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Estimating Efficiency in Domestic and Foreign Islamic Banking and Its Determinants among Three Neighboring Countries – Malaysia, Indonesia and Brunei

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ABSTRACT

This study attempts to investigate the technical efficiency (TE)of domestic and foreign Islamic banks and its determinants for three neighborhood countries namely Malaysia, Indonesia and Brunei that spans over the period from 2006 to 2014.This study employs a two stage procedure involving data envelopment analysis (DEA) approach to measure banks' efficiency while the parametric (t-test) and non-parametric (Mann-Whitney [Wilcoxon] and Kruskall-Wallis) to guage the difference in the efficiency between the domestic and foreign Islamic banks. Then, ordinary least squares (OLS) regressions is utilized to analyzed the determinants of technical efficiency. The results show that domestic Islamic bank for all countries exhibit significantly higher technical efficiency than foreign Islamic banks, which is consistent with home field advantage theory. The regressions on determinants results indicate that bank size and management quality have a negative and significant relationship with technical efficiency of Islamic banks, whereas market power and liquidity indicate a significantly positive relationship with technical efficiency of Islamic banks. The findings of this study give the banks' stakeholders, regulators, banks' managers and investors an important insight about the technical efficiency of Islamic banks and its significant determinants.

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INTRODUCTION

Islamic banking industry has expended very rapidly over the past few years due to a strong demand of *Shariah* compliant financial services including transactions of financing, banking, and related business and commercial affairs. Islam is the second largest religion of the worldwide population. There are about 1.6 billion Muslims in the world or 23.2% of the global population in 2010 (Pew Research Center, 2011a). One of the important feature of being *Shariah* compliant financial services that has increasingly received profound interest in economic circles is to avoid riba (interest), which is prohibited in Islam because it appears explicitly in the Quran and the Sunnah of the Prophet Muhammad SAW (Hossain, 2009). Instead of interest used in conventional banking, Islamic banking adopts the principles *Shariah* compliance services such as profit-loss sharing (*Mudharabah* and *Musharakah*), fees or charges based (*murabahah*, *baimua'zzal, ijara, and ijarawa-iktina*), free service (*qardhassan*) and ancillary principles (*wadiahand rahn*) (Haron, 1998).

The three regions of Middle East, Southeast Asia and South Asia are the central hubs of world Islamic banking and finance reported by Khan and Bhatti (2008). Particularly, in Southeast Asia, the hubs of islamic banking is centred in Malaysia, Indonesia and Brunei leading to a great influenced on their economic progress in last three decades which is also the largest concentration Muslims in the worldwith around61.4%, 88.1%, and 51.9% of Muslim population, respectively(Pew Research Center, 2011b). In an environment, Islamic financial institutions such as Islamic banks and *Shariah* compliant financial services are well-established and operating efficiently, where there are 10 domestic Islamic banks and 6 foreign Islamic banks in Malaysia, 11 domestic Islamic banks in Indonesia and 1 domestic Islamic Banks in Brunei (Bank Negara Malaysia, 2015, Bank Indonesia, 2015 and Autoriti Monetari Brunei Darussalam, 2015). In addition, there are also growing demands for Islamic banking services in minority Muslim population in Southeast Asian countries such as Thailand and Singapore (Malaysia International Finance Center, 2015).

In recent years, banking industry in Malaysia, Brunei and Indonesia have experienced dynamic, fast-paced, and competitive environment at a cross-border scale. However, the regulations become more stringent and intrusive aftermath of the 2008 global financial crisis episode. In consequence, banking industry may not operate efficiently and economic growth will be adversely affected. In line with the apprehension, there is still insufficient of studies focusing on the technical efficiency of Islamic banks, particularly in Malaysia, Indonesia and Brunei. Numerous studies have been conducted to investigate the importance of efficiency to the banking sector(e.g.Sufian and Habibullah, 2009; Sufian, 2010; Afiatun and Wiryono, 2010; Firdaus and Hosen, 2013; Kamarudin *et al*., 2014a and Havid and Setiawan, 2015)but they were conducted by using the comparative analysis on Islamic and conventional banks. Analysis on the domestic and foreign Islamic banks is very shallow and little attention has been given on the efficiency of its operations. Empirical analysis covering the technical efficiency, pure technical efficiency specifically in these cross countries is completely missing from the literature.

In addition, this study also identifies the potential internal and external determinants that have affected its technical efficiency which are not identified by other studies. The internal determinants are micro or bank-specific variables that are products of bank business activities

and are affected by bank level management such as bank size, assets quality, capitalization level, market power, liquidity and management quality. On the other hand, the external determinants are from macro perspective or products of social, economic and legal environment that affects the operation and performance of banking industry such as economic growth, inflation and financial crisis. Therefore, this study attempts to exclusively examine the technical efficiency of Islamic banks and its determinants in Malaysia, Indonesia and Brunei over the period of 2006-2014. These three countries have been highlighted in this study since they are represent as among of the countries in the Southeast Asia that play as a main role that offer the wider range and full-fledge of Islamic banking and finance product and services over the world. Besides, those countries should have the similar comparable criteria and homogenous properties of data and it may produce robust results. This provides new dimension regarding Islamic banking efficiency, which will benefit bank's stakeholders including regulators, managers, investors, customers and researchers.

The rest of the study is organized as follows: Section 2 reviews the related literature on the use of DEA for measuring efficiency in Islamic banks. Section 3 describes our data sources and research methodology using the data envelopment analysis (DEA). Section 4 discusses our results for the technical efficiency of Islamic banks and its determinants. In Section 5, a summary follows with implications of findings and suggestions for future research.

