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The Efficiency Analysis of the Life Insurance Industry in China
-- Based on the DEA Method

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The Efficiency Analysis of the Life Insurance Industry in China
--Based on the DEA Method

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Dedication

To My Parents

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Abstract

The Efficiency Analysis of the Life Insurance Industry in China -- Based on the DEA Method

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The University of Texas at Austin, 2010

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The life insurance industry in China has developed rapidly at nearly average 30% annual growth rate in premium, since the reform in 1980. The enterprise property, the industry organization and the market size have significantly changed in the last two decades, which can be observed through the four representative categories of companies constituted in different period, including the state-owned enterprises, the large domestic enterprises, the medium domestic enterprises and the joint ventures. How to evaluate the efficiency that the companies make use of the resource and contribute to the economy? How to make possible adjustment for each type of companies to improve the efficiency? In this paper we estimate and compare the efficiency of these four categories, according to the two main roles of the life insurance, (1) risk pooling, risk sharing and risk allocation (2) premium collecting, reinvesting for the high rate of return. We use the DEA method, a popular method for analyzing efficiency in management science, to solve the problem. The method replicates the input and output of the unit company by all the other companies in the industry to establish the ideal efficiency frontier, and ranks the real efficiency of each unit company according to the ideal efficiency frontier. In the empirical test, we attain the evaluation of efficiency for each category of companies. We can make appropriate input & output adjustment to them by the ranking of the efficiency. Based on the theoretical results, we provide some practical approaches, including the scale, expense and investment improvement, to promote efficiency of the life insurance industry in China.

Contents

1. Introduction

The life insurance industry, which performs the role of evaluating, diversifying and managing the risk, is a huge part of financial industry. First, the life insurance industry provides approaches for risk pooling and risk bearing. Annuity providers, private pension fund plans, which are the complementary to the social security system, contribute to the social sustainable development and also relieve the government burden. Second, the life insurance industry plays the role as the financial intermediary, which strengthens the whole financial system and provides the long term sustainable capital resources. The fund accumulated by life insurance is reinvested in Treasury bonds, corporation bonds, stocks and infrastructures. The fund contributes to the stock market and bond market significantly.

In these 20 years, the premium of life insurance industry in China keeps growing at double-digital rate. The diversification, the capital size and the market range of the life insurance keeps improving. However, there still exists problems and weakness. We try to answer the questions: How to make full use of the capital resources and generate higher rate of return? How to balance the trade-off of stability and development, scale and efficiency as well? How to facilitate the connection of the life insurance industry and the capital market?

In the life insurance industry in China, we can divide the companies into four categories. First, the state-owned enterprises constituted before 1980; second, the first series of Chinese stock enterprises constituted during 1990; third, the second series of Chinese stock enterprises constituted during 1995; fourth, the joint venture enterprises which enter the China life insurance market around 2000. Do the companies belonging to the same category have any similar characteristics related to the scale and the efficiency? Does each type of the companies need to be adjusted to improve the output/input ratio? Can we provide the suggestions for the strategy planning for different type of the companies?

The recent researches focus on the following questions, including the evaluation and measurement of the value and the efficiency of the life insurance company; the sustainable development of the life insurance industry; the adjustment of the scale and the rate of the

company's development; the development of the core advantage and the market diversification, and so on. In order to solve these problems, the first step is to design the criteria to measure if a company is "good" or "bad". We consider the company as a production unit which absorbs the input and produces the output. If a company needs less input and produces more output comparing to the other companies in the industry, we consider it as a "good" or efficient unit. Then the question turns to be the proper index for measuring the input and output. With different objects, different perspectives, different type of companies, the criteria and proxy choices are different. We need to consider:

For whose benefit do we evaluate efficiency? Do we measure the company efficiency for the stock holder, the employee, the customer, the government or the public wealth?

By which economic proxy do we measure the efficiency? The quantitative proxies concerning a company's evaluation index include the profit, the revenue, the employee number, the expense, the scale, the output/input ratio, the P/E ratio.

In which way do we choose the economic proxy? The economic proxies should be able to capture the feature of the object and accommodate the economic or financial theory. The economic proxies should be accessible from the financial statement and be applicable to the computation.

In this paper, we adopt the DEA (Data Envelope Analysis) Model for the evaluation of the company efficiency. The model treats the life insurance company as DMU (Decision Making Unit), which makes use of the input and produces the output after the value added process. The more output and less input of the DMU, the more efficient of DMU in evaluation. We compare the objective company with all the other companies in the industry. If we can replicate the objective company with the linear combination of any other companies in the industry, and make the combination with the same output but less input comparing to the object company, then we consider the objective company is inefficient, and vice versa. In this way, we can compare every company in the industry with the efficient frontier. If the company is on the efficient frontier, it's efficient and efficiency value is 1. Otherwise, the more far away the company is from the efficient frontier, the more inefficient is the company and the less is the efficiency value. So,

we can acquire the ranking of the efficiency evaluation of all the companies in the industry. Also, we can find out the weakness of the objective company from comparing the input and output of the objective company with that of the efficient frontier. As a result, it is known which input should be reduced or which output should be increased.

