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HOW EFFICIENT WERE ISLAMIC BANKS DURING THE FINANCIAL CRISIS? EMPIRICAL EVIDENCE FROM ASIAN COUNTRIES

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Abstract. *The aim of this study is to examine the efficiency of Islamic banks during and after the financial crisis, specifically in Asian countries from 2007 to 2011. This is evaluated using a non-parametric approach, in the form of a data envelopment analysis. The data was extracted from the BankScope database for the five-year period (2007-2011). The aim of this study is twofold firstly, it attempts to investigate sources of (in)efficiency in Asian Islamic banks during the recent financial crisis and the recovery period. Secondly, by using a Tobit regression analysis, it assesses the determinants of efficiency in the countries examined. An assessment of the efficiency levels of Islamic banks during the financial crisis and the recovery period, as well as within an international context, has policy ramifications for central banks in terms of enhancing the levels of efficiency and competitiveness*

of Islamic banks in the region. Accordingly, this will also help Islamic banks to weather future financial crises better and, in turn, improve their efficiency levels.

Keywords: *Asian countries, data envelopment analysis, efficiency, financial crisis, Islamic banks.*

JEL Classification: *G21, C14, L29*

1. Introduction

Islamic banks exist today in all parts of the world. From the pioneering efforts of the Dubai Islamic Bank in 1975, the number of Islamic banks has increased to more than 300 today. In Asia, the Islamic banking industry has expanded with new and potential players. With its sizeable market potential for Muslim and non-Muslim banking customers, both public and private entities are intensifying their efforts to lead the Islamic finance industry. Among the countries with developed Islamic bank systems in Asia are Malaysia, Indonesia, Pakistan and Brunei. Based on the World Islamic Banking Competitiveness Report 2012-2013, Malaysia and Indonesia are reported to be among the most remarkable Asian countries in terms of the share of total assets constituted by Islamic banking. Comparatively, in light of the growth and regulatory developments in the Islamic banking industry in Indonesia, Pakistan and Brunei in recent years, they are expanding their volume of *Shari'ah*-compliant banking assets. Meanwhile, Pakistan, Bangladesh and Sri Lanka are developing their Islamic banking industries through the establishment of Islamic banks in those countries. Elsewhere in Asia, India and China, which have large Muslim populations, highlight new market opportunities for Islamic financial institutions. East Asian countries such as Japan, Hong Kong and South Korea have also shown an interest in developing Islamic banking markets locally.

The global financial crisis of 2007-2008, with its epicentre in the US, brought immense complications for the world's economy. It started as an asset bubble created by an array of financial derivatives that led to the subprime mortgage boom. It then triggered a housing crisis. From a housing crisis, it quickly grew into a banking crisis, with the investment and merchant banks first absorbing the impact before it spread to the commercial banks (Krugman, 2009).

The financial crisis, which caused the collapse of investment banks, has focused public attention on the weaknesses of conventional financial systems, which has in turn led to the identification of Islamic financing as an alternative. Mirakhor (2008) asserted that Islamic finance was resilient to shocks because of its inherent stability (Mirakhor, 2008). This view was supported by Siddiqi (2008), who argued that the world of banking and finance without *riba* and *maysir* was a better alternative to the current scenario. Asian countries with no ex-

ceptions were also affected by the crisis. It is therefore important to evaluate how and to what extent the Islamic banks in the region performed during the crisis.

This paper therefore seeks to evaluate the performance of Islamic banks operating in Asian countries during the period 2007-2011, which includes the period of the 2007-2008 financial crisis. The study has a straightforward aim: to assess the performance of the Islamic banking sector during the financial crisis through a comparison among Islamic banks operating in Asian countries. Such an assessment can be important for a future reform agenda in Asia. This paper compares the efficiency indicators of Islamic banks in Asia using a non-parametric measure called data envelopment analysis (DEA) and further evaluates factors influencing efficiency using the Tobit regression model.

The rest of this paper is structured as follows: the next section reviews the available literature, focusing on the efficiency of Islamic banks across various countries. The research methodology is outlined in Section 3, followed by the presentation of the results of the analysis in Section 4. The final section contains some concluding remarks and areas for future work.

2. Literature review

In the banking literature, many researchers have focused on the determinants of banks' performance in terms of their profitability and efficiency (Khediri et al., 2015). In terms of studies on bank efficiency, most of these have focused on geographical regions or individual countries, where they have focused on types of bank. There are numerous studies that have focused on the US (see, for example: Aly et al., 1990; Spong et al., 1995) and European countries (see, for example: Favero and Papi, 1995; Pasiouras, 2008). There are also many studies that have focused on cross-country efficiency analysis, such as those of Hassan et al. (2000), Diestsch and Lozano-Vivas (2000), Chaffai et al. (2001) and Mostafa (2009). However, a limited number of studies have focused on Islamic banks (see, for example, Yudistira, 2004; Sufian and Noor, 2009; and Abdul Rahman and Rosman, 2013). Despite the rapid growth of the Islamic banking and finance sectors, the study of Islamic banking is still in its infancy (Sufian and Noor, 2009). Furthermore, only a few studies that have examined the impact of the financial crisis on the banking industry have included Islamic banks in their samples (for example, Johnes et al., 2014; Said, 2013; Rosman et al., 2014; and Belanès et al., 2015). Most of the findings have explained that the financial crisis had a negative impact on levels of efficiency at Islamic banks.

