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Journal:	*Applied Economics*
Manuscript ID:	APE-08-0222
Journal Selection:	Applied Economics
Date Submitted by the Author:	19-Mar-2008
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JEL Code:	G21 - Banks|Other Depository Institutions|Mortgages < G2 - Financial Institutions and Services < G - Financial Economics, D24 - Production|Capital and Total Factor Productivity|Capacity < D2 - Production and Organizations < D - Microeconomics, C29 - Other < C2 - Econometric Methods: Single Equation Models < C - Mathematical and Quantitative Methods
Keywords:	Malaysian Banking, Islamic Banking, cost efficiency, productivity

THE IMPACT OF ISLAMIC BANKING ON THE COST EFFICIENCY AND PRODUCTIVITY CHANGE OF MALAYSIAN COMMERCIAL BANKS

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March 2008

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Abstract

This study employs stochastic frontier analysis to analyze Malaysian commercial banks during 1996-2002, and particularly focuses on determining the impact of Islamic banking on performance. We derive both net and gross efficiency estimates, thereby demonstrating that differences in operating characteristics explain much of the difference in costs between Malaysian banks. We also decompose productivity change into efficiency, technical, and scale change using a generalised Malmquist productivity index. On average, Malaysian banks experience moderate scale economies and annual productivity change of 2.68 percent, with the latter driven primarily by technical change, which has declined over time. Our gross efficiency estimates suggest that Islamic banking is associated with higher input requirements. However, our productivity estimates indicate that full-fledged Islamic banks have overcome some of these cost disadvantages with rapid technical change, although this is not the case for conventional banks operating Islamic windows. Merged banks are found to have higher input usage and lower productivity change, suggesting that bank mergers have not contributed positively to bank performance. Finally, our results suggest that while the East Asian financial crisis had a short-term cost-reducing effect in 1998, the crisis triggered a more lasting negative impact by increasing the volume of non-performing loans.

1. Introduction

Malaysian financial institutions can generally be divided into banks and non-bank financial intermediaries. The banks can be further divided into monetary and non-monetary institutions. Monetary institutions refer to institutions whose principal liabilities are accepted as money, namely the Central Bank of Malaysia (BNM), the commercial banks, and the Islamic banks. The non-monetary institutions are the finance companies, merchant banks, and discount houses whose liabilities are normally accepted as near money. The banking system also covers the representative offices of foreign banks and offshore banks in the International Offshore Financial Centre in Labuan. BNM is responsible for the regulation and supervision of the banking system except for the offshore banks operating in Labuan, which are regulated by the Labuan Offshore Financial Services Authority (Central Bank of Malaysia 1999b).

Commercial banks are the largest component of the Malaysian banking system. They have increased their share of total banking assets from 56.6 to 69.2 percent between 1992 and 2005 (Central Bank of Malaysia 1999b, 2005). Commercial banks provide banking services such as accepting deposits, granting loans, and providing trade-financing facilities. Historically, foreign banks played a more important role in the Malaysian banking system because domestic banks were not well developed, and in 1957, domestic banks accounted for less than 10 percent of all commercial bank deposits and loans. However, in 1966, foreign banks were restricted from opening new branches in Malaysia, and by 1974, the number of domestic banks exceeds the number of foreign banks. By September 1988 the share of domestic commercial bank deposits and loans had respectively increased to 75 and 72 percent (Central Bank of Malaysia 1989), and by 1997, these shares further increased to over 80 percent (Detragiache and Gupta 2004). However, starting from January 2006, foreign banks are once again allowed to open additional branches (Central Bank of Malaysia 2005).[1]

Malaysian commercial banks have also consolidated in recent years with their number reducing slightly from 38 in 1994 to 36 in 1997, as the result of mergers. The 1997-98 East Asian financial crises further pushed the industry to consolidate, and the number of commercial banks subsequently shrunk from 36 in 1998 to 25 in 2003. Starting from 2004, some commercial banks merged with finance companies in an effort to increase the capacity and capability of domestic financial institutions (Central Bank of

[1] Foreign banks also have minority shares in some local banking institutions (Detragiache and Gupta 2004).

Malaysia 2004). However, despite substantial declines in the number of domestic banks since 1996, the number of foreign banks has remained almost the same.

A further important development in Malaysian banking has been the increasing prevalence of Islamic banking. The history of Islamic banking in Malaysia began in 1963 with the establishment of Tabung Haji by the government in order to both mobilise funds for Muslims going on pilgrimage to Mecca, and to encouraging them to participate in economic activities. Building on this experience, Malaysia has implemented a systematic Islamic financial system and has emerged as the first country to have a dual system where the Islamic banking system operates side by side but separately from the conventional banking system. Islamic banking has not only allowed the banking industry to tap the previously unexploited business potential of providing banking services to the Muslim community, it has also allowed the mobilization of funds for productive purposes, that would have otherwise not available. Moreover, the development of Islamic banking in Malaysia has not been in isolation as some form of Islamic financial services is now available in at least 70 countries (Husain 2005). However, while Sudan and Iran have entirely converted to Islamic financial systems (Sundararajan and Errico 2002), it is more common for countries with large Muslim populations to operate Islamic banking systems alongside conventional banking systems, as is now the case in Malaysia, Bahrain, Pakistan, Saudi Arabia, and Egypt (Hassan 2003).

Islamic banking differs from conventional banking because it strives to be compliant with the basic precepts of shari'a, the legal code of Islam, which is based on the principles of justice, fair dealings and harmony through equitable distribution of wealth. The salient features of Islamic banking are therefore the prohibition of interest payment in transactions, and the prohibition of undertaking or financing anti-social and unethical behaviour such as gambling, prostitution, alcohol, and narcotics. The 1983 Islamic Banking Act (IBA) governs Islamic banking, and the first full-fledged (pure) Islamic bank was established in 1983.[2] However, sixteen years would elapse before the second full-fledged Islamic bank was opened by separating existing IBS assets from a conventional bank's assets in October 1999.

More significant growth in Islamic banking was triggered in 1993, when BNM initiated a pilot project that allowed three conventional banks to offer Islamic banking products through the Islamic Banking Scheme (IBS). This scheme proved quite

[2] Under this act, an Islamic bank is allowed to operate based on equity participation such as musharaka (partnership), which is similar to the activity of merchant banks and debt-like financing such as murabaha (sale at cost plus margin of profit) and ijarah (leasing), which are similar to the activities of commercial banks.

successful and by 2004, 90 percent of domestic commercial banks provided Islamic banking products through IBS windows, and Islamic banking assets were RM94.6 billion or 8 percent of the total Malaysian banking system assets (Central Bank of Malaysia 2004). In order to operate an IBS Islamic window, commercial banks must have a separate Islamic Banking Division (IBD) and a dedicated Islamic Banking Fund (IBF), which is the only allowed source of funding for the IBD, although physical capital and personnel may be shared with conventional banking (Rosly and Bakar 2003). Moreover, a committee comprised of experts in shari'a must be formed at bank level to determine the validity of new products and the compatibility of daily operations with shari'a. Any new IBS product must also be approved by the Shari'a Advisory Council established by BNM. Banks operating IBS must also submit separate Islamic and conventional statistical reports on a monthly basis to BNM, and provide an additional disclosure of their Islamic banking portfolio in their financial statements. In order to facilitate the parallel operating of the Islamic and conventional banking systems, BNM has also established an Islamic cheque clearing and settlement system, as well as an Islamic inter-bank money market system, which operates alongside but separately from conventional banking systems.

Malaysian Islamic banking entered a more mature stage in its development in 2005, when a further ten full-fledged Islamic banks were established or given regulatory approval by BNM. Of these, seven were established by separating existing IBS assets from conventional assets, thereby further demonstrating the important role that the IBS has played in promoting Islamic banking. The establishment of these full-fledged Islamic bank subsidiaries is meant to encourage more flexible operations, which will allow the new Islamic banks to engage in a range of activities similar to those of commercial, investment, and merchant banks. The further three new Islamic banks resulted from the entry of foreign full-fledged Islamic banks. Attracting full-fledged foreign Islamic bank is aimed to enhance the competitiveness of the domestic Islamic banking industry and further develop global linkages (Central Bank of Malaysia 2005). To further facilitate Malaysia becoming a premier international Islamic financial centre, BNM has also established an Islamic finance education centre for the local and international banking industry in response to the scarce provision of expertise.

This rapid expansion of full-fledged Islamic banks caused the share of IBS in total Islamic banking assets to drop significantly to 53 percent in 2005, and this share will decline further in the future, as full-fledged Islamic banking becomes increasingly prevalent. Thus, while full-fledged Islamic banking has grown from 0.7 to 12 percent of all banking assets between 1988 and 2007 (Bank Islam Malaysia Berhad 1989; Central

Bank of Malaysia 1999b; Aziz 2007) this share is expected to increase to 20 percent by 2010 (Central Bank of Malaysia 2002a). Nevertheless, within the Malaysian context, it is extremely important to note that IBS banking can be seen as the critical catalyst that led to this dramatic growth in Islamic banking, as highlighted by the fact that at least 8 of the 12 full-fledged Islamic banks currently operating were founded as IBS banks. Moreover, within the available sample period of 1996 to 2002 for this study, IBS banking was the predominant form of Islamic banking in Malaysia.

Given these developments within the Malaysian banking sector, this study aims to measure the relative efficiency of Malaysian banks as well as the determinants of their productivity performance, and will particularly focus on the relative performance of Islamic banks. More specifically, by deriving estimates of net and gross efficiency for Malaysian commercial banks after estimating a cost function with stochastic frontier techniques, our analysis highlights the impact of operating characteristics, including Islamic banking, foreign ownership, loan quality, equity to asset ratios, and the East Asian financial crisis on the relative costs of Malaysian banks. In particular, our gross efficiency estimates highlight that during our sample period Islamic banking activities appear to be associated with higher input usage. However, our estimates of productivity change, which is decomposed into efficiency change, technical change and scale change effect using generalised parametric Malmquist productivity index, also suggest that full-fledged Islamic banks in particular have been able to overcome some of these cost disadvantages due to rapid technical change. .

The rest of the paper is organised as follows. Section 2 provides a brief literature review focused on Islamic banking, and is followed by a description of the methodology in section three. Data and the empirical specification are discussed in section four. Section five reports on results which are comprised of the cost function estimates, net and gross efficiency estimates, economies of scale, average productivity change and its decomposition, and firm specific productivity change and its decomposition. Finally, section six offers some conclusions.

