應用 Super SBM 模型評估越南人壽保險業經營效率
Using Super SBM Model to Measure the Operating Efficiency of Life Insurance Companies in Vietnam

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Abstract

In recent years, the life insurance industry in Vietnam is developing extremely rapidly, bringing benefits to the people and bringing huge investment to the country. This study evaluates the operational efficiency of Vietnam's life insurance companies utilizing Data Envelopment Analysis (DEA), a non-parametric method effective for handling multiple inputs and outputs in efficiency assessments. The analysis's data is sourced from financial statements, annual reports, and industry databases, ensuring consistency and comparability.

The study employs Super Slack-Based Measurement (Super SBM) model and Malmquist Productivity Index to calculate efficiency scores and then identify efficient companies that set benchmarks and inefficient ones that need improvement. The results highlight best practices and areas for operational enhancements, providing actionable recommendations for companies and policy suggestions for regulators.

This comprehensive assessment not only aids in identifying inefficiencies within the industry but also offers strategic insights for enhancing the overall performance of life insurance companies in Vietnam. Future research directions include incorporating risk management practices and exploring alternative efficiency measurement methods。

Keywords: Life Insurance Company, Data Envelopment Analysis, Super SBM, Malmquist Productivity Index, Vietnam.

1. Introduction

1.1 Research background and research motivation

Vietnam has been established for years, but Vietnamese businesses only truly integrated into the world market or economy after Vietnam's reform and opening up about forty years ago, the pace of development of Vietnamese insurance companies is essentially consistent with this environment. Before 1993, Vietnam had only one insurance enterprise, the Vietnam Insurance Corporation, operating under government subsidy. The turning point came with the issuance of Decree No. 100-CP on December 18, 1993, by the government. This decree laid the initial groundwork and legal framework for the insurance business in Vietnam. Nearly 30 years after the issuance of Decree No. 100-CP, Vietnam now boasts 79 active insurance businesses. The speed and progress in the business history of Vietnamese insurance companies are identical to the broader environment and are confused by similar problems. Meanwhile, the problem of industry development also exists.

Insurance plays a significant role in Vietnam's economy, contributing to 2% of the country's GDP. The insurance sector has shown substantial growth, with an average annual growth rate of 29%. Over the past 5 years, the life insurance market in Vietnam has experienced substantial growth, making a positive contribution to the overall insurance industry. The insurance market as a whole has been growing at an average rate of 20% per year, contributing to the promotion of international economic integration and cooperation. To thrive amidst intensifying competition, Vietnamese insurance companies must enhance competitiveness by adapting their operational models. The crux of insurance companies' competitiveness lies in boosting efficiency. Surviving and growing in a highly competitive market environment necessitates a relentless focus on cost control and profit generation.

1.2 Research objectives

This study will use the Super Slacks Based Measure (Super SBM) of Data Envelopment Analysis (DEA) and the Malmquist Productivity Index to analyze the life insurance industry's operating efficiency and the company's market value. Then the performance will be sorted and compared, and conclusions will be drawn from it. The final research results will be used as a reference for the company's future business strategies. It is expected to complete the following research purposes:

1. Select appropriate input and output items to measure the operational efficiency of the life insurance companies in Vietnam.
2. Use Super SBM to measure the operating efficiency of the life insurance companies.
3. Apply the Malmquist Productivity Index to analyze the changing trends of productivity in the life insurance industry.
4. It is hoped that the research results can be used as a reference for relevant life insurance companies in making business decisions.

2. Literature Review

2.1 Related literature on efficiency measurement

Business efficiency is highlighted as one of the most crucial goals for an enterprise. Business efficiency is influenced by a range of factors, categorized as macro factors and micro factors inherent to the business itself.

Domestically and around the world, there has been much research work by scientists, both theoretically and experimentally, on business efficiency as well as factors affecting the business efficiency of enterprises. So, there are still many inconsistent views on the concept of "business efficiency", each researcher based on different perspectives and approaches has given a different view on this concept.

Adam Smith (1776) defined efficiency as the result achieved in economic activities, is the revenue from the consumption of goods. According to this point of view, determining business efficiency is simply based on the ability to sell products. Adam Smith's view ignored the cost factor in calculating business efficiency, so there was no clear distinction between business efficiency and business results. However, another researcher Nguyen (2021) believes that business efficiency of an enterprise is a category that reflects the relationship between the business results obtained by an enterprise and the costs or resources spent to achieve those results.