So, we apply the DEA Model to evaluate the companies' efficiency and conclude the similar feature of the companies in the same category, from the perspective of the technical efficiency, the scale efficiency, the pure technical efficiency, the input & output adjustment. Then, we provide the management strategy for the company and the suggestion for the regulation on the industry.

The paper is organized as the following: In Section 2, we give a brief overview of life insurance industry in China. Section 3 describes the concept and methodology. In section 4, we define the life insurance company input & output, and describe the data. The result comes in Section 5 and section 6 concludes.

2. Overview of the insurance industry in China

The insurance market in China has developed rapidly since the Chinese economic reform in 1978. According to the Chinese Macroeconomics Data, The premium has increased from 57.5 million dollars to 61.59 billion dollars in 1980-2005, with roughly 30% annually growth rate. In 2005, the year on year growth rate reaches 14%.

From the industry perspective, the insurance industry in China keeps structure reforming and adjusting from the monopoly market to competition market. There are 93 insurance companies in China until the end of 2005, including 35 property & liability insurance companies, 42 life insurance companies, 5 reinsurance companies, 6 insurance groups, 5 insurance asset management companies. There are 1800 insurance intermediaries and 1.47 million insurance agents in China until the end of 2005. The amount of companies keeps increasing and the market appears to be diversified. There are State-Owned Enterprise, Domestic Stock Enterprise, Joint Venture Enterprise in the China insurance industry.

From the macro perspective, the insurance industry plays a more significant role in the macro economy. It not only contributes to the GDP growth and the financial system development, but also facilitates the social security system reform. The macro system management and regulation for the insurance industry becomes more strict and specific. The China Insurance Regulation Committee is set up and performs as the government regulation on the insurance industry. Since then, the insurance industry regulation is separated from the bank and security industry regulation. From the micro perspective, the insurance companies proceed in the ownership system reformation and operation system improvement. The insurance companies strengthen the inner control over product lines and claim settlements, and strategically focus on the comparative advantage and the long term sustainable development. From the corporate finance perspective, the companies absorb the foreign asset and make strategically foreign investment. The connection with the foreign asset has deeply changed the structure, the management and the operation of the Chinese insurance industry. The Chinese insurance market gradually opens to the global investment. Foreign insurance companies can enter the Chinese

market through different ways, including setting up the joint ventures with Chinese companies, constituting branch companies in China, holding shares of stocks of Chinese insurance companies, etc. The foreign capital has invested in Shanghai, Guangzhou, Shenzhen and other cities in China.

The Chinese insurance market has developed at a tremendous speed, but the history of the Chinese insurance market is short, comparing with the developed countries. So, there still exist some problems and weaknesses. For example, the amount of companies and the market is relatively small. Some new companies have weakness in the claim settlement ability due to deficiency in the premium and equity, which leads to the potential default risk. The rules of the market and the regulation of the government institution are not comprehensive. The education level, knowledge and skills of the insurance agents are not advanced and have to be improved.

China has made commitment to the WTO that the Chinese insurance market would open completely to the global corporations in 2006, which means the business in Chinese insurance market will be more competitive. In the past decade, the foreign insurance companies have developed their branches in China in the form of the controlled companies, or furthermore, in the form of the area headquarter. New competition will occur among foreign insurance companies, domestic insurance companies and joint ventures. Also, new competition will occur between insurance industry and others, such as banking industry, securitization industry. As the new competition occurs, the insurance products and services will develop to achieve a new milestone.

Looking backward, we can analyze the development pathways of the Chinese insurance companies. We can divide it into four periods according to the timeline.

First, during the Monopoly Market period 1980-1986, there is only one insurance company, the People's Insurance Company of China (PICC group), in the market. It's the recovery of the Chinese insurance industry since the Chinese economic reform in 1978. The life insurance and the property & liability insurance are not separated. The terms of the life insurance policy were revised in 1980. Several provinces tested and provided the Life Insurance Policy, Group Life Insurance Policy and Life Accident Insurance Policy in 1982. As the macroeconomic system reforms in this period, the insurance industry recovers and develops. But the products, the services and the market size are still insufficient.

