Technical and Cost Efficiency of Islamic Banking in Malaysia

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Abstract: This study is an examination of the efficiency of full-fledged Islamic banks and Islamic Windows in Malaysia from 1997 to 2003. It measures their technical and cost efficiency using Data Envelopment Analysis (DEA). The findings show that: on average the efficiency of the overall Islamic banking industry increased during the period of study; secondly the full-fledged Islamic banks were more efficient than the Islamic Windows but less efficient than the conventional banks; and thirdly, the Islamic Windows of the foreign banks were more efficient than the Islamic Windows of the domestic banks. This paper also looks at the determinants of banking efficiency using the Generalized Least Squares regressions model and finds that efficiency differences appear to be determined by bank-specific factors.

I. Introduction

Islamic banking, in existence since the 1970s, has shown tremendous growth over the last 30 years. The practice of Islamic banking is now spread world-wide, from east to west, all the way from Malaysia to Bahrain to Europe and the USA. As of 2006, the size of the world-wide Islamic banking industry assets are estimated to have grown to in excess of $265 billion from merely hundreds of thousands of dollars in the 1970s (Abdul Ghafour, 2006; Dubai Islamic Bank, 2006).

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Since the early 1990s, studies focused on the efficiency of financial institutions have become an important part of banking literature (Berger and Humphrey, 1997). Perhaps, one of the reasons for this is that efficiency can be used as an indicator to measure banks' success. Specifically, the efficiency criterion can be used to gauge the performance of individual banks as well as of the industry overall. It can also be used to investigate the potential impact of government policies on a bank's efficiency. It is very much in the regulators' interest to know the impact of their policy decisions on the performance and efficiency of the banks, which in turn so enormously affect the economy.

While there has been extensive literature on the efficiency of US and European conventional banking industries over the recent years (Berger and Humphrey, 1997; Goddard *et al.*, 2001), empirical work on the efficiency of Islamic banking, 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 for ten years from July 1983 as the only Islamic bank before the government allowed conventional banks also to offer Islamic banking services using their existing infrastructure and branches in 1993 (Bank Negara Malaysia [BNM)], 1994 and 1999). Allowing conventional banking institutions to set up 'Islamic Windows' was thought to be the best way to increase the number of institutions offering Islamic banking services, *i.e.* at lowest cost and within the shortest time frame (Bank Negara Malaysia [BNM)], 1994 and 1999). Doing this was supposed to make the Malaysian Islamic banking industry more competitive, which in turn would result in improved performance efficiency (Alias *et al.*, 1993; Kaleem, 2000). However, with facilities and incentives extended in this way, especially by the Central Bank, to both the full-fledged Islamic banks and Islamic Windows, one wonders what improvement there was in fact in performance efficiency over the two-decade period (1980s and 1990s)? Although the question is obviously pertinent, only a few studies have been undertaken to try and answer it.

This study examines the efficiency of the Islamic banking industry in Malaysia from 1997 to 2003. Its findings will provide some empirical insights into how these two modes of Islamic banking (full-fledged Islamic banks and Islamic Windows) fared in Malaysia through 1997–2003. 1997 was chosen as the initial year because this was the year in which the Islamic banks were undergoing the second phase of liberalization; 2003 was chosen as the terminal year because this was the year in which Malaysian government initiated a further financial liberalization of Islamic banking as a whole. For the study, we gathered the yearly financial statements for 1997–2003 of the two full-fledged Islamic banks, 20 Islamic Windows and 20 conventional banks (parent banks of Islamic Windows). First, we examined technical and cost efficiency of Malaysian Islamic banks using Data Envelopment Analysis. Second, we tested the significance of the results. And finally, we applied Generalized Least Squares regressions to explain the determinants of efficiency. This paper is the first comprehensive study of the efficiency of the Islamic banking industry in Malaysia to include the full-fledged Islamic banks and Islamic Windows as well as the conventional banks.

