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A Meta-Frontier Function for the Estimation of Islamic and Conventional Banks' Cost and Revenue Efficiency: The Case of Malaysia from 2006 to 2012

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Abstract

We measure cost and revenue efficiency of the Islamic and conventional Malaysian banks by using the stochastic frontier method and the meta-frontier analysis (MFA) over the period 2006-2012. The use of MFA allows for the correction of the efficiency measurement errors caused by the technological and operational gap. The specific as well as the common frontiers obtained by the stochastic frontier method show the superiority of Islamic banks (IBs) compared to conventional banks (CBs) in terms of cost and revenue efficiency. This can reflect their high managerial capability. Efficiency measurement using MFA partially revealed different results. CBs have higher annual averages of cost efficiency scores than those of IBs over the period 2006-2011. The observed evolutionary trends of these averages contradict those of the capital base. This change in results is explained according to Johnes et al. (2013) by the modus operandi of IBs which seems in average less efficient than that of CBs. As for revenue efficiency, IBs are more efficient than CBs over the entire study period even though the evolution of the technological gap ratio confirms the inefficiency of their modus operandi. These results may be useful to political decision-makers and regulatory authorities.

Keywords: Islamic banks, conventional banks, cost efficiency, revenue efficiency, meta-frontier analysis, stochastic frontier analysis, genetic algorithm

1. Introduction

For the first time, the last financial crisis offered the possibility to the Islamic financial system to emerge as a substitute for the conventional financial system. Chapra (2008) states that the subprime crisis would not have taken place with an Islamic financial system. He added that the mechanisms behind the development and spread of this crisis cannot take effect under Sharia rules and guidelines.

Besides the existence of an underlying asset and the prohibition of illicit activities, the rules governing Islamic financial transactions can be summarized into three pillars, namely the prohibition of "riba", the principle of sharing profits and losses and the prohibition of "bay al gharar". For the prohibition of "riba" Al Masri (2009) defines two categories of "riba": "riba an-nassia" and "riba al-buyu". "Riba an-nassia" takes two forms, it results from the predetermined increase required by the lender over time (riba al Qurudh) or it is the consequence of the surplus paid to the lender in return for rescheduling the date of repayment in case the borrower is unable to repay on time (riba al Duyun). As for the "riba al-buyu" which represents the sale of "ribawis" goods (Note 1) Al Masri (2009) divided it also into two types: "riba al Fadhl" (hand to hand exchange of two similar goods of the same category (Note 2) and the same nature but with different quantities) and "riba an-Nasa'" (non-simultaneous exchange of two goods belonging to the same category). As for the principle of sharing profits and losses, it bears on two *fiqh* rules (Quaed fiqhia), "Alghounmou Bilghourmi or Alghourmou Bilghounmi" (the yield (or gain) obtained is based on endured difficulties and incurred expenses) and "Alkharajou biddhaman" (revenue or yield in exchange of the corresponding guarantee). According to both rules, the usufruct, revenue or yield associated with a property belongs to the person or people who are willing to endure its potential losses (Owaida (2010) and Shekhar (2008)). Al-Masri (2010) concluded that risk is a production factor that depends on either property or labor. A prohibited risk is then the one which is separated from the latter two. In general, it arises from this last rule the banning of two main operations, namely the sale of what one does not possess and fixed-income financing operations.

As for the prohibition of "bay al gharar", or selling tainted with uncertainty or hazard, Balala (2011) notes that the prohibited transactions under "gharar" are those implying some type of risks and uncertainty that is difficult to master by the buyer, either because the seller has an informational advantage, or because of the future nature of the contract's object that may be uncontrolled by the two contractors. Ibn Rushd Al Jadd (grandfather) (Note 3) (1072-1126) (Note 4) states that the sale stained with "gharar" is business transaction in which the level of "gharar" is described as excessive or influential, while a moderate level of gharar "gharar yassir" does not make the contract defective or unlawful. El Gamal (2001) adds that "forbidden gharar" is nothing other than the unnecessary transfer of risks, which can only be economically inefficient. Thus, the "forbidden gharar" was at the origin of banning the main contemporary risk management contracts such as derivative products and business insurance.

However, despite the resilience of IBs during the last financial crisis, Johnes et al. (2013) suggest that it is expected that their performance will be inferior to that of CBs. Three main reasons can explain this difference. First, the diversity of Islamic schools of thoughts raises a problem of standardization of Islamic banking products and contributes thus to an increase in IBs' operating costs compared to those of CBs (Chapra, 2007). Then, size may also be decisive. Indeed, IBs are generally smaller than CBs while evidence points to a positive relationship between technical efficiency and size in the banking industry (Bhattacharryya et al., 1997; Miller & Noulas, 1996; Jackson & Fethi, 2000; Chen et al., 2005; Abdul Majid et al., 2005; Drake et al., 2003). Finally, IBs are often domestic banks, whereas most evidence suggests that foreign banks have a cost efficiency that is greater than that of domestic banks (Isik & Hassan, 2002; Hassan & Merton, 2003; Kasman & Yildirim, 2006; Matthews & Ismail, 2006; Mokhtar et al., 2008). This difference in efficiency can also result from IBs holding a higher level of capital. In this regard, Khediri et al. (2015) suggests that it is useful for IBs to maintain higher capital buffers to mitigate liquidity risk. In this study, we plan then to test the hypothesis which claims the superiority of CBs compared to IBs in terms of efficiency.

To this end, we will examine a sample of 37 Malaysian banks consisting of 17 IBs and 20 CBs over the period 2006 and 2012. We proceed into two steps. The first is used to calculate and compare cost and revenue efficiency scores of Islamic and conventional banks by the stochastic frontier analysis (SFA). Three efficiency frontiers are then considered: two specific frontiers and a common frontier. In the second step, a global efficiency frontier which contains the two specific frontiers is obtained by means of MFA. This latter approach can correct for efficiency measurement errors caused by the technological and operational gap. The meta-production approach has been introduced for the first time by Hayami (1969) and Hayami and Ruttan (1970 and 1971) to examine agricultural productivity across different countries. These two latter authors note that "the meta-production function can be regarded as the envelope of commonly conceived neoclassical production functions" (Note 5). The meta-frontier function makes it possible to compare several groups of producers operating under different technologies by calculating a technological gap ratio.

This paper is organized into five sections. The literature review is presented in Section 1. The methodology is described in Section 2. Section 3 describes the database and all the selected variables of our models. The results are presented and discussed in Section 4. The conclusions are presented in the last section.

