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MEASURING TECHNICAL EFFICIENCY OF INSURANCE COMPANIES USING DYNAMIC NETWORK DEA: AN INTERMEDIATION APPROACH

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Abstract. This study measures technical efficiency of the Malaysian insurance companies using a new framework for performance efficiency, built on the intermediation approach, by decomposing the complex service processes of insurance companies into two functional divisions, premium accumulation and investment capability. The study employs a dynamic network data envelopment analysis for performance evaluation of insurer (life, general and composite insurers) and ownership (local and foreign) types, spanning the period 2007–2014. The findings reveal a lack of efficiency in the investment capability function among local insurers as compared to their foreign counterparts. While the composite or non-specialized segment performs better in the investment capability function, the general segment achieves better efficiency in the premium accumulation function. The results suggest the high usage of input quantities and lack of total investment as key reasons for low efficiency, particularly among the local insurers. Implications for business excellence for insurance companies are further discussed.

Keywords: performance evaluation, data envelopment analysis, intermediation approach, dynamic network slacks-based measure, insurance companies.

JEL Classification: G22, L25.

Introduction

In the context of performance efficiency using the data envelopment analysis (DEA) approach, the important question on the true measure of production mechanism for insurance companies remains vague (Brockett *et al.* 2005). There are two theoretical streams to evaluate the efficiency of an insurance company, namely the production approach and the financial intermediary approach (Brockett *et al.* 2004). Under the production approach, the role of financial institutions is confined to that of service providers to account hold-

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ers, while in the intermediation approach, financial institutions act to channel the funds between savers and investors. Berger and Humphrey (1997) differentiate between the two approaches in identifying how to measure the performance of financial services. The production approach is found to be suitable for evaluating financial branches or subsidiaries, while the intermediation approach is more appropriate for evaluating the entire financial industry (Berger, Humphrey 1997; Brockett *et al.* 2004).

The current insurance literature has given more emphasis on the use of the production approach, which is more appropriate for evaluating the performance of manufacturing companies (Chen *et al.* 2011; Cummins, Rubio-Misas 2006; Cummins *et al.* 2010; Cummins, Xie 2008; Eling, Luhnen 2010b; Kuo *et al.* 2017; Lu *et al.* 2014; Nourani *et al.* 2017), while the application of the intermediation approach has not received much attention in insurance-related studies. Additionally, although recent research has increasingly focused on the empirical evaluation of insurance efficiency, recent studies have largely adopted traditional measures of efficiency evaluation (Biener, Eling 2012; Cummins *et al.* 2010; Huang *et al.* 2012; Huang, Eling 2013; Xie 2010); therefore, a consistent conclusion remains elusive. The traditional DEA assumes a service process as a single black box that transforms inputs to outputs. However, more than one stage may be involved in completing a service process. Therefore, by using the traditional DEA approach, we are in fact neglecting the internal linking of activities between different stages or divisions, and thereby neglecting the decomposed inefficiencies of each stage. As such, the multi-stage DEA approach, introduced to open up black boxes, is needed to address the issue of efficiency (Färe *et al.* 2007) as it identifies the source(s) of inefficiency in the whole service process. In this respect, one may overestimate or underestimate the efficiency scores if a proper technique is not applied. In fact, an accurate measure of performance measurement is a preliminary step to achieve business excellence within any financial or non-financial entity.

This study builds on the use of the financial intermediation approach in line with Brockett *et al.* (2005) and proposes a new framework for insurance companies to assess their performance, which is supported by an extant theory on insurance literature. Following which, the results of this study provide useful input on resource allocation and strategic decision-making for insurance companies. The remainder of this study unfolds as follows: Section 1 details the proposed new framework for measuring insurance efficiency. Section 2 describes the research design. Section 3 discusses the research findings, and the final section concludes the study.

1. Proposed insurance efficiency framework

1.1. The service process for insurance

The traditional performance assessment framework for insurance companies is rooted in the production process of manufacturing systems. Unlike manufacturing, insurance reflects a special type of service process (Müller 1981). Pfeffer and Klock (1974: 3) define insurance as follows: Insurance is a device for the reduction of uncertainty of one party, called the insured, through the transfer of particular risks to another party, called the insurer, who offers a restoration, at least in part, of economic losses suffered by the insured. The contemplation of this definition highlights the fundamental function of an insurance company; the reduction of risks through some transfer mechanisms. The concept of risk transfer is a theoretical phenomenon, it is not operational or practical to the needs of an insurance company (Müller 1981). In fact, an important deduction of the insurance definition lies in the process where risk transfer occurs. It is not a convincing argument for insureds to assume a certain amount of premium in exchange for the transfer of risks, but rather to explain what is taking place during the risk transfer mechanism. The process of operationalizing an insurance company covers economic losses (Pfeffer, Klock 1974), and the flow of money into the insurance system from premium contributors and from the insurance system to claimants (Trowbridge 1975). An insurance company favours the money transfer definition of insurance arrangement (Müller 1981). The flow of money in the insurance system requires the regeneration of money through investment.

Here, the concept of service process of an insurance company relates to the entire spectrum of business activities. There are a number of theories underlying the service process of an insurance company. The production theory for an insurance company provides a shallow picture of insurance activities, given its non-material nature. The contribution of actuarial sciences to insurance can provide provisional risk estimation and forecasting, yet the service process is bounded to probability distributions and stochastic processes (Müller 1981). The financial portfolio theory for an insurance company views the activity of an insurer as a "levered investment operation" that borrows funds, by issuing risky obligations (premium accumulation) and investing part of these funds in securities (Biger, Kahane 1978; Doherty 1980). Relying on the same theoretical concept, Haugen and Kroncke (1970) considers an insurance company as a financial intermediary that generates capital by selling a diversified portfolio of insurance claims (capital generating opportunities), and invests the funds in a balanced portfolio of financial instruments (investment opportunities). Likewise, MacMinn and Witt (1987) forwards that an insurance company has to make two decisions; the first decision involves the number of policies to sell pertaining to the underwriting activities to accumulate premiums, and the second involves, how to invest these generated funds in an investment portfolio to yield highest profits.

While the "levered investment operation" view of an insurance company has received criticism[1], it appears to be the most rational perspective. In fact, for a firm-level analysis of cash flow activities, the insurance company is viewed as a financial intermediary that aims to maximize profits. Figure 1 shows the flow of funds in an insurance company. It revisits the insurance cash flow activities as a financial intermediary entity (Brockett *et al.* 2004, 2005), and allows us to capture the financial cash flow of an insurer as a fund receiver and a fund investor chronologically.

Based on the discussion above, the following sections define the key functions of the service process and emphasizes the important role of the time dimension for the analysis.

[1] It is argued that the insurance activities are reduced to decision on financial operations (Müller 1981). However, in the same article, Müller (1981) stated that there is no definite approach to define the input-output process and organizational arrangement for insurance processes.

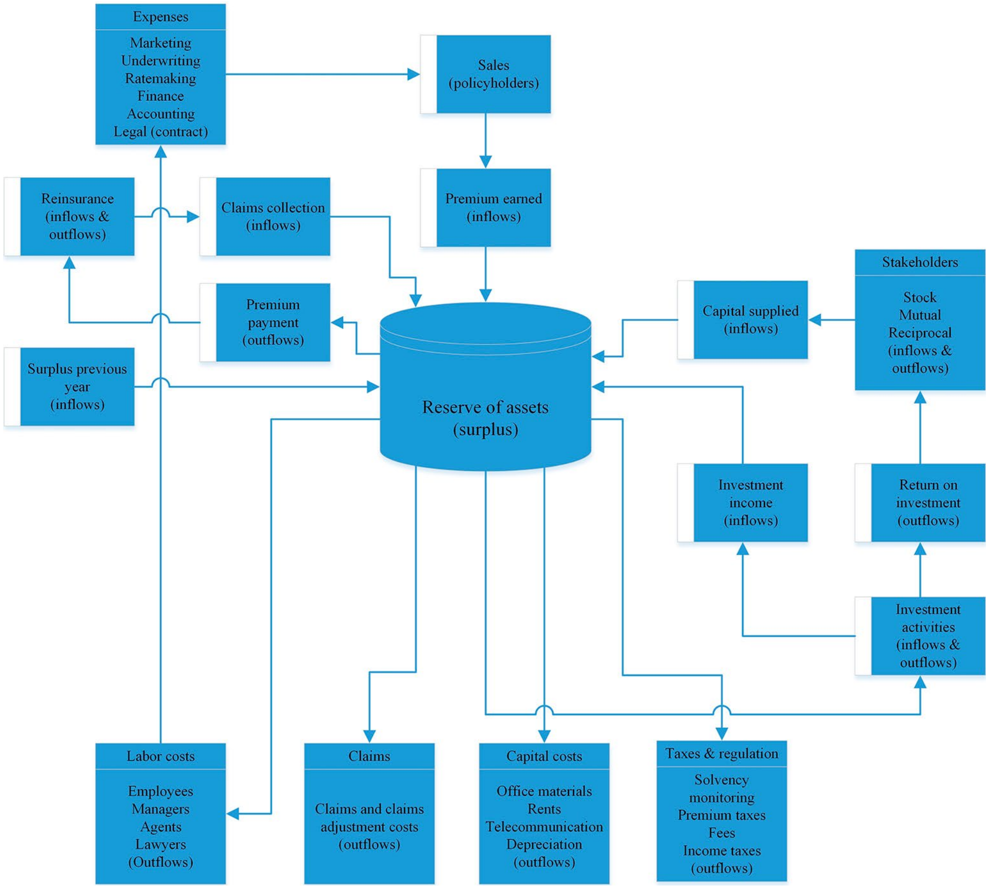

Figure 1. Insurance cash flow as a financial intermediary
(source: retrieved and modified from Brockett *et al.* 2005, 2004)

1.2. Core service functions

The first stage involves activities to accumulate and/or generate funds, which is the premium accumulation function. Being a financial intermediary entity, an insurance company issues contingent claims to policyholders. More precisely, insurers borrow money from policyholders to feed the reserve of assets. Ultimately, a part of the borrowed funds will be returned to the claimants as the costs of claims. As shown in Figure 1, these activities provide inflows and outflows into the reserve within the premium accumulation function.

The second involves investment activities of an insurance company, which is the investment capability function. An insurance company uses a part of the capital accumulated from policyholders (premiums) and stakeholders (capital supplied) to purchase a portfolio of assets. A higher insurance capital provides more security for policyholders in terms of compensation in the event of losses.