Focusing on the subject of efficiency in the Islamic banking industry, Yudistira (2004) used DEA to examine the performance of 18 Islamic banks from the Gulf Cooperation Council (GCC) countries, and East Asian, Middle Eastern and African countries from 1997 to 2000. The findings suggested that

these banks had experienced slight inefficiency during the global crisis of 1998 and 1999. The source of this inefficiency was related to pure technical rather than scale inefficiencies. Meanwhile, the study found that risk-taking and profitability did not have a significant effect on overall technical efficiency.

Recently, Sufian and Noor (2009) examined the efficiency of the Islamic banking sector in countries in the Middle East and Africa (MENA) region and Asia using DEA to estimate the overall technical efficiency, pure technical efficiency and scale efficiency for each bank from 2001 to 2006. The outcome was that Islamic banks in MENA countries obtained a higher mean technical efficiency rating than those in Asian countries. Meanwhile, the source of technical inefficiency was pure technical inefficiency rather than scale inefficiency in both the MENA and Asian banking sectors. This study also found positive effects from size, capitalisation and profitability on the efficiency of Islamic banks. However, the risk factor proxy of loans loss provision to total loans had a negative effect on efficiency.

A recent study conducted by Abdul Rahman and Rosman (2013) examined and compared the efficiency of Islamic banks in the MENA countries, including the GCC and Asian countries, using DEA based on an intermediation approach for the period between 2006 and 2009. The sample comprised 63 Islamic banks across the countries. The study found that the main source of technical inefficiency among the Islamic banks was their scale inefficiency, while Islamic banks from Asian countries were found on average to be relatively more efficient than those in MENA countries. It was also found that the main determinant of an Islamic bank's efficiency was the economic condition of the country it was in.

Only a few studies have discussed the impact of the financial crisis on the performance of Islamic banks. Johnes et al. (2014) compared the performance of Islamic and conventional banks prior to, during, and immediately after the 2008 financial crisis. The findings included the observation that during the financial turmoil, both Islamic and conventional banks suffered a drop in their efficiency levels. However, the managers of Islamic banks coped with the crisis better than those of the conventional banks. Said (2013) then measured the overall technical efficiency of Islamic banks operating in the MENA region during the financial crisis of 2007-2009. The study found that during the crisis, Islamic banks in the other MENA countries and North Africa were on average relatively inefficient. Rosman et al. (2014) examined the efficiency of Islamic banks during the financial crisis in Middle Eastern and Asian countries from 2007 to 2010 by adopting DEA to measure technical efficiency which included 79 Islamic banks across a number of countries. It was found that Islamic banks were able to sustain the financial crisis, but most were scale inefficient where they were operating at a decreasing to scale. Moreover, it was found that capitalisation and profitabil-

ity were the main determinants of Islamic banking efficiency. Recently, Belanès et al. (2015) investigated the influence of the subprime crisis on the efficiency of Islamic banks in the GCC region for the period between 2005 and 2011. It was found that the crisis led to a slight decline in Islamic banking efficiency. However, most of these banks remained efficient, because only some of them had relatively minor decreases in their efficiency levels.

Following the thorough literature review, this study is expected to extend the previous literature by providing empirical evidence of the efficiency of Islamic banks in Asian countries not only during the financial crisis, but also afterwards. In addition, this study examines the sources of technical inefficiency and subsequently explains the main determinants of efficiency, including bank-specific factors, risk factors and macroeconomic factors. These findings make significant contributions, not only in light of the limited number of studies conducted during the financial crisis, but by aiding an understanding of efficiency and its determinants with regard to Islamic banks during and after the financial crisis. This can help give some insight to policymakers and international bodies such as the Islamic Financial Services Board.

3. Research methodology

3.1. Data envelopment analysis

In this study, a non-parametric DEA has been used, with variable return to scale assumptions, to measure the input-oriented technical efficiency of Islamic banks in Asian countries. Charnes, Cooper and Rhodes (1978) introduced a DEA model known as the CCR model for measuring the efficiency of each decision-making unit (DMU). It is obtained as a maximum of a ratio of weighted outputs to weighted inputs. This denotes that if more outputs are produced for a given input, the production is considered to be more efficient. The weights for the ratio are determined by a restriction that similar ratios for every DMU must be less than or equal to unity. This definition of efficiency allows multiple outputs and inputs to be measured without requiring pre-assigned weights. Multiple inputs and outputs are reduced to a single "virtual" input and single "virtual" output by optimal weights. The efficiency measure is then a function of the multipliers of the virtual input-output combination.

