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EFFICIENCY OF COMMERCIAL BANKS IN MALAYSIA

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ABSTRACT

This study investigates the change in the productivity of banking industry during the period of 2000 to 2004. The data consists of a panel of 11 commercial banks in Malaysia namely Malayan Banking, Bumiputra-Commerce, Public Bank, RHB Bank, Hong Leong Berhad, EON Bank, Affin Bank, Southern Bank Berhad, Bank Islam Malaysia Berhad (BIMB), Ambank and Bank Muamalat. Productivity is measured by the Malmquist index, using a Data Envelopment Analysis (DEA) technique. The Malmquist productivity measures are decomposed into two components: efficiency change and technical change index. Efficiency change is again decomposed into pure efficiency and scale efficiency. Overall, the results show that Total Factor Productivity (TFP) has slightly increased for the whole industry in which efficiency change is found to be the most important source of productivity growth to Malaysia's banking industry as compared to technical component that contributes a negative change to the overall TFP growth. In this case, the scale efficiency is found to be a more important source of efficiency change than pure efficiency component. This implies that the size does matter in improving bank efficiency. Negative growth of technical efficiency indicates a great potential for the industry to increase productivity through higher utilization of technology as well as technological knowledge dispersion. Continuous training programs to familiarize and improve technical expertise appear to offer better prospects for Malaysia's banking industry to achieve greater TFP growth.

Keywords: Data Envelopment Analysis (DEA), Malmquist index, bank efficiency, Islamic commercial banks in Malaysia

INTRODUCTION

The efficiency of financial institutions has been widely and extensively studied in the last few decades. For financial institutions, efficiency implies improved profitability, greater amount of funds channeled in, better prices and services quality for consumers and greater safety in terms of improved capital buffer in absorbing risk (Berger, Hunter, & Timme, 1993).

The study of efficiency of commercial banks is important for the Malaysian dual banking system where the Islamic banks are operating in parallel with the conventional banks. Furthermore, the landscape of Malaysian banking sector has undergone major structural change in the era of globalization with various liberalization measures being introduced during the last decade. This includes government reforms to improve the bank infrastructure, existing ownership structures, lending practices and capital requirements; deregulation to allow for increased competition, and focus on consolidation and mergers and acquisitions. As part of the reform to develop large, high-performing banks to support growth at home and abroad, the government promotes banking sector to move towards a more private market driven industry sector; to implement Basel Accord II or to adopt similar risk management standards; and to improve bank structure and performance in home country (Aziz, 2006). These factors are expected to have an impact on the efficiency of the commercial banks. This study therefore aims to extend the established commercial banking area by investigating efficiency of all the commercial banks incorporated in Malaysia.

The information obtained on the evaluation of the banks' performance may be used to improve its overall efficiency of operations and in turn, may contribute towards achieving its competitive edge. In this context, the objective of this study is to analyze the sources of efficiency and technical changes of all commercial banks in Malaysia. Using a non-parametric approach of Data Envelopment Analysis (DEA) together with Malmquist index, we isolate the contributions of technical change, efficiency change, the pure and scale changes to total factor productivity growth of different commercial banks and Islamic banks in Malaysia.

This paper is organized as follows. Section 2 presents the literature review, Section 3 discusses the methodology of DEA and Malmquist Index. Section 4 presents the results and analysis and finally, Section 5 concludes.

LITERATURE REVIEW

There are quite significant number of research conducted in the area of banking efficiency both for developed and emerging economies. Their findings have important implications for the bank management who always seek improvement of operating performance. For the policy makers, awareness on the determinants of bank efficiency may help in designing policies to improve the stability of the banking industry and to enhance the effectiveness of the monetary system as a whole.

The measurement of bank efficiency is mostly focused on two different approaches namely the parametric and non-parametric methods. The most commonly used parametric approaches are the Stochastic Frontier Approach (SFA), Distribution Free Approach (DFA) and the Thick Frontier Approach (TFA). Whereas, the most commonly used non-parametric approach are the DEA and the Free Disposable Hull (FDH) (Berger & Humphrey, 1997).

The SFA that is also known as the econometric frontier approach specifies a functional form for cost, profit or production relationship among inputs, outputs, and environmental factors while allowing for random error. Similarly, the DFA specifies a functional form for the frontier, but separates the inefficiencies in the random error in a different way. Lastly, the TFA also specifies a functional form and assumes that deviations from predicted performance values within the highest and lowest quartiles of observations represent random error. Among the studies that employ SFA to measure banks' efficiency are Fries and Taci (2005), Carvallo and Kasman (2005), Beccalli (2004), Kwan (2003), Hassan and Tufte (2001) and DeYoung and Hassan (1998). The results of these studies however, differ across studies and markets based on the selection of input and output indicators.

For the non-parametric approach, the DEA or the mathematical programming approach constructs the frontier of the observed input-output ratios by linear programming techniques. It estimates efficiency under the assumption of constant returns to scale and variable returns to scale. DEA assumes that linear substitution is possible between observed input combinations on an isoquant. The FDH is a special case of DEA model where it assumes that no substitution is possible so the isoquant looks like a step function formed by the intersection of lines drawn from observed input combinations. The studies that employ DEA include Sturm and Williams (2004), Mukherjee, Ray, and Miller (2001) and Wheelock and Wilson (1999).

Nevertheless, there is still an on-going debate as to which methodology is preferred for determining the best-practice frontier against which relative efficiencies are measured. Despite the debate, there seems to be an emerging view suggesting that it is not necessary to have consensus as to one single frontier approach for measuring bank efficiency. Instead, there should be consistent conditions for efficiency measures derived from various methodologies to meet. Therefore if efficiency estimates are consistent across various approaches, then these measures are therefore valid estimates. In this present paper, we choose to employ the DEA by using the Malmquist index. The advantages of using this index will be highlighted in the methodology section. In this section, we highlight existing studies on banking efficiencies that used the DEA.