1.3. Time dimension

Von Lanzenauer and Wright (1977) pointed out that there is a need to explicitly model the interactions in insurance activities in a dynamic manner because the stationary condition is rather a weak assumption. While the study by Müller (1981) implicitly discussed the time dimension in the insurance information model, the literature, to date, has not discoursed the issue of time dimension in the context of service processes of insurance companies. Particularly, there are some input factors within the service process that may not produce any effects within the postulated time. In short, there is a lag effect for these factors in the service process. These input factors are so called carry-over inputs (Tone, Tsutsui 2010). The service process of an insurance company often is evaluated in a static nature without much consideration given to the time dynamics. Hence, it is important to incorporate the evolutionary perspective (time dimension) into the service processes of insurance companies.

2. Research design

2.1. Performance evaluation in insurance

Performance evaluation has progressively become a reliable measure of business excellence. Nowadays, various business enterprises, including insurance companies, utilize the frontier efficiency analysis because a performance measurement technique has to deliver enough information to link up with business strategies, whereas, the single-dimensional ratio analysis such as profit or cost evaluation techniques lack inferential ability. In the literature, two primary methodologies have been used by insurance studies to estimate efficient frontiers: econometric or parametric approach, and mathematical programming or nonparametric approach. While both approaches have their own advantages and disadvantages, nonparametric methods, in particular the DEA, are highly popular among insurance studies (Eling, Luhnen 2010b).

Efficiency-related studies using the DEA technique among insurance companies can be traced back to the early 1990s (Bjurek *et al.* 1990; Mahajan 1991; Fecher, Pestieau 1993; Cummins *et al.* 1996, Cummins, Zi 1998, Cummins *et al.* 1999). There are also recent attempts to measure the efficiency of insurance companies (for example, Huang *et al.* 2012; Huang, Eling 2013; Barros, Wanke 2014; Barros *et al.* 2014; Kweh *et al.* 2014a, 2014b; Kuo *et al.* 2017; Barros, Wanke 2015, 2016; Wanke, Barros 2016), but insurance-related studies remain limited relative to research on other financial institutions. The study by Liu *et al.* (2013) on DEA application in research published between 1978 and 2010 show that only 44 (1.4 percent) papers focused on insurance companies, whereas 323 (10.3 percent) papers were related to the banking sector. The need for research on insurance efficiency is of fundamental importance, as the insurance sector has the potentials to contribute to economic growth (Arena 2008).

Apart from the dearth of literature on insurance, limitations also prevail in the models employed to measure performance. The traditional frontier efficiency models, including conventional DEA models, are unable to detail the sources of inefficiency (Wu *et al.* 2016).

For example, insurers use assets and expenditures to generate premiums, and then premiums are meant to be utilized for investments plans. The premiums play a dual role in the whole service process. In the first stage, premiums are the outputs, and then become the inputs in the second stage. The first stage outputs are the intermediate measures of service processes that link the two stages (Färe, Whittaker 1995). Instead, the multi-stage DEA approaches, or so called network DEA (NDEA), open up black boxes to provide detailed efficiency measures about what happens inside them (Färe *et al.* 2007). Hence, the multi-stage efficiency approach is now becoming popular in insurance-related research.

To date, the DEA literature on insurance has also focused largely on the dynamic aspect (Kweh *et al.* 2014a; Wanke *et al.* 2015, 2016) or the network aspect (Kao, Hwang 2008). However, the vibrant and complex service processes of insurance companies demand the consideration of both structures in efficiency evaluation. In this study, both structures are considered as the two service functions of insurance companies require a network structure, connected through intermediate measures, and the time dimension, in turn, requires the linking of activities or carry-over factors, to explain the dynamic nature of businesses. To this end, the service process of an insurance company, as the form of an underlying dynamic network DEA (DN-DEA) problem, requires the identification of input, intermediate, carry-over and output factors.

2.2. Choice of input and output factors

An important step in performance evaluation is identifying the contributing factors. This issue is particularly critical for a service sector such as insurance, as opposed to manufacturing sectors where physical resources produce physical products. Generally, the resources used in a service process are the inputs, and the outcomes are the outputs (Zhu 2014: 1). There are three main insurance inputs, labor, business services and materials, and capital (Brockett *et al.* 2005, 2004; Cummins, Weiss 2013). The selection of output quantities relates to the service processes of insurance companies. The production approach uses the value of losses incurred as an output (Cummins *et al.* 1999). However, Brockett *et al.* (2005, 2004) asserted that the inclusion of incurred losses as output, counters the general notion of efficiency.

The dynamic network process combined with the financial intermediation approach in this study provide a better understanding of insurance activities, as illustrated in Figure 2. In the first stage, an insurer accumulates premiums by utilizing the inputs that are commonly used by both production and financial intermediary approaches (Brockett *et al.* 2005, 2004; Cummins, Weiss 2013). This study utilizes labor and business service expenses, equity capital and debt capital as the inputs for the premium accumulation function. Brockett *et al.* (2005, 2004) used the owners' stake or equity of the previous year for the DEA analysis. The reason for this is the lag effect of equity capital in the service process of an insurance company. Hence, this study includes equity capital as the carry-over input in the first stage. The utilized inputs in the first stage produce the net earned premium (positive) and net claims (negative). These two factors are intermediate items, since these are also the input factors for the second stage. The aim of second stage is to gain profit and add value to the business through investment activities. Therefore, the investment stage uses two in-

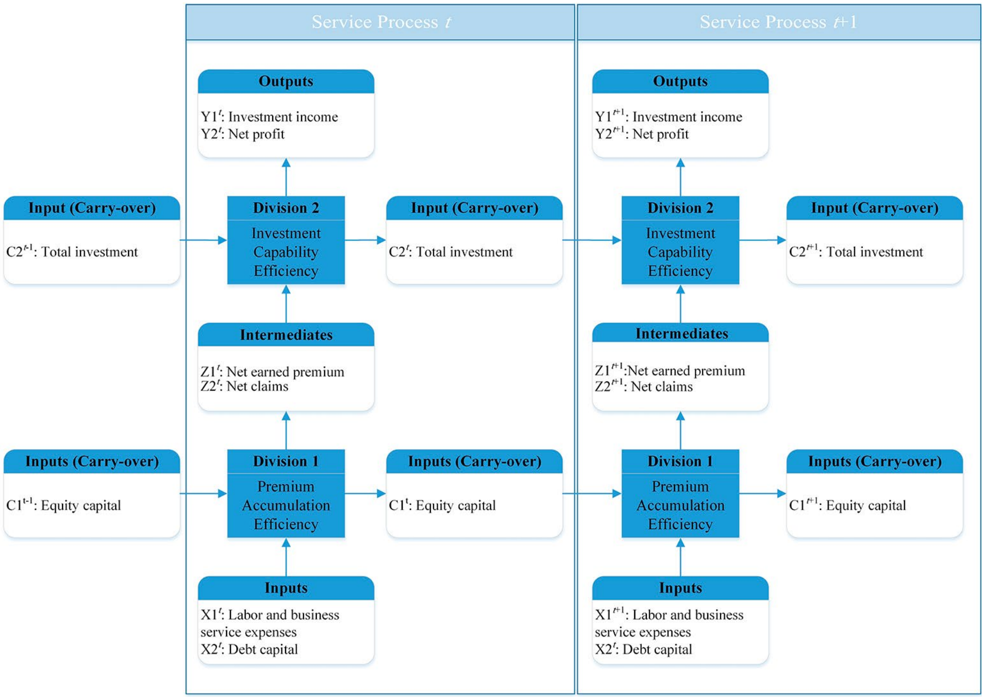

Figure 2. Dynamic network insurance efficiency framework

termediate factors along with total investment, which are accumulated from previous year insurance activities, to produce the two final outputs, investment income and net profit. It is worth noting that total investment is an input quantity, which one cannot except to see its immediate effect in achieving the profit/loss for an insurance company. Subsequently, this study includes total investment as carry-over item in the second stage. Table 1 provides the summary of the variables used in the dynamic network insurance efficiency framework.

2.3. Preliminary requirements of DEA

First, the decision-making units (DMUs) of a DEA analysis must fulfil the homogeneity assumption. Farrell (1957) proposes that the evaluation results is significant only when the DMUs are homogenous. Considering that DMUs of a DEA model must possess identical attributes, similar objectives and same market conditions (Golany, Roll 1989), this study only selects conventional insurance companies publicly traded in the Malaysian market as the DMUs. Further, all insurance companies, including life, composite and general, are considered similar in operating the two functions, premium accumulation and investment capability.

Second, the minimum number of DMUs must follow a rule prior to the DEA analysis. According to Golany and Roll (1989), the number of DMUs should be at least twice the number of input and output factors. In this study, there are 31 DMUs and this satisfies the requirement for the minimum number of DEA in the two stages [i.e., $31 > 2 \times (4 + 2 + 2)$].

Table 1. Definitions of input, carry-over, intermediate and output variables

Variable	Symbol	Definition	Literature	Source
		Inputs		
Labor and business service expenses	X1	The total amount of labor and business service expenses including employee benefit expenses and key management personnel compensation for the year.	(Eling, Luhnen 2010a)	Income statement
Debt capital	X2	The total amount of insurance contract liabilities, financial liabilities, insurance payables and tax liabilities of the year.	(Brockett *et al.* 2005, 2004)	Balance sheet
		Carry-over inputs		
Equity capital	C1	The total amount of shareholders' equities including share capital, retained earnings and other reserves at the beginning of the year.	(Brockett *et al.* 2005, 2004)	Balance sheet
Total investment	C2	The total amount of all government and non-government securities and other investments of an insurance company at the beginning of the year.	(Brockett *et al.* 2005, 2004)	Balance sheet
		Intermediate inputs/outputs		
Net earned premiums	Z1	The total amount of gross earned premiums minus premiums ceded to reinsurers for the year.	(Kao, Hwang 2008)	Income statement
Net claims	Z2	The total amount of gross benefits and claims paid minus the claims ceded to reinsurers for the year.	(Brockett *et al.* 2005, 2004)	Income statement
		Outputs		
Investment income	Y1	The total amount of generated income from all the investment activities for the year.	(Brockett *et al.* 2005, 2004)	Income statement
Net profit	Y2	The total amount of income after deducting all the operating and tax expenses for the year.	(Kao, Hwang 2008)	Income statement

Note: Compiled from the literature.

