JKAU: Islamic Econ., Vol. **24** No. 2, pp: 147-174 (2011 A.D./1432 A.H.)
DOI: 10.4197 / Islec. 24-2.5

The Impact of Foreign-Owned Islamic Banks and Islamic Bank Subsidiaries on the Efficiency and Productivity Change of Malaysian Banks

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Abstract. The paper examines the efficiency of a sample of Islamic and conventional banks in Malaysia for the period 2000 to 2008, using a stochastic frontier approach, and mainly focuses on determining the impact of foreign-owned Islamic bank and Islamic banking subsidiaries on performance. We model the impact of bank characteristics such as Islamic banking and foreign ownership, after taking into account the distinction between full-fledged Islamic banks as opposed to Islamic banking windows operating within conventional banks as well as Islamic banks operating as subsidiaries of conventional banks. We also test the impact of economic crisis, public ownership and mergers on bank efficiency. In contrast to domestic conventional banks with Islamic window, our results show that full-fledged Islamic banks have higher input requirements. In addition, using a generalised Malmquist productivity index, we decompose productivity change into efficiency, technical, and scale change. Unlike foreign full-fledged Islamic banks, conventional banks with Islamic bank subsidiary have relatively higher efficiency. However, both foreign full-fledged Islamic banks and conventional banks with Islamic bank subsidiary exhibited negative productivity change, attributed to negative rate of technical change and scale change effects. Despite the flexibility in operation, the newly converted bank subsidiary may need sometimes to develop technology, while foreign Islamic banks may need more time to overcome their output disadvantages.

Keywords: stochastic frontier analysis; Islamic banking; efficiency; productivity.

1. Introduction

Over the past 20 years, many countries liberalized bank activities that traditionally had been operating conventional banking and was heavily regulated as well as protected from competition. Consequently, Islamic banks and foreign banks which had previously played a marginal role as a division, branch banking or representative office, established a significant presence in several countries. These raise new questions about its effectiveness in increasing competition hence improving the efficiency and productivity of a banking system.

In contrast to the growing literature on the mode of foreign bank entrance into local market (branch, subsidiary, representative office) which can affect efficiency, little attention has been given to the mode of local bank entrance into the market. In addition, numerous studies are available related to the association between foreign banks and efficiency but are lacking on foreign Islamic banks. The current study contributes to the literature in exploring the impact of converting a branch or division into a bank subsidiary in local banks on the efficiency and productivity of banks in the country. Furthermore, it adds Islamic banking perspective into the long-standing debate on the association between foreign banks and efficiency. In particular, this paper tries to reduce the above gaps by examining the efficiency of a sample of Islamic and conventional banks in Malaysia for the period 2000 to 2008, using a stochastic frontier approach, and particularly focuses on determining the impact of foreign-owned Islamic bank and Islamic banking subsidiaries on performance.

There is at least one reason why bank customers, bankers and policy makers should care about the effect of converting a branch or division of a bank into a subsidiary. Subsidiaries typically involve different legal entity, hence are responsible for the assets or liabilities as they have different set of statutory accounts. In addition, a subsidiary can be registered under different act, hence could have different nature of operation. Furthermore, subsidiaries could have extensive networks as they are in direct competition with other banks for clients. These can have implications not only for the banks but local supervisory body who concerns about the competitive structure of the banking system, hence efficiency and productivity level of banks of a country. There is also at least one reason why they should be concerned about the consequence of foreign banks operating in host markets. The organizational structure of foreign bank operations may change the competitive form of the local banking system, pressurise the profits and market segment of domestic banks and have an effect on the price and quality (Cerutti, Dell'Ariccia, & Martinez Peria, 2007) hence efficiency of banking services in the host country.

We build an empirical model following Fare and Primont (1995) and Cuesta and Orea (2002), but also allowing for exogenous factors (such as foreign banks and banks with an Islamic bank subsidiary) in a stochastic output distance function hence, the estimated efficiency is net of the exogenous factors. Two main approaches that have been employed in estimating efficiency are Data Envelopment Analysis (DEA) and Stochastic Frontier Approach (SFA). As compared to former, SFA has the advantage of decomposing the deviations from the efficient levels into noise and pure efficiency. In addition, the latter has the ability to statistically test the validity of the model specification. An output-oriented efficiency measure compares the observed level of output with the maximum output that could be produced with given inputs. This approach allow us to use identifiable output and input quantities such as deposits and capital, hence avoid the possible problem of input price endogeneity (Orea, 2002). Given differences in Islamic and conventional banking assets, we believe that, the common approach of using accounting data to define input and/ or output prices may lead to distorted and inaccurate price estimates, and hence distorted profit or cost efficiency estimates. The authors have also employed the output distance function approach because it does not require strong behavioural assumptions such as those required with a profit maximization or cost minimization approach. Given managerial objectives of Islamic banks that differ from those of conventional banks, the fewer behavioral assumptions in the output distance function approach should allow a more accurate comparison of the productive efficiency of Islamic and conventional banks. By employing Orea's (2002) parametric generalised Malmquist Productivity Index, the estimated function and inefficiency estimates can be directly employed to calculate the index. It can further be decomposed into technical efficiency change (TEC) and technical change (TC) and scale change effects (SCE). As compared to the frequently employed econometric estimation (Allen. N. Berger & Mester, 1999; Allen N. Berger & Mester, 2003; Stiroh, 2000) the currently employed parametric Malmquist Productivity Index has the advantages of requiring neither price information nor restrictive behavioural assumptions such as cost minimization or profit maximization. The efficiency estimates and the productivity change are then analysed focusing on foreign Islamic banks and banks with an Islamic bank subsidiary.

The findings of this paper can be summarized as follows. There would appear to be little prospect for foreign full-fledged Islamic banks to improve their lower output given they require higher factor inputs and their slow growth in efficiency. In contrast, domestic full-fledged Islamic banks have potential to improve their lower output as they have both considerable rate of technical change and efficiency growth despite requiring higher factor inputs. Furthermore, conventional banks with Islamic bank subsidiaries have been able

to improve efficiency levels but fail to improve current technology. However, Islamic banking window in conventional banks has been efficient and able to improve efficiencies in their operation as well as successful in developing new output enhancing products and technologies particularly in domestic banks.

The remainder of the paper is organized as follows. Section 2 reviews the related literature followed by section 3 which gives a background of the Malaysian banking. Section 4 presents the methodology including dataset collected. Section 5 discusses the empirical results before conclusion is offered in the final section.

2. Literature Review

This paper builds on the existing literature of associating bank efficiency with foreign-owned banks in Malaysia (*e.g.*, Abdul-Majid, Saal, & Battisti, 2009; Mokhtar, Abdullah, & Alhabshi, 2008; Sufian, 2009) as well as in other countries (*e.g.*, Kraft, Hofler, & Payne, 2006; Lin & Zhang, 2009), while another strand of studies suggests that foreign bank entry could reduce efficiency (*e.g.*, Chang, Hasan, & Hunter, 1998; Rao, 2005). Although mixed results are found on their relative efficiencies, foreign banks are found to be more efficient than domestic banks in the majority of studies. Even if they have high price of physical capital due to high rent of office spaces in expensive buildings or areas, which is suitable with their target customers, foreign banks still perform better than domestic banks (Isik and Hassan 2003). The superiority of foreign-owned banks could be due to several reasons. For example, in India, their efficiency has increased after allowing them to extend their services from small branch networks into metropolitan areas. Moreover, they managed to borrow with lower interest rates from abroad and are very efficient in labour hiring practice (El-Gamal and Inanoglu 2005). Despite numerous studies on foreign banks efficiency, the efficiency of foreign Islamic banks is yet to be discovered.