The results provide us with explicit indications as to whether the decision to allow Islamic Windows to operate side-by-side with full-fledged Islamic banks was appropriate for the ultimate objective of creating an environment conducive to efficient competition. The efficiency measurement also gives an indication as to whether current Islamic banks in Malaysia are ready to face financial liberalization. This is because, under Phase Three of the Financial Sector Master Plan, the Central Bank of Malaysia has issued full-fledged Islamic banking licenses to foreign banks as part of the financial liberalization of Islamic banking in Malaysia (BNM, 2004).

The paper is divided into six sections. Following this introduction, section II recounts the development of Islamic banking in Malaysia. Section III reviews briefly previous studies on bank frontier efficiency and the concept of it. Section IV proceeds with the methodology and data used to carry out the efficiency analysis. Section V examines the empirical findings and section VI concludes the paper.

II. Development of Islamic Banking in Malaysia

Malaysia is the first country to implement a dual banking system, *i.e.* one in which Islamic banking operates side-by-side with conventional banking. The Malaysian model has been recognized by many Islamic countries as the model of the future and they have expressed interest in adopting it themselves. 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 .

The Malaysian Islamic banking industry, in terms of assets, deposits and financing base, grew very rapidly over the seven-year period, as illustrated in Table 1 (See, Appendix). 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 mobilized 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 showed an impressive growth from RM10.7 billion to RM48.6 billion during the same period. What is of interest for this paper is whether and to what extent this growth is matched by higher efficiency.

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. This is a specialized financial institution providing an organized mobilization of funds from Muslims to assist them to perform the pilgrimage to Makkah, as well as encouraging them to participate in investment opportunities and economic activity. In fact, Tabung Haji is considered unique, the first institution of its kind in the world (Mohammed Seidu, 2002).

Banking on the experience of Tabung Haji, the government of Malaysia then began a well–coordinated, systematic process of implementing the Islamic financial system. The process can be divided into three phases. The first phase, considered the period of familiarization (1983–1992), was when BIMB was established and started Islamic banking operations in accordance with *Sharīʿah* principles, and when the 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 intended to give Islamic banking ample time to seek a larger market share. Also, while creating awareness among the public, especially the Muslims, about the benefits of Islamic banking, this was the period when conventional banks were allowed to offer Islamic banking services by setting up 'Islamic Windows' in 1993.

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

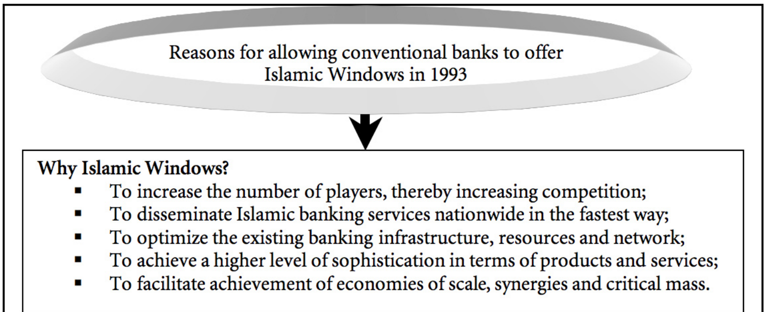
2.1.1. *First phase (1983–1992): The establishment of the first Islamic bank*
It can be said that the Central Bank was instrumental in the development of Islamic banking in Malaysia. In 1981, the government formed a National Steering Committee on the establishment of an Islamic bank. The Central Bank was given the task to prepare a paper on the possibility of instituting the first Islamic bank in this country.

Two years of hard work later, 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 whereby BIMB was permitted to carry out banking business as prescribed in *Sharīʿah*. From 1983 to 1993, BIMB enjoyed ten years of monopoly as the sole provider of banking services based on Islamic principles. This exclusive right given to BIMB was to allow it to develop as many Islamic products as possible and 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's. As a result, BIMB, in terms of total assets, grew tremendously. Backed by total assets of RM325.5 million in 1984, its assets 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 had 84 branches nationwide and 2,022 employees compared with 6 branches and 272 employees in 1984 (BIMB Annual Report, 1984 and 2003).