2. Literature Review

Several studies (Berger & Humphrey, 1997; Berger & Mester, 1997; Brown & Skully, 2002) presented a detailed review of the literature on CBs efficiency. As for the studies on IBs efficiency, they can be classified into two groups. The first group examined a sample of uniquely IBs from different countries (Yudistira, 2004; Hassan 2005, 2006; Sufian, 2009; Viverita et al., 2007) or from one single country (Hassan & Hussein, 2003; Saaid et al., 2003; Saaid, 2005; Kamaruddin et al., 2008). The second group of studies used a comparative approach and can be divided according to the obtained results: studies showing the absence of any difference between IBs and CBs in terms of efficiency (Abdul-Majid et al., 2005; El-Gamal & Inanoglu, 2005; Mokhtar et al., 2006; Bader, 2008; Hassan et al., 2009; Shahid et al., 2010); other studies did not test the significance of the difference in efficiency between the IBs and CBs for lack of observations (Hussein, 2004; Al-Jarrah & Molyneux, 2005; Said, 2012); while few studies have shown a higher efficiency of IBs compared to CBs (Yudistira, 2004; Masruk & al., 2007; Al-Muharrami, 2008; Zahoor et al., 2011); and some other studies attested for the pre-eminence of CBs in terms of efficiency (Hassan, 2006; Mokhtar et al., 2007, 2008; Safiullah, 2010; Sraïri, 2010).

Another set of comparative studies deserves a particular attention because it distinguished between gross efficiency and net efficiency. These are mainly the studies of Abdul-Majid et al. (2008), Johnes et al. (2009), Abdul-Majid et al. ((2010), (2011a, b)) and Johnes et al. (2013). Gross efficiency takes into account both management quality and the effectiveness of the modus operandi. Net efficiency can isolate the managerial component and thus provides a measure of managerial efficiency. Studying the Malaysian banking industry, Abdul-Majid et al. (2008, 2011a, b) calculated gross efficiency scores by estimating the cost function using the stochastic frontier analysis (SFA) without considering specific variables (even that reflecting the nature of the bank, Islamic or conventional). These variables are introduced during in the second step of calculating net efficiency scores. The results show that CBs have a significant higher gross efficiency than that of IBs, whereas a slight difference is obtained for net efficiency. Johnes et al. (2009) adopted a different approach using the data envelopment analysis (DEA) to calculate gross and net efficiency scores. According to Abdul-Majid et al. ((2008), (2010),(2011a, b)), the results indicate that the poor performance of IBs operating in the Gulf Cooperation Council (GCC) countries is mainly due to their modus operandi rather than to managerial incompetence. Johnes et al. (2013) obtained the same result despite using MFA. These authors defined three levels of efficiency: gross efficiency, net efficiency and type efficiency. Gross efficiency is determined by MFA; net efficiency is calculated from specific efficiency frontiers established by the nonparametric DEA method; and type efficiency is defined by the distance between the specific frontier and the meta-frontier. In this study, we will extrapolate this latter study in order to assess the evolution of cost and revenue efficiency for Islamic and conventional banks of Malaysia over the period 2006-2012.

3. Methodology

Step 1: SFA to determine for each bank category two specific frontiers relating respectively to cost and revenue efficiency.

SFA proposed by Aigner et al. (1977) and Meeusen and Broek (1977), and used by Mester (1993), Cebenoyan et al. (1993) and Bauer et al. (1993), is one of the parametric methods designed to evaluate cost and profit efficiency. Unlike non-parametric approaches like DEA, which ignores the possibilities of measurement errors and the effects of the inaccuracy associated with accounting data, parametric approaches, such as the stochastic frontier model, decomposes error term in two components. The first component results from measurement errors and external shocks, and the second measures the specific inefficiency for each entity to be evaluated. In this regard, to calculate inefficiency related to each observation, Jondrow et al. (1982) proposed a decomposition method of error term, which proved its superiority over other methods (called deterministic methods). According to Berger and Mester (1997), cost efficiency is the measure of the distance between the cost of producing a set of outputs of a bank i and that of a bank having the best cost practice, operating in similar conditions. Thus, assessing cost efficiency makes it possible to know the deviation of the production cost of a set of outputs from the minimum production cost of the same bundle. SFA determines efficiency scores from a stochastic cost function that can be formulated for a sample of N banks, as follows:

$$\ln CT_i = f(Y_i, P_i, \beta) + \varepsilon_i,\ with\ \varepsilon_i = u_i + v_i \qquad (1)$$

Where $\ln CT_i$ is the total cost of a bank i; Y is the vector of outputs of a bank i; P is the vector of inputs of a bank i; β is the vector of the parameters to be estimated. The error term ε_i is divided into two parts: u_i captures the effect of inefficiency and is distributed on one side of the frontier (one-sided error term); v_i is the stochastic error which captures the effect of noise and measurement errors and it is distributed on each side of the production frontier (two-sided error term). These two error terms are supposed to be independent. Note that the function f can take several functional forms such as Translog, Gobb-Douglas, CES, squared-root quadratic and quadratic generalized Box-Cox (Konstantinos et al. (2003)). The cost frontier is estimated by the maximum likelihood method and efficiency levels are deducted from the regression error as follows: $CE_{it} = \frac{1}{\exp(\hat{u}_i)} = \exp(-\hat{u}_i)$. A cost efficiency score equal to 1 represents a bank that is on the efficiency frontier, while scores between 0 and 1 denote banks with lower efficiency.

For the selection of variables of model (1), it should be remembered that there are two approaches that define inputs and outputs of banking institutions: the production approach, introduced by Benston (1965) and Bell and Murphy (1968), and the intermediation approach proposed by Sealey and Lindley (1977). Both approaches are widely used in the literature and there is no consensus on the superiority of one over the other (Berger and Humphrey (1997)). In this study, we will adopt the intermediation approach that promotes banks' intermediation vocation when defining banking activity. Deposits are then considered among the bank's inputs together with labour and capital. In addition, outputs are measured in value rather than in number of accounts managed by the bank. Total cost then takes into account interest costs and the amounts allocated to depositors in addition to expenses of personnel, amortization, provisions and other expenses. Based on the translog functional form, the model to be estimated is as follows:

$$LnCT_{it} = \beta_0 + \sum_{k=1}^{2}\beta_k ln(Y_{kit}) + \sum_{h=1}^{3}\alpha_h ln(P_{hit}) + \frac{1}{2}\sum_{j=1}^{2}\sum_{k=1}^{2}\beta_{jk}\, ln(Y_{jit}) ln(Y_{kit}) + \frac{1}{2}\sum_{h=1}^{3}\sum_{j=1}^{3}\alpha_{hj}\, ln(P_{hit}) ln(P_{jit}) + \sum_{j=1}^{3}\sum_{k=1}^{2}\lambda_{jk}\, ln(P_{jit}) ln(Y_{kit}) + \varepsilon_{it} \quad (2)$$

Where, i varies from 1 to N (N is the total number of banks of the sample); t represents the year which varies between 1 and 7; h varies from 1 to 3 and represents the number of input prices; k varies between 1 and 2 and represents the number of outputs. In addition, two restrictions are to be introduced so as to reduce the number of estimation parameters of the model (2). These restrictions are the result of two constraints: a symmetry constraint and a homogeneity constraint. In the presence of three inputs and two outputs, these two constraints allow us to reduce the coefficients to be estimated to 21 instead of 34. At this level, this model has to be used to identify two specific efficiency frontiers and a common frontier. The first frontier is based on a sample of uniquely IBs, while the second contains only CBs. These two categories of banks are grouped in a single sample to construct the common frontier.

