Two Stage DEA Method for Performance Evaluation of General Insurance Companies

Saiful Hafizah Jaaman[1], Nurul Sakhinah Che Mat Roplan[2]

[1]Centre of Modelling and Data Science, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia

[2]Actuarial Science Program, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia

---***---

Abstract - *Data Envelopment Analysis (DEA) is an approach to measure the relative efficiency of decision making units (DMUs) with multiple inputs and outputs. Through DEA, the diagnosis of the deficiencies can be detected and possible ways to improve efficiency can be implemented. The two-stage approach in the DEA methodology is used to decompose the operation process into two-stage process as an effort to identify the factors leading to the occurrence of inefficiencies. This study determines the efficiency of general insurance companies in Malaysia using the two-stage DEA which involves the intermediate measures of the production process. The entire production process of the general insurance companies is categorized into two sub-processes, the written premium acquisition and investment profit generation. The first sub-process is characterized by marketing of the insurance to attract customers and pay direct written premium. The second sub-process is characterized by investment, where premium are invested in a portfolio to earn profits. In this study the performances of fourteen general insurance companies are measured and factors that lead to the occurrence of inefficiencies are identified. The findings indicate that two stage DEA method provides added information on the efficiency score. Prudential Assurance Malaysia Berhad show the best practices in overall performance to be ranked first among the list of companies involved in this study. In conclusion, among the two sub-processes under study, general insurance companies in Malaysia should emphasize on the efficiency at generating investment profits.*

*Key Words***: *Data Envelopment Analysis, Efficiency, General Insurance, Two-Stage DEA, Written Premium, Investment Profit*.

1. INTRODUCTION

In Malaysia, the insurance industry is one of the important financial sectors that contributes in enhancing economic growth and stability. Malaysian economy has gone through various changes such as the depreciation of the Malaysian Ringgit (RM) against the US dollar (USD) and other major global currencies, as well as the introduction and abolishment of the Goods and Services Tax (GST). Pertinent to the insurance industry, motor tariff liberalization has been introduced since July 2017 with the intention to spur growth and encourange insurance companies to develop economical and creative insurance products. Detariffication allows insurance companies to set prices based on the risk-based pricing commensurate to the risk profile of insured and insurance policies offered.

Among the studies on the performance of the insurance sector in Malaysia include by [1], [2], [3], and [4]. In measuring corporate performance, insurers should incorporate various indicators to ensure they have comprehensively understood the specific details regarding performance of the company. Performance measures such as financial ratios are normally used in practice. However, single dimensional performance measures might not be able to capture the exact picture of a firm's financial performance. An alternative method that could incorporate various attributes together and considers relationships among the attributes to provide meaningful information is data envelopment analysis (DEA). This information on aggregated relationships provides managers the exact picture of the company's financial performance.

The main aim of this study was to measure the efficiency of general insurance companies in Malaysia using the Two-Stage DEA method and to compare and determine the position of general insurance companies in Malaysia from 2011-2015 based on the obtained efficiency scores.

2. DATA ENVELOPMENT ANALYSIS (DEA)

DEA is a non-parametric method that utilizes mathematical programming integrates various characteristics together so that promising associations among the characteristics are considered in estimating a single efficiency score for a decision-making unit (DMU). DEA also known as the CCR model was introduced by [5]. It is a linear programming technique which measures the efficiency of each DMU obtained as a maximum of the ratio between weighted outputs and weighted inputs. Fewer the inputs invested in producing the given output, the more efficient the production. DEA is also used to evaluate the operational efficiency of a unit by comparing the operation of that unit with other units in the same organization or comparing operation between companies. Based on DEA, the performance of a company is evaluated on an efficient frontier which is built by the linear combination of the existing companies. DMU is said to have efficient performance when the efficiency score equal to one (or efficiency value equals to 100 percent), otherwise when the

efficiency score is less than one then the DMU is considered as inefficient.

