Measuring Efficiency of Insurance and *Takāful* Companies in Malaysia Using Data Envelopment Analysis (DEA)

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Abstract: This study investigates efficiency of the life insurance industry in Malaysia during the period 2002 to 2005. To measure their efficiencies, the output-input data consisting of a panel of 13 life insurance companies is utilized. Both conventional insurances and *takāful* companies are comparatively analyzed. The most commonly used non-parametric approach, namely, Data Envelopment Analysis (DEA) is adopted to investigate efficiency of the Malaysian insurance companies and *takāful* operators. In the DEA technique, efficiency is measured by the Malmquist index. The Malmquist efficiency measures are decomposed into two components: efficiency change and technical change index. Efficiency change is further decomposed into pure efficiency and scale efficiency. From this analysis, we hope to compare the performances of *takāful* operators vis-à-vis their conventional counterparts.

I. Introduction

The efficiency of financial institutions has been widely and extensively studied in the last few decades. For financial institutions, efficiency implies

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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 *et al.*, 1993).

The study of efficiency of life insurance companies is important for the Malaysian dual financial system where the *takāful* operators are operating alongside their conventional counterparts. Furthermore, the Malaysian financial system has undergone major structural changes in the era of globalization with various liberalization measures being introduced during the last decade. These factors are expected to have an impact on the efficiency of the life insurance companies and the *takāful* operators. This study, therefore, focuses on two aspects of life insurance companies in Malaysia. Firstly, it aims to extend the established conventional insurance sector by investigating the efficiency of the life insurance companies for the period 2002-2005. Secondly, it seeks to compare the performance of conventional life insurance companies and the *takāful* operators in Malaysia.

For the *takāful* operators, the information obtained on the evaluation of the institutions' performance may be used to improve the overall efficiency of their 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 the life insurance companies in Malaysia. By using the 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 life insurance companies and *takāful* operators in Malaysia.

Buoyed by the increase in the public awareness in Islamic finance, the *takāful* industry in Malaysia continues to enhance its competitiveness. In terms of new business, the family *takāful* sector in Malaysia continues to experience a higher growth rate of 20.2% in the year 2005 compared to 18.1% in the previous year. This was mainly due to a more than seven-fold increase in the investment-linked plan with a larger share of new business contributions of 9.75% compared to 1.6% in the year 2004. In order to enhance the resilience of the *takāful* industry in facing challenging operating environment, six key areas are highlighted. One of these is enhancing operational efficiency of *takāful* sector (*Takāful* Annual Report, 2005). Having this in mind, this study hopes to identify the determinants of efficiency of the *takāful* industry and thereby provide recommendations

to further strengthen the resilience of *takāful* sector within the Malaysian financial system.

The paper is organized as follows: Section 2 reviews the relevant literature; Section 3 discusses the methodology of DEA and Malmquist Index; Section 4 presents the results and analysis, and finally Section 5 presents some conclusions.

II. Literature Review

There is an expanding body of literature on efficiency in the insurance industry both for developed and emerging economies. Its findings have important implications for the insurance operators who are always working to improve operating performance. For policy makers, an awareness of the determinants of insurance efficiency may help them in designing policies to improve the stability of the financial institutions and to enhance the effectiveness of the monetary system as a whole.

The measurement of insurance 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). The most commonly used non-parametric approaches are the Data Envelopment Analysis (DEA) and the Free Disposable Hull (FDH) (Cummins *et al.*, 1999; Cummins and Zi, 1998).

The SFA, 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. A study employing SFA to measure efficiency of the life insurance industry was conducted by Yuengert (1993).

For the non-parametric approach, the DEA or 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. Among the studies that employ DEA are: Cummins *et al.* (1996), Cummins *et. al.* (1999), and Cummins and Rubio-Misas (2001).

There is still an on-going debate as to which methodology is to be preferred for determining the best-practice frontier against which relative efficiencies are measured. Despite the debate, there seems to be an emerging consensus that it is not necessary to agree on a single frontier approach for measuring efficiency. Instead, there should be consistent conditions to be met for efficiency measures derived from various methodologies. Accordingly, if efficiency estimates are consistent across various approaches, these measures are therefore valid estimates. In this paper, we choose to employ the DEA by using the Malmquist Index, the advantages of which will be set out in the next section. Here, we highlight existing studies on insurance efficiencies that used the DEA.