Focussing on the study of bank subsidiary efficiency, as far as the authors are aware of, none have been focussed on this. The closest study is on whether operating abroad through branches or subsidiaries improve efficiency (*e.g.*, Pasiouras, 2008).

While the paper's analysis of the impact of foreign ownership on Islamic and conventional banking efficiency contributes to the policy debate in relation to foreign bank entry, the study on the effect of local Islamic bank subsidiary on efficiency innovates.

3. Malaysian Banking Sector

Traditionally, Malaysian banking system is comprised of the Central Bank of Malaysia (BNM), commercial banks, Islamic banks, finance companies, and merchant banks. It includes the representative offices of foreign banks and offshore banks in Labuan. BNM is responsible for the supervision of the banking system except for the offshore banks as they are regulated by the Labuan Offshore Financial Services Authority (Central Bank of Malaysia, 1999).

Commercial banks are the main component of the Malaysian banking system. Traditionally, foreign banks played a significant role in the Malaysian banking system as domestic banks were not well developed. Therefore, domestic banks accounted for less than 10 percent of all commercial bank deposits and loans in 1957. However, foreign banks were restricted from opening new branches in Malaysia starting 1966 and only forty years later they were allowed to open additional branches (Central Bank of Malaysia, 2005).

Consolidation of Malaysian commercial banks has started in early 1990s. The East Asian financial crisis further pushed the industry to consolidate which was completed in 2002. In an effort to increase the capacity and capability of domestic financial institutions, commercial banks started to merge with finance companies in the following year (Central Bank of Malaysia, 2004). As a result, the number of domestic banks declined substantially since 1996. Nonetheless, the number of foreign banks has remained almost the same until early 2000s before increases in the succeeding years. Malaysian banking system is now comprised of the BNM, commercial banks, Islamic banks and investment (merchant) banks.

Malaysian banking experiences further significant growth with the implementation of a dual system where the Islamic banking system operates side by side but separately from the conventional banking system. The most important features of Islamic banking are the prohibition of interest payment in transactions, and the prohibition of financing unethical behaviour such as gambling. The 1983 Islamic Banking Act (IBA) governs Islamic banking, and the first Islamic bank was set up in 1983.

Further important development in Islamic banking was triggered a decade later, when BNM allowed three conventional banks to offer Islamic banking products through the Islamic Banking Scheme (IBS). In operating an IBS Islamic window, commercial banks must have a separate Islamic Banking Division and a dedicated Islamic Banking Fund, although personnel and physical capital may be shared with conventional banking (Rosly & Bakar,

2003). BNM requires banks operating IBS to submit separate Islamic and conventional statistical reports. In facilitating the parallel operation of the Islamic and conventional banking systems, BNM has further set up 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. The importance of IBS in Malaysian banking can be seen through the establishment of the second full-fledged Islamic bank in 1999 where it is the separation of IBS assets from a conventional bank's assets. In 2004, 90 percent of domestic commercial banks provided Islamic banking products through IBS and Islamic banking assets were 8 percent of the total Malaysian banking system assets (Central Bank of Malaysia, 2004).

Malaysian Islamic banking came into a more advanced stage in its development in 2005, when BNM approved a further ten full-fledged Islamic banks. Of these, six were established as full-fledged Islamic bank subsidiaries by separating existing IBS assets from conventional assets. Its establishment is to encourage more flexible operations, which will enable the new Islamic banks to engage in an array of activities similar to those of commercial and investment banks. The additional two new Islamic banks resulted from the entry of foreign full-fledged Islamic banks. BNM attracts full-fledged foreign Islamic banks in order to enhance the competitiveness of domestic Islamic banking industry and to further expand global linkages (Central Bank of Malaysia, 2005).

This rapid growth of Islamic bank subsidiaries caused the number to reach 12 in 2008 and of these, only three are subsidiaries of foreign-owned banks. On the contrary, there are five full-fledged Islamic banks and three of them are foreign-owned banks. Thus, while full-fledged Islamic banking has grown from (0.7) to (12 percent) of all banking assets between 1988 and 2007 (Aziz, 2007; Bank Islam Malaysia Berhad, 1989; Central Bank of Malaysia, 1999), this share nearly reaches (20 percent) in 2010. In terms of the overall growth of Islamic banking, while the total deposits has increased by more than 50 percent from RM47billion in 2001 to RM73 billion in 2004, the total financing were doubled from RM28billion to RM57billion during the period. The total deposits and total financing have increased rapidly that the amount were almost doubled in 2008 to RM155billion and RM108billion respectively (Central Bank of Malaysia, 2005, 2011).

4. Methodology

4.1 Output-oriented distance functions

Distance functions are useful in describing multi-input, multi-output production processes without having to specify strong behavioural objectives such as cost minimization or profit maximization. With given inputs, an output-

oriented efficiency measure compares the observed level of output with the maximum output that could be produced. The production technology can be represented by a technology set, which is the technically a feasible combination of inputs and outputs (Fare & Primont, 1995). If the vector of K inputs, indexed by *k* is denoted by $X=(X_1,X_2,\ldots,X_K)$ and the vector of M outputs, indexed by *m*, is denoted by $Y=(Y_1,Y_2,\ldots,Y_M)$, the technology set can be defined as:

$$T=\left\{X,Y\right):X\in R_{+}^{K},Y\in R_{+}^{M},X\ can\ \ produce\ Y\right\} \quad (1)$$

Where R_{+}^{K} and R_{+}^{M} are the sets of non-negative, real K and M-tuples respectively. For each input vector, X**,** let P(X) be the set of producible output vectors, Y, that are obtainable from the input vector X:

$$P(X)=\left\{Y:\left(X,Y\right)\in T\right)\}. \quad (2)$$

The output distance function can be described in terms of the output set, P(X) as:

$$D_o\left(X,Y\right)=\min.\left\{\varpi>0:\left(\frac{Y}{\varpi}\right)\in P(X)\right\} \quad (3)$$

The output distance function is non-decreasing, positively linearly homogeneous and increasing in Y, and decreasing in X. It is defined as the maximum feasible expansion of the output vector given input vector and the efficiency lies between zero (inefficiency) and one (efficiency).

4.2 The econometric specification

Following Fare and Primont (1995) and Cuesta and Orea (2002), and allowing for exogenous factors, the general form of a stochastic output distance function is shown as follows:

$$1=D_o\left(Y_{n,t},X_{n,t},Z_{n,t},\beta\right)\ h\left(\varepsilon_{n,t}\right) \quad (4)$$

where $h\left(\varepsilon_{n,t}\right)=\exp\ \left(u_{n,t}+v_{n,t}\right)$, $Y_{n,t}$ is a vector of outputs, $X_{n,t}$ is an input vector, $Z_{n,t}$ is an exogenous factor vector and β is a vector of parameters. Inefficiency is accommodated in the specification of $h(.)$ because $\varepsilon_{n,t}$ is a composed error term comprised of $u_{n,t}$, which is assumed to be attributable to technical inefficiency and $v_{n,t}$ which represents random uncontrollable error that affects the n-th firm at time t.