Therefore, it is necessary to clearly distinguish between two concepts: business efficiency and business results. Business results are what a business achieves in a certain period, quantified by several indicators such as revenue, sales volume, market share, etc. Business efficiency reflects the level of using resources of the enterprise, calculated as the ratio between the results achieved and the costs spent to achieve those results.

2.2 Related literature on measuring corporate performance by DEA:

DEA method is often applied to analyze the performance of DMUs in many fields of education, health care, economics, and construction... This method has been widely used in many fields. Many studies to measure the effectiveness of branches.

In the 1984 publication titled "Some Models for Estimating Scale and Technical Inefficiencies in Data Envelopment Analysis," authored by R. D. Banker, A. Charnes, and W. W. Cooper in the Management Science journal, various models in the context of DEA are presented for the estimation of technical and scale inefficiencies. The paper introduces and delves into several

DEA models, with notable mentions of the BCC model (Banker, Charnes, and Cooper), which focuses on assessing technical and scale inefficiencies, and the CCR model (Charnes, Cooper, and Rhodes), serving as the fundamental DEA model for evaluating relative effectiveness. The authors provide a comprehensive demonstration of how these models can be effectively utilized to estimate both technical inefficiency (which pertains to the suboptimal utilization of inputs in generating outputs) and scale inefficiency (arising from operations being conducted at a less-than-optimal scale) across various decision-making units (DMUs). This work underscores DEA's adaptability in the realms of benchmarking and performance assessment. Furthermore, the article introduces the concept of the efficient frontier, representing the utmost level of efficiency attainable by a DMU concerning its inputs and outputs. DEA models are employed for the identification of DMUs positioned either above or below this efficient frontier, aiding in the assessment of their relative efficiency.

Notably, Sherman and Gold (1985) pioneered the application of the DEA method, using it to assess the performance of 14 branches of a U.S. bank. Their study incorporated input variables such as deposits, labor and capital, while the output variables was amount of investment, number of loans, interest income, non-interest income.

Ghimire (2016) conducted a study focusing on evaluating the efficiency of the life insurance sector in Nepal using Data Envelopment Analysis. The analysis employed a dataset with two distinct variables: output variables (Gross Premium, Investment Income) and input variables (total assets, claims).

3. Research Methodology

This section lays the groundwork for the study's research methods. It begins by presenting the overall research structure, and providing a clear overview of the study's organization. Following this, the focus shifts to an in-depth exploration of the DEA models employed—specifically, the CCR model, BCC model, and Super SBM model. The section concludes with an explanation of the Malmquist productivity index, a vital metric for assessing productivity changes over time.

3.1 DEA model

Data Envelopment Analysis (DEA) is a non-parametric method designed to assess the efficiency of a Decision Making Unit (DMU) in comparison to others operating under similar conditions. Unlike traditional methods, DEA does not require predefined weights or detailed descriptions of inputs and the functional relationship between outputs. Instead, it employs mathematical programming to calculate the efficiency frontier using retrospective data. By selecting relevant input and output items, DEA determines whether a DMU is relatively efficient.

When the efficiency value equals 1, the DMU is considered fully efficient, lying precisely on the efficiency frontier line. Conversely, inefficient DMUs have efficiency values ranging between 0 and 1, enveloped by the frontier. Each input and output item contributes to the relative efficiency value, providing a comprehensive and objective indicator for evaluating enterprises. This measurement method addresses the limitations of traditional efficiency measurement approaches.

3.1.1 CCR model

The CCR (Charnes, Cooper, and Rhodes) model serves as the foundational model in Data Envelopment Analysis (DEA), building upon Farrell's concepts. Developed in 1978, this model employs Pareto Optimality to identify Decision Making Units (DMUs) situated on the efficiency frontier. The DMU acts as a benchmark, revealing the range between the highest and lowest efficiency levels. The CCR model comes in two orientations: input orientation and output orientation. Input orientation evaluates the efficiency of input resource utilization while maintaining a set output level.

