Determinants of Islamic Banking Efficiency in Malaysia

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ABSTRACT

In an attempt to enrich the literature of the efficiency of Islamic banking, this study investigates the efficiency of the full-fledged Islamic banks as well as Islamic Windows in Malaysia. This study measures the technical and cost efficiency of these banks using the Data Envelopment Analysis (DEA). The findings show that on average the efficiency of the overall Islamic banking industry has increased during the period of study. The study also revealed that although the full-fledged Islamic banks were more efficient than the Islamic Windows, they were still less efficient than the conventional banks. Furthermore, Islamic Windows of the foreign banks were found to be more efficient than Islamic Windows of the domestic banks. We also examine the determinants of banking efficiency using Generalised Least Squares regressions model. We found that efficiency differences appear to be determined by bank-specific factors. The results of the regression suggest that, there is a clear association between the size of the bank and the technical and cost efficiencies. Second, technical and cost efficiencies are positively related to capital strength, and third, bank age, as measured by number of years the bank has been established, is positively related to cost efficiency. Lastly, the findings of this study show that bank expense has negative effects on the banking sector efficiency.

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I. Introduction

Islamic banking has been in existence since the 1970s, and it has shown tremendous growth over the last 30 years. The practice of Islamic banking now spreads all over the world from the east to the west, all the way from Malaysia, Bahrain to Europe and the USA. As of 2006, the sizes of the worldwide banking industry assets are estimated to exceed 265 billions of dollars from merely hundreds of thousands dollars in the 1970s (Abdul Ghafour, 2006; Dubai Islamic Bank, 2006).

Since early 1990s, studies that were focused on efficiency of financial institutions have become an important part of banking literature (Berger and Humphrey, 1997). Perhaps, one of the reasons is efficiency can be used as an indicator to measure banks' success. Specifically, using the efficiency criterion the performance of individual banks as well as the industry can be gauged. Another reason is that the efficiency can also be used to investigate the potential impact of government policies on a bank's efficiency. Indeed, it is of regulators interest to know the impact of their policy decisions on the performance and efficiency of the banks, as they will enormously affect the economy.

While there has been extensive literature examining the efficiency of the US and European conventional banking industries over the recent years (Berger and Humphrey, 1997; Goddard *et al.,* 2001), the empirical work on Islamic Banking efficiency, particularly in Malaysia, is still in its infancy. Typically, the studies on Islamic banks have 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, 2002).

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 decision 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, 1994 and 1999). By so doing it would also forge the Malaysian Islamic banking industry to be more competitive, which in turn would result in improved performance efficiency (Alias, Kamarulzaman and Bhupalan, 1993; Kaleem, 2000). However, with the facilities and incentives extended, most especially by the Central Bank, to both the full-fledged Islamic banks and Islamic Windows one wonders whether they had over the two-decade period (1980s-1990s) performed efficiently? Although this issue is very pertinent, only a few studies have been undertaken to investigate it.

This study examines the efficiency of the Islamic banking industry in Malaysia from 1997 to 2003. The findings of this study will provide some empirical insights as how these two modes of Islamic banks (full-fledged Islamic banks and Islamic Windows) had fared through in Malaysia over 1997-2003. We note here that this period was chosen for two reasons: First, 1997 was chosen as the initial year because this was the year where the Islamic banks were undergoing the second phase of liberalization; and, 2003 was chosen as the terminal year because this was year where government had initiated a further financial liberalization on Islamic banks as a whole. In undertaking this study, we gathered over the 1997-2003 period the yearly financial statements of the two full-fledged Islamic banks, 20 Islamic Windows and 20 conventional banks (parent banks of Islamic Windows). First, we examine technical and cost efficiency of Malaysian Islamic banks using Data Envelopment Analysis. Second, we test the significance of the results and third, we implement Generalised Least Squares regressions to explain the determinants of efficiency. This paper is the first comprehensive study of efficiency of Islamic banking industry in Malaysia which includes the full-fledged Islamic banks and Islamic Windows as well as the conventional banks.

The results would provide us with explicit indications whether the decision to allow Islamic Windows to operate side-by-side with full-fledged Islamic banks 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 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 and its concept. 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.

II. 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 the Malaysian system in their respective countries. 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 systems work.

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 in Appendix 1. For example, the total assets accumulated by the industry (comprising of Bank Islam, Bank Muamalat and Islamic Windows) rose sharply from RM17.8 billion in 1997 to RM77.4 billion at the end of 2003. Total deposits mobilised by this industry increased tremendously from RM9.9 billion in December 1997 to RM55.9 billion in December 2003. On the financing side, the Islamic banking system has shown an impressive growth from RM10.7 billion to RM48.6 billion during the same period. However, it would be intriguing to investigate whether the growth achieved was corresponding to higher efficiency level.

History prior to the Establishment of Islamic Bank

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 to perform pilgrimage in Makkah as well as to 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).

Banking on the experience of Tabung Haji, the government of Malaysia had 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 started the Islamic banking operations in accordance with Syariah principles, and also the period where Islamic Banking Act (IBA) was officially enacted.

The **second phase**, from 1993-2003, 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 Muslim, about the benefits of Islamic banking system, this was also the period where conventional banks were allowed to offer Islamic banking services by setting up “Islamic Windows” in 1993.

The **third phase** that commenced from 2004 was the period of further financial liberalisation (BNM, 2004). During this period, the Central Bank paved the way for new foreign Islamic banks to operate in Malaysia by means of issuing licenses to them.

First Phase (1983-1992): The Establishment of the First Islamic Bank

It can be said that the Central Bank was instrumental in the development of the Islamic banking system in Malaysia. In 1981, the government formed a National Steering Committee on the establishment of an Islamic bank. The Central Bank was given the task to prepare a paper on the possibility of instituting the first Islamic bank in this country.

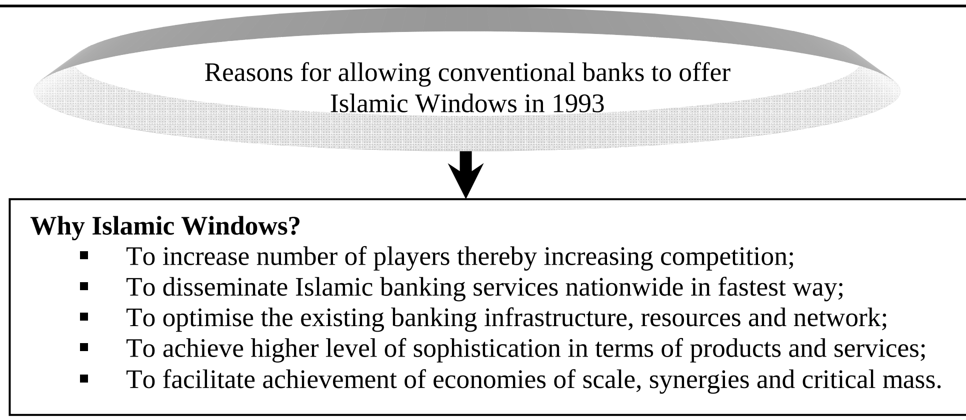
After two years of hard work, BIMB was established in Malaysia. It commenced operations on 1st July 1983. The legal basis for the setting-up of BIMB was the Islamic Banking Act (IBA) 1983 where BIMB was permitted to carry out banking business as prescribed in Syariah (Islamic laws). From 1983 to 1993, BIMB had enjoyed 10 years of monopoly as the sole provider of banking services based on Islamic principles. This exclusive right given to BIMB was to allow the bank to develop as many Islamic products as possible and to get them tested in the market. It was also intended, in a way, to protect the bank from having to compete with other conventional banks whose experience was far richer than BIMB. As a result, BIMB, in terms of total assets, has grown tremendously. Backing with total assets of RM325.5 million in 1984 the amount rose to RM13.7 billion in 2003, indicating an average growth rate of 216.3% per annum throughout the period (BIMB Annual report, 1984 and 2003). BIMB also proved to be a viable banking institution with its activity expanding rapidly throughout the country. As of 2003, BIMB has 84 branches nationwide and 2,022 employees compared with 6 branches and 272 employees in 1984 (BIMB Annual Report, 1984 and 2003).