Following from Equation (4) and Appendix A, an estimate of output distance can be derived as $D_o\left(Y_{n,t}, X_{n,t}, Z_{n,t}, \beta\right) = \exp(-\mu)$. However, as it relies on the unobservable inefficiency, $u_{n,t,}$ the authors follow the approach of Jondrow, *et al*. (1982) who employ the conditional expectation of $u_{n,t}$ given the observed value of overall composed error term, $\varepsilon_{n,t}$.

As firms are assumed to operate with the same production technology in SFA, it is necessary to control for differences in characteristics and the operating environment that may influence the efficient level of output. If we do not control for differences between bank groups, it may lead to inappropriate conclusions about a bank's performance (Bos, Koetter, Kolari, & Kool, 2009; Bos & Kool, 2006). Therefore, environmental variables are often included directly in the estimated distance function to control for these differences. Nevertheless, the resulting efficiency scores must be cautiously interpreted as estimates of net efficiency after accounting for the impact of environmental influences on potential output (Coelli, Perelman, & Romano, 1999).

Estimated scale elasticity can therefore, be calculated as the negative of the sum of the input elasticities (Cuesta & Orea, 2002):

$$SCALE_{n,t} = -\sum_{k=1}^{K} \frac{\partial \ln D_o\left(Y_{m,n,t}, X_{k,n,t}\right)}{\partial \ln X_{k,n,t}} \tag{5}$$

If $SCALE_{n,t} > 1$, a bank is operating with increasing returns to scale (IRS). If $SCALE_{n,t} < 1$, there is decreasing returns to scale (DRS) and constant returns to scale (CRS) are present if $SCALE_{n,t} = 1$.

Malmquist productivity indices are commonly used in the literature because they require neither price information nor restrictive behavioural assumptions such as cost minimization or profit maximization. Following Orea (2002)'s approach of generalized Malmquist Productivity Index, the authors therefore employ previously estimated output distance function and inefficiency estimates to calculate Total Factor Productivity Change (TFPC) and decompose it in Appendix B such that, $TFPC = TEC + TC + SCE$.

4.3 The data and empirical specifications

Data on 30 banks was drawn from banks' annual reports as well as Bureau van Dijk's (BvD's) BankScope database for the period 2000-2008. Table 1 shows the sample of Malaysian banking institutions by type of bank for each of the years under study. Due to incomplete information in some banks, it has

resulted in an unbalanced panel of 218 observations. The sample is representative and covers 80 percent of all Malaysian banks. The table illustrates the trends in the number of banks in several alternative categories and shows the increasing preponderance of foreign banks over time. It further reveals a significantly greater preponderance of conventional banks with Islamic bank subsidiary in domestic banks rather than in foreign-owned banks, and, particularly at the end of the sample period, a considerably greater preponderance of Islamic banks attributed to foreign-owned group.

Table 1. Sample of banks and by category.

	00	01	02	03	04	05	06	07	08	All Years
Panel I: All Banks	24	24	23	24	25	23	23	26	26	218
Without IBS	10	9	9	9	10	10	13	13	18	101
With IBS [b]	12	13	12	13	13	11	9	8	3	94
Islamic	2	2	2	2	2	2	1	5	5	23
Panel II: Foreign	12	12	12	12	13	13	13	15	15	117
Without IBS	9	8	8	8	9	9	9	8	11	79
With IBS [b]	3	4	4	4	4	4	4	4	1	32
Islamic [a]	-	-	-	-	-	-	-	3	3	3
Panel III: Domestic	12	12	11	12	12	10	10	11	11	101
Without IBS	1	1	1	1	1	1	4	5	7	22
With IBS [b]	9	9	8	9	9	7	5	4	2	62
Islamic	2	2	2	2	2	2	1	2	2	17
Panel IV: All Banks	24	24	23	24	25	23	23	26	26	218
Without Islamic Subsidiary	22	22	21	22	23	19	16	14	11	170
With Islamic Subsidiary [b]	-	-	-	-	-	2	6	7	10	25
Islamic	2	2	2	2	2	2	1	5	5	23
Panel V: Foreign	12	12	12	12	13	13	13	15	15	117
Without Islamic Subsidiary	12	12	12	12	13	13	13	12	11	110
With Islamic Subsidiary [b]	-	-	-	-	-	-	-	-	1	1
Islamic [a]	-	-	-	-	-	-	-	3	3	6
Panel VI: Domestic	12	12	11	12	12	10	10	11	11	101
Without Islamic Subsidiary	10	10	9	10	10	6	3	2	-	60
With Islamic Subsidiary [b]	-	-	-	-	-	2	6	7	9	24
Islamic	2	2	2	2	2	2	1	2	2	17

Notes: [a] Started operation in 2007. [b] Converting IBS into Islamic subsidiary in stages starting 2005 hence, some banks still have both accounts in their financial statements after 2005.

Similar to Abdul-Majid *et al*., (2009), and Isik and Hassan (2003), Hassan (2006) the intermediation approach is employed to define bank output,, as it is the most suitable with the concept of Islamic banking. The selection of the input and output variables follows the existing literature (*e.g*., Sturm & Williams, 2008). The outputs are loans (Y_1) and total other earning assets (Y_2), and the inputs are labour (X_1), capital (fixed assets) (X_2), and deposit (X_3). X_1 is the expenses on labour, X_2 is value of fixed assets, and X_3 is the interest expense or profit distributed to depositors in Islamic banking. It is noted that linear homogeneity in outputs is imposed using Y_2 as a numeraire and these variables have been mean-corrected prior to estimation.

Table 2 provides a summary of descriptive statistics of these variables and the explanatory variables for all banks in the sample. All monetary variables are expressed in MYR and in real 2000 terms by deflating with the Malaysian GDP deflator index. The ownership information is taken from individual bank annual reports and *Association of Banks in Malaysia* (Various Years).

Table 2. Descriptive statistics for sample banks, 2000-2008.

Symbol	Variables	Mean	Std. Dev	Minimum	Maximum
	Outputs				
Y_1	Loans (MYR, million)	158.090	198.481	0.317	1059.312
Y_2	Other Earning Assets (MYR, million)	99.579	116.913	2.023	637.742
	Inputs				
X_1	Labour Cost (MYR, million)	1.919	2.308	0.040	11.771
X_2	Capital (MYR, million)	1.705	2.116	0.006	10.249
X_3	Deposits (MYR, million)	6.342	7.625	0.043	42.978
	Control Variables				
Z_1	Loan Quality	0.103	0.105	0.001	0.666
Z_2	Risk	0.113	0.073	0.013	0.372
Z_3	Foreign Islamic Bank	0.028	0.164	0	1
Z_4	Domestic Islamic Bank	0.078	0.269	0	1
Z_5	Domestic bank with IBS	0.284	0.452	0	1
Z_6	Domestic bank with Islamic subsidiary	0.110	0.314	0	1
Z_7	Foreign bank with Islamic subsidiary	0.005	0.068	0	1
Z_8	Year 2008 dummy	0.119	0.325	0	1
Z_9	Public-owned Bank	0.183	0.388	0	1
Z_{10}	Merged Bank	0.362	0.482	0	1

The first operating environment variable is loan quality (Z_1), represented by the ratio of the NPLs-to-total loans (*e.g*., Williams & Nguyen, 2005). Unmeasured differences in loan quality that are not captured by banking data may be mistakenly measured as inefficiency if output quality is not controlled for (Allen N. Berger & Mester, 1997). This is due to the reason that banks with better loan quality may appear inefficient as they use more capital and labour to monitor loans (Mester, 1996). A positive coefficient is therefore expected for this quality variable, implying that banks with higher NPL-to-loans (lower loan quality) generate lower output.