The same model and the same procedures will be used in order to calculate revenue efficiency. We keep the same inputs and outputs of the previous model, while the dependent variable will be replaced by the total revenues coming from financing, loans and other operating activities after deducting amounts allocated to depositors. Like the cost frontier, the revenue frontier divides the bank's total revenues by prices of inputs and outputs. It then allows us to determine the deviation from the bank having the best practice. The use of the stochastic frontier model to evaluate revenue efficiency was also developed by Fiordelisi et al. (2011) in the European context.

2nd step: The principle of MFA

Bos and Schmiedel (2003), Bikker (2002) and Dietsch and Lozano-Vivas (2000) support the hypothesis which states that considering a single efficiency frontier for banks operating in different environments and having access to different technologies leads to erroneous results. To take into account these measurement weaknesses, we then decided to extend our analysis of efficiency measurement trying to benefit from the proposals of Battese et al. (2004) who have managed to develop a meta-frontier production function. This last function allows comparing several groups of producers operating under different technologies and this by calculating a technological gap ratio.

Following Battese et al. (2004), Huang et al. (2011) have attempted to build a cost frontier that envelops all stochastic cost frontiers for the different European banking groups. The construction of a meta-frontier starts by defining a model of a stochastic cost frontier for each bank i of country r at time t as follows:

$$C_{it(r)} = f(X_{it(r)}, \varphi_r) e^{V_{it(r)} + U_{it(r)}};\ i = 1,\ldots, N_r;\ t = 1,\ldots, T;\ r = 1,\ldots, R \quad (3)$$

Where, $C_{it\,(r)}$ is total cost; $X_{it\,(r)}$ is the vector of input and output prices; φ_r is the vector of parameters to be estimated; $V_{it(r)}$ and $U_{it(r)}$ are the two components of error term. For convenience reasons, the model (3) is represented as follows:

$$C_{it(r)} = e^{X_{it(r)}\varphi_r + V_{it(r)} + U_{it(r)}} \quad (4)$$

Through this model, Battese et al. (2004) suppose that there is only one data generation process for banks within the same country or using the same technology. In model (3), the meta-frontier cost function is defined as being a global function with a mathematical form that envelopes all deterministic elements of the stochastic cost functions elaborated individually. Thus, the meta-frontier cost function takes the following form:

$$C_{it}^{*} = f(X_{it}, \varphi^{*}) \equiv e^{X_{it}\varphi^{*}};\ i=1,\ldots,\ N=\sum_{r=1}^{R} N_r\ ;\ t=1,\ldots,\ T \quad (5)$$

Where, C_{it}^{*} is the minimum expenses incurred by bank i at time t; and φ^{*} is the vector of parameters of the meta-frontier cost function. These parameters are determined in such a way that $X_{it}\varphi^{*} \le X_{it}\varphi_r$. The meta-frontier cost function is a parametric deterministic function whose values must be less than or equal to the deterministic components of the stochastic cost functions of the different identified groups (this inequality must be checked for all groups and over the whole studied period). Figure (1) illustrates the meta-frontier cost function which is assumed to be a smooth function. The stochastic frontier cost of different countries in the case of a single output are established and denoted by frontier 1, frontier 2 and frontier 3.

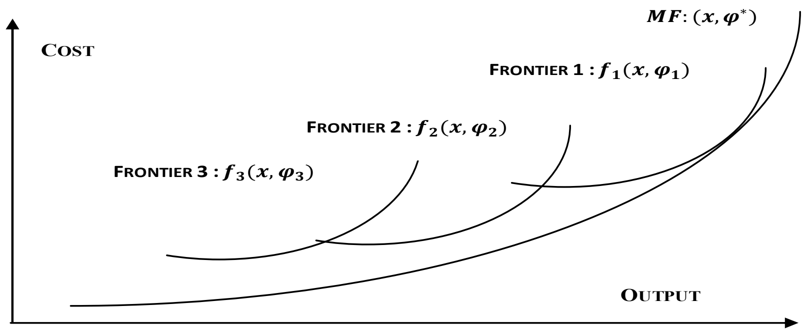

Figure 1. Meta-frontier function

Source: Huang et al. (2011).

Measuring the overall cost efficiency (OCE) for bank *i* at time *t*, in country *r* is made by the minimum cost (determined by the meta-frontier) to the observed cost ratio, adjusted by the corresponding random error:

$$OCE_{it(r)} = \frac{e^{X_{it}\varphi^* + V_{it(r)}}}{C_{it(r)}} \quad (6)$$

$$OCE_{it(r)} = \frac{e^{X_{it}\varphi^* + V_{it(r)}}}{e^{X_{it(r)}\varphi r + V_{it(r)} + U_{it(r)}}} = e^{-U_{it(r)}} \times \frac{e^{X_{it}\varphi^*}}{e^{X_{it(r)}\varphi r}} \quad (7)$$

The first term of the equation on the right, $e^{-U_{it(r)}}$, is cost efficiency $(CE_{it(r)})$ related to the stochastic frontier of country *r*. It measures the distance between the cost of a bank *(i)* and the stochastic cost frontier of country *r*. The second term of the equation on the right is the technological gap ratio. Equation (7) is then rewritten as follows:

$$OCE_{it(r)} = CE_{it(r)} \times TGR_{it(r)} \quad (8)$$

The procedures followed to calculate OCE can be summarized in three steps:

1- estimation of the parameters of the stochastic cost function of country *r*, $\hat{\varphi}_r$, by using the maximum likelihood method;

2- estimation of the parameters of the meta-frontier cost function, $\hat{\varphi}^*$, with reference to one of the mathematical programming methods;

3- calculation of cost efficiency $(CE_{it(r)})$ and the technological gap ratio $TGR_{it(r)}$.

These steps will be performed to calculate the OCE of IBs and CBs. According to the approach adopted by Battese et al. (2004) estimating the parameters of the meta-frontier cost function (φ^*)involves solving the following system:

$$\text{MinL}^* \equiv \sum_{t=1}^{T}\sum_{i=1}^{N}\left|lnf\left(X_{it}, \hat{\varphi}_{(r)}\right) - lnf(X_{it}, \varphi^*)\right|, \text{ u/c} lnf(X_{it}, \varphi^*) \leq lnf\left(X_{it}, \hat{\varphi}_{(r)}\right) \quad (9)$$

In view of this latter constraint, the absolute value can be removed, which leads to solving the following problem:

$$\text{MinL}^* \equiv \sum_{t=1}^{T}\sum_{i=1}^{N}\left[lnf\left(X_{it}, \hat{\varphi}_{(r)}\right) - lnf(X_{it}, \varphi^*)\right], \text{ u/c } lnf(X_{it}, \varphi^*) \leq lnf\left(X_{it}, \hat{\varphi}_{(r)}\right) \quad (10)$$

Where, *i*: 1, ..., N (N = 37, is number of the banks in the selected sample); *t*: 2006, ..., 2012; *r*: group 1 or group 2 (*r* = 1: Islamic banks group; *r* = 2: conventional banks group); $X_{it}$is the vector of inputs and outputs.