Initially, modern efficiency measurement begins with Farrell (1957) to define a simple measure of a firm efficiency which could account for multiple inputs. He proposed that the efficiency of a firm consists of two components: *technical efficiency* which reflects the ability of a firm to obtain maximal output from a given set of inputs, and *allocative efficiency*, which reflects the ability of a firm to use inputs in optimal proportions, given their respective prices. For example, if a given firm uses quantities of inputs to produce a unit of output, the technical inefficiency of that firm could be represented by certain distance, which is the amount by which all inputs could be proportionally reduced without a reduction in output (Coelli, 1996). Technical efficiency takes a value between zero and one, and hence provides an indicator of the degree of technical inefficiency of the firm. A value of one indicates the firm is fully technically efficient.

In analyzing the change in the productivity of Australian banks during the period of 1995 to 1999, Sathye (2002) finds that technical efficiency of banks in the panel has declined by 3.1% and the Total Factor Productivity (TFP) declined by 3.5%. The data of the study consists of annual observations of outputs, i.e. net interest income and non-interest income and inputs such as interest expenses and non-interest expenses. By using the intermediation approach, the study concludes that although the mean technical change efficiency change and the mean of TFP remain positive, the decline in productivity is still a cause for concern. For the European and the US banking system, Pastor, Perez, and Quesada (1997), use a different approach namely the added value approach to select the output and input variables. Loans, other productive assets and deposits are selected as output while non-interest expenses and personal expenses are taken as inputs. The study finds that France, Spain and Belgium appear as the countries with the most efficient banking systems, whereas, UK, US and Germany show the lowest efficiency levels. By selecting different input and output combinations for the US banking system, Wheelock and Wilson (1999) and Mukherjee et al. (2001) assert that for the period of 1984 to1990, banks of all sizes experienced reduction in technical efficiency and that, on average the productivity growth was about 4.5% per year.

For the Malaysian banking system, Abd. Karim (2001), Abd. Majid, Md. Nor, and Said (2003), Amir (2004) and Suhaimi (2005) employ the parametric approach to measure the efficiency of both conventional and Islamic banks. Abd. Karim (2001) investigates efficiencies of banks in selected ASEAN countries and the overall results suggest that ASEAN banks enjoy increasing returns to scale and larger banks tend to have higher cost efficiency than smaller banks. Abd. Majid et al. (2003) finds that there is no empirical evidence that foreign banks are more efficient than local banks. Consistent with Abd. Majid et al. (2003), Suhaimi (2005) provides empirical evidence that there are no significant differences in terms of cost and profit efficiency between local and foreign banks. In addition, the local bank appear to reach its optimum profit efficiency at the asset size of RM40 billion, whereas the foreign bank reach its highest profit efficiency at a smaller asset size of RM15 billion. This could be partly due to the fact that local bank is more susceptible to macroeconomic shocks than foreign banks. However, over the medium term foreign banks are only marginally superior to local banks. During the 1997 financial crisis, it seems that the local banks were more exposed to the risks than foreign banks operating in Malaysia. It is also possible that during the said period, the local banks have higher levels of non-performing loans and loan losses as compared to the foreign banks. Finally, unlike foreign banks, the local banks were less capitalized and most of the banks were operating with higher expenses.[1]

RESEARCH METHODOLOGY

The motivation of our paper is to investigate efficiency of all the commercial banks in Malaysia using the nonparametric approach. This study adopts the generalized output-oriented Malmquist index, developed by Fare, Grosskopf, Lindgren, and Ross (1989), to measure the contributions from the progress in technology (technical change) and improvement in efficiency (efficiency change) to the growth of productivity in Malaysian commercial bank industries. The Malmquist indexes are constructed using the DEA and estimated using a program developed by Coelli (1996), called DEAP version 2.1. Malmquist index was chosen as there are a number of desirable features for this particular study. The DEA does not require input prices or output prices in their construction, which make the method particularly useful in situations in which prices are not available publicly or non-existent. The method also does not require a behavioral assumption such as cost minimization or profit maximization in the case where the producers' objectives differ, unknown or unachieved. This is first

[1] Most of the studies find that more efficient banks have lower levels of non-performing loans and the inefficient bank is associated with higher loan losses. Generally, the banks with higher expense may overutilise inputs and therefore be less efficient (Berger & Humphrey, 1997).

demonstrated by Fare et al. (1989) using the geometric mean formulation of the Malmquist index. Following this, Forsund (1991) derived the decomposition of the simple version of the Malmquist productivity index into technical change and efficiency change.

Fare, Shawna, and Knox (1994) listed several traditional methods to calculate the Malmquist productivity index. But most of them require specification of a function form for technology. Charnes et al. (1978) proposed the DEA to construct a best-practice frontier without specifying production technology. Unlike traditional analysis techniques that look for the average path through the middle points of a series of data, DEA looks directly for a best-practice frontier within the data. Using a non-parametric linear programming technique, DEA takes into account of all the inputs and outputs as well as differences in technology, capacity, competition, and demographics and then compares individual with the best-practice (efficiency) frontier. According to Ali and Seiford (1993), DEA is a well-established non-parametric efficiency measurement technique which has been used extensively in over 400 studies of efficiency in management sciences during the last decade.

In 1953, Sten Malmquist, a Swedish economist and statistician, published in *Trabajos de Estadistica* (Malmquist, 1953) a quantity index for use in consumption analysis. Later Caves, Cristensen, and Diewert (1982) adapted Malmquist's idea for production analysis and they named the productivity changes index after Sten Malmquist. Because of its advantages, the Malmquist productivity indexes and DEA have been used in a variety of studies. These studies include aggregate comparisons of productivity between countries (Fare, Shawna, Mary, & Zhongyang, 1994) as well as various economic sectors such as agriculture by Tauer (1998) and Mao and Koo (1996), airlines by Alam and Sickles (1995), telecommunications industry by Asai and Nemoto (1999) and Calabrese, Campisi, and Paolo (2001), banking by Tulkens and Malnero (1996), and universities by Avkiran (2001).