Second, during 1986-1995, the Chinese insurance market is Monopolistic Competition Market (Oligopoly market). In 1986, the first Property & Liability Insurance Company, Xinjiang Bingtuan Insurance Company (XJBT) was founded. This Company has begun to provide the life insurance product and service since 1987, which changed the circumstance that People's Insurance Company of China is the monopoly of the market. Ping An Insurance Group Company of China (Ping An) and China Pacific Insurance Company (Pacific) was founded after 1988, which provided both life insurance and P&L insurance. In 1992 and 1995, the first foreign insurance company entered in China. American International Assurance Company (AIG) set up controlled company in Shanghai and Beijing. As the participants of the insurance market increases, the market becomes more competitive. PICC group is no longer the only one that dominates the market. The main dominate participants include PICC group, Ping An and Pacific in life insurance industry. Taking the life insurance market share condition in 1995 as an example, the premium of the whole market is 2.55$ billion. The premium of PICC group is 2.17$ billion, 84.9% of the market share. The premium of Pacific is 0.189$ billion, 7.4% of the market share. The premium of Ping An is 0.144$ billion, 5.6% of the market share; The premium of XJBT is 3.75$ million, 0.2% of the market share. The premium of AIG Shanghai is 48.75$ million, 1.9% of the market share.

Third, around 1995-1996, The Chinese insurance market engaged in the multi-level competition. The business of the life insurance and the P&L insurance are separated in operation. In 1995, China issued the Law of Insurance, which set the rule that the same insurance company cannot operate both the life insurance business and the P&L insurance business. The companies founded before the law are required to separate the business. In 1996, the State Council allows the People's Insurance Company of China separate to be the China Life Insurance Company (China Life) and PICC Property and Casualty Company (PICC P&C), in charge of life insurance and P&L insurance respectively. In the same year, Tai Kang Life Insurance Company and Xinghua Life Insurance Company established. The competitive insurance market emerges.

Fourth, after 1996, foreign capital joins in the China insurance market and an amount of joint venture emerges to occupy the Chinese insurance market shares. Such as, Manulife-Sinochem Life Insurance, CITIC-Prudential Life Insurance Company, etc. The new resources of

the market participants enforce the Chinese insurance market to be more competitive and advanced. In 2001, the market share of the joint ventures and the foreign insurance companies is roughly 14% in Shanghai and 6% in Guangzhou.

3. Methodology

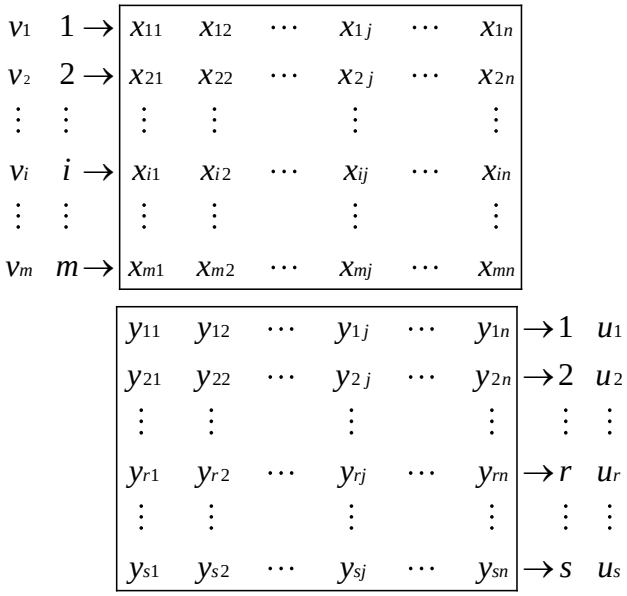
In the DEA method, we consider every company in the industry as a DMU (Decision Making Unit), which has similar type of Input & Output and performs the similar function in the industry. So the DMUs can be compared with each other. We set the criteria for efficiency evaluation as the ratio of Output/Input. The higher the ratio, the more efficient of the company. Through the linear transformation, the above criteria ratio turns to be equal to the statement that, if we can find the replication of the objective company with the other companies to enable the replication one has the same output but less input comparing to the objective one, then the objective one is inefficient.

3.1. THE DEA MODEL

3.1.1. The Model set up

Assume there are n production units or DMU (Decision making units) under the similar circumstance and own the similar inner property, execute the similar task and perform in the similar production process. Every DMU has m Inputs which represent the consumption of the resources and s Outputs which represent the production of the DMU with the usage of the Inputs. If the Input is smaller and the Output is larger, the DMU is evaluated as more efficient.

