventional Banks

Islamic Windows	
Local Commercial Banks Malayan Banking Berhad *(i)*[6] Public Bank Berhad *(i)* Hong Leong Bank Berhad *(i)* Alliance Bank Berhad *(i)* EON Bank Berhad *(i)*	RHB Bank Berhad *(i)* AmBank Berhad *(i)* Perwira Affin Bank Berhad *(i)* Southern Bank Berhad *(i)*
Foreign Commercial Banks HSBC Bank (M) Berhad *(i)* Standard Chartered (M) Berhad *(i)*	OCBC Bank (M) Berhad *(i)* Citibank (M) Berhad *(i)*
Domestic Finance Companies Am Finance Berhad *(i)* Hong Leong Finance Berhad *(i)* Public Finance Berhad *(i)*	EON Finance Berhad *(i)* Mayban Finance Berhad *(i)*
Local Merchant Banks AmMerchant Berhad *(i)*	Affin Merchant Berhad *(i)*

[6] The researcher puts the letter *(i)* for each Islamic window in order to differentiate between Islamic windows and their parent banks, i.e. the conventional banks.

TABLE 4: (continued)
List of Islamic Windows, Full-fledged Islamic Banks and Conventional Banks

Full-Fledged Islamic Banks	
Bank Islam (M) Berhad	Bank Muamalat (M) Berhad
Conventional Banks	
Local Commercial Banks Malayan Banking Berhad Public Bank Berhad Hong Leong Bank Berhad Alliance Bank Berhad EON Bank Berhad	RHB Bank Berhad AmBank Berhad Perwira Affin Bank Berhad Southern Bank Berhad
Foreign Commercial Banks HSBC Bank (M) Berhad Standard Chartered (M) Berhad	OCBC Bank (M) Berhad Citibank (M) Berhad
Domestic Finance Companies Am Finance Berhad Hong Leong Finance Berhad. Public Finance Berhad	EON Finance Berhad Mayban Finance Berhad
Local Merchant Banks AmMerchant Berhad	Affin Merchant Berhad

TABLE 5:
Overall SFA Technical and Cost Efficiency Estimates, 1997-2003

N=288	No. of banks	Year	Technical Efficiency Mean	Technical Efficiency Std. Dev.	Cost Efficiency Mean	Cost Efficiency Std Dev
Islamic Banking System	19	1997	0.717	0.216	0.808	0.181
	21	1998	0.827	0.078	0.874	0.019
	22	1999	0.756	0.135	0.851	0.040
	21	2000	0.797	0.096	0.869	0.024
	22	2001	0.832	0.117	0.871	0.038
	22	2002	0.826	0.080	0.873	0.021
	22	2003	0.850	0.090	0.876	0.023
	149	Overall Mean	**0.801**	0.058	**0.860**	0.027
Conventional Banking System	20	1997	0.822	0.049	0.875	0.008
	20	1998	0.845	0.042	0.875	0.008
	20	1999	0.825	0.048	0.875	0.008
	19	2000	0.832	0.054	0.877	0.009
	20	2001	0.844	0.035	0.880	0.006
	20	2002	0.845	0.041	0.878	0.006
	20	2003	0.830	0.057	0.876	0.010
	139	Overall Mean	**0.835**	0.037	**0.876**	0.006

TABLE 6:
Stochastic Technical Frontier Maximum Likelihood Parameter Estimates

Variable	**Parameter**	**Coefficient**	**Standard Error**	**T-Ratio**
β_0	Intercept	-3.5586	1.7972	-1.9801
β_1	$ln X_1$	1.7685	0.2563	6.8991
β_2	$ln X_2$	-0.5119	0.1423	-0.3597
β_3	$ln X_1 \, ln X_1$	-0.0664	0.0189	-3.5113
β_4	$ln X_2 \, ln X_2$	-0.0161	0.0081	-1.9964
β_5	$ln X_1 \, ln X_2$	0.0373	0.0111	3.3678
Sigma square	$\sigma^2 = \sigma^2_v + \sigma^2_u$	0.1042	0.0117	8.9089
Gamma	$\gamma = \sigma^2_u / (\sigma^2_v + \sigma^2_u)$	0.8070	0.0400	20.1660
Log likelihood function		28.1824		

Notes: X1= Total deposits (deposits from customers and deposits from other financial institutions)
X2= Total Overhead Expenses (personnel and other operating expenses)

TABLE 7:
Stochastic Cost Frontier Maximum Likelihood Parameter Estimates

Variable	Parameter	Coefficient	Standard Error	T-Ratio
β_0	Intercept	3.3447	1.3526	2.4727
β_1	*Ln*Y	0.6162	0.1255	4.9105
β_2	*ln(**W1 / W2**)*	0.7570	0.1263	5.9950
β_3	*ln*Y *ln*Y	0.0771	0.0072	10.6440
β_4	*ln(**W1 / W2**) ln(**W1 / W2**)*	0.0102	0.0059	1.7445
β_5	*ln(**W1 / W2**) ln*Y	-0.0125	0.0057	-2.1746
Sigma square	$\sigma^2 = \sigma^2_v + \sigma^2_u$	0.1153	0.0127	9.0692
Gamma	$\gamma = \sigma^2_u / (\sigma^2_v + \sigma^2_u)$	0.8588	0.0331	25.9364
Log likelihood function		26.7479		

Notes: Y= Total Earning Assets (Financing/Loans, Trading & Investment Securities and placement to other financial institutions). W1= Price of labor and capital, W2= price of deposits.