2. Previous Findings on the Relative Performance of Islamic Banks

While some of the previous literature on Islamic banking performance has employed relatively unsophisticated techniques such as financial ratios, some studies have also employed more advanced techniques such as Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). We briefly review this literature and focus on its findings with regard to: the relative performance of full-fledged Islamic banks relative to

conventional banks, the relative performance of Islamic banking windows operated by conventional banks relative to conventional banking operations and full-fledged Islamic banks.

For studies using financial ratios, the performance of Islamic banks relative to conventional banks varies according to the financial indicators employed and across the studies. Islamic banks are found to outperform conventional banks in term of overall productivity as measured by an income-to-expenditure ratio (Hamid, M. A. 1999) and profitability, as measured by return-on-equity (ROE) (Hamid, M. A. 1999; Iqbal 2001; Hassoune 2002). Islamic banks have higher growth in equity, deposits, investment and total assets (Iqbal 2001), better asset quality and capital adequacy (Hassan and Bashir 2003), better credit performance (Samad 2004), less risk due to excess liquidity (Metwally 1997; Hamid, M. A. 1999; Samad and Hassan 1999; Samad 2004) and greater investment in government securities (Samad and Hassan 1999). Excess liquidity and high investment in government securities are due to relatively limited investment opportunities, because of the restrictions imposed by shari'a (Metwally 1997; Hamid, M. A. 1999; Samad and Hassan 1999; Samad 2004). However, not all Islamic banks suffer from excess liquidity (Iqbal 2001; Hassan and Bashir 2003) and some Islamic banks are relatively less cost effective as measured by a cost-to-income ratio (Iqbal 2001) and have higher labour costs (Hamid, M. A. 1999). Nevertheless, some Islamic banks perform as well as conventional banks in terms of profitability (Nienhaus 1988; Metwally 1997; Samad 2004), liquidity (Samad 2004), total asset (Nienhaus 1988), credit risk, and efficiency as measured by an operating expenditure-to-assets ratio (Metwally 1997). Using linear regression technique, Hassoune (2002) found that the ROE of Islamic banks is less volatile compared to conventional banks, because the latter is more heavily influence by nterest rate fluctuations.

We focus next on studies employing SFA and DEA. Islamic banks are found to have higher cost efficiency relative to conventional commercial and investment banks, in (Alshammari 2003) which studies banks located in Bahrain, Saudi Arabian, Kuwaiti, Oman, Qatar and the U.A.E. This study also finds that no significant difference in economies of scale exists between Islamic and conventional banks. Similar efficiency results are found in a study of banks in Bahrain, Egypt, Jordan, and Saudi Arabia (Al-Jarrah and Molyneux 2005), which also found that Bahraini banks are most cost efficient. Al-Jarrah and Molyneux (2005) include controls for bank types, country dummies, assets, liquidity, a concentration ratio, but allow these factors directly influence cost inefficiency, rather than modelling these factors as environmental variables directly influencing the cost

function. In contrast, when loan quality and capital are directly controlled for in the cost function and bank type controls and country dummies are allowed to directly influence inefficiency, Alshammari (2003) found Bahraini banks to be least cost efficient. These differing results suggest that careful consideration of the impact of control variables on measured efficiency is necessary when judging the relative efficiency of banks.

Islamic banks are found to be relatively efficient when compared to conventional banks in Turkey, using a cost function estimated with SFA and (El-Gamal and Inanoglu 2005) and DEA (Alpay and Hassan 2006), despite limited investment avenues for Islamic banks. Turkish Islamic bank cannot even invest in government securities because they are interest-bearing in Turkey. On the other hand, Islamic banks in Malaysia are found to be equally cost efficient with conventional commercial banks by (Mokhtar, Abdullah, and Al-Habshi 2006) and (Abdul-Majid, Mohammed Nor, and Said 2005). However, these Malaysian bank studies do not control for any environmental factors either directly in the estimated costs function, or as directly influencing inefficiency. Our model below will therefore improve on this earlier work by both controlling for such environmental factors, but also considering their impact on estimated efficiency.

We finally, note while Hassan (2003) and Hassan (2005) have estimated the productivity change of full-fledged Islamic banks, (Alpay and Hassan 2006) study of Turkish banks, which employs a non-parametric Malmquist productivity index, is the only study that has considered differences in productivity change between Islamic and conventional banks. Interestingly, this study finds that the productivity change and technical change of Islamic banks has declined relative to that of conventional banks between 1990 and 2000.[3] Given these limited previous findings, our below model will employ Orea's (2002) generalised Malmquist total factor productivity index so that we can better analyze the determinants of productivity change in Malaysian banking and the relative productivity performance of Islamic banks.

As discussed above, the growth of Islamic banking in Malaysia was greatly stimulated by the IBS, which allowed conventional banks to operate Islamic banking windows if certain rules were adhered to. Therefore, the impact of IBS banking on performance is obviously of interest. Compared to Malaysian conventional banks, Rosly and Bakar (2003) observed that during 1996-99, IBS banking operations have higher profitability as measured by ROA but lower asset utilization and investment margin

[3]Hassan (2003; 2005) employs non-parametric Malmquist productivity indices to analyze the productivity growth of full-fledged Islamic banks. Islamic banks are found to experience moderate productivity growth in most countries operating Islamic banking (Hassan 2005), but experience productivity loss in Pakistan, Sudan and Iran over 1994-2001 (Hassan 2003). Despite these differences, technical change is the dominant determinant of productivity growth in both studies

ratios. Performance comparisons between IBS banking operations and Malaysian full-fledged Islamic bank over 1996-1999 using financial ratios found that the former is more efficient in terms of capital structure, assets, deposit structure and profitability (Hamid, S. A. and Ahmad 2002). In contrast, after estimating a cost function with SFA for the period 1997-2003. Mokhtar, et al (2006) argued that domestic Malaysian parent banks are more efficient than their IBS subsidiaries, while this result is reversed for foreign banks. Moreover, this study found that IBS banking operations are less efficient than full-fledged Islamic banks. However, as the conventional and Islamic operations of IBS banks share their non-financial resources, if not their financial resources, it is difficult to see how these studies could have meaningfully separated non-financial costs for IBS operations, as would be required to properly specify these models. Our below model will therefore simply consider the overall performance of banks which operate IBS windows relative to other types of banks, so that we can provide what we argue are less biased estimates of the impact of IBS Islamic banking on bank efficiency and productivity growth.

From the literature review, it can be concluded that past empirical studies on the relative performance of Islamic and conventional banks have used financial ratio analysis, DEA, SFA, and linear regression techniques. However, on balance, there has been relatively little use of more sophisticated techniques such as SFA and DEA, and very few studies have provided estimates of differences in productivity change between Islamic and conventional banks. Moreover, despite the recent surge of interest in conventional banks offering Islamic banking products, no study has compared the efficiency of conventional banks operating IBS, full-fledged Islamic bank, and conventional banks without IBS. Furthermore, those studies that have compared the relative performance of IBS banking operations are potentially biased because they must assume an artificial separation between Islamic and conventional operations, which is not consistent with the nature of IBS banking operations.

Finally, most previous studies have not controlled for environmental factors when estimating efficiency. Moreover, consideration of those that do (Alshammari 2003; Al-Jarrah and Molyneux 2005) suggests that the method employed to allow for environmental factors will have a significant impact on relative efficiency estimates. While it is clear that legitimate differences in operating characteristics that influence operating costs should be allowed for when estimating efficient costs, it is not always clear whether such factors are actually indicators of higher efficient costs that should be allowed for, or are instead indicators of higher inefficiency. Thus, for example, a control for whether a bank engages in Islamic banking, could be interpreted as capturing legitimate difference in costs

associated with compliance with Sharia', or could alternatively be interpreted as a control for systematic inefficiency that may be associated with Islamic banking. If the former dominates, netting out the impact of operating characteristics is appropriate and the resulting net efficiency measure, as defined by Coelli, Perelman, and Romano (1999), is an appropriate measure of managerial efficiency. In contrast, if operating characteristics are predominantly indicators of higher inefficiency, then a gross efficiency measure, as defined by Coelli, et al. (1999), is a more appropriate managerial efficiency measure as it will quantify the impact of differences in operating characteristics on actual costs. Regardless of whether operating characteristics are indicators of higher efficient costs or higher inefficiency, gross efficiency estimates allow us to quantify the impact of operating characteristics on observed costs, and are therefore useful if we wish to study how differences in operating characteristics influence observed differences in the costs of firms. Therefore, by providing both net efficiency estimates and gross efficiency estimates as proposed by Coelli, et al. (1999), this study would be able to analyse the relative impact of these operating characteristics on the costs of Malaysian commercial banks , and therefore expand upon the existing literature that has analyzed the relative efficiency of Islamic banks.

3. *Methodology*

The measured efficiency of a firm is interpreted as the difference between its observed input and output levels and the corresponding optimal values. An output-oriented measure of efficiency compares observed output with the maximum output possible for given input levels. Alternatively, an input-oriented efficiency measure compares the observed level of inputs with the minimum input that could produce the observed level of output. However, these are measures of technical efficiency, and as such ignore the behavioural goals of a firm. Comparison of the observed mix of inputs or outputs with the optimal mix that would minimise cost, maximise profit or obtain any other behavioural goal is a measure of allocative efficiency. In a cost minimisation context, allocative efficiency occurs when a firm use the optimal mix of inputs to minimize costs given input prices. As a significant number of previous bank studies have adopted a cost function approach (e.g., Ferrier and Lovell 1990; Mester 1993; Kwan and Eisenbeis 1996; Dietsch and Lozano-Vivas 2000; Isik and Hassan 2002; Abdul-Majid, et al. 2005; Carvallo and Kasman 2005; Mokhtar, et al. 2006), we will adopt this approach for Malaysia

However, before proceeding we first note that Islamic banking differs from conventional banking in at least two significant ways. Firstly, Islamic banks are forbidden from paying or receiving interest. Therefore, they cannot issue or hold interest-bearing loans or securities but use alternative contract arrangements (Karim 2001).[4] However, as the available investment avenues using contracts are very limited, and most of them concentrate on short term investments, they may yield lower returns. Secondly, by Shari'a, while Islamic banks operate as businesses, they must also act to improve socio-economic development. As business firms, they seek to maximize profit in order to give a good return to shareholders and depositors. However, when meeting their duties to promote economic development, they must also satisfy objectives such as promoting justice and the equitable distribution of income and wealth, maintaining sectoral balance in the economy, and developing human resources through training and retraining (Hamid, M. A. 1999; Choudhury and Hussain 2005).

