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BANK-SPECIFIC CHARACTERISTICS AND TECHNICAL EFFICIENCY OF FULL-FLEDGED ISLAMIC BANKS AND ISLAMIC SUBSIDIARIES OF CONVENTIONAL BANKS IN MALAYSIA

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Abstract: *This study respected the performance of full-fledged Islamic banks and Islamic subsidiaries of conventional banks in term of efficiency. The Malaysian Islamic banking industry has grown very fast in term of assets, deposits and financing base. This study analyses the technical efficiency growth of these banks using the Stochastic Production Frontier (SFA) model. The findings of this study reveal that the Islamic subsidiaries of conventional banks are more efficient than full-fledged Islamic bank, while domestic Islamic banks tends to be more efficient than foreign owned banks. The estimation using the technical inefficiency effects model and a system Generalized Method of Moments (GMM) estimator further reveals that bank specific characteristics, namely the types, ownership, dividend policy and size are crucial determinants of these Islamic banks' efficiency.*

Keywords: *Bank-specific characteristics; Stochastic frontier analysis; Islamic Banks; Technical efficiency; Dynamic panel analysis.*

1. INTRODUCTION

Malaysia has emerged as one of the most developed Islamic banking markets in the world. Islamic banking in Malaysia has been in existence since the 1970s, and it has present remarkable growth over the last 30 years. As of 2016, the Islamic banking sector sustained a resilient asset growth of 30% to RM537.1 billion from merely RM17.8 billion in year 1997. While deposits and financing rose to RM400 billion and RM398 billion, respectively as compared to RM9.8 billion and RM10.7 billion, respectively in year 1997. The delivery channels have also enhanced substantially with over 2,200 branches of Islamic banks and Islamic Banking Scheme (IBS) banks offering Islamic banking products and services. Islamic banking has embarked on efforts by other non-bank financial intermediaries. Among others, the development financial institutions, savings institutions and housing credit institutions to establish Islamic instruments and schemes to fulfill their consumer needs. Moreover,

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the capital market has seen the fast development of Islamic debt securities and equity markets. To make up for these growths, the Labuan International Offshore Financial Centre (IOFC) has also embarked on a significant attempt to launch an International Islamic Financial Market to enhance the creation of liquidity and financial instruments as well as improve investment opportunities aimed at enhance mobilization of Islamic funds.

The studies of efficiency on banking have become popular since early 1990s for two reasons. The first reason is that efficiency can be employed as an indicator to measure a bank's performance. Particularly, employing the efficiency approach, the success of a bank in addition to the industry can be determined. The second reason is that the efficiency can be employed to examine the possible impact of government policies on a bank's efficiency. In fact, it is of regulators interest to identify the impact of their policy decisions on the success and efficiency of the banks as it will significantly affect the economy growth. Furqani and Mulyany (2009) concluded in their study that Islamic financial development is positively and significantly correlated with Malaysian economic growth in the long-run.

Not surprisingly, there has been extensive literature investigative the efficiency of the United States (US) and European conventional banking industries over recent years (Berger and Humphrey, 1997; Goddard et. al., 2001; Bolt and Humphrey, 2015; Huang, et. al., 2015; Tsionas, et. al., 2015; Antara, Musa, & Hassan, 2016). However, the empirical work on Islamic Banking efficiency, particularly in Malaysia, is still in its infancy and there has been considerable debate as whether full-fledged Islamic banks or the Islamic windows of the conventional banks are more efficient (Kamaruddin, et. al., (2008)). Since year 2010, the comparison with the Islamic windows of the conventional banks is beside the point as both local and foreign conventional banks' Islamic windows were replaced by full-blown Islamic subsidiaries in year 2010. In view of this, this study evaluates the performance of Islamic banking operations on the operations efficiency aspect; particularly, both the profit efficiencies of the Islamic banks and subsidiaries of commercial banks over 2008-2014 period. A comparison has also been made to examine the efficiency of the Islamic domestic banks and locally incorporated Islamic foreign banks over the same period.

Islamic banking in Malaysia has experienced four development stages. The first stage is started off with the establishment of the first full-pledged Islamic bank in 1983, under Islamic Banking Act 1983 and the formation of the first full-pledged Islamic insurance company (takaful) in 1984. This instituting foundations stage allows a single full-pledged Islamic bank benefit from a desirable domination. The second stage is the institutional building, activity generation and market vibrancy stage with legislative amendments to allow window-concepts in many conventional banks in 1993. The commercial bank can benefit from its existing branch network

to open so-called Islamic windows, through which to reach the potential new customers. However, opening an Islamic window raised the issue of Islamic and conventional funds might be commingled. The third stage is the strategic positioning and international integration stage over the period 2001 to 2010 which witness the establishment of Malaysia International Financial Centre. In addition, Financial Sector Master Plan was launch with Malaysia as Islamic financial hub and liberalise domestic Islamic finance sector. Thus, more domestic as well as foreign wholesome Islamic banks appeared on the scene. Finally, in the fourth stage, both local and foreign conventional banks' Islamic windows were replaced by full-blown Islamic subsidiaries. The advantages of replacement are considered to be twofold. First, a full replacement signals the bank's full commitment to operate under Shariah principles, thus enhancing its credibility. Second, it can deal with the issue of commingling of Islamic and conventional funds.

