Analyzing the Efficiency of the Top Non-Life Insurance Companies in the Philippines: Derivation of Common Weights in Data Envelopment Analysis (DEA) using Goal Programming Approach

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Abstract

Aside from the financial and technical ratios and parameters currently used by the Insurance Commission, this paper, as based on Gharakhani et. al's model (2017) develops a measure of efficiency derived using two-stage dynamic network Data Envelopment Analysis, a non-parametric linear programming approach as an alternative in evaluating the performance of the non-life insurance sector. Using balanced panel data acquired from financial reports from 2015 to 2017 of the top non-life insurers of the Philippines based on 2017 Gross Premiums Written (GPW), goal programming was used to develop a set of common weights to be applied to the said insurers for the following variables: operations expenses; benefit, claims and expenses; general administrative expenses; direct premiums written; reinsurance premiums; net income and investment income, to compute for their respective efficiencies. Results revealed that by comparing the average normalized overall efficiency scores across 3 years, DMU3 is the most efficient among all. Moreover, DMUs 1 and 4 have also obtained the maximum efficiency for year 2016 and 2017, respectively. Strengths and techniques of the said efficient DMUs were also presented and discussed in this paper.

Keywords
Data envelopment analysis (DEA), non-life insurance, goal programming, common weights

1. Introduction

There have been numerous prior studies with diverse objectives regarding efficiency and performance evaluation in the financial sector particularly in the insurance industry. In fact, performance measurement and benchmarking are two of the most prominent research themes in the field (Barros et al, 2005; Cummins and Weiss, 1933; Cummins and Zi, 1998; Cummins et al, 1996, Katrischen and Scordis, 1998; and Rai 1996). Gharakhani et. al (2017) highlighted that performance evaluation is essential in assessing and designing company procedures and strategies. It is imperative to identify units with worsening performance to be able to make necessary adjustments and enhancements since it is expected that they should manifest improving performance through time. In addition, due to globalization, rapid evolution of the market and competitive pressure, insurance companies are forced to change their strategies in order to maintain and improve the quality of their services while minimizing their operations costs (Yang, 2005). Efficiency models and measures also serve as alternatives to the accounting-based financial ratio measures of the industry performance takes into consideration the importance of operational and strategic decision-making (Benyouseff and Hemrit, 2019). Thus, developing a tool to measure and evaluate the performance and efficiency of the insurance industry is essential.

Cummins et. al (2008) used DEA approach in estimating efficiency in US insurance firms to determine whether it is better for companies to specialize in a narrow range of products than operating a diversity of businesses. Through analyzing cost, revenue and profit efficiency, results reveal that the former is superior to the latter. The same is concluded by Liebenberg and Sommer (2008) on their study of performance of diversified versus non-diversified insurers using panel data from 1995 to 2004. On the other hand, Benyouseff and Hemrit (2019) examined the efficiency of Takaful insurance (Islamic insurance) versus cooperative insurance in Saudi Arabia. The approach was also applied in comparing the efficiency of paid-up capital compliant and non-compliant non-life insurers in the Philippines using 2008 to 2012 data (Datu, 2018). Analysis of Nektarios and Barrios (2010) regarding the efficiency of Greek insurance companies during periods 1994 to 2003 found that the productivity of life insurance and non-life insurance increased by 16.1% and 6.5% respectively and overall efficiency of the Greek insurance sector increased by 3%. Two-stage DEA is also created in order to assess the efficiency of Canadian life and health insurers by considering production performance and investment performance.

Data envelopment analysis or DEA is the most appropriate tool to use in analyzing efficiency of companies, firms and organizations (Gharakhani et. al, 2017). This non-parametric linear programming approach has several advantages compared to other models. First, this model can handle multiple input and output variables (Benyouseff and Hemrit, 2019). Also, it does not require knowledge of distributional assumptions and the functional form of inputs and outputs (Cummins, 2010).

However, conventional or traditional DEA models are also faced with several limitations. Gharakhani et al. (2017) noted that weights in these models are arbitrary and can be freely decided by the decision-making units (DMUs) to evaluate efficiency scores. Each DMU tends to choose favorable weights to achieve maximum possible efficiency hence, causing bias to the scoring. As a result, DMUs cannot be differentiated properly and completely. Moreover, using different sets of weight leads to many different efficient DMUs, making comparison and ranking of DMUs very impossible. Thus, in order to compare and rank each insurance company, the researchers used common weights in the dynamic network DEA model.