The aim of this minimization problem is to minimize the distance between current cost (determined by the stochastic cost function of each group) and minimum cost (calculated by the meta-frontier function). The function of the meta-frontier $lnf(X_{it}, \varphi^*)$ takes the same form as that of individual stochastic cost frontiers. Furthermore, solving this minimization problem will be possible using an optimization technique based on the genetic algorithm method. Note that in our case, this optimization problem consists of 233 constraints that should be respected.

Proceeding in the same way, calculating the global revenue efficiency requires solving the following minimization problem:

$$\text{Min } L^{*} \equiv \sum_{t=1}^{T}\sum_{i=1}^{N}\left|lnf(X_{it},\varphi^{*}) - lnf\left(X_{it},\hat{\varphi}_{(r)}\right)\right|, \text{ u/c } lnf\left(X_{it},\hat{\varphi}_{(r)}\right) \leq lnf(X_{it},\varphi^{*}) \quad (11)$$

4. Data and Definition of Variables

Our sample consists of 37 Malaysian commercial banks, 17 of which are IBs and 20 are CBs. The choice of Malaysia is justified by three main reasons. The first relates to the heterogeneity of accounting systems adopted by IBs from different countries. This heterogeneity makes it difficult not only the development of harmonized financial statements but also any comparative study of similar entities. The second reason for our choice relates to Malaysia's international rank in terms of Islamic finance. The third reason relates to the implementation of the Basel II agreement as of 2008 in the Malaysian banking sector. This decision gives us the opportunity to examine the impact of any variation in capital (Figure 2) on efficiency.

The audited annual financial statements, which are available on the website of each of the banks of our sample, are the main sources of our database. The period of our study extends between 2006 and 2012 and takes into account the effects of the subprime crisis. The total number of observations is set at 233 observations: 103 observations for IBs and 130 for CBs. Table (1) below presents the names of the banks of our sample, their nature (Islamic or conventional), affiliation (domestic or foreign), their creation date and the number of observations attributable to each of them. It should be noted that all observations that might give biased results because of their abnormal variability were eliminated.

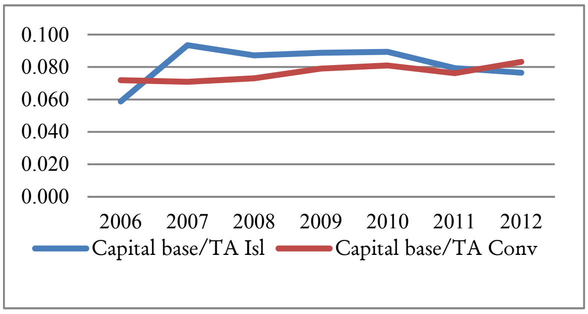

Figure 2. Evolution of capital base

By adopting the intermediation approach, three inputs and two outputs are used to calculate cost and revenue efficiency scores. The three production factors are respectively: physical capital (K), financial capital (F) and labour (W). Physical capital price is calculated by dividing the total of amortization, provisions and other expenses by the total of net fixed assets. As for the financial capital price, it is measured by the total of the amounts allotted to the different lenders (including funds provided by customers of the bank) divided by the total of short, medium and long term liabilities. As for labour price, it is defined by the personnel expenses to total assets ratio. The two considered outputs are: total loans (Y1) and total securities portfolio (Y2). Total loans takes into account cash and short-term funds, deposits and placements from banks and other financial institutions, and financing, advances and other loans. As for the total securities portfolio, it is equal to the sum of the value of securities held for trading, held to maturity and available-for-sale.

Table 1. The sample

Banks	N°	Nature	D/F*	Creation date	Number of Observations
Bank Islam Malaysia	1	Isl	D	1983	7
Bank Muamalat Malaysia	2	Isl	D	1999	6
Affin Islamic Bank Berhad	3	Isl	D	2005	7
CIMB Islamic Bank	4	Isl	D	2005	7
EONCAP Islamic Bank **	5	Isl	D	2005	5
Hong Leong Islamic Bank**	6	Isl	D	2005	7
RHB Islamic Bank	7	Isl	D	2005	7
AmIslamic Bank	8	Isl	D	2006	6
My Bank Isamic	9	Isl	D	2007	5

Alliance Islamic Bank	10	Isl	D	2007	5
Public Islamic Bank	11	Isl	D	2008	5
Kuwait Finance House	12	Isl	F	2004	7
Al Rajhi Banking	13	Isl	F	2006	7
Asian Finance Bank	14	Isl	F	2006	7
OCBC Al Amin Bank Berhad	15	Isl	F	2008	5
Standard Chartered	16	Isl	F	2008	5
HSBC Amanah	17	Isl	F	2008	5
Hong Leong Bank	18	Conv	D	1934	7
Maybankberhad	19	Conv	D	1960	7
Public Bank Berhad	20	Conv	D	1960	7
Am Bank Berhad	21	Conv	D	1975	7
RHB Bank	22	Conv	D	1997	7
Affin Bank Berhad	23	Conv	D	2001	7
Alliance Bank Berhad	24	Conv	D	2001	7
Bongkok Bank Berhad	25	Conv	F	1959	7
JP Morgan Chase Berhad	26	Conv	F	1964	7
Deutsche Bank Berhad	27	Conv	F	1967	7
Standard Chartered Bank Malaysia	28	Conv	F	1984	7
United Overseas Bank Berhad	29	Conv	F	1993	7
Bank of TokoyoBerhad	30	Conv	F	1994	7
HSBC Bank	31	Conv	F	1994	7
OCBC Bank Berhad	32	Conv	F	1994	7
The Bank of Nova Scotia Berhad	33	Conv	F	1994	7
Bank of China Berhad	34	Conv	F	2001	6
The Royal Bank of Scotland Berhad	35	Conv	F	2007	7
Industrial and Commercial Bank of China	36	Conv	F	2010	3
BNP Paris Malaysia Berhad	37	Conv	F	2010	2
Total	37				233

Isl: Islamic; Conv: Conventional

*Domestic or foreign bank;

** The bank Hong Leong Islamic Bank completed in November 2011 its merger with the EONCAP Islamic Bank.

The descriptive statistics of the variables of the two stochastic functions (cost and revenue) are presented in Table 2. Total loans as well as total securities portfolio of CBs are three times more than those of IBs. In addition, the high price of IBs' physical capital is essentially explained by the low value of net fixed assets with respect to total of amortization, depreciation, provision and other expenses.