Among the strengths of the DEA method are that it is less demanding of data and works with a small sample size (Canhoto and Dermine, 2003). These are among the reasons for choosing DEA as the tool for examining the efficiency of Islamic banks in Asian countries. DEA does not require a preconceived structure or specific functional form for it to be used on the data for identifying and determining the efficient frontier, error and inefficiency structures of the DMU (Bauer et al., 1998).

The CCR model presupposes that there is no significant relationship between the scale of operations and efficiency. It assumes that all DMUs are operating at constant return to scale (CRS) and it delivers overall technical efficiency (OTE). Nevertheless, in practice firms might face either economies or diseconomies of scale. If the CRS assumption is used when not all DMUs are operating at optimal scale, the computed measures of technical efficiency will therefore be contaminated with scale efficiencies.

An extension of the CCR model developed by Banker, Charnes and Cooper (1984) relaxes the CRS assumption. This BCC model was used to evaluate the efficiency of the DMU characterised by variable returns to scale (VRS). The VRS assumption provides a measurement of pure technical efficiency, which is a measurement of technical efficiency devoid of scale efficiency effects. If the scores for technical efficiency and pure technical efficiency of a particular DMU are different, then it shows the existence of scale inefficiency.

Using the VRS assumption, the input-oriented DEA model can be represented by the following linear programming problem:

(1)

$$\begin{gathered} min\ \varphi, \lambda, \varphi \\ \text{subject to } -\varphi yi, + Y\lambda, \geq 0 \\ xi - X\lambda \geq 0 \\ N1' \lambda = 1 \\ \text{And } \lambda \geq 0 \end{gathered}$$

where λ is an N x 1 intensity vector of constants and φ is a scalar ($1 \geq \varphi \leq \infty$). $N1$ is an N x 1 vector of ones. For N number of firms, yi and xi are the M x N and K x N output and input vectors, respectively. Y comprises the data for all N firms. Given a fixed level of inputs for the ith firm, the proportional increase in outputs to be achieved by the firm is indicated by $\varphi - 1$. Note that without the convexity constraint $N1' \lambda = 1$, equation (1) becomes a DEA model with CRS technology. The convexity constraint implies that an inefficient firm is benchmarked against firms of a similar size and the projected point of that firm on the DEA frontier will therefore be a convex combination of the firms observed. In other words, each firm would produce on or to the right of the convex production possibility frontier. If technical efficiency scores for a particular firm with or without the convexity constraint imposed are the same, then the firm is operating under CRS. If these scores are different, the firm operates under VRS technology. However, in such a case, it would be necessary to identify whether the firm or DMU operates with IRS or DRS. To do this, an assumption of non-increasing returns to scale (NIRS) is imposed in (1) and the convexity constraint $N1' \lambda = 1$ is substituted with $N1' \lambda \leq 1$. This gives the following:

(2)

$$\begin{gathered} min\ \varphi, \lambda, \varphi \\ \text{subject to } -yi, - Y\lambda, \geq 0, \\ \varphi xi - X\lambda \geq 0, \\ N1' \lambda \leq 1 \\ \lambda \geq 0 \end{gathered}$$

The solution of equation (2) reveals the nature of scale efficiencies. IRS exists if the technical efficiency score obtained with NIRS technology differs from the technical efficiency estimates with VRS technology. If both of these efficiency scores are equal, then the corresponding firm operates with DRS.

DEA can be used to derive measures of scale efficiency by using VRS alongside the CRS. It can be derived to construct an input orientation or output orientation measure. Input orientation aims to reduce input volumes as much as possible without a reduction in output, whereas output orientation aims to maximise output levels without an increase in inputs (Cooper et al., 2000).

The standard approach to measuring scale effects using DEA is to run models on both a CRS and VRS basis. Scale efficiency is found by dividing the efficiency score from the CRS model by the efficiency score from the VRS model. Because the data points are enveloped more tightly under the VRS model, the VRS efficiency scores will be higher and the scale efficiency measures will therefore be in the range of 0 to 1. One important characteristic of the VRS model is that it shows whether a DMU is operating at increasing, constant or decreasing returns to scale. Constant returns to scale will apply when the CRS and VRS efficiency frontiers are tangential with each other – in other words, when the slope of the efficiency frontier is equal to the ratio of inputs to outputs (Cooper et al., 2000). Increasing returns to scale must apply below that level, as the slope of the efficient frontier that reflects the marginal rate of the transformation of inputs to outputs will be greater than the average rate of conversion. On the other hand, decreasing returns to scale must apply above the zone in which constant returns to scale apply. Any DMUs not on the efficient frontier must first be projected onto the efficient frontier before their return-to-scale status can be assessed.