Fare et al. (1989) showed that the output-based Malmquist productivity index between time periods t and $(t + 1)$ can be decomposed into two components, as:[2]

$$M_o\left(x^t, y^t, x^{t+1}, y^{t+1}\right) = \left(\frac{D_o^t\left(x^{t+1}, y^{t+1}\right)}{D_o^t\left(x^t, y^t\right)} \frac{D_o^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_o^{t+1}\left(x^t, y^t\right)}\right)^{\frac{1}{2}} \tag{1}$$

[2] See, for example, Fare, Shawna, Mary, and Zhongyang (1994), Coelli (1996), and Grifell and Lovel (1997).

where the notations $D_o^t\left(x^{t+1}, y^{t+1}\right)$, represents the distance from the period $t + 1$ observation to the period t technology, while x and y indicate input and output, respectively. Following Fare et al. (1989), an equivalent way of writing the Malmquist productivity index (1) is as follows:

$$M_o\left(x^t, y^t, x^{t+1}, y^{t+1}\right) = \frac{D_o^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_o^t\left(x^t, y^t\right)} \times \left[\left(\frac{D_o^t\left(x^{t+1}, y^{t+1}\right)}{D_o^{t+1}\left(x^{t+1}, y^{t+1}\right)}\right)\left(\frac{D_o^t\left(x^t, y^t\right)}{D_o^{t+1}\left(x^t, y^t\right)}\right)\right]^{\frac{1}{2}} \quad (2)$$

where the first ratio on the right hand side of Equation (2) measures the change in relative efficiency (i.e., the change in how far observed production is from maximum potential production) between years t and $t + 1$. The second term inside the squared brackets (geometric mean of the two ratios) captures the shift in technology (i.e., movements of the frontier function itself) between the two periods evaluated at x^t and x^{t+1}. That is:

$$\text{Efficiency change} = \frac{D_o^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_o^t\left(x^t, y^t\right)} \quad (3)$$

$$\text{Technical change} = \left[\left(\frac{D_o^t\left(x^{t+1}, y^{t+1}\right)}{D_o^{t+1}\left(x^{t+1}, y^{t+1}\right)}\right)\left(\frac{D_o^t\left(x^t, y^t\right)}{D_o^{t+1}\left(x^t, y^t\right)}\right)\right]^{\frac{1}{2}}. \quad (4)$$

Essentially, the former investigates how well the production process converts inputs into outputs (catching up to the frontier) and the latter reflects improvement in technology. According to Fare, Shawna, Mary, and Zhongyang (1994), improvements in productivity yield Malmquist index values greater than unity. Deterioration in performance over time is associated with a Malmquist index less than unity. The same interpretation applies to the values taken by the components of the overall TFP index. Improvement in the efficiency component yielded index values greater than one and is considered to be evidence of catching up (to the frontier). Values of the technical change component greater than one are considered to be evidence of technological progress.

In empirical applications, four distances measures that appear in Equation (2) above are calculated for each operator in each pair of adjacent time periods using mathematical programming technique. Assume that there are $k = 1, \ldots, K$ firms that produce $m = 1, \ldots, M$ outputs $y^t_{k,m}$ using $n = 1, \ldots, N$ inputs $x^t_{k,n}$ at each time period $t = 1, \ldots, T$. Under DEA, the reference technology with constant returns to scale (CRS) at each time period t from the data can be defined as:

$$G^t = \left[\left(x^t, y^t \right) : y_m^t \le \sum_{k=1}^{K} z_k^t y_{k,m}^t \right] \quad m = 1,\ldots, M,$$
$$\sum_{k=1}^{K} z_k^t x_{k,n}^t \le x_n^t \qquad n = 1,\ldots, N, \tag{5}$$
$$z_k^t \ge 0 \qquad k = 1,\ldots, K,$$

where z^t_k refers to weight on each specific cross-sectional observation. Following Afriat (1972), the assumption of CRS may be relaxed to allow variable returns to scales (VRS) by adding the following restriction:

$$\sum_{k=1}^{K} z_k^t = 1 \quad \text{(VRS)}. \tag{6}$$

Following Fare, Shawna, Mary, and Zhongyang (1994), this study used an enhanced decomposition of the Malmquist index by decomposing the efficiency change component calculated relative to the CRS technology into a pure efficiency component (calculated relative to the VRS technology) and a scale efficiency change component which captures changes in the deviation between the VRS and CRS technology. The subset of pure efficiency change measures the relative ability of operators to converts inputs into outputs while scale efficiency measures to what extent the operators can take advantage of returns to scale by altering its size towards optimal scale.

To construct the Malmquist productivity index of firm k' between t and t + 1, the following four distance functions are calculated using DEA approach: $D_o^t\left(x^t, y^t\right)$, $D_o^{t+1}\left(x^t, y^t\right)$, $D_o^t\left(x^{t+1}, y^{t+1}\right)$, $D_o^{t+1}\left(x^{t+1}, y^{t+1}\right)$. These distance functions are the reciprocals of the output-based Farrell's measure of technical efficiency. The non-parametric programming models used to calculate the output-based Farrell measure of technical efficiency for each firm k' = 1, …, K, is expressed as:

$$\left[D_o^t \left(x_{k'}^t, y_{k'}^t \right) \right]^{-1} = \max \lambda^{'k'} \tag{7}$$

subject to

$$\begin{aligned}
&\lambda^{k'} y^t_{k,m} \le \sum_{k=1}^{K} z^t_k y^t_{k,m} && m = 1, \ldots, M, \\
&\sum_{k=1}^{K} z^t_k x^t_{k,n} \le x^t_{k',n} && n = 1, \ldots, N, \\
&\sum_{k=1}^{K} z^t_k = 1 && \text{(VRS)} \\
&z^t_k \ge 0 && k = 1, \ldots, K.
\end{aligned} \tag{8}$$

The computation of $D^{t+1}_o\left(x^{t+1}, y^{t+1}\right)$ is similar to Equation (8), where $t + 1$ is substituted for t.