2.1.2. *Second phase (1993–2003): The emergence of Islamic Windows*
Following its remarkable achievements in the first phase, the bank's long-term objectives were mapped out for the subsequent phase (Khalid, 1996). Specifically, in this phase the Malaysian government envisaged the setting-up of a comprehensive, viable and sound Islamic banking system to serve all Malaysians, Muslims and non-Muslims alike. In other words, it aimed to create an Islamic banking system, one that does not involve interest or *ribā*, operating side by side with the conventional banking system.

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

Figure 1: Reasons for the Setting-up of Islamic Windows



Source: Husain (2002)

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 had Islamic Windows were also required to upgrade the Islamic banking unit to Islamic banking division so as to further expand the Islamic banking industry.

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 such that the Islamic banking operations of the two banks were transferred to the newly formed entity. Following this merger, Bank Islam stood to lose its monopoly as the only full-fledged Islamic bank. The creation of BMMB would ensure healthy competition for Bank Islam, which over recent years had come under constant press criticism for its over-cautious and bureaucratic approach (Hashim, 2002).

2.1.3. *Third phase (2004 onwards): Towards financial liberalization of Islamic banks*

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

The first full-fledged foreign Islamic bank licensed to operate in Malaysia was Kuwait Finance House; the second and third were Al Rajhi Banking and Investment Corporation, and a consortium led by Qatar Islamic Bank (Sidhu, 2004b; BNM, 2004). In addition, all the Islamic Windows or IBS were encouraged to set up as Islamic Subsidiary (IS) which would be licensed as full-fledged Islamic banks (BNM, 2004). The IS banks would have special licence to operate as a bank within a bank, with their own board, management and separated capital, and allowing 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, this move was not well-received. Some argued that it led to duplication of resources, which in turn raises costs. Others saw it as turning the clock back because the issuance of licenses to new full-fledged Islamic banks (foreign and local-based) means more banks competing in a small unchanging market (Fernandez and Shamsudin, 2004).

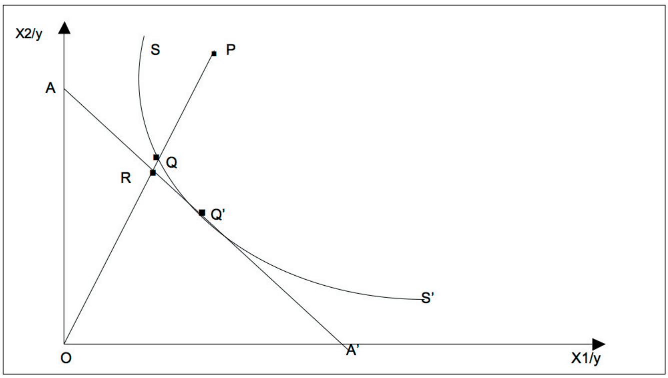
The first local-based banking group that launched Islamic Subsidiary was RHB Group, which opened RHB Islamic Bank Berhad. Second was Commerce Group when it launched the Commerce Tijari Bank Berhad (Bernama, 2005; Dhesi, 2005), and the third banking group was Hong Leong Group, which established the Hong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

III. Literature Review

3.1. The concept of efficiency

The concept of measuring efficiency was first discussed by Farrell (1957). Drawing inspiration from Koopmans (1951) and Debreu (1951), Farrell was the first to measure efficiency empirically. According to Farrell (1957), the concept of efficiency measurement can be divided into two components, technical efficiency (TE) and allocative efficiency (AE): technical efficiency is the firm's ability to obtain maximal output from a given set of inputs, while allocative efficiency is its ability to use inputs in optimal proportions, given their respective prices and production technology. Allocative efficiency is also widely known as economic efficiency where the objective of producers is to attain a high degree of economic efficiency (cost, revenue or profit efficiency).[1] Based on Farell's (1957) concept, the combination of the two components gives the measure of overall economic efficiency (OE). The concept is illustrated in Figure 2.