3.2. Multivariate Tobit regression analysis

To test the determinants of efficiency for Islamic banks in Asian countries, three models of efficiency (OTE, PTE and SE) will be tested against the determinants. OTE measures the overall ability of operators (or DMUs) to convert inputs into outputs. Consequently, DEA also permits further decomposition of OTE into its two components – namely pure technical efficiency (PTE) and scale efficiency (SE). PTE measures the ability of operators to convert inputs into out-

puts (devoid of SE effects), while SE measures the extent to which operators can take advantage of returns to scale by altering its size towards the optimal scale. Because the DEA technique produces efficiency scores bounded by 0 and 1, it is appropriate to use a limited dependent variable approach such as the Tobit model to perform the multivariate analysis. The possible determinants of the efficiency of Islamic banks are investigated using a random effects Tobit model.

The standard Tobit model can be defined as follows for bank i:

$$y_i^* = \beta x_i + \varepsilon_i, \quad y_{i=} y_i^* \; if \; y_i^* \geq 0 \; and \; y_i = 0, otherwise \tag{3}$$

whereare $\varepsilon_{i\sim} N(0, \sigma^2), x_i$ the vectors of the explanatory variables and unknown parameters, respectively, y_i^* is a latent variable and y_i is the DEA efficiency score.

With efficiency scores as the dependent variable, the following regression model is estimated:

$$EFF_{jt} = \alpha + \beta_1 \sum Bank\ characteristics + + \beta_2 \sum Macroeconomic\ conditions + \varepsilon$$

where EFF_{jt} is the technical efficiency, pure technical efficiency and scale efficiency of the *j*th bank in period t obtained from DEA, bank characteristics are an array of bank-specific trait variables, and macroeconomic conditions are a vector of macroeconomic variables. Details of the independent variables and their hypothesis are shown in Table 3.3.

3.3. Definition and choice of variables

In the banking literature, two main approaches are broadly used in defining and measuring the inputs and outputs used – namely the production approach and the intermediation approach[1] (Sealey and Lindley, 1977). This study adopts the intermediation approach, because this has been used extensively in specifying the inputs and outputs of the banking industry. We used two outputs and three inputs in investigating the efficiency of Islamic banks in Asian countries

1 Under the production approach, banks are primarily regarded as producers of services for customers. The inputs used in this approach include labour and materials or their associated costs. The output under this approach portrays the services provided to customers and is best measured by the number and type of transactions, documents processed or specialised services provided over a given time period. Under the intermediation approach, financial institutions are regarded as intermediaries between savers and investors. In this study, Islamic banks collect deposits and other liabilities, and invest the funds in productive sectors of the economy that yield returns that are free from riba.

for the period between 2007 and 2011. Table 3.1 outlines the descriptive statistics of the inputs and outputs used in this study.

Table 3.1: *Descriptive statistics for inputs and outputs, 2007-2011*

	Minimum	Maximum	Mean	SD
Outputs				
2007				
Financings	0.01	5,885.66	924.71	1,421.08
OEA	0.10	1,455.54	416.29	522.71
2008				
Financings	0.00	3,778.69	1,009.41	1,064.41
OEA	0.86	1,859.14	329.89	457.22
2009				
Financings	0.12	5,065.73	1,256.62	1,553.79
OEA	8.86	2,806.39	465.57	722.13
2010				
Financings	0.05	7,058.41	1,436.48	1,877.72
OEA	11.36	4,939.00	596.23	1,069.81
2011				
Financings	1.83	8,836.67	1,884.14	2,348.55
OEA	9.28	4,236.29	720.26	984.50
Inputs				
2007				
Deposits and STF	4.62	5,885.66	1,359.74	1,670.79
Fixed assets	0.01	46.37	8.57	12.73
Personnel Expenses	0.12	61.93	11.84	15.56
2008				
Deposits and STF	3.30	6,458.62	1,687.96	1,941.93
Fixed assets	0.02	44.19	8.313	12.70
Personnel expenses	0.12	67.18	10.95	15.74
2009				
Deposits and STF	1.20	8,095.35	2,117.50	2,646.69
Fixed asset	0.04	44.73	9.85	14.48
Personnel expenses	0.13	71.89	11.47	16.89
2010				
Deposits and STF	0.10	10,639.91	2,359.90	3,001.74
Fixed assets	0.03	57.13	12.45	16.86
Personnel expenses	0.14	135.66	16.82	29.51
2011				
Deposits and STF	4.82	12,429.75	3,085.37	3,497.0
Fixed assets	0.02	63.24	12.72	19.3833
Personnel expenses	0.13	106.42	18.98	26.70

OEA: Other earnings asset; STF: Short-term funding

Table 3.2: *Samples of Islamic banks operating in Asian countries during the period 2007-2011*

	Year				
Country	2007	2008	2009	2010	2011
Malaysia	7	11	10	11	11
Indonesia	1	1	0	0	0
Bangladesh	2	2	1	2	2
Pakistan	5	5	6	6	4
Singapore	1	1	1	1	1
Philippines	1	1	0	1	1
Brunei	1	1	1	1	1
	18	22	19	22	20

The outputs were financing and other earnings assets, while the inputs were deposits and short-term funding, fixed assets and personnel expenses. The efficiency frontier was constructed by using an unbalanced sample of 23 Islamic banks operating in Asian countries during the period 2007-2011, yielding 101 bank-year observations (Table 3.2). Table 3.3 provides the list of banks and countries used in this study. Data were extracted from the BankScope database for the five-year period. All the variables were measured in millions of US dollars. Meanwhile, Table 3.4 lists the variables used in the regression models.