Construction of the Malmquist index also requires calculation of two mixed-distance functions, which is computed by comparing observations in one time period with the best practice frontier of another time period. The inverse of the mixed-distance function for observation k' can be obtained from:

$$\left[D^t_o\left(x^{t+1}_{k'}, y^{t+1}_{k'}\right)\right]^{-1} = \max \lambda^{'k'} \tag{9}$$

subject to

$$\begin{aligned}
&\lambda^{k'} y^{t+1}_{k,m} \le \sum_{k=1}^{K} z^t_k y^t_{k,m} && m = 1, \ldots, M, \\
&\sum_{k=1}^{K} z^t_k x^t_{k,n} \le x^{t+1}_{k',n} && n = 1, \ldots, N, \\
&\sum_{k=1}^{K} z^t_k = 1 && \text{(VRS)} \\
&z^t_k \ge 0 && k = 1, \ldots, K.
\end{aligned} \tag{10}$$

To measure changes in scale efficiency, the inverse output distance functions under the VRS technology are also calculated by adding Equation (6) into the constraints in Equations (8) and (10). Technical change is calculated relative to the CRS technology. Scale efficiency change in each time period is constructed as the ratio of the distance function satisfying CRS to the distance function under VRS, while the pure efficiency change is defined as the ratio of the own-period distance functions in each period under VRS. With these two distance functions with respect to the VRS technology, the decomposition of Equation (2) becomes:

$$M_o\left(x^t, y^t, x^{t+1}, y^{t+1}\right) = \left(\frac{D_o^{t+1}\left(x^t, y^t\right)}{D_o^t\left(x^t, y^t\right)}\right)\left(\frac{D_o^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_o^t\left(x^{t+1}, y^{t+1}\right)}\right)^{\frac{1}{2}} \times \left(\frac{D_o^t\left(x^t, y^t\right)}{D_o^{t+1}\left(x^{t+1}, y^{t+1}\right)}\right)$$
$$\times \left(\frac{D_{oc}^{t+1}\left(x^t, y^t\right)}{D_o^{t+1}\left(x^t, y^t\right)} \frac{D_o^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_{oc}^{t+1}\left(x^{t+1}, y^{t+1}\right)} \frac{D_{oc}^t\left(x^t, y^t\right)}{D_o^t\left(x^t, y^t\right)} \frac{D_o^t\left(x^{t+1}, y^{t+1}\right)}{D_{oc}^t\left(x^{t+1}, y^{t+1}\right)}\right)^{\frac{1}{2}} \tag{11}$$

where

$$\left(\frac{D_o^{t+1}\left(x^t, y^t\right)}{D_o^t\left(x^t, y^t\right)}\right)\left(\frac{D_o^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_o^t\left(x^{t+1}, y^{t+1}\right)}\right)^{\frac{1}{2}} = \text{Technical change}$$

$$\left(\frac{D_o^t\left(x^t, y^t\right)}{D_o^{t+1}\left(x^{t+1}, y^{t+1}\right)}\right) = \text{Pure efficiency change}$$

$$\left(\frac{D_{oc}^{t+1}\left(x^t, y^t\right)}{D_o^{t+1}\left(x^t, y^t\right)} \frac{D_o^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_{oc}^{t+1}\left(x^{t+1}, y^{t+1}\right)} \frac{D_{oc}^t\left(x^t, y^t\right)}{D_o^t\left(x^t, y^t\right)} \frac{D_o^t\left(x^{t+1}, y^{t+1}\right)}{D_{oc}^t\left(x^{t+1}, y^{t+1}\right)}\right)^{\frac{1}{2}} = \text{Scale efficiency change}$$

Note that when the technology in fact exhibits CRS, the scale change factor equals to one and it is the same decomposition as Equation (2).

MEASURING EFFICIENCY: INPUT AND OUTPUT SPECIFICATIONS

The definition and measurement of bank's inputs and output have been a matter of long standing debate among researchers. In defining inputs and outputs, three main approaches have been widely used in banking literature, namely the production approach, the intermediation approach and the modern approach. The first two approaches apply traditional microeconomic theory of the firm to banking and differ only in the specification of banking activities. In the production approach, bank defines its activity as production of services and views the banks as using physical inputs such as labor and capital to provide deposit and loan accounts. While the intermediation approach views banks as the intermediator of financial services and assumes that banks collect deposits, using labor and capital, then intermediate those sources of funds into loans and other earning assets (Sealey & Lindley, 1977). This intermediation approach is argued to be particularly appropriate for banks where most activities consist of turning large deposits and funds purchased from other financial institutions into loans or financing and investments (Favero & Papi, 1995). Finally, the third approach goes one step further and incorporates some specific activities into the classical theory.