Conventional banks continue dominating the banking industries in Malaysia with Islamic banks consist of around one-fifth. Islamic banks established as subsidiaries of conventional banks exceeded full-pledged Islamic banks. Obviously, full-pledged Islamic banks cannot do what conventional banks can (through their Islamic subsidiaries). It is unlikely for a full-pledged Islamic bank to own conventional subsidiaries or windows. Apparently, the full-pledged Islamic banks fair in comparison (Ariff, 2014). The root of the dilemma is that the existing Islamic bank products are differentiated products of conventional bank products with shariah compliance instead of shariah-based products. If the Islamic subsidiaries of conventional banks continue having a great monopoly as chief stakeholders in the Islamic banking industry, the likelihood are that Islamic banks may stay focused on producing shariah-compliant products rather than shariah-based products. It is a controversial question who would take the lead in propelling the Islamic banking industry to the next levels: the Islamic subsidiaries of conventional banks or full-fledged Islamic banks? This stakeholder interest in the question of the efficiency of Islamic banks and especially how the bank-specific characteristics impacts Islamic banks efficiency. Surprisingly, rare empirical research has investigated the factors contributing efficiency of the Islamic banks. This study also identifies the factors contributing efficiency of the Islamic banks besides examines the efficiency of the Islamic banking industry in Malaysia from 2008 to 2014. The findings would give indications whether the decision to let Islamic subsidiaries to operate alongside with full-fledged Islamic banks commensurate with the essential aim of creating a conducive environment for them to compete in an efficient manner.

Subsequent to this introduction, the earlier studies on bank efficiency and its definition are reviewed briefly in related literature. Then, the dynamic panel generalized method of moments (GMM) techniques, stochastic frontier analysis (SFA) methodology and input and output employed to perform the efficiency analysis as well as factors contributing to efficiency level and hypothesis are detailed

in methodology. Interpretation of results is shown in the empirical findings. The final section concludes the paper.

2. LITERATURE REVIEW

Definition of Efficiency

According to Kumbhakar and Lovell (2003), a firm is considered technically efficient if it is able to acquire maximum outputs from given inputs or minimise inputs employed in producing given outputs. Efficiency measurement is one way of examining a firm's performance and it can be measured in three aspects: maximisation of output, maximisation of profits and minimisation of cost. While Koopmans (1951) stated that a firm is regarded as technically efficient if, and only if, it is not possible to produce more of any output without producing less of some other output or using more of some inputs. Thus, it is to achieve objective of firm to avoid waste. In contrast, allocative efficiency associates with the optimal combination of inputs and outputs at a given price. The aim of firms is to produce given outputs at minimum costs; to use given inputs so as to maximise revenue; and to allocate inputs and outputs so as to maximize profit. In other words, it is to achieve objective of firm to attain a high degree of economic efficiency (cost, revenue or profit efficiency).

Bank Competition and Efficiency Studies

One way to ensure the costs of production are minimised and concurrently it promotes efficiency is through competition (Nickell, 1996). With highly competitive market, banks force to operate more efficiently in order to survive, thus, provide services and products demanded efficiently with the least cost and make optimal profits. There are mixed results concerning impact of bank deregulation on competition, efficiency and performance. Among others, Elyasiani and Mehdian (1995) found deregulation in the US banking industry did not change efficiency. While, Bauer et. al., (1993) found deregulation and increases in competition lead to modest change in mean efficiency and deterioration of productivity over the period. Studied by Grifell-Tatje and Lovell (1996, 1997) found the efficiency and productivity of Spanish banks have not improved during the deregulated phase. Following the deregulation stage, the studies demonstrated a deterioration of efficiency among Spanish savings banks (Khumbakar et. al., 2001). The findings tend to advocate that because of the deregulation, the banks found it challenging to improve themselves and hence they performed inefficiently. Ahmad and Burki (2015) in their study show that deregulation triggered over-utilization of labour and deposits vis-à-vis operating cost thus reducing efficiency of the Pakistan banks.

Nevertheless, the studies on Norwegian banks (Berg et. al., 1992), Taiwanese banks (Shyu, 1998) and Turkish banks (Zaim, 1995; Isik and Hassan, 2003) had

demonstrated a good impact of deregulation on efficiency and productivity. The findings tend to suggest that the banks performed better in terms of efficiency because of the banks improved resources management practices and support of small and medium industry as a result of the deregulation. While, the impact of deregulation on banking efficiency and productivity in developing countries are mixed when consider the types of ownership (Bhattacharya et. al., 1997; Burki and Niazi, 2003; Das and Ghosh, 2006; Fujii, et. al., 2014; Gulati, 2015). Bhattacharya et. al., (1997) and Gulati (2015) found that Indian public-owned banks were the most efficient, followed by foreign banks and the privately owned banks were the least efficient banks and the pattern did not significantly vary over the 1986-1991 period. Burki and Niazi (2003) showed that Pakistan state-owned bank was the most inefficient followed by private banks. Foreign banks were the most efficient over the period of 1991 to 2000. Das and Ghosh (2006) found that Indian medium-sized public sector banks performed reasonably well and was the most technical efficient. Fujii, et. al., (2014) found that Indian foreign banks were more efficient than local banks. A study conducted by Noulas (2001) on the efficiency of Greek banks for the period 1993 to 1998 suggested that the private banks were more efficient than state-controlled banks. Schaeck and Cihak (2013) found that competition is stability-enhancing, and the effect is greater for healthy banks than for fragile ones. Thus, they suggest that competition increase the efficiency of the healthy banks.