Figure 2: Overall Technical and Allocative Efficiency



Source: Coelli *et al.* (1998:135)

Assuming a firm, *ABC*, is using only two inputs, X_1 and X_2 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 marks cost minimization. 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 inputs 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 can measure the Overall Efficiency (*OE*), since we have the ratio calculation for *TE* and *OE*. According to Farrell, *OE* is *TE* multiplied by *AE*:

$$OE = TExAE = (OQ/OP)x(OR/OQ)$$

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, "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.

3.2. Literature on bank efficiency

The studies of efficiency using frontier approaches on banking began with Sherman and Gold (1985). They applied the frontier approaches to the banking industry by focussing on the operating efficiency of branches of a savings bank. Since then, numerous and extensive research using frontier approaches to measure banking efficiency in the US and European countries have been done, most of them focused on conventional banking (Berger and Humphrey, 1997; Goddard *et al.*, 2001). Only a few have been done on Islamic banking (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 non-parametric 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 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 by Brown and Skully (2003) concluded that Islamic banking in Iran was the largest and most cost-efficient bank, whilst that in Sudan, which offer agriculture finances, was the least so. Using the non-parametric techniques (DEA), they also found that the most cost-efficient banks were from the Middle East region. Perhaps the Sudanese Islamic banks being the least efficient can be explained by the argument of Elzahi Saaid (2002) and Abdullah and Elzahi Saaid (2003) that economic sanctions may have partly affected the Sudanese banks' performance.

Regarding the Malaysian bank efficiency studies, few efficiency studies had been done on Malaysian banks and most of them focued 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 indicate that, over the period of observation, technical efficiency ranged from 68% to 80%, and that banks with a higher level of technical efficiency had 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 1993–2000 so as to compare their efficiency before and after the financial crisis. Their study found no significant difference. It also found that the foreign-owned banks were more efficient than local-owned banks. Mat Nor and Hisham (2003) looked at the effects of mergers on technical efficiency of commercial banks using Data Envelopment Analysis (*DEA*) for the years 2000–2001. They found that mergers did not lead to any changes in efficiency. However, it might be inappropriate to conclude that mergers have no impact on efficiency since the study was based on only two years of data.

IV. Methodology

Conceptually, there are two general methodologies to measure frontier efficiency; the parametric approach using econometric techniques, and the non-parametric approach using the linear programming method. The two approaches differ mainly in how they handle the random error and the assumptions made on the shape of the efficient frontier. However, each has its particular strengths and weaknesses. The most widely employed parametric methods are Stochastic Frontier Approach (*SFA*), Thick Frontier Approach (*TFA*) and Distribution-free approach (*DFA*). 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 does not allow for noise to be taken into account.

4.1. Data envelopment analysis (*DEA*)

To measure efficiency, the *DEA* is the choice here 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, *DEA* has been extensively used to measure the efficiency of banks in many countries by many researchers, like Aly *et al.* (1990), Elyasiani and Mehdian (1992), Favero and Papi (1995), Bhattacharrya *et al.* (1997) and Sturm and Williams (2004). Perhaps, as Coelli *et al.* (2003) point out, DEA has been so popular because it is easy to draw on diagrams and easy to calculate. Apart from the above reasons, *DEA* is chosen here 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 (1994:4) 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." Notwithstanding this drawback, Seiford and Thrall (1990) have argued that that DEA is the 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, a method of measuring efficiency 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) can be mentioned.

4.2 .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:

$$min_{\theta,\lambda}\theta \qquad (1)$$

subject to:

$$-y_i+Y\lambda\geq 0,$$
$$\theta x_i-X\lambda\geq 0,$$
$$N1'\lambda=0$$
$$\lambda\geq 0$$

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 similar size and the projected point of that bank on the *DEA* frontier will be a convex combination of the observed bank.[2]

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

$$min_{\lambda,XI^*}P'_i x^*_i \qquad (2)$$

subject to:

$$-y_i+Y\lambda\geq 0,$$
$$x^*_i-X\lambda\geq 0,$$
$$N1'\lambda=0$$
$$\lambda\geq 0$$

where P_i is a vector of input prices for the *i-th* bank and X_i^* is the cost-minimizing 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.