LITERATURE REVIEW

The measurement of the efficiency in banking industry, particularly in Islamic banking sector has grown recently, yet not extensive. Since then, Malaysia is generally recognized as a pioneer in Islamic banking among others. Several studies have been conducted to investigate the efficiency of Islamic banks in Malaysia and compared the efficiency of Islamic banks between Malaysia and other selected country. In recent study, Rahim *et al*., (2015) examined cost, revenue and profit efficiency of 17 Islamic banks in Malaysia over the period of 2008-2009 based on four particular bank categories including domestic bank-backed, stand-alone domestic, foreign bank backed and stand-alone foreign. They found that domestic bank-backed Islamic banks were the most efficient while the stand-alone Islamic banks were the least efficient. They suggested that domestic bank-backed Islamic banks have the opportunity to leverage on its conventional banks. However, foreign bank-backed Islamic banks have limited branch network and need to expand on its own in order to reach the potential customers.

On the other hand, Ismail *et al*., (2013) compared the cost efficiency of Islamic and conventional banks in Malaysia over the period of 2006-2009. The results indicate that the technical efficiency of Islamic banks is lower as compared to the conventional banks in Malaysia. They also found that capitalization and bank sizes are positive and significantly associated to efficiency. However, the results indicate that the assets quality is negative and significantly associated to efficiency. In earlier, Sufian (2007), has investigated the technical efficiency of Islamic banks in Malaysia over the period of 2001-2004 by using the data envelopment analysis (DEA) method. The results showed that the Malaysian Islamic banks have been operating at the wrong scale of operations. They also found that profitability has

significantly positive influence on technical efficiency of Malaysia's Islamic banks. This is further supported byYildirim (2015) who also examined efficiency and productivity of Islamic banks in Malaysia over the period of 2010-2014. He noticed that technical efficiency level of Islamic banks in Malaysia are not always increasing, mainly due to scale inefficiency in which Islamic banks seem not to operate on an optimal scale.

Furthermore, number of studies have also investigated the efficiency of Indonesian Islamic banking sector, among others Afiatun and Wiryono (2010), Firdaus and Hosen (2013), Havid and Setiawan (2015). Afiatun and Wiryono (2010), for instance, examined the efficiency and productivity of Indonesian Islamic banking over the period of 2004-2009. They discovered that technical efficiency of conventional banks is generally higher than Islamic banks. Subsequently, Firdaus and Hosen (2013) measured the efficiency of Islamic bank of Indonesia over the period of second quarter of 2010 until the fourth quarter of 2012 using DEA method. They found that technical efficiency of Islamic banks showed a trend of fluctuation and no Islamic banks had a stable efficiency scores for the period of measurement. By using the same method of analysis, Havid and Setiawan (2015) examined the efficiency of Indonesian Islamic banks for the period of 2008-2014. They found that bank size, return on assets have a negative relationship with technical efficiency. They suggested that technical inefficient of Islamic banks is due to scale inefficient.

The growing interests on the subject matter have led further investigation on comparing Islamic bank efficiency across country. For example, Sufian and Noor (2009) who make the analysis of the technical efficiency of 16 countries' Islamic banks in MENA and selected Asian countries using DEA method over the period of 2001-2006. The findings point out that Islamic banks in MENA are more technical efficient than Islamic banks in Asian. Also, they suggested that loan intensity, size, capitalization, and profitability are significantly influenced the technical efficiency of Islamic banks. Besides, Rahman and Rosman (2013) found that Islamic banks operated at the wrong scale and cause technical inefficiency. They also proposed that GDP per capita has significantly positive effect on technical efficiency.

In related studies, Islam *et al*., (2013) examine the technical efficiency of Islamic banks of South East Asia and South Asia over the period of 2009-2011. The findings based on DEAestablished that the efficiency of South East Asian Islamic banks was higher than South Asian Islamic banks. The results further suggested that the smaller size of the Islamic banks in South East Asia, the more efficient the banks in generating outputs from inputs. Moreover, Ahmad and Noor (2011) examined efficiency performance of 78 Islamic banks in the world over the period of 1992-2009. The results indicate that technical efficiency of the world Islamic bank increased from 2003 to 2004, declined from 2005 to 2007 and increased from 2008 to 2009. The findings further exhibited that Islamic banks have better prepared for financial crisis and customers have better confidence for Islamic banks than conventional banks. Recent study by Sufian and Kamarudin (2015) examined the revenue efficiency of 15 domestic Islamic banks and 6 foreign Islamic banks operating in Southeast Asian countries specifically Malaysia, Indonesia and Brunei over the period of 2006-2011. The results revealed that revenue efficiency on domestic Islamic bank is higher compared to foreign Islamic banks. Besides, they also suggested that the bank size, asset quality, capitalization, market share, liquidity and management quality significantly influenced the revenue efficiency of domestic Islamic banks.

Most of the previous studies such as Miller and Parkhe (2002), Matousek and Taci (2004) and Havrylchyk (2006) also summarized that foreign banks in transition and developing markets show higher efficiency than their domestically-owned counterparts while foreign banks in developed countries show another way around.

In addition, the impacts of financial crisis are worth to study because financial crises hit the global economy in 2007-2008 and affected the housing and construction markets thus it affected the performance of banks worldwide (Altunbas *et al*.,, 2011). Some Islamic banks did face bankruptcy during the financial crisis such as Amlak and Tanweer in Dubai, Islamic Bank in Qatar, Gulf Finance in Bahrain, Emirate Islamic of UAE and Investment Dar in Kuwait ran into serious difficulties (Hasan, 2014). Belanès *et al*., (2015), for instance, examined the impact of financial crisis on efficiency of Islamic banks in GCC region. They found that the average efficiency including technical efficiency, pure technical efficiency and scale efficiency were slightly decreased after 2007. Said (2013) who evaluated the technical efficiency of Islamic banks in the MENA during the financial crisis over the period of 2006-2009, found that Islamic banks in GCC region exhibited higher technical efficiency than North Africa countries and other MENA countries. On the other hand, Rosman *et al*., (2014) also examined the technical efficiency of Middle Eastern and Asian Islamic banks over the period of 2007-2010. They found that most of the Islamic banks were operating at decreasing to scale. Also, they suggested that profitability and capitalizations have significant positive relationship with Islamic banks' efficiency during the financial crisis. The findings seem to recommend that Islamic banks have the ability to withstand the negative shock of financial crisis.