Second Phase (1993-2003): The Emergence of Islamic Windows

Following a splendid achievement in the first phase, the bank's long term objectives have been mapped out for the subsequent phase (Khalid, 1996). Specifically, in this phase it is envisaged by the Malaysian government to set-up a comprehensive, viable and sound Islamic banking system serving all Malaysians, both Muslims and non-Muslims. In other words, it is aimed to create an Islamic banking system which does not involve interest or riba to operate side by side with conventional banking system.

To meet these objectives, the Central Bank decided to undertake a gradual and step-by-step approach. The first step was to introduce the Skim Perbankan Tanpa Faedah (SPTF) or Interest-free Banking Scheme in 1993 whereby the conventional banks were allowed to offer similar Islamic banking facilities as the full-fledged Islamic bank did. Figure 1 highlights some of the reasons for allowing the conventional banks to set-up Islamic Windows.

In December 1998, the term interest-free banking scheme used for Islamic Windows was replaced by Islamic Banking Scheme (IBS) or Skim Perbankan Islam (BNM, 1998). In that year, all banking institutions that have Islamic Windows were also required to upgrade the Islamic banking unit to Islamic banking division so as to further expand the Islamic banking industry.



Source: Husain (2002)

Figure 1: Reasons for setting up of Islamic Windows

The second phase also saw the setting-up of the second full-fledged Islamic bank, the Bank Muamalat Malaysia Berhad (BMMB). The establishment of BMMB was the result of merger arrangements between Bank Bumiputra Malaysia Berhad (BBMB) and Bank of Commerce Malaysia Berhad (BOCB). The arrangement was made in such a way that the Islamic banking operations of these two banks were transferred to this newly established bank. With the merger, Bank Islam stands to lose its monopoly status as the only full-fledged Islamic bank. The creation of BMMB will ensure healthy competition for Bank Islam, which comes under constant criticism from the press over recent years for its over-cautious and bureaucratic approach (Hashim, 2002).

Third Phase (2004 onwards): Towards Financial Liberalization of Islamic Banks

The distinctive feature of this phase is that the government had brought forward the financial liberalisation of the Islamic banking industry from 2007 to 2004. What came out from the liberalization was the instant emergence of three new foreign full-fledged Islamic banks, all of them from the Middle-east, in Malaysian banking market (BNM, 2004). The strategy was to create more competition and to tap new growth opportunity as well as raise the performance of the Islamic banking industry as a whole.

The first full-fledged foreign Islamic bank issued with license to operate in Malaysia was Kuwait Finance House, while the second and third were Al Rajhi Banking & Investment Corporation, and a consortium led by Qatar Islamic Bank (Sidhu, 2004b; BNM, 2004). Besides that, all the Islamic Windows or IBS were encouraged to be set up into Islamic subsidiary (IS) which will be licensed as full-fledged Islamic banks (BNM, 2004). The banks will have special licence to operate like a bank within bank, with their own board, management and separated capital, which allows them to invite foreign partners to the bank (Aziz, 2005). The intention was to strengthen and spur the growth of the local-based Islamic banks as well as to encourage them to expand offshore (Sidhu, 2004a). However, the move was not well-received. Some argued that it leads to duplication of resources, which in turn will raise the costs. Others see it as turning the clock back. This is the case because with the issuance of licenses to the new full-fledged Islamic banks (foreign and local-based) it means more banks are competing in a small unchanging banking market (Fernandez and Shamsudin, 2004).

The first local-based banking group that launched Islamic subsidiary was RHB Group, which opened RHB Islamic Bank Berhad. Second was Commerce group when it launched the Commerce Tijari Bank Berhad (Bernama, 2005; Dhesi, 2005), and the third banking group was Hong Leong Group, which established the Hong Leong Islamic Bank (Hamsawi, 2005). Recently, AmBank group also upgraded their Islamic window operations to become Islamic subsidiary named as AmIslamic Bank ("AmIslamic Bank", 2006).

III. Related Literature

The concept of Efficiency

The concept of measuring efficiency was first discussed by Farrell (1957). Drawing inspirations from Koopmans (1951) and Debreu (1951), Farrell was first to measure the efficiency empirically. According to Farrell (1957), the concept of efficiency measurement can be divided into two components, technical efficiency (TE) and allocative efficiency (AE). According to him, technical efficiency is the firm's ability to obtain maximal output from a given set of inputs while allocative efficiency means the firm's ability to use inputs in optimal proportions, given their respective prices and production technology. The allocative efficiency is also widely known as economic efficiency where the objective of producers becomes one of attaining a high degree of economic efficiency (cost, revenue or profit efficiency)[2]. Based on Farell's

[2] Berger and Mester (1997) argued that there are two most important economic efficiency concepts: cost and profit efficiency.

(1957) concept, the combinations of two components will produce overall economic efficiency (OE). The concept is illustrated in Figure 2.