4.3. 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 analyzing efficiency. In general, the literature on bank efficiency has two prominent approaches, namely the production and intermediation approaches (Elyasiani and Mehdian, 1990; Aly *et al.*, 1990; Ferrier and Lovell, 1990; Mester, 1997).

The production approach defines bank activity as production of services. In other words, it views the banks as using physical inputs such as labour and capital to provide deposit and loan accounts, viewed as the banks' outputs.[3] On the other hand, the intermediation approach views banks as the intermediator of financial services. It assumes that banks collect deposits, then, using labour and capital, 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 most of whose 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-thirds of total costs. However, he commended the production approach as 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; second, this approach is widely used (Kwan, 2001), and third, the principle of Islamic financial system is based on participation in enterprise or equity-based, in which participants can end up with loss as well as profit. 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 X_1 (*i.e.*, the quantity of deposit input), is *total deposits,* which includes both *al-wadīʿah* savings deposits and *muḍārabah* investment deposits from customers and deposits from other banks. The second input, denoted by X_2, is the *personnel expenses* (*i.e.*, the quantity of labour input), while the third input, denoted by X_3, 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[4] and other earning assets. The output is *total earning assets*, denoted by *Y*1, 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 *P*1; prices of labour, denoted by *P*2; and prices of physical capital, denoted by *P*3. *P*1 is defined as the income paid to depositors/interest expenses[5] divided by total deposits. *P*2 is calculated using personnel expenses divided by the total assets, while *P*3 is calculated using other overhead expenses divided by the total assets. Table 2 in Appendix summarizes the descriptive statistics of the bank's input and output variables from 1997 to 2003 for Islamic and conventional banking in Malaysia.

4.4. 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. The explanatory variables are the bank specific variables, commonly used in previous bank efficiency studies. The basic regressions equation can be expressed as follows:[6]

$$Eff_{it} = \beta_0 + \beta_1 size_{it} + \beta_2 equity_{it} + \beta_3 LLR_{it} + \beta_4 age_{it} + \beta_5 TCTA_{it} + e_{it} \quad (3)$$

First, the log of total assets is used 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 most studies, such as Mester (1993 and 1996) and Girardone *et al.* (2004), have found that to be the case. It is argued in the banking literature that high-capitalized banks tend to be more efficient since efficient banks tend to have more profits, which in turn strengthens their capitalization status (Berger and Mester, 1997; Isik and Hassan, 2003). Alternatively, as Mester (1993 and 1996) points out, low-capitalized banks give managers and owners incentives to engage in morally hazardous[7] activities. They have less incentive to make sure that the bank is run efficiently: when taking excessive risk they stand to 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. Fourth, the bank age (*age*) is defined by the number of years the bank has been established. The bank age might be positively related to efficiency since banking operations can involve "learning by doing" (Mester, 1994 and 1996). In other words, the bank is expected to become more efficient as it becomes more experienced. Finally, we include the variable of total cost to total assets *(TCTA)* as a proxy for bank expenses. The sign of *TCTA* is expected to be negative on the grounds that the more efficient bank is able to control its expenses efficiently. In other words, banks with lower expenses should be more efficient in both the 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.

4.5. Data

The study used 288 panel data from the financial statements[8] of 20 Islamic Windows, 2 full-fledged Islamic banks and 20 conventional banks from 1997 to 2003. The samples for the Islamic banking system were more than 95% of 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 were 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 shows the list of the banks.

V. Empirical Findings

This section summarizes the findings on technical and cost efficiency of Islamic banking in Malaysia using (*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 of the *DEAP* computer program is provided in Appendix.

Robustness of the data and results were checked by applying 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 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 is 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.

5.1. Estimates levels of technical and cost efficiency

Technical efficiency (*TE*) measures reflect the degree to which a bank could minimize its inputs used in the production of given outputs (input oriented measures). 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 Vennet, 2002). Thus, if the measured cost efficiency of a bank is 0.80, it implies that it is about 80% cost efficient or it has wasted 20% of its cost relative to a best practice bank.[9] In this case the bank should use its inputs more efficiently in order to gain a reduction of 20% in its costs so as to reach the minimum cost of the best practice bank.