The insurance industry in the United States has been analyzed by Berger *et al.* (1997), Cummins *et al.* (1999), Cummins, Weiss, and Zi (1999), and Meador *et al.* (2000). The insurance industries in Japan, Italy, and Spain have been studied by Fukuyama (1997), Cummins *et al.* (1996), and Cummins and Rubio-Misas (2001). The results of the studies show that in terms of total factor productivity (TFP) growth, which is measured by Malmquist index, the Japanese life insurers (Fukuyama, 1997) and the Italian life and property-liability insurers (Cummins *et al.,* 1996) show efficiency gains that are considerably higher than in the U.S. Fukuyama reported TFP gains of about 19% for Japanese insurance firms over the period of 1988-1993; Cummins *et al.* (1996) found measured TFP gains of about 3.4% for Italian insurers for the period 1986-1993. In the case of the Spanish insurance industry, Cummins and Rubio-Misas (2001) found that cost efficiencies for Spanish insurers are low compared to their U.S. counterparts.

Rees and Kessner (2000) and Diacon *et al.* (2002) have conducted studies involving international comparison of the efficiency of insurance companies in Europe. Rees and Kessner (2000) found that the average level of efficiency of German firms was about 48% and the average level of efficiency of the British firms was markedly higher, with a mean of around 57% and median of 52%. Diacon *et al.* (2002) on the other hand, found that, when comparison is made among insurance companies in the U.K., Spain, Sweden and Denmark, U.K. insurers appear to have particularly low levels of scale and mix efficiency.

There has been only one prior study on the efficiency of the Malaysian insurance industry. Abu Mansor and Radam (2000) measured the productivity of the life insurance industry in Malaysia using the non-parametric Malmquist Index approach. In measuring the efficiency performance, they evaluate the Malmquist Index of a sample of 12 Malaysian insurance companies over the 1987 to 1997 period. They found that the overall productivity growth of the insurance industry in Malaysia was attributed to both technical efficiency and technical progress. We extend their research by including Islamic insurance companies or *takāful* operators into our analysis. One important consideration for *takāful* is to ensure that its transactional element is conforming to Islamic contractual practices in order to guarantee that the whole commercial undertaking fully adheres to *Sharīʿah* rules and requirements. Following this important framework, the contract under *takāful* is based on profit-sharing or the principle of al-*muḍārabah*. Under this concept, participant of a *takāful* product is entitled to enjoy a return on the contribution or premium paid to *takāful* companies.

Against this backdrop, the motivation of our paper is to investigate the insurance industry in Malaysia using the nonparametric approach. We also hope to shed some light on the performance of the *takāful* operators (whose operations are based on profit-sharing), as compared to the conventional insurance companies during the period of analysis.

III. Methodology

In exploring the contributions to growth in productivity of technical and efficiency changes in the Malaysian life insurance industries, the generalized output-oriented Malmquist index, developed by Fare *et al.* (1989), is adopted in this study. The Malmquist indexes are constructed using the Data Envelopment Approach (DEA) and estimated using Coelli's (1996) DEAP version 2.1. The Malmquist index was chosen as there are a number of desirable features suited to this particular study. Not only does the DEA not require input prices or output prices in their construction, which makes the method particularly useful in situations where prices are not publicly available or non-existent, it also does not require a behavioural assumption such as cost minimization or profit maximization in the case where producers' objectives differ, are unknown or unachieved. This was first 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 *et al.* (1994b) 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 all of the inputs and outputs as well as differences in technology, capacity, competition, and demographics and then compares the 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.

To date, the Malmquist productivity index and DEA have been used in a variety of studies. These studies include aggregate comparisons of productivity between countries (Fare *et al.*, 1994a) as well as various economic sectors such as agriculture (Tauer, 1998 and Mao and Koo, 1996), airlines (Alam and Sickles, 1995), telecommunications industry (Asai and Nemoto, 1999 and Calabrese *et al.*, 2001), banking (Tulkens and Malnero, 1996), universities (Avkiran, 2001), insurance (Cummins *et al.*, 1999; Abu Mansor and Radam, 2000; and Diacon, 2002).

Following Fare *et al.*, (1989), the Malmquist index of total factor productivity growth is written as follows:

$$M_o\left(x^t, y^t, x^{t+1}, y^{t+1}\right) = (a) \times (b) \tag{1}$$

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

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

where the notations $D_o^t\left(x^{t+1}, y^{t+1}\right)$ represent the distance from the period $t+1$ observation to the period t technology. The first ratio on the right hand side

of equation (1) 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 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}. Essentially, the change in relative efficiency measures how well the production process converts inputs into outputs (catching up to the frontier) and the latter reflects improvements in technology.

According to Fare *et al.* (1994a), 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 unity are considered to be evidence of technological progress.

In empirical applications, four distances measures that appear in (1) 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:

$$
\begin{aligned}
G^t &= \left[\left(x^t, y^t\right) : y^t_m \le \sum_{k=1}^{K} z^t_k y^t_{k,m} \right] && m = 1,\ldots, M, \\
&\sum_{k=1}^{K} z^t_k x^t_{k,n} \le x^t_n && n = 1,\ldots, N, \\
& z^t_k \ge 0 && k = 1,\ldots, K,
\end{aligned}
\qquad (2)
$$

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

$$
\sum_{k=1}^{K} z^t_k = 1 \qquad \textit{(VRS)} \qquad (3)
$$

Following Fare *et al.* (1994a), this study uses 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 convert inputs into outputs, while scale efficiency measures to what extent the operators can take advantage of returns to scale by altering its size toward optimal scale.