The second operating environment variable is risk (Z_2), measured by the equity-to-total assets ratio (*e.g.*, Allen N. Berger & Mester, 1997; Williams & 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. Therefore in the absence of this control variable, risk adverse banks that prefer equity financing and produce less output would appear inefficient. On the contrary, unlike income paid to depositors, dividends paid on equity is not considered as a cost, hence banks with more equity financing will appear more efficient (Allen N. Berger & Mester, 1997) and produce higher output if equity-to-total assets ratio is not controlled for. Therefore, no *a priori* assumption is made on the sign of Z_2.

The environmental variables of (Z_3): (Z_{10}) are dummy variables that are meant to capture potential differences in bank characteristics and operating environment that may affect bank output. Thus, while (Z_3) indicating foreign full-fledged Islamic banks is to control for the potential impact of foreign full-fledged Islamic banking, (Z_4) is to control for the impact of domestic full-fledged Islamic banking on bank output, respectively. No *a priori* assumption is made due to mixed results in the literature on the direction of foreign bank effects (*e.g.*, Allen N. Berger, Hasan, & Zhou, 2008; Rao, 2005) as well as Islamic banking effects (*e.g.*, Abdul-Majid *et al*., 2009; Al-Jarrah & Molyneux, 2005; El-Gamal & Inanoglu, 2005).

The dummy variable indicating domestic banks with IBS (Z_5), is to control for the potential impact of domestic conventional banks offering Islamic banking products through a separate Islamic banking window on bank output. Higher input requirements or combination of factor inputs may be associated with Islamic financing and/or the need to maintain strict financial separation between Islamic and non-Islamic operations (Abdul-Majid *et al*., 2009; Abdul-Majid, Saal, & Battisti, 2010). Therefore, a positive coefficient is expected for this Z_5 variable.

In order to test the effect of conventional banks with subsidiary on bank's output, dummy variables for domestic conventional banks with subsidiary (Z_6) and foreign conventional banks with subsidiary (Z_7) are included. While no previous literature have been found, the ambiguity with regard to the likely impact of bank subsidiary in foreign countries on efficiency (*e.g.*, Pasiouras, 2008) implies that the signs of the coefficients for the Z_6 and Z_7 variables cannot be *a priori predicted*.

A dummy for observations in 2008 is included to control for the global economic crisis (Z_8) and it is expected that the coefficient of the 2008 economic

crisis dummy to be positive[2]. Public ownership (Z_9) dummy variable is expected to have a positive sign indicating lower output[3]. As state-owned banks are usually associated with directed lending or with specific objectives (Allen N. Berger, Clarke, Cull, Klapper, & Udell, 2005), they generally perform poorly relative to private-owned banks in developing nations *(e.g., Allen N. Berger et al*., 2005; Isik & Hassan, 2003).

Finally, as some banks have gone through mergers, a merger dummy variable (Z_{10}) is designed to control for the effect these mergers[4]. Z_{10} is expected to have a positive coefficient implying lower output because merged banks need some time for personnel integration and system integration (Peristani, 1997; Rhoades, 1998; Sherman & Rupert, 2006).

5. Results

5.1 The output distance function estimates

Table 3 reports the estimated output distance function parameters. Model A and B have the same inputs and outputs, but different environmental variables. While Model A includes all previously explained environmental variables *(Z_1-Z_{10})*, Model B excludes the domestic banks with Islamic bank subsidiaries *(Z_6)*, foreign banks with Islamic bank subsidiaries *(Z_7)*, 2008 dummy variable *(Z_8)*, public-owned banks *(Z_9)* and merged banks *(Z_{10})* which are insignificant in Model A. As the log likelihood ratio test of the joint significance of these parameters is 1.09, the null hypothesis that these parameters are jointly insignificant cannot be rejected. Thus, Model B is preferred and the following discussion will be restricted to this model. This result implies that *ceteris paribus* no statistically significant difference in efficient outputs can be identified for the group made up of conventional domestic banks without IBS windows, conventional foreign banks with IBS windows, all conventional banks with Islamic subsidiary, public-owned banks and merged banks. The significant estimate of $\lambda = 7.27$ indicates that estimated deviation from the frontier is due mainly to inefficiency rather than statistical noise. The estimated coefficients of all variables have the expected signs except for domestic banks with IBS (ζ_5). Loan quality (ζ_1) is positive as predicted, and indicates that lower output quality (higher NPL-to-loan ratio) reduces output, thereby reflecting more factor inputs is needed to monitor default loans. The positive relationship of (Z_2) with outputs, implies that as the equity-to-asset ratio increases, outputs are lower compared to those banks that rely more on deposits.

Table 3. Maximum likelihood estimates for parameters of the output distance function for Malaysian banks: 2000-2008.

Parameters	Coefficient	Model A		Model B	
		Estimated Value	SE	Estimated Value	SE
φ_0	Constant	-0.466***	0.062	-0.465***	0.051
α_1	ln X_1	-0.350***	0.083	-0.371***	0.068
α_2	ln X_2	-0.054	0.053	-0.065*	0.033
α_3	ln X3	-0.508***	0.085	-0.468***	0.074
$\alpha_{1,1}$	$(\ln X_1)^2$	0.027	0.271	0.030	0.251
$\alpha_{2,2}$	$(\ln X_2)^2$	0.178**	0.075	0.162**	0.074
$\alpha_{3,3}$	$(\ln X_3)^2$	-0.174	0.112	-0.150	0.113
$\alpha_{1,2}$	ln X_1 ln X_2	-0.134	0.094	-0.126	0.090
$\alpha_{1,3}$	ln X_1 ln X_3	0.201	0.179	0.185	0.173
$\alpha_{2,3}$	ln X_2 ln X_3	-0.115	0.075	-0.107	0.074
β_1	ln Y_1	0.677***	0.031	0.683***	0.669***
$\beta_{1,1}$	$(\ln Y_1)^2$	0.164***	0.022	0.163***	0.161***
$\theta_{1,1}$	ln X_1 ln Y_1	-0.053	0.052	-0.047	-0.049
$\theta_{2,1}$	ln X_2 ln Y_1	0.075**	0.031	0.079**	0.072**
$\theta_{3,1}$	ln X_3 ln Y_1	$-3.36X10^{5}$	0.034	-0.011	0.035
λ_1	t	-0.003	0.016	-0.005	0.001
λ_{11}	t^2	0.031***	0.008	0.029***	0.030***
δ_1	ln X_1 t	-0.043*	0.024	-0.044*	-0.047**
δ_2	ln X_2 t	0.033***	0.012	0.032***	0.036***
δ_3	ln X_3 t	-0.005	0.020	-0.002	-0.002
ψ_1	ln Y_1 t	0.023***	0.008	0.023***	0.022***
ζ_1	Loan Quality	0.875***	0.178	0.895***	0.179
ζ_2	Risk	1.710***	0.493	1.672***	0.482
ζ_3	Foreign Islamic Bank	0.301***	0.101	0.312***	0.092
ζ_4	Domestic Islamic Bank	0.089	0.095	0.107*	0.058
ζ_5	Domestic bank with IBS	-0.089*	0.049	-0.094**	0.045
ζ_6	Domestic bank with Islamic subsidiary	0.056	0.083		
ζ_7	Foreign bank with Islamic subsidiary	0.094	$3.9X10^{6}$		
ζ_8	Year 2008 dummy	-0.031	0.076		
ζ_9	Public-owned Bank	0.010	0.064		
ζ_{10}	Merged Bank	-0.016	0.059		
Λ	Lambda	7.332**	3.205	7.267**	3.141
Σ	Sigma	0.282***	0.016	0.283***	0.015
Log Likelihood			97.52		96.43