Table 3.3: *List of countries and banks used in the study*

Country	Banks
Bangladesh	ICB Islamic Bank Shahjalal Islamic Bank
Brunei	Bank Islam Brunei
Indonesia	Bank Syariah Mandiri
Malaysia	Affin Islamic Bank Alliance Islamic Bank AmIslamic Bank Asian Finance Bank Bank Islam Malaysia Bank Muamalat Malaysia CIMB Islamic Bank Hong Leong Islamic Bank HSBC Amanah OCBC Al Amin Public Islamic bank
Pakistan	Meezan Bank First National Bank Modaraba First Habib Modaraba Burj Bank Standard Chartered Modaraba Bank Islam Pakistan Ltd
Philippines	Al Amanah Islamic Inv Bank
Singapore	Islamic Bank of Asia

Table 3.4: *Description of the variables used in the regression models*

Variable	Description	Hypothesised relationship with efficiency
ROA	Return on assets	+
LNTA	Natural logarithm of total assets	+
LTA	Loans to total asset	+
EQTA	Total book value of shareholders' equity over total assets	+
CR	Credit risk measured by loan loss provisions over total loans	-
LNGDP	Natural logarithm of gross domestic product	+
CPI	The rate of inflation	-

Table 3.4 shows the variables used in the regression model, including the return on assets (ROA), natural logarithm of total assets (LNTA), loans to total assets (LTA), total book value of shareholders' equity over total assets (EQTA), credit risk (CR), natural logarithm of gross domestic product (LNGDP) and inflation, measured by the consumer price index (CPI). It is expected that ROA, LNTA, LTA, EQTA and LNGDP will positively affect efficiency, whereas CR and CPI are expected to be negatively related to efficiency.

4. Results and findings

In this section, the results of efficiency measured using the DEA method are discussed. We constructed an annual frontier specific for each year that was more flexible and more appropriate than estimating a single multi-frontier. In this study, there are five separate frontiers. Furthermore, separation of OTE into its PTE and SE components is discussed.

4.1. Efficiency of Islamic banks

Figure 4.1 illustrates trends in the efficiency of Asian Islamic banks from 2007 to 2011. This comprises the period of the financial crisis (i.e. 2007 to 2009) and post-financial crisis (i.e. 2010 and 2011). OTE reached its peak in 2009, from its lowest level in 2007. This was an interesting outcome, because it indicated that Islamic banks in Asia were able to improve their overall technical efficiency during the financial crisis. However, this level of efficiency dropped again in 2010, immediately after the financial crisis, but improved again in 2011. Table 4.1 shows that during the study period, the Islamic banks exhibited a mean OTE of 68.5%. This result suggests that 31.5% of the inputs could have been saved by banks while still producing the same amount of outputs that they generated. In other words, by using 68.5% of the inputs they actually used, the banks could have produced the same quantity of outputs.

Figure 4.1: *Overall technical efficiency (OTE), pure technical efficiency (PTE) and scale efficiency (SE) of Asian Islamic banks, 2007-2011*