Suppose there is a DMU to evaluate its relative efficiency. Each DMU has m input items and s output items. The following formula represents the relative efficiency of DMU_k:

$$Max \quad H_k = \frac{\sum_{r=1}^{s} u_r Y_{rk}}{\sum_{i=1}^{m} v_i x_{ik}}$$

s.t. $\frac{\sum_{r=1}^{s} u_j Y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1$

$u_j, v_i \geq \varepsilon > 0$, r = 1,2,…s; i =1,2,3,…,m; j = 1,2,3,….,n

$H_k = DMU_k$ efficiency value

$s =$ Number of output items

$m =$ Number of input items

$n =$ Number of DMUs

u_r= The weight of the r^{th} output item

v_i = The weight of the i^{th} output item

Y_{rk} = The r^{th} output value of the k^{th} DMU

x_{ik} = The i^{th} input value of the k^{th} DMU

ε = Non-Archimedean constant

The constraints mean the efficiency measure must be less than or equal to one for every DMU. Hence, the optimal value is value of 1. From this, the primal model can be defined as:

$Max\ H_k = \sum_{r=1}^{s} u_r Y_{rk}$

s.t. $\sum_{i=1}^{m} v_i x_{ik} = 1$

$\sum_{r=1}^{s} u_j Y_{rj} - \sum_{i=1}^{m} v_i x_{yj} \leq 0$

$u_j, z_i \geq \varepsilon > 0$, r = 1,2,…s; i =1,2,3,…,m; j = 1,2,3,….,n

In general, to make the solution more efficient and analyze differential variables, the dual mode is constructed as follows:

$Min \quad H_k = \theta - \varepsilon(\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+)$

s.t. $\sum_{i=1}^{m} \lambda_i x_{ij} - \theta x_{ik} + S_i^- = 0$

$\sum_{j=1}^{n} \lambda_j Y_{rj} - Y_{rk} - S_r^+ = 0$

$S_i^-, S_r^+, \lambda_j, \lambda_j, \geq 0$, i=1,2,…,m, r=1,2,…,s, j=1,2,…,n

θ has no positive or negative restrictions

S_i^- =Difference variable of input items

S_r^+= Difference variables of output items

λ_j= Weight of DMU

3.1.2 BCC model

Banker, Charnes, and Cooper (1984) introduced the BCC model as an extension of the CCR model, aiming to address the assumption of fixed returns to scale in the production process. The BCC model incorporates the Shephard distance function, allowing for variable returns to scale (VRS). This adjustment provides a more flexible framework for assessing efficiency.

The BCC model allows for a distinction between input-oriented and output-oriented analyses, catering to users' specific analytical needs.

The input- oriented BCC model evaluating the efficiency of k^{th} DMU as following:

$Max \quad H_k = \frac{\sum_{r=1}^{s} u_r y_{rk} - u_0}{\sum_{i=1}^{m} v_i x_{ik}}$

$s.t. \quad \frac{\sum_{r=1}^{s} u_r y_{rj} - u_0}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1$

$u_{r,} v_i \geq \varepsilon > 0, \quad i = 1,2, \ldots\ldots, m; \; r = 1,2, \ldots\ldots, s; \; j = 1,2, \ldots\ldots, n$

u_0 Has no positive or negative restrictions

u_0= Indicator of returns to scale

Then convert the fractional programming form into a linear programming form to facilitate the solution. By fixing the denominator of the ratio form to 1, the efficiency value measured by the linear programming form is the same as that of the ratio form.

$$Max \quad H_k = \sum_{r=1}^{s} u_r\, y_{rk} - u_0$$

$$s.t. \quad \sum_{i=1}^{m} v_i\, x_{ik} = 1$$

$$\sum_{r=1}^{s} u_r\, y_{rj} - \sum_{i=1}^{m} v_i\, x_{ij} - u_0 \leq 0$$

$$u_{r,}\, v_i \geq \varepsilon > 0,\ \ i = 1,2,\ldots\ldots, m;\ \ r = 1,2,\ldots\ldots,;\ \ j = 1,2,\ldots\ldots, n$$

In general, to make the solution more efficient and analyze differential variables, the dual mode is constructed as follows:

$$Min \quad H_k = \theta - \varepsilon\left(\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+\right)$$

$$s.t. \quad \sum_{j=1}^{n} \lambda_j x_{ij} - \theta x_{ik} + S_i^- = 0$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - y_{rk} - S_r^+ = 0$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j,\ S_i^-, S_r^+ \geq 0,\ \ i = 1,2,\ldots,m;\ \ r = 1,2,\ldots,s;\ \ j = 1,2,\ldots,n$$

3.1.3 SBM model

The CCR (Charnes, Cooper, and Rhodes) and BCC (Banker, Charnes, and Cooper) models focus on measuring radial efficiency, which means that input or output items can only vary in equal proportions. In response to this limitation, Tone (2001) introduced the Slack-Based Measure (SBM) model. SBM employs slack variables as the basis for measurement, taking into account the differences between input and output items (slack). This non-radial approach allows for a scalar estimation, presenting SBM efficiency as a value between 0 and 1.