There is therefore a gap in the literature created by the majority of these studies which have mainly concentrated on the technical, pure technical, scale, cost and profit efficiency of the Islamic and conventional banks, while virtually nothing has been done to specifically investigate the technical efficiency specifically on domestic and foreign Islamic banks from Malaysia, Indonesia and Brunei. In light of this gap in literature, this study seeks to provide the empirical evidence particularly technical efficiency together with pure technical efficiency and scale efficiency in the domestic and foreign Islamic banking sector. In addition, it is important to identify both internal and external determinants which may affect bank's efficiency. Hence, the main purpose of this paper is to determine the technical efficiency of domestic and foreign Islamic banks and its determinants for the three neighboring countries – Malaysia, Indonesia and Brunei, for the period of 2006-2014.

DATA AND METHODOLOGY

In favor of this study, the efficiency of a firm is measured through the parametric and non-parametric approaches. Parametric approach is based on the underlying relationship between the parameter under the study and the various observed independent variables. Therefore, it requires a specific pre-specified function. In the meantime, non-parametric approach is based on the optimizing behavior of firms under study. This approach does not require any pre-specific function. It takes data of actual operations of the firms under study and frontier is constructed as the piecewise linear combination of the most efficient observations (Vinod, 2013).

In addition, Data Envelopment Analysis (DEA) established by Charnes *et al*., (1978) is utilized to measure the efficiency of Decision Making Units (DMUs). DEA is an application of mathematical programming model that constructs efficient frontier based on observed input-output combination of DMUs. If the firm's input-output combination lies on the efficient frontier, the firm is considered efficient. However, the firm is considered inefficient if the firm's input-output combination lies inside the frontier. In that case, DEA is employed to measure technical efficiency scores for the firms. Technical efficiency has two types of measure: input-oriented and output-oriented. An input-oriented measure of technical efficiency measures an organization's ability to minimize its inputs used to produce given outputs. Whilst, an output-oriented measure of technical efficiency measures an organization's ability to achieve maximum output of given inputs (Walden and Kirkley, 2000).

The technical efficiency (TE) is then composed to Pure Technical Efficiency (PTE) and Scale Efficiency (SE). Decomposing technical efficiency allows us to figure out the main sources of inefficiencies. Pure technical efficiency reveals the ability of an organization to optimize its output for a given level input and in symmetrically level, minimizing its consumption of resources for a given level of production. It includes the organization of work within the production unit, the ability to organize, to motivate and to effectively monitor employees and supervisors as well as to avoid mistakes and bad decisions. Pure technical inefficiency can be due to inefficiency implementation of the production plan. Scale efficiency allows reporting the measurement of technical efficiency to scale return obtained for an optimal level of activities. It characterizes the gap between observed performance and those that would be obtained in a situation of constant return to scale. Therefore, an organization is inefficient on scale level if its initial situation is characterized by either increasing or decreasing returns to scale (Mekdem, 2015).

The DEA approach is based on the following optimization system: Min $\lambda 0\theta 0$ subject to

$$\sum_{j=1}^{n} \lambda_0 y_{rj} \geq y_{r0} \quad where\ r = 1, 2, \dots, s; \tag{1}$$

$$\theta_0 x_{i0} \geq \sum_{j=1}^{n} \lambda_0 x_{ij} \quad where\ i = 1, 2, \dots, n; \sum_{j=1}^{n} \lambda_{0j} = 1 \lambda_{0j} \geq 0 \quad where\ j = 1, 2, \dots, n \tag{2}$$

where θ_0 : technical efficiency; y_{r0}: output r of DMU_0; x_{j0}: input j of DMU_0; y_{rj}: output r concerning the unit of reference j; x_{ij}: input i concerning the concerning the unit of reference j; λ_{0j}: the weight of reference unit j; s: number of outputs; n: number of DMUs.

An appealing part of the study is to select the appropriate inputs and outputs combination that best reflect the Islamic banking efficiency.Sufian and Kamarudin (2014), Kamarudin *et al*., (2014b) and Panah *et al*., (2014) highlighted at least three approaches can be used to analyze the inputs and outputs in Islamic banking system namely; intermediation approach, production approach and value added approach. They suggested that the intermediation approach is more acceptable and appropriate for Islamic banking system where the best inputs are labors and deposits while the best outputs are loans and investments.

It is also interesting to investigate whether domestic Islamic banks are able to meet the challenges of foreign Islamic banks. The investigation focuses on the performance of domestic Islamic banks and compared to foreign Islamic banks. Ab-Rahim *et al*.,(2013) examined the

efficiency performance including technical efficiency, pure technical efficiency, scale efficiency, cost efficiency and allocative efficiency of 16 domestics and foreign Islamic banks in Malaysia over the period of 2006-2011. They used personnel expenses, fixed assets and total deposits as inputs while total loans, securities portfolio and off-balance sheet items as outputs. The DEA analysis on the study shows that domestic Islamic banks exhibited higher technical efficiency than foreign Islamic banks in Malaysia.

The data used in this study was extracted from the Bank Scope database produced by the Bureau van Dijk. The samples are selected on the basis that the bank has Islamic banking operations within the period of study and also on the basis of data availability. The data includes 23 domestic Islamic banks and 6 foreign Islamic banks [1]. All currencies are converted to USD for the purpose of comparability. In addition, we use natural logarithm for all the variables in regression analysis for ease of comparison.

This study employs a two stage procedure involving data envelopment analysis (DEA) approach and follows by ordinary least squares (OLS) regressions. These methods were proposed by Banker and Natarajan (2008) to provide consistent parameter estimation. On the first stage, we propose the selection of inputs and outputs variables using intermediation approach. Under the intermediation approach, banks are treated as financial intermediaries that combine deposits, labor and capital to produce loans and investments. At the same time, we also follow the guidance provided by Cooper *et al*., (2002) to select the number of inputs and outputs:

$$n > \max \{m*s, 3(m+s)\} \quad (3)$$

where, n is the number of DMUs; m is the number of inputs; and s is the number of outputs. Therefore, three inputs and two outputs are selected. Deposits, labor and capital are selected as input measures whereas loans and investments are selected as output measures.