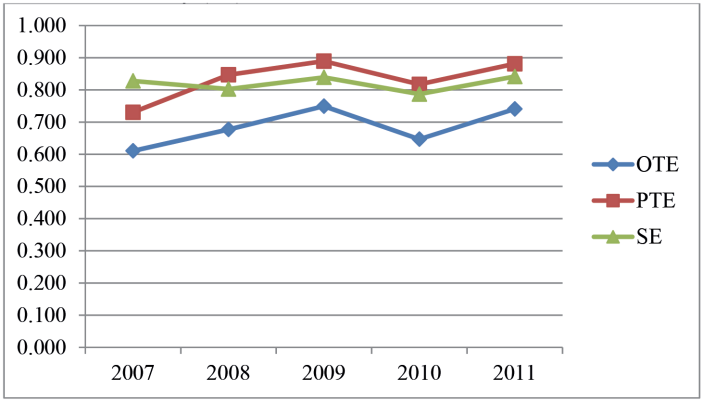

Table 4.1: *Summary statistics of efficiency scores, 2007-2011*

Efficiency measures	Mean	SD	Minimum	Maximum
Panel A: Asian Islamic banks 2007				
Overall technical efficiency	0.611	0.318	0.003	1
Pure technical efficiency	0.730	0.266	0.114	1
Scale efficiency	0.828	0.244	0.004	1
Panel B: Asian Islamic banks 2008				
Overall technical efficiency	0.677	0.292	0.09	1
Pure technical efficiency	0.847	0.230	0.132	1
Scale efficiency	0.803	0.260	0.09	1
Panel C: Asian Islamic banks 2009				
Overall technical efficiency	0.749	0.261	0.339	1
Pure technical efficiency	0.889	0.173	0.351	1
Scale efficiency	0.839	0.214	0.42	1
Panel D: Asian Islamic banks 2010				
Overall technical efficiency	0.647	0.279	0.297	1
Pure technical efficiency	0.817	0.210	0.319	1
Scale efficiency	0.787	0.228	0.355	1
Panel D: Asian Islamic banks 2011				
Overall technical efficiency	0.741	0.225	0.426	1
Pure technical efficiency	0.881	0.179	0.528	1
Scale efficiency	0.842	0.172	0.426	1
Panel D: Asian banks all years				
Overall technical efficiency	0.685	0.280	0.003	1
Pure technical efficiency	0.834	0.217	0.114	1
Scale efficiency	0.818	0.223	0.004	1

Additionally, by examining both pure technical efficiency and scale efficiency, it can be seen that pure technical efficiency dominated scale efficiency in each year except 2007. But interestingly, the difference between pure technical efficiency and scale efficiency was minimal. This may have been because of the higher overall technical efficiency score achieved by Islamic banks in Asian countries. Likewise, the decomposition of overall technical efficiency into its pure technical and scale efficiency components suggests that scale inefficiency outweighed pure technical inefficiency in Islamic banks for every year in the study period except 2007. Hence, for the period from 2008 till 2011, the cause of inefficiency among Islamic banks was their operation at the wrong scale (that is, producing at IRS or DRS). Table 4.2 shows the percentage share of Islamic banks' return to scale (RTS).

Table 4.2: *Islamic banks' RTS for 2007, 2008, 2009, 2010 and 2011 (percentage share)*

Year		IRS	CRS	DRS	Total
2007	No. of banks	5	5	8	18
	% share	27.8	27.8	44.4	100
2008	No. of banks	5	9	8	22
	% share	22.7	40.9	36.4	100
2009	No. of banks	2	8	9	19
	% share	10.5	42.1	47.4	100
2010	No. of banks	4	4	14	22
	% share	18	18	64	100
2011	No. of banks	3	5	12	20
	% share	15	25	60	100

In this study, the majority of Islamic banks were found to be operating at DRS over the four-year period, except in 2008 (44.4% in 2007; 36.4% in 2008; 47.4% in 2009; 64% in 2010; and 60% in 2011). This means that when the banks increased their inputs, the result was a less than proportionate increase in outputs. Most of the Islamic banks were found to be operating at an optimum scale – that is, at a constant RTS (27.8% in 2007; 40.9% in 2008; 42.1% in 2009; 18% in 2010; and 25% in 2011). These were the only banks operating at the right scale. Finally, a smaller percentage of the banks were operating at IRS (27.8% in 2007; 22.7% in 2008; 10.5% in 2009; 18% in 2010; and 15% in 2011), in which a rise in inputs resulted in a more than proportionate rise in outputs. The table shows that a higher percentage (i.e. more than 50%) of Islamic banks were operating at DRS after the financial crisis. As compared to during the financial crisis, there were minimal differences in the percentage of CRS and DRS, especially in 2008 and 2009. The trend was therefore that Islamic banks in Asia that were operating at CRS during the financial crisis were operating at DRS after it.

Despite the fact that the majority of the Islamic banks were operating at DRS over the period covered, it was also found that a high percentage them were actually operating at an optimum level, particularly in 2008 and 2009. The banks operating at CRS were operating at the right scale. However, this was not the case after the financial crisis, when there was a lower percentage of CRS banks (18% in 2010 and 25% in 2011). This is an issue, because IRS and DRS banks need to reach an optimum scale of operations. It is suggested that Islamic banks with IRS increase the scale of their operations, while those with DRS consider downsizing to achieve significant cost savings and efficiencies.

4.2. Factors affecting efficiency

Regression results focusing on the relationship between bank efficiency and its determinants are presented in Tables 4.3, 4.4 and 4.5, with overall technical efficiency (OTE), pure technical efficiency (PTE) and scale efficiency (SE) as dependent variables, respectively. Five bank characteristics (ROA, LNTA, LTA, EQTA and CR) and two macroeconomic variables (LNGDP and CPI) were assessed in determining the efficiency of Islamic banks in Asian countries.

The proxy of profitability, ROA, reveals a significant positive relationship with OTE, indicating that more efficient banks tend to be more profitable. However, ROA was insignificant in determining the PTE and SE of Islamic banks in Asian countries. LNTA, a proxy for the size of a bank, was found to negatively affect OTE and SE (the variable was found to positively affect PTE, but insignificantly). These results were found to be in contradiction with the hypothesised relationship, whereby larger banks were assumed to be more efficient. The negative relationship might be down to the fact that increasing the size of a bank is a source of additional costs and tends to reduce the efficiency of larger banks (Moussawi and Obeid, 2011).