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

The positive estimate for ζ_3 implies that full-fledged foreign Islamic banks are found to have outputs that *ceteris paribus* are (31.2 percent) lower than other banks and this may be due to the need of extra resources to set-up new banks as well as constrained opportunities in terms of investments and limited expertise in Islamic banking. The coefficient for full-fledged domestic Islamic banks (Z_4) is positive, indicating that output decreases by (10.7 percent) relative to other banks and this may be due to constrained opportunities as mentioned above. However, domestic banks with IBS (Z_5) are found to have potential output that *ceteris paribus* is (9.4 percent) higher than other banks.

5.2 Efficiency estimates

Table 4 provides estimated efficiency for Model B. Efficiency of Malaysian commercial banks is on average 0.82 and ranges from (0.23) to (0.99), hence on average banks only produce (82 percent) of the output they could produce if they operated on the efficient frontier.

The efficiency scores demonstrate that there is little variation in estimated efficiency once differences in the environmental variables such as full-fledged foreign Islamic banks, full-fledged domestic Islamic banks and domestic banks with IBS are controlled for. In addition, Table 4 demonstrates that the yearly average has slightly declined and the range of the efficiency scores has risen. Besides a slight decrease in average efficiency over the sample period, the trends in efficiency show the existence of a group of banks that were steadily deviating from the output frontier. Therefore, the minimum efficiency score fall from (0.57) in 2000 to 0.23 in 2008 and average efficiency worsened from (0.85) in 2000 to (0.82) in 2008.

Furthermore, that after netting out the impact of environmental factors, Table 4 indicates that the efficiency estimates of different bank groups consistently cluster around the overall mean. Therefore, there is little further difference in estimated efficiency across the groups once the impact of operating characteristics on estimated outputs is netted out. Concentrating on Islamic banking, full-fledged Islamic banks have average efficiency equal to 0.82, similar to the average of all banks. Furthermore, the group of all conventional banks with Islamic banking windows has average efficiency of 0.84, while those without IBS have lower efficiency (0.81). The results imply that after netting out the differences in operating characteristics, conventional banks with Islamic banking windows show the best output performance, followed by full-fledged Islamic banks, and finally conventional banks without Islamic banking windows. For the high average efficiency of conventional banks with Islamic banking windows, the slightly higher contribution is from the group of foreign banks with IBS (0.85) relative to domestic banks with IBS (0.83). In contrast, the average efficiency of full-fledged Islamic banks can be attributed to group of domestic-owned (0.83) rather than the foreign-owned of 0.78.

Table 4. Efficiency estimates for all banks and by category.

	00	01	02	03	04	05	06	07	08	All Years
	Descriptive Statistics: All Banks									
Average	0.85	0.80	0.79	0.82	0.83	0.81	0.84	0.81	0.83	0.82
Standard Deviation	0.12	0.12	0.13	0.12	0.11	0.11	0.11	0.13	0.17	0.12
Minimum	0.57	0.45	0.39	0.61	0.60	0.58	0.56	0.44	0.23	0.23
Maximum	0.97	0.98	0.95	0.97	0.99	0.97	0.97	0.98	0.97	0.99
	Average Efficiency by Category									
Panel I: All Banks	0.85	0.80	0.79	0.82	0.83	0.81	0.84	0.81	0.83	0.82
Without IBS	0.78	0.74	0.76	0.83	0.84	0.80	0.86	0.81	0.81	0.81
With IBS [b]	0.90	0.84	0.82	0.81	0.84	0.83	0.82	0.80	0.93	0.84
Islamic	0.92	0.80	0.78	0.79	0.79	0.82	0.84	0.80	0.84	0.82
Panel II: Foreign	0.92	0.80	0.78	0.79	0.79	0.82	0.84	0.80	0.84	0.82
Without IBS	0.78	0.73	0.74	0.82	0.83	0.79	0.84	0.79	0.79	0.79
With IBS [b]	0.93	0.81	0.79	0.83	0.86	0.85	0.83	0.86	0.97	0.85
Islamic [a]	-	-	-	-	-	-	-	0.77	0.80	0.78
Panel III: Domestic	0.85	0.80	0.79	0.82	0.84	0.81	0.84	0.81	0.83	0.82
Without IBS	0.83	0.79	0.92	0.93	0.93	0.83	0.89	0.85	0.85	0.86
With IBS [b]	0.89	0.85	0.83	0.80	0.83	0.82	0.80	0.75	0.90	0.83
Islamic	0.92	0.80	0.78	0.79	0.79	0.82	0.84	0.84	0.90	0.83
Panel IV: All Banks	0.85	0.80	0.79	0.82	0.83	0.81	0.84	0.81	0.83	0.82
Without Islamic Subsidiary	0.85	0.80	0.79	0.82	0.84	0.82	0.83	0.80	0.80	0.82
With Islamic Subsidiary [b]	-	-	-	-	-	0.73	0.85	0.82	0.86	0.84
Islamic	0.92	0.80	0.78	0.79	0.79	0.82	0.84	0.80	0.84	0.82
Panel V: Foreign	0.92	0.80	0.78	0.79	0.79	0.82	0.84	0.80	0.84	0.82
Without Islamic Subsidiary	0.81	0.76	0.76	0.82	0.84	0.81	0.84	0.81	0.80	0.81
With Islamic Subsidiary	-	-	-	-	-	-	-	-	0.84	0.84
Islamic [a]	-	-	-	-	-	-	-	0.77	0.80	0.78
Panel VI: Domestic	0.85	0.80	0.79	0.82	0.84	0.81	0.84	0.81	0.83	0.82
Without Islamic Subsidiary	0.88	0.85	0.84	0.81	0.84	0.85	0.81	0.76	-	0.84
With Islamic Subsidiary	-	-	-	-	-	0.73	0.85	0.82	0.86	0.84
Islamic	0.92	0.80	0.78	0.79	0.79	0.82	0.84	0.84	0.90	0.83

Notes: [a] Started operation in 2007.
[b] Converting IBS into Islamic subsidiary in stages starting 2005 hence, some banks still have both accounts in their financial statements after 2005.