Based on the previous empirical studies, there is significant evidence to suggest that competition can increase banks efficiency through well implemented regulation.

3. METHODOLOGY

Generally, there are two methods to measure frontier efficiency; the parametric method employing econometric techniques, and the non-parametric method using the linear programming approach. Both methods dissimilar mostly in terms of how they deal with the random error and the assumptions made on the shape of the efficient frontier. Nonetheless, each of the methods has its own advantages and disadvantages. The most popular used parametric methods are stochastic frontier approach (SFA), thick frontier approach (TFA) and distribution-free approach (DFA). In contrast, the generally employed non-parametric methods are free disposal hull analysis (FDH) and data envelopment analysis (DEA).

The parametric method has the strength of allowing noise in the measurement of inefficiency. While the non-parametric method is straightforward and easy to employ as it does not require any specification of the functional form (Coelli, 2004). But, it suffers from the weakness that all deviations from the best-practice frontier are attributed to inefficiency as it did not allocate for noise to be taken into account, thus, it does not allow for any error in the data. As argued by Mester (1994) that "the bank that has been lucky or whose costs have been under-measured would

be labelled as the most efficient while any unfavourable influence beyond a bank's control would be attributed to inefficiency".

SFA

To measure efficiency, the translog SFA will be this study preference as it offers great flexibility in specifying the nature of production. The translog model can be interpreted as a second-order approximation to the unknown, but true, functional form. This model specifies a time variable as a proxy for technical change over time. Duffy and Papageorgiou (2000) argued that the Cobb-Douglas form of the production function typically assumed when econometric estimation of the production function is undertaken is misspecified. In addition, the reason for using SFA is that it has been extensively employed in measuring the efficiency of banks in many countries by many researchers like Tahir and Haron (2008), Bhattacharyya and Pal (2013), Westuizen and Battese (2013), Lensink and Meesters (2014) and Foroutan, et. al., (2015)*.

This study estimates the coefficients of the stochastic production frontier and the inefficiency model simultaneously employing maximum likelihood approach. Given Y_{it} (in logarithm) stands for the Islamic banks' output of the ith Islamic bank at time t, the stochastic production frontier, which comprises of a random error term, can be formulated as below:

$$Y_{it} = f(X_{it}, \beta, t) \quad \text{with} \quad \varepsilon_{it} = v_{it} + u_{it},\ u_{it} \geq 0 \tag{1}$$

where $i = 1, 2, \ldots, m$ represents the Islamic banks and $t = 1, 2, \ldots, T$ represents the time trend and proxy for technological progress. X_{it} is a vector of inputs which comprises of natural log of premises and fixed assets (K) and labor force (L) for Islamic bank i at time t with β as a vector of unknown parameters identified as elasticity. Ultimately, ε_{it} signified the stochastic composed (random) error term. The random error term is decomposed into two unobservable components, statistical noise (v_{it}) and technical inefficiency (u_{it}) which are independent of each other. The statistical noise, v_{it} is a two-sided error term and is assumed to be independently and identically distributed (i.i.d.), $N(0, \sigma)$. It captures measurement error and random variation in production due to factors beyond the control of banks, such as labour strikes, luck, war, etc, as well as the pooled effects of unidentifiable factors inputs in the production function.

The one-sided error term u_{it} captures technical inefficiency in production is assumed to be bank-specific, non-negative random variables, independently distributed as non-negative truncations (at zero) of the distribution $N^{+}(\delta z_{it}, \sigma)$. The one-sided inefficiency effect for the panel data model is specified as follows:

* A complete review of stochastic frontier models can be obtained from Coelli et. al., (2005) and Kumbhakar and Lovell (2000).

$$u_{it} = \delta z_{it} + \omega_{it} \tag{2}$$

where z_{it} represents a vector of Islamic bank-specific factors that determine the technical inefficiency and δ is a vector of coefficients to be identified in the inefficiency model. Bank-specific factors contributing to inefficiency include types of Islamic banks, ownerships, risk-taking, dividend policy and size of Islamic banks. ω_{it} is denoted by the truncations of the distribution $N(0, \sigma)$.

The technical efficiency scores of Islamic bank i at time t are denoted as the ratio of the actual output for the ith Islamic bank relative to the corresponding frontier function/the maximum achievable output, i.e., $TE_{it} = \exp(-u_{it}) = \exp(\delta z_{it} + \omega_{it})$. This technical efficiency measure takes a value between zero and one, with one signifying the Islamic bank being totally productive efficient and, likewise, the actual output attaining its highest achievable amount; while a technical efficiency of less than one signifying the existence technical inefficiency on the component of the Islamic bank, i.e. the Islamic bank could have produced more output given the inputs being employed.