According to the model of Tone (2001), n DMUs can be defined as:

$$P = \{(X, Y) | X \geq X^{\lambda}, Y \leq Y^{\lambda}, \lambda \geq 0\}$$

In order to estimate the efficiency of DMU(x_0, y_0), first set it as:

$$x_0 = X\lambda + s^-$$

$$y_0 = Y\lambda - s^+$$

Among them, $\lambda \geq 0, s^- \geq 0, s^+ \geq 0$, s^- represents excess input, s^+ represents insufficient output, both are called slacks, $X\lambda$ and $Y\lambda$ are input items and The efficiency boundary value of the output item is then solved for the efficiency value of DMU (x_0, y_0). Using ρ as the non-ray difference index, the SBM fractional programming formula is constructed.

The Fraction Programming Formula as following:

$$Min \quad \rho = \frac{1 - \frac{1}{m}\sum_{i=1}^{m} S_i^- / x_{i0}}{1 + \frac{1}{s}\sum_{r=1}^{s} S_r^+ / y_{r0}}$$

$$s.t. \quad x_0 = X\lambda + s^-$$

$$y_0 = Y\lambda - s^+$$

$$\lambda \geq 0, s^- \geq 0, s^+ \geq 0$$

ρ=DMU(x_0, y_0) efficiency value

s_i^-= Excess investment in item i

s_r^+ = Production shortage of item r output

Then, the denominator and numerator of the above equation are multiplied by a scalar variable t greater than 0. However, because the ρ value does not change, the t value is adjusted so that the denominator is 1, forming Nonlinear programming formula of SBMt.

The SBMt nonlinear programming formula as following:

$$Min \quad \tau = t - \frac{1}{m}\sum_{i=1}^{m} ts_i^- / x_{i0}$$

$$s.t. \quad 1 = t + \frac{1}{s}\sum_{r=1}^{s} ts_r^+ / y_{r0}$$

$$x_0 = X\lambda + s^-$$

$$y_0 = Y\lambda - s^+$$

$$\lambda \geq 0, s^- \geq 0, s^+ \geq 0, t > 0$$

First define $S^- = ts^-$, $S^+ = ts^+$, $\Lambda = t\lambda$, and then convert the given equation into a linear programming equation.

- SBM-CRS Model as following:

$$Min \quad \rho *= \frac{1-\frac{1}{m}\sum_{i=1}^{m} s_i^- / x_{i0}}{1+\frac{1}{s}\sum_{r=1}^{s} s_r^+ / y_{r0}}$$

$$s.t. \quad x_{i0} = \sum_{j=1}^{n} \lambda_j X_{ij} + s_i^-$$

$$y_{r0} = \sum_{j=1}^{n} \lambda_j Y_{rj} - s_r^+$$

$$i = 1,2, \ldots\ldots, m$$

$$r = 1,2, \ldots\ldots, s$$

$$\lambda_j, s_i^-, s_r^+ \geq 0$$

$\rho *=$ DMU efficiency value

$X_{ij} = j^{th}$DMU's v^{th} input item

$Y_{rj} =$ The r^{th} output item of the j^{th} DMU

$s_i^- =$ Excess investment in i item investment

$s_r^+ =$ Production shortage of item r output

λ_j = DMU weight

- SBM-VRS Model as following:

$$Min \quad \rho *= \frac{1-\frac{1}{m}\sum_{i=1}^{m} s_i^- / x_{i0}}{1+\frac{1}{s}\sum_{r=1}^{s} s_r^+ / y_{r0}}$$

$$s.t. \quad x_{i0} = \sum_{j=1}^{n} \lambda_j X_{ij} + s_i^-$$

$$y_{r0} = \sum_{j=1}^{n} \lambda_j Y_{rj} - s_r^+$$

$$i = 1,2, \ldots\ldots, m$$

$$r = 1,2, \ldots\ldots, s$$

$$\lambda_j, s_i^-, s_r^+ \geq 0$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

By adding one more restriction formula $\sum_{j=1}^{n} \lambda_j = 1$ to the SBM-CRS model formula, it becomes the SBM-VRS model.

3.1.4 Super SBM model

The Super SBM (Slacks-Based Measure) model in Data Envelopment Analysis (DEA) enhances traditional efficiency assessments by incorporating the concept of slacks, thus providing a more detailed evaluation of decision-making units (DMUs).