Given, that Islamic banks cannot charge or pay interest and are therefore likely to face higher capital costs, and also satisfy objectives other than profit maximization it would be inappropriate to judge the relative performance of Islamic banks with a profit or revenue function. In contrast, using a cost function allows the potential higher costs of capital faced by Islamic banks to be controlled for. Moreover, if the non-profit oriented activities of Islamic bank are carefully controlled for, it is reasonable to assume that Islamic banks will attempt to minimize their costs of operation. We therefore argue that a cost efficiency study is appropriate for countries such as Malaysia where Islamic and conventional banks operate side-by-side.[5] Moreover, several studies have adopted a cost function approach to consider the relative efficiency of Islamic banking. These include El-Gamal and Inanoglu (2005) which uses Turkish data and finds that Islamic banks are more efficient than conventional banks. For Malaysia, Abdul-Majid, et al. (2005) finds no evidence of efficiency differences between Islamic, and conventional banks for the period 1993-2000. Similarly, Mokhtar (2006) also found that the efficiency of full-fledged Islamic banks in Malaysia does not differ from conventional banks.

In specifying our cost function model, we employ the intermediation approach, which has been widely employed in conventional bank studies (e.g., Cebenoyan, Cooperman, and Register 1993; Mester 1993; Kwan and Eisenbeis 1996; Mester 1996;

[4] Examples of contracts are musharaka, murabaha and ijarah.
[5] The work of El-Gamal and Inanoglu (2005) employs an Estimation-Classification (EC) estimator to identify bank technology in Turkey, and concludes that Islamic banks have the same technology as other banks, thereby suggesting that it is appropriate to jointly assess the cost efficiency of Islamic and conventional banks.

Berger and Mester 1997; Altunbas, Evans, and Molyneux 2001; Isik and Hassan 2002; Rao 2005), Islamic bank studies (e.g., Brown and Skully 2003; Hassan 2003; Saaid, Rosly, Ibrahim, and Abdullah 2003; Yudistira 2004) and Islamic and conventional bank studies (e.g., Alshammari 2003; El-Gamal and Inanoglu 2005). The intermediation approach is the most suitable with the concept of Islamic banking in intermediating savers and investors of funds. This is because the nature of Islamic banking that relies on profit-sharing contract, which involves equity participation principle[6] with depositors[7] and banks can therefore be seen as intermediating savers and investors by transforming deposits into earning assets, rather than as producers of services and loans.

Given this discussion, we will employ SFA to estimate a total cost function for Malaysian commercial banks. A single-equation stochastic cost function model can be described as:

$$\ln C_{n,t} = f(Y_{n,t}, W_{n,t}, Z_{n,t}) + \varepsilon_{n,t} \quad (1)$$

where $C_{n,t}$ is the observed total cost of production for the n-th firm at time t, $Y_{n,t}$ is a vector of outputs, $W_{n,t}$ is an input price vector and $Z_{n,t}$ is an exogenous factor vector. Following Aigner, et al. (1977), we assume a composed error term;

$$\varepsilon_{n,t} = v_{n,t} + u_{n,t} \quad (2)$$

where $v_{n,t}$ and $u_{n,t}$ are independently distributed; $v_{n,t}$ represents random uncontrollable error and is assumed to be normally distributed with zero mean and variance, σ_v^2. $u_{n,t} \geq 0$ is drawn from a one-sided distribution that is assumed to capture inefficiency. Similar to many previous studies, $u_{n,t}$ is assumed to be drawn from a half-normal distribution with mean zero and variance σ_u^2 (e.g., Kaparakis, Miller, and Noulas 1994; Mester 1996; Berger and Mester 1997). Given this assumption, the approach of Jondrow, Lovell, Materov, and Schmidt (1982) is followed to derive the log likelihood which is expressed in terms of the two variance parameters, $\sigma^2 = \sigma_v^2 + \sigma_u^2$ which captures the variance of composed error and and $\lambda = \sigma_u / \sigma_v$. which is a measure of the amount of variation originating from inefficiency relative to statistical noise.

[6] Some current Islamic banks also practice debt-like financing such as murabaha.
[7] Similar to conventional banks, some Islamic banks, including 2 Islamic banks in Malaysia put equity contributed by depositors, under deposits from customers, but for some Islamic banks, the equity is categorised under shareholders' funds (Karim 2001).

Maximum-likelihood estimates are obtained by estimating a multiproduct translog cost function, which provides a second order approximation of any potential cost function. The specified cost function, after including environmental variables, imposing the standard assumption of homogeneity in input prices, and allowing for the composed error terms, is:

$$\begin{aligned}\ln \tilde{C}_{n,t} &= \varphi + \sum_{\mathrm{k}=1}^{K-1} \alpha_{\mathrm{k}} \ln \mathrm{P}_{\mathrm{k,n,t}} + 0.5 \sum_{k=1}^{K-1} \sum_{s=1}^{K-1} \alpha_{\mathrm{k,s}} \ln \mathrm{P}_{\mathrm{k,n,t}} \ln \mathrm{P}_{\mathrm{s,n,t}} \\ &+ \sum_{\mathrm{m}=1}^{\mathrm{M}} \beta_{\mathrm{m}} \ln \mathrm{Y}_{m,n,t} + 0.5 \sum_{\mathrm{m}=1}^{\mathrm{M}} \sum_{j=1}^{\mathrm{M}} \beta_{\mathrm{m,j}} \ln Y_{m,n,t} \ln Y_{j,n,t} \\ &+ \sum_{k=1}^{K-1} \sum_{m=1}^{M} \theta_{k,m} \ln P_{k,n,t} \ln Y_{m,n,t} + \sum_{k=1}^{K-1} \delta_k \ln P_{k,n,t}\, t \\ &+ \sum_{m=1}^{M} \psi_m \ln Y_{m,n,t}\, t + \lambda_1 t + 0.5 \lambda_{11} t^2 \\ &+ \sum_{h=1}^{H} \zeta_h Z_{h,n,t} + v_{n,t} + u_{n,t} \end{aligned} \tag{3}$$

where, $P_{k,n,t} = W_{k,n,t} / W_{K,n,t}$ and $\tilde{C}_{n,t} = C_{n,t} / W_{K,n,t}$

k=1,…,K, and s=1,…,K are indices for input prices; m=1,…M and j=1,…,M are indices for output prices; h=1,…,H is an index for environmental variables; while the Greek letters (except v and u) represent unknown parameters to be estimated. Standard symmetry is imposed to the second order parameters: $\alpha_{ks} = \alpha_{sk}$ and $\beta_{mj} = \beta_{jm}$ In addition, all variables in this approximation are normalized around their means. The parameters defined in (3) as well as the σ^2 and λ parameters discussed above are estimated using Maximum-Likelihood Estimation (MLE).

Given our model specification and assumptions, it can be readily demonstrated that a measure of cost efficiency can be derived as the ratio of observed costs to predicted efficient costs, which is theoretically equivalent to:

$$CE_{n,t} = \exp(\mu_{n,t}) \tag{4}$$

These relative efficiency measures range from one to infinity with a score of one indicating full efficiency. However, $CE_{n,t}$ relies on the unobservable inefficiency, $u_{n,t.}$. We therefore follow the now standard approach of Jondrow, et al. (1982) and employ the conditional expectation of $u_{n,t}$ given the observed value of the overall composed error term, $\varepsilon_{n,t}$, which can be expressed as:

$$E\left(u_{n,t}\middle|\varepsilon_{n,t}\right)=\frac{\sigma\lambda}{1+\lambda^2}\left[\frac{\phi\left(\varepsilon_{n,t}\lambda/\sigma\right)}{1-\Phi\left(\varepsilon_{n,t}\lambda/\sigma\right)}+\left(\frac{\varepsilon_{n,t}\lambda}{\sigma}\right)\right] \quad (5)$$

where, ϕ is the standard normal density function and Φ is the standard normal cumulative distribution function.

In our model, we have also followed the standard practice of controlling for differences in operating characteristics that may influence the efficient level of costs, by including Z factors directly in the cost function. Moreover, Bos and Kool (2006) argue that failure to account for differences between bank groups may yield inappropriate conclusions about bank performance. However, this also implies that the resulting efficiency scores are net of the impact of environmental influences on efficient input requirements. As a result these net efficiency measures enable one to predict how firms are ranked under the assumption that firms operate in an equivalent environment. Moreover, given the assumption that all major environmental influences have been accounted for and are truly exogenous, the net efficiency measure can theoretically be interpreted as a measure of managerial performance (Coelli, et al. 1999).

However, in practice, this assumption is less than tenable, as it is common to employ exogenous factors such as foreign, public ownership, and bank type dummies, which are potentially indicative of differences in efficiency rather than differences in efficient costs. Thus previous studies, have included exogenous variables such as bank location and branch banking limitation indicators (Berger and DeYoung 1997), the number of branches and mergers (Lozano-Vivas 1998), country specific variables (Dietsch and Lozano-Vivas 2000), and dummy variables for new banks, private ownership, and oreign ownership (Kraft, Hofler, and Payne 2006).[8] Therefore, in order to better judge the impact of such factors on estimated efficiency, we follow the approach of (Coelli, et al. 1999) to provide alternative gross efficiency $\left(GE_{n,t}\right)$.

Following Coelli, et al. (1999) we first identify the the most favorable operating characteristics, by identifying the observation with the minimum value of $\left[\sum_{h=1}^{H}\xi_h Z_{h,n,t}\right]$, which hereafter is referred to as $Min\left[\sum_{h=1}^{H}\xi_h Z_{h,n,t}\right]$. By assuming that other firms face this most favoured operating environment, rather than their own, a predicted efficient cost for firms relative to the most favored operating environment can be estimated. This

[8] Another potential method is to model exogenous factors such as size, organizational type, portfolio composition as directly influencing inefficiency effects (e.g., Cavallo and Rossi 2002; Al-Jarrah and Molyneux 2005).

yields a revised estimate of the deviation of a firm's actual costs from frontier costs, which can be expressed as:

$$\varepsilon_{n,t}^{Gross} = \varepsilon_{n,t} + \sum_{h=1}^{H} \xi_h Z_{h,n,t} - Min\left[\sum_{h=1}^{H} \xi_h Z_{h,n,t}\right] \quad (6)$$

Measures of the firm's gross inefficiency $\mu_{n,t}^{Gross}$ can then be obtained by substituting $\varepsilon_{n,t}^{Gross}$ for $\varepsilon_{n,t}$ in (5), and then calculating gross efficiency as:

$$GE_{n,t} = \exp(\mu_{n,t}^{Gross}) \quad (7)$$

Because $(GE_{n,t})$ is calculated under the assumption that a firm faces the most favorable operating environment, differences that can be attributed to differences in Z-factors will be reflected as differences in gross efficiency. As discussed above, this is not the case with $CE_{n,t}$, which by definition nets out the impact of differences in operating environment (Coelli, et al. 1999).