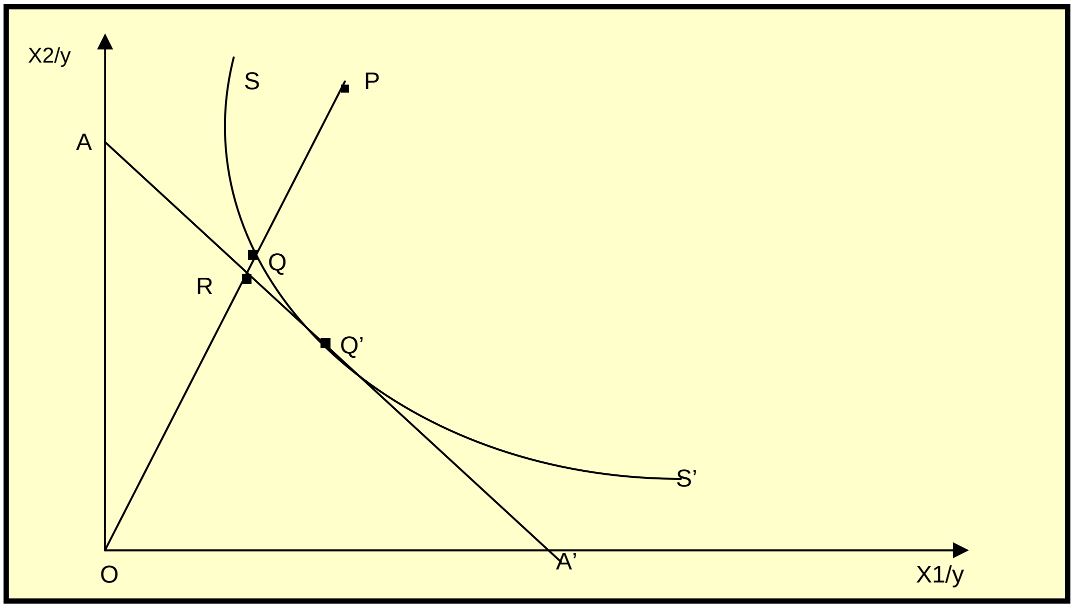


Figure 2: Overall, Technical & Allocative Efficiency [Source: Coelli *et al.*, (1998), p.135]

Assuming a firm, ABC, is using only two inputs, x1 and x2 to produce a single output (y) at point P. SS' slope shows the possible combinations of inputs the firm can produce if it is perfectly efficient. The slope AA' represents the input price ratio and it shows the various combinations of inputs that require the same level of expenditure. If the firm's production is efficient, it should occur at point Q', which indicates the cost minimisation. That is where SS' and AA' slope intersect, which means the input combinations Q' is both technically and allocatively efficient.

Since the ABC firm produces using the combination of input at point P, two types of inefficiency arise. First, it is technically inefficient, since by moving to point Q, it could produce the same output with fewer inputs. In order to measure the magnitude of a firm's technical efficiency (TE), the ratio is calculated as OQ/OP which is equal to one minus QP/OP. Second, it is allocatively inefficient. Producing at point P shows that the firm made an incorrect choice as to the combination of inputs at the given prices, therefore incurring more cost than if it had produced at point Q'. To measure the allocative efficiency (AE), the ratio is calculated as OR/OQ.

Then, we would be able to measure the Overall Efficiency (OE), since we have the ratio calculation for TE and OE. According to Farrell, OE is TE multiplied by AE:

$$OE = TE \times AE = (OQ/OP) \times (OR/OQ)$$

Farrell's original ideas were illustrated in input-oriented measures under the assumption of constant returns to scale. This input-oriented measure addresses the question of "by how much can input quantities be proportionally reduced without changing the output quantities produced?" One could also ask another question; "by how much can output quantities be proportionally expanded without altering the input quantities used? This is, according to Coelli (1996), an output-oriented measure as opposed to the input-oriented measure as discussed by Farrell above.

The Bank Efficiency Study

The studies of efficiency using frontier approaches on banking did not start until Sherman and Gold (1985) initiated their study. They applied the frontier approaches to the banking industry by focussing on operating efficiency of branches of a savings bank. Since then, numerous studies have been conducted using frontier approaches to measure the banking efficiency. There have been extensive studies on bank efficiency done in the US and European countries and most of the studies focused on conventional banking (Berger and Humphrey, 1997; Goddard *et al.*, 2001). Only a 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 by Hassan (2003) during the period of 1994-2001. By employing both parametric and nonparametric techniques, he had 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 of Japanese credit associations. He also found that Islamic banks are relatively more efficient in containing cost but relatively inefficient in generating profit. The results from Hassan (2003) showed that a larger bank size and greater profitability has higher efficiency which is consistent with the findings from Brown and Skully (2003).

Another cross-country study on 35 Islamic banks, Brown and Skully (2003) had concluded that Iran was found to be the largest and the most cost efficient bank, whilst the Sudanese which offer agriculture finances are to be the least cost efficient bank. Using the non-parametric techniques (DEA), they also found that most cost efficient bank were from the Middle East region. Perhaps why Sudanese Islamic banks are the least efficient bank could be explained by the Elzahi (2002) and Abdullah & Elzahi (2003) arguments that economic sanctions could partly affect the Sudanese banking efficiency.

Malaysian Bank Efficiency Studies

A few efficiency studies had been done on Malaysian banks and most of the studies focus on conventional banking (Katib, 1999; Abdul Majid *et al.*, 2003; Mat Nor and Hisham, 2003). Katib (1999) had 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 the ones that are less efficient.

Two recent seminal papers on Malaysian commercial banks were Abdul Majid *et al.* (2003) and Mat Nor and Hisham (2003). The former studied the impact of crisis on efficiency and the latter studied the effect of mergers on efficiency. Using the stochastic frontier cost function, Abdul Majid *et al.* (2003) examined the cost efficiency of Malaysian commercial banks over the period of 1993 to 2000 to compare the efficiency before and after the financial crisis. The findings showed that efficiency of Malaysian banks before and after the crisis was not significantly different. The study also found that the foreign owned banks are more efficient than local-owned banks. Mat Nor and Hisham (2003), had attempted to find the effects of mergers on technical efficiency of commercial banks using Data Envelopment Analysis (DEA) for the year 2000 and 2001. They found 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 they had been based on only two years of study.

IV. Methodology

Conceptually, there are two general methodologies to measure frontier efficiency; the parametric approach using econometric techniques, and the non-parametric approach utilising the linear programming method. Both approaches differ mainly in how they handle the random error and the assumptions made on the shape of the efficient frontier. However, each of the techniques has its own strength and weaknesses. The most widely employed parametric methods are Stochastic Frontier Approach (SFA), Thick Frontier Approach (TFA) and Distribution-free approach (DFA). On the other hand, the commonly used non-parametric techniques are Free Disposal Hull Analysis (FDH) and Data Envelopment Analysis (DEA).

The parametric approach has the advantage of allowing noise in the measurement of inefficiency. However, the approach requires us to specify the functional form for the production, cost or profit function. On the other side of the coin, the non-parametric approach is simple and easy to use since it does not require any 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 as it did not allow for noise to be taken into account.

Data Envelopment Analysis (DEA)

To measure efficiency, the DEA will be this study choice because it does not require us to specify the functional form or distributional forms for errors. In essence, it is more flexible than the parametric approach. Furthermore, the reason for using DEA is that it has been extensively used in measuring the efficiency of banks in many countries by many researchers like Aly *et al.* (1990), Elyasiani and Mehdian (1992), Favero and Papi (1995), Bhattacharyya *et al.* (1997) and Sturm and Williams (2004). Perhaps as Coelli *et al.*, (2003) pointed out that DEA has been the more popular method because it is easy to draw on diagrams and easy to calculate. Apart from the above reasons, DEA is chosen because it is more reliable in measuring the technical efficiency as it can be applied to multi-input and multi-output variables.