Figure1. n DMU with m Input and s Output Variables



As shown（DMU_j， $1 \le j \le n$）

$x_{ij} = DMU_j$'s i th Input， $x_{ij} > 0$； $i = 1, 2, \cdots, m;\ j = 1, 2, \cdots, n;$

$y_{rj} = DMU_j$'s r th Output， $y_{rj} > 0$； $r = 1, 2, \cdots, s;\ j = 1, 2, \cdots, n;$

$v_i =$ The weight of the i th Input； $i = 1, 2, \cdots, m;$

$u_r =$ The weight of the r th Output； $r = 1, 2, \cdots, s;$

For convenience

$X_j = (x_{1j}, x_{2j}, \cdots, x_{mj})^T,\quad j = 1, 2, \cdots, n,$

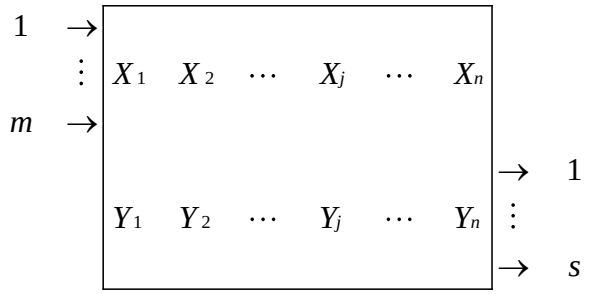
$Y_j = (y_{1j}, y_{2j}, \cdots, y_{sj})^T,\quad j = 1,\ 2;\cdot\ n,$

$v = (v_1, v_2, \cdots, v_m)^T,$

$u = (u_1, u_2, \cdots, u_s)^T.$

Here, X_j and Y_j are DMU_j's Input and Output vector as given, $j = 1, 2, \cdots, n,$

Figure2. n DMUs m Input and s Output Vectors



3.1.2. The CCR Model of the DEA method (For evaluation of Technical Efficiency)

For weight $v \in E^m$ 和 $u \in E^s$， the Efficiency Evaluation Index of DMU_j， $1 \le j \le n$ is

$$h_j = \frac{u^T Y_j}{v^T X_j}, \quad j = 1, 2, \cdots, n,$$

Select proper weight v and u to make

$$h_j \le 1, \quad j = 1, 2, \cdots, n,$$

The meaning of the Efficiency Evaluation Index h_j is: Under the weight of v and u, the ratio of the Output $u^T Y_j$ on the Input $v^T X$. For convenience, we regard the DMU to be evaluated as

$$X_0 = X_{j_0}, \quad Y_0 = Y_{j_0}. \quad 1 \le j_0 \le n \qquad h_{j_0} = \frac{u^T Y_0}{v^T X_0},$$

The objective function should be optimized. Using all the DMU_j （ $j = 1, 2, \cdots, n,$ ） Efficiency Evaluation Index (Including DMU_{j_0})

$$h_j = \frac{u^T Y_j}{v^T X_j} \le 1, \quad j = 1, 2, \cdots, n,$$

as the constrains, we can form the following optimization problem (CCR Model)

$$(1)(CCR)^O \begin{cases} \min \dfrac{v^T X_0}{u^T Y_0} = V_p^O \\ s.t. \dfrac{v^T X_j}{u^T Y_j} \geq 1,\ j = 1,...,n \\ u \geq 0, v \geq 0 \end{cases} \qquad (2)(CCR)^I \begin{cases} \max \dfrac{u^T Y_0}{v^T X_0} = V_p^I \\ s.t. \dfrac{u^T Y_j}{v^T X_j} \leq 1,\ j = 1,...,n \\ u \geq 0, v \geq 0 \end{cases}$$

Model (1) minimizes the input as the output is given and Model (2) maximizes the output as the input is given.

Let

$$t = \frac{1}{v^T X_0}, \omega = tv, \mu = tu$$

The objective function is

$$\frac{u^T Y_0}{v^T X_0} = \mu^{\mathrm{T}} Y_0,$$

and the constraints are

$$\frac{\mu^{\mathrm{T}} Y_j}{\omega^{\mathrm{T}} X_j} = \frac{u^T Y_j}{v^T X_j} \leq 1,\ j = 1,2,...n,$$
$$\omega \geq 0, \mu \geq 0.$$

Since

$$t = \frac{1}{v^T X_0},$$

then

$$\omega^T X_0 = 1.$$

We can transform (1)(2) to the linear programming form(3)(4). They have the equal solution.

$$(3)(P_{CCR}^O) \begin{cases} \min\ \ \omega^{\mathrm{T}} X_0 = V_{CCR}^O \\ s.t. \omega^T X_j - \mu^T Y_j \geq 0,\ j = 1,2,...,n \\ \mu^T Y_0 = 1 \\ \omega \geq 0, \mu \geq 0 \end{cases} \qquad (4)(P_{CCR}^I) \begin{cases} \max\ \ \mu^{\mathrm{T}} Y_0 = V_{CCR}^I \\ s.t. \omega^T X_j - \mu^T Y_j \geq 0,\ j = 1,2,...,n \\ \omega^T X_0 = 1 \\ \omega \geq 0, \mu \geq 0 \end{cases}$$