Despite the availability of various related literature on the insurance sector in other countries, there are only limited studies analyzing the efficiency of non-life firms in the Philippines. This paper aims to contribute to the application of the said model to non-life insurance industry data in the said country, particularly to the top insurance companies. Specifically, through this study, the researchers propose a measure of efficiency derived from dynamic network DEA-model whose weights are computed using the goal programming-approach as based on Gharakhani et al.'s model (2017). GP was used in order to yield a common set of weights to be applied to all insurance companies with the objective that the total deviation between the actual efficiency and maximum possible efficiency per DMU is minimized for all DMUs. Moreover, with the results of the model, overall efficiency of each insurance company would be obtained and the trend of production would be observed over time for 3 years, from 2015 to 2017. Lastly, this study aims to identify each non-life insurance company's strengths and strategies in conducting insurance business.

2. Methodology

2.1. Data Envelopment Analysis (DEA)

Data envelopment analysis or DEA, first developed by Charnes and Copper (1962), is a non-parametric mathematical method for measuring the efficiency of peer decision making units (DMUs) when there are multiple inputs and outputs (Dotoli et., al, 2015). Based on linear programming (LP), it is used to address the problem of calculating the relative efficiency for a group of DMUs by using multiple measures of inputs and outputs. As mentioned by Wanke and Barros (2016), given set of DMUs, inputs and outputs, the DEA model determines a measure of efficiency for each DMU, obtained as a ratio of weighted outputs to weighted inputs.

DEA is the most appropriate tool to use in analyzing efficiency of companies, firms and organizations (Gharakhani et. al, 2017). Compared to other approaches, DEA has lots of advantages. One is the convenience of handling multiple inputs and outputs because it does not require an assumption of a functional form relating inputs and outputs (Molyneux and Vallelado, 2008). Moreover, decision-making units (DMUs) are directly compared against a peer or combination of peers (Cummins et. al, 2010).

Gharakhani et., al (2017) and Benyousse and Hemerit (2019) summarized the different inputs and outputs used in several existing related literature and studies utilizing DEA:

Table 1. Summarized Literature Review of Inputs and Outputs

Author (s)	Inputs	Outputs
Wanke and Barros (2016) Biener et. Al. (2016)	- Current assets, real assets, long term assets-fixed, long term assets-others Labor and business - Services, Debt capital, Equity capital Operation expenses, insurance expenses	- Direct premium, insurance premium retained premium, earned premium Losses incurred, total investments - Underwriting profit, investment profit
Kao and Hwang (2008), Cook et al.(2010), Lim and Zhu (2016) Yang (2006)	- Labour expenses, capital equity, claims incurred, general operating expenses, total investments, segregated funds' assets	- Net premiums written combined, net income, investment gains in equities and real estate, investment gains in bonds and mortgages
Barros and Barroso (2005)	- Wages, capital, total investment income and premiums issued - Health, life and non-life: net operating	- Claims paid and profits - Health and life: incurred benefits net of
Ennsfellner et al. (2004)	- expenses, equity capital and technical provisions net of reinsurance	- reinsurance, changes in reserves net of reinsurance, total invested assets
Mahlberg and Url (2003)	- Administration and distribution costs and costs of capital investments	- Aggregate value of: expenditure on claims incurred, net change in technical provisions and the amount of returned premiums desegregated on Health insurance, Life insurance, property– liability insurance
Diacon et al. (2002)	- Total operating expenses net of reinsurance commissions, total capital, total technical reserves, total borrowings	- General insurance net earned premiums; long term insurance net earned premium total investment income
Noulas et al. (2001)	- Direct cost (Claims) and indirect costs (salaries and other expenditures)	- premium income and revenue from investments
Cummins et al. (1999)	- Labor costs, materials, policy holders supplied Debt capital and Equity capital and real invested assets	- Short tail personal lines, Short tail Commercial lines, long tail personal tail, long tail Commercial tail, return on assets
Cummins and Zi (1998)	- Labor, financial capital and materials	- Incurred benefits desegregated into ordinary life insurance, group life insurance and individual annuities, addition to reserves
Fukuyama (1997)	- Asset value, number of workers and tied agents or sales representatives	- Insurance reserves, loans
Weiss (1991)	- Labor, capital	- Incurred losses, loss reserves
Eling & Schaper (2017)	- Number of employees, debt capital, equity capital	- Losses plus additions to reserves, total invested assets
Ertugrul et al. (2016)	- Labor expenses, equity capital and debt capital	- Insurance technical provisions and losses paid
Al-Amri (2015)	- Labor, Debt capital and Equity capital	- Losses incurred and investments
Khan & Noreen (2014)	- Labor, fixed assets, business services and equity capital	- Invested assets, net premium
Antonio, Ali, & Akbar (2013)	- Management expenses, fees and commission expenses	- Gross premium and investment income.
Ismail et al. (2011)	- Labor, business services and materials, and equity capital	- Real incurred losses, and the real value of investments
Cummins et al. (2010)	- Labor, business Services and Equity capital	- individual annuities, group annuities, personal (Commercial) Short and long tail
Eling & Luhnen (2009)	- Labor and business service, Debt capital, Equity capital.	- non-life Claims + additions to reserves, life benefits + additions to reserves, Investments.
Davutyan and Klumpes (2008)	- Business services, labour, and equity capital	- the actuarial, Underwriting and related expenses, real financial Services, the net interest margin