Estimates of Economies of Scale can be obtained by first calculating the *M* output elasticities:

$$\zeta_{m,n,t} = \frac{\partial \ln \tilde{C}_{n,t}}{\partial \ln Y_{m,n,t}} = \beta_m + \sum_{j=1}^{M} \beta_{m,j} \ln Y_{j,n,t} + \sum_{k=1}^{K-1} \theta_{k,m} \ln P_{k,n,t} + \psi_m t \quad (8)$$

From which a scale elasticity can be calculated as:

$$\varsigma_{Scale,n,t} = \left(\sum_{i=1}^{M} \varsigma_{m,n,t}\right)^{-1}. \quad (9)$$

If $\varsigma_{Scale,n,t} > 1$, there is economies of scale, if $\varsigma_{Scale,n,t} = 1$, there is constant returns to scale; and if $\varsigma_{Scale,n,t} = 1$, there is diseconomies of scale.

In order to measure productivity change, we follow the Generalised Malmquist approach that has recently been proposed in the literature (Orea 2002; Coelli, Estache, Perelman, and Trujillo 2003). This approach extends the standard Malmquist Productivity Index which captures only the impact of technical change (TC) and cost efficiency change (CEC), by further allowing for the impact of scale change effect (SCE) on productivity change. We can therefore employ our estimated cost function and inefficiency estimates to calculate Total Factor Productivity Change (TFPC) and its decomposition as:

$$TFPC = CEC + TC + SCE \quad (10)$$

where $CEC = \ln(CE_{n,t} / CE_{n,t+1})$ measures the change in productivity attributable to improved efficiency, $TC = -0.5\left[\partial \ln \tilde{C}_{n,t+1}/\partial t + \partial \ln \tilde{C}_{n,t}/\partial t\right]$ is the mean of the estimated trend change rate of estimated efficient cost, and the contribution of scale change to productivity change is measured as:

$$SCE = 0.5 \sum_{m=1}^{M} \left[\left(\left(\varsigma_{Scale,n,t+1} - 1\right)\varsigma_{m,n,t+1} + \left(\varsigma_{Scale,n,t} - 1\right)\varsigma_{m,n,t}\right)\ln\left(Y_{m,n,t+1}/Y_{m,n,t}\right)\right]$$

Consideration of SCE reveals that for firms characterized by economies (diseconomies) of scale, output growth results in increased (decreased) rates of productivity change. In contrast, under constant returns to scale, SCE=0, and TFPC will be equivalent to the standard Malmquist productivity change rate. Thus, the further ς_{Scale} deviates from one, the greater the estimated impact of scale change on TFPC will be. Thus, SCE reveals an important link between estimated economies of scale and the potential TFPC that can be generated through bank growth.

4. Data and Empirical Specification

Data on 33 banks were drawn from Bureau van Dijk's (BvD's) Bankscope database for the period 1996-2002 and were verified against the banks' annual reports. The data is expressed in Malaysian Ringgit (MYR) and are adjusted for inflation using the Malaysion GDP Deflator, which was extracted from IMF (2004). The number of full-time workers and ownership information is taken from Central Bank of Malaysia (2002b) and Association of Banks in Malaysia (Various Years). This process results in an unbalanced panel of 168 observations. Mergers during the sample period have caused a marked reduction in the number of Malaysian commercial banks. Over this period, ten mergers and acquisitions took place: two in 1999, one in 2000, six in 2001 (involving 14 banks) and one in 2002. Given these trends, we included each pre-merger commercial bank as a separate bank and assumed that these banks merged into the one of the pre-merger banks.

Table 1 describes the sample of Malaysian banking institutions by type of bank for each of the years under study. The sample is representative and covers 70 percent of all Malaysian banks. By illustrating trends in the number of banks in several alternative categories, the table reveals the increasing preponderance of merged banks over time, a significantly greater preponderance of conventional banks operating IBS windows rather than full-fledged Islamic banks, and, particularly at the end of the sample period, a significantly greater preponderance of conventional banks operating IBS windows among domestic banks relative to foreign banks.

(Table 1 about here)

Table 2 demonstrates the size distribution of sample banks in each year, with size measured in total assets in 2000 MYR, and categories based on quartiles in the entire sample.. Given mergers the distribution of banks has shifted towards larger banks over time. In the smallest asset range, there was a relatively balanced mixture of domestic and foreign banks over 1996-1998. Subsequently, domestic banks have merged with other banks leaving only foreign banks in this category after 2000. Generally, the number of foreign banks in the very small-sized category is increasing over time and decreasing in the small-asset category. Although most banks in the largest-sized category are domestic banks, the number of foreign banks increased over time, and particularly after 2000.

(Table 2 about here)

The selection of output and input variables follows the existing literature (e.g., Allen and Rai 1996; Mester 1996; Casu and Girardone 2002). Total costs (C) are defined as operating and financial costs and are calculated as the sum of labour expenses, physical

capital expenses, and either income paid to depositors for Islamic banks or interest expense for conventional banks. Input prices are the price of labour (W_1), the price of financial capital (W_2), and the price of physical capital (W_3). W_1 is labour expenses divided by the number of full time workers, and labour expenses include wages, salaries, bonuses, costs of defined contribution plans, termination benefits and other personnel costs. (W_2) is the amount of income paid to depositors divided by total deposits, and total deposits include customer funding and short term funding. W_3 is the physical capital expenses divided by the fixed assets, and physical capital expenses is total expenses on fixed assets allocated for all furniture, equipment, and bank premises, including depreciation, and administration and general expenses. Bank outputs, are defined as the sum of total loans (Y_1), and total other earning assets (Y_2). The latter are comprised of deposits with other banks, securities and equity investments.

The first operating environment variable is an indicator of loan quality (Z_1), and is proxied by the ratio of the non-performing loans (NPL)-to-total loans. (e.g., Clark 1996; Mester 1996; Berger and Mester 1997; Girardone, Molyneux, and Gardener 2004; Williams and Nguyen 2005)). When comparing efficiency, banks must have homogeneous output quality, otherwise unmeasured differences in loan quality may be mistakenly measured as inefficiency (Berger and Mester 1997). This is because, banks with superior loan quality may appear inefficient because they use more labour and physical capital to monitor loans (Mester 1996). Similarly, according to the 'bad management hypothesis', a bank may incur extra expenses in administering bad loans if it has bad management, while the 'bad luck hypothesis' argues that a negative economic shock will cause some banks extra expenses to recover default loans and related administration costs. Finally, according to the 'skimping hypothesis', banks may save costs now by not investing in loan monitoring expenses and face high default loans later (Berger and DeYoung 1997). It is expected that the 'bad luck hypothesis' will prevail in this study because the financial crisis caused banks' NPL to rise significalty in 1998 and remain high for the rest of the sample period. . Moreover, since the increase in the NPL is due to an external shock, it should be controlled for in the function (Berger and Mester 1997). We therefore expect a positive coefficient for this variable, therebv indicating that banks with high NPL-to-loans (lower loan quality) incur higher costs.

The second operating environment variable is measured by the equity-to-total assets ratio (Z_2) (e.g., Clark 1996; Mester 1996; Berger and Mester 1997; Girardone, et al. 2004; Williams and Nguyen 2005). Two contrasting theoretical arguments on the relationship between equity financing and inefficiency exist. In the first, raising equity

involves higher costs relative to raising deposits, hence, risk adverse banks that prefer equity financing would appear inefficient, in the absence of this control variable. In contrast, unlike income paid to depositors, in the standard specification of the intermediation model, dividends paid on equity is not considered as a cost, hence if we do not control for the equity-to-total-asset ratio , banks with more equity financing will appear more efficient (Berger and Mester 1997). Therefore, no *a priori* assumption is made on the sign of Z_2.

The remaining environmental variables are dummy variables that are designed to capture potential differences in bank characteristics, and operating environment that may influence costs. The dummy variable indicating full-fledged Islamic banks (Z_3), is to control for the potential impact of full-fledged Islamic banking on bank costs. No priori assumption is made due to mixed results in literature on the direction of the influences (e.g., Al-Jarrah and Molyneux 2005; El-Gamal and Inanoglu 2005; Mokhtar, et al. 2006). Given that some banks have gone through mergers, one can control for this effect by using a merger dummy variable (Z_4). This dummy is expected to have a positive impact on costs because merged banks need some times for system integration and personnel integration (Peristani 1997; Rhoades 1998; Sherman and Rupert 2006). As changes in bank scale should be captured through the impact of output growth on estimated costs, the impact of mergers identified through Z_4 will be net of the impact of changes in bank scale attributable to the merger.

A dummy for observations in 1998 is included to control for the East Asian financial crisis (Z_5). The financial crisis, which started in the third quarter of 1997 hit the stock market and banking sector badly. In response, banks eliminated a large number of employees and cut other expenses drastically during and after the crisis (Central Bank of Malaysia 1997, 1998, 1999a). However, the government also took several immediate measures, such as reducing interest rates, to both counter the banking crisis and stimulate the economy (see Lindgren, Balino, Enoch, Gulde, Quintyn, and Teo 1999 for actions taken). As a result of these immediate measures, much of the impact of the financial crisis was concentrated in 1998 as demonstrated by Malaysian GDP growth, which was respectively 7.3, -7.4, and 6.1 percent in 1997, 1998, and 1999 (Ministry of Finance Malaysia Various Years). As the decline in interest rates coupled with cost cutting on operating expenses resulted in declines in total costs for banks, we expect the coefficient of the 1998 financial crisis dummy to be negative.[9]

[9]A dummy variable for 1997,1998, all post-crisis years as well as individual dummy variables for each of the years after 1998 were tested but were found to be statistically insignificant. Other potential

We considered including a foreign owned dummy, for banks with more than 50 percent foreign ownership. However, while almost all domestic banks operate an IBS window relatively few foreign banks do (see Table 1). We therefore, chose to interact a foreign dummy variable with a dummy variable for conventional banks that operate IBS windows and include the resulting set of dummy variables. Therefore, the model includes dummy variables for foreign banks without IBS (Z_6), foreign banks with IBS (Z_7), domestic banks with IBS (Z_8), and leaves domestic banks without IBS as the base case measured in the constant.[10]

When predicting the expected impact of these dummy variables on efficient costs, we note that foreign banks are expected to have lower cost relative to domestic banks because they have priority access to technology from their parent banks and better access to multinational clients (Berger, Clarke, Cull, Klapper, and Udell 2005). Moreover, in the literature foreign banks are found to be more efficient than domestic banks in Malaysia (Matthews and Ismail 2006; Mokhtar, et al. 2006), in transition countries (Hasan and Marton 2003; Kasman and Yildirim 2006), in India (Bhattacharyya, Lovell, and Sahay 1997), in Australia (Sturm and Williams 2004) but not the USA (Mahajan, Rangan, and Zardkoohi 1996; Chang, Hasan, and Hunter 1998).