- Super SBM model as following:

$$Min \quad \delta^* = \frac{\frac{1}{m}\sum_{i=1}^{m}\bar{x}_i/x_{i0}}{\frac{1}{s}\sum_{r=1}^{s}\overline{y_r}/y_{r0}}$$

$$s.t. \quad \bar{x} \geq \sum_{j=1,\neq 0}^{n} \lambda_j\, x_j$$

$$\bar{y} \leq \sum_{j=1,\neq 0}^{n} \lambda_j\, y_j$$

$$\bar{x} \geq x_0, \;\; \bar{y} \leq y_0, \;\; \bar{y} \geq 0, \;\; \lambda \geq 0$$

Since the above model cannot calculate variable returns to scale, it is modified as follows:

- Super SBM VRS model

$$Min \quad \delta^* = \frac{\frac{1}{m}\sum_{i=1}^{m}\bar{x}_i/x_{i0}}{\frac{1}{s}\sum_{r=1}^{s}\overline{y_r}/y_{r0}}$$

$$s.t. \;\; \bar{x} \geq \sum_{j=1,\neq 0}^{n} \lambda_j\, x_j$$

$$\bar{y} \leq \sum_{j=1,\neq 0}^{n} \lambda_j\, y_j$$

$$\sum_{j=1,\neq 0}^{n} \lambda_j = 1$$

$$\bar{x} \geq x_0, \;\; \bar{y} \leq y_0, \;\; \bar{y} \geq 0, \;\; \lambda \geq 0$$

3.1.5 Malmquist productivity index

The concept of Malmquist productivity index was first introduced by Malmquist (1953) and has further been studied and developed in the nonparametric framework by several authors. See for example, among others, Caves, Christensen and Diewert (1982), Färe and Grosskopf (1992), Färe, Grosskopf, Lindgren and Roos (1989, 1994), Färe, Grosskopf and Russell (1998b) and Thrall (2000). It is an index representing Total Factor Productivity (TFP) growth of a Decision-Making Unit (DMU), in that it reflects progress or regress in efficiency along with progress or regress of the frontier technology over time under the multiple inputs and multiple outputs framework.

Malmquist productivity index = efficiency change × technological change index as following:

$$\text{MPI}= \frac{d_0^t(x^{t+1},y^{t+1})}{d_0^t(x^t,y^t)} \times \left[\frac{d_0^t(x^{t+1},y^{t+1})}{d_0^{t+1}(x^{t+1},y^{t+1})} \times \frac{d_0^t(x^t,y^t)}{d_0^{t+1}(x^t,y^t)}\right]^{1/2}$$

$$\text{Catch-up}= \frac{d_0^t(x^{t+1},y^{t+1})}{d_0^t(x^t,y^t)}$$

$$\text{Frontier-shift}= \left[\frac{d_0^t(x^{t+1},y^{t+1})}{d_0^{t+1}(x^{t+1},y^{t+1})} \times \frac{d_0^t(x^t,y^t)}{d_0^{t+1}(x^t,y^t)}\right]^{1/2}$$

4. Research results and analysis

4.1 Sample data and selection of input and output items

4.1.1 Sample data

The scope of the sample set for this study is life insurance companies in Vietnam. The study period is from 2018 to 2022 and was collected through the Vietnamese Ministry of Finance and arranged with the necessary sample information.

Table 4-1 Samples selected for this study

DMUs	Companies
A	AIA
B	CATHAYLIFE
C	CHUBBLIFE
D	DAI-ICHI LIFE
E	FUBONLIFE
F	GENERALI
G	HANWHA
H	MANULIFE

Table 4-1 Samples selected for this study

DMUs	Companies
I	MB AGEAS
J	METLIFE
K	MVI AVIVA
L	MIRAE ASSET PREVIOIR
M	PRUDENTIAL
N	SUNLIFE
O	FWD

4.1.2 Input items and output items

After reviewing related papers in section 2, expenses or cost, number of employees and revenue are very popular variable in DEA. Therefore total assets, total operating costs, number of employees are selected as input variables while profit after tax, insurance premium income, financial activities's income are selected as output variables.

Furthermore, Pearson correlation was conducted to evaluate the correlation between input and output variables. Essentially, this correlation coefficient shows that a higher correlation coefficient indicates isotropic relationship between input and output variables.

Table 4-2 Input items and Output items

Outputs / Inputs	Profit after tax	Insurance premium income	Financial activities' income
Total assets	0,504***	0,954***	0,989***
Total operating costs	0,528***	0,991***	0,949***
Number of employees	0,663***	0,903***	0,762***

Source: Compiled by this study

4.2 Efficiency analysis

This study uses DEA-Slover Pro 15 software to calculate and evaluate the relative efficiency and inter-temporal productivity changes of each DMU in the current year. It uses Super SBM model and the Malmquist Productivity Index for 15 Vietnamese Insurance companies from 2018 to 2022.