Despite the wide use of the model, the conventional DEA are also faced with challenges and limitations. As discussed in Gharakhani et. al (2017), one of which is that traditional models allow each DMU to assess its efficiency by choosing and assigning the most favorable weights for itself. That is, DMUs tend to select the best weight scheme that would allow them to achieve maximum efficiency possible. Hence, difference in weights lead to many possible DMUs classified as "efficient", making comparison and ranking impossible and efficiency ranking of DMUs cannot be accurately distinguished. Maui et. al (2008) also supports this mentioning that flexibility in the weights prevents comparison among DMUs on a common base.

2.2. Common Weights

The idea of common weights was first introduced by Roll et al. (1991) and developed by Kao and Huang (2010). In common weights, flexibility is not permitted and all DMUs are evaluated by identical weights (Gharakhani, 2017). This addresses the issue of convenient and arbitrary assignments of weights and non-comparability of efficiency of DMUs.

Several studies have developed and proposed different techniques to derive a set of common weights. As mentioned in Gharakhani (2017), these include non-linear programming approach (Kao and Hung, 2005), computing the average of multipliers found by different DMU (Doyle, 1995), non-linear discriminated analysis (Sinuany-Stern and Friedman, 1988), regression analysis (Wang et al., 2011). Makui et. al (2008), on the other hand, used goal programming to derive the common weight scheme in order to improve the discriminating power of the DEA model. This paper utilized the goal programming-approach in order to yield a common set of weights that would be applied to all insurers with the objective that the deviation between the actual efficiency and maximum attainable efficiency is minimized for all DMUs.

2.3. Goal Programming

Charnes and Cooper (1961) established the first goal programming (GP) model. GP model objective is to optimize several conflicting goals accurately determined by the decision maker. The model is created by minimizing the undesirable deviations from the aspiration levels. The mathematical model can be represented as follows:

$$Minimize: \sum_{i=1}^{p}(d_i^- + d_i^+) \qquad (1)$$

s.t.

$$\sum_{j=1}^{n}\left(a_{ij}x_j\right) - d_i^- + d_i^+ = b_i, \;\; i = 1,2,\dots,p$$

$$d_i^- + d_i^+ \geq 0, \;\; i = 1,2,\dots,p$$

The initial objective functions are defined as a linear equation with aspiration values and two auxiliary variables. These two auxiliary variables indicate under achievement of the aspiration value by the negative deviation (d^-) and overachievement of the aspiration value by positive deviation(d^+). If underachievement of the goal is not desirable, d^-should be driven to zero. In contrast, if overachievement of the goal should be realized, $d^+$is driven to zero. b_i is the target value of the goal *i*. The coefficient d_{ij} reveals the contribution (impact) of the *j*th variable to the accomplishment of the *i*th objective $f_i(x_1, x_2, \dots, x_n) = \sum_{j=1}^{n}\left(a_{ij}x_j\right)$.