The only drawback of the DEA approach is that it does not allow for any error in the data. As Mester (1994) correctly pointed out, “the bank that has been lucky or whose costs have been under-measured would be labelled as the most efficient while any unfavourable influence beyond a bank’s control would be attributed to inefficiency.” Despite this drawback, Seiford and Thrall (1990) argued that that DEA is a more robust approach for efficiency estimation because it measures the relative efficiency of each firm with respect to the efficient frontier that is constructed from the actual data.

On the return to scale assumption, this study uses the variable returns to scale (VRS) assumptions to define the best practice frontier, which guarantees that a bank is only compared with another bank of similar size. Finally, this study uses the input-based orientation and this method of measuring efficiency has been employed by many studies, among others, Aly *et al.* (1990), Ferrier and Lovell (1990), Furukawa (1995), Zaim (1995), Miller and Noulas (1996), Resti (1997), Bauer *et al.* (1998), and Casu and Molyneux (2000).

Mathematical Formulation

Following Coelli *et al.* (1998) and Coelli (2004), we assume there are *N* banks operating in the Malaysian banking industry, and each has *K* inputs and *M* outputs. **For the *i-th* banks, x_i and y_i represent the column vectors of input and output** respectively. For *N* banks, X represents the K*N input matrix and Y is the *M*N* output matrix. The variable returns to scale (VRS) input-oriented technical efficiency of each bank is estimated by solving a linear programming problem. The mathematical formulation is as follows:

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

where λ is *N*1* intensity vector of constants and θ is a scalar. *N1* is an N*1 vector of ones. The estimated value of θ is the efficiency score for each of the N banks. The estimate will satisfy the restriction $\theta \leq 1$ with a value $\theta = 1$ indicating a technically efficient bank. The problem has to be solved *N* times, once for each bank, to derive a set of *N* technical efficiency scores. Note that the convexity constraints ($N1'\lambda = 1$) ensures that an inefficient bank is benchmarked against another bank of a similar size and the projected point of that bank on the DEA frontier will be a convex combination of the observed bank[3].

The cost efficiency is defined as the ratio of the minimum possible cost to the observed cost (Coelli *et al.*,1998, and Coelli, 2004). DEA's cost efficiency can be estimated by solving a linear programming problem. In this study, the problem is to choose the input quantities that will minimise costs holding constant input prices and output quantities. Mathematically, it can be shown as follows:

$$
\begin{aligned}
&\min_{\lambda, Xi*}\ \ P_i^{'} x_i * \\
&\text{subject to}\ \ -y_i + Y\lambda \geq 0, \\
&\qquad\qquad x_i^{*} - X\lambda \geq 0, \\
&\qquad\qquad N1'\lambda = 1 \\
&\qquad\qquad \lambda \geq 0
\end{aligned}
\qquad \text{(2)}
$$

[3] For detail explanation of the inputs and output together with the notations used, refer to the next section on inputs and output variables.

where P_i is a vector of input prices for the i-th bank and $Xi*$ is the cost-minimising vector of input quantities for the *i-th* bank, given the input price (P_i) and the output quantities (y_i). Cost efficiency for bank *i* is calculated as the ratio of $P_i^{'} x_i^{*} / P_i^{'} x_i$, where $P_i^{'}$ is the transpose of bank *i*'s input price vector. Thus, cost efficiency (CE) is the ratio of frontier costs of bank *i*'s output vector, given the set of its input prices, to its actual cost, where $0 \leq CE \leq 1$, and CE=1 for fully efficient banks.

Inputs and Outputs Variables

Despite the large body of literature on bank efficiency, there is no general consensus on how to define inputs and outputs as variables in analysing the efficiency. In general, the literature on bank efficiency has two prominent approaches, they are: production; and, intermediation approach (Elyasiani and Mehdian, 1990; Aly *et al.*, 1990; Ferrier and Lovell, 1990; Mester, 1997).

The production approach defines the bank activity as production of services. In other words, it views the banks as using physical inputs such as labor and capital to provide deposit and loan accounts, viewed as the banks' outputs.[4] On the other hand, the intermediation approach views banks as the intermediator of financial services. It assumes that banks collect deposits, using labor and capital then convert those sources of funds into loans and other earning assets (Sealey and Lindley, 1977). The latter approach is argued to be particularly appropriate for banks where most activities consist of turning large deposits and funds purchased from other financial institutions into loans or financing and investments (Favero and Papi, 1995).

In practice, the intermediation approach is the most widely used technique to measure efficiency (Kwan, 2001). In choosing the appropriate approach, Berger and Humphrey (1997) suggested 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-third of total costs. However, he recommended that the production approach is more appropriate for evaluating the efficiency of the bank's branches because branches process customer documents for the banks as a whole.

This study employs the intermediation approach for three reasons: First, it will be evaluating the bank efficiency as a whole; two, this approach is widely used (Kwan, 2001), and three, the principle of Islamic financial system is based on participation in enterprise or equity-based where the business participants may end up with profit or loss. This, by no means, implies the importance of intermediary activities.

For the choice of input and output, this study uses three inputs and one output variables. The first input, denoted by **X1** (i.e., the quantity of deposit input), is *total deposits*, which includes both Al-Wadiah Savings Deposits and Mudharabah Investment Deposits from customers and deposits from other banks. The second input, denoted by **X2** is the *personnel expenses* (i.e., the quantity of labor input) while the third input, denoted by **X3** is the *other operating or overhead expenses* (i.e., the input quantity of physical capital). These represent the resources expended into converting deposits to financing[5] and other earning assets. The output is *total earning*

[4] Cobb and Douglas (1928) explained about the theory of production.
[5] The term financing is for Islamic banks, which is equivalent to the loans for conventional banks.

assets, denoted by **Y1**, which includes financing/loans, dealing securities, investment securities and placements with other banks.

In the calculation of cost efficiency, apart from quantity of input and output, two input prices are also required. They are: prices of deposits, denoted by **P1**; prices of labor, denoted by P2; and prices of physical capital, denoted by **P3**. **P1** is defined as the income paid to depositors/ interest expenses[6] divided by total deposits. **P2** is calculated using personnel expenses divided by the total assets, while **P3** is calculated using other overhead expenses divided by the total assets. Tables 2 in Appendix 1 summarise the descriptive statistics of the bank's input and output variables from 1997 to 2003 for the Malaysian Islamic and conventional banking.

Determinants of efficiency

After measuring the efficiency levels, one may need to go further and investigate the possible determinants of technical and cost efficiency. Two dependent variables are the measured technical (Model 1) and cost (Model 2) efficiency. Whereas, the explanatory variables are the bank specific variables which are commonly used in previous bank efficiency studies. The basic regressions equation can be expressed as follows[7]:

$$Eff_{it} = \beta_0 + \beta_1 size_{it} + \beta_2 equity_{it} + \beta_3 LLR_{it} + \beta_4 age_{it} + \beta_5 TCTA_{it} + \mathrm{e}_{it} \qquad (3)$$

First, the log of total assets are use to account for bank size *(SIZE)*. It is interesting to find out the influence of the bank size on Islamic banking efficiency in Malaysia as the previous literature found mixed results (Berger and Mester, 1997). Second, capital adequacy *(equity)*, defined by the ratio of equity to total assets, is expected to be positively related to efficiency as in most studies found it such as Mester (1993 and 1996) and Girardone *et al.* (2004). It is argued in the banking literature that high capitalised banks tend to be more efficient since efficient banks tend to have more profits, which in turn strengthen their capitalisation status (Berger and Mester, 1997; Isik and Hassan, 2003). Alternatively, as Mester 1993 and 1996 point out, low capitalised bank gives managers and owners incentives to incur moral hazard[8] activities. They have less incentive to make sure that the bank is run efficiently by taking excessive risk since they could lose only the amount of capital that they invested in the bank if the risk does not pay off.