Third, the DEA analysis requires "isotonic" assumption, meaning that input and output factors should have positive correlation (Golany, Roll 1989). More specifically, a proportional increase in an input variable should result in a proportional increase in an output variable. Based on the Spearman's rho correlation test reported in Table 2, significant positive relationships exist between the input and output factors. This result satisfies the isotonic assumption. Thus, the developed DN-DEA framework is considered to hold high construct validity.

2.4. Model specification of DN-DEA

A DEA model provides the efficiency scores as well as the frontier projections, based on slack values for inefficient DMUs. In doing so, the selected model defines the reference set for inefficient DMUs; then they have to follow a certain efficient DMU in order to become efficient units. There are two types of efficiency measure models, namely radial and non-radial. Each model type provides a unique result and suggestion for inefficient units.

Table 2. Spearman's rho correlation coefficients

Variable	X1	X2	Z1	Z2	C1	C2	Y1	Y2
X1	1.000							
X2	0.737**	1.000						
Z1	0.832**	0.875**	1.000					
Z2	0.835**	0.894**	0.892**	1.000				
C1	0.808**	0.592**	0.688**	0.652**	1.000			
C2	0.722**	0.873**	0.763**	0.862**	0.603**	1.000		
Y1	0.784**	0.903**	0.809**	0.908**	0.636**	0.954**	1.000	
Y2	0.750**	0.619**	0.688**	0.654**	0.788**	0.577**	0.612**	1.000

Notes: (1) Refer to Table 1 for definition of variables. ** Significant at the 0.01 level (2-tailed) and *significant at the 0.05 level (2-tailed).

The Charnes, Cooper and Rhodes (CCR) model (Charnes *et al.* 1978) is the basis for the radial approach, and the slacks-based measure (SBM) model (Tone 2001) represents the non-radial approach. While radial models neglect the non-radial input and output slacks, non-radial models overlook the radial characteristics of inputs and outputs, if any (Cooper *et al.* 2007: 89). Radial models may lack objectivity in terms of reflecting the real input/output conditions for each organization, and stand on the assumption that inputs or outputs undergo proportional changes (Wu *et al.* 2016). Non-radial models, on the other hand, which deal directly with the input excesses and the output shortfalls and do not change proportionally, may achieve results that are more realistic. The changing nature of operational preferences of companies in today's business world makes the choice of the non-radial approach more relevant (Avkiran 2009). Hence, this study measures the efficiency of insurance companies using the non-radial approach. For this purpose, the SBM model is considered a reliable non-radial measure.

Tone and Tsutsui (2010, 2009) introduced the network SBM and the dynamic SBM model in which both models account for slacks when measuring efficiency. Combining both models, Tone and Tsutsui (2014) formalized the dynamic DEA with network structure and named it as the dynamic network slack-based measure (DNSBM). As pointed out by Tone and Tsutsui (2014), this model takes into account multiple divisions linked to intermediate activities of the network structure at each period of time (vertically) and connects the network structure through carry-over activities among two following periods (horizontally). In fact, the blend of two structures, dynamic and network, provide a more comprehensive analysis, whereby both divisional and periodical interactions are considered simultaneously. Hence, this study selects the DNSBM model to measure the efficiency of insurance companies.

2.4.1. Objective function

There are three main objective functions to follow, input-oriented, output-oriented and non-oriented *(Cooper et al.* 2007: 115). The input-oriented approach targets to minimize input quantities, while satisfying at least the given level of output quantities. On the contrary, the output-oriented approach aims to maximize output quantities, while maintaining the observed level of input consumption. The third approach, non-oriented, deals with input excesses and output shortfalls at the same time in order to maximize both. The choice of objective function will determine the projection path to the envelope surface by which a DEA analyst can suggest the area of improvements in both inputs and outputs. Whether to choose the input-, output- or non-oriented approach depends on the service process that characterizes the company's operation. For the purpose of the insurance efficiency framework, the objective is to identify both over-utilization of input quantities and shortage of output quantities. Therefore, the non-oriented approach for the objective function is chosen.

2.4.2. Production technology

The envelopment surface, which defines the production possibility set (PPS), will differ depending on the scale assumptions relevant to the production technology. Two general scale assumptions exist: constant returns to scale (CRS) and variable returns to scale (VRS). CRS refers to the proportional changes of inputs and outputs, while the VRS does not assume such proportional changes. There is a need for rendering reasonable care when choosing a return to scale type, though the identification will not be an easy one since DEA is a data oriented and non-parametric technique. Cooper *et al.* (2007: 334) suggest "if the data set includes numeric values with a large difference in magnitude, the VRS model may be a choice. However, if the data set consists of normalized numbers, the CRS model might be an appropriate candidate". The VRS is chosen to offset the possible influence of different scales of inputs and outputs on efficiency. Following Lu *et al.* (2016), this study also conducted statistical tests between the efficiency scores under CRS and VRS technologies for the two stages. The unreported results support the use of VRS technology.

2.4.3. DNSBM model

This study selects the non-oriented, VRS, DNSBM model to evaluate the efficiency of insurance companies. As suggested by Cooper *et al.* (2007), this study runs the efficiency analysis with the help of DEA SolverPro^{TM} V.11 developed by SAITECH, which encompasses all the new models including the DNSBM. The DNSBM formulation proposed by Tone and Tsutsui (2014) is as follows:

Consider the dynamic network processes presented in Figure 2 that deal with n insurers ($j = 1, \ldots, n$), consisting of k divisions ($k = 1, \ldots, K$) over T terms ($t = 1, \ldots, T$). At each term, insurers have common m_k inputs ($i = 1, \ldots, m_k$), q link variables ($p = 1, \ldots, q$), r_k outputs ($h = 1, \ldots, r_k$) and c_k ($w = 1, \ldots, c_k$) carry-overs from period $t - 1$ to period t consisting of k divisions. Let x_{ijt}^{t}, y_{hjk}^{t} and $v_{pjk}^{t(b-g)}$ denote the input, output, and link from division b to division g values of insurer j consisting of k divisions at term t, respectively. $z_{wjk}^{t,t+1}$ denotes the continuity of link flows (carry-overs) between terms t and t+1. This study defines the non-oriented efficiency by solving the program as follows:

$$\phi_o = Min \frac{\frac{1}{T}\sum_{t=1}^{T}\frac{1}{K}\sum_{k=1}^{K}\left[1-\frac{1}{m_k+c_k+q}\left(\sum_{i=1}^{m_k}\frac{s_{iot}^{k-}}{x_{iot}^{k}}+\sum_{p=1}^{q}\frac{s_{po}^{t-}}{v_{po}^{t(b-g)}}+\sum_{w=1}^{c_k}\frac{s_{wok}^{t,t+1}}{x_{iot}^{k}}\right)\right]}{\frac{1}{T}\sum_{t=1}^{T}\frac{1}{K}\sum_{k=1}^{K}\left[1+\frac{1}{r_k+q}\left(\sum_{h=1}^{r_k}\frac{s_{hot}^{k+}}{y_{hot}^{k}}+\sum_{p=1}^{q}\frac{s_{po}^{t+}}{v_{po}^{t(b-g)}}\right)\right]} \quad (1)$$

s.t.

$$x_{iot}^{k} = \sum_{j=1}^{n} x_{ijt}^{k}\lambda_{jt}^{k} + s_{iot}^{k-},\ (i=1,...,m_k; k=1,...,K;\ t=1,\ldots,T), \quad (2)$$

$$y_{hot}^{k} = \sum_{j=1}^{n} y_{hjt}^{k}\lambda_{jt}^{k} - s_{hot}^{k+},\ (h=1,...,r_k;\ k=1,...,K;\ t=1,\ldots,T), \quad (3)$$

$$\sum_{j=1}^{n}\lambda_{jt}^{k} = 1,\ \ (k=1,...,K;\ t=1,\ldots,T), \quad (4)$$

$$v_{po}^{t(b-g)}\lambda_{jt}^{g} = \sum_{j=1}^{n} v_{pj}^{t(b-g)}\lambda_{jt}^{b} + s_{po}^{t-},\ \forall\ (b,g)\ (t=1,\ldots,T;\ p=1,...,q), \quad (5)$$

$$v_{po}^{t(b-g)}\lambda_{jt}^{g} = \sum_{j=1}^{n} v_{pj}^{t(b-g)}\lambda_{jt}^{b} - s_{po}^{t+},\ \forall\ (b,g)\ (t=1,\ldots,T;\ p=1,...,q), \quad (6)$$

$$z_{wok}^{t,t+1} = \sum_{j=1}^{n} z_{wjk}^{t,t+1}\lambda_{jt}^{k} + s_{wok}^{t,t+1}(w=1,\ldots,c_k;\ t=1,\ldots,T;\ k=1,...,K), \quad (7)$$

$$\lambda_{jt}^{k} \geq 0,\ s_{iot}^{k-} \geq 0,\ s_{hot}^{k+} \geq 0,\ s_{po}^{t-} \geq 0,\ s_{po}^{t+} \geq 0,\ s_{wok}^{t,t+1} \geq 0,$$

where s_{iot}^{k-} and s_{hot}^{k+} are, respectively input/output slacks, s_{po}^{t-} and s_{po}^{t+} are, respectively as-input/as-output link slacks, $s_{wok}^{t,t+1}$ is carry-over excess slacks. (4) suggests that the constructed best practice frontier exhibits VRS technology at stage. (5) points that the linking activities are treated as input to the succeeding division and excesses are accounted for in the input inefficiency. (6) presents that the linking activities are treated as output from the preceding division and shortages are accounted for in the output inefficiency. (7) shows that the carry-overs are treated as inputs and their values are restricted to be not greater than the observed ones. Comparative excess in carry-overs is accounted as inefficiency. The production possibility set for the objective DMU_o (o = 1, …, n) is expressed by (2), (3), (4), (5), (6) and (7).

