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**Analysis on the total factor productivity of Chinese life insurance enterprises and its influence factors\***  
**Based on DEA-Malmquist index and its decomposition**

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**Abstract**

With the improvement of people's living standards, people's requirements for the quality of life are constantly improving and the awareness of venture capital is also increasing. At present, China is facing a serious problem of aging population, the emergence of major diseases and epidemics. The opening of the second child policy is leading to a significant increase in the demand for insurance products. As an important part of the insurance industry, life insurance industry will also face a broader development space. In the context of the rising consumption of life insurance products, life insurance enterprises should not only rely on quantity and short-term interests, but also should pay attention to the improvement of efficiency. From the perspective of long-term development, it is conducive to promoting

social and economic progress. Based on DEA-Malmquist index this paper analyzes the efficiency of China's life insurance enterprises from 2011 to 2017. We put forward relevant policy suggestions to improve the efficiency of life insurance enterprises and promote the industry reform.

**Keywords:** life insurance enterprises, total factor productivity, data envelopment analysis

## 1. INTRODUCTION

In 2019, the per capita disposable income of Chinese residents reached 30733 yuan, an increase of 8.9% over the previous year. With the improvement of people's living standards, the consumption structure is gradually changing from material consumption to service-oriented consumption. The proportion of per capita health care consumption expenditure in per capita disposable income of Chinese residents has increased year by year. It can be found that people's awareness of quality of life and venture capital is increasing. At the same time, the global population aging problem will intensify in 2020. China's financial policy report in 2010 pointed out that China will become the country with the highest aging degree in the world by 2030. In 2015, the full opening of the second child policy was implemented so that the demand for infant health insurance will continue to increase in the future. At present, the novel coronavirus epidemic has also had a significant impact on people's production and life. These problems make the insurance industry have broad development space and good market demand, which will further promote the development of the insurance industry.

As an important part of the financial industry insurance industry has an significant impact on the economy and society. Insurance institutions are important institutional investors and long-term capital providers in the financial market. They are stable sources of funds in the financial market and have positive significance for improving the quality of investment. Moreover, insurance institutions can help banks and other financial institutions to manage risks and improve the stability of the financial market better through innovative products such as

credit insurance and guarantee insurance. Therefore, under the requirements of high quality development in the new era, insurance enterprises should not only rely on quantity and short-term interests but also pay attention to the improvement of efficiency, which will promote social and economic progress. In the future, the focus of China's insurance industry is improve the allocation efficiency of insurance resources. Life insurance enterprises occupy a significant proportion in the insurance industry. Therefore, it is of great significance to study the efficiency of life insurance enterprises.

As early as the 1980s, studies on the efficiency of insurance companies have been carried out abroad. For example, Weiss (1986) analyzed the total factor productivity of life insurance industry<sup>[1]</sup>. Cummins et al. (1993) analyzed the efficiency of life insurance enterprises in the United States<sup>[2]</sup>. Weiss (1991) made a comparative analysis of transnational data and analyzed the operating efficiency of property insurance enterprises in different countries<sup>[3]</sup>. With the deepening of the research on the efficiency of the insurance industry<sup>[4]</sup>, more and more scholars began to use different methods to measure the efficiency of the insurance industry. Klumpes (2004) used Fourier elasticity to calculate the cost and profit of asset allocation system of 40 life insurance companies in the UK from 1994 to 1999<sup>[5]</sup>. Eling and luhnen (2009) used data envelopment analysis and stochastic frontier analysis to measure and compare the efficiency of 6462 insurance institutions in 36 countries in the world<sup>[6]</sup>. Micajkova (2015) used DEA method to calculate technical efficiency, pure technical efficiency and scale efficiency of Macedonian insurance company from 2009 to 2013<sup>[7]</sup>.

Most of the above studies focus on the efficiency of the insurance industry as a whole and there are few literatures on TFP of the life insurance industry. Due to the difference of sample selection the research results of Malmquist productivity index are not the same, some even get the opposite conclusion. Most of the literatures do not decompose Malmquist productivity index effectively and many decomposition only stay on the decomposition level of technical efficiency and technological progress. Therefore, based on the DEA Malmquist index model, this paper analyzes the relevant data of China's life insurance enterprises from 2011 to 2017. We make a reasonable decomposition<sup>[8]</sup> and classifies the sample enterprises according to different influencing factors. Then we compare the main reasons for the difference in total

factor productivity so as to improve the efficiency of life insurance enterprises and promote industry reform Relevant policy recommendations.