In a nutshell, the empirical model in this study is a translog production function of $f(X_{it}, \beta, t)$ with the following form:

$$\begin{aligned} \ln(Y_{it}) = {} & \beta_0 + \beta_K \ln(K_{it}) + \beta_L \ln(L_{it}) + 0.5\, \beta_{KK} \ln(K_{it})^2 + 0.5\, \beta_{LL} \ln(L_{it})^2 \\ & + \beta_{KL} \ln(K_{it}) \ln(L_{it}) + \beta_t t + 0.5\, \beta_{tt} t^2 + \beta_{Kt} \ln(K_{it}) t + \beta_{Lt} \ln(L_{it}) t \\ & + v_{it} - u_{it} \end{aligned} \tag{3}$$

where Y is Islamic bank's output, K is Islamic bank's capital, L is Islamic bank's labor and subscripts i and t imply the ith Islamic bank at tth year. This model is employed due to its adequate and flexible functional form which would be confirmed with likelihood ratio (LR) test in the following section*.

GMM

Following the SFA, the contemporary developed dynamic panel generalized method of moments (GMM) technique is use in analysing the Islamic bank's efficiency determinants. The proposed dynamic efficiency model to be estimated in this study will be as follows:

$$\begin{aligned} \Delta EFF_{it} = {} & \beta_1 \Delta TY_{it} + \beta_2 \Delta OWN_{it} + \beta_3 \Delta RT_{it} + \beta_4 \Delta DIV_{it} + \beta_5 \Delta SIZE_{it} + \beta_6 \Delta T_{it} \\ & + \beta_7 \Delta EFF_{it-1} + \Delta \varepsilon_{it} \end{aligned} \tag{4}$$

* Sharma et. al., (2007) supported translog model by given four reasons: (1) it provides a local second order approximation to an arbitrary functional form and so gives for some generality; (2) CES and Cobb-Douglas production functions are also special cases of the translog and so the translog includes these frequently employed specifications; (3) it allows for nonconstant returns to scale as well as for technical change to be both neutral and factor augmenting; and (4) partial elasticities of substitution among inputs are allowed to vary and elasticity of scale can vary with output and input proportions.

where EFF, a measure of technical efficiency, is estimated from former SFA. TY is a measure of Islamic bank's type, denoted by dummy variables. TYPE = 0 if the Islamic bank is full-fledged and TYPE = 1 if the Islamic bank is subsidiaries of conventional banks. OWNERSHIP = 0 if the Islamic bank owned locally; OWNERSHIP = 0 if the Islamic bank is foreign-owned bank. RT is a measure of Islamic bank's risk-taking propensity, calculated as the total equity divided by total assets. DIV, a measure of Islamic bank's dividend policy, denoted as DIVIDEND = 1 if the directors recommended dividend payment and dividend has been paid in respect of the current financial year and DIVIDEND = 0 if the directors do not recommend any dividend payment and no dividend has been paid in respect of the current financial year. SIZE, a measure of Islamic bank's size, calculated as the natural log of the total assets. T, a measure of trend, used –3 for year 2008, –2 for 2009 and so on. This panel model consists i cross-sectional units, denoted $i = 1, \ldots, I$, observed at each of T time periods, $t = 1, \ldots, T$.

All the variables are in first difference, i.e. Δ is the difference operator means $\Delta EFF_{it} = EFF_{it} - EFF_{it-1}$ and, analogously, for the other variables. First differences are required to eliminate the Islamic bank's specific effects. To deal with the autoregressive problem, it is assume that $\mu_{it} = \rho\mu_{it-1} + \varepsilon_{it}$, where $|\rho| < 1$ and ε_{it} is a white noise disturbance term and ε_{it} is also denotes the estimated residuals which represent deviations from the long-run relationship. Due to the double-logarithmic form of the model and it is a dynamic model, the parameters of β_1, β_2, β_3, β_4, β_5, β_6 and β_7 are the short-run elasticities while the long-run elasticities can be calculated by dividing each of the parameters by $(1 - \beta_7)$. Therefore, another benefit of employing this dynamic model is that both short-run and long-run elasticities may be obtained. An additional advantage is that by differencing data, it can avoid the unit root and non-stationarity problem and this approach will provide us confidence in the reported coefficients and standard errors.

Factors that Contributing to Islamic Banks' Efficiency and hypothesis

Several aspects influence the productive efficiency of Islamic banks. Under this study, we emphasize the impacts of the five specific features that Islamic banks have on the employment of production sources. They are the Islamic bank's types, ownership, risk-taking, dividend policy and size.

As far as we are aware of, there are little studies conducted to compare the efficiency of full-fledged Islamic banks and Islamic subsidiary banks in Malaysia. However, several studies examine the efficiency of full-fledged Islamic banks and Islamic Windows in Malaysia. Among others, Mokhtar, et. al., (2007) found that on average the efficiency of the overall Islamic banking industry increased from 1997 to 2003 and the full-fledged Islamic banks were more efficient than the Islamic windows. Majid and Hassan (2011) found that foreign full-fledged Islamic banks

have higher input requirement and exhibited low efficiency. But they did not identify other factors affecting the inefficiency level and merely focuses on the impact of operating abroad. While our paper's analysis of the impact of Islamic subsidiaries of conventional banks on efficiency contributes to the policy debate in relation to whether to allow Islamic subsidiaries to operate side by side with full-fledged Islamic banks. To accomplish this objective, we set the first null hypothesis as:

H_{01}: There are similarities in technical efficiency between full-fledged Islamic banks and Islamic subsidiary banks.