Next, we construct an input-oriented technical efficiency frontier for domestic and foreign Islamic banks using DEA approach to obtain technical efficiency scores. After technical efficiency scores have been collected, we are interested to examine whether the technical efficiency scores of domestic and foreign Islamic banks are statistically significant. Hence, we perform series of robustness checks including parametric (t-test) and non-parametric (Mann-Whitney and Kruskall-Wallis) which suggested by Sufian and Kamarudin (2015) to obtain more robust results.

On the second stage, we begin to perform Kendall's Tau-b correlation test to examine the relation between two or more independent variables before we run the regression analysis. Yau(2013) suggested Kendall's Tau-b correlation is more effective in determining whether the two non-parametric independent variables are correlated to each other. Then, we proceed to examine the internal (bank-specific) and external (macroeconomics) determinants which influenced the technical efficiency of Islamic banks. In this study, we specify 12 regression models, namely Model 1-12 to carry out ordinary least squares regression analysis.

By using technical efficiency scores as the dependent variable, we extend an equation and estimate the following regression model:

[1] Please refer Appendix I for the complete list of the Islamic banks used in this study.

$$ln\theta_{jt} = \alpha_t + \beta_{jt}(\ln TA_{jt} + \ln LLRGL_{jt} + \ln ETA_{jt} + \ln BDTD_{jt} + \ln LOANSTA_{jt} + \ln NIETA_{jt} + \ln GDP_{jt} + \ln CPI_{jt} + FCRISIS_{jt} + DUM_{jt} + DUM*\ln TA_{jt} + DUM*\ln LLRGL_{jt} + DUM*\ln ETA_{jt} + DUM*\ln BDTD_{jt} + DUM*\ln LOANSTAjt + DUM*\ln NIETA_{jt} + DUM*\ln GDP_{jt} + DUM*\ln CPI_{jt} + DUM*FCRISIS_{jt}) + \varepsilon_{jt} \quad (4)$$

where the $\ln\theta_{jt}$ is the technical efficiency scores of the *j*-th bank in the period *t* obtained from the DEA model. The scores range between 0 and 1 where Islamic banks that are fully efficient scores 1 whereas 0 for inefficient Islamic banks. We expect domestic Islamic banks to exhibit higher technical efficiency than foreign Islamic banks because domestic Islamic banks have more competitive advantages compared to foreign Islamic banks [2]. The *lnTA* is the total assets (bank size) of the Islamic banks. The relationship between bank size and technical efficiency could be positive or negative [3]. In this context, we predict that the relationship between bank size and technical efficiency to be positive because larger banks can deliver banking services more efficiently than smaller banks.The *lnLLRGL* is the assets qualitythat refers to the loan loss reserves over gross loans of the Islamic banks. We expect assets quality to have a negative coefficient. The high ratio of assets quality indicates the poorer of loans performance and tends to lower the efficiency of banks. Ismail *et al*., (2013) found that assets quality negatively and significantly associated to efficiency.

The *lnETA* is the equity over the total assets (capitalisation level) of the Islamic banks; The coefficient of the capitalisation level to be positive because well capitalised banks leads to more efficient in banking services [4]. The *lnBDTD* is the bank's deposits over total deposits (market power).We predict that market power to have a positive relationship with technical efficiency because market power can have positive impact on banking services. Banking services are more efficient when the banks have more market power compared to banks that have less power. Sufian and Kamarudin (2015) suggested that assets quality significantly influenced the efficiency of Islamic banks.The *lnLOANSTA* refers to the net loans over total assets of the Islamic banks (liquidity). The relationship between liquidity and technical efficiency could be positive or negative. Liquidity can be positive has a positive relationship with technical efficiency because banks with more liquid assets have higher efficiency in banking services [5]. The l*nNIETA* denotes the non-interest expenses over total asset of the Islamic banks (management quality). The management quality can be positive due to higher non-interest expenses such as staff compensation tends to motivate staff to perform more efficiently [6].

The *lnGDP* is the gross domestic product per capita (current USD) of the countries. The sign of coefficient of GDP could be positive or negative. However, we predict that GDP to have a positive sign because higher GDP leads to a higher technical efficiency of banks [7].The *lnCPI* is the price index for cost of living of the countries (consumer price index). The CPI is

[2] Ab-Rahim et al., (2013) and Rahim et al., (2015) found that domestic Islamic banks exhibited higher technical efficiency than foreign Islamic banks in Malaysia.
[3] Sufian and Noor (2009), Firdaus and Hosen (2013) found that bank size shows positive significant influenced towards technical efficiency of Islamic banks. However, Sufian (2007), Islam *et al*., (2013), Rahman and Rosman (2013), Yildirim (2015) Havid and Setiawan (2015) suggested that most of the Islamic banks have been operating at the wrong scale of operations.
[4] Sufian and Noor (2009), Ahmad and Noor (2011) and Ismail *et al*., (2013) suggested that capitalisation level exhibited positive relationship with bank efficiency.
[5] Sufian and Kamarudin (2015) suggested that liquidity significantly influenced the efficiency of Islamic banks. However, Ismail *et al*., (2013) found that asset quality negatively and significantly associated to efficiency.
[6] Ahmad and Noor (2011) also suggested that management quality exhibited positive relationship with bank efficiency.
[7] Rahman and Rosman (2013) found that GDP per capita has significantly positive effect on technical efficiency. On the other hand, Ahmad and Noor (2011) suggested that GDP has a negative relationship with bank efficiency.

expected to have positive sign which indicates that the higher the CPI, the higher the technical efficiency of the Islamic banks [8]. The *FCRISIS* is the dummy variable for financial crisis. The value of *FCRISIS* equals to 1 if the years are 2007 and 2008 whereas 0 for otherwise.The coefficient of financial crisis is expected to be negative because the impacts of financial crisis will pull down the technical efficiency of banks [9]. The *DUM* denotes the dummy variable for domestic Islamic; bank *j* is the number of banks; *t* is the number of year; α is the constant term; β is the vector of coefficients; and ε_{jt} is normally distributed disturbance term.