Third, loan quality variable *(LLR)* is expected to be negatively related to efficiency, indicating that the less efficient bank has the higher provisions, which suggest that they have problematic loans, and therefore regulators force them to increase their loan provisions in accordance with deteriorating loan quality (Mohamed, 2003). Similar to Molyneux *et al.* (1996), we used the ratio of loan loss reserve to total loans to measure the loan quality. Forth, is the bank age (*age*) is

[6] For conventional banks, it refers to interest expense.

[7] β is regression coefficient of explanatory variables in explaining the technical and cost efficiency, e_{it} is disturbance term, i denotes panel data of both Islamic banking and conventional banking, t denotes time.

[8] Moral hazard, according to Lindgren *et al.* (1996), is "the tendency for people to be less careful when they do not expect to bear the full cost of their behavior".

defined by number years of bank established. The relationship of bank age with efficiency might be positively related since the banking operations might involve "learning by doing" (Mester, 1994 & 1996). In other words, the bank will be more efficient as they become more experience. Finally, we include the variable of total cost to total assets *(TCTA)* as a proxy to bank expenses. The sign of TCTA is expected to be negative, on the grounds that the more efficient bank is able to control their expenses efficiently. In other words, banks with lower expenses should be more efficient in both technical and cost area.

Table 3 in Appendix 1 presents the descriptive statistics of the variables that are considered as possible efficiency determinants. Besides the regression analysis, we also use ANOVA statistics to test differences in efficiency between different types of banks and T-test statistics to test differences in efficiency between different kinds of ownership status.

Data

The study used **288** panel data from the banks' financial statement[9] of **20** Islamic Windows, **2** full-fledged Islamic banks and **20** conventional banks from **1997 to 2003**. The samples for Islamic banking system are more than 95 percent than its population. The financial statements 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 had Islamic banking operations within the study period and data availability. The conventional banks included are the parent banks of Islamic Windows. Table 4 in Appendix 1 shows the list of the banks:

V. Empirical Findings

This section summarises the findings of technical and cost efficiency of Islamic banking in Malaysia using Data Envelopment Analysis (DEA), from which the efficiency scores are obtained for all the 288 banks from 1997 to 2003. The DEA efficiency analysis for this study was carried out using DEAP version 2.1, a data envelopment analysis computing software developed by Coelli (1996). A brief description about DEAP computer program is provided in Appendix 2.

Robustness of the data and results was checked by taking the following procedures. First, we deleted the efficient banks (banks on the frontier), and then second, we re-estimated the efficiency scores and correlated the new efficiency ranking with the ranking prior to deleting any observations. The results in Table 5 in Appendix 1 show that the correlation between the efficiency that was calculated before and after removing all efficient banks are significant at 0.01 levels, and the associated p-value for correlation are 0.0001. The results suggest that the efficiencies obtained using all the panel data (288 banks) are reasonably robust, at least on an ordinal scale of ranking of the banks. In other words, the data are not sensitive to the outliers.

Estimates Levels of Technical and Cost Efficiency

Technical efficiency (TE) measures reflect the degree to which a bank could minimise its inputs used in the production of given outputs (input oriented measures).

[9] Financial statements comprised of balance sheets, income statement and notes to the accounts.

A value of 1 or 100% indicates full efficiency and the operations are made on the production frontier. A value of less than 1 (or less than 100%) reflects operations below the frontier. The wedge between 1 and the value observed measures the technical inefficiency.

Cost efficiency measures the distance of a bank's cost from the best practice bank's cost, if both were to produce the same output bundle under the same market conditions (Berger and Mester, 1997; Vander and 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[10]. In this case the bank should use its inputs more efficiently in order to gain a reduction of 20 per cent in their costs so that it could reach the minimum cost of the best practice bank.

Overall Efficiency and Efficiency over Time

The technical and cost efficiency estimates, derived from the DEA model, are summarised in Tables 6-13 and exhibited in Appendix 1. Table 6 shows the technical and cost efficiency trend of Islamic banks and conventional banks in Malaysia from 1997 to 2003. The average technical and cost efficiency scores for Islamic Banking were 62.3% and 45.7% respectively. However, that level of efficiency is still lower than the technical and cost efficiency scores of conventional banks, which were 79.4% and 77.8% respectively. The technical efficiency results of the conventional banks that are computed here are similar to that of Katib (1999). They range between 68-80%[11]. On the other hand, the cost efficiency of the conventional banks are found to be similar to the levels of inefficiency in the US (Ferrier and Lovell, 1990) and in Italy (Resti, 1997) where the mean cost inefficiency recorded was 21% to 25%.

For comparison sake, although the efficiency results of the Islamic banking were somewhat smaller than that of the conventional banking, they are still acceptable considering the fact that the banks had been in the market for less than two decades. By any standard, 20 years of Islamic banking existence in the Malaysian banking industry is too short a period compared with conventional banking, which has the history of more than hundred year of existence in this country.

The result in Table 6 also shows that the trend of both the technical and cost efficiency of the Islamic banking were on the rise, suggesting that the Islamic banks have improved their efficiency over the study period. Specifically, technical efficiency of Islamic banking has increased from 56.3% in 1997 to 69.8% in 2003, while cost efficiency has increased from 40.7% in 1997 to 54.5% in 2003. Indeed, the results obtained here provide useful information for the policy maker. It indicates that the introduction of Islamic Windows had given positive impacts on the Islamic banking industry in Malaysia, albeit lower than the conventional banks (technical efficiency estimates for conventional banks have marginally increased from 75.2% in 1997 to 81.2% in 2003 while the cost efficiency of conventional banks trend has slightly improved from 73.3% to 79.8%).

[10] The score one refers to best practice bank while the score of zero refers to worst practice bank.
[11] Katib (1999) studied the technical efficiency of commercial banks in Malaysia from 1989-1995.

Average Bank Efficiency by Type

Table 7 and 8 exhibit the comparison of technical and cost efficiencies by bank type. As can be seen from Table 7, the average technical efficiency for banks that operate based on Islamic principle ranged from 57.6% for Islamic Windows of merchant bank to 71.8% for full-fledged Islamic banks. On the hand, the banks that operate based on conventional banking principles; the average technical efficiency ranged 68.2% for merchant bank to 82.5% for commercial banks. These results clearly show that the full-fledged Islamic banks were more efficient than Islamic Windows. However, if a comparison is made between the full-fledged Islamic banks and conventional banks, the former banks are still less efficient than the latter banks (i.e. commercial banks and finance houses). Perhaps, one possible reason for this is because much of the full-fledged Islamic banks' funding still remains idle. This finding is consistent with that of Samad (1999) where it was shown that Bank Islam Malaysia Berhad has more surplus liquidity compared to conventional banks.