A few studies had shown that foreign owned banks are more efficient compared to their domestic peers (e.g. Sathye, 2003 on Indian banks, Hassan and Marton, 2003 on Hungarian banks, Isik and Hassan, 2003 on Turkish banks and Sufian, 2007 on Malaysian banks). Foreign owned banks may have advanced access to capital markets, greater ability to diversify risks, and the ability to provide some services to multinational clients, not easily offered by domestically owned banks. These studies intend to suggest that foreign owned banks from developed countries in developing countries also have access to better technologies, mostly information technologies for collecting and assessing "hard" quantitative information. The study of Sufian (2007) found that foreign banks that offered Islamic banking services in Malaysia have exhibited higher mean technical efficiency of 77.7% compared to their domestic Islamic banks. They advocate that foreign Islamic banks were well managerially efficient in controlling their costs and have been operating at a relatively more optimal scale of operations compared to their domestic Islamic banks. While the study of Williams (2012) on Latin American banking sectors found that foreign owned banks are less efficient than domestic owned banks. In addition, Elyasiani and Mehdian (1997) found that foreign owned banks are less efficient than domestic owned banks as a consequence of their reliance on purchased fund. Other studies such as Kamaruddin, et. al., (2008), Avkiran (1997), Chang, et. al., (1998), Rao (2005), Sathye (2001) and Mariani and Hassan (2011) are also supported that foreign own banks are less efficient. Based on these mixed results, the null hypothesis is formulated as below:

H_{02}: There are similarities in technical efficiency between foreign Islamic banks and domestic Islamic banks.

Berger and Mester (1997) and Isik and Hassan (2003) point out in their banking studies that high capitalized banks tend to be more efficient since efficient banks tend to have more profits, which consecutively reinforces their capitalization status. On the other hand, Mester (1996) suggest that low-capitalized banks encourage managers and shareholders to engage in morally hazardous' activities. They have disincentive to ensure that the bank is operate efficiently as when taking excessive risk they stand to lose only the amount of capital that they invested in the bank if the risk does not pay off. The study of Kwan and Eisenbeis (1997) is also found

the positive effect of inefficiency on risk-taking and supports the moral hazard hypothesis that poor performers are more vulnerable to risk-taking than high performance banking organizations. Jensen and Meckling (1976) in their agency costs hypothesis is also suggested that low risk-taking with higher leverage generates incentives for managers to perform more in the interests of shareholders (thus decreases the propensity to commit moral hazard), which in turn should raise the firm's efficiency. Nevertheless, it is widely recognized that the effect of leverage on total agency costs is expected to be non-monotonic that when leverage exceeded the optimal capital structure, it may raise costs of financial distress, liquidation or bankruptcy. As such the agency costs of outside debt may overwhelm the agency costs of outside equity*, so further increases in leverage actually result in higher agency costs overall. In short, these studies suggest that Islamic banks with lower risk-taking is expected to lower moral hazard activities, decrease agency costs, and thereby lead to an improvement in Islamic banks efficiency. These arguments lead to the following null hypothesis:

H_{03}: There are similarities in technical efficiency between high risk-taking Islamic banks and low risk-taking Islamic banks.

Focusing on the study of dividend policy and bank efficiency, as far as we are aware of, none have been focused on this. The closest studies are on whether dividend payout improves managers' performance and shareholders' wealth (*e.g.*, Asquith and Mullins, 1983; Easterbrook, 1984). Jensen and Meckling (1976) agency theory claims that dividend payouts help lower the total free cash flows and control agency problem. Similarly, Easterbrook (1984) believes that dividends are employed to remove the free cash from the supervision of managers and pay it off to shareholders. Higher dividends enlarge the chances that the banks will have to approach capital market for funding needs, and consequently, expose banks to endless examination and scrutiny and hence reducing the cost of monitoring the managers. Thus, our paper's analysis of the impact of dividend payout on Islamic banking efficiency contributes to the policy debate in relation to bank dividend payment. The forth null hypothesis is formulated as below:

H_{04}: There are similarities in technical efficiency between dividend paid Islamic banks and non-dividend paid Islamic banks.

The effect of bank size on technical efficiency is less obvious though. The divisibility theory asserted that there will be no such operational advantage accruing to large banks, if the technology is divisible, that is, small scale banks can produce financial services at costs per unit output comparable to those of large banks, suggesting no or possibly negative association between size and performance. This was made possible as advances in technology reduced the size and cost of automated

* See Jensen (1986) on the discussion of how the use of debt versus equity in raising capital can pose different degrees of agency cost to firms.

equipment, thus significantly enhance small banks' ability to purchase expensive technologies, implying more divisibility in the banking industry's technologies (Kolari and Zardkoohi, 1987; Toby, 2006; Sufian, 2007). According to Toby (2006), small banks manifest large economies of scale. In contrast, several studies supported that larger banks have higher levels of technical efficiency, among others, Miller and Noulas (1996), and Bos and Kolari (2005). Bos and Kolari (2005) shown that large U.S. banks have greater efficiency than European banks on average. They suggest that potential efficiency gains are possible via geographic expansion of large European and U.S. banks. Jovanovic (1982)'s model supports that larger firms are more efficient than smaller ones given that larger firms are more diversified, have better technology and managers, superior training support than smaller firms and more qualified human capital resources. In addition, larger firms are also likely to benefit from innovation for the reason that large firms incur lesser duplicative attempt and investments which in the case of smaller firms would prove less cost-effective (Wu *et. al*., 2007 and Tabak and Tecles, 2010).

H_{05}: There are similarities in technical efficiency between large-sized Islamic banks and small-sized Islamic banks.