Let an optimal solution (1) subject to (2), (3), (4), (5), (6) and (7) be

$$\{\lambda_{jt}^{k*},\ j=1,...,n;\ s_{iot}^{k-^*},i=1,...,m_k;\ s_{hot}^{k+^*},\ h=1,...,r_k;\ s_{po}^{t-^*},\ s_{po}^{t+^*},$$

$$p=1,...,q;\ s_{wok}^{t,t+1},\ w=1,\ldots,c_k;\ k=1,...,K,\ t=1,...,T\}.$$

The non-oriented overall efficiency during the term T for the objective DMU_o can be defined by

$$\phi_o^{*} = \frac{\frac{1}{T}\sum_{t=1}^{T}\frac{1}{K}\sum_{k=1}^{K}\left[1-\frac{1}{m_k+c_k+q}\left(\sum_{i=1}^{m_k}\frac{s_{iot}^{k-^*}}{x_{iot}^{k}}+\sum_{p=1}^{q}\frac{s_{po}^{t-^*}}{v_{po}^{t(b-g)}}+\sum_{w=1}^{c_k}\frac{s_{wok}^{t,t+1^*}}{x_{iot}^{k}}\right)\right]}{\frac{1}{T}\sum_{t=1}^{T}\frac{1}{K}\sum_{k=1}^{K}\left[1+\frac{1}{r_k+q}\left(\sum_{h=1}^{r_k}\frac{s_{hot}^{k+^*}}{y_{hot}^{k}}+\sum_{p=1}^{q}\frac{s_{po}^{t+^*}}{v_{po}^{t(b-g)}}\right)\right]}. \quad (8)$$

This objective function (8) is an extension of the non-oriented SBM model (Tone 2001) and deals with excesses in both input resources and undesirable (bad) links. The numerator is the average input efficiency and the denominator is the inverse of the average output efficiency. This study defines the non-oriented overall efficiency as a ratio that ranges between 0 and 1, and attains 1 when all slacks are zero. This objective function value is also units-invariant.

Period efficiency is defined for the objective DMU_o by

$$\pi_o^{t*} = \frac{\frac{1}{K}\sum_{k=1}^{K}\left[1-\frac{1}{m_k+c_k+q}\left(\sum_{i=1}^{m_k}\frac{s_{iot}^{k-*}}{x_{iot}^{k}}+\sum_{p=1}^{q}\frac{s_{po}^{t-*}}{v_{po}^{t(b-g)}}+\sum_{w=1}^{c_k}\frac{s_{wok}^{t,t+1*}}{x_{iot}^{k}}\right)\right]}{\frac{1}{K}\sum_{k=1}^{K}\left[1+\frac{1}{r_k+q}\left(\sum_{h=1}^{r_k}\frac{s_{hot}^{k+*}}{y_{hot}^{k}}+\sum_{p=1}^{q}\frac{s_{po}^{t+*}}{v_{po}^{t(b-g)}}\right)\right]}, \ (\forall t). \quad (9)$$

Divisional efficiency for the objective DMU_o is defined by

$$\eta_o^{k*} = \frac{\frac{1}{T}\sum_{t=1}^{T}\left[1-\frac{1}{m_k+c_k+q}\left(\sum_{i=1}^{m_k}\frac{s_{iot}^{k-*}}{x_{iot}^{k}}+\sum_{p=1}^{q}\frac{s_{po}^{t-*}}{v_{po}^{t(b-g)}}+\sum_{w=1}^{c_k}\frac{s_{wok}^{t,t+1*}}{x_{iot}^{k}}\right)\right]}{\frac{1}{T}\sum_{t=1}^{T}\left[1+\frac{1}{r_k+q}\left(\sum_{h=1}^{r_k}\frac{s_{hot}^{k+*}}{y_{hot}^{k}}+\sum_{p=1}^{q}\frac{s_{po}^{t+*}}{v_{po}^{t(b-g)}}\right)\right]}, \ (\forall k). \quad (10)$$

Period-divisional efficiency (premium accumulation efficiency or investment capability efficiency at time t) for the objective DMU_o is defined by

$$\varphi_{ko}^{t*} = \frac{\left[1-\frac{1}{m_k+c_k+q}\left(\sum_{i=1}^{m_k}\frac{s_{iot}^{k-*}}{x_{iot}^{k}}+\sum_{p=1}^{q}\frac{s_{po}^{t-*}}{v_{po}^{t(b-g)}}+\sum_{w=1}^{c_k}\frac{s_{wok}^{t,t+1*}}{x_{iot}^{k}}\right)\right]}{\left[1+\frac{1}{r_k+q}\left(\sum_{h=1}^{r_k}\frac{s_{hot}^{k+*}}{y_{hot}^{k}}+\sum_{p=1}^{q}\frac{s_{po}^{t+*}}{v_{po}^{t(b-g)}}\right)\right]}, \ (\forall k,t). \quad (11)$$

The projection of a target insurer is defined by

$$\begin{aligned}
\hat{x}_{iot}^{k} &= x_{iot}^{k} - s_{iot}^{k-} (i=1,\ldots,m_k;\ k=1,\ldots,K;\ t=1,\ldots,T),\\
\hat{y}_{hok}^{t} &= y_{hok}^{t} + s_{hok}^{t+} (h=1,\ldots,r_k;\ k=1,\ldots,K;\ t=1,\ldots,T),\\
\hat{v}_{po}^{t(b-g)} &= v_{po}^{t(b-g)} + s_{po}^{t+}\ \forall\ (b,g)\ (t=1,\ldots,T;\ p=1,\ldots,q),\\
\hat{z}_{wok}^{t,t+1} &= z_{wok}^{t,t+1} - s_{wok}^{t,t+1} (w=1,\ldots,c_k;\ t=1,\ldots,T;\ k=1,\ldots,K). \quad (12)
\end{aligned}$$

2.5. Data description

The efficiency analysis requires firm-level data of insurance companies. The firm-level data for this study is compiled from annual reports of publicly-traded insurance companies in Malaysia, including companies in general insurance segment, life insurance segment and life and general insurance segment (composite or non-specialized). As of 2014, there are

33 insurers operating in the Malaysian insurance sector. After excluding the insurers with missing values, a total of 31 insurers were selected; 19 general insurers, 9 life insurers and 5 composite insurers. The data covers 8 years, 2007–2014. Given the lag effect of carry-over items, the sample is made up of 217 observations. The total net premiums earned by the 31 companies constitute 98 percent of the total, suggesting that the sample is representative of the Malaysian insurance sector.

Table 3 presents the summary statistics of the sample. There is significant variation in the data, which indicates the differences in the operating scales of the sampled insurers. The large differences across insurers also justify the use of unit-invariant in the efficiency analysis (Du *et al.* 2014). For more details on yearly statistics, see Appendix Table A1.

Table 3. Summary statistics of the input, carry-over, intermediate, and output variables

Variable	Mean	Median	SD	CV	Range	Skewness	N
X1	107835	70115	99281	0.92	622892	2.15	217
X2	4395794	1181206	9646814	2.19	58952778	4.07	217
C1	829592	394831	1221174	1.47	6332665	2.90	217
C2	735913	269531	1279446	1.74	7952759	3.41	217
Z1	511809	306143	520414	1.02	3612709	2.52	217
Z2	3995068	953953	8830321	2.21	57429577	4.13	217
Y1	198029	53411	409743	2.07	2439690	3.71	217
Y2	98078	45309	144014	1.47	986693	2.38	217

Notes: (1) Refer to Table 1 for definition of variables; (2) SD: standard deviation; CV: coefficient of variation (SD/mean).

3. Research findings

3.1. Efficiency analysis

Table 4 reports the overall efficiency scores of insurers. The findings suggest that specialized insurers achieved higher overall efficiency, on average, at 82.86 percent for life insurers and 79.72 percent for general insurers, as compared to composite or non-specialized insurers at 77.67. The overall efficiency of general insurers consistently surpassed that of the life and composite segments, while the latter two witnessed fluctuations in their efficiency scores. However, the efficiency scores for life insurers remained above the sectoral average, and *vice versa* for general insurers.

To statistically examine if differences exist between the insurance-type, life, general and composite, as well as ownership-type, foreign and local, this study utilizes the Kruskal–Wallis test. This non-parametric test shows that overall efficiency does not differ across company type (Table 7). The non-significant result may suggest that the insurance companies are homogenous, and thus supports the homogeneity requirement for the DEA analysis. However, an opening up of the black box will enable us to reveal some finer differences among them. The same result does not hold for ownership type. The overall efficiency scores for foreign insurers' are found to be higher than that of local insurers, and also of the total average, suggesting the strength of foreign players in the local market.

Table 4. Overall efficiency scores for Malaysian insurers

Insurer	Ownership	Rank	2008	2009	2010	2011	2012	2013	2014	Average
General Insurers										
Allianz General Insurance Co. Bhd	F	9	0.9287	0.9998	0.9999	0.9116	0.9999	0.9998	0.9999	0.9762
AmGeneral Insurance Bhd	L	13	1	0.5665	0.7733	0.7435	0.9053	0.9999	0.9998	0.8233
AXA Affin General Insurance Bhd	L	29	0.4886	0.4665	0.5726	0.5808	0.6977	0.6317	0.7295	0.5843
Berjaya Sompo Insurance Bhd	L	28	0.5191	0.4766	0.5278	0.6871	0.7056	0.7046	0.7482	0.6092
AIG Malaysia Insurance Bhd	F	12	0.5935	0.7806	0.9047	0.8288	0.9351	1	0.9204	0.8316
Lonpac Insurance Berhad	L	7	0.9122	1	1	1	1	1	1	0.9875
MSIG Insurance Bhd	F	4	1	0.9983	0.9998	0.9999	0.9999	0.9999	0.9999	0.9997
Multi-Purpose Insurans Bhd	L	24	0.5242	0.5409	0.7617	0.7271	0.739	0.6856	0.7449	0.6618
Overseas Assurance Corporation Bhd	F	11	0.675	0.7158	0.9056	1	0.9577	0.8357	1	0.8524
Tune Insurance Malaysia Bhd	L	16	0.6834	0.7652	0.7558	0.8554	0.8964	0.8321	0.8815	0.8022
Pacific & Orient Insurance Co. Bhd	L	26	0.5216	0.5803	0.6248	0.7244	0.6907	0.6743	0.7498	0.6442
The Pacific Insurance Bhd	F	15	0.648	0.7392	0.7653	0.8379	0.8922	0.9013	1	0.8115
Progressive Insurance Bhd	L	1	1	1	1	1	1	1	1	1
QBE Insurance Bhd	F	3	0.9992	1	1	1	1	1	1	0.9999
RHB Insurance Bhd	L	18	0.6151	0.6826	0.7638	0.795	0.8091	0.7562	0.9086	0.7528
Tokio Marine Insurans Bhd	F	25	0.4258	0.5591	0.6357	0.7236	0.7397	0.774	0.8089	0.6443
Uni.Asia General Insurance Bhd	L	31	0.4448	0.4234	0.4676	0.6655	0.7605	0.7365	0.7512	0.5718
Composite Insurers										
AIA Bhd	F	6	1	1	0.9999	0.9235	0.9998	1	1	0.9890
Etiqa Insurance Bhd	L	23	0.4053	0.6155	0.8343	0.8633	0.8719	0.8334	0.8322	0.6921