With regard to banks operating IBS windows, there is a less clear-cut expected relationship. Thus, the provision of IBS banking services may reduce efficient costs by allowing a bank to service additional market segments with its existing staff and facilities. However, higher costs may be associated with Islamic financing and/or the need to maintain strict financial separation between Islamic and non-Islamic operations. Therefore, while the previous literature suggests that the coefficient on (Z_6) will be negative to reflect that foreign bank without IBS will incur less cost then domestic banks without IBS services, the ambiguity with regard to the likely impact of IBS banking services on efficient costs, implies that we cannot a priori predict the sign of the coefficient for the Z_7 and Z_8 variables.

Finally, Z_9 provides a dummy variable indicating public ownership, and is expected to have a positive sign indicating higher costs.[11] Generally, state-owned banks

environmental variables such as asset size and potential relevant ratios are also not significant in this model. We also note that the increase in bad loans that was associated with the crisis are controlled for with the Z_1 variable.

[10] As all Islamic banks in our sample are domestically owned, and by definition are not conventional banks, the impact of Islamic banking on costs measures by Z_3 is also relative to the base case of a domestic bank that does not operate IBS.

[11] Publicly-owned banks are defined as banks with more than 50 percent government ownership through its agencies such as the Employees Provident Fund (EPF) and Permodalan Nasional Berhad (PNB). By definition, no foreign banks are included in the publicly owned category. .

perform poorly relative to private-owned banks in developing nations (e.g., Isik and Hassan 2003a; Berger, et al. 2005; Bonaccorsi di Patti and Hardy 2005). This may be because state-owned banks are usually associated with directed lending or with specific objectives such as developing certain industries or regions (Berger, et al. 2005).

(Table 3 about here)

Descriptive statistics are presented in Table 3 in real 2000 MYR. The difference in bank size is relatively high. The biggest bank has approximately 200 times the assets of the smallest bank. Most banks with a high price of physical capital are foreign banks.[12] Foreign banks usually rent office spaces in expensive buildings or areas suitable with their target customers and they only have a few branches, thereby making their costs for physical capital very high. There is a bank with a Loan Quality (NPL-to-loans) ratio of 0.77 in 1999, reflecting an extremely high level of NPLs relative to the sample average of 0.13. Another bank has an equity-to-asset ratio of -0.05 in 2000 that is due to negative equity. High-accumulated losses in this bank have lead to high negative reserves and thus negative equity.

5. Results

5.1 The Cost Function Estimates

The estimated cost function parameters are reported in Table 4. Model A includes the nine environmental variables (Z_1-Z_9) described above. while Model B excludes the foreign with IBS (Z_7), domestic bank with IBS (Z_8), and public (Z_9) dummy variables, which are individually insignificant in Model A. Moreover, as a log likelihood ratio test of the joint significant of these three parameters is 4.81, we cannot reject the null hypothesis that these parameters are jointly insignificant and as it is the preferred model the following discussion will be limited to Model B. However, as domestic banks without IBS windows are the base case in Model A, this result suggests that *ceteris paribus* no statistically significant difference in efficient costs can be identified for the group made up of all domestic banks, foreign banks with IBS windows, and publicly owned banks.

(Table 4 about here)

Recalling that $\lambda=\sigma_u/\ \sigma_v$ the highly significant estimate of 1.501 implies that estimated deviation from the frontier is due mainly to inefficiency rather than statistical noise. Loan quality (Z_1) is positive as predicted and indicates that the lower output quality (higher the NPL-to-loan ratio), the higher the cost incurred by banks, which may reflect higher monitoring costs. Moreover, as the NPL-to-loan ratio increased significantly from

[12] Similar to Isik and Hassan (2002).

6 to 17 percent for the average bank between 1997-1999, this implies that estimated efficient costs for an average bank increased by 3.5 percent, because of the increase in non-performing loans associated with the financial crisis. Moreover, as the average NPL-to-loan ratio remains stable at approximately 16 percent after 1999, the financial crisis appears to have a long-term upward effect on costs by causing a sustained reduction in loan quality. The equity-to-asset ratio (Z_2) has a negative relationship with costs, indicating that as the equity-to-asset ratio increases, costs are lower relative to those banks that depend more on deposits. However, while the average equity-to-asset ratio increases slightly between 1996 and 2002, this change is not substantial and there is no significant impact attributed to financial crisis.

The positive coefficient for the Islamic bank dummy (Z_3) indicates that full-fledged Islamic banks are found to have costs that *ceteris paribus* are 15.0 percent higher than for other banks This may result from constrained opportunities in terms of investments and limited expertise in Islamic banking. Merged banks (Z_4) are found to have costs that are 10.8 percent higher, after controlling for other variables.[13] The dummy variable for the financial crisis (Z_5) is positive, indicating that costs fell by 4.8 percent in 1998 after controlling for other variables. Finally, foreign banks without IBS windows (Z_6) are found to have costs that are 21.8 percent lower than the combined group of all domestic banks, publicly owned banks, and foreign owned banks with IBS windows.

5.2 Net and Gross Efficiency Estimates

Table 5 and 6 respectively report estimated net and gross efficiency for Model B. As expected, given the theoretical discussion above, average net efficiency is higher than estimated average gross efficiency. The net efficiency of Malaysian commercial banks is on average 1.066, and ranges from 1.019 to 1.217. In contrast, the average gross efficiency measure is 1.340, thereby indicating that the costs of the average bank are 34 percent higher than if it faced the most favourable operating environment. Moreover, the gross efficiency estimates range from 1.032 to 1.688. Thus, while the net efficiency scores demonstrate that there is relatively little variation in estimate efficiency once differences in the Z variables are controlled for, the gross efficiency scores suggest that substantial difference in costs that can in fact be attributed to differences in operating environment.

(Table 5 about here)

[13] Berger and Humphrey (1997) noted that some mergers improve cost efficiency whereas others worsen their performance. Orea (2002) found that merged banks have negative efficiency change in contrast to the unmerged banks in the initial period of merger activities.

Tables 5 and 6 also indicate that the yearly average as well as the range of the efficiency scores, has increased for both net and gross efficiency. The trend in net efficiency suggests a decline in average efficiency over the sample period, but also the presence of a group of firms that were steadily slipping further away from the cost frontier. Thus, average net efficiency deteriorated from 1.064 in 1996 to 1.075 in 2002 and the maximum net efficiency score increased from 1.142 in 1996 to 1.206 in 2002. This may indicate that there are high gains achieved by best-practice banks (technical change) but declines in efficiency as other banks struggle to keep up with best practice (Wheelock and Wilson 1999).

Focusing on Table 5 also reveals that after netting out the impact of environmental factors, the efficiency estimates of different bank categories consistently cluster around the overall mean, with a minimum group average of 1.057 for full-fledged Islamic banks and a maximum group average of 1.075 for merged banks without IBS windows. Thus, once we net out the impact of operating characteristics on estimated costs, there is little further difference in estimated efficiency across the identified categories. Stated more pointedly, If we judge efficiency against an efficient frontier, which for example allows full-fledged Islamic banks to have 15 percent higher costs and requires foreign banks without IBS windows to have 21.8 percent lower costs, it is not surprising that the resulting net efficiency scores demonstrate little difference across these groups. We would also note that this criticism is relevant for studies such as (Berger and DeYoung 1997; Lozano-Vivas 1998; Kraft, et al. 2006) which have reported net efficiency scores by including exogenous variables directly into the cost function.

(Table 6 about here)

In contrast, because the gross efficiency estimates reported in Table 6 include the impact of net efficiency as well that of unfavourable operating characteristics, they yield considerable information with regard to the underlying differences in the costs of banks across the various identified categories. Moreover, these differences are broadly consistent with our above interpretation of the cost implications for the relevant dummy variables in Table 4. Thus, for example, while the average gross efficiency score is 1.34 for all banks, foreign banks without IBS have average gross efficiency of 1.173, demonstrating relatively low costs for these banks. Similarly, the higher average gross efficiency estimates for merged banks (1.432) versus unmerged banks (1.321) suggest that the process of consolidation in Malaysian banking may have contributed to increased banking costs. Moreover, we would also note that this result cannot be attributed to a misspecification that attributes the effects of economies of scale to the merger dummy,

because such effects will be directly controlled for with the output variables. Thus, rather than contributing to improved efficiency, the spate of mergers in Malaysian banking may have actually resulted in transitional problems and managerial inefficiency that reduced the cost effectiveness of the merged banks.

Focusing more specifically on Islamic banking, the pure Islamic banks have average gross efficiency equal to 1.502, thereby strongly suggesting that full-fledged Islamic banking has been associated with higher input requirements. Moreover, while the group of all conventional banks without IBS have average gross efficiency of (1.212) those with Islamic banking windows have higher input requirement as demonstrated by higher gross efficiency (1.386).[14] Thus, after the impact of operating characteristics on input requirements is allowed for, these results suggest a clear hierarchy with pure conventional banks exhibiting the best cost performance, followed by conventional banks that operate IBSs windows, and finally pure Islamic banks with the worst cost performance. These results can be compared to the previous literature: Islamic banks are found to be no difference with conventional banks in Malaysia (Abdul-Majid, et al. 2005; Mokhtar, et al. 2006), but more cost efficient in Turkey (El-Gamal and Inanoglu 2005), Arabian countries (Al-Jarrah and Molyneux 2005) and GCC countries (Alshammari 2003) when compared to conventional banks. These differences may potentially be due to the absence of environmental variables particularly the control for loan quality (Z_1) and equity-to-assets ratio (Z_2) in previous studies employing the intermediation approach, different input and output specifications, and cross-country differences in Islamic banking that may influence relative cost efficiency.[15]

We finally focus on the overall trend in gross efficiency. The average gross efficiency estimates show that average gross efficiency drops moderately form 1.308 in 1997 to 1.293 in 1998, and this decline in average estimated gross efficiency is observed in all bank categories. However, average gross efficiency increases to 1.366 in 1999 and remains near this level until 2002. Thus, our results suggest a temporary improvement in overall cost performance in 1998 followed by a sustained reduction in cost performance. We interpret these results as reflecting the dual impact of the financial crisis on cost efficiency. Thus, the sustained deterioration in gross efficiency after 1998 reflects the

[14] We would note that higher input requirements as reflected by higher average gross efficiency estimates for IBS banks are also observed within the foreign banks, merged banks, and unmerged banks categories, thereby supporting this conclusion. While this conclusion is not suggested by the domestic banks category, only 8 of 96 conventional domestic bank observations do not have IBS banking, and this result is therefore dependent on a single non IBS bank in the domestic group in each year after 1996

[15] For example, Islamic banks in other countries may employ more equity-based financing rather than debt-like financing which is more common in Malaysia.

sustained increase in non-performing loans and the resulting increase in input requirements discussed above. In contrast, the temporary improvement in gross efficiency in 1998 reflects an immediate but temporary response to the financial crisis which can be attributed to a decline in total costs as a result of elimination a large number of workers, cuts in other operating expenses, and declines in interest rate. However, in the long run, it is clear that reduced loan quality had a significant positive impact on costs in the Malaysian banking sector.