4.2.1 Super SBM efficiency value

The Super SBM oriented (Super-SBM-I-V) model apply to assess the relative performances and to ranking measure of the 15 Insurance Companies in Vietnam. We can see from Table 4-3 below, Super SBM is highly in the measurement of efficiency and the rank is clear. The results show that **DMU E** has best value and the score always larger than 2 from 2018 to 2022, its rank is also in first place in this period. **DMU D** is ranked in the second place, and **DMU C** is ranked as the third place in 2022. That means these company reach the efficiency of outputs.

Table 4-3 Super SBM efficiency value

DMUs	Insurance Company	Score	Rank
E	FUBON LIFE	2.377	1
D	DAI-ICHI LIFE	1.899	2
C	CHUBB LIFE	1.617	3
B	CATHAY LIFE	1.464	4
I	MB AGEAS	1.398	5
A	AIA	1.152	6
H	MANULIFE	1.130	7
L	MIRAE ASSET PREVIOR	1.093	8
O	FWD	1.093	9
J	MET LIFE	1.082	10
M	PRUDENTIAL	1	11
K	MVI AVIVA	0.925	12
G	HANWHA	0.848	13
F	GENERALI	0.775	14
N	SUNLIFE	0.764	15

Source: Compiled by this study

4.2.2 Slack variable analysis

Table 4-4 Slack variable analysis

DMUs	Companies	Total assets	Total operating costs	Number of employees	Profit after tax	Insurance premium income	Income
A	AIA	2.454.656.320.766	1.524.594.024.883	222	0	0	0
B	CATHAYLIFE	3.055.746.619.238	2.285.545.565.597	0	424.594.538.559	3.643.300.758.847	0
C	CHUBBLIFE	3.131.484.936.750	2.173.955.803.272	304	0	2.219.850.660.099	68.863.690.855
D	DAI-ICHI LIFE	70.277.820.321.799	10.966.122.541.296	0	321.612.372.880	9.313.095.404.806	5.776.971.200.766
E	FUBONLIFE	2.003.772.274.913	279.352.957.800	32	39.833.920.758	351.852.763.896	96.510.184.133
F	GENERALI	2.529.676.088.194	153.312.832.145	176	126.639.357.722	0	0
G	HANWHA	1.493.871.041.212	15.665.073.466	142	0	0	0
H	MANULIFE	13.239.796.194.077	0	194	1.433.268.851.855	0	1.878.003.213.050
I	MB AGEAS	4.947.879.310.946	516.519.325.274	0	145.155.092.946	0	300.587.625.394
J	METLIFE	0	0	38	29.539.235.236	451.885.643.949	15.402.257.897
K	MVI AVIVA	929.812.756.052	221.357.803.750	0	14.571.353.502	0	0
L	MIRAE ASSET PREVIOIR	0	72.757.964.112	12	0	118.857.607.411	0
M	PRUDENTIAL	0	0	0	0	0	0
N	SUNLIFE	5.455.810.775.988	0	127	280.019.966.718	0	0
O	FWD	0	272.070.087.715	0	22.699.950.210	0	208.657.535.684

Source: Compiled by this study

According to Table 4-4, the items that DMU A must improve within the next 5 years include reducing total assets by 2,454,656,320,766 VND, reducing business operating costs by 1,524,594,024,883 VND and reducing 222 numbers of employees.

DMU B must reduce total assets by 3,055,746,619,238 VND, reduce business operating costs by 2,285,545,565,597 VND, increase profit after tax by 424,594,538,559 VND, increase insurance premium revenue by 3,643,300,758,847 VND.

DMU C needs to reduce total assets by 3,131,484,936,750 VND, total operating costs by 2,173,955,803,272 VND, the number of employees by 304. Then increase insurance premium income by 2,219,850,660,099 VND, financial activities's income by 68,863,690,855 VND.

It can be seen that the increase or decrease of inputs and outputs has a great impact on the company's performance. Points with a slack of 0 should not be changed by the company. In this study, Prudential company with DMU named M, the slacks are all 0, this proves that the company is operating very well and need not improve anything.

4.2.3 Malmquist productivity index analysis

Using the Malmquist Productivity Index to examine changes in productivity over time, changes in business performance of life insurance companies in Vietnam from 2018 to 2022. Tables below presents the results of analyzing changes in technical efficiency from 2018 to 2022.