To construct the Malmquist productivity index of firm k' between t and t+1, the following four distance functions are calculated using the DEA approach:

$$D_o^t\left(x^t,y^t\right),\quad D_o^{t+1}\left(x^t,y^t\right),\quad D_o^t\left(x^{t+1},y^{t+1}\right),\ D_o^{t+1}\left(x^{t+1},y^{t+1}\right)$$

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 $k' = 1,\ldots, K$, is expressed as:

$$\left[D_o^t\left(x_{k'}^t,y_{k'}^t\right)\right]^{-1} = \max \lambda^{k'} \tag{4}$$

subject to

$$\begin{aligned}
&\lambda^{k'} y_{k,m}^t \le \sum_{k=1}^{K} z_k^t y_{k,m}^t && m = 1,\ldots, M,\\
&\sum_{k=1}^{K} z_k^t x_{k,n}^t \le x_{k',n}^t && n = 1,\ldots, N,\\
&\sum_{k=1}^{K} z_k^t = 1 && \textit{(VRS)}\\
&z_k^t \ge 0 && k = 1,\ldots, K
\end{aligned} \tag{5}$$

The computation of $D_o^{t+1}\left(x^{t+1},y^{t+1}\right)$ is similar to (5), 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

$$\left[D_o^t\left(x_{k'}^{t+1}, y_{k'}^{t+1}\right)\right]^{-1} = \max \lambda^{'k'} \tag{6}$$

subject to

$$\begin{aligned}
&\lambda^{k'} y_{k,m}^{t+1} \le \sum_{k=1}^{K} z_k^t y_{k,m}^t && m = 1, \ldots, M, \\
&\sum_{k=1}^{K} z_k^t x_{k,n}^t \le x_{k',n}^{t+1} && n = 1, \ldots, N, \\
&\sum_{k=1}^{K} z_k^t = 1 && \text{(VRS)} \\
&z_k^t \ge 0 && k = 1, \ldots, K]
\end{aligned} \tag{7}$$

To measure changes in scale efficiency, the inverse output distance functions under the VRS technology are also calculated by adding (3) into the constraints in (5) and (7). 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 (1) becomes:

$$M_o\left(x^t, y^t, x^{t+1}, y^{t+1}\right) = (a) \times (b) \times (c) \tag{8}$$

where

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

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

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

Note that when the technology in fact exhibits CRS, the scale change factor equals to unity and it is the same decomposition as (1).

IV. Empirical Results and Analysis

4.1 Input and output specifications

Two inputs and outputs are utilized to investigate efficiency of life insurance firms in Malaysia in this study. The inputs are commission and management expenses and the outputs are premium and net investment income. These inputs and outputs are used to investigate efficiency of 13 insurance firms in Malaysia, in which one of them is an Islamic insurance firm. The firms under study are Takaful Nasional Sdn Bhd, Allianz Life Insurance Malaysia Bhd, AmAssurance Bhd, Asia Life (M) Bhd, Great Eastern Life Assurance (M) Bhd, Hong Leong Assurance Bhd, ING Insurance Bhd, Malaysian Assurance Alliance Bhd, Mayban Life Assurance Bhd, MCIS ZURICH Insurance Bhd, Malaysia Nasional Insurance Bhd, Prudential Assurance Malaysia Bhd and Tahan Insurance Malaysia Bhd. Data on inputs and outputs were collected for the period 2002 to 2005. The study has excluded Syarikat Takaful Malaysia since this company is the only one that has used cash basis of income recognition whereas other insurance and *takāful* companies used accrual basis. If this company is selected, then the data will not be consistent with others. In addition, this company is also the only one that has not used agents. Since this study selected commission expenses as one of the inputs and no data is available on commission expenses, for Syarikat Takaful, it had to be dropped.

Table 1: Descriptive Statistics, 2002-2005

	OUTPUT		INPUT	
	Premium	Net Investment Income	Commission	Management Expenses
Mean	4,130,493,942	160,154,928	113,858,033	57,339,568
Median	1,596,523,500	97,162,500	56,811,000	42,681,000
Std Dev.	7,669,019,662	238,756,741	133,908,968	44,292,046
Minimum	159,330,000	5,225,000	4,866,000	5,261,000
Maximum	30,706,637,000	1,231,960,000	549,029,000	172,664,000

Table 1 reports the descriptive statistics of the outputs and inputs of these 13 life insurance firms in Malaysia during the period of study. It seems that Great Eastern Life Assurance (M) Bhd has the highest amount of output, both premium and net investment income within the period of analysis, while AmAssurance Bhd and Allianz Life Insurance Malaysia Bhd have the lowest amount of outputs, premium and net investment income,

respectively. As for the inputs, Great Eastern Life Assurance (M) Bhd seems to have the highest amount of inputs, while Tahan Insurance Malaysia Bhd seems to have the lowest. On average, the amount of premium and net investment income within the period of study are RM4,130,493,942 and RM160,154,928, respectively. Meanwhile, the average of commission and management expenses are RM113,858,033 and RM57,339,568, respectively.