In Model 1 the baseline of the regression model includes all six bank-specific variables, namely bank size (lnTA), assets quality (lnLLRGL), capitalisation level (lnETA), market power (lnBDTD), liquidity (lnLOANSTA) and management quality (lnNIETA). Meanwhile Model 2 includes the macroeconomic variables, namely gross domestic product (lnGDP), consumer price index (lnCPI) and financial crisis (FCRISIS) in the regression model.

The domestic and foreign Islamic banks may react differently to the same efficiency determinants. In order to check for the robustness of the data and results, we perform a number of sensitivity analyses to indicate that the results are not affected by foreign Islamic banks. To do so, we include a dummy variable in Model 3. In addition, there are two rules that we need to follow by using dummy variables. First, we should not use any of the original categorical variables. Second, we should always use one fewer dummy than the number of categories for any categorical variable (Asteriou and Hall, 2007). A dummy variable equals to 1 if the DMU is domestic Islamic bank and 0 if the DMU is foreign Islamic bank.

Furthermore, we seek to examine the potential bank-specific and macroeconomic determinants on the technical efficiency of domestic Islamic banks. Therefore, we introduce several interaction variables, namely, DUM*lnTA, DUM*lnLLRGL, DUM*ln ETA, DUM*lnBDTD, DUM*lnLOANSTA, DUM*lnNIETA, DUM*lnGDP, DUM*lnCPI and DUM*lnFCRISIS in Model 4 to 11.

After regression analysis has been run, we are excited to evaluate the fit of the regression models. Martin (2012) purposed using R-squared, adjusted R-squared, F-test to evaluate the fit. Therefore, we perform R-squared and adjusted R-squared to analyse the variability in the response variables and F-test to examine the joint explanatory power of the variables. In addition, we also perform Durbin-Watson test to detect the present of autocorrelation in regression analysis which suggested by Akter (2014).

RESULTS AND DISCUSSIONS

Table 1 presents the descriptive statistics of the inputs and outputs for Islamic banks in Malaysia, Indonesia and Brunei. The statistic are reported on different subsamples of the inputs and outputs, which are divided into domestic Islamic banks, foreign Islamic banks and full sample of all Islamic banks. The statistics results indicate that there is considerable variation with similar pattern throughout the inputs for Islamic banks samples. For example, the mean value of the deposits (4453.13) is higher in domestic Islamic banks than in foreign Islamic banks (1648.55). It is noticed that the same variation is also observed for all subsamples of the outputs for the Islamic banks.

[8] Havid and Setiawan (2015) found that inflations have a positive relationship with technical efficiency.
[9] Financial crisis affected the housing and construction markets thus it affected the performance of banks (Altunbas *et al*., 2011). However, Ahmad and Noor (2011), Rosman et al., (2014), Said (2013), and Belanès *et al*., (2015) suggested that Islamic banks have better preparation for financial crisis.

Table 1 Inputs and Outputs of Islamic banks

	Mean	Minimum	Maximum	Standard Deviation
		Inputs		
		Domestic Islamic banks 2006-2014		
Total Deposits (x_1)	4453.127	0.000	38981.431	5567.432
Total Labour (x_2)	26.168	0.000	137.506	29.914
Total Capital (x_3)	15.934	0.000	204.799	27.971
		Foreign Islamic banks 2006-2014		
Total Deposits (x_1)	1648.545	0.000	3856.366	962.415
Total Labour (x_2)	11.760	0.173	34.923	9.692
Total Capital (x3)	5.474	0.000	21.049	5.609
		All Islamic Banks 2006-2014		
Total Deposits (x_1)	3780.027	0.000	38981.431	5018.015
Total Labour (x_2)	22.710	0.000	137.506	27.189
Total Capital (x_3)	13.423	0.000	204.799	24.923
		Outputs		
		Domestic Islamic banks 2006-2014		
Total Loans (y_1)	3128.885	13.436	30823.806	4228.154
Total Investments (y_2)	767.048	0.000	4983.785	972.805
		Foreign Islamic banks 2006-2014		
Total Loans (y_1)	1176.216	0.000	3006.438	806.426
Total Investments (y_2)	265.779	0.000	1224.378	242.510
		All Islamic Banks 2006-2014		
Total Loans (y_1)	2660.244	0.000	30823.806	3797.070
Total Investments (y_2)	646.744	0.000	4983.785	882.064

Table 2 shows the efficiency scores for each Islamic bank and Table 3 summarizes the efficiency scores for domestic and foreign Islamic banks over the period of 2006-2014. The results indicate that domestic Islamic banks have exhibited a higher mean technical efficiency level compared to the foreign Islamic banks (0.828 > 0.716). This suggests that the domestic Islamic banks have exhibited mean technical efficiency of 82.8%, suggesting mean input waste of 17.2%. In other words, the domestic Islamic banks could have produced the same amount of outputs by using only 82.8% of the amounts of inputs it employed. On the other hand, foreign Islamic banks have exhibited mean technical efficiency of 71.6%. This result suggests that foreign Islamic banks could save 28.4% of the inputs to produce the same amount of outputs. This implies that the foreign Islamic banks could have produced the same amount of outputs by using only 71.6% of the amount of inputs used.