The cost efficiency results in Table 8 also show that the full-fledged Islamic banks were more efficient than Islamic Windows. However if the result is compared with the conventional banks' performance, the full-fledged Islamic banks were found to be less efficient than commercial banks and finance houses. From this result one can conclude that the conventional banks experienced superior cost efficiency levels as compared to full-fledged Islamic banks.

A statistical test of ANOVA in Table 9, shows that there was significantly different level of technical efficiency (F=34.212, df=2,285, p=0.0001) and cost efficiency (F=238.218, df=2,285, p=0.0001) for all types of banks. The strength of relationship between efficiency and bank types as measured by Eta Square is 0.19 for technical efficiency and 0.63 for cost efficiency. Besides that, the Tamhane's T2 test, as shown Table 10, indicates that the full-fledged Islamic Banks have higher technical efficiency than Islamic Windows (mean diff.= 0.103, s.e.= 0.028) but lower than conventional banks (mean diff.= -0.076, s.e= 0.023). For cost efficiency, Tamhane's T2 test also indicates the same findings, where the results showed that full-fledged Islamic banks have higher cost efficiency than Islamic Windows (mean diff.=0.278, s.e.= 0.023) but lower than conventional banks (mean diff.=-0.065, s.e.= 0.022).

Average Bank Efficiency by Ownership Status

One distinctive feature of this study is that the efficiency analysis is extended to the extent that it allows us to make comparison between foreign and domestic banks performance. The results are shown in Tables 11 and 12. As evident from the tables, Islamic Windows of the foreign banks turned out to be more efficient than Islamic Windows of the domestic banks. The finding is consistent with the previous studies, including that of Zaim (1995) and Hussein (2003) who found that foreign banks were the most efficient banks.

The results of t-test in Tables 13 seemed to indicate that there was significant different, in terms of technical and cost efficiency, between two different ownerships status. The mean technical and cost efficiency for domestic and foreign Islamic Windows are significantly different at p=0.09 and p=0.01 respectively. Islamic Windows of the foreign banks were found to have experienced higher technical and cost efficiency than Islamic Windows of domestic banks[12]. The finding is line with the arguments that foreign banks are more superior as they normally has advance technology and skills; sophisticated services and broader international networks (Levine, 1996; Unite and Sullivan, 2003).

Determinants of efficiency

Regression model follows standard procedures for panel data estimation (see for example, Wooldridge, 2000; Gujarati, 2003; Baltagi, 2005). The estimation is first done through fixed effects and random effect models. However, since Durbin Watson test on fixed effects and random effect models displays some degree of autocorrelation problem, we estimated the model using the Panel Generalised Least Square (GLS).

The panel GLS technique follows Sayrs (1989), Ismail & Sanusi (2005) and Zakaria & Ismail (2006a; 2006b) because it is suggested that GLS corrected for errors may be used if the model displays autocorrelation. Besides that, following Zakaria & Ismail (2006a; 2006b), the cross section weight in each GLS regression is assigned since *"it takes into account the presence of cross-section heteroskedasticity"*. In addition, as suggested by Wallace & Silver (1998), Gujarati (2003) and Zakaria & Ismail (2006a; 2006b), White's method of estimation is assigned on each regression to take care of any heteroskedasticity problem. Therefore the estimators reported are heteroskedasticity robust standard errors (Gujarati, 2003)[13].

Table 14 in Appendix 1 presents the results of regression analysis for technical and cost efficiency[14]. The result in table 14 indicates that, first bank size (*size*) is positively correlated with technical and cost efficiency. The relationships are statistically significant, suggesting that the larger banks tend to achieve higher efficiency. This result is consistent with, among others Abdul Majid *et al.* (2003), who found positive relationship between size and efficiency of the bank. Second, the ratio of equity to assets (*equity*) found to exert a significant positive influence on technical and cost efficiency. This is consistent with a view that banks become more efficient as their safety and soundness improve. This result is consistent with Isik & Hassan (2003), who found well capitalised bank are more efficient. This finding is also consistent with Nikiel & Opiela (2002) who found a positive correlation between the equity to assets ratio and efficiency, in 43 Polish Banks from 1997 to 2000.

Third, bank expenses denoted by *TCTA* shows that a higher proportion of total cost to total assets is significantly related to higher technical and cost inefficiency. It implies that banks with higher expense may overutilise inputs and therefore be less efficient. This result is similar to Berger and Mester (1997) and Bauer *et al.* (1998) studies, which reported a negative correlation bank expenses and efficiency. Fourth, loan quality denoted by *LLR* show insignificant negative coefficient of Loan Quality (*LLR*) for both types of efficiency. This weak evidence shows that bank with higher

[12] For conventional banks, although foreign banks appear to be more efficient than domestic banks, it is not statistically significant.

[13] In other words, it is robust to cross-equation (contemporaneous) correlation as well as different error variances in each cross-section.

[14] We also check the stationary of data by using panel unit root tests of Levin-Lin and Chu (LLC); Im, Pesaran and Shin (IPS); and Fisher tests. The tests indicated that all variables are stationary at level and therefore the models are free from spurious regression.

loan provisions has lower efficiency levels, all other things being equal. Finally, that bank age has positive significant relationship with both technical and cost efficiencies indicate that as the banks grow older, they could manage their cost and operation better and become more efficient. It could also possible to infer that more efficient banks are more likely to survive (Isik and Hassan, 2003).

The proportion of explained variance as measured by adjusted R square are respectively 75.6% and 85.9% for technical and cost efficiency, In other words, the adjusted R square suggests that about 75.6% (technical) and 85.9% (cost) of the variation of measured efficiency is explained by those five factors. Durbin Watson statistics also reveal that there were no auto correlation problems for GLS estimation.

VI. Conclusions

Although there are several studies that have been conducted to measure banks' efficiency particularly in the US, the study on Islamic banking efficiency is still lacking; let alone using the frontier technique This study is intended mainly to fill such gap.

This study is set out to provide empirical evidence of Islamic banks' efficiency in Malaysia for the years 1997 to 2003. This was the period where Islamic Windows were introduced and further financial liberalisation of Islamic banking industry was promulgated. For analysis purpose, the annual report of two full-fledged Islamic banks, 20 Islamic Windows and 20 conventional banks were used. The findings showed that the average efficiency of the overall Islamic banking industry has increased during the under survey period. The study also revealed that the full-fledged Islamic banks were more efficient that the Islamic Windows. However, the efficiency level of Islamic banking was still less efficient than the conventional banks. On the other hand, foreign banks were found to be more efficient than domestic banks.

The results of regression analyses strongly support that first, bank size as measured by total assets is positively related to all type of efficiencies and this could explain why the Central Banks encouraged the banks to merge among themselves in recent years. Second, technical and cost efficiencies are positively related to capital strength as measured by equity to assets ratio, and third, bank age is found to be positively related to both technical and cost efficiencies. There was also some evidence from the regressions that both types of efficiencies are negatively related to ratio of total cost to total assets.