TABLE 8:
SFA Technical Efficiency (TE) Estimates by Bank Type

N=288	Full-fledged Islamic Banks	Islamic Windows of			Conventional Banks		
		Commercial Bank	Finance Co.	Merchant Bank	Commercial Bank	Finance Co.	Merchant Bank
1997	0.809	0.712	0.739	0.647	0.827	0.806	0.830
1998	0.863	0.824	0.841	0.789	0.853	0.815	0.866
1999	0.844	0.731	0.784	0.757	0.821	0.816	0.869
2000	0.830	0.781	0.802	0.843	0.836	0.808	0.872
2001	0.847	0.814	0.858	0.867	0.848	0.834	0.844
2002	0.839	0.822	0.833	0.821	0.853	0.826	0.842
2003	0.831	0.828	0.887	0.917	0.839	0.810	0.813
Mean	**0.838** (n=12)	**0.789** (n=88)	**0.821** (n=35)	**0.806** (n=14)	**0.840** (n=90)	**0.816** (n=35)	**0.848** (n=14)
Std dev	0.018	0.142	0.106	0.129	0.045	0.047	0.047

TABLE 9:
SFA Cost Efficiency (CE) Estimates by Bank Type

N=288	Full-fledged Islamic Banks	Islamic Windows of			Conventional Banks		
		Commercial Bank	Finance Co.	Merchant Bank	Commercial Bank	Finance Co.	Merchant Bank
1997	0.874	0.787	0.841	0.803	0.876	0.873	0.870
1998	0.881	0.874	0.878	0.861	0.878	0.869	0.871
1999	0.880	0.842	0.858	0.853	0.875	0.873	0.878
2000	0.876	0.866	0.867	0.881	0.877	0.875	0.885
2001	0.879	0.867	0.876	0.879	0.879	0.879	0.880
2002	0.878	0.872	0.872	0.874	0.879	0.876	0.881
2003	0.873	0.871	0.884	0.888	0.876	0.875	0.877
Mean	**0.877** (n=12)	**0.854** (n=88)	**0.868** (n=35)	**0.863** (n=14)	**0.877** (n=90)	**0.874** (n=35)	**0.878** (n=14)
Std dev	0.005	0.090	0.033	0.039	0.008	0.008	0.008

TABLE 10a:
Results of ANOVA between SFA Technical Efficiency and Bank Type

Technical Efficiency	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.093	2	0.046	4.921	0.008
Within Groups	2.682	285	0.009		
Total	2.774	287			

TABLE 10b:
Results of ANOVA between SFA Cost Efficiency and Bank Type

Cost Efficiency	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.020	2	0.010	3.807	0.023
Within Groups	0.767	285	0.003		
Total	0.787	287			

TABLE 11a:
Results of Tamhane T2, Multiple Comparisons between SFA TE and Bank Type

(I) Bank Type	(J) Bank Type	Mean Difference (I-J)	Std. Error	Sig.
Full-fledged Islamic banks	Islamic Windows	0.03889148(*)	0.012469649	0.007
	Conventional Banks	0.00326631	0.006610759	0.947
Islamic Windows	Full-fledged Islamic banks	-0.03889148(*)	0.012469649	0.007
	Conventional Banks	-0.03562517(*)	0.011969730	0.010
Conventional Banks	Full-fledged Islamic banks	-0.00326631	0.006610759	0.947
	Islamic Windows	0.03562517(*)	0.011969730	0.010

* The mean difference is significant at the .05 level. Dependent Variable: SFA technical efficiency (TE)

TABLE 11b:
Results of Tamhane T2, Multiple Comparisons between SFA CE and Bank Type

(I) Bank Type	(J) Bank Type	Mean Difference (I-J)	Std. Error	Sig.
Full-fledged Islamic banks	Islamic Windows	0.01781361(*)	0.006524342	0.021
	Conventional Banks	0.00100899	0.001533143	0.889
Islamic Windows	Full-fledged Islamic banks	-0.01781361(*)	0.006524342	0.021
	Conventional Banks	-0.01680462(*)	0.006413865	0.029
Conventional Banks	Full-fledged Islamic banks	-0.00100899	0.001533143	0.889
	Islamic Windows	0.01680462(*)	0.006413865	0.029

* The mean difference is significant at the .05 level. Dependent Variable: SFA cost efficiency (CE).