The findings also indicate that LTA, a measure of loan intensity, has a significant positive effect on OTE, PTE and SE at the 1% levels, respectively. The results suggest that banks with a higher loan-to-asset ratio tend to exhibit higher efficiency levels (Sufian and Mohamad Noor, 2009). Based on the efficient market hypothesis, market power in loan markets may be the result of efficient operations, whereby those with the ability to manage operations more productively might bear lower production costs, which in turn enables them to offer more reasonable loan terms and gain a larger market share.

Table 4.3: *Multivariate Tobit regression results with OTE as a dependent variable*

Explanatory variables	Model 1		Model 2		Model 3	
Constant	0.333672***	0.0000	0.301026***	0.0000	0.286444***	0.0000
ROA	0.002189	0.9002	0.032643	0.1095	0.035651*	0.0614
LNTA	0.041068**	0.0081	-0.119810*	0.0102	-0.123476**	0.0058
LTA	0.007067***	0.0004	0.007803***	0.0000	0.008228***	0.0000
EQTA	0.007913**	0.0013	0.000113	0.9679	0.000625	0.8127
CR	-0.089947	0.2608	-0.081936	0.1230	-0.089683*	0.0893
LNGDP			0.143074**	0.0010	0.128742**	0.0019
CPI			0.001611	0.7969	-0.001160	0.8575
DUM2008					0.083525	0.5014
DUM2009					0.217076*	0.0637
DUM2010					0.100219	0.3465
DUM2011					0.232249*	0.0383
Log likelihood	-43.15030		-36.48016		-33.36938	
No. of observations	87		87		87	

$$\varphi_{jt} = \beta_1 ROA + \beta_2\, LNTA + \beta_3\, LTA + \beta_4\, EQTA + \beta_5\, CR + \beta_6\, LNGDP + \beta_7\, CPI + \beta_8 \sum DUMYEAR_{2007-2011} + \varepsilon_j$$

*Notes: Significant at the *10, **5 and 1*** per cent levels respectively; values in parentheses are Prob. values.*

The dependent variable is the overall technical efficiency score derived from DEA; ROA is a measure of profitability; LNTA is the size of the bank measured as the natural logarithm of total bank assets; LTA is a measure of the bank's loan intensity calculated as the ratio of total loans to total assets; EQTA is a measure of capitalisation measured by the ratio of equity to total assets; CR is a measure of credit risk calculated as the ratio of loan loss provision to total loan; LNGDP is the natural logarithm of gross domestic product; CPI is a measure of inflation; DUM2008, DUM2009, DUM2010 and DUM2011 are dummy variables that take a value of 1 for the years 2008, 2009, 2010 and 2011 respectively, 0 otherwise.

Table 4.4: *Multivariate Tobit regression results with PTE as a dependent variable*

Explanatory variables	Model 1		Model 2		Model 3	
Constant	0.343607***	0.0000	0.318817***	0.0000	0.299467***	0.0000
ROA	0.006710	0.6828	0.013253	0.5167	0.015369	0.4115
LNTA	0.098542***	0.0000	0.067762	0.1991	0.067596	0.1671
LTA	0.003515	0.1290	0.003144	0.1409	0.003565*	0.0629
EQTA	0.006057**	0.0053	0.003794	0.1856	0.004548*	0.0886
CR	-0.080778	0.2574	-0.090987*	0.0946	-0.097149*	0.0753
LNGDP			0.021600	0.6487	0.002184	0.9611
CPI			0.014711*	0.0455	0.011124	0.1354
DUM2008					0.102127	0.4415
DUM2009					0.236929*	0.0571
DUM2010					0.099883	0.3884
DUM2011					0.271300*	0.0473
Log likelihood	-43.42030		-41.12848		-37.86574	
No. of observations	87		87		87	

$$\varphi_{jt} = \beta_1 ROA + \beta_2\, LNTA + \beta_3\, LTA + \beta_4\, EQTA + \beta_5\, CR + \beta_6\, LNGDP + \beta_7\, CPI + \beta_8 \sum DUMYEAR_{2007-2011} + \varepsilon_j$$

*Notes: Significant at the *10, **5 and 1*** per cent levels respectively; values in parentheses are Prob. values.*

The dependent variable is the pure technical efficiency score derived from DEA; ROA is a measure of profitability; LNTA is the size of the bank measured as the natural logarithm of total bank assets; LTA is a measure of the bank's loan intensity calculated as the ratio of total loans to total assets; EQTA is a measure of capitalisation measured by the ratio of equity to total assets; CR is a measure of credit risk calculated as the ratio of loan loss provision to total loan; LNGDP is the natural logarithm of gross domestic product; CPI is a measure of inflation; DUM2008, DUM2009, DUM2010 and DUM2011 are dummy variables that take a value of 1 for the years 2008, 2009, 2010 and 2011 respectively, 0 otherwise.