Table 2. Descriptive statistics for the inputs and outputs of stochastic functions

All years	CBs		IBs		All	
	Mean	SD	Mean	SD	Mean	SD
Price of physical capital	2,757	3,484	31,128	74,577	14,864	50,638
Price of financial capital	0,023	0,009	0,021	0,006	0,022	0,008
Price of labor	0,006	0,003	0,005	0,005	0,006	0,004
Total loans (RM'000)	40321	50914	11140	11581	27869	41802
Securities portfolio (RM'000)	7843	11047	2245	2892	5454	8999

5. Presentation and Analysis of Results

5.1 Cost Efficiency

Table (A1) in the appendix presents the results of four cost efficiency frontiers. The first three relate to samples which respectively consist of IBs, CBs (specific frontiers) and of IBs and CBs (the common frontier). The fourth frontier is the global frontier (the meta-frontier) that envelops the first two. It is determined after solving the optimization problem (10). The parameters λ ($\lambda = \frac{\sigma_u}{\sigma_v}$) of the first three estimations appear statistically insignificant, which leads us to conclude that random shocks dominate in explaining inefficiency. Indeed, when $\lambda \sim 0$, this is almost equivalent to $\sigma_u \sim 0$ and / or $\sigma_v \sim +\infty$. This result is confirmed by estimating σ_v^2 and σ_u^2 given that the parameter σ_v^2 is statistically significant at the 1% level while σ_u^2 is insignificant. Moreover, the average of cost efficiency scores calculated from the two specific frontiers as well as the common frontier (Table (3)) show that IBs are more efficient than CBs. In addition, the difference of means test reveals that the detected differences are statistically significant, respectively, at the 1% and 10% levels.

Table 3. Average of cost efficiency scores of IBs and CBs

		Specific frontier		Common frontier		Meta-frontier	
	Obs	Mean	p-value	Mean	p-value	Mean	p-value
Islamic Banks	103	0,999353		0,999105		0,968548	
Conventional Banks	130	0,999217	0,0000	0,999104	0,0530	0,983122	0,0077
All	233	0,999276		0,999104		0,976788	

However, MFA (Note 6) shows that the average of efficiency scores of CBs is higher than that of IBs and that the difference is statistically significant at the 1% level. Table 4 and Figure 3b show that this latter result is explained by the evolution of the annual average of the technology gap ratio. Indeed, over the period 2006-2010, IBs obtained an average technological gap ratio lower than that of CBs, which translates according to Johnes et al. (2013), Abdul-Majid et al. (2011a, b), Johnes et al. (2009) and Abdul-Majid et al. (2008) the ineffectiveness of their modus operandi. This finding confirms the hypothesis which states that technological and environmental differences can be crucial and have to be taken into account when comparing groups in terms of banking efficiency.

The magnitude of the difference between efficiency measures presented by both methods (SFA and MFA) is also illustrated in Figures (3a) and (3c). This last figure highlights a negative relationship between cost efficiency and the capital base (Figure 2). Indeed, when cost efficiency of IBs increases between 2006 and 2012, their capital base decreases. Whereas, a decrease in the cost efficiency of CBs comes along an increase in their capital base. This result agrees with that of Altunbas et al. (2007) and Deelchand and and Padgett (2009).

Table 4. Annual averages of technological gap ratio over the period 2006-2012

	MEAN CE			TGR		MEAN OCE		
	IBs	CBs	All	IBs	CBs	IBs	CBs	All
2006	0,9993531	0,9992149	0,9992643	0,9272547	0,9855535	0,9266547	0,9847799	0,9640209
t test	40,9842*					0,1350		
2007	0,99935	0,9992168	0,9992673	0,9576331	0,9873055	0,9570106	0,9865323	0,9753344
t test	58,8025*					-4,0943*		
2008	0,9993521	0,9992202	0,9992842	0,9715222	0,9849017	0,9708927	0,9841336	0,9777023
t test	64,1838*					-2,1331**		
2009	0,9993532	0,9992168	0,999281	0,9709665	0,9880234	0,9703384	0,9872495	0,9792914
t test	71,5735*					-3,6650*		
2010	0,9993544	0,9992166	0,9992817	0,970983	0,988571	0,9703562	0,9877965	0,9795608
t test	60,7572*					-1,7169***		
2011	0,9993533	0,9992163	0,9992755	0,980795	0,9785577	0,9801607	0,9777908	0,9788156
t test	84,7853*					0,2214		
2012	0,9993538	0,9992179	0,9992751	0,985486	0,9765902	0,9848492	0,9758264	0,9796255
t test	44,0394*					0,7986		

(*) Translate a significance of 1% (**) of 5% and (***) of 10%. (CE) is cost efficiency calculated from the stochastic frontiers; and (OCE) is cost efficiency determined through the meta-frontier approach.

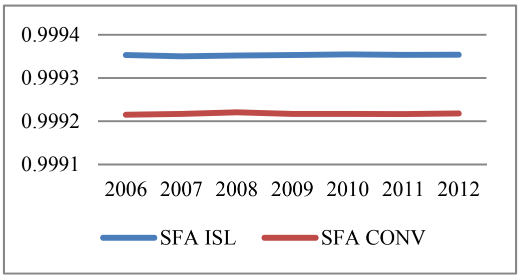

Figure 3a. Annual average of cost efficiency scores measured by the SFA

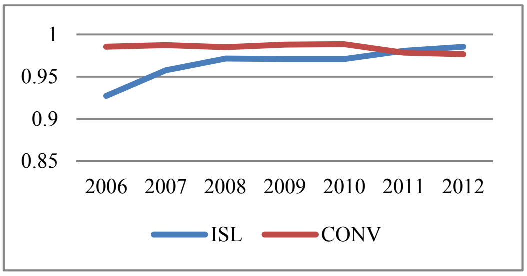

Figure 3b. Annual average of the technology gap ratio

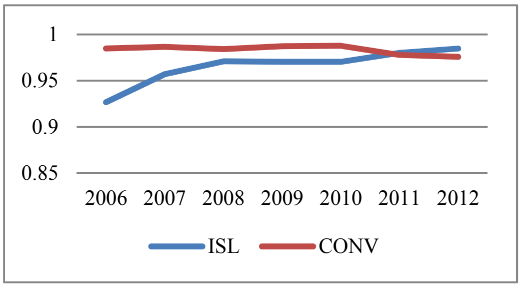

Figure 3c. Annual average of cost efficiency scores measured by the MF

5.2 Revenue Efficiency

Table (A1) in the appendix reports the results of the parameters of the four revenue efficiency frontiers. The averages of efficiency scores calculated from the specific frontiers, shown in Table 5, reveal that IBs have a higher revenue efficiency than CBs and that the difference is statistically significant at the 1% level. Table 5 shows also that this result is in line with the averages of efficiency scores measured by MFA. The annual evolution of the average of these scores is shown in Table 6 and Figures 4a and 4c. IBs' higher revenue efficiency is explained, according to Figure 4d, by the importance of revenues from their financing and lending operations compared to those of CBs. This figure highlights the similarity of the evolution trends of financing and lending revenues, divided by total assets, to those of the annual average of revenue efficiency scores determined by the meta-frontier function (Figure 4c). It should be noted that the decrease in IBs' revenues during 2008 is the result of the entry into operation of five new IBs (The Alliance Islamic Bank (end 2007), My Bank Islamic (end 2007), Public Bank (2008), OCBC Al-Amin Bank (2008), Standard Charactered (2008), HSBC Amanah (2008)) whose total assets represent approximately 68% of the total assets of the banks at the end of 2007. At the end of their first year of operation, these banks made too low revenues when scaled to their total assets. In addition, the decrease in CBs' revenues during 2009 is explained by the recession of the Malaysian economy in 2009 (a negative GDP growth rate (-1,513%) for the first time since 1998), which slowed down the growth in demand for financing and for banking services and caused, therefore, a decrease in lending rates.