End of Table 4

Insurer	Ownership	Rank	2008	2009	2010	2011	2012	2013	2014	Average
MCIS Insurance Bhd	L	27	0.8298	0.3505	0.6921	0.6064	0.7145	0.7306	0.7225	0.6194
Prudential Assurance Malaysia Bhd	F	5	0.9960	1	1	1	1	1	1	0.9994
Zurich Insurance Malaysia Berhad	F	30	0.2841	0.6918	0.6283	0.8371	0.6703	0.7568	0.7058	0.5838
Life Insurers										
Allianz Life Insurance Malaysia Bhd	F	22	0.7733	0.7329	0.6904	0.5968	0.8026	0.7668	0.7455	0.7237
AmMetLife insurance Bhd	L	14	0.8915	0.7625	0.7911	0.6706	0.8745	1	0.8464	0.8225
AXA Affin Life Insurance Bhd	L	19	1	0.6422	0.6867	0.7373	0.6772	0.7909	0.7195	0.7397
Sun Life Malaysia Assurance Bhd	L	17	0.5079	0.7791	0.7037	0.9268	0.8774	0.9114	0.9233	0.7786
Great Eastern Life Assurance Bhd	F	1	1	1	1	1	1	1	1	1
Hong Leong Assurance Bhd	L	10	0.8303	1	1	1	1	1	0.8976	0.9589
Manulife Insurance Bhd	F	21	0.4857	0.8871	0.8736	0.8323	0.7699	0.7134	0.7095	0.7253
Tokio Marine Life Insurance Bhd	F	20	0.8731	0.8427	0.8012	0.5629	0.7099	0.6849	0.7099	0.7286
Gibraltar BSN Life Bhd	L	8	0.8738	1	1	1	1	1	1	0.9798
Average			0.7332	0.7613	0.8116	0.8270	0.8612	0.8619	0.8727	0.8030
Average Foreign			0.7630	0.8534	0.8717	0.8610	0.8912	0.8880	0.9000	0.8475
Average Local			0.7087	0.6854	0.7621	0.7990	0.8365	0.8404	0.8503	0.7664
Average General			0.7047	0.7232	0.7917	0.8283	0.8664	0.8548	0.8966	0.7972
Average Composite			0.7030	0.7316	0.8309	0.8461	0.8513	0.8642	0.8521	0.7767
Average Life			0.8040	0.8496	0.8385	0.8141	0.8568	0.8742	0.8391	0.8286
Max			1	1	1	1	1	1	1	1
Min			0.2841	0.3505	0.4676	0.5629	0.6703	0.6317	0.7058	0.5718
SD			0.2281	0.2044	0.1633	0.1469	0.1240	0.1327	0.1201	0.1506
No. efficient			6	8	7	8	7	10	9	2

Notes: F – foreign; L – local.

The Kruskal–Wallis test further confirms that significant differences exist between the overall efficiency scores of foreign and local insurers at the 1 percent significant level (Table 7). Foreign insurers are able to better utilize resources given their technological advancement (Huang *et al.* 2012), and quality of services (Choi, Elyasiani 2011). In this regard, policy-makers should encourage learning and understanding of the best practices of the foreign insurers among the local insurers.

Based on yearly average scores, only local insurers became more inefficient in 2009 with the implementation of some liberalization measures in the sector. In fact, most insurers experienced increases in efficiency scores in the aftermath of the 2009 financial liberalization policy and the 2008–2009 global financial crisis. Progressive Insurance Bhd, with a long history of operation in Malaysia, is the only general insurer that gained an efficiency score of one for all the years, while the Great Eastern Life Assurance Bhd, a Singaporean based company and the biggest insurance company in terms of total assets, achieved full overall efficiency among the life insurance segment.

The disaggregated insurance efficiency scores into premium accumulation and investment capability are presented in Table 5 and Table 6, respectively. It is apparent that the main driver of overall efficiency in the Malaysian insurance sector is premium accumulation. In other words, the Malaysian insurance companies appear to be more efficient in terms of accumulating premiums (89.58%) rather than in investment strategies (78.80%). This finding holds true for both foreign and local insurers.

Table 5. Premium accumulation efficiency scores for Malaysian insurers

Insurer	Ownership	Rank	2008	2009	2010	2011	2012	2013	2014	Average
General Insurers										
Allianz General Insurance Co. Bhd	F	9	0.8579	0.9999	0.9999	0.9999	0.9999	0.9999	1	0.9796
AmGeneral Insurance Bhd	L	11	1	1	1	0.8489	0.9948	1	1	0.9777
AXA Affin General Insurance Bhd	L	21	0.7467	0.8071	0.776	0.9248	0.9878	0.9286	0.9284	0.8713
Berjaya Sompo Insurance Bhd	L	19	0.6635	0.7116	0.996	1	1	0.9634	0.9989	0.9048
AIG Malaysia Insurance Bhd	F	20	0.5672	0.877	0.9387	0.9358	1	1	1	0.9027
Lonpac Insurance Berhad	L	13	0.8244	1	1	1	1	1	1	0.9749
MSIG Insurance Bhd	F	1	1	1	1	1	1	1	1	1
Multi-Purpose Insurans Bhd	L	28	0.588	0.6959	0.7722	0.819	0.8049	0.727	0.7977	0.7435
Overseas Assurance Corporation Bhd	F	16	0.8862	1	0.9559	1	0.9156	0.8806	1	0.9483

Continue of Table 5

Insurer	Ownership	Rank	2008	2009	2010	2011	2012	2013	2014	Average
Tune Insurance Malaysia Bhd	L	18	1	1	1	1	1	0.707	0.7811	0.9269
Pacific & Orient Insurance Co. Bhd	L	14	0.7807	1	1	1	1	1	1	0.9687
The Pacific Insurance Bhd	F	1	1	1	1	1	1	1	1	1
Progressive Insurance Bhd	L	1	1	1	1	1	1	1	1	1
QBE Insurance Bhd	F	1	1	1	1	1	1	1	1	1
RHB Insurance Bhd	L	12	0.8738	1	1	1	1	0.9531	1	0.9753
Tokio Marine Insurans Bhd	F	17	0.7318	0.9548	0.946	1	1	1	0.9649	0.9425
Uni.Asia General Insurance Bhd	L	24	0.7646	0.7967	0.7565	0.8131	0.8219	0.8134	0.8872	0.8076
Composite Insurers										
AIA Bhd	F	10	1	1	0.9999	0.8469	0.9997	1	1	0.9781
Etiqa Insurance Bhd	L	31	0.2609	0.4518	0.6686	0.7266	0.7437	0.6668	0.6645	0.5976
MCIS Insurance Bhd	L	30	0.6596	0.197	0.6156	0.702	0.6866	0.72	0.6646	0.6065
Prudential Assurance Malaysia Bhd	F	8	0.9921	1	1	1	1	1	1	0.9989
Zurich Insurance Malaysia Berhad	F	29	0.1649	0.7842	0.7518	0.7121	0.6874	0.6501	0.7029	0.6362
Life Insurers										
Allianz Life Insurance Malaysia Bhd	F	1	1	1	1	1	1	1	1	1
AmMetLife insurance Bhd	L	22	1	1	0.7763	0.8178	0.7491	1	0.6927	0.8623
AXA Affin Life Insurance Bhd	L	27	1	0.6659	0.6631	0.6469	0.6982	0.8638	0.8429	0.7687
Sun Life Malaysia Assurance Bhd	L	26	0.5897	0.9462	0.6785	0.8535	0.7547	0.8228	0.8465	0.7846
Great Eastern Life Assurance Bhd	F	1	1	1	1	1	1	1	1	1
Hong Leong Assurance Bhd	L	15	0.7589	1	1	1	1	1	1	0.9656
Manulife Insurance Bhd	F	23	1	1	0.8053	0.9437	0.7203	0.7484	0.7805	0.8569

End of Table 5

Insurer	Ownership	Rank	2008	2009	2010	2011	2012	2013	2014	Average
Tokio Marine Life Insurance Bhd	F	25	1	1	0.8158	0.7321	0.6382	0.6617	0.681	0.7898
Gibraltar BSN Life Bhd	L	1	1	1	1	1	1	1	1	1
Average			0.8294	0.8996	0.9005	0.9136	0.9098	0.9067	0.9108	0.8958
Average Foreign			0.8714	0.9726	0.9438	0.9408	0.9258	0.9243	0.9378	0.9309
Average Local			0.7948	0.8395	0.8649	0.8913	0.8966	0.8921	0.8885	0.8668
Average General			0.8403	0.9319	0.9495	0.9613	0.9721	0.9396	0.9622	0.9367
Average Composite			0.6155	0.6866	0.8072	0.7975	0.8235	0.8074	0.8064	0.7635
Average Life			0.9276	0.9569	0.8599	0.8882	0.8401	0.8996	0.8715	0.8920
Max			1	1	1	1	1	1	1	1
Min			0.1649	0.197	0.6156	0.6469	0.6382	0.6501	0.6645	0.5976
SD			0.2216	0.1884	0.1318	0.1145	0.1303	0.1275	0.1248	0.1225
No. efficient			14	19	14	16	16	16	17	7

Notes: F – foreign; L – local.