(3)(4) Can continue to transform to (5)(6)

$$(5)(D^{O}_{CCR})\begin{cases}\min\ \theta = V^{O}_{D_{CCR}} \\ s.t.\ \sum_{j=1}^{n} X_j\lambda_j \le \theta X_0 \\ \sum_{j=1}^{n} Y_j\lambda_j \ge Y_0 \\ \lambda_j \ge 0, \quad j = 1,2,\cdots,n.\end{cases} \qquad (6)(D^{I}_{CCR})\begin{cases}\max\ \delta = V^{I}_{D_{CCR}} \\ s.t.\ \sum_{j=1}^{n} Y_j\lambda_j \ge \delta Y_0 \\ \sum_{j=1}^{n} X_j\lambda_j \le X_0 \\ \lambda_j \ge 0, \quad j = 1,2,\cdots,n.\end{cases}$$

Adding the slack variables, we can transform the inequations in (5)(6) to equations in (7)(8).

The Linear Optimization Form for CCR Model

$$(7)(\overline{D}^{O}_{CCR})\begin{cases}\min\ \theta = V^{O}_{\overline{D}_{CCR}} \\ s.t.\ \sum_{j=1}^{n} X_j\lambda_j + S^{-} = \theta X_0 \\ \sum_{j=1}^{n} Y_j\lambda_j - S^{+} = Y_0 \\ \lambda_j \ge 0, S^{-} \ge 0, S^{+} \ge 0, \quad j = 1,2,\cdots,n.\end{cases}$$

$$(8)(\overline{D}^{I}_{CCR})\begin{cases}\max\ \delta = V^{I}_{\overline{D}_{CCR}} \\ s.t.\ \sum_{j=1}^{n} Y_j\lambda_j - S^{+} = \delta Y_0 \\ \sum_{j=1}^{n} X_j\lambda_j + S^{-} = X_0 \\ \lambda_j \ge 0, S^{-} \ge 0, S^{+} \ge 0, \quad j = 1,2,\cdots,n.\end{cases}$$

(7)(8) can be applied in computational programming to get the solution of the CCR model in the DEA method. Since (7)(8) are duality, we can get the solution by solving either one. Take (7) as an example, we can analyze the intuition of the theoretical optimization problem for the real world situation. If we can replicate the objective DMU with other DMUs which provide the same Output but need less Input, we don't need to use the objective DMU. In this case, we claim the objective DMU is inefficient and vice versa. Technically, when we evaluate the efficiency of DMU_{j_0} with the Input and Output vector X_0 and Y_0, we constitute a new

$DMU_{\bar{j}}$ using all the DMU_j with the weight λ_j ($j = 1, 2, \cdots, n$) for each one, given that the new $DMU_{\bar{j}}$ has the same Output Y_0 as DMU_{j_0}. If we can change λ_j to make the Input vector $X_{\bar{j}}$ of $DMU_{\bar{j}}$ less than X_0 of the objective DMU_{j_0}, the DMU_{j_0} is inefficient, the DMU_{j_0} is efficient. $\theta = \frac{X_{\bar{j}}}{X_0}$, the minimum θ is the solution of the linear programming $(\overline{D}^{O}_{CCR})$. If θ =1, the objective DMU_{j_0} is efficient. And if θ <1, the object DMU_{j_0} is inefficient, the more distant from 1 of θ, the more inefficient of the objective DMU_{j_0}. The efficiency we get from the CCR Model is considered as the **Technical Efficiency**. In this paper, we apply LINDO (Linear Interactive and Discrete Optimizer) to execute the linear optimization programming.

3.1.3. The BCC Model in the DEA method (For the evaluation of the Pure Technical Efficiency)

The Technical Efficiency mentioned above can be decomposed into the Pure Technical Efficiency and the Scale Efficiency. The Pure Technical Efficiency is measured relative to a variable return to the scale production frontier, i.e., a frontier characterized by increasing, constant and decreasing returns to scale. There are two causes leading to the technical inefficiency. One is that the company is not performing on the constant returns to scale, so we can adjust it by increasing the company scale (if decreasing now) or by decreasing the company scale (if increasing now). The other is that the company has already performed on the constant return to scale while it's still technical inefficient due to the pure technical inefficiency. So we adopt the BBC Model, which is generated by Banker.R.D, Charnes. A and Cooper W.W, on 1984. It is similar to the CCD Model, only adding another constraint $\sum_{j=1}^{n} \lambda_j = 1$ which represents the constant return to scale. So we do the linear optimization to get the pure technical efficiency θ_t, and the scale efficiency is $\theta_s = \frac{\theta}{\theta_t}$.