Table 5. Average of revenue efficiency scores of IBs and CBs

		Specific frontier		Common frontier		Meta-frontier	
	Obs	Mean	p-value	Mean	p-value	Mean	p-value
Islamic Banks	103	0,9986653		0,9105815		0,9263455	
Conventional Banks	130	0,9148311	0,0000	0,9193982	0,0790	0,8979351	0,0007
All	233	0,9506052		0,9156359		0,9100585	

Moreover, Table 5 shows that the use of MFA resulted in a 7, 8% decrease in the average of efficiency scores of IBs while it has resulted in just a 1, 9% decrease in that of CBs. In this regard, Table 6 as well as Figure 4b show that all the technological gap ratios of IBs are lower than those of CBs, which confirms the assumption about the ineffectiveness of the modus operandi of IBs.

Table 6. Annual averages of the technology gap ratio over the period 2006-2012

	MEAN RE			TGR		MEAN ORE*		
	IBs	CBs	ALL	IBs	CBs	IBs	CBs	ALL
2006	0,9986643	0,9171888	0,9443473	0,9349579	0,9832759	0,9337091	0,9018266	0,9124541
t test	(4,1949)*					(1,4849)		
2007	0,998663	0,8996669	0,9372172	0,9070645	0,9892444	0,9058518	0,8903286	0,8962167
t test	(4,9500)*					(0,5638)		
2008	0,9986622	0,9347765	0,9667194	0,8766753	0,9826594	0,8755026	0,9186028	0,8976684
t test	(6,6220)*					(-1,4327)		
2009	0,9986683	0,919145	0,9565677	0,9354338	0,9870944	0,9341879	0,9074006	0,9200064
t test	(10,6755)*					(1,9260)***		
2010	0,9986691	0,9191437	0,9554982	0,9479319	0,9785048	0,9466701	0,8994819	0,9210537
t test	(9,9374)*					(3,5648)*		
2011	0,9986636	0,9155422	0,9511657	0,9450891	0,9673882	0,9438261	0,8854751	0,9104827
t test	(8,0417)*					(3,2765)*		
2012	0,9986654	0,9012086	0,9407181	0,948318	0,9831488	0,9470523	0,8863118	0,9109363
t test	(5,4524)*					(0,0073)*		

(*) Translates a significance of 1% (**) of 5% and (***) of 10%. (RE) is revenue efficiency calculated from the stochastic frontiers; and (ORE) is revenue efficiency determined through the meta-frontier approach.

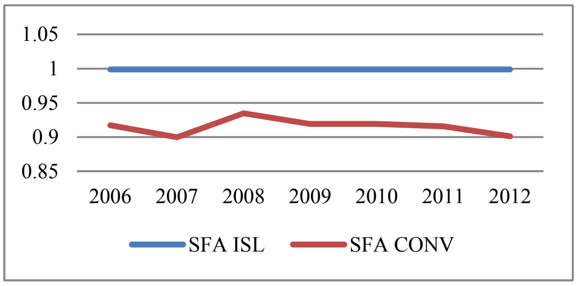

Figure 4a. Annual average of revenue efficiency scores measured by the SFA

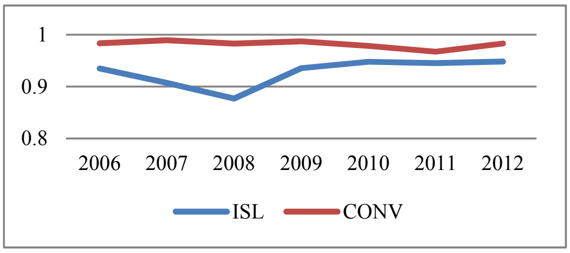

Figure 4b. Annual average of the technology gap ratio

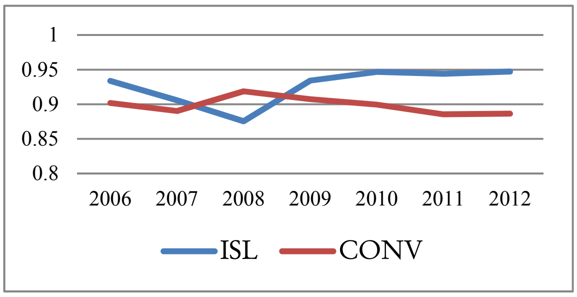

Figure 4c. Annual average of revenue efficiency scores measured by the MF

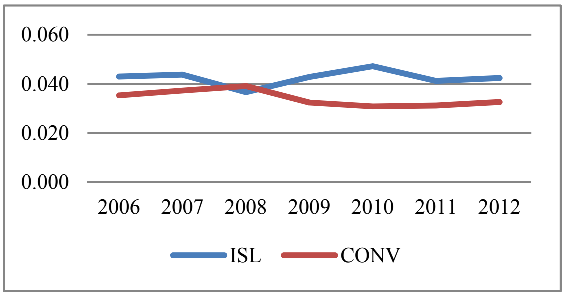

Figure 4d. Interest or profit income

6. Conclusion

The main objective of this study was to compare cost and revenue efficiency of Islamic and conventional banks over the period 2006-2012. For this purpose, two steps are performed. The first is to use the stochastic frontier method. The obtained results, based on specific and common frontiers, reveal that the average of cost and revenue efficiency scores of IBs are superior to those of CBs and that the differences are statistically significant at the 1% level.

The use of MFA, in a second step, made it possible to determine a global frontier that envelops the two specific frontiers. This approach corrects for the shortcomings of efficiency measures because of institutions operating under different production technologies. By using the genetic algorithm, the resolution of optimization programs related to the global frontiers of cost and revenue efficiency led to important results. For cost efficiency, the results show that the average of efficiency scores of CBs is higher than that of IBs and that the difference is statistically significant. The evolution of the annual average of the technological gap ratio proves that the low efficiency of IBs compared to CBs results from their modus operandi rather than from their managerial capability. This result agrees with that of Johnes et al. (2013). However, the analysis of the annual averages of cost efficiency scores showed that IBs become more efficient starting from 2011. The trend of the annual averages observed in both IBs and CBs contradicts that of the capital base. For revenue efficiency, the average of efficiency scores shows that IBs are more efficient than CBs even though the evolution of the technology gap ratio reaffirms the ineffectiveness of their modus operandi. This result is explained by the importance of IBs' revenues generated by lending and financing operations compared to those of CBs.