Data and Variables used

The data used in the empirical analysis were entirely drawn from balance sheet and income statements of individual Islamic banks' audited year-end financial statements. Annual data covering the period from 2008 to 2014 are extracted by focusing on two groups, i.e., 5 full-fledged Islamic banks and 11 Islamic subsidiaries of conventional banks which covers the entire population of banks offering Islamic banking operations in Malaysia.[*] In this way it was possible to compare profit efficiencies of the Islamic banks and Islamic subsidiaries over the period as well as analyse the characteristics of Islamic banks that influenced their efficiencies. This study adopts the Stochastic Frontier Analysis approach to construct the efficiency frontier. Two inputs and one output variable are chosen. The input vectors used are Islamic bank's capital (K), calculated as the natural log of premises and fixed assets and Islamic bank's labor (L), computed as the natural log of personal expenses, while, a measure of Islamic bank's output (Y), calculated as the natural log of profit before tax and zakat is the output vector. Table 1 presents the summary of data used to construct the efficiency frontier as well as used in the GMM dynamic panel regression analysis.

* 5 full-fledged Islamic banks are Bank Islam Malaysia Berhad, Bank Muamalat Malaysia Berhad, Al Rajhi Banking & Investment Corporation (Malaysia) Berhad, Asian Finance Bank Berhad, Kuwait Finance House (Malaysia) Berhad and 11 Islamic subsidiaries of conventional banks are Affin Islamic Bank Berhad, Alliance Islamic Bank Berhad, AmIslamic Bank Berhad, CIMB Islamic Bank Berhad, Hong Leong Islamic Bank Berhad, Maybank Islamic Berhad, Public Islamic Bank Berhad, RHB Islamic Bank Berhad, HSBC Amanah Malaysia Berhad, OCBC Al-Amin Bank Berhad and Standard Chartered Saadiq Berhad.

Table 1
Descriptive Statistics for the Variables Used to Construct the Efficiency Frontier and Used in the Panel Regression Analysis

Variables	*Minimum*	*Mean*	*Maximum*	*Standard Deviation*
LN(Y)	–9.903	2.442	4.579	1.400
LN(K)	–10.820	–0.862	4.494	3.088
LN(L)	–5.093	0.158	3.260	1.866
EFF	0.000	0.745	0.961	0.179
TYPE	0.000	0.688	1.000	0.466
OWNERSHIP	0.000	0.375	1.000	0.486
RISK-TAKING	0.032	0.141	0.967	0.200
DIVIDEND	0.000	0.321	1.000	0.469
SIZE	14.417	16.405	19.930	1.126
TREND	–3.000	0.000	3.000	2.009

Source: Banks annual reports and authors own calculations

4. EMPIRICAL FINDINGS

Dynamic Technical Efficiency

This study employs system GMM to estimate the dynamic technical efficiency model in Eq. (4) for all Islamic banks from 2008 to 2014 to determine various bank-specific factors leading to efficiency level and to quantify the speed of adjustment. Table 2 presents the estimated coefficients and the diagnostic tests results. All the three diagnostic statistics are found to be satisfactory and confirms the model is adequately-specified. The Sargan test statistics do not reject the null hypothesis of no over-identifying restrictions. As expected, the Arellano-Bond test statistics support the rejection of the null hypothesis of absence of first-order autocovariance and do not reject the null hypothesis of absence of second-order autocovariance. Thus, the model is adequately-specified and the instruments used in the analysis are valid. Note that the coefficient estimates associated with capital structure and size should be interpreted as elasticity measures while all other coefficients represent semi-elasticity measures. EFF_{it-1} is the coefficient for the lagged dependent variable and is significant at the 1% level. The coefficient value of 0.5202 infers that Malaysian Islamic banks partially adjust their efficiency towards optimal level efficiency at the rate of 47%, with a half life of 2.17 years. Islamic banks take approximately 2.17 years to adjust toward their optimal efficiency level after a one-unit shock to ε, ln(0.5)/ ln(1-speed of adjustment). The speed of adjustment shows the convergence time, i.e. how quickly firms can converge to their optimal efficiency level.

Whilst we confirm the technical efficiency level of Malaysian Islamic banks is affected across time by bank-specific characteristics, Table 2 further reports bank characteristics which influence the technical efficiency of the banks. The significant and negative types of banks coefficient reveal significant dissimilarities in technical efficiency between full-fledged Islamic banks and Islamic subsidiaries of conventional banks. This supports that average efficiency difference between full-fledged Islamic banks and Islamic subsidiaries of conventional banks is 15% less on average. This finding rejects the null hypothesis H_{01} that there are similarities in technical efficiency between the full-fledged Islamic banks and Islamic subsidiaries of conventional banks. Our SFA findings show that Islamic subsidiaries of conventional banks are more efficient as compared to full-fledged Islamic banks with the mean efficiency score of 78.56%* and 65.45%, respectively over the period 2008 to 2014. Although relatively higher efficiency, Islamic subsidiaries of conventional banks displayed slow growth in technical efficiency with mean annual technical efficiency growth rate of 0.43. While the full-fledged Islamic banks having negative technical efficiency growth rate of 1.22. This is consistent with the study of Mariani and Hassan (2011) that full-fledged Islamic banks have higher input requirements and Islamic subsidiaries of conventional banks have higher than average technical efficiency estimates. Based on these findings of slow growth in efficiency, there would appear to be little prospect, at least in the short run, for both full-fledged Islamic banks and Islamic subsidiaries of conventional banks to improve their outputs.