Table 6. Investment capability efficiency scores for Malaysian insurers

Insurer	Ownership	Rank	2008	2009	2010	2011	2012	2013	2014	Average
General insurers										
Allianz General Insurance Co. Bhd	F	8	0.9994	0.9996	0.9999	0.8377	0.9999	0.9997	0.9999	0.9766
AmGeneral Insurance Bhd	L	16	1	0.3952	0.6304	0.668	0.8309	0.9998	0.9996	0.7891
AXA Affin General Insurance Bhd	L	31	0.3832	0.348	0.4758	0.4311	0.5408	0.4844	0.607	0.4672
Berjaya Sompo Insurance Bhd	L	30	0.432	0.3785	0.3591	0.5234	0.5451	0.5569	0.5982	0.4847
AIG Malaysia Insurance Bhd	F	15	0.6206	0.712	0.8748	0.7487	0.8781	1	0.8526	0.8124
Lonpac Insurance Berhad	L	1	0.9999	1	1	1	1	1	1	1
MSIG Insurance Bhd	F	7	1	0.9966	0.9996	0.9998	0.9998	0.9997	0.9998	0.9993
Multi-Purpose Insurans Bhd	L	25	0.4828	0.4684	0.7537	0.6659	0.6933	0.6544	0.7075	0.6323
Overseas Assurance Corporation Bhd	F	14	0.5573	0.5574	0.8622	1	1	0.7973	1	0.8249

Continue of Table 6

Insurer	Ownership	Rank	2008	2009	2010	2011	2012	2013	2014	Average
Tune Insurance Malaysia Bhd	L	18	0.5191	0.6198	0.6075	0.7473	0.8123	0.9834	0.9884	0.754
Pacific & Orient Insurance Co. Bhd	L	29	0.4026	0.4087	0.4544	0.5679	0.5275	0.5087	0.5998	0.4957
The Pacific Insurance Bhd	F	21	0.4793	0.5863	0.6198	0.7211	0.8055	0.8204	1	0.7189
Progressive Insurance Bhd	L	1	1	1	1	1	1	1	1	1
QBE Insurance Bhd	F	6	0.9983	1	1	1	1	1	1	0.9998
RHB Insurance Bhd	L	24	0.4886	0.5181	0.6178	0.6597	0.6795	0.6318	0.8325	0.6326
Tokio Marine Insurans Bhd	F	27	0.3261	0.4006	0.4852	0.567	0.5869	0.6314	0.6997	0.5281
Uni.Asia General Insurance Bhd	L	28	0.3339	0.3058	0.3384	0.5775	0.7165	0.6794	0.6572	0.5155
Composite Insurers										
AIA Bhd	F	1	1	1	1	1	1	1	1	1
Etiqa Insurance Bhd	L	11	0.7775	0.8858	1	1	1	1	1	0.9519
MCIS Insurance Bhd	L	17	1	0.8803	0.7668	0.5425	0.7414	0.7394	0.78	0.7786
Prudential Assurance Malaysia Bhd	F	1	0.9999	0.9999	0.9999	1	1	1	1	1
Zurich Insurance Malaysia Berhad	F	20	0.6995	0.6333	0.5534	1	0.6575	0.8672	0.7079	0.7313
Life Insurers										
Allianz Life Insurance Malaysia Bhd	F	26	0.6304	0.5785	0.5272	0.4253	0.6702	0.6218	0.5942	0.5782
AmMetLife insurance Bhd	L	13	0.8043	0.6161	0.804	0.5767	1	1	1	0.8287
AXA Affin Life Insurance Bhd	L	19	1	0.624	0.7094	0.832	0.6615	0.7297	0.6283	0.7407
Sun Life Malaysia Assurance Bhd	L	12	0.4695	0.6676	0.7279	1	1	1	1	0.8379
Great Eastern Life Assurance Bhd	F	1	1	1	1	1	1	1	1	1
Hong Leong Assurance Bhd	L	10	0.895	1	1	1	1	0.9999	0.8142	0.9584
Manulife Insurance Bhd	F	23	0.3207	0.7971	0.9516	0.7462	0.8232	0.6817	0.6513	0.7103

End of Table 6

Insurer	Ownership	Rank	2008	2009	2010	2011	2012	2013	2014	Average
Tokio Marine Life Insurance Bhd	F	22	0.7748	0.7282	0.7894	0.4685	0.7834	0.707	0.7354	0.7124
Gibraltar BSN Life Bhd	L	9	0.7759	1	1	0.9999	1	1	1	0.968
Average			0.7152	0.7131	0.7712	0.7841	0.8372	0.8417	0.8533	0.7880
Average Foreign			0.7433	0.7850	0.8331	0.8225	0.8718	0.8662	0.8743	0.8280
Average Local			0.6920	0.6539	0.7203	0.7525	0.8088	0.8216	0.8360	0.7550
Average General			0.6484	0.6291	0.7105	0.7479	0.8009	0.8087	0.8554	0.7430
Average Composite			0.8954	0.8799	0.8640	0.9085	0.8798	0.9213	0.8976	0.8924
Average Life			0.7412	0.7791	0.8344	0.7832	0.8820	0.8600	0.8248	0.8150
Max			1	1	1	1	1	1	1	1
Min			0.3207	0.3058	0.3384	0.4253	0.5275	0.4844	0.5942	0.4672
SD			0.2572	0.2435	0.2207	0.2098	0.1702	0.1810	0.1648	0.1809
No. efficient			7	7	8	11	12	11	12	5

Notes: F – foreign; L – local.

However, the types of insurers matter. Composite insurers present better investment abilities (89.24%) than accumulating premiums (76.35%), relative to the other two segments. As Table 7 shows, the efficiency scores of the composite segment statistically differ from the other two segments, which supports the conglomeration hypothesis (Cummins *et al.* 2010) when it comes to the investment capability function, and supports the strategic focus hypothesis (Cummins *et al.* 2010) when it comes to the premium accumulation function. This is a key advantage of the network structure, as one is able to extract the underlying reasons for the different types of inefficiencies.

Similar to the results for overall efficiency, foreign insurers are again statistically superior in both the premium accumulation and investment capability functions as compared to local insurers (see Table 7 for tests of differences).

3.1.1. Comparing the results using different models

While the insurance efficiency framework justifies the use of a DN-DEA model, this study compares the discriminating power and the average efficiency scores between various DEA models in Table 8. In the traditional models, CCR and Banker, Charnes and Cooper (BCC), and SBM, the carry-over and intermediate variables are removed. The intermediate variables in the DSBM model and the carry-over variables in the NSBM model are not included in the analyses. Within traditional models, CCR shows lower efficiency scores and less efficient DMUs, supporting the higher discriminating power of this model (Banker *et al.* 1984). However, the network idea introduced to reveal the underlying function of a production or service process, leads to higher discrimination power because it literally expands the sample through a factor of the number of processes in the framework (Kao 2009).

Table 7. Tests of differences on efficiency scores by insurer and ownership types

Characteristics	Classification	N	Overall Efficiency	Premium Accumulation Efficiency	Investment Capability Efficiency
			Mean efficiency (p-value)		
Ownership	Foreign	98	0.8475 (0.002***)	0.9309 (0.003***)	0.8280 (0.053*)
	Local	119	0.7664 (0.002***)	0.8668 (0.003***)	0.7550 (0.053*)
Insurer	General	119	0.8095 (0.244)	0.9367 (0.001***)	0.7430 (0.000***)
	Composite	35	0.8113 (0.955)	0.7635 (0.000***)	0.8924 (0.001***)
	Life	63	0.8395 (0.218)	0.8920 (0.993)	0.8149 (0.131)

Notes: * p < 0.1, **p < 0.05, *** p < 0.01.

On the other hand, the dynamic approach poorly performs in terms of discriminating the efficient insurers, where it has the highest number of efficient DMUs among all the models. However, with the inclusion of the dynamic structure in the network approach, the discriminating power lessens as compared to the network model, and is therefore far better than the dynamic model. As mentioned by Avkiran (2015), this issue warrants the dimensionality in an efficiency analysis with greater emphasis on input quantities.

Table 8. Comparison of efficiency scores between traditional and SBM models

Models	2008	2009	2010	2011	2012	2013	2014
CCR	6 (0.5986)	8 (0.6770)	6 (0.8189)	5 (0.8305)	5 (0.8175)	5 (0.8202)	7 (0.8406)
BCC	9 (0.8080)	12 (0.8807)	13 (0.9153)	9 (0.8980)	10 (0.9090)	16 (0.9699)	11 (0.9491)
SBM	6 (0.5180)	12 (0.7686)	13 (0.8074)	9 (0.8662)	9 (0.8005)	16 (0.9489)	11 (0.8413)
DSBM	11 (0.7090)	16 (0.7801)	17 (0.8954)	14 (0.8730)	14 (0.9057)	19 (0.9398)	11 (0.9003)
NSBM	3 (0.5446)	6 (0.6508)	4 (0.7424)	7 (0.7727)	5 (0.8241)	6 (0.7945)	7 (0.8358)
DNSBM	6 (0.7332)	8 (0.7613)	7 (0.8116)	8 (0.8270)	7 (0.8612)	10 (0.8619)	9 (0.8727)

Notes: 1. Number of efficient insurers (average period efficiency score); 2. CCR and BCC are output oriented; 3. SBM, DSBM, NSBM, and DNSBM are non-oriented, VRS.

3.2. Cluster analysis

For multivariate data analysis, the cluster analysis has been identified as an effective tool for grouping objects (Jain 2010). It allows for a natural classification to identify the degree of similarity among objects. The cluster analysis goes through the data points by means of partitioning them into disjoint groups, in which the points fitting in the same cluster have similar attributes, while points fitting different clusters possess dissimilar attributes (Ding, He 2004). In fact, we perform the cluster analysis to have a better indication of the efficiencies of insurance companies by grouping them based on their three obtained efficiency scores. That is to say, we simultaneously include premium accumulation efficiency, investment capability efficiency and overall efficiency to obtain the location point for each insurer. Hence, a good performing insurance company must perform well in all three efficiency scores.

Using the cluster analysis, the study groups the insurers according to the efficiency scores obtained in the two functions and the overall efficiency. Two algorithm approaches are available in identifying the groups: hierarchy and partition. While the former finds a nested series of partitions to form a cluster hierarchy, the latter produces only one partition of the data without imposing a hierarchical structure (Jain *et al.* 1999). In a comprehensive review of the cluster analysis application, Punj and Stewart (1983) concluded that partition clustering algorithms are preferable to the hierarchical methods, however, the arbitrary number of output clusters may pose a problem (Punj, Stewart 1983). One can overcome this problem by running multiple algorithms with different numbers of clusters and selecting the best configuration obtained from all of the runs. The K-means has been known as the most reliable and popular partition method due to its simplicity, ease of implementation, empirical success and efficiency (Jain 2010; Punj, Stewart 1983). This study uses the K-means analysis as described in Jain (2010).

Using the average efficiency scores for premium accumulation, investment capability and overall, we run a K-means cluster analysis to categorize the homogeneous insurers into different groups. This study executes the K-means cluster analysis using the Matlab Statistics Toolbox™. In doing so, this study uses the Euclidean distance function, which is the best method for computing the distance between objects and centroid[2] (Hair *et al.* 2009). As mentioned above, the arbitrary number of clusters may be the most critical choice in performing K-means. Hence, we run the K-means for k equals to 2, 3 and 4 clusters. In order to find the best solution, we computed the average silhouette values[3] of all three possible options. The higher average silhouette values indicate a better cluster separation in that particular k number of clusters. Consequently, the comparison shows that the 4-cluster algorithm provides us with higher average silhouette values[4] (0.7040).