2.4. Data Collection and Sources

In the Philippines, there are 59 non-life insurance companies that are consistently remaining in the industry. The data used is based on the audited financial report from 2015 - 2017. The Philippine insurance industry continues to grow rapidly, but consistency and strong profitability is elusive. However, for the purpose of the study, this is limited to the top 5 insurers ranked by market share based on 2017 Gross Premium Written (GPW). The GPW of the top 5 companies represents almost 50% of the whole non-life insurance industry. Benyoussef and Hemrit (2019) also restricted the number of insurers based on companies ranked by market share. The data used can be obtained from the companies' financial report.

2.5. Selection of Inputs and Outputs

Based on table 1, the following inputs and outputs are chosen based on the gathered literature; Operations Expense, Benefit, Claims and Expense, General and Admin Expenses, Direct Written Premiums, Reinsurance Premiums, Net Income, and Investment & Other Income.

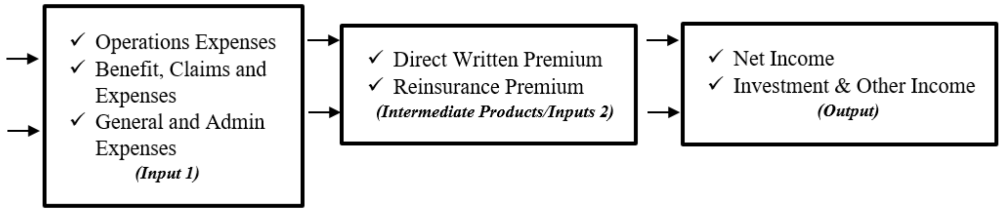

Figure 1. Two-Stage Process of Proposed Model

2.6. Proposed Model for DEA

In reference to the aforementioned objectives of the paper, this research serves as an application of Gharakhani et al's model (2018) to the Philippine insurance industry setting. Based on Chen and Zhu (2004), Kao and Hwang (2008), and Gharakhani et. al (2017), considering a two-stage network process for each of a set of n = 5 DMUs or non-life insurance company, we assume that each DMU_j (where j = 1, 2, 3, 4,5) consumes m = 3 inputs X_{ij} (where i = 1, 2, 3) in the first stage process and produces D = 2 outputs Z_{dj} (where d = 1, 2) from that stage. These intermediate products will afterwards be consumed as inputs to Stage 2. The outputs of Stage 2 are Y_{rj} (where r = 1, 2). Lastly, T = 3 represents the number of time periods.

For each DMU_j, efficiencies of first and second stage are defined as e_j^1 and e_j^2.

$$e_j^1 = \frac{\sum_{d=1}^{D} w_d z_{dj}}{\sum_{i=1}^{m} v_i x_{ij}} \text{ and } e_j^2 = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{d=1}^{D} w_d z_{dj}} \qquad (2)$$

In which v_i, w_d, w_d, and u_r are unknown non-negative weights. Note that w_d can be same as w_d. Individual efficiency scores e_j^1 and e_j^2 for stage 1 and 2 respectively, overall two-stage either as Model 3 or $e_0^{overall} = e_j^1 . e_j^2$. If the input-oriented DEA model is applied, then $e_j^1 \leq 1$ and $e_j^2 \leq 1$ should be met. The two-stage process is efficient if and only if $e_j^1 = e_j^2 = 1$:

$$e_0^{overall} = Max \sum_{r=1}^{s} u_r y_{r0} \qquad (3)$$

s.t.:

$$\sum_{r=1}^{s} u_r y_{rjt} - \sum_{d=1}^{D} w_d \, z_{djt} \leq 0 \quad j = 1,2, \dots, n$$

$$\sum_{d=1}^{D} w_d z_{djt} - \sum_{i=1}^{m} v_i \, x_{ijt} \leq 0 \quad j = 1,2, \dots, n$$

$$\sum_{i=1}^{m} v_i x_{i0} = 1$$

$$w_d \geq 0, d = 1,2, \dots, D; \;\; v_i \geq 0, i = 1,2, \dots, m; \; u_r \geq 0, r = 1,2, \dots, s; t = 1,2, \dots, T.$$