4.2. Production frontier and efficiency

Since the basic component of the Malmquist productivity index is related to measures of efficiency, the study initially reports efficiency change for the 13 firms from 2002-2005 in Tables 2 and 3 under CRS and VRS, respectively. The values of unity imply that the firm is on the industry frontier in the associated year, while the 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 unity.

Table 2: Efficiency of the Insurance Firms, 2002-2005 (Constant Returns to Scale)

No.	Insurance firm	2002	2003	2004	2005
1	Takaful Nasional Sdn.Bhd	0.721	0.644	0.474	0.625
2	Allianz Life Insurance Malaysia Bhd	1.000	0.541	0.405	0.409
3	AmAssurance Bhd	0.325	0.438	0.375	0.367
4	Asia Life (M) Bhd	0.949	0.944	0.834	0.923
5	Great Eastern Life Assurance (M) Bhd	1.000	1.000	1.000	1.000
6	Hong Leong Assurance Bhd	0.495	0.446	0.481	0.498
7	ING Insurance Bhd	0.646	0.547	0.538	0.584
8	Malaysian Assurance Alliance Bhd	0.467	0.545	0.889	0.772
9	Mayban Life Assurance Bhd	0.875	0.605	0.695	1.000
10	MCIS ZURICH Insurance Bhd	0.548	0.521	0.578	0.614
11	Malaysia Nasional Insurance Bhd	1.000	1.000	1.000	1.000
12	Prudential Assurance Malaysia Bhd	0.337	0.274	0.236	0.224
13	Tahan Insurance Malaysia Bhd	0.912	1.000	1.000	1.000
Mean		0.714	0.654	0.654	0.694

For the years reported in Tables 2 and 3, Great Eastern Life Assurance (M) Bhd, Malaysia Nasional Insurance Bhd and Tahan Insurance Malaysia Bhd were consistently efficient, both under CRS and VR). Asia Life (M) Bhd was consistently efficient under VRS but not under CRS. Prudential Assurance Malaysia Bhd was the least efficient firm for CRS and VRS

versions, respectively. The estimates also indicate that Mayban Life Assurance Bhd and MCIS ZURICH Insurance Bhd successfully kept pace with technically feasible production possibilities and improving their distance to the industrial production frontier for both versions of technology.

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. For example, in 2002, Takaful Nasional Sdn. Bhd produced 72.1% of its potential output level and Asia Life (M) Bhd produced 94.9% of its potential output under CRS. Under VRS of the same year, Takaful Nasional Sdn. Bhd produced 75.1% of its potential output and Asia Life (M) Bhd produced at its maximum potential output, 100%.

As indicated by the weighted geometric mean in Tables 2 and 3, the average efficiency for the whole industry reduced for the period 2002 to 2004, but showed a slight increase in 2005. On average, efficiency performance of Malaysia's insurance industry was relatively higher based on VRS than on CRS.

Table 3: Efficiency of the Insurance Firms, 2002-2005 (Variable Returns to Scale)

No.	Insurance firm	2002	2003	2004	2005
1	Takaful Nasional Sdn.Bhd	0.751	0.661	0.501	0.636
2	Allianz Life Insurance Malaysia Bhd	1.000	0.542	0.406	0.419
3	AmAssurance Bhd	0.357	0.440	0.378	0.370
4	Asia Life (M) Bhd	1.000	1.000	1.000	1.000
5	Great Eastern Life Assurance (M) Bhd	1.000	1.000	1.000	1.000
6	Hong Leong Assurance Bhd	0.496	0.446	0.481	0.498
7	ING Insurance Bhd	0.723	0.547	0.539	0.600
8	Malaysian Assurance Alliance Bhd	0.563	0.860	1.000	0.859
9	Mayban Life Assurance Bhd	0.887	0.606	0.696	1.000
10	MCIS ZURICH Insurance Bhd	0.548	0.567	0.578	0.616
11	Malaysia Nasional Insurance Bhd	1.000	1.000	1.000	1.000
12	Prudential Assurance Malaysia Bhd	0.338	0.277	0.236	0.225
13	Tahan Insurance Malaysia Bhd	1.000	1.000	1.000	1.000
Mean		0.743	0.688	0.678	0.709