5.3 Economies of Scale

Table 4 reports that the estimated scale economies for the sample average bank are 1.033 and significantly different from one, thereby indicating the presence of moderate scale economies. Table 7 provides firm specific scale economy estimates for all banks and by bank category. The range of the estimated scale economies is between 0.911 and 1.218 and is consistent with the previous literature (e.g., Clark 1996; Orea 2002; Carvallo and Kasman 2005). On average, these estimated scale economies have declined from 1.066 in 1996 to 1.025 in 2002, and this result is consistent with the general increase in the scale of banks through mergers discussed above. Similarly, within almost all of the bank categories summarized in Table 7, very moderate economies of scale and a slight downward trend in estimated scale economies is evident. Thus, there is little evidence for a difference in scale economies across the groups identified in Table 7. Moreover, even though full-fledged Islamic banks are the only category with average economies of scale less than one in any year, this result is also consistent with the broader finding that most banks in the sample appear to operate at or near CRS.[16] In sum, the presence of moderate economies of scale in 1996, the subsequent decline in these estimates and the consolidation of banks, suggests that if total factor productivity change in Malaysian banking was affected by scale change during 1996-2002, these improvements would not only have been small, but would have also been largely dissipated by the end of the sample period. Moreover, this conclusion is appropriate for most of the bank categories summarized in Table 7.

(Table 7 about here)

5.4 Average productivity change and its decomposition

Table 8 reports average estimated productivity change across all banks and its decomposition into technical efficiency change, technical change and scale change effect.

[16] Yudistira (2004) found that small and medium-sized Islamic banks in most countries have diseconomies of scale but Alshammari (2003) found that bank type has no effect of economies of scale in GCC countries.

Over the sample period, average productivity change was 2.68 percent per year.[17] Thus, productivity change has been largely driven by technical change.[18] However, as estimated average technical change declined from 3.41 percent in 1997 to 1.65 percent in 2002, the trend decline in overall productivity change can also be attributed to declining rates of technical change.

(Table 8 about here)

The positive average scale change effect of 0.32 is consistent with the finding that banks are characterised by moderate economies of scale, but also further reinforces the finding that mergers have not contributed substantially to productivity gains. However, between 1996 and 1997 scale change contributed a 1.35 percent increase in productivity change, and it may be significant that this occurred before the financial crisis and cannot be attributed to mergers, which are concentrated later in the sample. The following year saw a negative scale change effect of 0.43 percent, which may reflect declines in output due to the financial crisis and reduced economic growth in Malaysia in 1998. Subsequent to this, the average scale effect declined from 0.48 percent in 1999 to 0.07 percent in 2002, and this result is highly consistent with the decline in estimated economies of scale documented above. Moreover, as the average returns to scale in Malaysian banking was only 1.025 in 2002, there is little reason to believe that scale change will contribute significantly to productivity change in the future.

While on average technical change and scale change have contributed positively to productivity change, cost efficiency change is on average responsible for a 0.52 percent reduction in productivity change over the sample period. However, the pattern of annual efficiency change is quite erratic and with large positive contributions to productivity change in 1997 and 2001 but substantial negative effects in other years. Thus, while technical change has determined the long term downward trend in average productivity change, efficiency change has been responsible for dramatic deviations around this trend.. Moreover, while efficiency change reduced average productivity change by 0.86 percent in 1998 during the financial crisis, the magnitude of this effect is actually less than in other years when efficiency change was negative. Thus, our results suggest that no systematic decline in productivity caused by declines in net efficiency can be attributed to the

[17] Sufian and Ibrahim (2005) reported average total productivity growth for post-merger Malaysian banks of -1.3 percent for the period 2001-2003.

[18] This result is similar to findings by Orea (2002) on Spanish banks, Isik and Hassan (2003b) for Turkish banks and Casu, Girardone, and Molyneux (2004) on Spanish and Italian banks where technical change is the main determinant of productivity change. Krishnasamy, et al. (2004) found productivity improvement in 10 Malaysian commercial banks was also primarily determined by technical change during the 2000-2001 period.

financial crisis in 1998. In contrast, as our gross efficiency estimates suggest, the financial crisis has had the impact of driving up efficient costs by triggering a sustained increase in non-performing loans.

5.5 Firm specific productivity change and its decomposition

Table 9 provides average productivity change estimates over the entire sample period for all banks and by bank category. It also decomposes these rates into efficiency change, technical change, and a scale change effect. It is clear that substantial differences exist between average productivity change for the various bank categories. Thus, the small group of full-fledged Islamic banks have the highest average productivity change at 4.23 percent,[19] while the minimum group average of 0.75 is for foreign banks with IBS windows. Merged banks also have lower average productivity change (1.48 percent) relative to unmerged banks (2.88 percent). However, this result appears to be largely attributable to the low average productivity change of merged banks with IBS windows (0.86 percent) Compared to foreign banks (2.12 percent), domestic banks have higher average productivity change (3.01 percent). Nevertheless, this result is largely attributable to the above-mentioned high productivity change of full-fledged Islamic banks, and the relatively low average productivity change of foreign banks with IBS (0.75 percent).

(Table 9 about here)

Focusing on the decomposition of productivity change reveals some important insights into these substantial differences in productivity change across bank categories. The high estimated productivity change for full-fledged Islamic banks can be primarily explained by particularly rapid technical change (3.70 percent), and moderate gains in efficiency (0.27 percent), thereby suggesting that Islamic banks have not only been adept at developing new cost reducing products and processes, but have also managed to eliminate inefficiencies in their operations.[20] Thus, despite the relatively higher costs of Islamic banking detailed in our above discussion of the gross efficiency estimates, full-fledged Islamic banks appear to be making rapid strides in improving their productivity and may be able to eliminate a substantial proportion of their cost disadvantage over time.

In contrast, the relatively low average productivity change rates of foreign banks that operate IBS windows is attributable to very low average technical change (1.13 percent), as well as substantial deterioration in efficiency (-0.61 percent). As foreign

[19] Moderate productivity growth is found in Islamic banks for most countries (Hassan 2005) but productivity loss is found for Islamic banks in Sudan, Iran and Pakistan (Hassan 2003).
[20] This is consistent with Hassan (2003; 2005) who also found that the productivity change of Islamic banks is driven by technical change.

banks without IBS windows have relatively superior technical change (2.63 percent) and efficiency change (-0.17), these results suggest that, in particular, foreign banks that have adopted IBS have not only failed to develop new cost saving technologies, but have also become less efficient over time. This may suggest that despite the fact that these banks moved into the developing market for Islamic banking services, they were laggards in developing cost efficient products and processes for this market. In contrast, foreign banks that have remained focused on conventional banking services have been able to sustain technical change and have been more able to maintain efficiency levels. Thus, our results may suggest that, for foreign conventional banks, entering the Islamic banking market has been a distraction from their core competencies.

When compared to unmerged banks, which have average productivity change of 2.88 percent, merged banks achieved a much lower average productivity change of 1.48 percent. This can be largely attributed to much higher rates of technical change for the unmerged banks (3.05 percent) relative to the merged banks (1.89 percent), and may be a symptom of the need to focus managerial effort on integrating personnel and synchronising the systems (Rhoades 1998; Sherman and Rupert 2006). [21] However, it is also evident that the scale change effect for the merged banks (0.12) is lower than for the unmerged banks (0.35 percent), once again suggesting that mergers have not contributed to productivity change through scale effects.

However, as mentioned above, much of the difference in productivity change between merged and unmerged banks can be attributed to the 0.86 average productivity change for merged banks with IBS windows, which is largely attributable to average efficiency change of -1.01 per annum and a very low scale change effect (0.06 percent). When coupled with the broad similarity in estimated productivity change, technical change, efficiency change, and scale change effect for unmerged banks with or without IBS windows, this suggests a further disruptive impact of Malaysian banking mergers during our sample period. Put simply, merged banks with IBS banking windows may have been unable to devote sufficient managerial effort to developing their IBS operations, because their managers were distracted by the these mergers.

We finally note, that no substantial difference in average productivity, technical change and efficiency change is evident between the group of all conventional banks with or without IBS windows, although the detrimental impact of efficiency change for the

[21] The result is consistent with Orea (2002) on revenue efficiency that average rate of productivity change of merging banks is lower than non-merging banks, and Berger and Mester (2003) that costs productivity deterioration is more for merging banks than non-merging banks.

later group (-0.41) is moderately lower than for the former group (-0.64). This suggests that there is little difference in productivity change that can be generally attributed to the provision of IBS Islamic banking services by conventional banks. However, we do note that our above discussion suggests that both foreign banks and merged banks that offered IBS banking services have experience lower average rates of productivity change, and that we have offered potential explanations for this above. In contrast, if we focus on the group of unmerged banks that operate IBS windows, we see that their average productivity change (2.84 percent) and the contribution of technical change (3.06 percent) are moderately higher than the overall sample average, while their efficiency and scale change effect are quite similar to the sample average. This therefore suggests that those banks that have been able to sufficiently focus on the development of IBS banking products have been able to achieve productivity change rates that are at least comparable to banks that only provide conventional banking services.