Model (3) presents the overall efficiency of the two-stage structure. Thus, the efficiency score of the first and second stages can be calculated as follows:

$$e_0^{1,overall} = \frac{\sum_{d=1}^{D} w_d * z_{d0}}{\sum_{i=1}^{m} v_i * x_{i0}} = \sum_{d=1}^{D} w_d * z_{d0} \quad and \; e_0^{1,overall} = \frac{\sum_{r=1}^{Ds} u_r * y_{r0}}{\sum_{d=1}^{D} w_d * z_{d0}} \qquad (4)$$

If $e_0^{1,overall}$ designates the optimal objective value of Model (3), the we have

$$e_0^{1,overall} = e_0^{1,overall} . e_0^{2,overall}.$$

The maximum attainable value of $e_0^{1,overall} = \theta_1$ can be calculated though Model (5):

$$\theta_1 = Max \sum_{d=1}^{D} w_d z_{d0}$$

s.t: (5)

$$\sum_{r=1}^{s} u_r y_{rjt} - \sum_{d=1}^{D} w_d \, z_{djt} \leq 0 \quad j = 1,2,\ldots,n$$

$$\sum_{d=1}^{D} w_d z_{djt} - \sum_{i=1}^{m} v_i \, x_{ijt} \leq 0 \quad j = 1,2,\ldots,n$$

$$\sum_{r=1}^{s} u_r y_{r0} - e_0^{overall} \sum_{i=1}^{m} v_i \, x_{i0} = 0$$

$$\sum_{i=1}^{m} v_i x_{i0} = 1$$

$$w_d \geq 0, d = 1,2,\ldots,D; \;\; v_i \geq 0, i = 1,2,..,m; \; u_r \geq 0, r = 1,2,\ldots,s; t = 1,2,\ldots,T.$$

The maximum attainable value of $e_0^{2,overall} = \theta_2$ can be calculated though Model (6):

$$\theta_2 = Max \sum_{r=1}^{s} u_r y_{r0}$$

s.t: (6)

$$\sum_{r=1}^{s} u_r y_{rjt} - \sum_{d=1}^{D} w_d \, z_{djt} \leq 0 \quad j = 1,2,\ldots,n$$

$$\sum_{d=1}^{D} w_d z_{djt} - \sum_{i=1}^{m} v_i \, x_{ijt} \leq 0 \quad j = 1,2,\ldots,n$$

$$\sum_{r=1}^{s} u_r y_{r0} - e_0^{overall} \sum_{i=1}^{m} v_i \, x_{i0} = 0$$

$$\sum_{i=1}^{m} v_i x_{i0} = 1$$

$$w_d \geq 0, d = 1,2,\ldots,D; \;\; v_i \geq 0, i = 1,2,..,m; \; u_r \geq 0, r = 1,2,\ldots,s; t = 1,2,\ldots,T.$$

Proposed Model for Goal Programming

In goal programming, as developed by Gharakhani et. al (2017), the researchers computed the common weights in dynamic network DEA using the proposed model (7) as follows:

$$Min \left[\sum_{j=1}^{n} (d_{jt} - + \; d_{jt+}) + \sum_{j=1}^{n} (a_{jt} - + \; a_{jt+}) \right]$$

s.t.: (7)

$$\sum_{r=1}^{s} u_r y_{rjt} - \sum_{d=1}^{D} \theta_2 w_d z_{djt} - d_{jt+} + d_{jt}- = 0$$

$$\sum_{r=1}^{s} u_r y_{rjt} - \sum_{d=1}^{D} \theta_2 w_d z_{djt} \leq 0$$

$$\sum_{d=1}^{D} w_d z_{djt} - \sum_{i=1}^{m} \theta_1 v_i x_{ijt} - a_{jt+} + a_{jt}- = 0$$

$$\sum_{d=1}^{D} w_d z_{djt} - \sum_{i=1}^{m} \theta_1 v_i x_{ijt} \leq 0$$

$$\sum_{r=1}^{s} u_r + \sum_{d=1}^{D} w_d = 1$$

$$\sum_{d=1}^{D} w_d + \sum_{i=1}^{m} v_i = 1$$

$$w_d \geq 0, d = 1,2, \dots, D; \ v_i \geq 0, i = 1,2, \dots, m; \ u_r \geq 0, r = 1,2, \dots, s; t = 1,2, \dots, T.$$
$$d_j^-, d_j^+, a_j^-, a_j^+ \geq 0, j = 1,2, \dots, n$$