The Linear Optimization of the BCC Model

$$(9)(\overline{D}^{O}_{BCC})\begin{cases}\min\ \theta_t = V^{O}_{\overline{D}_{BCC}} \\ s.t.\ \sum_{j=1}^{n} X_j\lambda_j + S^- = \theta_t X_0 \\ \sum_{j=1}^{n} Y_j\lambda_j - S^+ = Y_0 \\ \sum_{j=1}^{n} \lambda_j = 1 \\ \lambda_j \geq 0, S^- \geq 0, S^+ \geq 0, \quad j = 1,2,\cdots,n.\end{cases}$$

$$(10)(\overline{D}^{I}_{BCC})\begin{cases}\max\ \delta_t = V^{I}_{\overline{D}_{BCC}} \\ s.t.\ \sum_{j=1}^{n} Y_j\lambda_j - S^+ = \delta_t Y_0 \\ \sum_{j=1}^{n} X_j\lambda_j + S^- = X_0 \\ \sum_{j=1}^{n} \lambda_j = 1 \\ \lambda_j \geq 0, S^- \geq 0, S^+ \geq 0, \quad j = 1,2,\cdots,n.\end{cases}$$

(9) (10) are the BCC Model. Model (9) minimizes the input as the output is given and Model (10) maximizes the output as the input is given.

3.2. REQUIREMENTS FOR THE DEA MODEL

The requirements for selecting the DMU (Decision Making Unit)

(I) From the internal perspective, the DMUs should satisfy the condition that they have the similar property, goal and perform similar tasks or process. For example, the commercial banks which have similar operation system and process, and provide similar service to customers. Or factories which produce the similar products with the similar technology.

(II) From the external perspective, the DMUs should satisfy the condition that they are in the similar environment or have the similar background. For example, the insurance

companies which are in the same country, with the same industry regulation, for the same market and customers.

(III) DMUs have the similar Input and Output Variables.

(IV) DMUs are representative and distinguishable.

The principles for selecting the Input and Output Variables

(I) Completeness. The Input and Output Variables should describe the real world properties of the DMUs as completely as possible.

(II) Independence and Exclusiveness. The Input and Output Variables should exclusively describe one of the features of the DMUs. With this principle, we could exclude the excess variables and clarify the variables we select.

(III) Smoothness. The different DMUs data for the same variable should be smooth and no abnormal data exist.

(IV) Accessibility. The data used for calculating the Input and Output Variables is easily acquired.

(V) Comparability. Relative value instead of absolute value is employed to represent the variable for easily comparison between the DMUs.

The DEA method is an effective way to evaluate the multi-input and multi-output efficiency problem.

(I) The general statistical method dealing with such problem requires large sample of the DMUs which provide large amount of data for the freedom degree requirement. The DEA method does not need such kind of restriction.

(II) The multi-input (multi-output) variables are allowed to include totally different types of variables. For example, they can include the human resource, the money, the machine, etc. Since we compare the different DUMs with the same variable, instead of comparing the different variables for the same DMUs.

(III) The multi-input variables do not require specific weight parameter. It is much more convenient than the traditional statistical method.

The weakness of the DEA method

(I) In the DEA model, the Input and Output Variables are required to conclude all the information on how DMUs consume resources and supply products. Actually, the real world statistical data cannot provide as much information as needed in the model. It is difficult to collect complete data to describe every feature of the DMUs. So, in the computing process, we can only analysis the most important and representative characteristic of the DMUs.

(II) The efficiency of the DEA model is a theoretical concept which is not exactly consistent with the so called efficiency in the real world problem.

(III) From different perspective, different Input and Output Variables would be selected to employ in the efficiency problem. So the ranking of the efficiency of the DMUs will be influenced seriously by the selection of variables. Different setting leads to different results.

(IV) DEA method only evaluates the DMUs efficiency on the cross sectional data which cannot consider the dynamic efficiency changes related to the time.

(V) With the same Input and Output Variables given, the Minimum Input Model or Maximum Output Model may give different ranking of the efficiency of the DMUs.

4. Variable Selection and Data Description

4.1. PROXY VARIABLES

4.1.1. The proxy variables for Output

When we consider evaluating the efficiency of the Chinese insurance companies, the first question is how and from what perspective we measure the efficiency. Since we have already considered the company as a unit, we will not measure the efficiency from the perspective of the employees (They represent the internal view of the unit). We can stand on the stock holders' side, the government side or the public wealth side. Obviously, from different perspective, we select different proxies as the Input and Output. When we discuss the problem from the perspective of the stock holders, the Output should be the revenue, the profit, the stock price, the dividend, and so on. When we stand on the government side, the Output should be the tax that the company pays, the job opportunities the company provides, the contribution that the company makes to the society, etc. In this paper, we decided to consider it from the social welfare perspective, since the research in economics pays more attention to the problems of the resources allocation, the Pareto optimization, and the social efficiency maximization.