TABLE 12:
SFA Technical Efficiency (TE) Scores by Ownership Status, 1997-2003

(N=178)	Islamic Windows		Conventional Banks	
	Domestic CB*	Foreign CB*	Domestic CB*	Foreign CB*
1997	0.665	0.838	0.830	0.820
1998	0.816	0.844	0.850	0.859
1999	0.677	0.852	0.830	0.801
2000	0.752	0.841	0.843	0.821
2001	0.773	0.907	0.839	0.868
2002	0.792	0.890	0.844	0.876
2003	0.839	0.805	0.830	0.860
Mean	**0.761** n=61	**0.854** n=27	**0.838** n=62	**0.844** n=28
Std Dev	0.1528	0.0860	0.0433	0.0501

* CB= Commercial Banks.

TABLE 13:
SFA Cost Efficiency (CE) Scores by Ownership Status, 1997-2003

(N=178)	Islamic Windows		Conventional Banks	
	Domestic CB*	Foreign CB*	Domestic CB*	Foreign CB*
1997	0.753	0.879	0.876	0.875
1998	0.869	0.884	0.878	0.880
1999	0.825	0.882	0.877	0.871
2000	0.857	0.884	0.879	0.872
2001	0.858	0.889	0.878	0.880
2002	0.866	0.886	0.878	0.880
2003	0.876	0.860	0.875	0.877
Mean	**0.845** n=61	**0.881** n=27	**0.877** n=62	**0.877** n=28
Std Dev	0.1051	0.0201	0.0073	0.0093

* CB= Commercial Banks.

TABLE 14:
Results of the t-test (Ownership Status and SFA TE of Islamic Banking)

Ownership Status	N	Mean	Std Dev	t	df	P-value
Domestic Commercial Banks	61	0.76061546	0.152819435	-2.981	80.944	0.0001
Foreign Commercial Banks	27	0.85440489	0.086004470			

TABLE 15:
Results of the t-test (Ownership Status and SFA CE of Islamic Banking)

Ownership Status	N	Mean	Std Dev	t	df	P-value
Domestic Commercial Banks	61	0.84458566	0.105062902	-2.583	69.274	0.012
Foreign Commercial Banks	27	0.88075133	.020139802			

TABLE 16:
SFA Average Efficiency Scores of Individual Banks (Islamic Banking System)

	Technical Efficiency		**Cost Efficiency**	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
Full-fledged Islamic Banks				
Bank Islam	0.843	0.018	0.879	0.003
Bank Muamalat	0.831	0.018	0.875	0.006
Islamic Windows of:				
Domestic Commercial Banks				
Maybank	0.841	0.116	0.868	0.033
RHB Bank	0.766	0.109	0.856	0.030
Public Bank	0.611	0.174	0.809	0.061
AmBank Bhd.	0.761	0.070	0.862	0.022
Hong Leong Bank	0.788	0.072	0.862	0.013
Perwira Affin Bank	0.807	0.079	0.858	0.023
Alliance Bank	0.753	0.216	0.858	0.061
Southern Bank	0.733	0.250	0.766	0.297
EON Bank	0.783	0.172	0.866	0.045
Foreign Commercial Banks				
HSBC Bank	0.887	0.074	0.887	0.012
OCBC Bank	0.824	0.087	0.877	0.011
Standard Chartered Bank	0.843	0.120	0.874	0.036
Citibank	0.864	0.050	0.885	0.006
Finance Companies				
Am Finance	0.814	0.064	0.870	0.018
EON Finance	0.797	0.086	0.875	0.013
Hong Leong Finance	0.778	0.200	0.856	0.064
Mayban Finance	0.858	0.072	0.856	0.028
Public Finance	0.856	0.025	0.883	0.002
Merchant Banks				
Am Merchant	0.815	0.177	0.874	0.020
Affin Merchant	0.797	0.064	0.851	0.052

TABLE 17:
SFA Average Efficiency Scores of Individual Banks
(Conventional Banking System)

	Technical Efficiency		**Cost Efficiency**	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
Domestic Commercial Banks				
Maybank	0.866	0.015	0.883	0.003
RHB Bank	0.878	0.024	0.884	0.004
Public Bank	0.747	0.040	0.862	0.007
AmBank	0.846	0.034	0.878	0.005
Hong Leong Bank	0.819	0.019	0.875	0.003
Perwira Affin Bank	0.834	0.023	0.875	0.006
Alliance Bank	0.850	0.013	0.880	0.002
Southern Bank	0.863	0.019	0.880	0.003
EON Bank	0.839	0.016	0.877	0.003
Foreign Commercial Banks				
HSBC Bank	0.784	0.054	0.865	0.009
OCBC Bank	0.885	0.015	0.885	0.003
Standard Chartered Bank	0.853	0.020	0.879	0.004
Citibank	0.852	0.038	0.877	0.006
Finance Companies				
Am Finance	0.841	0.034	0.878	0.006
EON Finance	0.808	0.012	0.875	0.002
Hong Leong Finance	0.765	0.038	0.867	0.009
Mayban Finance	0.848	0.040	0.878	0.007
Public Finance	0.820	0.056	0.874	0.010
Merchant Banks				
Am Merchant	0.880	0.027	0.882	0.007
Affin Merchant	0.817	0.040	0.873	0.006

SFA Modelling Framework