The following procedures are implemented to find the common weights and rank of all DMUs in the dynamic-DEA model:

- Solve the Models (3)-(6) and calculate the efficiency scores $e_0^{overall}, \theta_1, \theta_2$ for all the DMUs.
- Solve the Model (7) and obtain the common weights vector $(v_1, v_2, v_3, w_1, w_2, u_1, u_2, u_3)$.
- Calculate the final efficiency scores with common weights for Stages 1 and 2 using equation (8):

$$Csw - e_1 = \left((w_1 * z_1 + w_2 * z_2)/(v_1 * x_1 + v_2 * x_2 + v_3 * x_3)\right)$$
$$Csw - e_2 = \left((u_1 * y_1 + u_2 * y_2 + u_3 * y_3)/(w_1 * z_1 + w_2 * z_2)\right)$$

- Calculate the final efficiency using equation (9):

$$e^{final} = Csw - e_1 * Csw - e_2$$

- Obtain the normalized efficiency and rank all DMUs.

3. Results and Discussion

Table 2 to 4 shows the data of the top 5 non-life insurance in the Philippines from 2015 – 2017 based on 2017 Gross Premiums Written. The variables under input 1 are Operation Expense, Claims and Expenses, and General and Administrative Expenses. On the other hand, input 2 or the intermediate products include Direct Written Premiums and Reinsurance Premiums. Finally, output of the proposed model refers to variables Net Income, and Investment and Other Income.

Table 2. Top 5 Non-Life Insurance in the Philippines in 2015 (T=1, 'in thousands)

	Input 1 (Xi)			Input 2 (Zd)		Output (Yr)	
DMU (j)	**Operation Expense (x1) i = 1**	**Claims and Expenses (x2) i = 2**	**General and Admin Expenses (x3) i = 3**	**Direct Written Premiums (z1) d = 1**	**Reinsurance Premiums (z2) d = 2**	**Net Income (y1) r = 1**	**Investment and Other Income (y2) r = 2**
1	2,852,328,769	2,917,409,815	1,593,966,593	9,305,715,027	5,998,925,925	29,603,983	1,144,978,432
2	2,444,942,365	2,911,229,158	1,117,944,532	7,693,218,507	3,967,585,648	334,567,213	334,488,169
3	1,161,315,655	1,813,474,823	584,623,466	6,121,348,400	4,367,099,204	514,774,181	588,679,221
4	1,216,699,000	1,137,459,000	535,764,000	5,631,324,000	3,246,493,000	249,858,000	219,185,000
5	1,165,905,318	1,222,658,454	637,923,330	3,999,754,568	2,003,372,680	42,352,690	348,476,252

Table 3. Top 5 Non-Life Insurance in the Philippines in 2016 (T=2, 'in thousands)

	Input 1 (Xi)			Input 2 (Zd)		Output (Yr)	
DMU (j)	**Operation Expense (x1) i = 1**	**Benefit, Claims and Expenses (x2) i = 2**	**General and Admin Expenses (x3) i = 3**	**Direct Written Premiums (z1) d = 1**	**Reinsurance Premiums (z2) d = 2**	**Net Income (y1) r = 1**	**Investment and Other Income (y2) r = 2**
1	2,675,012,305	3,443,534,411	1,661,832,312	8,530,722,465	4,323,594,264	715,254,112	1,078,815,750
2	2,608,066,331	3,019,047,489	1,095,326,348	7,677,168,475	3,689,277,540	287,501,967	380,383,853
3	1,280,887,461	1,582,456,218	659,333,622	6,836,176,135	4,924,074,070	241,162,869	610,047,770
4	1,322,092,000	1,376,779,000	596,332,000	5,623,175,000	2,929,111,000	244,381,000	249,188,000
5	1,739,541,401	603,269,457	1,069,977,489	4,690,693,151	2,712,590,558	(1,070,647,035)	341,343,509

Table 4. Top 5 Non-Life Insurance in the Philippines in 2017 (T=3, 'in thousands)