DEA has several advantages, for instance it is able to manage multiple inputs and outputs stated in different measurement units and since DEA is a non-parametric method it does not require any assumptions regarding the distribution of the subjects and can be used with small samples. Among studies on the efficiency of the insurance sector in Malaysia using the DEA method were carried out by [6], [7], [8] and [2].

2.1 Two-Stage DEA

In order to procure to the source of inefficiency, the overall efficiency needs to be disassembled into components. One way is to decompose the structure of the DEA model according to various stages of production processes. Complex production process is divided into sub-processes where intermediate products become the outputs of a sub-process on one hand and the inputs of another sub-process on the other hand. According to [9] and [10] previous studies adopted the use of independent two-level DEA conventional model which treat the whole production process and the two sub-processes as independent. However, [11] takes into account the sequential consecutive relationship of the two sub-processes in measuring the efficiencies. They showed that the overall efficiency is the product of the efficiencies of the two sub-processes. This relationship is depicted in Figure 1.
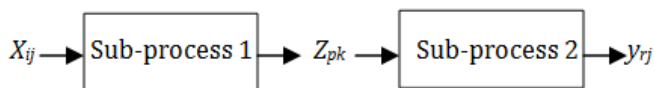

Figure – 1: Flow of Two-Stage DEA

In this study the whole process of production can be categorized into two sub-processes, premium recovery and profit generation. The first sub-process observes the insurance marketing feature in attracting customer to pay written premium. On the other hand, the second sub-process measures the investment capability where the received premiums invested in a portfolio to generate profit. The general insurance industry has a common two-stage structure for the production process thus two-stage DEA method can be used to measure the overall efficiency of both the process and the sub-processes.

There are twenty-one general insurance companies registered under the Malaysian Association of General Insurance (PIAM). However, only fourteen companies have enough data to carry out the data analysis process. The input data employed in this study are operating expenses (x_1) and insurance expenses (x_2) and the output data are underwriting profit (y_1) and investment income (y_2). The in-between data used is gross premium earned (z_1).

The complete process uses m number of inputs, x_{ij} (i = 1,2,..., m) to generate s number of output, y_{rj}, (r = 1,2,..., s). In this study, the entire production process consists of two sub-processes with q intermediate result, z_{dj}, (d = 1,2,..., q), q is output of sub-process 1 and input to sub-process 2. Based on [11], the efficiency of the entire system DMU$_j$ is given as:

$$\theta_j^* = \text{maximize} \sum_{r=1}^{s} u_r \, y_{rj}$$

Subject to

$$\sum_{i=1}^{m} v_i \, x_{ij} = 1,$$

$$\sum_{r=1}^{s} u_r \, y_{rj} - \sum_{i=1}^{m} v_i \, x_{ij} \leq 0, j = 1, \dots, n \qquad (1)$$

Using similar method, the efficiency of the first and second stages are obtained.

$$\theta_j^1 = \text{maximize} \sum_{d=1}^{D} \eta_d \, z_{dj}$$

Subject to

$$\sum_{i=1}^{m} v_i \, x_{ij} = 1,$$

$$\sum_{d=1}^{D} \eta_d^1 z_{dj} - \sum_{i=1}^{m} v_i \, x_{ij} \leq 0, \qquad (2)$$

$$\theta_j^2 = \text{maximize} \sum_{r=1}^{s} u_r \, y_{rj}$$

Subject to

$$\sum_{d=1}^{D} \eta_d^2 z_{dj} = 1$$

$$\sum_{r=1}^{s} u_r \, y_{rj} - \sum_{d=1}^{D} \eta_d^2 z_{dj} \leq 0, \qquad (3)$$

$$v_i \, , u_r \, , \eta_d^1, \eta_d^2 \geq 0$$

3. RESULTS AND DISCUSSION

Table 1 presents the overall average efficiency results for all fourteen general insurance companies studied. As shown, all 14 companies are in the good standing category obtaining average efficiency score between 70% to 100%, with no company producing efficiency score of less than 50%. Prudential Assurance Malaysia Berhad exhibits best practices for measuring overall performance by earning a score of a perfect 1 to be ranked first among all companies involved in this study. Lonpac Insurance Berhad follows closely at second place with an average overall score of 99.92% with Progressive Insurance Berhad ranks third with efficiency score of 94.96%. On the other hand, the average efficiency score of RHB Insurance Berhad, Chubb Insurance Malaysia Berhad and Berjaya Sompo Insurance Berhad is at the 70%, the score hints that the companies are not operating efficiently.