## **2. METHODOLOGY**

### **A. Data**

This paper studies the total factor productivity of China's major life insurance companies from 2011 to 2017. In order to ensure the comparability of the study, 42 life insurance companies established before 2010 with complete and available business data were selected as decision-making units, including 16 Chinese funded life insurance companies, 24 foreign-funded or joint venture life insurance enterprises, and 2 joint ventures between Taiwan, Hong Kong, Macao and China. The business scope of these enterprises includes endowment insurance, health insurance and other personal insurance. Through the business data of 42 life insurance companies, the total factor productivity is calculated and decomposed. The data used in this paper are all from wind database, China Insurance Yearbook and annual reports of life insurance companies.

### **B. Index system**

The index system should be selected from two aspects of input and output. In the aspect of life insurance it is usually an indicator of personnel investment in the business process. In this paper, in order to more comprehensively measure the index of human input, we take the sum ( $E_x$ ) of employee compensation, service charge and commission expenses as the proxy variable. In terms of capital investment, this paper uses net capital, namely owner's equity ( $C_x$ ) as the proxy variable of capital investment. In terms of risk management level, according to Berger et al. (1997)<sup>[9]</sup>, the factors causing value reduction should be regarded as input variables so compensation expenditure ( $P_x$ ) is considered as input variables.

According to Grace and Timme (1992)<sup>[10]</sup>, Gardner and Grace (1993)<sup>[11]</sup>, this paper takes premium income as output variable. Premium income ( $I_y$ ) is the main source of life insurance funds and the basic foundation of life insurance development. Therefore, it should be a major output index of life insurance companies. In addition, Grace and Timme (1992)<sup>[10]</sup> believe that

investment is an important activity of life insurance companies. Under the trend of increasing opening up and intensifying industry competition, the underwriting profit margin of each company is reduced. It is considered to use investment income to reduce insurance premium rate and enhance competitiveness. Therefore, this paper takes the investment income ( $R_y$ ) as the second output variable.

### C. Model

Malmquist index was first proposed by Malmquist in 1953<sup>[12]</sup>. Until 1992, Färe et al. constructed DEA Malmquist index model based on DEA theory and Malmquist productivity index established by Caves:

$$\begin{aligned} MI^{t+1}(X_p^{t+1}, Y_p^{t+1}, X_p^t, Y_p^t) &= \sqrt{MI^{t+1}(X_p^{t+1}, Y_p^{t+1}, X_p^t, Y_p^t) \times MI^t(X_p^{t+1}, Y_p^{t+1}, X_p^t, Y_p^t)} \\ &= \sqrt{\frac{D^{t+1}(X_p^{t+1}, Y_p^{t+1})}{D^{t+1}(X_p^t, Y_p^t)} \times \frac{D^t(X_p^{t+1}, Y_p^{t+1})}{D^t(X_p^t, Y_p^t)}} \end{aligned} \quad (1)$$

In 1994, Färe et al. further decomposed the change of technical efficiency into scale efficiency change (SC) and pure technical efficiency change (PEC). The decomposition form is improved as follows:

$$\begin{aligned} MI(x_p^{t+1}, y_p^{t+1}, x_p^t, y_p^t) &= \frac{D_V^{t+1}(x_p^{t+1}, y_p^{t+1})}{D_V^t(x_p^t, y_p^t)} \times \left( \frac{D_C^t(x_p^t, y_p^t)}{D_C^{t+1}(x_p^t, y_p^t)} \times \frac{D_C^t(x_p^{t+1}, y_p^{t+1})}{D_C^{t+1}(x_p^{t+1}, y_p^{t+1})} \right)^{\frac{1}{2}} \times \frac{D_C^{t+1}(x_p^{t+1}, y_p^{t+1})/D_V^{t+1}(x_p^{t+1}, y_p^{t+1})}{D_C^t(x_p^t, y_p^t)/D_V^t(x_p^t, y_p^t)} \\ &= PEC_p \times TC_p \times SC_p \end{aligned} \quad (2)$$

Here  $PEC_p$  represents the change degree of pure technical efficiency of observation object P from period t to period t+1.  $TC_p$  represents the movement of production frontier from t period to t+1 period and the degree of production technology change. In production activities the index reflects the degree of technological progress or innovation.  $SC_p$  represents the change degree of scale efficiency from t period to t+1 period.

The distance function in Malmquist index is just the reciprocal of the optimal value of CCR model and BCC model in DEA theory.

### 3. EMPIRICAL ANALYSIS

#### A. The trend of total factor productivity of life insurance companies in China

We use DEAP to analyze the TFP of 42 life insurance enterprises in China from 2011 to 2017. The calculation results are shown in Table 1. The index value is divided by 1. If the index value is greater than 1 the efficiency is improved. If the index value is equal to 1 the efficiency is not change. If the index value is less than 1 the efficiency is decline.