	Input 1 (Xi)			Input 2 (Zd)		Output (Yr)	
DMU (j)	**Operation Expense (x1) i = 1**	**Benefit, Claims and Expenses (x2) i = 2**	**General and Admin Expenses (x3) i = 3**	**Direct Written Premiums (z1) d = 1**	**Reinsurance Premiums (z2) d = 2**	**Net Income (y1) r = 1**	**Investment and Other Income (y2) r = 2**
1	2,753,959,394	2,889,132,944	1,668,772,968	9,540,712,344	5,577,510,341	118,630,760	978,539,754
2	3,313,668,626	3,608,878,652	1,681,918,298	8,130,093,907	4,591,654,925	113,836,927	1,422,757,107
3	1,344,110,461	1,621,301,082	643,315,959	7,905,830,722	5,650,541,244	137,847,000	565,576,255
4	1,544,882,000	1,225,274,000	755,929,000	5,942,872,000	2,986,411,000	385,068,000	198,763,000
5	1,898,259,360	1,872,475,727	1,177,366,531	5,234,470,078	1,723,375,885	69,651,177	342,389,744

Table 5 shows the summarized the maximum possible overall and per stage efficiency scores $e_0^{overall}, \theta_1, and\ \theta_2$ that can be obtained by each DMUs. However, as discussed in the weaknesses of conventional and traditional DEA, maximization of the overall efficiency of each DMU would lead to differences in the weights to be applied to the variables considered per insurance company. Hence, the goal programming approach was used in order to yield a common set of weights that would be applied to all insurers with the objective that the deviation between the actual efficiency and maximum attainable efficiency is minimized for all DMUs. Table 5 summarizes the results of the maximum overall, stage 1 and stage 2 efficiency scores per DMU.

Table 5. Result of Efficiency Score for all DMUs

DMU	$e_0^{overall}$	θ_1	θ_2
1	0.533641	0.709566	0.752067
2	0.364952	0.502716	0.564522
3	0.714678	0.933847	0.618937
4	0.555707	0.9116	0.609595
5	0.287918	0.675134	0.517327

Table 6 shows the calculated common set of weights for the inputs and outputs obtained from the proposed model using goal programming. By using GP, the flexibility of weights of the proposed model is not permitted and each DMU's is evaluated by identical weights as follows:

Table 6. Common Set of Weights Generated by Proposed Goal Programming (GP)

v_1	v_2	v_3	w_1	w_2	u_1	u_2
0.385545	0.337686	0.000000001	0.125718	0.000231	0.508793	0.365259

Table 7. Stage 1, Stage 2 and Overall Efficiency Score of the Top 5 Non-Life Insurance Companies in the Philippines, 2015-2017

	2015					2016					2017				
DMU	**CSw-e$_1$**	**CSw-e$_2$**	e^{final}	e^{normal}	**Rank**	**CSw-e$_1$**	**CSw-e$_2$**	e^{final}	e^{normal}	**Rank**	**CSw-e$_1$**	**CSw-e$_2$**	e^{final}	e^{normal}	**Rank**
1	0.561798	0.369917	0.207819	0.461938	**3**	0.489232	0.706094	0.345444	1	**1**	0.589342	0.347939	0.205055	0.770813	**4**
2	0.502716	0.302039	0.15184	0.337508	**5**	0.477036	0.295254	0.140847	0.407727	**4**	0.409879	0.564522	0.231386	0.869791	**3**
3	0.726867	0.618937	0.449885	1	**1**	0.836951	0.401513	0.336046	0.972795	**2**	0.933847	0.27805	0.259656	0.976061	**2**
4	0.830648	0.292343	0.242834	0.53977	**2**	0.726016	0.304346	0.22096	0.63964	**3**	0.740864	0.359074	0.266025	1	**1**
5	0.583617	0.295713	0.172583	0.383616	**4**	0.675134	-0.71157	-0.4804	-1.39069	**5**	0.482683	0.243748	0.117653	0.442263	**5**

Table 7 summarizes the efficiency scores, both overall and per stage, and ranking of the top 5 non-life insurance companies calculated by the proposed goal programming-based common set of weights. Comparing the efficiency values of Stage 1 and Stage 2, it can be said that in general, for all the years, all insurance companies are more efficient in the former stage than the latter. Meanwhile, analyzing the trend of the overall efficiency of each DMU, only DMU 1 has increasing efficiency score as time passes by. DMU 3, on the contrary, has decreasing efficiency score while there is no obvious and general trend over the years for DMUs 2, 4 and 5. The outlying negative value of DMU5 for the year 2016 is due to the impact of the large magnitude of loss the insurance company has attained for the year.