Table 4.5: *Multivariate Tobit regression results with SE as a dependent variable*

Explanatory variables	Model 1		Model 2		Model 3	
Constant	0.298760***	0.0000	0.208533***	0.0000	0.203949***	0.0000
ROA	-0.032997	0.1289	0.023775*	0.0413	0.025868*	0.0222
LNTA	0.065843***	0.0000	-0.169730***	0.0000	-0.173472***	0.0000
LTA	0.006046***	0.0007	0.006878***	0.0000	0.007071***	0.0000
EQTA	0.009991***	0.0001	-0.003271*	0.0306	-0.003546*	0.0218
CR	-0.056855	0.5011	-0.034398	0.3711	-0.031848	0.4175
LNGDP			0.209257***	0.0000	0.210934***	0.0000
CPI			0.005052	0.2158	0.006421	0.1360
DUM2008					-0.061076	0.5486
DUM2009					0.048011	0.6048
DUM2010					-0.027345	0.7594
DUM2011					0.034333	0.7059
Log likelihood	-32.83670		-10.64604		-9.237504	
No. of observations	87		87		87	

$$\varphi_{jt} = \beta_1 ROA + \beta_2\, LNTA + \beta_3\, LTA + \beta_4\, EQTA + \beta_5\, CR + \beta_6\, LNGDP + \beta_7\, CPI + \beta_8 \sum DUMYEAR_{2007-2011} + \varepsilon_j$$

*Notes: Significant at the *10, **5 and 1*** per cent levels respectively; values in parentheses are Prob. values.*

The dependent variable is the scale efficiency score derived from DEA; ROA is a measure of profitability; LNTA is the size of the bank measured as the natural logarithm of total bank assets; LTA is a measure of the bank's loan intensity calculated as the ratio of total loans to total assets; EQTA is a measure of capitalisation measured by the ratio of equity to total assets; CR is a measure of credit risk calculated as the ratio of loan loss provision to total loan; LNGDP is the natural logarithm of gross domestic product; CPI is a measure of inflation; DUM2008, DUM2009, DUM2010 and DUM2011 are dummy variables that take a value of 1 fo ther years 2008, 2009, 2010 and 2011 respectively, 0 otherwise.

Following Isik and Hassan (2003) and Havrylchyk (2006), the credit risk variable, which is measured by the loan loss provisions over total loans, is incorporated in the regression model. As expected, it was found that credit risk had a significant negative relationship with OTE and PTE (credit risk was found to be insignificant with SE, although the relationship is the same). These results are consistent with earlier findings (for example, Kwan and Eisenbeis (1995), Resti (1997), and Sufian and Mohamad Noor (2009)), which identified a negative relationship between problem loans and bank efficiency – implying that the greater the risk, the less efficient the bank. It is therefore suggested that Islamic banks should take credit risk management as one of their agendas for improving their efficiency, because problem loans have been proven to be troublesome (Sufian, 2009).

With regard to macroeconomic variables, as was expected and consistent with previous findings (eg. Sufian and Noor, 2009 and Sufian and Habibullah. 2013), it was found that GDP as measured by LNGDP exhibits a significant positive relationship with bank efficiency. As favourable economic conditions have developed in countries after the financial crisis, the demand for Islamic banking products and services have also tended to grow.

As a final check, dummy variables for each year (DUM2008, DM2009, DUM2010 and DUM2011) were used to take into account changes in the Islamic

banking environment during the study period. The findings suggest that Islamic banks in Asian countries were relatively more efficient in 2009 and 2011.

5. Conclusion

By employing the DEA and Tobit regression models, this paper has managed to examine the efficiency of Asian Islamic banks during the financial crisis and further determine the factors that had an impact on their efficiency. During the period under study, Asian Islamic banks showed a mean overall technical efficiency of 68.5%. It is worth noting that this efficiency was mainly contributed by the pure technical efficiency, implying that Islamic banks in Asian countries were managerially more efficient at exploiting their resources during the financial crisis. The results also indicate that internal factors and exogenous factors appear to significantly contribute to varying efficiency scores. This is important in strengthening Islamic banks to deal with future crises. With huge competition from their conventional banking counterparts, Islamic banks need to be able to face this kind of challenge in order to be competitive.

Owing to its limitations, this study could be extended in a number of ways. Firstly, its scope could be extended to investigate other types of efficiencies, such as cost and allocative efficiency. Secondly, future research could also consider using a parametric approach to examine the efficiency of Islamic banks in this region. Other variables such as other types of risk (such as liquidity risks) and the age of the banks could also be included in a regression model.

Despite these limitations, this study provides a significant contribution to the operating performance of the Islamic banking industry in Asian countries. The findings can give policymakers, bank managers and international bodies such as the Islamic Financial Services Board better insights into the performance of Islamic banks during a financial crisis. Issues relating to scale inefficiencies may influence policymakers and bank managers to consider downsizing, because these Islamic banks have already grown beyond their most productive scale. Lastly, this study has provided further insights into banks' specific management and further facilitates directions for the sustainable competitiveness of Islamic banking in the future.

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