Islamic banks in Malaysia are now facing ever-increasing competition, particularly with the issuance of three new licenses to three 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 revealed that the technical and cost efficiencies of Malaysian Islamic banks could be improved further. In this regard, it requires a concerted effort from the management and policy-makers to try to optimise the utilization of scarce resources owned by the banking industry in Malaysia. This finding would also facilitate them to set the directions for future improvement of Islamic banking operations in Malaysia. Finally, this study would open a fruitful avenue for future research in the area of Islamic banking efficiency and competition in other Muslim countries.

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Appendix 1

Table 1:
Total Assets, Total Deposits and Total Financing of Islamic Banking Industry (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 IB*	5,202.1	5,698.4	11,724.2	14,008.9	17,404.8	20,159.6	20,929.7
Islamic Windows:							
Commercial Bank	9,078.0	11,385.2	15,589.1	20,058.5	27,026.1	29,109.8	36,830.0
Finance Company	2,924.4	3,321.4	4,806.1	7,149.9	9,821.6	12,622.9	17,915.1
Merchant Bank	676.8	778.1	1,439.3	1,508.0	1,352.9	1,429.6	1,715.8
Total Deposits	**9,895.2**	**16,432.0**	**23,695.7**	**33,650.7**	**44,743.8**	**49,553.9**	**55,919.7**
Full-fledged IB*	3,223.4	4,039.7	9,685.2	11,301.6	14,375.6	16,421.2	17,583.7
Islamic Windows:							
Commercial Bank	5,153.2	9,106.3	10,576.0	16,089.4	22,031.0	23,353.9	26,518.7
Finance Company	1,170.2	2,667.0	3,033.1	5,392.6	7,663.7	9,094.6	10,965.6
Merchant Bank	348.4	677.0	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 IB*	3,350.7	3,471.4	5,029.5	6,423.4	7,671.0	9,158.2	9,764.5
Islamic Windows:							
Commercial Bank	4,705.8	4,702.8	4,920.5	8,533.6	12,257.6	16,706.4	22,324.3
Finance Company	2,189.9	1,878.4	2,995.5	5,089.8	7,617.4	10,049.6	15,745.8
Merchant Bank	503.0	408.5	778.2	769.3	771.6	803.5	780.8

* IB refers to Islamic Banks,
# Sources: BNM Annual Report (1997- 2003), individual banks' annual report (1997- 2003).

Table 2: Input and Output Variables (Pooled Data 1997-2003)

Variables	Description	Mean (RM' million)	Std. Dev. (RM' million)
Islamic Banking			
X1	Total Deposits	1,485.691	2,250.944
X2	Personnel expenses	5.974	15.867
X3	Other Overhead expenses	6.288	17.398
Y1	Total Earning assets	1,465.189	2,336.291
P1	Price of deposits (%)	3.646	2.448
P2	Price of labor (%)	0.265	0.290
P3	Price of physical capital (%)	0.236	0.286
TC	Total Costs	53.995	83.571
Conventional Banking			
X1	Total Deposits	17,807.215	16,766.796
X2	Personnel expenses	150.581	151.807
X3	Other Overhead expenses	154.284	136.246
Y1	Total Earning assets	18,254.799	17,589.748
P1	Price of deposits (%)	4.785	2.219
P2	Price of labor (%)	0.649	0.203
P3	Price of physical capital (%)	0.714	0.335
TC	Total Costs	1,078.650	961.838

Sources: Author's calculation based on financial reports of Malaysian banks, Central bank annual reports (various years).

Table 3: Statistics of Bank Specific Variables (1997-2003)

Bank-specific Variables	Description	Mean	Std. Dev.
Conventional Banking			
Size (in log)1	Size of the Bank	23.54	0.75
Equity (%)2	Adequacy of Capital	8.43	2.98
TCTA (%)3	Bank Expenses	5.24	1.80
LLR (%)4	Quality of the Loan	1.97	1.87
Age (no. of years)5	Age of the Bank	44	29
Islamic Banking			
Size (in log)	Size of the Bank	20.29	1.55
Equity (%)	Adequacy of Capital	8.20	7.07
TCTA (%)	Bank Expenses	3.49	1.90
LLR (%)	Quality of the Loan	1.76	2.85
Age (no. of years)	Age of the Bank	7	3

* Sources: Author's calculation based on financial reports of Malaysian banks, central bank annual reports, ABM Bankers Directory and The Bankers' Almanac (various years). 1. Log of total assets, 2. ratio of equity to total assets, 3. ratio total cost to total assets, 4. ratio of loan loss reserve to total loans, 5. Number of years the bank established.

Table 4: List of panel data

Islamic Windows	
Local Commercial Bank	
Malayan Banking Berhad *(i)*[15]	RHB Bank Berhad *(i)*
Public Bank Berhad *(i)*	AmBank Berhad *(i)*
Hong Leong Bank Berhad *(i)*	Perwira Affin Bank Berhad *(i)*
Alliance Bank Berhad *(i)*	Southern Bank Berhad *(i)*
EON Bank Berhad *(i)*	
***Foreign Commercial Banks*:**	
HSBC Bank (M) Berhad *(i)*	OCBC Bank (M) Berhad *(i)*
Standard Chartered (M) Berhad *(i)*	Citibank (M) Berhad *(i)*
Domestic Finance Companies	
Am Finance Berhad *(i)*	EON Finance Berhad *(i)*
Hong Leong Finance Berhad *(i)*	Mayban Finance Berhad *(i)*
Public Finance Berhad *(i)*	
Local Merchant Bank	
AmMerchant Berhad *(i)*	Affin Merchant Berhad *(i)*
Full-fledged Islamic Banks	
Bank Islam (M) Berhad	Bank Muamalat (M) Berhad
Conventional Banks	
Local Commercial Bank	
Malayan Banking Berhad	RHB Bank Berhad
Public Bank Berhad	AmBank Berhad
Hong Leong Bank Berhad	Perwira Affin Bank Berhad
Alliance Bank Berhad	Southern Bank Berhad
EON Bank Berhad	
***Foreign Commercial Banks*:**	
HSBC Bank (M) Berhad	OCBC Bank (M) Berhad
Standard Chartered (M) Berhad	Citibank (M) Berhad

[15] The researcher put the letter *(i)* for each Islamic Windows in order to differentiate between Islamic Windows and their parent banks, i.e. the conventional banks.

Domestic Finance Companies	
Am Finance Berhad	EON Finance Berhad
Hong Leong Finance Berhad.	Mayban Finance Berhad
Public Finance Berhad	
Local Merchant Bank	
AmMerchant Berhad	Affin Merchant Berhad

Table 5: DEA efficiency correlation analysis

Category	CRSTE	VRSTE
Pearson Correlation	0.921* (0.0001)	0.884* (0.0001)
Spearman Correlation	0.932* (0.0001)	0.876* (0.0001)

Notes: CRSTE= technical efficiency under constant returns to scale(CRS), VRSTE= technical efficiency under VRS. The associated p-values are shown in parentheses. *Correlation is significant at 0.01 level (two-tailed).