Table 8. Summary of the Efficiency Score of the Top 5 Non-Life Insurance Companies in the Philippines, 2015-2017

	e^{normal}				
DMU	**2015**	**2016**	**2017**	**Average**	**Rank**
1	0.461938	1	0.770813	0.744251	**2**
2	0.337508	0.407727	0.869791	0.538342	**4**
3	1	0.972795	0.976061	0.982952	**1**
4	0.53977	0.63964	1	0.72647	**3**
5	0.383616	-1.39069	0.442263	-0.18827	**5**

Data also suggest that none of the DMUs is consistently and dominantly efficient across all periods reviewed. Findings show that there are 3 DMUs identified as efficient. Particularly, DMU 3, DMU 1 and DMU 4 for the years 2015, 2016 and 2017 respectively. These insurers have the highest efficiency score among all the 5 for the said respective years. Upon reviewing, DMU1, in general, has the highest values of Input1 variables. That is, this insurance company, among the others, has the largest expenses in terms of operation and have incurred large losses. However, it has also attained the highest direct premiums written across the years. Hence, it can be said that this insurer, as a large operating company, is maximizing its retention on risks being written. Moreover, high efficiency and profitability can also be attributed to its high income coming from investments as compared to others. DMU 4, on the other hand, has been able to manage and minimize its administrative expense and benefits and claim payments while producing the highest net income, in general, among others. This highlights the strength of this insurer in risk selection and risk evaluation. Finally, computing for the average of normalized efficiency scores across the years, non-life insurance company 3 is the most efficient entity among all. This DMU has attained the smallest operation expense for all years among all. Moreover, in general, it is one of the insurance companies with the lowest administrative expense yet has been able to produce high net income. Overall, this insurer has the highest reinsurance premium across the years. In contrary to the technique and approach of DMU1, DMU3 has managed to accept risks yet cede a portion or percentage to reinsurers for risk transfer so that in case of large losses, not all will be absorbed by the company.

4. Conclusion

In this paper, through applying Gharakhani et. al's model (2017) to Philippine non-life insurance data specifically, balanced panel data from 2015 to 2017 from annual audited financial reports, a dynamic two-stage network Data envelopment analysis (DEA) model was developed to measure and evaluate the performance and efficiency of the industry, particularly, of the top 5 non-life insurance companies in the country based from 2017 Gross Premium Written.

To address the weakness and limitation of conventional DEA models, the goal programming approach was used to derive the common set of weights to be applied to the input variables - Operation Expense, Claims and Expenses, and General and Administrative Expenses (Stage 1) and Direct Written Premiums and Reinsurance Premiums (Stage 2) and output variables - Net Income, and Investment and Other Income. Afterwards, the overall efficiency measures were obtained and the insurers were ranked and compared accordingly. Moreover, the researchers were also able to observe the trend and behavior of the efficiency scores as well as stage 1 and stage 2 performance across time from 2015 - 2017.

Results revealed that considering all years, DMU3 is the most efficient among all non-life insurers. This company has operated efficiently compared to others as it was able to minimize operation and administrative expenses while producing maximum possible net income. This insurer focused on the "risk transfer technique" – accepting risks and ceding percentage to reinsurers to other insurance companies. Moreover, DMUs 1 and 4 were also identified as the most efficient in years 2016 and 2017, respectively. DMU1 reflects large operating insurance companies with high expenses and operating costs yet have managed to maximize their risk retention. Lastly, DMU4 highlights the importance of risk selection and risk evaluation, producing the highest net income, in general, with low operating costs and loss and claim payments.

For future studies, the researchers recommend the application of the dynamic network DEA model using goal programming to the insurance data of all the existing 59 non-life companies, as well as life insurance firms. Moreover, future researchers may also opt to compare the proposed model with other ranking models such as super efficiency models, CCR and BCC models.

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