6. Conclusions

The aim of this study is to examine the efficiency, economies of scale and productivity of Islamic banks relative to conventional banks using SFA and a generalised parametric Malmquist productivity index. In achieving this objective, the study also found some important results with regard to the Malaysian banking industry. The average Malaysian bank faced 6.6 percent higher costs than a bank on the most efficient frontier, but 34.0 percent higher costs than the efficient costs defined by the bank with the most favourable operating environment, thereby suggesting that differences in bank characteristics play a significant role in determining bank costs. On average, banks become more inefficient between 1996 and 2002, causing an average 0.52 percent decline in productivity change. In contrast, most banks exhibited moderate scale economies, and as a result, scale change effect contributed a 0.32 percent increase in average productivity change. However, as it contributed 2.88 percent to average productivity change, technical change was the primary determinant of productivity change which averaged 2.68 percent per year between 1996 and 2002.

Focusing more specifically on our efficiency estimates, our estimation of gross efficiency enables better understanding of difference in costs across bank categories, because, by definition, net efficiency estimates net out the impact of operating characteristics on bank cost. Thus, regardless of whether one argues that cost differences attributable to differences in operating characteristics provide evidence of differences in efficiency (gross efficiency) or that they provide evidence of differences in the efficient

frontier (net efficiency), only gross efficiency estimates quantify the impact of these differences on costs. Moreover, as in our application, it is unclear whether characteristics such as foreign ownership or IBS banking capture legitimate differences in costs or differences in efficiency, and our results suggest little difference in net efficiency, our gross efficiency estimates suggest that it is differences in operating characteristics which explain much of the cost differences between Malaysian banks.

Thus, for example, the high gross efficiency estimates for both full-fledged Islamic banks and conventional banks with IBS windows suggest that Islamic banking requires substantially higher costs, a finding that is not reflected in the net efficiency estimates. Similarly, while our net efficiency estimates suggest little impact from the East Asian financial crisis, the gross efficiency estimates suggest that the crisis had a temporary cost reducing effect in 1998. More significantly, the gross efficiency estimates also demonstrate that the crisis triggered a sustained negative impact on the cost performance of Malaysian banks, which can be attributed to an increase in non-performing loans.

The pattern and determinants of overall productivity change also reveals some significant findings. Most interestingly, despite their relatively poor gross efficiency, full-fledged Islamic banks also exhibited very high productivity change, which is explained by high rates of technical change. This suggests that while full-fledged Islamic banks were initially costly to operate, they have been able to eliminate a significant proportion of this cost disadvantage during our sample period, and may be able to continue this in the long term. In contrast, given the inferior gross efficiency of conventional banks with IBS windows, and our finding that their productivity, efficiency, scale, and technical change are broadly similar to that of an average bank, there would appear to be less prospect for these banks to overcome the cost disadvantages associated with Islamic banking.

Given the substantial number of bank mergers in Malaysia during our sample period, it is also striking that merged banks have experienced substantially lower productivity change relative to unmerged banks. However, this difference can be largely attributed to the lower efficiency change of merged banks that operate IBS services. This suggests that the need for managers to simultaneously develop new Islamic banking products and consolidate operations after mergers, may have contributed to this poor performance. Looking forward, this result has two possible implications for the full-fledged Islamic banks that were created from the Islamic operations of IBS banks in 2005: On the positive side, the separation of Islamic from conventional banking services may allow managers to better focus on improving the cost efficiency of Islamic banking. However, on the negative side, there is also the potential that at least in the short run, the

new Islamic banks will suffer similar transitional problems. Nevertheless, once the new full-fledged Islamic banks overcome any transitional problems, the experience of existing Islamic banks suggests that there is the potential for these banks to significantly, reduce the cost disadvantage that is currently associated with Islamic banking. However, it is far from certain that this experience will be replicated as the full-fledged Islamic banking sector rapidly expands.

In sum, our results suggest that given the rapid growth of Islamic banking as well as its existing cost disadvantages, policy makers must continue to work to both make the banking environment more conducive for Islamic banking and to encourage managers to reduce these cost disadvantages. If these goals can be achieved, this majority Muslim country will not only be able to satisfy its demand for Islamic banking services: It will also be able to minimize the increase in costs associated with a move to a dual-banking system. If these goals are not achieved, Malaysia will certainly benefit from a banking system that is compliant with its majority religious faith and the resulting mobilization of untapped financial resources that this will allow: However, it will also suffer from a substantial increase in the average cost of banking services. Nevertheless, provided that Malaysia continues its policy of a dual banking system, competition between both Islamic and non-Islamic banks, and between the10 full-fledged Islamic banks that have existed since 2005, may in principle act to drive the Islamic banking cost premium down to the minimum level required for compliance with Sharia'.

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Table 1
Sample of Malaysian banking institutions by category: 1996-2002

	1996	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*All Years*
All banks	*16*	*24*	*28*	*28*	*24*	*24*	*24*	*168*
Without IBS	6	6	7	7	9	8	8	51
With IBS	9	17	20	20	13	14	14	107
Islamic	1	1	1	1	2	2	2	10
Foreign banks	***5***	***7***	***8***	***9***	***11***	***11***	***11***	***62***
Without IBS	4	5	6	6	8	7	7	43
With IBS	1	2	2	3	3	4	4	19
Domestic banks	*11*	*17*	*20*	*19*	*13*	*13*	*13*	*106*
Without IBS	2	1	1	1	1 [c]	1	1	8
With IBS	8	15	18	17	10	10	10	88
Islamic	1	1	1	1	2	2	2	10
Merged banks [a,b]	-	*1*	*1*	*3*	*4*	*10*	*10*	*29*
Without IBS	-	1	1	1	2	2	2	9
With IBS	-	-	-	2	2	8	8	20
Unmerged banks	*16*	*23*	*27*	*25*	*20*	*14*	*14*	*139*
Without IBS	7	6	7	7	9	8	8	52
With IBS	9	17	20	18	11	6	6	87

Notes;
[a] No mergers between Islamic banks have occurred during the sample period.
[b] Includes 2 foreign mergers.
[c] In 1999 (reflected in 2000 account) 2 banks that operate IBS merged and their IBS assets were transferred to form a new Islamic bank.

Table 2
Frequency distribution of banks by year, size, foreign-domestic ownership in the sample

Year	Assets range (MYR, millions)											
	531-5,137			5,138-10,638			10,639-20,207			20,208-114,756		
	Dom	*For*	*All*	*Dom*	*For*	*All*	*Dom*	*For*	*All*	*Dom*	*For*	*All*
1996	3	2	5	3	2	5	3	1	4	2	0	2
1997	2	3	5	8	1	9	3	2	5	4	1	5
1998	3	4	7	7	2	9	5	2	7	5	0	5
1999	2	4	6	8	2	10	5	2	7	5	0	5
2000	1	6	7	3	1	4	5	3	8	4	1	5
2001	0	6	6	2	0	2	5	0	5	7	4	11
2002	0	6	6	3	0	3	4	2	6	6	3	9

Notes:
Dom and For respectively refer to domestic and foreign banks.
Assets measured in 2000 Malaysian Ringgit (MYR)
Source:
Central Bank of Malaysia Annual Reports, various issues, author's calculations, and Bank Scope 2002.

Table 3:
Descriptive statistics for sample banks, 1996-2002

Symbol	*Variables*	*Mean*	*St. Dev*	*Min*	*Max*
C	Total Costs (MYR, million)	8.44	10.19	0.22	70.81
	Outputs				
Y_1	Loans (MYR, million)	103.85	130.21	1.46	767.70
Y_2	Other earning assets (MYR, million)	56.76	71.04	1.52	357.56
	Input Prices				
W_1	Price of labour (MYR, thousand)	0.59	0.34	0.18	2.30
W_2	Price of financial capital (MYR, thousand)	47.53	23.04	13.29	155.45
W_3	Price of physical capital (MYR, thousand)	1,158.77	1,522.02	179.78	9,975.00
	Control Variables				
Z_1	Loan quality	0.13	0.12	0.01	0.77
Z_2	Equity/Asset Ratio	0.10	0.05	-0.05	0.33
Z_3	Islamic bank Dummy	0.06	0.24	0	1
Z_4	Merged bank Dummy	0.17	0.38	0	1
Z_5	Financial crisis Dummy	0.17	0.37	0	1
Z_6	Dummy- Equals 1 for 1998. Foreign without IBS Dummy	0.26	0.44	0	1
Z_7	Foreign with IBS Dummy	0.11	0.32	0	1
Z_8	Domestic with IBS Dummy	0.52	0.50	0	1
Z_9	Publicly owned bank Dummy	0.16	0.37	0	1

Table 4
Maximum likelihood estimates for parameters of the costs function for Malaysian banks: 1996-2002

Coefficient	*Parameters*	*Model A*		*Model B*	
		Estimated value	Std Error	Estimated value	Std Error
φ_0	Constant	0.134**	0.058	0.088**	0.043
$\acute{\alpha}_1$	ln P_1	0.205***	0.039	0.183***	0.030
$\acute{\alpha}_2$	ln P_2	0.779***	0.028	0.796***	0.026
$\acute{\alpha}_{1,1}$	$(\ln P_1)^2$	-0.004	0.077	-0.024	0.070
$\acute{\alpha}_{2,2}$	$(\ln P_2)^2$	0.048	0.059	0.030	0.057
$\acute{\alpha}_{1,2}$	ln P_1 ln P_2	-0.011	0.054	0.001	0.051
β_1	ln Y_1	0.550***	0.030	0.533***	0.029
β_2	ln Y_2	0.425***	0.024	0.435***	0.024
$\beta_{1,1}$	$(\ln Y_1)^2$	0.144***	0.025	0.138***	0.026
$\beta_{2,2}$	$(\ln Y_2)^2$	0.251***	0.038	0.258***	0.035
$\beta_{1,2}$	ln Y_1 ln Y_2	-0.192***	0.028	-0.191***	0.027
$\theta_{1,1}$	ln P_1 ln Y_1	-0.040	0.026	-0.050**	0.023
$\theta_{1,2}$	ln P_1 ln Y_2	0.033	0.032	0.038	0.032
$\theta_{2,1}$	ln P_2 ln Y_1	0.050	0.030	0.060**	0.029
$\theta_{2,2}$	ln P_2 ln Y_2	-0.051	0.034	-0.055	0.034
λ_1	t	-0.029***	0.007	-0.026***	0.008
λ_{11}	t^2	-0.001	0.006	0.0001	0.006
δ_1	ln P_1 t	0.025	0.016	0.028*	0.016
δ_2	ln P_2 t	-0.023	0.016	-0.025	0.016
ψ_1	ln Y_1 t	0.016*	0.008	0.015*	0.009
ψ_2	ln Y_2 t	-0.015	0.009	-0.013	0.009
ζ_1	Loan quality	0.327***	0.098	0.309***	0.103
ζ_2	Equity/Asset Ratio	-0.743***	0.231	-0.736***	0.229
ζ_3	Islamic bank	0.142**	0.072	0.150***	0.041
ζ_4	Merged bank	0.089***	0.028	0.108***	0.026
ζ_5	Financial crisis	-0.044*	0.025	-0.048**	0.023
ζ_6	Foreign without IBS	-0.268***	0.053	-0.218***	0.028
ζ_7	Foreign with IBS	-0.084	0.063		
ζ_8	Domestic with IBS	-0.045	0.049		
ζ_9	Publicly owned bank	-0.030	0.033		
λ	Lambda	2.123***	0.647	1.501***	0.439
σ	Sigma	0.103***	0.013	0.096***	0.014
Log likelihood			208.158		205.751
Economies of scale for the sample average bank				1.033**	0.015

Notes;
*,**,*** Significant at 90, 95 and 99 percent confidence level.