Table 6: Overall Technical and Cost Efficiency, 1997-2003

	No. of banks	Year	Technical Efficiency Mean	Technical Efficiency Std. Dev.	Cost Efficiency Mean	Cost Efficiency Std. Dev.
Islamic Banking	19	1997	0.563	0.262	0.407	0.138
	21	1998	0.640	0.241	0.469	0.153
	22	1999	0.607	0.222	0.386	0.136
	21	2000	0.602	0.205	0.423	0.130
	22	2001	0.639	0.221	0.490	0.177
	22	2002	0.605	0.158	0.472	0.139
	22	2003	0.698	0.229	0.545	0.197
	149	Overall Mean	**0.623**	0.220	**0.457**	0.160
Conventional Banking	20	1997	0.752	0.104	0.733	0.091
	20	1998	0.800	0.101	0.784	0.097
	20	1999	0.769	0.126	0.745	0.106
	19	2000	0.789	0.142	0.772	0.132
	20	2001	0.811	0.131	0.800	0.129
	20	2002	0.823	0.132	0.814	0.133
	20	2003	0.812	0.140	0.798	0.139
	139	Overall Mean	**0.794**	0.125	**0.778**	0.120
	288					

Table 7: Technical Efficiency (TE) Scores by Bank Type, 1997-2003

(N=288)	**Mean**	Std. Dev.
Full-fledged Islamic Banks	0.718	0.069
Islamic Windows of:		
Commercial Banks	0.611	0.233
Finance Company	0.639	0.227
Merchant Banks	0.576	0.188
Conventional Bank:		
Commercial Banks	0.825	0.098
Finance Company	0.756	0.104
Merchant Banks	0.682	0.221

Table 8: Cost Efficiency (CE) by Bank Type, 1997-2003

(N=288)	**Mean**	Std. Dev.
Full-fledged Islamic Banks	0.713	0.067
Islamic Windows of:		
Commercial Banks	0.444	0.165
Finance Company	0.413	0.100
Merchant Banks	0.430	0.118
Conventional Bank:		
Commercial Banks	0.812	0.090
Finance Company	0.740	0.101
Merchant Banks	0.658	0.208

Table 9: Results of the ANOVA between Efficiency and Bank Type

Technical Efficiency	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2.206	2	1.103	34.212	0.0001
Within Groups	9.189	285	0.032		
Total	11.396	287			
Cost Efficiency	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	8.261	2	4.131	238.218	0.0001
Within Groups	4.942	285	0.017		
Total	13.203	287			

Table 10: Results of Tamhane T2, multiple comparisons between the bank types

	Bank Type (I)	Bank Type (J)	Mean Diff. (I-J)	Std. Error	Sig.
Technical Efficiency	Full-fledged IB*	Islamic Windows	0.103(*)	0.028	**0.002**
		Conventional Banks	-0.076 (*)	0.023	**0.011**
	Islamic Windows	Full-fledged IB*	-0.103(*)	0.028	0.002
		Conventional Banks	-0.179(*)	0.022	0.0001
	Conventional Banks	Full-fledged IB*	0.076 (*)	0.023	0.011
		Islamic Windows	0.179(*)	0.022	0.0001
Cost Efficiency	Full-fledged IB*	Islamic Windows	0.278(*)	0.023	**0.0001**
		Conventional Banks	-0.065(*)	0.022	**0.025**
	Islamic Windows	Full-fledged IB*	-0.278(*)	0.023	0.0001
		Conventional Banks	-0.343(*)	0.016	0.0001
	Conventional Banks	Full-fledged IB*	0.065(*)	0.022	0.025
		Islamic Windows	0.343(*)	0.016	0.0001

* The mean difference is significant at the 0.05 level. IB refers to Islamic Banks.

Table 11: Technical Efficiency (TE) Scores by Ownership Status, 1997-2003

(N=178)	**Mean**	Std. Dev.
Islamic Windows		
Domestic Commercial Banks	0.584	0.233
Foreign Commercial Banks	0.674	0.224
Conventional Banks		
Domestic Commercial Banks	0.820	0.099
Foreign Commercial Banks	0.837	0.095

Table 12: Cost Efficiency (CE) by Ownership Status, 1997-2003

(N=178)	**Mean**	Std. Dev.
Islamic Windows		
Domestic Commercial Banks	0.406	0.142
Foreign Commercial Banks	0.529	0.182
Conventional Banks		
Domestic Commercial Banks	0.804	0.090
Foreign Commercial Banks	0.828	0.090

Table 13: Results of T-test (Ownership Status and Efficiency of Islamic Banking)

	Ownership Status	N	t	df	P-value
Technical Efficiency	*Domestic Banks*	*61*	-1.708	86	**0.09***
	Foreign Banks	*27*			
Cost Efficiency	Domestic Banks	61	-3.400	86	**0.001****
	Foreign Banks	27			

** significant at the 0.05 level, * significant at the 0.10 level.

Table 14: GLS Regression results on Efficiency and Bank-Specific factors#

Variable	**Technical Efficiency (Model 1)**		**Cost Efficiency (Model 2)**	
	Coefficient	**Std. Error**	**Coefficient**	**Std. Error**
Constant	-0.729	0.219*	-0.510	0.137*
Size	0.047	0.013*	0.029	0.008*
EQUITY	0.626	0.120*	0.643	0.095*
LLR	-0.515	0.282	-0.288	0.239
TCTA	-0.551	0.227*	-0.884	0.222*
AGE	0.011	0.003*	0.015	0.003*
R2 (adjusted)		0.756		0.859
DW Statistics		1.878		1.971
Jarque-Bera		1.796		3.657
Probability		0.407		0.161

Note: * denoted significant at 0.05 level. # Heteroskedasticity-consistent covariance matrix estimators are reported.

Appendix 2

We provide a brief description about DEAP computer program version 2.1. DEAP is a data envelopment analysis computer program written by Tim Coelli for the measurement of efficiency and/or productivity. The program is widely used in efficiency and productivity literature including the banking industry. The program and manual can be downloadable **free** from Centre for Efficiency and Productivity Analysis (CEPA) web site (http://www.une.edu.au/econometrics/cepa.htm).

The program can be run in a variety of models which centred around three principal options. First, it can calculate the technical and scale efficiency under Constant Return to Scale (CRS) and Variable Return to Scale (VRS) models and second, it can measure the cost and allocative efficiency. Finally, the program can apply the Malmquist DEA methods to calculate the indices of total factor productivity (TFP) change; technological change, technical efficiency change and scale efficiency change. All of the three principal options mentioned are available in either in input or output orientation except for cost efficiency calculation. The program is written in Fotran (Lahey F77LEM/32) for IBM compatible PCs. It is a DOS program but can be run easily from WINDOWS using FILE MANAGER. Further information on how to run the program is discussed in Coelli (1996) and Coelli *et al.* (1998).