Table – 1: Overall Efficiency Score

Decision Making Unit (DMU)	5 years Average Score	Rank
AIG Malaysia Insurance Berhad	0.7566	10
Allianz General Insurance Company (Malaysia) Berhad	0.8918	4
AXA Affin General Insurance Berhad	0.7752	8
Berjaya Sompo Insurance Berhad	0.7078	12
Pacific & Orient Insurance Co. Berhad	0.8898	5
MPI General Insurance Berhad	0.8062	7
Prudential Assurance Malaysia Berhad	1.000	1
Tune Insurance Malaysia Berhad	0.8142	6
RHB Insurance Berhad	0.7002	14
QBE Insurance (Malaysia) Berhad	0.7692	9
Progressive Insurance Berhad	0.9496	3
Tokio Marine Insurance (Malaysia) Berhad	0.7436	11
Lonpac Insurance Berhad	0.9992	2
Chubb Insurance Malaysia Berhad	0.7028	13
Overall Average	0.8218	

Table 2 gives the yearly efficiency score for the 14 general insurance companies studied. Prudential Assurance Berhad obtains a perfect efficiency score of 1.00 for each year from 2011 to 2015. This score indicates that the general business activities of Prudential Assurance is managed efficiently, able to engage policy holders to pay written premium on the insurance coverage on policy issued timely and able to generate profit from the investments made. Lonpac Insurance Berhad gives perfect efficiency score of 1.00 for the years 2011 to 2014. In 2015 it drops to 99.6%, this drop serves as an early warning system to the company to scrutinize its inputs and outputs in order to identify the source of inefficiency.

Tables 3 and 4 present the average efficiency score for each sub-process in the 2 stage DEA model for all 14 general insurance companies. As shown in Table 3, for sub-process 1 which evaluates on the marketing team's capability on acquiring written premium gives an average efficiency score of 76.48%. General insurance companies are most efficient in their marketing strategy offering attractive insurance packages in year 2011 as indicated by the efficiency score of 94.1% shown in Table 4. The second sub-process which measures on the investment capabilities to generate returns provide an average efficiency score of 73.82%. The efficiency score for this sub-process remains at around 70% for all the 5 years from 2011 to 2015. This suggests that general insurance companies need to search for investments that create value to its funds.

Table – 2: Yearly Efficiency Score

Decision Making Unit (DMU)	θ_j^*				
	2011	2012	2013	2014	2015
AIG Malaysia Insurance Berhad	0.781	0.712	0.825	0.674	0.791
Allianz General Insurance Company (Malaysia) Berhad	0.884	0.801	0.819	0.955	1.000
AXA Affin General Insurance Berhad	0.672	0.689	0.856	0.761	0.898
Berjaya Sompo Insurance Berhad	0.734	0.658	0.664	0.699	0.784
Pacific & Orient Insurance Co. Berhad	0.812	0.916	0.863	0.858	1.000
MPI General Insurance Berhad	0.961	0.911	0.732	0.630	0.797
Prudential Assurance Malaysia Berhad	1.000	1.000	1.000	1.000	1.000
Tune Insurance Malaysia Berhad	1.000	0.700	0.620	0.820	0.931
RHB Insurance Berhad	0.796	0.661	0.736	0.693	0.615
QBE Insurance (Malaysia) Berhad	0.617	0.736	0.780	0.713	1.000
Progressive Insurance Berhad	0.895	1.000	0.900	0.953	1.000
Tokio Marine Insurance (Malaysia) Berhad	0.734	0.761	0.707	0.781	0.735
Lonpac Insurance Berhad	1.000	1.000	1.000	1.000	0.996
Chubb Insurance Malaysia Berhad	1.000	0.528	0.730	0.539	0.717
Yearly Average	0.849	0.791	0.802	0.791	0.876