Table 5
Average net efficiency for all banks and by category

	1996	1997	1998	1999	2000	2001	2002	All Years
Descriptive statistics: All banks								
Average	1.064	1.057	1.064	1.071	1.075	1.056	1.075	1.066
Standard Deviation	0.029	0.026	0.033	0.039	0.048	0.036	0.041	0.037
Minimum	1.033	1.022	1.025	1.026	1.02	1.019	1.024	1.019
Maximum	1.142	1.124	1.155	1.181	1.217	1.157	1.206	1.217
Average efficiency by category								
All banks	*1.064*	*1.057*	*1.064*	*1.071*	*1.075*	*1.056*	*1.075*	*1.066*
Without IBS	1.071	1.057	1.066	1.082	1.078	1.057	1.083	1.071
With IBS	1.061	1.057	1.062	1.068	1.076	1.057	1.072	1.065
Islamic	1.058	1.056	1.072	1.061	1.062	1.042	1.059	1.057
Foreign banks	*1.089*	*1.059*	*1.061*	*1.060*	*1.072*	*1.059*	*1.089*	*1.070*
Without IBS	1.075	1.057	1.069	1.066	1.081	1.056	1.086	1.071
With IBS	1.142	1.064	1.038	1.048	1.05	1.065	1.094	1.067
Domestic banks	*1.053*	*1.056*	*1.065*	*1.077*	*1.078*	*1.053*	*1.062*	*1.064*
Without IBS	1.062	1.055	1.05	1.181	1.053	1.066	1.06	1.074
With IBS	1.051	1.056	1.065	1.071	1.083	1.054	1.063	1.064
Islamic	1.058	1.056	1.072	1.061	1.062	1.042	1.059	1.057
Merged banks[a,b]	-	*1.093*	*1.082*	*1.052*	*1.059*	*1.058*	*1.067*	*1.063*
Without IBS	-	1.093	1.082	1.097	1.071	1.069	1.061	1.075
With IBS	-	-	-	1.030	1.046	1.055	1.069	1.057
Unmerged banks	*1.064*	*1.055*	*1.063*	*1.073*	*1.079*	*1.054*	*1.080*	*1.067*
Without IBS	1.069	1.051	1.065	1.077	1.076	1.050	1.083	1.068
With IBS	1.061	1.057	1.062	1.072	1.081	1.060	1.076	1.066

Notes:
[a] No mergers between Islamic banks have occurred during the sample period.
[b] Includes 2 foreign mergers.

Table 6
Average gross efficiency for all banks and by category

	1996	1997	1998	1999	2000	2001	2002	All Years
Descriptive statistics: All banks								
Average	1.309	1.308	1.293	1.366	1.361	1.351	1.385	1.340
Standard Deviation	0.109	0.109	0.099	0.112	0.155	0.173	0.164	0.136
Minimum	1.113	1.032	1.037	1.108	1.043	1.066	1.052	1.032
Maximum	1.508	1.509	1.555	1.564	1.615	1.688	1.651	1.688
Average efficiency by category								
All banks	*1.309*	*1.308*	*1.293*	*1.366*	*1.361*	*1.351*	*1.385*	*1.340*
Without IBS	1.226	1.184	1.169	1.261	1.236	1.184	1.220	1.212
With IBS	1.342	1.340	1.330	1.397	1.422	1.428	1.457	1.386
Islamic	1.508	1.509	1.422	1.480	1.527	1.480	1.544	1.502
Foreign banks	*1.222*	*1.212*	*1.179*	*1.262*	*1.250*	*1.221*	*1.266*	*1.234*
Without IBS	1.160	1.151	1.149	1.212	1.207	1.138	1.181	1.173
With IBS	1.471	1.365	1.272	1.364	1.364	1.365	1.416	1.371
Domestic banks	*1.348*	*1.347*	*1.339*	*1.415*	*1.455*	*1.461*	*1.486*	*1.402*
Without IBS	1.359	1.350	1.291	1.556	1.469	1.506	1.492	1.423
With IBS	1.325	1.336	1.337	1.403	1.439	1.453	1.473	1.389
Islamic	1.508	1.509	1.422	1.480	1.527	1.480	1.544	1.502
Merged banks [a,b]	-	*1.305*	*1.251*	*1.360*	*1.405*	*1.451*	*1.475*	*1.432*
Without IBS	-	1.305	1.251	1.304	1.387	1.388	1.387	1.354
With IBS	-	-	-	1.388	1.423	1.467	1.497	1.467
Unmerged banks	*1.309*	*1.308*	*1.295*	*1.367*	*1.352*	*1.280*	*1.321*	*1.321*
Without IBS	1.267	1.218	1.193	1.286	1.267	1.207	1.259	1.243
With IBS	1.342	1.340	1.330	1.398	1.421	1.377	1.403	1.367

Notes:
[a] No mergers between Islamic banks have occurred during the sample period.
[b] Includes 2 foreign mergers.

Table 7
Economies of scale for all banks and by category

	1996	1997	1998	1999	2000	2001	2002	All Years
Descriptive statistics: All banks								
Average	1.066	1.061	1.059	1.042	1.026	1.026	1.025	1.043
Standard Deviation	0.036	0.042	0.041	0.040	0.053	0.039	0.049	0.048
Minimum	0.990	0.973	0.965	0.944	0.925	0.936	0.911	0.911
Maximum	1.115	1.140	1.150	1.166	1.218	1.084	1.104	1.218
Average economies of scale by category								
All banks	*1.066*	*1.061*	*1.059*	*1.042*	*1.026*	*1.026*	*1.025*	*1.043*
Without IBS	1.070	1.080	1.073	1.054	1.032	1.013	1.015	1.045
With IBS	1.064	1.056	1.054	1.038	1.027	1.038	1.038	1.045
Islamic	1.051	1.045	1.056	1.023	0.992	0.992	0.980	1.010
Foreign banks	*1.060*	*1.065*	*1.062*	*1.045*	*1.033*	*1.021*	*1.028*	*1.041*
Without IBS	1.052	1.068	1.065	1.049	1.035	1.010	1.016	1.039
With IBS	1.091	1.058	1.053	1.037	1.026	1.039	1.049	1.045
Domestic banks	*1.068*	*1.060*	*1.058*	*1.040*	*1.021*	*1.030*	*1.023*	*1.044*
Without IBS	1.105	1.140	1.121	1.079	1.008	1.032	1.012	1.075
With IBS	1.061	1.055	1.054	1.038	1.028	1.038	1.033	1.045
Islamic	1.051	1.045	1.056	1.023	0.992	0.992	0.980	1.010
Merged banks[a,b]	-	*1.063*	*1.053*	*1.026*	*1.032*	*1.036*	*1.027*	*1.033*
Without IBS	-	1.063	1.053	1.064	1.023	1.032	1.033	1.040
With IBS	-	-	-	1.007	1.041	1.037	1.025	1.030
Unmerged banks	*1.066*	*1.061*	*1.059*	*1.043*	*1.025*	*1.018*	*1.024*	*1.045*
Without IBS	1.067	1.077	1.074	1.048	1.025	1.003	1.002	1.039
With IBS	1.064	1.056	1.054	1.042	1.025	1.040	1.054	1.048

Notes:
[a] No mergers between Islamic banks have occurred during the sample period
[b] Includes 2 foreign mergers.

Table 8
Productivity change in Malaysian banking

Period	*Mean Cost Efficiency Change*	*Mean Technical Change*	*Mean Scale change Effect*	*Mean Productivity Change*
1996/97	0.75	3.41	1.35	5.51
1997/98	-0.86	3.72	-0.43	2.43
1998/99	-1.04	3.71	0.48	3.15
1999/2000	-1.18	2.72	0.49	2.03
2000/01	1.58	2.09	0.26	3.93
2001/02	-1.74	1.65	0.07	-0.02
1996/2002	-0.52	2.88	0.32	2 .68

Table 9
Productivity change for all banks and by category 1996-2002

	Mean Efficiency Change	*Mean Technical Change*	*Mean Scale change effect*	*Mean Productivity Change*
Descriptive statistics: All banks				
Average	-0.52	2.88	0.32	2.68
Standard Deviation	3.41	1.41	1.07	3.66
Minimum	-11.69	-0.76	-2.64	-7.93
Maximum	9.38	6	5.58	12.67
Average productivity change by category				
All banks	*-0.52*	*2.88*	*0.32*	*2.68*
Without IBS	-0.41	2.72	0.33	2.64
With IBS	-0.64	2.88	0.32	2.56
Islamic	0.27	3.7	0.26	4.23
Foreign banks	*-0.3*	*2.18*	*0.24*	*2.12*
Without IBS	-0.17	2.63	0.24	2.71
With IBS	-0.61	1.13	0.24	0.75
Domestic banks	*-0.64*	*3.3*	*0.36*	*3.01*
Without IBS	-1.83	3.21	0.85	2.23
With IBS	-0.65	3.26	0.33	2.94
Islamic	0.27	3.7	0.26	4.23
Merged banks [a,b]	*-0.53*	*1.89*	*0.12*	*1.48*
Without IBS	0.31	2.01	0.22	2.54
With IBS	-1.01	1.82	0.06	0.86
Unmerged banks	*-0.52*	*3.05*	*0.35*	*2.88*
Without IBS	-0.4	3.02	0.34	2.96
With IBS	-0.58	3.06	0.36	2.84

Notes:
[a] No mergers between Islamic banks have occurred during the sample period.
[b] Includes 2 foreign mergers.