Since the intermediation approach has been used extensively in determining the inputs and outputs of the bank industry, this study therefore adopts this approach. Three inputs and outputs are utilized to investigate efficiency of 11 commercial banks in Malaysia (Malayan Banking, Bumiputra-Commerce, Public Bank, RHB Bank, Hong Leong Berhad, EON Bank, Affin Bank, Southern Bank Berhad, Bank Islam Malaysia Berhad (BIMB), Ambank and Bank Muamalat) for the period of 2000 to 2004. The outputs are loans and advances, capital market investments, and money market investments, while inputs are total deposits, personnel expenses, and capital expenses.[3]

Table 1
Descriptive Statistics of Inputs and Outputs of the Commercial Banks, 2000–2004

	Mean	Median	Maximum	Minimum	Std. Dev.
Input					
Total deposits	29,205,370	16,299,759	111,046,214	4,696,464	26,327,587
Personnel expenses	259,348	162,053	974,371	35,713	239,709
Capital expenses	46,506	31,173	141,137	4,455	37,446
Output					
Loans and advances	21,923,715	12,544,988	86,718,412	1,726,830	21,270,914
Capital market investment	1,142,230	675,375	7,753,559	0	1,582,997
Money market investment	3,446,204	2,085,903	14,946,581	285,187	3,576,070

Table 1 reports descriptive statistics of outputs and inputs of 11 commercial banks in Malaysia during the study period. On the average, loans and advances and total deposits are the most common output and input in the Malaysian banking industry, respectively. Of 11 commercial banks, Malayan Banking is found to have the highest figures of outputs and inputs, with the

[3] We have also tried to use three other different pairs of inputs and outputs, the results are not much different.

exception of capital expenses (RHB Bank records the highest figures). On the other hand, Bank Muamalat is found to have the lowest value of outputs and inputs, with the exception of money market investments (Ambank records the lowest figures). This is simply due to the fact that Bank Muamalat is a newly established bank as of October 1, 1999.

EMPIRICAL RESULTS

Production Frontier and Efficiency

Since the basic component of the Malmquist productivity index is related to measures of efficiency, the study first reports efficiency change for the 11 banks from 2000 to 2004 in Tables 1 and 2 under CRS and VRS. Values of unity imply that the firm is on the industry frontier in the associated year. Values less than unity imply that the firm is below the frontier or technically inefficient. Thus, the lower the values from unity the more inefficient it is compared to the values closer to one.

For the years reported in Tables 2 and 3, EON Bank, Southern Bank, Ambank, and Bank Muamalat are consistently efficient, both under CRS and VRS. In addition, Malayan Banking, Bumiputra-Commerce, RHB Bank, and Affin Bank are also found to be consistently efficient under VRS. On the contrary, Hong Leong Bank, Public Bank and BIMB are the least efficient banks for CRS and VRS versions, respectively. The estimates also indicate that except BIMB, Public Bank and Hong Leong Bank have successfully kept pace with technically feasible production possibilities and increased their distance to the industrial production frontier for both versions of technology.

The inverse of the values in Tables 2 and 3 show the percentage of the realized output level compared to the maximum potential output level at the given input mix. Thus for example Bumiputra-Commerce produced 83.4% of its potential output and Public Bank produced only 63.8% of its potential output in 2000 under CRS version. On the contrary, under VRS version, Public Bank produced 80.6% of its potential output and Hong Leong Bank produced only 80.2% of its potential output in 2000.

As indicated by the weighted geometric mean in Tables 2 and 3, the average efficiency for the whole industry increased continuously from 2000 to 2002, but showed a slight decline in 2003. In 2004, the average efficiency again increased. Figure 1 gives a visual summary of the whole industry efficiency change from 2000 to 2004 under the two versions of technology. The average efficiency performance of the Malaysia's commercial banking industry is relatively higher based on VRS than CRS. Most of the banks achieved highest efficiency in 2004, while the lowest efficiency was realized in 2003 for both VRS and CRS.

Table 2
Efficiency of the Commercial Banks, 2000–2004 (CRS)

No.	Bank	2000	2001	2002	2003	2004
1	Malayan Banking	1.000	0.967	1.000	1.000	1.000
2	Bumiputra-Commerce Bank	0.834	1.000	1.000	0.998	1.000
3	Public Bank	0.638	0.831	0.740	0.767	0.908
4	RHB Bank	0.919	0.993	0.970	0.986	1.000
5	Hong Leong Bank	0.788	0.693	0.674	0.717	1.000
6	EON Bank	1.000	1.000	1.000	1.000	1.000
7	Affin Bank	0.901	1.000	1.000	1.000	1.000
8	Southern Bank	1.000	1.000	1.000	1.000	1.000
9	BIMB	1.000	0.667	0.977	0.852	0.775
10	Ambank	1.000	1.000	1.000	1.000	1.000
11	Bank Muamalat	1.000	1.000	1.000	1.000	1.000
	Mean	0.916	0.923	0.942	0.938	0.971

Table 3
Efficiency of the Commercial Banks, 2000–2004 (VRS)

No.	Bank	2000	2001	2002	2003	2004
1	Malayan Banking	1.000	1.000	1.000	1.000	1.000
2	Bumiputra-Commerce Bank	1.000	1.000	1.000	1.000	1.000
3	Public Bank	0.806	1.000	0.742	0.772	1.000
4	RHB Bank	1.000	1.000	1.000	1.000	1.000
5	Hong Leong Bank	0.802	0.760	0.751	0.722	1.000
6	EON Bank	1.000	1.000	1.000	1.000	1.000
7	Affin Bank	1.000	1.000	1.000	1.000	1.000
8	Southern Bank	1.000	1.000	1.000	1.000	1.000
9	BIMB	1.000	1.000	0.996	0.883	0.852
10	Ambank	1.000	1.000	1.000	1.000	1.000
11	Bank Muamalat	1.000	1.000	1.000	1.000	1.000
	Mean	0.964	0.978	0.954	0.943	0.987

Figure 1. Malaysia commercial banks industry efficiency performance, 2000–2004

Productivity Performance of Individual Bank

Tables 4 to 6 report the performance of banks from 2000 to 2004 for TFP change and its two subcomponents, technical change and efficiency change respectively. Note that a value of the Malmquist TFP productivity index and its components of less than one imply a decrease or a deterioration. Conversely, values greater than one indicate improvements in the relevant aspect.

Subtracting 1 from the number reported in the table gives an average increase or decrease per annum for the relevant time period and relevant performance measure. Also note that these measures capture performance relative to the best practice in the relevant performance or relative to the best practice in the sample.