Table – 3: 1st and 2nd Stage Average Efficiency Score

Stages	Average Score
1st Stage: Marketing Features	0.7648
2nd Stage: Investment Capability	0.7382
Overall Average	0.8218

Table – 4: Average Efficiency Score By Stages

	2011	2012	2013	2014	2015
1st Stage: Marketing	0.941	0.936	0.891	0.186	0.870
2nd Stage: Investment	0.759	0.734	0.752	0.704	0.742
Yearly Overall	0.849	0.791	0.802	0.791	0.876

4. CONCLUSION

The objective of efficiency measurement is to detect weak areas so that appropriate effort can be taken to improve company's performance. DEA is an efficiency measurement technique that allows decision making unit (DMU), in this case general insurance companies, to measure the efficiency of the services provided. Through DEA, the diagnosis of the deficiencies can be detected and possible ways to improve efficiency can be implemented. When an operating system can be separated into two sub-processes, it provides additional information regarding efficiency where besides calculating the efficiency of the whole system by using the conventional DEA model, the efficiencies of the two sub-processes can also be calculated to identify the source that causes the inefficiency of the whole operating system. Two stage DEA method has been applied to measure the overall efficiency of general insurance companies in Malaysia and the efficiency of two important sub-processes. The findings show that general insurance companies need to improve on its investment strategy and locate investment vehicles that could promise better returns. Future studies could combine DEA techniques with company's capital budget and product mixture to provide more detail picture on each service provider's performance.

ACKNOWLEDGEMENT

REFERENCES

[1]   S.H. Jaaman, N. Ismail, and N. Majid, "Assessing risk and financial strength of general insurers in Malaysia," Journal of Quality Measurement and Analysis, 3(1), 2007, pp. 65-73.

[2]   R. Yakob, Z. Yusop, A. Radam, and N. Ismail, "Camel Rating Approach to Assess the Insurance Operators Financial Strength," Jurnal Ekonomi Malaysia, 46(2), 2012, pp. 3-15.

[3]   M. Ismail, "Determinants of financial performance: The case of general takaful and insurance companies in Malaysia," International Review of Business Research Papers, 9(6), 2013, pp. 111-130.

[4]   S.H. Jaaman and C.X. Ong, "Solvency analysis by business classification of General Insurance industry in Malaysia," International Journal of Sciences: Basic and Applied Research, 48(5), 2019, pp. 24-32.

[5]   A. Charnes, W.W. Cooper, and E. Rhodes, "Measuring the efficiency of decision making units," European Journal of Operational Research, (2), 1978, pp. 429–444.

[6]   S. A. Mansor and A. Radam, 2000. "Productity and Efficiency Performance of the Malaysian Life Insurance Industry," Jurnal Ekonomi Malaysia, (34), pp. 93-105.

[7]   N. Md. Saad, H. Idris and N. Edzalina, "Efficiency of life insurance companies in Malaysia and Brunei: a comparative analysis," International Journal of Humanities and Social Science, (3), 2011, pp. 111-122.

[8]   N. Md. Saad, M. S. A. Majid, R. M. Yusof, J. Duasa and A.R. Abdul Rahman, "Measuring Efficiency of Insurance and takaful Companie in Malaysia Using Data Envelopment Analysis," Review on Islamic Economics, (10), 2006, pp. 5-26.

[9]   Y. Chen, W.D. Cook, N. Li and J. Zhu, "Additive efficiency decomposition in two-stage DEA," European Journal of Operational Research, (196), 2009, pp. 1170-1176.

[10] Y. Chen, L. Liang and J. Zhu, 2009. "Equivalence in two-stage DEA approaches," European Journal of Operational Research, (193), 2009, pp. 600-604.

[11] C. Kao and S-N. Hwang, "Efficiency decomposition in two-stage data envelopment analysis: An application to non-life insurance companies in Taiwan," European Journal of Operational Research, (185), 2008, pp. 418-429.