Different from other industries, the life insurance industry does not supply material product. It provides financial services which indirectly contribute to the economy and the social public wealth. In general, it mainly plays two important roles:

First, the life insurance industry plays the role of risk-pooling and risk-bearing. Life insurances, annuity providers and pension fund plans, as the complementary and addition to the social security system, contribute to the social stability and development, and relieve the government burden as well.

Second, the life insurance industry plays the role as the financial intermediary, which strengthens the whole financial system and provides long term sustainable capital resources.

Since the life insurance company is not the products making factory, it's hard to measure exactly the price of the products. Although the life insurance policy has price, it includes the future scenario dependent payment and benefit, which is different from the traditional consuming product. We can observe it from the difference of the financial statements of the two types of companies. However, the life insurance company also provides value-added services as the other financial institutions. In this paper, we adopt the value-added approach according to (Cummins, 2002). The life insurance companies mainly provide the following two types of services:

Risk-pooling and risk-bearing. Insurance provides a mechanism through which consumers and businesses exposed to uncertain losses can engage in risk reduction through pooling and sharing. The actuarial, underwriting, and related expenses incurred in risk pooling are important components of the value added in the industry. Insurers also add value by holding equity capital to bear the residual risk of the risk pool.

Intermediary. For life insurers, the financial intermediary is a principal function, accomplished through the sale of asset accumulation products such as annuities. For non-life insurers, intermediary is an important but incidental function, resulting from the collection of premiums in advance of policy claim payments. The value of the insurers added from the intermediary role is reflected in the net interest margin between the rate of return earned on invested assets and the rate credited to policyholders.

In this paper, we decide to use Benefit and Add to Reserve as the proxies for the Output of the life insurance industry.

The Benefit measures the payment to the policy holders when the policy claim is triggered by the sudden loss occurred to them. The amount of the benefit can be regarded as the company's contribution to the risk-pooling and risk-bearing, the measure of the amount of the added value. The Benefit also describes the accumulation of the premium for risk sharing and the redistribution of the resources for the loss.

Most life insurance policy and annuity products involve the process of premium accumulation, reinvestment and pay back as benefit due to sudden accident. The reinvestment process contributes significantly to the value added function of the company. The investment return can be expressed as the Add to Reserve. The company invests in diversified financial instruments, including the Treasury bond, the corporation bond, the equity, the currency, the derivatives and infrastructure construction to gain the return to the reserve. The more Add to Reserve created, the more value added by the company as a financial intermediary. So the Add to Reserve is an appropriate proxy variable, measuring the performance of the company as financial intermediary.

In conclusion, the output proxy variables are the Y1 (Benefit) and Y2 (Add to Reserve). According to the items accessible in the financial statement in <Annual of Chinese Insurance Industry>, the variables are described as:

Y1（Benefit）	＝	Payment for Claim
Y2（Add to Reserve）	＝	Reserve of the present year – Reserve of the last year

4.1.2. The proxy variables for Input

The input includes the expense and the equity of the company. The expense means the cost that the company has to spend to maintain the business and the operation, including employee wages, legal fees, travel fees, communications fees, advertisement fees, and materials. According to the financial statement in <Annual of Chinese Insurance Industry>, we can acquire the data for the wages, fees, expenses and others to calculate the proxy variable X1 (Expense). Besides, Equity is another essential input of the company which maintains the payment capability for loss triggered event. Equity is an important criterion that the regulation institution use to supervise the performance of the company. It describes the size and the scale of the business of the company. So, the second input proxy variable is selected as X2 (Equity).

In conclusion, the input proxy variables are the X1 (Expense) and X2 (Equity). According to the items accessible in the financial statement in <Annual of China Insurance Industry>, the variables can be measured as:

X1 (Expense) = Fees + Wage + Expense + Others

X2 (Equity) = Equity

4.2. DATA DESCRIPTION

To analyze the characteristics and the performance of the four categories of companies, the state-owned enterprise, the domestic stock enterprise, the joint venture enterprise, etc, we select the samples for each category. The features and time period of establishment for each category of companies are shown in Table. 1.

Table.1 The Characteristics Description of the Chinese Life Insurance Companies

Company	Establishment Time Period	Ownership
1.China Life	1980	State Owned Enterprise
2.Pacific	1991	Domestic Stock Enterprise
2.Ping An	1988	Domestic Stock Enterprise
3.Xing Hua	1996	Domestic Stock Enterprise
3.Tai Kang	1996	Domestic Stock Enterprise
4.Zhong Hong	1996	Joint Venture Enterprise
4.An Tai	1998	Joint Venture Enterprise
4.Anlian Dazhong	1998	Joint Venture Enterprise
4.Jing Sheng	1999	Joint Venture Enterprise
4.Kang Lian	2000	Joint Venture Enterprise
4.Xing Cheng	2000	Joint Venture Enterprise
4.Heng Kang	2000	Joint Venture Enterprise
4.Tai Ping	2001	Domestic Stock Enterprise
4.Zhong Yi	2002	Joint Venture Enterprise
4.Guang Da	2002	Joint Venture Enterprise
4.Hai Er	2002	Joint Venture Enterprise

1. The state-owned enterprises founded before 1980. Benefit from the government policy, the equity amount is extraordinary large and the brand awareness is extraordinary high. After the socialist market economy established in China around 1980, they are the participants who first entered and explored the market. They were once the monopoly of the market and still own large shares (more than half) of the

market today. The Input and Output of the company is enormous. The representative of this kind is the China Life.