Table 2 Efficiency Scores of Islamic Banks

Domestic Islamic Banks					Foreign Islamic Banks				
No.	DMU Name	VRS TE	VRS PTE	VRS SE	No.	DMU Name	VRS TE	VRS PTE	VRS SE
1	Affin Islamic Bank Berhad	0.75	0.76	0.99	1	Al Rajhi Banking &Investment Corporation (M) Bhd	0.63	0.71	0.83
2	Alliance Islamic Bank Berhad	0.97	1.00	0.97	2	Asian Finance Bank Berhad	0.49	0.75	0.67
3	AmIslamic Bank Berhad	0.95	0.98	0.97	3	HSBC Amanah Malaysia Berhad	0.84	0.90	0.93
4	Bank Islam Brunei Darussalam Berhad	0.48	0.53	0.90	4	Kuwait Finance House (Malaysia) Berhad	0.77	0.88	0.87
5	Bank Islam Malaysia Berhad	0.90	0.97	0.91	5	OCBC Al-Amin Bank Berhad	0.92	0.95	0.98
6	Bank Muamalat Malaysia Berhad	0.79	0.86	0.92	6	Standard Chartered SaadiqBerhad	0.72	0.91	0.81
7	CIMB Islamic Bank Berhad	0.90	0.95	0.95					
8	EONCAP Islamic Bank Berhad	0.83	0.89	0.93					
9	Hong Leong Islamic Bank Berhad	1.00	1.00	1.00					
10	Maybank Islamic Berhad	1.00	1.00	1.00					
11	PT Bank BRI Syariah	0.65	0.81	0.82					
12	PT Bank Jawa Barat BantenSyariah	1.00	1.00	1.00					
13	PT Bank Maybank Syariah Indonesia	0.94	1.00	0.94					
14	PT Bank Mega Syariah	0.86	1.00	0.86					

Table 2 (Cont.)

15	PT Bank Muamalat Indonesia Tbk	0.78	0.90	0.85				
16	PT Bank PaninSyariah	0.77	0.89	0.88				
17	PT Bank Syariah BNI	0.76	0.88	0.85				
18	PT Bank SyariahBukopin	0.69	0.87	0.79				
19	PT Bank SyariahMandiri	0.73	0.95	0.76				
20	PT Bank Victoria Syariah	1.00	1.00	1.00				
21	PT BCA Syariah	0.60	0.91	0.68				
22	Public Islamic Bank Berhad	0.86	0.87	0.99				
23	RHB Islamic Bank Berhad	0.86	0.93	0.93				
	Mean	0.83	0.91	0.91	Mean	0.72	0.84	0.84

In addition, the domestic Islamic banks have also exhibited a higher mean pure technical efficiency level compared to the foreign Islamic banks (0.905 > 0.840). The results also indicate that the domestic Islamic banks have exhibited a higher scale efficiency level compared to the foreign Islamic banks (0.910 > 0.842).

Table 3 Efficiency Scores for Domestic and Foreign Islamic Banks

	Mean	Minimum	Maximum	Standard Deviation
Efficiency measures				
	Islamic banks 2006-2014			
Technical Efficiency	0.800	0.000	1.000	0.211
Pure Technical Efficiency	0.900	0.190	1.000	0.159
Scale Efficiency	0.894	0.000	1.000	0.157
	Domestic Islamic banks 2006-2014			
Technical Efficiency	0.828	0.359	1.000	0.187
Pure Technical Efficiency	0.905	0.387	1.000	0.141
Scale Efficiency	0.910	0.482	1.000	0.127
	Foreign Islamic banks 2006-2014			
Technical Efficiency	0.716	0.000	1.000	0.258
Pure Technical Efficiency	0.840	0.190	1.000	0.199
Scale Efficiency	0.842	0.000	1.000	0.222

Table 4 indicates the statistical tests for efficiency scores of Islamic banks. Based on parametric (t-test) and non-parametric (Mann-Whitney and Kruskall-Wallis) test, the results indicates that the domestic Islamic banks have exhibited higher technical efficiency than foreign Islamic banks in Malaysia, Indonesia and Brunei over the period 2006-2014 at 1% significance level. Moreover, the pure technical efficiency and scale efficiencyscores have the same value, which arestatistically significant at conventional levels.The finding corroborates that the domestic Islamic banks lead to provide a strong and healthy financial environmentas compared to foreign Islamic banks throughout the study samples. In this respect, investors will find such results of their interest when they want to invest their money in a way that maximizes their return.

Table 4 Statistical tests for Efficiency Scores of Islamic Banks 2006-2014

Test statistics	Test groups					
	Parametric test		Non-parametric test			
	t-test (Prb>t)		Mann-Whitney test (Prb>z)		Kruskall-Wallis test (Prb> $\chi 2$)	
	Mean	t-test	Mean rank	z-test	Mean rank	$\chi 2$
	Technical Efficiency					
Domestic Islamic Banks	0.828	2.778[a]	106.81	-2.789a	106.81	7.776[a]
Foreign Islamic Banks	0.716		80.51		80.51	
	Pure Technical Efficiency					
Domestic Islamic Banks	0.905	2.137[b]	106.13	-2.566b	106.13	6.583[b]
Foreign Islamic Banks	0.840		82.66		82.66	
	Scale Efficiency					
Domestic Islamic Banks	0.910	2.033[b]	106.04	-2.459b	106.04	6.046[b]
Foreign Islamic Banks	0.842		82.95		82.95	

Note: a, b and c indicate significance at the 1%, 5%, and 10% level respectively.

Moreover, the correlation matrix for determinants of Islamic banks throughout the study period is displayed in Table 5. The results indicate that most of the correlation coefficient is less than 0.8. Thus, the independent variables have low degree of correlation with each other.

Table 5 Kendall's Tau-b Correlation Matrix for Determinants of Islamic Banks 2006-2014

	lnTA	lnLLRGL	lnETA	lnBDTD	lnLOANSTA	lnNIETA	lnGDP	lnCPI	FCRISIS	DUM
lnTA	1									
lnLLRGL	0.052	1								
lnETA	-0.402[a]	0.058	1							
lnBDTD	0.640[a]	0.126[a]	-0.424[a]	1						
lnLOANSTA	0.064	-0.128[a]	-0.03	0.002	1					
lnNIETA	-0.300[a]	0.08	0.228[a]	-0.276[a]	0.225 [a]	1				
lnGDP	-0.072	-0.314[a]	0.072	-0.281[a]	0.345[a]	0.280[a]	1			
lnCPI	0.152[a]	-0.241[a]	0.061	-0.195[a]	0.227[a]	0.007	0.566 [a]	1		
FCRISIS	-0.118[b]	0.147	-0.043	0.134[b]	-0.091	-0.029	-0.258[a]	-0.470[a]	1	
DUM	0.229[a]	-0.062	-0.179[a]	0.300 [a]	0.150[a]	-0.048	0.191[a]	0.029	-0.004	1

Notes:[a] Correlation is significant at the 0.01 level (2 tailed) and [b] Correlation is significant at the 0.05 level.