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Appendix

Table (A1). Parameters estimation of the different cost and revenue efficiency frontiers

	Cost efficiency				Revenue efficiency			
	Islamic	Conventional	Common	Meta-frontier	Islamic	Conventional	Common	Meta-frontier
α_1	0,1668594	0,500328***	0,1590492***	0,1154*	-0,2866857	1,234692**	0,073996	0,2620*
	(0,1469965)	*(0,2715282)*	*(0,0955418)*	*(2 ,00E-12)*	*(0,3066469)*	*(0,5518855)*	*(0,1746824)*	*(2,2e-012)*
α_2	-2,651468*	-0,4377865	-0,7726205*	-1,1492*	-3,639785**	2,774046**	0,9036876***	1,7494*
	(0,5464753)	*(0,3540121)*	*(0,2130411)*	*(1,10E-11)*	*(1,436716)*	*(1,098868)*	*(0,4820879)*	*(8,4e-012)*
α_3	0,8161025*	3,075159*	0,4200515*	0,4689*	-0,0422781	2,982532**	-0,537307**	-0,0500*
	(0,1931422)	*(0,5961614)*	*(0,1418506)*	*(2,90E-12)*	*(0,4019339)*	*(1,338251)*	*(0,2602116)*	*(4,3e-012)*
β_1	3,327204*	0,1257142	0,6166509**	0,4717*	2,472748***	0,5100291	-0,3033907	-0,8858*
	(0,6670809)	*(0,3752712)*	*(0,2487264)*	*(8,70E-12)*	*(1,389996)*	*(0,8605579)*	*(0,4567114)*	*(6,1e-012)*
β_2	-0,0930422	1,070829*	0,9254417*	0,8543*	0,6018553	0,3885877	0,9822634*	1,4219*
	(0,3414434)	*(0,2563816)*	*(0,1624565)*	*(4,60E-12)*	*(0,7874492)*	*(0,6319411)*	*(0,3158763)*	*(2,4e-012)*
α_{11}	0,0086005	-0,0303248	-0,0401967***	-0,0348*	0,057039	-0,0612283	0,0267472	0,0672*
	(0,0282428)	*(0,0359377)*	*(0,0217412)*	*(3,60E-13)*	*(0,0587574)*	*(0,0816596)*	*(0,0412614)*	*(2,9e-013)*
α_{12}	-0,0827917	0,0559387	0,0911009**	0,1156*	-0,275974**	0,100442	-0,029394	0,0048*
	(0,0629262)	*(0,0739441)*	*(0,0362221)*	*(1,80E-12)*	*(0,1312818)*	*(0,1520376)*	*(0,0658892)*	*(5,7e-013)*
α_{13}	-0,0346604	0,145016	-0,043093**	-0,0455*	0,0485172	0,3741423***	0,0588257	0,1399*
	(0,0249241)	*(0,1124262)*	*(0,021251*	*(7,10E-13)*	*(0,0520348)*	*(0,2278105)*	*(0,0395736)*	*(3,1e-013)*
α_{22}	-0,0595337	-0,3331931**	0,2470548*	-0,1307*	-0,4917561	0,0021221	0,2236692	0,3576*
	(0,1223669)	*(0,1352249)*	*(0,0591121)*	*(3,30E-12)*	*(0,3423216)*	*(0,5033675)*	*(0,180007)*	*(2,2e-012)*
α_{23}	-0,2498851*	-0,0047193	-0,4124838*	-0,2233*	-0,5629835*	0,668259**	-,4220873*	-0,2744*
	(0,0518868)	*(0,1430018)*	*(0,0370735)*	*(1,90E-12)*	*(0,1080738)*	*(0,3390118)*	*(0,071886)*	*(2,0e-012)*
α_{33}	0,1434989**	1,168309*	0,3655386*	0,2062*	0,3526856**	1,126587**	0,0881647	0,4521*
	(0,0725501)	*(0,2442965)*	*(0,0488816)*	*(1,50E-12)*	*(0,155846)*	*(0,5538592)*	*(0,0919066)*	*(4,1e-013)*
β_{11}	-0,578474*	0,197809**	0,124274	0,2707*	0,0590176	0,1979675	0,1272945	0,4653*
	(0,2107698)	*(0,0829337)*	*(0,08337)*	*(2,40E-12)*	*(0,4597324)*	*(0,1787581)*	*(0,1575272)*	*(1,4e-012)*
β_{12}	0,0597447	-0,1630442*	-0,1115508**	-0,2066*	-0,2775949	-0,1030239	-0,0898175	-0,2531*
	(0,0830229)	*(0,0479641)*	*(0,0448918)*	*(1,20E-12)*	*(0,1922181)*	*(0,1024255)*	*(0,0826894)*	*(7,1e-013)*
β_{22}	0,1229388*	0,1240072*	0,0618916**	0,141*	0,1542058**	0,0206534	0,0614986	0,1181*
	(0,0370391)	*(0,029958)*	*(0,0246113)*	*(9,10E-13)*	*(0,0773126)*	*(0,0643424)*	*(0,0452341)*	*(6,5e-013)*
δ_{11}	-0,114164**	-0,0766686***	-0,0468029	-0,0427*	0,0623429	-0,0816237	0,0119252	0,0348*
	(0,0515603)	*(0,0459008)*	*(0,0315609)*	*(7,10E-13)*	*(0,1075645)*	*(0,102716)*	*(0,0583056)*	*(6,1e-013)*
δ_{12}	0,0148424	0,0815777**	0,0361797	0,0487*	-0,0992512	0,0514605	0,0012724	-0,0098*
	(0,0360652)	*(0,0370215)*	*(0,022488)*	*(4,00E-13)*	*(0,0761191)*	*(0,0790581)*	*(0,0424561)*	*(2,8e-013)*
δ_{21}	0,6679552*	0,0139416	0,0180607	0,1799*	0,6583027***	-0,372114	-,3817774*	-0,4665*
	(0,1777313)	*(0,0934969)*	*(0,0663256)*	*(3,70E-12)*	*(0,3786344)*	*(0,2352121)*	*(0,1230545)*	*(1,9e-012)*
δ_{22}	0,0177813	0,123582**	0,2243721*	0,0779*	-0,2574779***	0,1081091	0,0754034	0,0892*
	(0,0721499)	*(0,0540546)*	*(0,0331251)*	*(1,60E-12)*	*(0,1568774)*	*(0,1679153)*	*(0,0816201)*	*(1,1e-012)*