Turning to the next category, conventional banks with Islamic bank subsidiary has relatively higher average efficiency (0.84) compared to conventional banks without Islamic bank subsidiary (0.82). The higher average efficiency of the former has been contributed equally by both foreign- and domestic-owned conventional banks. However, it is important to note that in the sample, foreign conventional banks have their Islamic subsidiaries only in 2008(5).

5.3 Returns to scale

Table 5 shows firm specific return to scale estimates for all banks and by bank category. The average estimated return to scale is (0.84), thereby indicating the presence of decreasing return to scale. The range of estimated returns to scale is between (0.56) and (1.04). On average, this estimated scale elasticity has increased from (0.81) in 2000 to (0.89) in 2008.

Table 5. Return to scale for all banks and by category

	00	01	02	03	04	05	06	07	08	All Years
	Descriptive Statistics: All Banks									
Average	0.81	0.82	0.82	0.84	0.83	0.84	0.87	0.88	0.89	0.84
Standard Deviation	0.09	0.09	0.10	0.11	0.12	0.11	0.12	0.10	0.09	0.11
Minimum	0.65	0.69	0.61	0.56	0.58	0.59	0.61	0.65	0.66	0.56
Maximum	0.96	0.96	0.97	0.98	0.97	0.99	1.01	1.04	1.04	1.04
	Average Return to Scale by Category									
Panel I: All Banks	0.81	0.82	0.82	0.84	0.83	0.84	0.87	0.88	0.89	0.84
Without IBS	0.74	0.75	0.73	0.75	0.72	0.76	0.82	0.88	0.89	0.80
With IBS [b]	0.86	0.87	0.88	0.90	0.91	0.92	0.92	0.93	0.93	0.90
Islamic	0.83	0.81	0.84	0.84	0.84	0.82	0.87	0.79	0.83	0.82
Panel II: Foreign	0.76	0.78	0.75	0.77	0.75	0.79	0.80	0.82	0.84	0.79
Without IBS	0.73	0.73	0.70	0.72	0.70	0.75	0.76	0.82	0.84	0.75
With IBS [b]	0.85	0.86	0.86	0.86	0.87	0.89	0.89	0.90	0.85	0.87
Islamic [a]	-	-	-	-	-	-	-	0.74	0.80	0.77
Panel III: Domestic	0.86	0.87	0.89	0.90	0.91	0.92	0.95	0.95	0.95	0.91
Without IBS	0.90	0.90	0.92	0.92	0.93	0.92	0.98	0.98	0.97	0.96
With IBS[b]	0.87	0.88	0.90	0.91	0.92	0.94	0.95	0.95	0.96	0.91
Islamic	0.83	0.81	0.84	0.84	0.84	0.82	0.87	0.87	0.88	0.84
Panel IV: All Banks	0.81	0.82	0.82	0.84	0.83	0.84	0.87	0.88	0.89	0.84
Without Islamic Subsidiary	0.81	0.82	0.82	0.84	0.83	0.84	0.83	0.86	0.84	0.83

With Islamic Subsidiary [b]	-	-	-	-	-	0.95	0.97	0.97	0.96	0.97
Islamic	0.83	0.81	0.84	0.84	0.84	0.82	0.87	0.79	0.83	0.82
Panel V: Foreign	0.76	0.78	0.75	0.77	0.75	0.79	0.80	0.82	0.84	0.79
Without Islamic Subsidiary	0.76	0.78	0.75	0.77	0.75	0.79	0.80	0.85	0.84	0.79
With Islamic Subsidiary	-	-	-	-	-	-	-	-	0.92	0.92
Islamic [a]	-	-	-	-	-	-	-	0.74	0.80	0.77
Panel VI: Domestic	0.86	0.87	0.89	0.90	0.91	0.92	0.95	0.95	0.95	0.91
Without Islamic Subsidiary	0.87	0.88	0.90	0.92	0.92	0.94	0.95	0.94		0.91
With Islamic Subsidiary	-	-	-	-	-	0.95	0.97	0.97	0.97	0.97
Islamic	0.83	0.81	0.84	0.84	0.84	0.82	0.87	0.87	0.88	0.84

Notes: [a] Started operation in 2007.
[b] Converting IBS into Islamic subsidiary in stages starting 2005 hence, some banks still have both accounts in their financial statements after 2005.

5.4 Productivity change and its decomposition

Table 6 gives average estimated productivity change across all banks. It also decomposes the productivity change into efficiency change, technical change and scale change. Average productivity change was 0.84 percent per year over the sample period. As technical change increased (1.46 percent), productivity change is largely driven by technical change. However, as estimated average technical change declined from (10.19 percent) in 2001 to (-7.24 percent) in 2008, the trend decrease in overall productivity change can also be attributed to decreasing rates of technical change.

Table 6. Mean Productivity change in Malaysian banking.

Period	Mean Changes in Efficiency	Mean Technical Change	Mean Scale Effect	Mean Productivity Growth
2000/01	-7.14	10.19	-2.92	0.13
2001/02	-0.66	7.51	2.91	9.75
2002/03	4.14	5.03	0.90	10.08
2003/04	3.65	2.54	0.98	7.16
2004/05	-1.83	0.31	-1.15	-2.66
2005/06	2.71	-1.53	-0.90	0.27
2006/07	-3.60	-3.86	-2.99	-10.44
2007/08	1.14	-7.24	-1.09	-7.19
Average	-0.11	1.46	-0.51	0.84

The negative average scale change effect of (0.51) is consistent with the result of average decreasing returns to scale. Between 2001 and 2004, scale change contributed (0.9-2.91 percent) increase in productivity change, and this may be attributed to mergers between banks which were completed in 2002. The succeeding years saw negative scale change effects of (0.90-2.99 percent), which possibly signals that the mergers between commercial banks and finance companies have not contributed to productivity increase during the sample period.

Average productivity change which is influenced by the technical change illustrates a descending trend with efficiency change varies around this trend. The pattern of annual efficiency is quite unpredictable. Its contributions to productivity change is positively large in 2003 and 2004, but big negative effects in 2001 and 2007. While, efficiency change contributed (4.14) and (3.65 percent) in 2003 and 2004 respectively to the average productivity change, efficiency change reduced the average productivity change by (1.83) percent in 2005 before increased by (2.71 percent) in the following year and reduced again by (3.6 percent) in 2007. Overall, the decline in productivity was caused by a decline in technical change and scale effect as well as efficiency change towards the end of the sample period.

5.5 Firm specific productivity change and its decomposition

Table 7 shows productivity change estimates over the sample period and decomposes these rates into efficiency change, technical change, and the scale change effect for all banks and by bank category. Considerable differences exist between average productivity change for various bank categories. Thus, the small group of foreign conventional banks without IBS has the highest average productivity change at (2.36) percent, while the minimum group average of (-19.03) is for foreign full-fledged Islamic banks.

Table 7. Summary of Firm Specific productivity growth for all banks and by category.