Table 6 Results for Technical Efficiency and its Determinants of Islamic Banks Variable

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Constant (SE)	1.641[a]	1.717[a]	1.727[a]	1.648[a]	1.710[a]	1.731[a]	1.848[a]	1.866[a]	1.628[a]	1.718[a]	1.635[a]	1.685[a]
	(0.075)	(0.199)	(0.193)	(0.210)	(0.187)	(0.192)	(0.177)	(0.218)	(0.185)	(0.215)	(0.075)	(0.196)
Bank-specific variables												
lnTA	-0.012[a]	-0.012[c]	-0.011[c]		-0.011[c]	-0.011[c]	-0.009	0.000	-0.014[b]	-0.012[c]	-0.010[c]	-0.011[c]
	(0.004)	(0.006)	(0.006)		(0.006)	(0.006)	(0.006)	(0.009)	(0.006)	(0.006)	(0.006)	(0.006)
lnLLRGL	-0.013	-0.012	-0.011	-0.018[c]		-0.012	-0.010	-0.003	-0.006	-0.013	-0.013	-0.012
	(0.011)	(0.009)	(0.009)	(0.010)		(0.009)	(0.009)	(0.009)	(0.011)	(0.009)	(0.010)	(0.009)
lnETA	0.001	0.001	0.001	0.000	0.000		0.002	0.007	-0.007	0.001	0.002	0.001
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)		(0.007)	(0.012)	(0.008)	(0.007)	(0.007)	(0.007)

Table 6 (Cont.)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
lnBDTD	0.040[a]	0.039[a]	0.037b	0.041[a]	0.037b	0.037b		0.020	0.034b	0.038b	0.035b	0.036b
	(0.012)	(0.014)	(0.015)	(0.015)	(0.015)	(0.015)		(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
lnLOANSTA	0.055[a]	0.055[a]	0.054[a]	0.045[a]	0.054[a]	0.054[a]	0.055[a]		0.061[a]	0.055[a]	0.053[a]	0.054[a]
	(0.012)	(0.013)	(0.013)	(0.011)	(0.013)	(0.013)	(0.013)		(0.011)	(0.012)	(0.012)	(0.013)
lnNIETA	-0.039[a]	-0.041[a]	-0.041[a]	-0.035b	-0.044[a]	-0.040b	-0.042[a]	-0.044b		-0.040[a]	-0.040[a]	-0.040[a]
	(0.014)	(0.014)	(0.014)	(0.015)	(0.015)	(0.016)	(0.014)	(0.017)		(0.015)	(0.014)	(0.014)
Macroeconomic variables												
lnGDP		0.001	0.001	0.000	0.002	0.001	0.002	0.012	0.002		0.002	0.001
		(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)		(0.008)	(0.008)
lnCPI		-0.018	-0.019	-0.011	-0.019	-0.020	-0.036	-0.033	-0.015	-0.016		-0.011
		(0.046)	(0.045)	(0.046)	(0.045)	(0.045)	(0.044)	(0.047)	(0.044)	(0.045)		(0.045)
FCRISIS		-0.005	-0.005	-0.005	-0.005	-0.005	-0.004	-0.004	-0.004	-0.005	(0.005)	-0.005
		(0.005)	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)	(0.006)			(0.006)
DUM			0.003	0.097[b]	0.011	-0.004	-0.052c	-0.047	0.123[b]	0.003	0.177	0.003
			(0.008)	(0.043)	(0.028)	(0.024)	(0.030)	(0.079)	(0.047)	(0.052)	(0.209)	(0.008)
Interaction variables												
DUM*lnTA				-0.013[b]								
				(0.006)								
DUM*lnLLRGL					-0.004							
					(0.013)							
DUM*lnETA						0.002						
						(0.009)						
DUM*lnBDTD							0.029[b]					
							(0.014)					

Table 6 (Cont.)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
DUM*lnLOANSTA								0.014				
								(0.018)				
DUM*lnNIETA									-0.059[b]			
									(0.023)			
DUM*lnGDP										0.000		
										(0.009)		
DUM*lnCPI											-0.038	
											(0.045)	
DUM*FCRISIS												0.000
												(0.007)
R2	0.364	0.366	0.367	0.378	0.363	0.367	0.355	0.182	0.373	0.367	0.370	0.365
Adjusted R2	0.344	0.336	0.334	0.345	0.330	0.334	0.321	0.139	0.340	0.333	0.337	0.331
Durbin Watson	1.339	1.334	1.336	1.355	1.331	1.336	1.323	1.188	1.354	1.332	1.343	1.347
F-statistic	18.406[a]	12.212[a]	10.965[a]	11.496[a]	10.787[a]	10.971[a]	10.402[a]	4.219[a]	11.266[a]	10.955[a]	11.098[a]	10.865[a]
No. of observations	200	200	200	200	200	200	200	200	200	200	200	200

Notes: a, b and c indicate significance at the 1, 5 and 10% level respectively; figures in parentheses are standard errors.

Table 6 indicates the summary of ordinary least squares (OLS) regression results for technical efficiency and its determinants of Islamic banks in Malaysia, Indonesia and Brunei over the period of 2006-2014. Model 1 indicates that bank size and management quality have a negative relationship with technical efficiency of Islamic banks at 1% significance level whereas market power and liquidity indicate a positive relationship with technical efficiency of Islamic banks at 1% significance level. We believed that Islamic banks in Malaysia, Indonesia and Brunei were operating at the wrong scale. This is not surprising since many studies such as Sufian (2007), Islam *et al*., (2013), Rahman and Rosman (2013), Yildirim (2015), Havid and Setiawan (2015) have also found that the source of technical inefficiency is mainly scale inefficiency. We also suggest that poor management quality (due to high overhead cost) of Islamic banks influenced technical inefficiency of Islamic banks. It means that an increase in non-interest expenses resulted decrease in non-operating income. Thus, the technical efficiency also decreased.