5.2. Overall efficiency and efficiency over time

The technical and cost efficiency estimates, derived from the *DEA* model, are summarized in Tables 6 to 13 in Appendix. 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% to 80%.[10] 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, although the efficiency results of Islamic banking were somewhat smaller than that of conventional banking, they are still acceptable allowing for the fact that the banks had been in the market for less than two decades. By any standard, the 20 years of Islamic banking in Malaysia is a very short span compared to the hundred-year history of conventional banking in this country.

The result in Table 6 also shows that the trend of both the technical and cost efficiency of Islamic banking is upward, suggesting that the Islamic banks 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 positive impact on the Islamic banking industry in Malaysia, albeit lower than the conventional banks (technical efficiency estimates for conventional banks have increased marginally from 75.2% in 1997 to 81.2% in 2003 while the cost efficiency of conventional banks trend improved slightly from 73.3% to 79.8%).

5.3. Average bank efficiency by type

Tables 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 principles ranged from 57.6% for Islamic Windows of merchant banks to 71.8% for full-fledged Islamic banks. On the other hand, for the banks that operate on conventional banking principles, the average technical efficiency ranged from 68.2% for merchant banks 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 (*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 held more surplus liquidity compared to conventional banks.

The cost efficiency results in Table 8 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 a 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 in 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, the *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).

5.4. Average bank efficiency by ownership status

One distinctive feature of this study is that the efficiency analysis is extended to allow us to compare foreign and domestic banks performance. The results are shown in Tables 11 and 12. As is evident from these tables, the Islamic Windows of the foreign banks turned out to be more efficient than the 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 difference, in terms of technical and cost efficiency, between the two different ownership statuses. 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.[11] The finding is 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).

5.5. Determinants of efficiency

The 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 the Durbin Watson test on fixed effects and random effect models displays some degree of autocorrelation problem, we estimated the model using the Panel Generalized Least Square (*GLS*).

The Panel *GLS* technique follows Sayrs (1989), Ismail and Sanusi (2005) and Zakaria and Ismail (2006a; 2006b) because it is suggested that *GLS* corrected for errors may be used if the model displays autocorrelation. Besides that, following Zakaria and 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 and Silver (1998), Gujarati (2003) and Zakaria and 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).[12]

Table 14 in Appendix presents the results of regression analysis for technical and cost efficiency.[13] 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*) is found to exert a significant positive influence on technical and cost efficiency. This is consistent with the view that banks become more efficient as their safety and soundness improve. This result is consistent with Isik and Hassan (2003), who found well-capitalized banks to be more efficient, and with Nikiel and 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* show 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 expenses may overutilize inputs and therefore be less efficient. This result is similar to the studies by Berger and Mester (1997) and Bauer *et al.* (1998), which reported a negative correlation between bank expenses and efficiency.

Fourth, loan quality denoted by *LLR* shows insignificant negative coefficient of Loan Quality (*LLR*) for both types of efficiency. This weak evidence shows that banks with higher loan provisions have lower efficiency levels, all other things being equal.

Finally, that bank age has a positive significant relationship with both technical and cost efficiencies indicates that as the banks grow older, they are able to manage their cost and operation better and become more efficient. It could also be 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. Conclusion

Although there are several studies that were done to measure banks' efficiency particularly in the US, study of Islamic banking efficiency is still lacking. This study is intended mainly to fill that gap.

This study set out to provide empirical evidence of Islamic banks' efficiency in Malaysia for the years 1997 to 2003. This was the period when Islamic Windows were introduced along with further financial liberalization of the Islamic banking industry. For analysis purposes, the annual reports 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 increased during the survey period. The study also revealed that the full-fledged Islamic banks were more efficient than the Islamic Windows. However, the efficiency level of Islamic banking was still less than that of the conventional banks. Also, foreign banks were found to be more efficient than domestic banks.