The K-means analysis categorizes the insurers into four groups, namely, top, middle-high, middle-low and bottom clusters. Figure 3 illustrates the visual composition using the coordinates (average divisional efficiency and overall efficiency scores) of each insurer into a 3D plot. The cluster analysis assigned 10 insurers to the top cluster, eight insurers to the middle-high cluster, seven insurers to the middle-low cluster and six insurers to the bottom cluster.

Table 9 provides the average analysis of the clusters in accordance with insurer and ownership types. The top cluster consists of 10 insurers with an average overall efficiency of 98.90 percent, which is higher than the sectoral and other clusters' averages. This cluster takes the lead in the average divisional efficiency of sectorial and other clusters. The insurers in the middle-high cluster gained higher average efficiency in both premium accumulation division and overall efficiency, yet they achieved lower efficiency in the invest-

[2] The centroid or centre point of a cluster is the average point of all the objects within a particular cluster.

[3] The silhouette value shows the similarity of each object relevant to its peers in its cluster compared to objects in neighbouring clusters.

[4] The average silhouette values for 2-cluster and 3-cluster algorithms are 0.6327 and 0.6241, respectively.

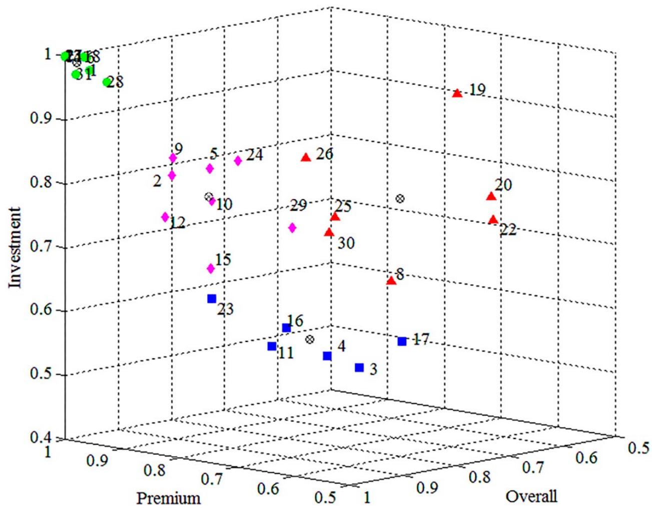

Figure 3. 3D plot for K-Means cluster analysis
Note: Four clusters are shown with circle (top), diamond (middle high), triangle (middle low), and square (bottom) colours. See Appendix Table A2, for insurers' codes.

ment capability division as compared to the insurers in the middle-low cluster. While the average premium accumulation of the six insurers in the bottom cluster is higher than the middle-low group, their investment capability efficiency and overall efficiency are lower than other clusters.

Table 9. K-Means clustering average of efficiencies, by insurer and ownership types

Cluster	Ownership	Insurer	Average			No. of Insurers
			Premium Accumulation	Investment Capability	Overall	
All	All	All	0.8958	0.7880	0.8030	31
1 (top)	All	All	0.9897	0.9902	0.9890	10
2 (middle-high)	All	All	0.9313	0.7589	0.8027	8
3 (middle-low)	All	All	0.7038	0.7693	0.6863	7
4 (bottom)	All	All	0.9158	0.5116	0.6296	6
1&2	Foreign	All	0.9665	0.9042	0.9185	10
1&2	Local	All	0.9603	0.8664	0.8909	8
3&4	Foreign	All	0.8421	0.6375	0.6701	4
3&4	Local	All	0.7837	0.6561	0.6557	9
1&2	All	General	0.9714	0.8643	0.8943	11
1&2	All	Composite	0.6590	0.6667	0.6628	2
1&2	All	Life	0.9370	0.8931	0.8973	5
3&4	All	General	0.8731	0.5206	0.6193	6
3&4	All	Composite	0.6134	0.8206	0.6318	3
3&4	All	Life	0.8358	0.7173	0.7427	4

Due to the few number of insurers in the sample, this study merged the top and middle-high groups and also middle-low and bottom groups to provide more meaningful results. The results reveal that foreign insurers outstripped their local counterparts in divisional and overall efficiencies in clusters 1 and 2. However, within the lower clusters, local insurers managed their investment strategies better than foreign insurers. The total number of foreign insurers as compared to local insurers in the upper clusters (10 versus 8) signal the need for addressing efficiency among local companies. This finding is consistent with the results of superiority of foreign insurers in achieving higher periodic efficiency scores as compared to locals.

Among the top performers, general insurers acquired the highest premium accumulation efficiency, while life insurers outperformed the other segments in investment capability and overall efficiencies, and composite insurers remained in the middle. The same holds for general insurers in the weak performing group. Composite insurers did better, comparatively, in the investment capability division. The majority of general insurers found their place among good-performing clusters, but not composite insurers.

3.3. Frontier projection analysis

Through frontier projection analysis, this study also identifies the potential areas of improvements for the input, output, intermediate and carry-over variables, distinguished by year, insurer and ownership types. The aim is to derive the marginal contributions of a decrease in input amounts or an increase in output amounts in improving the efficiency scores. Table 10 provides the average excess (negative values) and shortage (positive value) of each variable.

To improve the premium accumulation efficiency, the insurers, on average, have to reduce business service expenses (X1) by 8.45 percent, debt capital (X2) by 9.73 percent and net claims (Z2) by 1.37 percent, and increase their equity capital (C1) and net premium earned (Z1) by 9.28 percent and 8.75 percent, respectively. Interestingly, the Malaysian insurance sector appears to better able to manage the intermediates, where the needs to increase net premium earned and to decrease the net claims become less important.

The main deficiency of local insurers in the premium accumulation function was due to excess usage of input quantities (consistent through the years), which is directly related to inadequate managerial abilities to allocate the resources in efficient manner. The excess usage of inputs is also the reason for the low efficiency of composite insurers relative to other segments. Nevertheless, composite insurers have suffered from the shortage of their net premium earned. There is another vital weakness within the composite segment. Composite insurers appear to waste their equity capital, particularly from 2012 to 2014, as opposed to the shortage of this carry-over item in the life and general segments.

The lack of total investment by local insurers can explain their low efficiency scores. On average, local insurers have to increase their investments by 77.15 percent. Their investment income must also increase by approximately the same percentage. Local insurers must restructure their investment policies and attract more foreign direct investment (FDI).

Table 10. Frontier projections – average potential areas of improvement

	X1						X2						C1					
	Foreign	Local	General	Composite	Life	All	Foreign	Local	General	Composite	Life	All	Foreign	Local	General	Composite	Life	All
2008	−9.30	−18.01	−19.12	−22.26	0.00	−14.08	−1.44	−12.09	−2.86	−7.20	−15.68	−7.28	10.78	57.64	29.67	7.05	65.68	36.48
2009	−5.91	−9.31	−8.04	−19.12	−0.98	−7.77	−2.32	−16.60	−10.67	−14.30	−6.85	−10.15	1.40	−1.76	−0.80	2.53	−1.02	−0.33
2010	−4.55	−7.38	−5.49	−17.52	−0.93	−6.10	−5.25	−16.67	−5.30	−26.00	−15.20	−11.51	5.58	6.49	4.34	3.48	10.80	6.08
2011	−4.54	−10.93	−5.56	−15.82	−8.41	−8.04	−4.55	−12.60	−4.37	−22.13	−10.33	−8.97	8.37	11.09	6.03	−4.17	24.89	9.86
2012	−4.98	−12.94	−4.15	−16.70	−15.08	−9.34	−6.31	−12.95	−4.18	−18.37	−16.17	−9.95	−2.55	9.88	10.76	−18.60	4.69	4.26
2013	−2.99	−5.15	−2.36	−16.18	−0.93	−4.17	−5.49	−15.25	−7.46	−25.61	−9.03	−10.84	−0.10	8.16	9.35	−16.45	6.74	4.43
2014	−6.21	−12.45	−4.56	−24.68	−10.86	−9.63	−5.15	−12.89	−4.63	−22.53	−11.10	−9.40	2.01	5.95	7.77	−17.86	9.62	4.17
Average	−5.50	−10.88	−7.04	−18.90	−5.31	−8.45	−4.36	−14.15	−5.64	−19.45	−12.05	−9.73	3.64	13.92	9.59	−6.29	17.34	9.28

	C2						Z1						Z2					
	Foreign	Local	General	Composite	Life	All	Foreign	Local	General	Composite	Life	All	Foreign	Local	General	Composite	Life	All
2008	29.07	70.11	85.64	5.24	12.97	51.57	33.19	19.48	9.65	126.10	0.13	25.67	−5.63	−9.13	−7.84	−9.82	−5.74	−7.55
2009	64.53	61.71	102.66	11.88	16.43	62.98	0.00	24.40	0.78	75.72	2.55	13.38	0.00	−0.77	0.00	−2.63	0.00	−0.42
2010	23.32	167.73	187.03	−0.83	0.28	102.51	2.30	7.99	1.92	7.34	10.98	5.42	−1.59	0.00	0.00	0.00	−2.47	−0.72
2011	17.38	111.17	119.92	6.11	7.12	68.81	3.78	4.19	0.67	10.74	6.57	4.00	−0.36	0.00	0.00	0.00	−0.56	−0.16
2012	21.41	44.90	56.51	7.08	7.43	34.29	5.37	2.48	0.02	8.68	8.18	3.78	0.00	0.00	0.00	0.00	0.00	0.00
2013	14.03	40.20	47.31	3.88	6.23	28.38	6.72	4.69	3.50	6.37	9.17	5.61	0.00	−1.13	−0.23	−3.05	0.00	−0.62
2014	17.46	44.22	47.65	2.29	19.41	32.14	3.30	3.49	0.85	5.45	7.10	3.41	0.00	−0.16	−0.01	0.00	−0.28	−0.09
Average	26.74	77.15	92.39	5.09	9.98	54.38	7.81	9.53	2.48	34.34	6.38	8.75	−1.08	−1.60	−1.15	−2.21	−1.29	−1.37

	Y1						Y2					
	Foreign	Local	General	Composite	Life	All	Foreign	Local	General	Composite	Life	All
2008	101.77	113.24	156.97	7.13	71.75	108.06	12.31	22.21	7.85	21.50	34.34	17.74
2009	54.95	138.00	158.80	12.66	39.14	100.49	21.34	20.00	15.85	21.09	29.31	20.60
2010	36.03	97.12	110.23	12.05	24.58	69.53	21.10	15.26	9.76	32.39	25.23	17.90
2011	22.34	50.04	64.03	0.67	7.96	37.53	42.03	36.49	21.33	33.07	75.63	38.99
2012	17.02	50.33	55.43	3.46	14.93	35.29	19.97	10.65	8.19	31.33	18.29	14.86
2013	23.43	52.78	61.27	4.78	17.76	39.53	15.14	7.79	3.24	15.44	23.57	11.11
2014	11.36	39.11	36.65	0.62	21.96	26.58	25.68	10.73	7.31	27.16	31.32	17.48
Average	38.13	77.23	91.91	5.91	28.30	59.57	22.51	17.59	10.50	26.00	33.96	19.81

Note: labour and business service expenses (x1), debt capital (x2), equity capital (c1), total investment (c2), net earned premiums (z1), net claims (z2), investment income (y1), net profit (y2).