4.3. Productivity performance of individual company

Tables 4 to 6 report the performance of the firms from 2002 to 2005 in terms of 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 unity imply a decrease or deterioration in productivity. Conversely, values greater than unity indicate improvements of productivity 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: Insurance Firms Relative Malmquist TFP Change between Time Period *t* and *t* + 1, 2000-2004

No.	Insurance firm	2002-2003	2003-2004	2004-2005	Mean
1	Takaful Nasional Sdn.Bhd	1.204	0.589	1.320	0.978
2	Allianz Life Insurance Malaysia Bhd	0.447	0.743	0.936	0.678
3	AmAssurance Bhd	1.734	0.837	0.981	1.125
4	Asia Life (M) Bhd	1.095	0.952	1.150	0.062
5	Great Eastern Life Assurance (M) Bhd	0.910	1.090	0.985	0.993
6	Hong Leong Assurance Bhd	1.064	0.942	1.043	1.015
7	ING Insurance Bhd	0.948	0.979	0.992	0.973
8	Malaysian Assurance Alliance Bhd	1.719	1.037	0.864	1.155
9	Mayban Life Assurance Bhd	0.933	0.801	1.420	1.020
10	MCIS ZURICH Insurance Bhd	1.261	0.836	1.056	1.036
11	Malaysia Nasional Insurance Bhd	1.542	0.766	0.977	1.049
12	Prudential Assurance Malaysia Bhd	0.856	0.961	1.038	0.949
13	Tahan Insurance Malaysia Bhd	1.133	0.997	1.071	1.065
Mean		1.083	0.876	1.055	1.000

Table 4 displays calculated changes in the Malmquist-based Total Factor Productivity index. As evidenced in the results, Takaful Nasional Sdn.Bhd, Asia Life (M) Bhd, Hong Leong Assurance Bhd, MCIS ZURICH Insurance Berhad and Tahan Insurance Malaysia Bhd had positive productivity changes for adjacent years of 2002-2003 and 2004-2005. In contrast, Malaysian Assurance Alliance Bhd recorded deterioration in TFP

for years 2002 to 2005. However, there were some improvements of TFP change for Allianz Life Insurance Malaysia Bhd and ING Insurance Bhd. In addition, Malaysian Assurance Alliance Bhd had the highest average TFP growth at an annual average rate of 15.5%, AmAssurance Bhd came next with an annual rate of 12.5%, and Tahan Insurance Malaysia Bhd ranked third with an annual rate of 6.5%. Overall, all the firms did not increase their TFP on average for the period of 2002-2005. The TFP change, on average, only showed some growth in the periods of 2002-2003 and 2004-2005 with 8.3% and 5.5%, respectively. But it deteriorated between 2003 and 2004 by 12.4%.

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 5: Insurance Firms Relative Technical Change between Time Period *t* and *t* + 1, 2002-2005

No.	Insurance firm	2002-2003	2003-2004	2004-2005	Mean
1	Takaful Nasional Sdn.Bhd	1.349	0.800	1.000	1.026
2	Allianz Life Insurance Malaysia Bhd	0.826	0.992	0.928	0.913
3	AmAssurance Bhd	1.286	0.979	1.001	1.080
4	Asia Life (M) Bhd	1.100	1.077	0.040	1.072
5	Great Eastern Life Assurance (M) Bhd	0.910	1.090	0.985	0.993
6	Hong Leong Assurance Bhd	1.181	0.873	1.009	1.013
7	ING Insurance Bhd	1.119	0.996	0.914	1.006
8	Malaysian Assurance Alliance Bhd	1.475	0.636	0.996	0.977
9	Mayban Life Assurance Bhd	1.348	0.697	0.988	0.976
10	MCIS ZURICH Insurance Bhd	1.327	0.753	0.995	0.998
11	Malaysia Nasional Insurance Bhd	1.542	0.766	0.977	1.049
12	Prudential Assurance Malaysia Bhd	1.052	1.116	1.093	1.087
13	Tahan Insurance Malaysia Bhd	1.034	0.997	1.071	1.033
Mean		1.178	0.892	0.998	1.016

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, Asia Life (M) Bhd and Prudential Assurance Malaysia Bhd are the firms that experienced technical progress from year 2002 to 2005, while the other firms experienced both technical progress

and regress. Over the period of analysis, Malaysia Nasional Insurance Bhd recorded the highest change in technical progress (54.2%) in the year 2002-2003 and Prudential Assurance Malaysia Bhd recorded the highest technical progress in year 2003-2004 (11.6%), while the highest technical growth in 2004-2005 was again maintained by Prudential Assurance Malaysia Bhd with 9.3%. Table 5 also demonstrates that technical progress was experienced by 11 firms in 2002-2003, 3 firms in 2003-2004 and 6 firms in 2004-2005. On average, the years 2003-2004 and 2004-2005 are found to have been years of technical regress (-10.8% and 0.2%, respectively), while for the year 2002-2003 the insurance firms in Malaysia recorded technical progress of 17.8%. Over the period of analysis, Prudential Assurance Malaysia Bhd is found to have been the most technically progressive firm (8.7%), while Allianz Life Insurance Malaysia Bhd was found to have been the most technically regressive firm with -8.7%.