In addition, this study suggested that increased liquidity in Islamic banks lead to higher technical efficiency level. This is in line with previous studies, for instance, Soetanto and Ricky (2011). We also suggest that Islamic banks that have higher market share tend to have higher technical efficiency.

According to Model 2 as demonstrate in Table 6, implies that macroeconomic variables such as gross domestic product, consumer price index and financial crisis do not have significant relationship with technical efficiency of Islamic banks in Malaysia, Indonesia and Brunei. These results also indicate that technical efficiency of Islamic banks appears to be mainly determined by bank-specific factors. We include a dummy variable which representing domestic Islamic banks in Model 3 (Table 6). However, the results indicate that dummy variable do not have significant relationship with technical efficiency of Islamic banks.

From Model 4, we find that DUM*lnTA which representing bank size of domestic Islamic banks have a negative relationship with technical efficiency at 5% significance level. This result is consistent with result of Model 1. We suggest that domestic Islamic banks were operating at the wrong scale. Besides, we find that DUM*lnBDTD in Model 7 which representing market power of domestic Islamic banks have a positive relationship with technical efficiency at 5% significance level. This result is also consistent with result of Model 1. We suggest that domestic Islamic banks that have higher market share tend to have higher technical efficiency.

Moreover,we find that DUM*lnNIETA in Model 9 which representing management quality of domestic Islamic banks have a negative relationship with technical efficiency at 5% significance level. This result is consistent with the result of Model 1. We suggest that poor management quality of domestic Islamic banks influenced technical inefficiency of Islamic banks because the higher bank overhead cost lead to the lower bank efficiency since the bank has overstaffing and this may deteriorate the bank's profitability. It is also worth noticed that DUM*lnLOANSTA in Model 8 which representing liquidity of domestic Islamic banks turns insignificant after interaction. This result is not consistent with result of Model 1.

CONCLUSIONS

In this study, we examine the technical efficiency of Islamic banks and its determinants in Malaysia, Indonesia and Brunei. This study examines 23 domestic Islamic banks and 6 foreign Islamic banks in Malaysia, Indonesia and Brunei over the period of 2006-2014. It employs a two stage procedure involving DEA and follows by ordinary least squares regressions.

On the first stage, we found that domestic Islamic banks have exhibited higher technical efficiency than foreign Islamic banks in Malaysia, Indonesia and Brunei over the period 2006-2014 significance at 1% significance level. On the second stage, the OLS regression results indicate that bank size and management quality have a negative relationship with technical efficiency of Islamic banks at 1% significance level whereas market power and liquidity indicate a positive relationship with technical efficiency of Islamic banks at 1% significance level.

Based on this finding, a number of implications can be drawn. First, we suggested that Islamic banks in Malaysia, Indonesia and Brunei were operating at the wrong scale. Second, we believed that poor management quality of Islamic banks influenced technical inefficiency of Islamic banks. Third, we proposed that increased liquidity in Islamic banks lead to higher technical efficiency level. Forth, we suggested that Islamic banks that have higher market share tend to have higher technical efficiency.

The findings of this study give the banks' stakeholders an important insight about the technical efficiency of Islamic banks and its determinants. First, the regulators and managers should consider downsizing the Islamic banks because they have already grown beyond their most productive scale due to the wrong scale operated by the Islamic banks. Second, the manager should minimize the costing on non-interest expenses by reducing the cost of hiring the extra staff since it may deteriorate the bank's profitability. Third, the bank's manager should consider improving the operations of Islamic banks in order to increase their market shares in Islamic banking industry. Forth, the investors and customers can easily make decisions for investing in Islamic banks based on their technical efficiency scores. Lastly, this study discusses the impact of determinants on technical efficiency and provides a guideline for future researchers in banking efficiency.

However, this study owns certain limitations. This study may over look some important measurement of banking performance. First, the investigation of Islamic banking efficiency is limited to technical efficiency. Second, measure of Islamic banking productivity changes over the time is not included in this study. Hence, this study could be extended in a number of ways. Future researchers could consider measuring cost, revenue and profit efficiency of Islamic banks if the price data are available. In addition, researchers may employ the Malmquist Productivity Index for further investigation of changes of productivity in Islamic banks over the time.

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APPENDIX I

List of the Islamic Banks

No.	Domestic Islamic Bank	No.	Foreign Islamic Bank
1	Affin Islamic Bank Berhad (Malaysia)	1	Al Rajhi Banking & Investment Corporation (Malaysia) Berhad
2	Alliance Islamic Bank Berhad (Malaysia)	2	Asian Finance Bank Berhad
3	AmIslamic Bank Berhad	3	HSBC Amanah Malaysia Berhad
4	Bank Islam Brunei Darussalam Berhad	4	Kuwait Finance House (Malaysia) Berhad
5	Bank Islam Malaysia Berhad	5	OCBC Al-Amin Bank Berhad
6	Bank Muamalat Malaysia Berhad	6	Standard Chartered Saadiq Berhad
7	CIMB Islamic Bank Berhad		
8	EONCAP Islamic Bank Berhad		
9	Hong Leong Islamic Bank Berhad		
10	Maybank Islamic Berhad		
11	PT Bank BRI Syariah		
12	PT Bank Jawa Barat Banten Syariah		
13	PT Bank Maybank Syariah Indonesia		
14	PT Bank Mega Syariah		
15	PT Bank Muamalat Indonesia Tbk		
16	PT Bank Panin Syariah		
17	PT Bank Syariah BNI		
18	PT Bank Syariah Bukopin		
19	PT Bank Syariah Mandiri		
20	PT Bank Victoria Syariah		
21	PT BCA Syariah		
22	Public Islamic Bank Berhad		
23	RHB Islamic Bank Berhad		

Source: Bank Negara Malaysia, Bank Indonesia and AutoritiMonetari Brunei Darussalam.