Specifically, the general segment suffered severely from shortage of total investment, at 92.39 percent on average, which in turn has significantly reduced its investment capability efficiency. Composite insurers, however, efficiently utilized their total investments and gained investment income, but they did not outperform in terms of net profit. In fact, increasing net profit should be the key concern for life and composite insurers, but not general insurers. The detailed suggestions for each insurance company to become efficient are provided in Appendix Table A2.

Conclusions

Based on the intermediation approach, this study proposed a new framework for performance efficiency to evaluate the business excellence of insurance companies. Following from the financial portfolio theory, the proposed framework disaggregated the service processes of insurance companies into two functions, namely, premium accumulation and investment capability. This study then applied the new framework to measure the efficiency of the Malaysian insurance companies across insurer and ownership types.

The results indicate lack of overall and divisional efficiencies among local insurers. The lack of overall efficiency is mainly due to the poor performance in the investment capability division. On average, life insurers stand above the average overall efficiency, while general insurers are superior in premium accumulation division, and composite insurers are better in investment capability division. The cluster analysis produces results that are largely consistent with the efficiency scores. Foreign insurers produce better average efficiency scores than their local counterparts in the top clusters, while the local insurers in the bottom clusters perform better in investments. The high number of local insurers among low performers calls for special attention for addressing inefficiencies of local insurers.

Finally, this study provides the potential areas of improvement for insurers to tackle the inefficiencies in their operating activities. Overuse of input resources are the major reasons for the low premium accumulation efficiencies of local insurers. In addition to the shortage of input quantities, the mismanagement of composite insurers to earn enough net premium and the wastage of equity capital are the reasons behind their inefficiencies in premium accumulation. To enhance the efficiency of investment capability, local insurers need to increase their total investments and subsequently investment income.

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APPENDIX

Table A1. Yearly summary statistics of the input, carry-over, intermediate, and output variables

	Panel A: Year 2008				Panel B: Year 2009			
	Mean	Median	SD	Range	Mean	Median	Std. Dev.	Range
Labor and business service expenses ($X1_t$)	70732	58348	59154	290060	83425	55397	74386	276658
Debt capital ($X2_t$)	1122382	503803	1358305	4988548	3109898	717320	7889220	43322657
Equity capital ($C1_{t-1}$)	407124	238595	753018	4313728	594058	314137	929213	4516512
Investment assets ($C2_{t-1}$)	320901	158467	511364	2561933	572215	265177	971587	4320784
Net earned premiums ($Z1_t$)	360626	217882	378559	1692076	302920	236075	234779	922093
Net claims ($Z2_t$)	2592949	726254	5433726	28644731	2787948	768625	6398622	34497267
Investment income ($Y1_t$)	151059	31396	351527	1813560	158273	34938	328354	1660135
Net profit ($Y2_t$)	50043	21754	91693	420040	74164	29887	117528	520437
	Panel C: Year 2010				Panel D: Year 2011			
Labor and business service expenses ($X1_t$)	96521	69736	82528	292268	102689	79286	85349	330580
Debt capital ($X2_t$)	4613615	1086200	9365274	48244599	4750006	1225018	9650944	50563101
Equity capital ($C1_{t-1}$)	809637	456497	1100881	5203719	852061	476554	1171990	5446393
Investment assets ($C2_{t-1}$)	782523	358762	1339540	6671928	760733	340165	1298594	6644728
Net earned premiums ($Z1_t$)	381875	223262	309581	997164	478984	292206	433117	1736094
Net claims ($Z2_t$)	3356575	836859	7953285	42691761	4193559	953953	9049143	47277735
Investment income ($Y1_t$)	180533	39711	362998	1841422	190070	57476	384956	1991438
Net profit ($Y2_t$)	87062	39124	117986	453717	104272	38529	183296	986693
	Panel E: Year 2012				Panel E: Year 2013			
Labor and business service expenses ($X1_t$)	119823	88044	96297	358051	139273	103159	129027	493075
Debt capital ($X2_t$)	5102743	1657982	10500363	55344423	5906226	1489766	11962851	57639882
Equity capital ($C1_{t-1}$)	933327	481246	1276904	5673224	1057994	542402	1430121	5866297
Investment assets ($C2_{t-1}$)	886335	361685	1595035	7912758	859655	399622	1286004	5494705
Net earned premiums ($Z1_t$)	583568	383686	543009	2336241	682939	436132	591486	2330200
Net claims ($Z2_t$)	4433531	1022835	9492012	49980024	4912199	1167710	10431221	54824541
Investment income ($Y1_t$)	214095	58126	431783	2238195	237783	57145	481423	2409070
Net profit ($Y2_t$)	109950	51508	139260	552927	129713	64319	164546	665564
	Panel F: Year 2014							
Labor and business service expenses ($X1_t$)	142383	97979	131598	614873				
Debt capital ($X2_t$)	6165685	1577694	12355868	58797060				
Equity capital ($C1_{t-1}$)	1152941	505216	1621623	6284588				
Investment assets ($C2_{t-1}$)	969030	320391	1611906	6691649				
Net earned premiums ($Z1_t$)	791751	421287	787131	3560080				
Net claims ($Z2_t$)	5688714	1333350	11784214	57214469				
Investment income ($Y1_t$)	254389	65504	519399	2438425				
Net profit ($Y2_t$)	131345	67143	166306	699131				

Table A2. Frontier projections – potential areas for improvement, 2008–2014

Insurer	No.	Ownership	X1	X2	C1	C2	Z1	Z2	Y1	Y2
General Insurers										
Allianz General Insurance Co. Bhd	1	F	0.22	0.03	−5.78	−0.02	2.93	2.65	0.00	−0.32
AmGeneral Insurance Bhd	2	L	0.82	11.52	−3.89	−0.17	61.70	18.81	1.04	0.00
AXA Affin General Insurance Bhd	3	L	37.95	392.75	−20.43	−11.52	205.45	36.43	1.64	−2.58
Berjaya Sompo Insurance Bhd	4	L	13.92	138.31	−4.46	−7.96	207.99	19.27	7.53	−0.59
AIG Malaysia Insurance Bhd	5	F	−0.60	29.62	−12.79	−0.47	33.28	18.33	9.37	0.00
Lonpac Insurance Berhad	6	L	0.00	0.00	−5.77	−1.75	0.00	0.00	0.00	0.00
MSIG Insurance Bhd	7	F	0.00	0.07	0.00	0.00	0.13	0.01	0.00	0.00
Multi-Purpose Insurans Bhd	8	L	93.67	68.02	−17.96	−36.88	115.67	10.58	7.06	−8.75
Overseas Assurance Corporation Bhd	9	F	−1.60	6.79	−6.79	−3.95	55.21	2.00	1.08	−1.89
Tune Insurance Malaysia Bhd	10	L	−2.32	19.32	−2.68	−9.67	73.61	5.93	4.41	0.00
Pacific & Orient Insurance Co. Bhd	11	L	0.00	300.87	−3.54	0.00	196.67	15.37	2.00	−1.18
The Pacific Insurance Bhd	12	F	0.00	45.67	0.00	0.00	88.90	4.04	0.00	0.00
Progressive Insurance Bhd	13	L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QBE Insurance Bhd	14	F	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
RHB Insurance Bhd	15	L	0.00	51.70	−3.30	−4.12	120.80	3.96	0.00	0.00
Tokio Marine Insurans Bhd	16	F	3.74	209.91	−11.59	−3.62	185.60	17.40	0.00	−2.04
Uni.Asia General Insurance Bhd	17	L	17.22	296.04	−20.68	−15.74	214.52	23.79	8.09	−2.28
Composite Insurers										
AIA Bhd	18	F	−0.01	0.00	−2.44	−4.14	0.00	0.00	0.00	0.00
Etiqa Insurance Bhd	19	L	−57.09	−0.91	−42.54	−33.70	5.19	6.68	45.42	−1.88
MCIS Insurance Bhd	20	L	4.42	−0.97	−19.54	−37.03	4.83	59.93	58.91	−2.18
Prudential Assurance Malaysia Bhd	21	F	0.00	0.01	0.00	0.00	0.01	0.00	0.11	0.00
Zurich Insurance Malaysia Berhad	22	F	21.24	27.33	−29.95	−22.38	19.53	63.39	67.27	−7.01
Life Insurers										
Allianz Life Insurance Malaysia Bhd	23	F	0.00	36.85	0.00	0.00	62.77	89.97	0.00	0.00
AmMetLife insurance Bhd	24	L	35.10	−1.51	−17.54	−17.22	17.23	35.47	2.73	0.00
AXA Affin Life Insurance Bhd	25	L	14.70	22.57	−10.38	−19.29	50.65	26.14	18.44	−0.35
Sun Life Malaysia Assurance Bhd	26	L	78.30	8.27	−12.29	−35.57	27.68	29.52	4.61	−7.38
Great Eastern Life Assurance Bhd	27	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hong Leong Assurance Bhd	28	L	0.00	5.56	0.00	−9.95	6.20	3.67	0.17	0.00
Manulife Insurance Bhd	29	F	−7.28	19.20	0.00	−5.53	80.01	33.70	16.00	−0.72
Tokio Marine Life Insurance Bhd	30	F	35.25	−1.11	−7.60	−20.91	5.38	83.64	15.48	−3.17
Gibraltar BSN Life Bhd	31	L	0.00	0.00	0.00	0.00	4.75	3.50	0.00	0.00