4.2.3.1 Technical efficiency change analysis

Table 4-5 Analysis of technical efficiency changes during 2018~2022

DMUs	Catch-up	2018=>2019	2019=>2020	2020=>2021	2021=>2022	Average
A	AIA	1.011	1.522	0.662	0.898	1.023
B	CATHAY	1.290	0.756	1.146	1.562	1.188
C	CHUBB	0.659	1.178	1.050	0.849	0.934
D	DAICHI	1.139	0.734	1.196	1.195	1.066
E	FUBON	1.108	1.030	0.849	0.776	0.941
F	GENERALI	1.511	0.808	1.135	1.377	1.208
G	HANWHA	1.615	0.742	1.050	1.025	1.108
H	MANU	1.092	1.047	0.999	0.840	0.994
I	MB	1.249	0.865	0.984	0.953	1.013
J	METLIFE	1.820	0.976	0.964	0.971	1.183
K	AVIVA	1.360	1.145	0.961	1.648	1.278
L	MIRAE	1.139	0.744	1.114	1.035	1.008
M	PRUDENTIAL	1	1	1	1	1
N	SUNLIFE	1.154	0.806	1.192	1.495	1.162
O	FWD	1.329	0.575	1.926	0.924	1.188
	Average	1.232	0.929	1.082	1.103	1.086
	Max	1.820	1.522	1.926	1.648	1.278
	Min	0.659	0.575	0.662	0.776	0.934
	SD	0.279	0.237	0.271	0.283	0.108

Source: Compiled by this study

Table 4-5 above shows the results of the analysis of changes in technical efficiency from 2018 to 2022. From this trend, it can be seen that the overall technical efficiency of insurance companies from 2018 to 2022 is 1.086, showing a state of regression. During the five-year period, the inter-temporal average technical efficiency change is greater than 1, with a total of twelve companies, namely DMU A, B, D, F, G, I, J, K, L, M, N, O account for about 80%, but DMU C, E, H still have room for improvement.

4.2.3.2 Technological change analysis

Table 4-6 Analysis of technological changes during 2018~2022

DMUs	Frontier	2018=>2019	2019=>2020	2020=>2021	2021=>2022	Average
A	AIA	1.285	1.051	1.147	1.080	1.141
B	CATHAY	0.955	1.102	0.975	1.086	1.029
C	CHUBB	1.573	1.159	1.016	1.109	1.214
D	DAICHI	0.937	1.377	0.979	0.802	1.024
E	FUBON	1.065	0.920	0.952	1.138	1.019
F	GENERALI	1.006	1.059	0.951	0.972	0.997
G	HANWHA	1.154	1.062	0.940	0.949	1.026
H	MANU	1.116	1.073	1.062	1.091	1.085
I	MB	1.171	0.981	0.960	0.951	1.016
J	METLIFE	0.978	1.006	1.013	0.974	0.993
K	AVIVA	0.903	1.073	0.986	1.048	1.003
L	MIRAE	1.104	1.071	0.884	1.032	1.023
M	PRUDENTIAL	1	0.961	1	1	0.990
N	SUNLIFE	0.797	1.067	0.917	0.983	0.941
O	FWD	0.868	0.967	0.926	1.024	0.946
	Average	1.061	1.062	0.980	1.016	1.030
	Max	1.573	1.377	1.147	1.138	1.214
	Min	0.797	0.920	0.884	0.802	0.941
	SD	0.191	0.107	0.064	0.084	0.070

Source: Compiled by this study

According to the results of the technological changes shown in Table 4-6 from 2018 to 2022, when the technological change index is greater than 1, it suggestss that the technology of the DMU is in a state of progress. On the contrary, if the index is less than or equal to 1, it means that it is in a state of decline or maintenance. According to the table, the inter-temporal average technological change value of Vietnam Insurance Companies from 2018 to 2022 is 1.03, which means that the overall technology is moving towards an progressive trend during the five-year period from 2018 to 2022. DMU A, B, C, D, E, G, H, I, K, L nine of them have focused on technology, and the remaining DMUs whose average inter-period average is less than 1 need to work harder on technological growth and innovation.