Table 6: Changes in Firms Relative Efficiency between Time Period *t* and *t* + 1, 2002-2005

No.	Insurance firm	2002-2003	2003-2004	2004-2005	Mean
1	Takaful Nasional Sdn.Bhd	0.893	0.736	1.319	0.953
2	Allianz Life Insurance Malaysia Bhd	0.541	0.749	1.009	0.742
3	AmAssurance Bhd	1.348	0.855	0.980	1.042
4	Asia Life (M) Bhd	0.995	0.884	1.107	0.991
5	Great Eastern Life Assurance (M) Bhd	1.000	1.000	1.000	1.000
6	Hong Leong Assurance Bhd	0.901	1.079	1.035	1.002
7	ING Insurance Bhd	0.847	0.983	1.085	0.967
8	Malaysian Assurance Alliance Bhd	1.166	1.632	0.868	1.182
9	Mayban Life Assurance Bhd	0.692	1.148	1.438	1.045
10	MCIS ZURICH Insurance Bhd	0.950	1.110	1.062	1.038
11	Malaysia Nasional Insurance Bhd	1.000	1.000	1.000	1.000
12	Prudential Assurance Malaysia Bhd	0.814	0.861	0.949	0.873
13	Tahan Insurance Malaysia Bhd	1.096	1.000	1.000	1.031
Mean		0.920	0.982	1.056	0.985

Table 6 displays changes in relative efficiency for each individual company. The results indicate considerable variation across companies and times. Only two firms (Great Eastern Life Assurance [M] Bhd and Malaysia National Insurance Bhd) were found to be efficient (and therefore

showed no change in efficiency) in all periods from 2002 to 2005. For the other firms, there were periods with positive, negative or no changes in efficiency. Furthermore, the results show that many firms improved their efficiency during the period 2004-2005. During the entire period of the study, our results show that, on average, Malaysian Assurance Alliance Bhd recorded the highest efficiency change with 18.2%, followed by Mayban Life Assurance Bhd with 4.5%, AmAssurance Bhd with 4.2%, MCIS ZURICH Insurance Berhad with 3.8% and Tahan Insurance Malaysia Bhd with 3.1%. Takaful Nasional Sdn.Bhd is found to have experienced efficiency deterioration with - 4.7%. However, Takaful Nasional Sdn.Bhd is not at the worst position as compared to Allianz Life Insurance Malaysia Bhd which deteriorated with -25.8%. Overall, there was an improvement of changes in relative efficiency throughout these years from a deterioration of -0.8% to an improvement in efficiency of 5.6%.

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

The results show that the pure efficiency and scale efficiency appear to be equally important sources of growth to efficiency change. Two firms (Great Eastern Life Assurance (M) Bhd and Malaysia National Insurance Bhd) recorded no changes in annual growth for both the scale and pure efficiencies during the period 2002 to 2005. Relative to other insurance firms, Malaysian Assurance Alliance Bhd recorded the highest deterioration of scale efficiency of -2.37% in 2002-2003.

In terms of pure efficiency, Allianz Life Insurance Malaysia Bhd recorded the highest deterioration by -45.8% in 2002-2003. It is interesting to note that ING Insurance Bhd is found to have had the highest growth in scale efficiency with 11.9% in this period. On the other hand, Malaysian Assurance Alliance Bhd recorded the highest growth in pure efficiency with 52.7% in the same period. Hence, it seems to have experienced a growth in pure efficiency throughout the period of study as it records the highest pure efficiency in 2002-2003 and 2003-2004. Although its scale efficiency is the highest in 2003-2004, it did not maintain this good position in other years. During the entire period of study, only the year between 2004-2005 is identified as marked by pure efficiency improvement, while the years between 2003-2004 and 2004-2005 are recorded as years of scale efficiency improvement.