δ_{31}	-0,3051988*	-0,2115719	-0,0573661	-0,1058*	-0,0540559	0,2769539	-0,168138***	0,0150*
	(0,0924738)	*(0,1363178)*	*(0,0514436)*	*(2,50E-12)*	*(0,1967671)*	*(0,2911813)*	*(0,09644)*	*(8,5e-013)*
δ_{32}	0,14466**	0,1997042***	0,0695299***	0,078*	0,0954775	-0,0810672	0,2600789*	0,2520*
	(0,0583953)	*(0,1050867)*	*(0,0362421)*	*(2,00E-12)*	*(0,1232548)*	*(0,2342902)*	*(0,0665362)*	*(5,5e-013)*
β_0	-6,243303*	2,51058*	-1,481441*	-1,4472*	-8,047526*	4,949004**	0,0596175	2,0510*
	(1,082235)	*(0,9618801)*	*(0,4404506)*	*(1,40E-11)*	*(2,565003)*	*(2,018476)*	*(0,8589696)*	*(1,4e-011)*
lnsig2v	-5,846961*	-6,317966*	-5,50102*		-4,38398*	-5,622267*	-4,766221*	
	(0,1397608)	*(0,1234759)*	*(0,0924245)*		*(0,1425491)*	*(0,4638671)*	*(0,3153603)*	
lnsig2u	-14,23366	-13,85212	-13,58385		-12,78439	-4,286915*	-4,347281*	
	(129,4787)	*(91,9349)*	*(90,18478)*		*(132,1359)*	*(0,4214377)*	*(0,6000163)*	
sigma_v	0,0537463	0,0424689	0,0638953		0,1116943	0,0601368	0,0922631	
	(0,0037558)	*(0,0026219)*	*(0,0029527)*		*(0,007961)*	*(0,0139477)*	*(0,0145481)*	
sigma_u	0,0008113	0,0009819	0,0011228		0,0016746	0,1172487	0,1137627	
	(0 ,0525254)	*(0,0451336)*	*(0,0506301)*		*(0,1106357)*	*(0,0247065)*	*(0,0341297)*	
sigma2	0,0028893	0,0018046	0,0040839		0,0124784	0,0173637	0,0214544	
	(0,0004062)	*(0,0002275)*	*(0,000382)*		*(0,0017891)*	*(0,0044788)*	*(0,0054915)*	
Lambda	0,0150957	0,0231195	0,0175726		0,0149925	1,949701	1,233025	
	(0 ,0529429)	*(0,0455844)*	*(0,0510365)*		*(0,1115174)*	*(0,0371969)*	*(0,0476039)*	
Loglikelihood	*154,9637*	*233,1531*	*315,56943*		*76.527949*	*129,9006*	*173,51065*	
Wald chi2	*6934,69*	*43081,37*	*25200,77*		*1881,32*	*6442,43*	*5940,64*	
P>chi2	*0,000*	*0,000*	*0,000*		*0,000*	*0,000*	*0,000*	

The values in parentheses are the standard deviation of the estimated parameters. (*)Translates a significance of 1%, (**) of 5% and (***) of 10%.

Table (A2). Classification of IBs and CBs according to their average efficiency score measured by the meta-frontier function

	Cost efficiency			Revenue efficiency	
	Banks	MeanSD		*Banks*	Mean SD
Conv	Public Bank Berhad	0,99795830,0003299	Isl	AmIslamic Bank	0,978852 0,0088028
Conc	Hong Leong Bank	0,99516630,0008246	Isl	My Bank Islamic	0,96085570,0198687
Conv	RHB Bank	0,99498140,0003581	Isl	Hong Leong Islamic Bank	0,960463 0,012626
Conv	Industrial and Commercial Bank of China	0,99486130,0043092	Isl	CIMB Islamic Bank	0,95822560,0140237
Conv	OCBC Bank Berhad	0,99297160,0004458	Isl	RHB Islamic Bank	0,95455440,0050982
Conv	Am Bank Berhad	0,99257170,0020576	Isl	Bank Muamalat Malaysia	0,95245490,003243
Conv	Affin Bank Berhad	0,992076 0,0013403	Conv	Bank of Tokyo Berhad	0,95182460,0041643
Conv	United Overseas Bank Berhad	0,99136260,0012423	Isl	Bank Islam Malaysia	0,95166920,0042666
Conv	MaybankBerhad	0,98739040,0025527	Isl	Public Islamic Bank	0,94168880,0429152
Isl	Bank Islam Malaysia	0,98733860,0021853	Isl	Kuwait Finance House	0,93648280,0031843
Conv	The Bank of Nova Scotia Berhad	0,98733270,0014481	Isl	HSBC Amanah	0,93544940,0057621
Isl	Hong Leong Islamic Bank	0,98667380,0020998	Conv	HSBC Bank	0,93415490,0069745
Isl	My Bank Islamic	0,98590150,0049151	Conv	RHB Bank	0,93319780,0059657
Conv	Bongkok Bank Berhad	0,98576580,003962	Isl	Affin Islamic Bank	0,93102240,0047637
Conv	Deutsche Bank Berhad	0,98550540,002989	Conv	Standard Chartered Bank	0,92982580,0064974

Conv	Bank of Tokyo Berhad	0,98516220,0031916	Conv	JP Morgan Chase Berhad	0,92852060,0079844
Conv	JP Morgan Chase Berhad	0,98454350,0058967	Conv	OCBC Bank Berhad	0,92828990,0074525
Isl	CIMB Islamic Bank	0,98359010,0066265	Isl	EONCAP Islamic Bank	0,92736590,0064789
Conv	Alliance Bank Berhad	0,98168940,0014164	Conv	Public Bank Berhad	0,924319 0,0063371
Isl	RHB Islamic Bank	0,98127590,0019902	Conv	Hong Leong Bank	0,91853530,0056126
Isl	Public Islamic Bank	0,98051540,0114383	Conv	Affin Bank Berhad	0,91482970,0069292
Isl	Bank Muamalat Malaysia	0,98046540,0012176	Conv	United Overseas Bank	0,91411860,0120952
Conv	HSBC Bank	0,97931350,0013244	Conv	MaybankBerhad	0,91315240,0125397
Isl	Kuwait Finance House	0,97920780,0033207	Conv	Alliance Bank Berhad	0,91233260,0061715
Conv	Standard Chartered Bank Malaysia	0,97862290,0026628	Conv	Am Bank Berhad	0,90412750,013042
Isl	OCBC Al Amin	0,97629740,0117706	Isl	Al Rajhi Banking	0,90367920,0287069
Conv	Bank of China Berhad	0,97624660,0082341	Isl	Alliance Islamic	0,88951840,0303272
Isl	Asian Finance Bank	0,97302540,0112308	Conv	Bank of China Berhad	0,88511140,0110995
Conv	The Royal Bank of Scotland Berhad	0,97189780,0104338	Conv	Deutsche Bank Berhad	0,862030,0207804
Isl	Affin Islamic Bank Berhad	0,97175460,0034717	Isl	OCBC Al Amin	0,85433190,0694085
Isl	Standard Chartered	0,97096820,0145379	Isl	Asian Finance Bank	0,84778970,0187823
Isl	AmIslamic Bank	0,96664950,0090458	Isl	Standard Chartered	0,834452 0,0548413
Isl	HSBC Amanah	0,96322780,0042957	Conv	The Bank of Nova Scotia	0,83193020,0262943
Isl	EONCAP Islamic Bank	0,94703060,0053357	Conv	BNP Paris Malaysia	0,68131740,0205469
Isl	Alliance Islamic	0,94124170,0342111	Conv	Bongkok Bank Berhad	0,83463190,0116444
Conv	BNP Paris Malaysia Berhad	0,93225870,0193494	Conv	The Royal Bank of Scotland	0,82543260,0277966
Isl	Al Rajhi Banking	0,88740060,0694782	Conv	Industrial and commercial	0,811490,0326995

Conv: Conventional; Isl: Islamic

Notes

Note 1. “Ribawis” goods are: gold, silver, wheat, barley, dates and salt.

Note 2. “Ribawis” goods are divided into two categories: money (gold and silver) and staples (wheat, barley, date and salt).

Note 3. Al Moukadimat Al Moumahidat(p. 71).

Note 4. (Born, died).

Note 5. Hayami and Ruttan (1971, p. 89).

Note 6. Table 7 (A2) in the appendix presents the classification of IBs and CBs according to their average efficiency score measured by the meta-frontier function.