4.3.2.3 Malmquist productivity index analysis

Table 4-7 Malmquist Productivity Index Analysis 2018~2022

DMUs	Malmquist	2018=>2019	2019=>2020	2020=>2021	2021=>2022	Average
A	AIA	1.298	1.600	0.759	0.970	1.157
B	CATHAY	1.232	0.833	1.117	1.696	1.219
C	CHUBB	1.036	1.366	1.067	0.941	1.103
D	DAICHI	1.066	1.011	1.170	0.958	1.052
E	FUBON	1.181	0.948	0.808	0.884	0.955
F	GENERALI	1.520	0.855	1.079	1.338	1.198
G	HANWHA	1.864	0.788	0.987	0.972	1.153
H	MANU	1.218	1.124	1.060	0.917	1.080
I	MB	1.463	0.849	0.945	0.906	1.041
J	METLIFE	1.781	0.981	0.976	0.945	1.171
K	AVIVA	1.228	1.229	0.948	1.727	1.283
L	MIRAE	1.257	0.797	0.985	1.068	1.027
M	PRUDENTIAL	1	0.961	1	1	0.990
N	SUNLIFE	0.920	0.860	1.093	1.469	1.086
O	FWD	1.154	0.556	1.782	0.945	1.109
	Average	1.281	0.984	1.052	1.116	1.108
	Max	1.864	1.600	1.782	1.727	1.283
	Min	0.920	0.556	0.759	0.884	0.955
	SD	0.271	0.259	0.230	0.292	0.090

Source: Compiled by this study

Table 4-7 above shows the results of the Malmquist productivity index analysis. When the productivity index is greater than 1, it means that inter-temporal productivity is showing a progressive trend. On the contrary, if it is less than or equal to 1, it means that the productivity is regressing or maintaining the status. The overall productivity index of Vietnam's Insurance companies from 2018 to 2022 is 1.108, which means that the productivity of the industry has improved during the five years. Among them, the only two DMUs that have shown decrease in productivity during the five years are E, M. During the period, accounting for approximately 13% of the total DMUs.

5. Conclusions and Suggestions

5.1 Conclusions

The life insurance industry in Vietnam is undergoing a significant period of growth, reflecting the increasing awareness among the population about the importance of insurance as a crucial financial tool for protecting future and assets. The impressive growth of the life insurance market in recent years, with an average annual growth rate in double digits, is the result of strong economic development and rising personal incomes. The expansion of international insurance companies and the entry of foreign investors have also improved the quality of insurance services and products, playing a vital role in this development.

This study applies the Super efficiency of Slack-Based Measure (Super SBM) in Data Envelopment Analysis (DEA) to analyze the operating efficiency and performance of 15 listed Insurane Companies in Vietnam from 2018 to 2022. Based on the three inputs of total assets, total operating costs, number os employees and the three outputs of profit after tax, insurance premium income and financial activities' income, we evaluate the relative efficiency of each industry, provide resource adjustment suggestions for relatively inefficient companies, and then analyze according to the Malmquist Productivity Index The changes in inter-temporal productivity of each industry from 2018 to 2022.

5.2 Theoretical Limitations

While Data Envelopment Analysis (DEA) is an effective method for assessing the operational efficiency of Vietnam's life insurance industry, it has several limitations. Firstly, DEA relies on the selection of input and output variables, and inappropriate data selection can lead to inaccurate results. Secondly, DEA cannot explain the reasons for efficiency differences; it can only identify which companies are efficient without delving into specific factors causing inefficiency. Additionally, DEA assumes that all decision-making units (DMUs) are comparable, ignoring differences in market conditions and regulatory environments, which may affect the fairness and validity of the results. Lastly, the choice of different DEA models (such as CCR and BCC models) can significantly impact the outcomes, introducing an element of subjectivity into the analysis. Therefore, despite its advantages in efficiency assessment, these limitations need to be considered when interpreting and applying the results.

5.3 Management implications

The findings and conclusions of this study on the life insurance industry in Vietnam provide several important management implications for both local and international insurance companies. Companies should strategically target the rising middle class and rural markets, developing customized and affordable products to drive growth. Staying updated with regulatory changes and advocating for supportive policies will help ensure compliance and industry integrity. Leveraging technology, such as digital platforms and data analytics, can streamline operations, enhance customer experience, and improve efficiency. Innovation and diversification of insurance products, including microinsurance and wellness-linked plans, will attract a wider customer base.

5.4 Suggestions for future research

The study of the life insurance industry in Vietnam opens up several avenues for future research that can provide deeper insights and help further develop the industry. Future research could focus on understanding the specific factors that influence consumer decisions to purchase life insurance in Vietnam, including demographic factors, cultural influences, financial literacy levels, and risk perceptions. Additionally, investigating the impact of digital transformation on customer acquisition, retention, and overall operational efficiency would be valuable. This could include case studies of successful digital initiatives and their outcomes.

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