TABLE I. CHANGES IN TOTAL FACTOR PRODUCTIVITY OF CHINESE LIFE INSURANCE COMPANIES FROM 2011 TO 2017

YEAR	$EC_p$	$TC_p$	$PEC_p$	$SC_p$	$MI$
2011~2012	0.818	1.358	0.879	0.931	1.111
2012~2013	1.102	1.131	1.081	1.020	1.246
2013~2014	1.137	0.890	1.155	0.984	1.012
2014~2015	1.104	0.835	1.004	1.100	0.923
2015~2016	0.889	1.227	0.920	0.966	1.091
2016~2017	1.002	0.966	1.013	0.989	0.967
average value	1.001	1.052	1.005	0.997	1.053

As can be seen from Table 1, except for 2014-2015 and 2016-2017, the TFP index of other years is greater than 1, which indicates that there is a growth trend of total factor in China's life insurance enterprises. At the same time, it can be found that the total factor of China's life insurance enterprises increased by 5.3% on average from 2011 to 2017. From the perspective of index decomposition, 0.1% of TFP improvement comes from EC and 5.2% from TC. From the further decomposition of efficiency change, we can see that the contribution rate of PTE to EC is 0.5%, while the contribution rate of SC to EC is -0.3%. This shows that the improvement of efficiency mainly comes from the improvement of PTE while the SC has a negative effect on the improvement of TFP.

## **B. Changes in total factor productivity of life insurance companies in China**

By analyzing the changes of TFP of China's life insurance companies it can be seen that among all 42 life insurance companies, the TFP index of 12 companies is less than 1 and the TFP index of 30 companies is greater than 1. This shows that the productivity of about 29% of the companies has decreased and the productivity of 71% of the companies has been improved. Therefore, most life insurance companies have promoted the growth of TFP in the insurance industry.

TC refers to the relative change degree of production frontier. From the perspective of technology change, only 9 life insurance companies have a technology change index less than 1 and the other 33 life insurance companies have a technology change index greater than 1. The average value of all life insurance enterprises is 1.052, which indicates that China's insurance industry shows technological progress. It can be seen that with China's financial opening up and market competition intensifying, the insurance industry is constantly carrying out technological innovation and reform.

EC refers to the relative position change of the decision-making unit to the production frontier. From the perspective of EC, 22 life insurance enterprises is less than 1 and 20 life insurance enterprises is greater than 1. About 50% of the life insurance companies have positive and negative effects on the industry efficiency. It can be seen that the insurance industry still has much space for improvement in resource utilization.

By decomposing the EC index, we can find that most of the life insurance companies whose EC index is greater than 1 also have greater than 1 PTE index, which indicates that the main reason for efficiency improvement is the improvement of PTE rather than the improvement of SC. Most of the life insurance companies whose EC index is less than 1 have their PTE index and SC index not greater than 1, which shows that the reasons for the efficiency decline come from the decline of pure technical efficiency and the decline of scale efficiency.

## **C. The factors affecting the total factor productivity of China's life insurance enterprises**

### ***1) Time of establishment***

At present, there are two views on the impact of the life insurance enterprises' establishment period on the efficiency of life insurance enterprises. One view is that the life insurance enterprises established for a long time will rely on their own market advantages and ignore the efficiency improvement. Moreover, the longer the establishment time is, the more attention these enterprises pay to the expansion of scale rather than the improvement of efficiency. However, the emerging companies can seek market share through various innovative activities and form a late mover advantage by improving the operation efficiency of enterprises. The other view is that the longer the life insurance company is established, the more experience it has in management and the higher the efficiency of the enterprise. Therefore, this paper classifies the sample enterprises according to this problem. Taking 2000 as the dividing line, it is divided into the enterprises established before 2000 and the companies established after 2000. The TFP of enterprises measured by classification and its decomposition indexes are shown in Table 2.

TABLE II.      **DETAILS OF TOTAL FACTOR PRODUCTIVITY OF CHINESE LIFE INSURANCE COMPANIES  
GROUPED BY TIME OF ESTABLISHMENT**

<b>Time of establishment</b>	$EC_p$	$TC_p$	$PEC_p$	$SC_p$	$MI$
Befor 2000	1.044	1.026	1.086	0.961	1.064
After 2000	1.000	1.061	0.993	1.008	1.057

It can be seen from Table 2 that the TFP of long established enterprises is slightly higher than that of emerging enterprises, which supports the second view to a certain extent. The EC of long established enterprises is higher than that of emerging enterprises but its TC is lower than that of emerging enterprises. The main driving force of efficiency improvement comes from the improvement of PTE rather than the improvement of SC. This shows that the enterprises established for a long time have more mature management and technology. It can make more effective use of their own resources. On the other hand, it also shows that the enterprises established for a long time pay more attention to the expansion of scale rather than technological innovation, which leads to the decline of scale efficiency and the technological



progress is lower than that of emerging enterprises.