While the significant and positive ownership of banks coefficient shows significant dissimilarities in technical efficiency between foreign owned Islamic banks and domestic owned Islamic banks. This again supports that average efficiency difference between foreign owned Islamic banks and domestic owned Islamic banks is 15% more on average. This finding rejects the null hypothesis H_{02} that there are similarities in technical efficiency between the foreign owned Islamic banks and domestic owned Islamic banks. Our findings show that domestic owned Islamic banks are more efficient as compared to foreign owned Islamic banks with the efficiency score of 79.27% and 66.45%, respectively. This findings are inconsistent with the studies of Sathye (2003), Hassan and Marton (2003), Isik and Hassan (2003) and Sufian (2007) nevertheless consistent with the studies of Avkiran (1997), Elyasiani and Mehdian (1997), Sathye (2001), Kamaruddin (2008) and Williams (2012) that domestic owned banks are more efficient as compared to foreign owned banks as the foreign owned Islamic banks were relatively small compared to their domestic banks peers, have limited capabilities to expand their operations (number of branches, ATMs, etc.), and have limited knowledge on the local markets.

* The detailed results are available upon request.

The risk-taking found to be insignificant to the Islamic banks efficiency. Thus, the null hypothesis of there is no difference in technical efficiency between high risk-taking Islamic banks and low risk-taking Islamic banks cannot be rejected. This finding is inconsistent with the studies of Jensen and Meckling (1976), Mester (1996), Berger and Mester (1997) and Isik and Hassan (2003) which suggest that low risk-taking banks tend to be more efficient. Nevertheless, this outcome is consistent with the argument of Kahane (1977) and Koehn and Santomero (1980) that banks will respond to regulatory actions to increase their capital and reduce their leverage by increasing asset risk. However, bank actions may be limited by supervisors, particularly for weakly capitalized banks (Furlong, 1988; Kwan, 1991; Shrieves and Dahl, 1990). In Malaysia, the risk-taking activities are not significantly affecting Islamic banks efficiency over the study periods.

The dividend payout reports highly significant and negative impact on Islamic banking efficiency. This result is consistent with the findings of Jensen and Meckling (1976), Asquith and Mullins (1983) and Easterbrook (1984) and reject the hypothesis which predict no difference in technical efficiency between dividend paid Islamic banks and non-dividend paid Islamic banks. From the perspectives of agency cost theory, banks with dividend paid, lower free cash flows tend to employ more capital to control the opportunistic actions of managers, triggered higher level of banks efficiency. Thus, the outcome of this study display that Islamic banks with dividend paid is found to be lower agency costs, increase efficiency and thereby lead to an improvement in Islamic banks' performance.

In the case of Islamic bank size on efficiency, there is positive and significant impact of Islamic bank size effect on efficiency. We find that the large-sized Islamic banks are much more scale efficient than small-sized Islamic banks in Malaysia. This is consistent with the studies of Jovanovic (1982), Wu *et. al*., (2007) and Tabak and Tecles (2010) that larger banks are more efficient than smaller ones given that larger banks are more diversified, have better technology and managers, superior training support than smaller banks and more qualified human capital resources. Moreover, larger banks are also likely to benefit from innovation for the reason that large banks incur lesser duplicative attempt and investments which in the case of smaller banks would prove less cost-effective.

Interestingly, we found the coefficient for the time trend variable in our technical efficiency effects model to be negative and significant; suggesting that the technical efficiency of Islamic banks in Malaysia tended to deteriorate throughout the phase studied supporting the arguments of learning economics. A possible argument for this finding may be that the growing competition and congestion in product and input markets.

Table 2
Dynamic Technical Efficiency of Malaysian Islamic Banks

Variables	*Parameter*	*Coefficient*	*Corrected standard error*	*Z-statistics*
TYPES	Δ_{TYP}	–0.1456***	0.0559	-2.61
OWNERSHIP	Δ_{OS}	0.1497***	0.0493	3.03
RISK-TAKING	Δ_{RT}	–0.1355	0.4468	-0.30
DIVIDEND	Δ_{DIV}	0.0590***	0.0221	2.67
SIZE	Δ_{SIZE}	0.0820***	0.0140	5.85
TREND	Δ_{T}	–0.0162**	0.0074	-2.19
EFF_{it-1}	Δ_{LE}	0.5202***	0.1146	4.54
Constant	Δ_{0}	–0.9273***	0.2754	-3.37
Specification tests				
Sargan Test (*p*-value)			5.8825 (0.8811)	
Arrellano-Bond test for AR(1) (*p*-value)			–2.1334 (0.0329)*	
Arrellano-Bond test for AR(2) (*p*-value)			1.0486 (0.2944)	
Number of observations			112	
Sample period			2008 – 2014	
Number of Islamic banks (N)			16	

Notes: Dependent variable is efficiency scores of Islamic banks. This regression is estimated using the Dynamic GMM estimator (Arellano and Bond, 1991). The Sargan Chi-square statistic tests the null hypothesis of no correlation between the instruments and residuals. The Arrellano and Bond Z-statistic tests the null hypothesis that the residuals are first order correlated (AR(1)) and the residuals are not second order correlated (AR(2)) and ** indicates statistical significance at the 5% level and *** indicates statistical significance at the 1% level.