Table 7: Changes in Efficiency Components by Firms between Time Period *t* and *t* + 1, 2002-2005

No.	Insurance firm	2002-2003		2003-2004		2004-2005	
		PEch	**SEch**	**PEch**	**SEch**	**PEch**	**SEch**
1	Takaful Nasional Sdn.Bhd	0.880	1.014	0.757	0.972	1.270	1.039
2	Allianz Life Insurance Malaysia Bhd	0.542	0.998	0.749	0.999	1.031	0.979
3	AmAssurance Bhd	1.231	1.095	0.860	0.994	0.978	1.002
4	Asia Life (M) Bhd	1.000	0.995	1.000	0.884	1.000	1.107
5	Great Eastern Life Assurance (M) Bhd	1.000	1.000	1.000	1.000	1.000	1.000
6	Hong Leong Assurance Bhd	0.899	1.002	1.080	0.999	1.035	0.999
7	ING Insurance Bhd	0.757	1.119	0.985	0.998	1.114	0.974
8	Malaysian Assurance Alliance Bhd	1.527	0.763	1.162	1.404	0.859	1.010
9	Mayban Life Assurance Bhd	0.683	1.013	1.149	0.999	1.436	1.002
10	MCIS ZURICH Insurance Berhad	1.034	0.919	1.019	1.089	1.065	0.997
11	Malaysia National Insurance Bhd	1.000	1.000	1.000	1.000	1.000	1.000
12	Prudential Assurance Malaysia Bhd	0.820	0.993	0.854	1.008	0.952	0.997
13	Tahan Insurance Malaysia Bhd	1.000	1.096	1.000	1.000	1.000	1.000
Mean		0.923	0.996	0.962	1.021	1.048	1.008

Note: PEch = Pure Efficiency Change, and SEch = Scale Efficiency Change.

4.4. Productivity performance of the industry

Table 8 summarizes the performance of Malmquist productivity index of the insurance industry in Malaysia between 2002 and 2005. On average, Malaysian Assurance Alliance Bhd recorded the highest growth in TFP with 15.5%, efficiency and technical changes with 18.2% and -2.3%, respectively. Allianz Life Insurance Malaysia Bhd, on the other hand, recorded the lowest growth in TFP with -32.2%, which is mainly due to efficiency regress (-25.8%). On average, the TFP of the insurance industry in Malaysia is mainly due to technical change (1.6%) while efficiency change contributed a negative change (-1.5%). Furthermore, the efficiency change is largely contributed by scale efficiency rather than pure efficiency. This indicates that the size of the companies does matter in affecting efficiency changes. Our finding of substantial growth in technical components and negative growth in efficiency change suggests that TFP in Malaysia's insurance industry was due to innovation in technical components rather than to

improvement in efficiency. On average, the insurance firms are found to be experiencing technical progress. Even though there was a deterioration in efficiency change, the subcomponent of this efficiency change, namely scale efficiency, did show a slight improvement (0.8%). Due to almost similar impact of negative efficiency change and positive technical change, the overall TFP for these firms within the period of study was maintained (reflected by the mean 1.000 of TFP change).

Table 8: Summary of Malmquist Productivity Index of Insurance Firms, 2000-2004

No.	Insurance firm	TFPch	EFFch	TECch	PEch	SEch
1	Takaful Nasional Sdn.Bhd	0.978	0.953	1.026	0.946	1.008
2	Allianz Life Insurance Malaysia Bhd	0.678	0.742	0.913	0.748	0.992
3	AmAssurance Bhd	1.125	1.042	1.080	1.012	1.029
4	Asia Life (M) Bhd	1.062	0.991	1.072	1.000	0.991
5	Great Eastern Life Assurance (M) Bhd	0.993	1.000	0.993	1.000	1.000
6	Hong Leong Assurance Bhd	1.015	1.002	1.013	1.002	1.000
7	ING Insurance Bhd	0.973	0.967	1.006	0.940	1.029
8	Malaysian Assurance Alliance Bhd	1.155	1.182	0.977	1.151	1.027
9	Mayban Life Assurance Bhd	1.020	1.045	0.976	1.041	1.005
10	MCIS ZURICH Insurance Bhd	1.036	1.038	0.998	1.039	0.999
11	Malaysia Nasional Insurance Bhd	1.049	1.000	1.049	1.000	1.000
12	Prudential Assurance Malaysia Bhd	0.949	0.873	1.087	0.874	0.999
13	Tahan Insurance Malaysia Bhd	1.065	1.031	1.033	1.000	1.031
Mean		1.000	0.985	1.016	0.976	1.008

Note: TFPch = Total Factor Productivity Change; *EFFch* = Efficiency Change; *TECch* = Technical Change; *PEch* = Pure Efficiency Change; and *SEch* = Scale Efficiency Change.

Figure 1 depicts the mean evolution over time of TFP and its components for the 13 insurance firms measured by the geometric mean of Malmquist productivity index for each period. The table shows that on average, TFP experienced the highest growth in technical efficiency. The deterioration of TFP in the next period (2003-2004) also largely contributed to the deterioration of technical change rather than efficiency change.

Finally, Figure 2 presents the visual summary of changes in mean efficiency and its components, scale and pure efficiencies for the entire

period. Even though the efficiency change improved throughout 2002-2005, its deterioration in two consecutive periods made it significant in the contribution of overall of TFP change. From the figure, it seems that the change of efficiency is mainly attributable to change in pure efficiency rather than change in scale efficiency.