## 2) *Enterprise type*

There are a lot of researches on the nature of ownership of insurance companies but the conclusions are not uniform. The forms of ownership can be divided into three categories: state-owned enterprises, Chinese enterprises and foreign (joint venture) enterprises. One view is that the incentive mechanism of state-owned enterprises is not perfect and the corporate governance structure is not complete, which leads to the low efficiency of enterprise internal management. Another view is that the competition mechanism of China's insurance industry is not perfect so its operation efficiency is greatly affected by national policies. With the support of the central and local governments, state-owned enterprises often have the advantages of scale economy and scope economy. Therefore, this paper classifies the sample enterprises according to the nature of enterprises. The TFP and its decomposition indicators are shown in Table 3.

TABLE III. **DETAILS OF TOTAL FACTOR PRODUCTIVITY OF CHINESE LIFE INSURANCE COMPANIES GROUPED BY ENTERPRISE TYPE**

<b>Enterprise type</b>	$EC_p$	$TC_p$	$PEC_p$	$SC_p$	$MI$
State-owned	1.018	1.037	1.029	0.990	1.053
Chinese	1.048	1.037	1.027	1.022	1.084
Foreign (joint venture)	0.983	1.069	0.994	0.990	1.045

As can be seen from Table 3, the TFP of Chinese enterprises is the highest, followed by state-owned enterprises and the lowest is foreign (joint venture) enterprises, which supports the second view to a certain extent. Chinese enterprises and state-owned enterprises are greatly influenced by high-level management and national policies. The decomposition indexes of Chinese funded enterprises and state-owned enterprises are higher than those of foreign (joint venture) enterprises except for technical change indicators. This shows that a perfect incentive mechanism can promote technological innovation and progress but in the imperfect market of China's insurance industry only the competitiveness can not greatly

improve TFP. More attention should be paid to the internal resource allocation and management efficiency.

### 3) *Is the enterprise listed*

There are many researches on the impact of listing on the performance of life insurance companies but the conclusions are far from satisfactory. Some researchers believe that the impact of listing on business performance is not obvious. Another part of the researchers believe that the efficiency of listed companies is better than that of non listed general joint-stock banks because listed companies are often subject to more strict supervision and restriction, which usually improves the efficiency of companies. Therefore, this paper classifies the sample enterprises according to whether they are listed enterprises. The TFP and its decomposition indicators are shown in Table 4.

TABLE IV. **DETAILS OF TOTAL FACTOR PRODUCTIVITY OF CHINESE LIFE INSURANCE COMPANIES**  
**GROUPED BY LISTED**

<b>Is the enterprise listed</b>	$EC_p$	$TC_p$	$PEC_p$	$SC_p$	$MI$
listed	1.013	1.010	1.034	0.980	1.020
Non listed	1.006	1.061	1.005	1.002	1.063

It can be seen from Table 4 that there is no significant difference between the indexes of listed enterprises and non listed enterprises. The TFP of non listed enterprises is slightly higher than that of listed enterprises, which is not enough to supervise and promote listed enterprises by China's stock market. Capital market endows enterprises with financing privileges, which promotes the scale expansion of enterprises but it does not make the efficiency of enterprises greatly improved.

## 4. CONCLUSIONS

This paper estimates the TFP and its decomposition of China's life insurance enterprises from 2011 to 2017. The following conclusions can be drawn: (1)The TFP of China's insurance industry has improved; (2)Among all the sample enterprises 71% of the enterprises have played a promoting role in TFP; (3)The improvement of productivity is mainly due to the progress of technology and the TC has increased by 5.2% within seven years; (4)The efficiency of insurance industry has not changed much in the past and the SC has a downward trend; (5)The establishment time, type and listing of life insurance enterprises have a certain impact on TFP.

In view of the above conclusions, the following policy suggestions are put forward: (1)Continue to promote the financial opening policy, improve market competition and promote the technical innovation and technological progress of the insurance industry; (2)Strengthen the supervision and management of the insurance industry, control its costs, improve the efficiency of resource allocation and improve the utilization of existing technologies; (3)Life insurance enterprises should not expand scale blindly and should pay attention to improve their resource utilization rate so as to meet the requirements of high-quality development of Chinese society.

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