Table 4 displays calculated changes in the Malmquist-based TFP index. As evidenced in the results, Public Bank and Bumiputra-Commerce have positive productivity changes for all the two adjacent years of the study period. In contrast, Ambank, BIMB and Bank Muamalat recorded highest deterioration in TFP for the period of 2000 to 2001 and 2000 to 2004. In addition, Public Bank has the highest average TFP growth at an annual average rate of 15%, Bumiputra-Commerce follows next with an annual rate of 6.1%, and then Hong

Leong Bank came after with an annual rate of 6%. Overall, all the banks have increased their TFP on average by at least 13% per year for the period of 2000 to 2004. The Malmquist TFP index is further decomposed into its two components, technical change and efficiency change. The results of technical change and efficiency change are reported in Tables 5 and 6.

Table 4
Banks Relative Malmquist TFP Change between Time Period t and t + 1, 2000–2004

No.	Bank	2000–2001	2001–2002	2002–2003	2003–2004	Mean
1	Public Bank	1.194	1.022	1.069	1.340	1.150
2	Bumiputra-Commerce Bank	1.103	1.150	0.989	1.011	1.061
3	Hong Leong Bank	0.921	1.010	0.985	1.379	1.060
4	Malayan Banking	0.987	1.175	1.025	1.053	1.058
5	Southern Bank	0.982	1.059	0.971	1.206	1.050
6	RHB Bank	1.055	1.001	1.010	1.099	1.040
7	Affin Bank	0.979	1.101	1.051	0.981	1.027
8	EON Bank	0.764	1.185	1.051	1.042	0.998
9	Ambank	0.643	0.933	0.978	1.335	0.941
10	BIMB	0.747	1.154	0.903	0.920	0.920
11	Bank Muamalat	0.685	1.006	0.970	0.837	0.865
	Mean	0.898	1.069	0.999	1.096	1.013

Table 5 presents the index values of technical progress/regress as measured by average shifts in the best-practice frontier from period *t* to *t* + 1. According to the results, Malayan Banking is the only bank that experienced technical progress from year 2000 to 2004, while the other banks experienced both technical progress and regress. Over the period of analysis, Ambank recorded the highest change in technical regress (–3.5%) in the year 2000 to 2001 and also in technical progress (33.5%) in the year 2003 to 2004. Table 5 also displays that technical progress has been experienced by 9 banks (2001–2002), 8 banks (2003–2004), 5 banks (2002–2003) and 3 banks (2000–2001). On the average, the year 2000 to 2001 is found as the year of technical regress (–10.7%), while from the year 2000 to 2001 onwards the commercial banks in Malaysia recorded technical progress. Out of 11 banks, 5 banks (Hong Leong, EON, BIMB, Ambank and Muamalat) are found to have technical regresses. Malayan Banking is found as the most technical progressive bank (5.8%), while Bank Mualamat is found as the most technical regressive bank (–13.5%).

Table 5
Banks Relative Technical Change between Time Period t and t + 1, 2000–2004

No.	Bank	2000–2001	2001–2002	2002–2003	2003–2004	Mean
1	Malayan Banking	1.021	1.136	1.025	1.053	1.058
2	Public Bank	0.916	1.147	1.031	1.132	1.052
3	Southern Bank	0.982	1.059	0.971	1.206	1.050
4	RHB Bank	0.975	1.025	0.993	1.084	1.019
5	Bumiputra-Commerce Bank	0.920	1.150	0.991	1.009	1.014
6	Affin Bank	0.883	1.101	1.051	0.981	1.001
7	Hong Leong Bank	1.047	1.039	0.926	0.989	0.999
8	EON Bank	0.764	1.185	1.051	1.042	0.998
9	BIMB	1.120	0.787	1.036	1.011	0.980
10	Ambank	0.643	0.933	0.978	1.335	0.941
11	Bank Muamalat	0.685	1.006	0.970	0.837	0.865
	Mean	0.893	1.045	1.001	1.055	0.996

Table 6 displays changes in relative efficiency for each individual bank. The results indicate considerable variation across banks and times. Only four banks (EON, Southern, Ambank and Muamalat) are found to be efficient (and therefore showed no change in efficiency) in all periods from 2000 to 2004.[4] For the other banks, there are periods with positive, negative or no changes in efficiency. Furthermore, the results show that many banks improved their efficiency during the period of 2003 to 2004. This could be partly due to the ability of majority commercial banks under the study to increase significantly their loans and advances, capital market investment and money market investment as the economy recovers from the 1997 financial crisis. During the same period, the banks also seem to be able to minimize their personnel and capital expenses. For the whole period of analysis, our results further indicate that, on the average, Public Bank records the highest efficiency change with 9.2%, followed by Hong Leong Bank with 6.2%, Bumiputra-Commerce with 4.6%, Affin Bank with 2.6% and RHB Bank with 2.1%. BIMB is found to be the only bank that experienced efficiency deterioration with –6.2%. Although BIMB records the highest efficiency improvement during the period of 2001 to 2002 with 44.6%, on the average BIMB is found to have the worst efficiency deterioration. This is perhaps due to BIMB having a significant increase in capital and money market investments during the particular period. Overall, with the exception of the period of 2002 to 2003, all other periods from 2000 to 2004 record a positive efficiency change.

[4] On the average, the Malayan Banking also recorded to be an efficient bank during the entire period of the study.