The results of regression analyses strongly support the following: First, bank size as measured by total assets is positively related to all types 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 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 globalization. The findings of this study have 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 optimize the utilization of scarce resources owned by the banking industry in Malaysia. The findings of this study should help them to set directions for future improvement of Islamic banking operations in Malaysia. Finally, this study should open up a fruitful avenue for future research in Islamic banking efficiency and competition in other Muslim countries.

Notes

1. Berger and Mester (1997) argued that there are two most important economic efficiency concepts: cost and profit efficiency.
2. For detailed explanation of the inputs and output together with the notations used, refer to the next section on inputs and output variables.
3. Cobb and Douglas (1928) explained about the theory of production.
4. The term financing is for Islamic banks, which is equivalent to the loans for conventional banks.
5. For conventional banks, it refers to interest expense.
6. β is regression coefficient of explanatory variables in explaining the technical and cost efficiency, *eit* is disturbance term, *i* denotes panel data of both Islamic banking and conventional banking, *t* denotes time.
7. 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".
8. Financial statements comprised balance sheets, income statement and notes to the accounts.

9. The score 1 refers to best practice bank while the score of 0 refers to worst practice bank.
10. Katib (1999) studied the technical efficiency of commercial banks in Malaysia from 1989-1995.
11. For conventional banks, although foreign banks appear to be more efficient than domestic banks, it is not statistically significant.
12. In other words, it is robust to cross-equation (contemporaneous) correlation as well as different error variances in each cross-section.
13. 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.

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APPENDIX

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

Note: IB refers to Islamic Banks,
Source: BNM Annual Report (1997–2003), individual banks' annual reports (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 labour (%)	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 labour (%)	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			
(1) Size (in log)	Size of the Bank	20.29	1.55
(2) Equity (%)	Adequacy of Capital	8.20	7.07
(3) TCTA (%)	Bank Expenses	3.49	1.90
(4) LLR (%)	Quality of the Loan	1.76	2.85
(5) 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).

Notes: 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 bank established.

Table 4: List of Panel Data

A. Islamic Windows	
Local Commercial Bank Malayan Banking Berhad *(i)* 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 Bank AmMerchant Berhad *(i)*	Affin Merchant Berhad *(i)*
B. Full-fledged Islamic Banks	
Bank Islam (M) Berhad	Bank Muamalat (M) Berhad
C. Conventional Banks	
Local Commercial Bank 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 Bank AmMerchant Berhad	Affin Merchant Berhad

Note: (i) indicates Islamic Windows in order to differentiate between Islamic Windows and their parent banks, *i.e.* the conventional banks.

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. (*) indicates correlation is significant at 0.01 level (two-tailed).

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

	No. of banks	**Year**	**Technical Efficiency**		**Cost Efficiency**	
			Mean	Std. Dev.	Mean	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
	Total: 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
	Total: 139	Overall Mean	0.794	0.125	0.778	0.120

Note: Total number of Banks: 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					.
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

Notes: (*) indicates mean difference being 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			

Notes: (*) indicates significance at the 0.10 level; (**) significant at the 0.05 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*
R^2 (adjusted)		0.756		0.859
DW Statistics		1.878		1.971
Jarque-Bera Probability		1.796 0.407		3.657 0.161

Notes: (*) indicdates significance at 0.05 level.

A brief description about the DEAP computer programme version 2.1.

DEAP is a data envelopment analysis computer programme written by Tim Coelli for the measurement of efficiency and/or productivity. The programme is widely used in efficiency and productivity literature including the banking industry. The programme and manual can be downloaded **free** from Centre for Efficiency and Productivity Analysis (CEPA) web site (www.une.edu.au/econometrics/cepa.htm).

The programme can be run in a variety of models which centre on 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; second, it can measure the cost and allocative efficiency; third, it 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 three of the principal options mentioned are available in either input or output orientation except for cost efficiency calculation. The programme is written in Fotran (Lahey F77LEM/32) for IBM-compatible PCs. It is a DOS programme but can be run easily from WINDOWS using FILE MANAGER. Further information on how to run the programme is discussed in Coelli (1996) and Coelli *et al.* (1998).