	Mean Efficiency Change	Mean Technical Change	Mean Scale Change Effect	Mean productivity change
Descriptive Statistics: All Banks				
Average	-0.11	1.46	-0.51	0.84
Standard Deviation	14.99	6.51	4.93	18.30
Minimum	-62.34	-14.68	-24.68	-65.76
Maximum	65.56	17.98	22.71	68.76
Average Productivity Change by Category				
Panel I: All Banks	-0.11	1.46	-0.51	0.84

Without IBS	-1.03	1.56	0.33	0.85
With IBS [b]	0.69	1.67	-0.72	1.64
Islamic	0.04	-0.06	-3.18	-3.21
Panel II: Foreign Banks	-0.27	1.78	-0.17	1.33
Without IBS	-0.53	2.48	0.40	2.36
With IBS [b]	0.09	1.37	-0.30	1.16
Islamic [a]	1.46	-9.28	-11.22	-19.03
Panel III: Domestic	0.07	1.10	-0.90	0.28
Without IBS	-3.24	-2.43	-0.01	-5.68
With IBS [b]	1.01	1.84	-0.95	1.90
Islamic	-0.25	1.78	-1.58	-0.04
Panel IV: All Banks	-0.11	1.46	-0.51	0.84
Without Islamic Subsidiary	-0.53	2.32	-0.23	1.57
With Islamic Subsidiary [b]	3.97	-5.57	-0.22	-1.82
Islamic	0.04	-0.06	-3.18	-3.21
Panel V: Foreign	-0.27	1.78	-0.17	1.33
Without Islamic Subsidiary	-0.33	2.12	0.18	1.97
With Islamic Subsidiary	-	-	-	-
Islamic [a]	1.46	-9.28	-11.22	-19.03
Panel VI: Domestic	0.07	1.10	-0.90	0.28
Without Islamic Subsidiary	-0.85	2.65	-0.90	0.90
With Islamic Subsidiary	3.97	-5.57	-0.22	-1.82
Islamic	1.46	1.78	-1.58	-0.04

Notes;

[a] Started operation in 2007.

[b] Converting IBS into Islamic subsidiary in stages starting 2005 hence, some banks still have both accounts in their financial statements after 2005.

The comparatively higher average productivity change (1.33 percent) of foreign banks relative to all domestic banks (0.28 percent) can be primarily attributed to the foreign banks without IBS group.[6] In contrast, the much lower average productivity change of the domestic banks is attributable to domestic banks without IBS group (-5.68 percent) and domestic banks with Islamic bank subsidiary (-1.82 percent). Domestic banks with IBS have contributed to

productivity increase (1.90 percent) primarily through considerable technical change (1.84 percent) and improved efficiency (1.01 percent). The much lower average productivity change for foreign banks with IBS (1.16 percent) relative to foreign banks without IBS (2.36 percent) can be mainly explained by relatively low technical change (1.37 percent), as well as negative scale change effects (-0.30 percent). Coupled with lower input requirement of domestic conventional banks with IBS, these results suggest that while Islamic banking in conventional banks have been efficient and able to improve efficiencies in their operation, they were moderately successful in developing new output enhancing products and technologies particularly in domestic banks. In addition, these results imply that IBS operations in foreign banks have been slow to develop new technologies although they have become more efficient over time.

Turning to conventional banks with Islamic bank subsidiary, the negative productivity growth (-1.82 percent) can be mainly explained by negative rate of technical change (-5.57 percent) as well as scale change effects (-0.22 percent). Coupled with sizable efficiency change (3.97 percent), these results indicate that while conventional banks with Islamic bank subsidiary have been able to improve efficiency levels, they fail to develop product innovation and improve current technology.

In contrast to considerable technical change (1.78 percent) in domestic banks, the negative average productivity change of foreign full-fledged Islamic banks is attributable to negative scale change effects (-11.22 percent), as well as negative technical change (-9.28 percent) and slow growth in efficiency (1.46 percent). Hence, given poor technical change of foreign full-fledged Islamic banks and slow efficiency change, coupled with its higher input requirement, there is less potential to see these banks to overcome their inefficiencies.

The foregoing discussion proposes that both foreign full-fledged Islamic banks and conventional banks with Islamic bank subsidiary may have been unable to allocate adequate managerial effect to developing their operations because their managers were distracted by their newly established bank.

6. Conclusions

The study investigates the efficiency of a sample of Islamic and conventional banks in Malaysia for the period 2000 to 2008, using a stochastic frontier approach, and particularly focuses on determining the impact of foreign-owned Islamic bank and Islamic banking subsidiaries on performance. In achieving this goal, some significant results with regard to the Malaysian banking sector are found. The average Malaysian bank is estimated to produce only 82 percent of the output that could be produced if it operated on the

frontier defined by actual operating characteristics. In addition, on average, banks became less efficient between 2000 and 2008, causing an average 0.11 percent decline in productivity change. The finding that banks operate at decreasing return to scale is also consistent with the finding that scale change contributed a 0.51 percent decrease in average productivity change. As technical change contributed 1.46 percent to average productivity change, it was the main determinant of productivity change which averaged 0.84 percent per year between 2000 and 2008.

Focusing on the output distance function estimates and efficiency scores, the significant positive estimates for both foreign and domestic full-fledged Islamic banks suggest that full-fledged Islamic banks require higher factor inputs. In contrast, domestic conventional banks with Islamic banking windows have higher potential outputs than other banks. Even after the influence of operating characteristics on input requirements is allowed, conventional banks with Islamic windows still demonstrate a high performance in term of the efficiency estimates. Conventional banks with Islamic subsidiary have higher than average efficiency estimates.

The pattern and determinants of overall productivity change also reveals some significant findings. Despite relatively higher efficiency, conventional banks with Islamic bank subsidiary exhibited negative productivity change, which is explained by negative rate of technical change and negative scale change effects. This indicates that while conventional banks with Islamic bank subsidiary have been able to improve efficiency levels, they fail to develop product innovation and improve current technology.

Given significantly higher combination of factor inputs, foreign full-fledged Islamic banks shows negative productivity change, which are primarily determined by negative scale change effects and negative technical change. Based on these findings coupled with slow growth in efficiency, there would appear to be little prospect, at least in the short run, for foreign full-fledged Islamic banks to improve their outputs. In contrast, domestic full-fledged Islamic banks have potential to overcome their output disadvantages as they have both considerable rate of technical change and efficiency growth despite higher input requirements.

The relatively efficient foreign banks with IBS windows (as compared to foreign banks without IBS windows) have exhibited lower productivity change which is explained by relatively low technical change and negative scale change effects. The foregoing discussion implies that despite becoming more efficient over time, IBS operation in foreign banks have been developing new technologies very slowly.

This finding has several potential implications for the Islamic bank subsidiary that were created from the Islamic operations of IBS. The establishment of Islamic subsidiary from IBS may allow the bank to have more flexibility in offering Islamic banking products. Nevertheless, there is the possibility that the new subsidiaries take sometimes to develop technology and innovation. As for the full-fledged Islamic banking, while there is potential for domestic-owned bank to improve their output, little prospect is expected from foreign banks.

A study focusing on the factors leading to higher input requirements of full-fledged Islamic banks can be a valuable extension of this paper. A qualitative investigation of the reasons as to why Islamic banking has higher input requirement would also be a worthwhile addition to banking literature.