Table 6
Changes in Banks Relative Efficiency between Time Period t and t + 1, 2000–2004

No.	Bank	2000–2001	2001–2002	2002–2003	2003–2004	Mean
1	Public Bank	1.303	0.890	1.037	1.184	1.092
2	Hong Leong Bank	0.880	0.972	1.064	1.395	1.062
3	Bumiputra-Commerce Bank	1.199	1.000	0.998	1.002	1.046
4	Affin Bank	1.109	1.000	1.000	1.000	1.026
5	RHB Bank	1.081	0.977	1.017	1.014	1.021
6	Malayan Banking	0.967	1.034	1.000	1.000	1.000
7	EON Bank	1.000	1.000	1.000	1.000	1.000
8	Southern Bank	1.000	1.000	1.000	1.000	1.000
9	Ambank	1.000	1.000	1.000	1.000	1.000
10	Bank Muamalat	1.000	1.000	1.000	1.000	1.000
11	BIMB	0.667	1.466	0.872	0.910	0.938
	Mean	1.006	1.023	0.998	1.039	1.016

In order to identify a change in scale efficiency, the efficiency change is further decomposed into two subcomponents, namely pure efficiency change and scale efficiency change in which the results are reported in Table 7.

Table 7
Changes in Efficiency Components by Banks between Time Period t and t + 1, 2000–2004

		2000–2001		2001–2002		2002–2003		2003–2004	
No.	Bank	PEch	SEch	PEch	SEch	PEch	SEch	PEch	SEch
1	Malayan Banking	1.000	0.967	1.000	1.034	1.000	1.000	1.000	1.000
2	Bumiputra-Commerce Bank	1.000	1.199	1.000	1.000	1.000	0.998	1.000	1.002
3	Public Bank	1.241	1.050	0.742	1.200	1.040	0.997	1.295	0.914
4	RHB Bank	1.000	1.081	1.000	0.977	1.000	1.017	1.000	1.014
5	Hong Leong Bank	0.948	0.928	0.988	0.984	0.961	1.107	1.385	1.007
6	EON Bank	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	Affin Bank	1.000	1.109	1.000	1.000	1.000	1.000	1.000	1.000
8	Southern Bank	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	BIMB	1.000	0.667	0.996	1.473	0.887	0.983	0.965	0.943
10	Ambank	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	Bank Muamalat	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Mean	1.015	0.991	0.972	1.053	0.989	1.009	1.051	0.989

Notes: PEch = Pure efficiency change, and SEch = Scale efficiency change

The results show that the pure efficiency[5] appears to be less important source of growth to efficiency change as compared to the scale efficiency change component for every bank in the sample. Except for Public Bank and Hong Leong Bank, all other banks in our sample experience no changes in both pure and scale efficiencies during the entire period of the analysis. Five banks (EON, Affin, Southern, Ambank and Muamalat) record no changes in annual growth for both the scale and pure efficiencies during the period of 2000 to 2004. Relative to other banks, BIMB records the highest deterioration of scale efficiency of –0.33% in 2000 to 2001. In terms of pure efficiency, Public Bank records the highest deterioration by –0.26% in 2001 to 2002. It is interesting to note that BIMB is found to have the highest growth in scale efficiency with –47.3%. On the other hand, Hong Leong Bank records the highest growth in pure efficiency with 38.5% in the same period. During the entire period of study, only the years between 2000 to 2001 and 2003 to 2004 are identified as the years of pure efficiency improvement, while the years between 2001 to 2002 and 2002 to 2003 are recorded to be the years of scale efficiency improvement. Overall, our results suggest that the size of firms does matter in determining the banks' productivity and efficiency level. This implies that the larger the bank,[6] the higher their efficiency. Our finding supports the findings by Abd. Karim (2001) and Abd. Majid et al. (2003). In his study, Abd. Karim (2001) finds that the larger banks tend to be more efficient compared to their smaller rivals, while Abd. Majid et al. (2003) find that the bank's size had a positive relationship with the efficiency of the banks. In order to improve their efficiency, the small banks have to increase their assets.

Productivity Performance for the Entire Industry

Table 8 summarizes the performance of Malmquist productivity index of the commercial banking industry in Malaysia between 2000 to 2004. On the average, Public Bank records the highest growth in TFP with 15.0%, efficiency and technical changes with 9.2 and 5.2%, respectively. Bank Muamalat, on the other hand, records the lowest growth in TFP with –13.5%, which is mainly due to technical regress (–13.5%). On average, the improvement of TFP of the commercial banking industry in Malaysia is mainly due to efficiency change (1.6%) while technical change contributed a negative change (–0.3%) to the overall TFP growth (1.3%). Furthermore, the efficiency change is largely contributed by scale efficiency (1%) rather than pure efficiency (0.6%). This

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[5] As mentioned earlier, pure efficiency change measures the relative ability of operators to converts inputs into outputs. In Malmquist index, it is measured as the ratio of the own-period distance functions in each period under VRS [see Equations (6), (10) and (11)].

[6] Most of the studies used asset size to indicate the size of the banks (Berger & Humphrey, 1997).

indicates that the size of the bank does matter in affecting efficiency changes. Our finding of substantial growth in efficiency components and negative growth in technical change suggest that an increase in TFP in Malaysia's commercial banks industry is due to the innovation in efficiency components rather than the improvement in technical aspect. On average, the commercial banks are found to be even in experiencing a technical regresses.

Table 8
Summary of Malmquist Productivity Index of Bank Means, 2000–2004

No.	Bank	TFPch	EFFch	TECch	PEch	SEch
1	Public Bank	1.150	1.092	1.052	1.056	1.035
2	Bumiputra-Commerce Bank	1.061	1.046	1.014	1.000	1.046
3	Hong Leong Bank	1.060	1.062	0.999	1.057	1.005
4	Malayan Banking	1.058	1.000	1.058	1.000	1.000
5	Southern Bank	1.050	1.000	1.050	1.000	1.000
6	RHB Bank	1.040	1.021	1.019	1.000	1.021
7	Affin Bank	1.027	1.026	1.001	1.000	1.026
8	EON Bank	0.998	1.000	0.998	1.000	1.000
9	Ambank	0.941	1.000	0.941	1.000	1.000
10	BIMB	0.920	0.938	0.980	0.961	0.977
11	Bank Muamalat	0.865	1.000	0.865	1.000	1.000
	Mean	1.013	1.016	0.997	1.006	1.010

Notes: TFPch = Total productivity change; EFFch = Efficiency change; TECch = Technical change; PEch = Pure efficiency change; and SEch = Scale efficiency change

Figure 2 depicts the evolution over time of TFP and its components for the 11 commercial banks measured by means of the geometric mean of Malmquist productivity index for each period. The figure displays that on the average, there is positive efficiency change during the entire period, while technical change and TFP shows negative growths in the period of 2000 to 2001. The TFP and its components record the highest average growth in the period of 2003 to 2004.