Stochastic Production Frontier Estimations

The Stochastic Frontier Analysis Program (FRONTIER 4.1)*, developed by Coelli (1996), was employed to estimate the model specified in Equation 3. The coefficients of the model thus obtained are presented in Table 3.

Table 3
Panel estimation of stochastic frontier production function for Malaysian Islamic banking

Variable	*Parameter*	*Coefficient*	*Standard error*	*t-ratio*
		Production function		
Intercept	β_0	–0.0596	0.0733	-0.8130
ln(K)	β_K	0.1521***	0.0204	7.4451
ln(L)	β_L	0.1142***	0.0305	3.7470
0.5 $\ln(K)^2$	β_{KK}	0.0954***	0.0070	13.7254

* The authors would like to thank Tim Coelli for providing Frontier 4.1.

Variable	*Parameter*	*Coefficient*	*Standard error*	*t-ratio*
$0.5\ \ln(L)^2$	β_{LL}	0.0690**	0.0355	1.9439
ln(K) ln(L)	β_{KL}	–0.0172	0.0155	-1.1089
t	β_t	0.0369***	0.0166	2.2206
$0.5(t)^2$	β_{tt}	0.0087	0.0175	0.4965
ln(K)*t*	β_{Kt}	–0.0017	0.0061	-0.2817
ln(L)*t*	β_{Lt}	–0.0037	0.0116	-0.3187
		Variance parameters		
Sigma-squared	σ^2	7.0902***	1.1779	6.0193
Gamma	g	0.9969***	0.0012	842.9423
Constant	Δ_0	–21.8589***	4.1110	-5.3172
Ownership	Δ_{os}	15.8562***	2.9918	5.2999
Log-likelihood function	LR	–50.5322		

Note: The asterisk ** indicates statistical significance at the 5% level and *** indicates statistical significance at the 1% level.

The diagnostic test results are satisfactory in the context of a gamma (γ) which is 0.9969 and decisively rejected at 1% level significance level. This indicates that the deviation from the frontier is due entirely to inefficiency. The huge value of γ also implies that the stochastic frontier is superior to the OLS approach in modelling the production function of the Islamic banking thus confirming that the technical inefficiency effects have significant impact on the output. The significant and positive value of variance parameters (σ^2), on the other hand, also confirms that some proportions of the total variability in productions are interrelated with technical inefficiency and signifying that the observed output diverged from frontier output due to factors which are perhaps within the control of the banks. Meanwhile, all the other estimated parameters (i.e. all the β_K and β_L with the exception of β_0. β_{KL}. β_{tt}, β_{Kt} and β_{Lt}) are not only statistically significant but also have the positive signs, which are expected in production functions. Thus, the SFA model is adequately-specified and the instruments used in the analysis are valid.

5. CONCLUSIONS

The study attempt to investigate the efficiency of Malaysian Islamic banks during the period of 2008 to 2014, employing preferred parametric stochastic frontier analysis (SFA) methodology, and particularly emphasises on full-fledged Islamic bank and Islamic subsidiaries of conventional banks as well as foreign owned Islamic banks versus domestic owned Islamic banks. In addition, we have performed a dynamic panel generalized method of moments (GMM) technique to identify the determinants of Islamic banks.

The findings showed that the average efficiency of the overall Islamic banking industries had downsized by 0.66% during the survey period. The study also revealed that the Islamic subsidiaries of conventional banks were more efficient than the full-fledged Islamic banks with average efficiency score of 78.6% and 65.5%, respectively. On the other hand, domestic banks were found to be more efficient than foreign bank with average efficiency score of 79.3% and 66.45%, respectively. Domestic Islamic subsidiaries of conventional banks tend to be the most technical efficient with average efficiency score of 82.39% but with a decline growth rate of 0.83%. While foreign full-fledged Islamic banks tend to be the least technical efficient with average efficiency score of 64.53% with a slight increase growth rate of 0.54%.

The estimation employing the technical inefficiency effects model and a system GMM estimator further discloses that Islamic bank specific characteristics, namely the types, ownership, dividend policy and size are crucial determinants of these Islamic banks' efficiency. Our findings suggest that both dividend payments and Islamic bank size have a positive relationship to Islamic banks efficiency scores. The policy implication hence is that, Islamic banks and the regulatory authorities should find an optimal point on dividend payout and bank size whereby Islamic banks would not be holding on too much capital and liquidity without compromising on their efficiency. In other words, the findings indicate that Islamic banks should strive to be more efficient by managing their dividend policy and expansion program well.

Islamic banks in Malaysia are nowadays facing growing competition; primarily both local and foreign conventional banks' Islamic windows were replaced by full-blown Islamic subsidiaries during strategic positioning and international integration stage. The competition from conventional banks is also expected to magnify further in the near future owing to globalization. The findings of this study discovered that the technical efficiencies of Malaysian Islamic banks could be bolstered up further. Hereof, it involves a concentrated attempt from the bank and policy-makers to fully utilize the limited resources owned by the banking industry in Malaysia. The outcome would smooth the progress of setting directions for potential expansion of Islamic banking operations in Malaysia. Lastly, this paper would unlock a rewarding path for future research in the subject of Islamic banking efficiency and competition in other Muslim countries.

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