Figure 1: Changes in Mean TFP and its Components, 2002-2005.

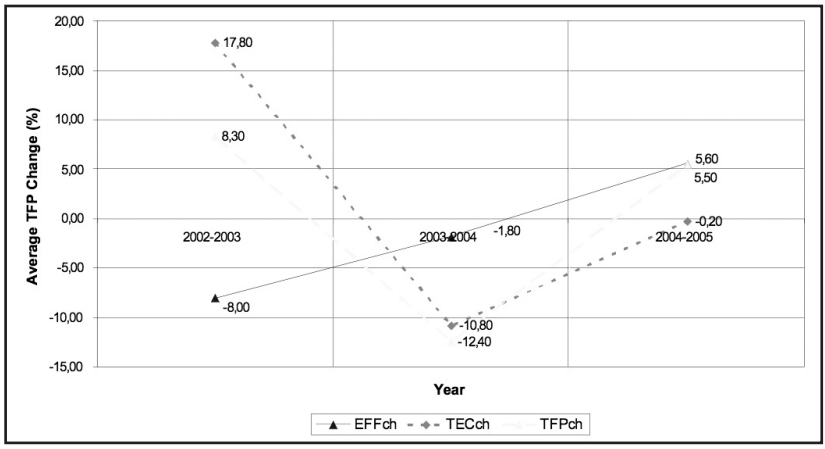
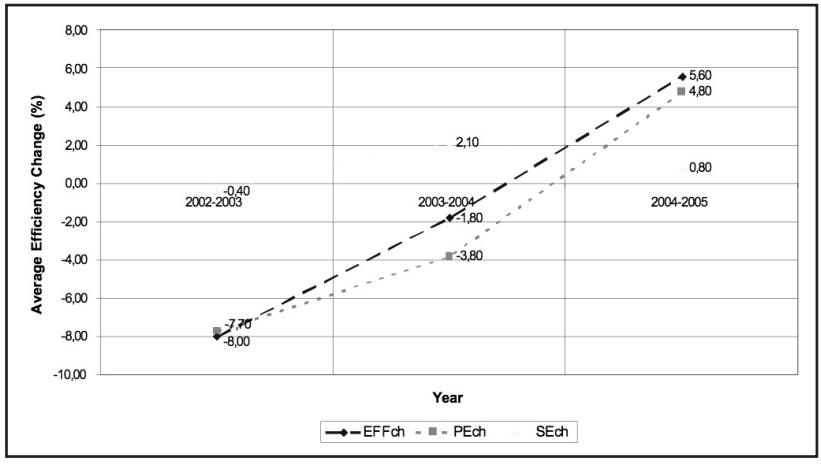


Figure 2: Changes in Mean Efficiency and its Components, 2002-2005.



5. Conclusion

The results have important implications for the insurance and *takāful* companies in Malaysia. On average, the TFP of the insurance industry in

Malaysia is mainly due to technical change (1.6%) while efficiency change contributed to negative change (-1.5%). Furthermore, the efficiency change is largely contributed by scale efficiency rather than pure efficiency. This indicates that the size of the companies does matter in affecting efficiency changes. Our finding of substantial growth in technical components and negative growth in efficiency change suggests that TFP in Malaysia's insurance industry is due to the innovation in technical components rather than the improvement in efficiency. On average, the insurance firms are found to be experiencing technical progress. This result indicates that Malaysia's insurance industry has great potential to further increase its TFP through an improvement in technical components such as optimizing the use of information and communication technology in providing good services to customers. Even though there was deterioration in the efficiency change, the subcomponent of this change, namely scale efficiency, did show a slight improvement (0.8%). The finding, thus, indicates that the bigger the size of the companies the higher the probability of the companies being more efficient in utilizing their inputs to generate more outputs. However, due to almost similar impact of negative efficiency change and positive technical change, the overall TFP for these firms within the period of study has not changed (reflected by the mean 1.000 of TFP change).

Overall, Takaful Nasional has been found to be below average in TFP but slightly above average (1% higher than average) for technical change (TECch). However, in the case of efficiency and pure efficiency change, Takaful Nasional was below average, except for scale efficiency change where they have equalled the industry average. Takaful Nasional can be considered as competitive if compared with the conventional insurance companies. However, the company is not among the leading companies in overall efficiency. One way for Takaful Nasional to improve its efficiency is through increasing the company size either by increasing its customer base and market share, or through merging with other *takāful* companies. This will hopefully contribute towards improving the scale efficiency so that it would be in a better position to gain competitive edge over its counterparts. As there was only one *takāful* company included in the analysis, the findings may only be indicative and definitely not conclusive of the *takāful* industry as a whole. Since more *takāful* companies have been established recently, further comprehensive studies are needed to examine the efficiency of *takāful* companies vis-à-vis the conventional insurance companies.

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