Finally, Figure 3 presents the visual summary of efficiency change and its components, scale and pure efficiencies for the entire period. From the figure, we find that opposite results between scale and pure efficiencies prevail. For instance in 2001 to 2002, when the pure efficiency growth is negative with –2.80%, the scale efficiency on the other hand shows a positive growth with 5.30%.

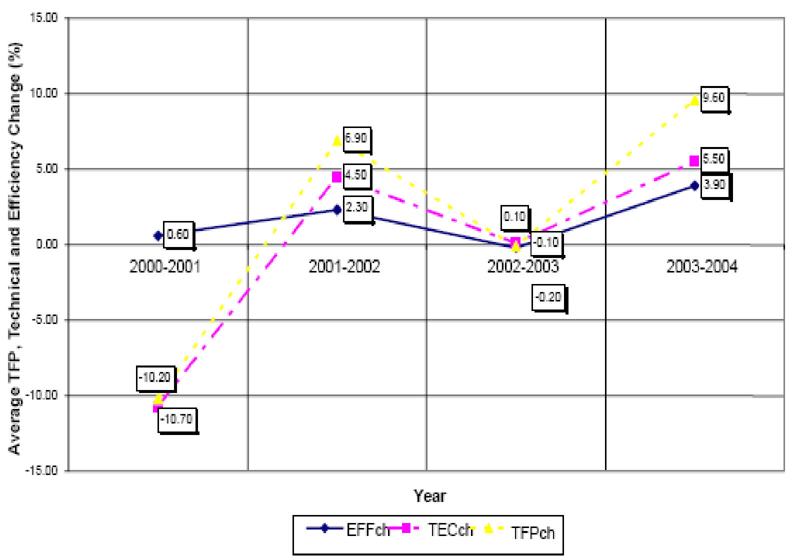

Figure 2. TFP, technical and efficiency changes of the Malaysian commercial banks, 2000–2004

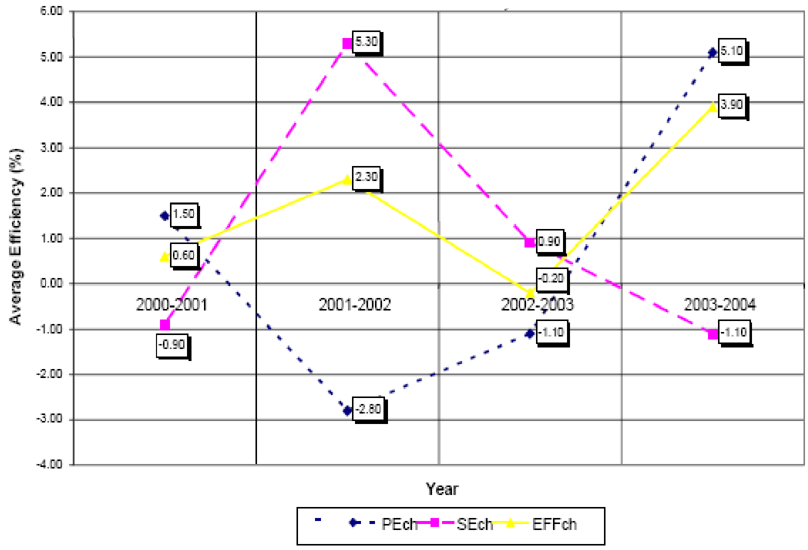

Figure 3. Changes in mean efficiency and its components of the Malaysian commercial banks, 2000–2004

CONCLUSION

The results obtained from this study have important implications for the commercial banking industry in Malaysia. As for the whole industry, TFP has increased 1.3% throughout the period of 2000 to 2004 with the years 2003 to 2004 recording the highest growth (9.6%). Indeed, this particular period also records the highest technical and efficiency changes at a rate of 5.5 and 3.9%, respectively. It is important to note that the very presence of TFP growth in the commercial banking industry in Malaysia has been largely due to the efficiency change (1.6%) compared to the technical component which contributes a negative change (–0.3%) to the overall TFP growth. This result therefore indicates that the Malaysia's commercial banking industry has a great potential to further increase its TFP through an improvement in the technical component. Given the high technological advancement within the banking industry, labor force should be well-equipped with knowledge in optimizing the technology possessed to give the bank a competitive advantage in the long term (Ketler & Willems, 2001). Thus, one area that needs particular emphasis is technological knowledge dispersion. Training and technical expertise should be constantly upgraded along with technological evolution. This can take the form of education and training program intended to improve managerial ability, or of extension programs designed to speed up the adoption of new technologies.

Comparing the two Islamic banks, BIMB and Bank Muamalat with the other conventional commercial banks, they are found to be less efficient than commercial banks. Apart from their small sizes, BIMB and Bank Muamalat record the lowest growth in efficiency change (–6.2%) and technical efficiency (–13.5%) (see Table 8). Improving bank scale, technical efficiency and efficiency change are the promising way for Islamic banks in order to be in a better position and to gain competitive edge over the conventional banks. In addition, the efficiency change is largely contributed by the scale efficiency (1%) rather than the pure efficiency (0.6%). This indicates that the size of the bank does matter in affecting efficiency changes. For small size banks, it is important to increase their sizes in order to improve their efficiency. For the whole Islamic banking sector, banks may consider mergers to increase efficiency. Finally, further research needs to be conducted in the direction of policy formulation as well as to enhance the overall efficiency levels of the commercial banking industry.

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