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Appendix A

The authors follow the common practice of imposing homogeneity of degree one in outputs on the distance function, which implies that $D_o(Z,X,\pi Y)=\pi D_o(Z,X,Y),\pi>0$. By arbitrarily choosing the M-th output, the authors can then define $\pi=\frac{1}{Y_M}$ and write:

$$D_o\left(Z,X,\frac{Y}{Y_M}\right)=\frac{D_o(Z,X,Y)}{Y_M} \quad \text{(A1)}$$

From Equation 4 and after assuming $Y^*_{n,t}=\left(Y_{1,n,t}/Y_{M,n,t},Y_{2,n,t}/Y_{M,n,t},.....,Y_{M-1,n,t}/Y_{M,n,t}\right).$ and rearranging terms yields the general form:

$$\frac{1}{y_{M,n,t}}=D_o\left(Y^*_{n,t},X_{n,t},Z_{n,t},\beta\right).\ h\left(\varepsilon_{n,t}\right) \quad \text{(A2)}$$

Finally after assuming the standard translog functional form[7] to represent the technology, the output distance can be represented as:

$$-\ln Y_{M,n,t}=\varphi_o+\sum_{k=1}^{K}\alpha_k\ln X_{k,n,t}+\sum_{m=1}^{M-1}\beta_m\ln Y^*_{m,n,t}+0.5\sum_{k=1}^{K}\sum_{s=1}^{K}\alpha_{k,s}\ln X_{k,n,t}\ln X_{s,n,t}$$

$$+0.5\sum_{m=1}^{M-1}\sum_{j=1}^{M-1}\beta_{m,j}\ln Y^*_{m,n,t}\ln Y^*_{j,n,t}+\sum_{k=1}^{K}\sum_{m=1}^{M-1}\theta_{k,m}\ln X_{k,n,t}\ln Y^*_{m,n,t}$$

$$+\sum_{k=1}^{K}\delta_{k,t}\ln X_{k,n,t}t+\sum_{m=1}^{M-1}\psi_{m,t}\ln Y^*_{m,n,t}t+\lambda_1 t+0.5\lambda_2 t^2+\sum_{h=1}^{H}\xi_h Z_{h,n,t}+v_{n,t}+u_{n,t} \quad \text{(A3)}$$

where, $Y^*_{m,n,t}=Y_{m,n,t}/Y_{M,n,t}$, k=1,2,..K and s=1,2,..K are indices for inputs; m=1,2,…M and j=1,2,..M are indices for output; h=1,2,…H is an index for environmental variables, and the Greek letters (except *v* and *u*) denote unknown parameters to be estimated. Standard symmetry is imposed to the second order parameters: $\alpha_{k,s}=\alpha_{s,k}$ and $\beta_{m,j}=\beta_{j,m}$ in (A3). $v_{n,t}$ 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 and is assumed to follow a normal distribution with zero mean and variance, σ_u^2 (*e.g.* Allen N. Berger & Mester, 1997; Kasman, 2005; Mertens &

Urga, 2001). Hence, the approach of Jondrow, Lovell, Materov, and Schmidt (1982) is followed to obtain the log likelihood for inefficiency 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 $\lambda = \sigma_u / \sigma_v$, which is a measure of the amount of variation originating from inefficiency relative to statistical noise. The parameters in the translog function as defined in Equation A3 as well as σ^2 and λ are estimated using maximum likelihood estimation (MLE) techniques.

Appendix B

For any given periods t and t+1, a generalised output-oriented Malmquist Productivity Index can be expressed as:

$$
\begin{aligned}
&TFPC = \ln\left(TFP_{n,t+1} / TFP_{n,t}\right) \\
&= \ln\left(D_{0,n,t+1} / D_{0,n,t}\right) - 0.5\left[\left(\partial \ln D_{0,n,t+1} / \partial t\right) + \left(\partial \ln D_{0,n,t} / \partial t\right)\right] \\
&+ 0.5 \sum_{k=1}^{K}\left[\left(SCALE_{OM,n,t+1} - 1\right)\Omega_{n,t+1} + \left(SCALE_{OM,n,t} - 1\right)\Omega_{n,t}\right] \ln\left(\frac{X_{k,n,t+1}}{X_{k,n,t}}\right) \qquad \text{(B1)}
\end{aligned}
$$

where; $\Omega_{n,t} = \dfrac{-\partial \ln D_{0.n,t} / \partial X_k}{SCALE_{OM,n,t}}$

The first term on the right hand side of (B1) is TEC, which measures the contribution of efficiency change to productivity. The second term is TC, which measure the contribution of technical change. The final term is SCE, which measures the contribution of changes in scale to productivity change. With IRS (DRS), increases in scale result in increased (decreased) productivity, while under CRS, this final term, SCE vanishes and TFPC is equivalent to a standard Malmquist Productivity Index.

Notes

1. The translog function allows the imposition of homogeneity and is easy to calculate, hence is preferred in estimating a parametric distance function.
2. A dummy variable for each year is not significant in this model. Crisis-associated bad loans are controlled for with the Z_1 variable.
3. Public-owned banks refer to banks with more than 50 percent government ownership through its agencies.
4. The potential effect of all individual mergers are statistically insignificant.
5. The earliest available data is 2008.
6. As we have available data starting from 2008, the effect of Islamic subsidiary cannot be determined.

تأثير البنوك الإسلامية المملوكة لأجانب والبنوك الإسلامية الفرعية على الفعالية وتغير الإنتاجية للبنوك الماليزية

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المستخلص. الورقة تبحث فعالية عيّنة من بنوك إسلامية وتقليدية في ماليزيا، للفترة من ٢٠٠٠ إلى ٢٠٠٨م بطريقة ستوكاستيكية رائدة، وتركز أساساً على تحديد تأثير البنوك الإسلامية المملوكة للأجانب والشركات التابعة لها على الأداء. نحن نمثل تأثير خصائص البنك مثل المصرفية الإسلامية والملكية الأجنبية، بعد الأخذ بعين الاعتبار الاختلاف بين البنوك الإسلامية كاملة النضوج وشبابيك المصرفية الإسلامية التي تعمل تحت البنوك التقليدية بالإضافة إلى البنوك الإسلامية التي تكون تابعةً لبنوك تقليدية. نحن كذلك نختبر تأثير الأزمات الاقتصادية، الملكية الحكومية والاندماج على فعالية البنك. على النقيض من البنوك التقليدية المحلية ذات شبابيك المصرفية الإسلامية، نتائجنا تبين أن البنوك الإسلامية كاملة النمو لديها متطلبات إدخال أعلى. بالإضافة، باستخدام مؤشر الإنتاجية مالمكويست معمم، نقسّم تغير الإنتاجية إلى فعالية، وتغير (تكنيكال) (technical) و(سكيل) (scale). على عكس البنوك الإسلامية الأجنبية كاملة النمو، البنوك التقليدية التي تملك بنوك إسلامية فرعية لديها فعالية أعلى نسبيًا. ولكن، كلا البنوك الإسلامية الأجنبية كاملة النمو والبنوك التقليدية التي تملك بنوك إسلامية فرعية تُظهران تغير إنتاجية سلبي، تُنسب إلى تأثيرات المعدل السلبي للتغير التقني والتغير الحجمي. برغم المرونة في العمليات، فرع البنك المحول حديثا قد يحتاج بعض الوقت لتطوير التقنية، بينما البنوك السلامية الأجنبية قد تحتاج لوقت أطول لتتغلب على عوائق الإخراج.

الكلمات المفتاحية: تحليل ستوكاستيكي رائد؛ المصرفية الإسلامية؛ الفعالية؛ الإنتاج.