2. The first series of the Chinese stock enterprises founded during 1990. This period is the beginning of the well-known Chinese economic reform and opening to the world. Benefit from the government preferential policy, the enterprise ownership structure, the management system and the competitive market incentive, the new entries developed rapidly and occupied the emerging market quickly. Today, except the state-owned enterprises, they dominate most of the life insurance market. Their Input and Output are less than the first type. The example of this type is Ping An, Pacific.
3. The second series of the Chinese stock enterprises founded during 1995. The new policy encouraged the development of the life insurance industry deeply and widely, and the new stock enterprises entered the market. These three categories of companies occupy more than 80% of the market. For example, the Tai Kang, the Xing Hua.
4. Many joint venture enterprises entered the China life insurance market around 2000. As China joins in the World Trade Organization and becomes more open, large foreign life insurance companies pay more attention to the rapidly growing Chinese market. The joint venture enterprises absorb the advantages of the foreign companies in management, technology and operation system, and also learn from the local market experience of the Chinese companies. The joint venture enterprises have much potential for the future development, but currently they do not perform as outstanding as expected, because the time after establishment is short, and market experience and the brand awareness is insufficient. Their market share in total is less than 15%. The Input and Output are low. The examples of this type are Zhong Hong, An Tai and Jing Sheng, etc.

The data comes from 2000-2004 <Annual of China Insurance Industry>. Based on the data accessibility, the time period is chosen from 1999 to 2003. The main Input and Output proxy variables are calculated from the items in the Balance Sheet and Cash Flow Statement, shown as followings. The data in 1999-2003 is shown in the Table.2-Table.6 in the Appendix.

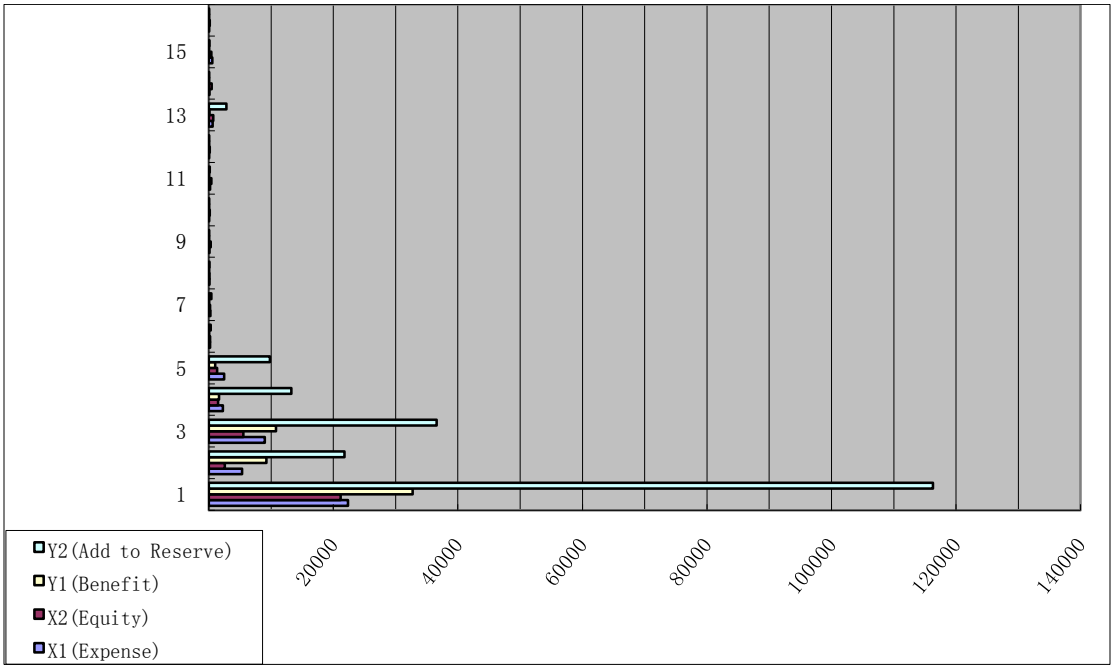
X1 (Expense)	=	Fees + Wage + Expense + Others
X2 (Equity)	=	Equity
Y1 (Benefit)	=	Payment for Claim
Y2 (Add to Reserve)	=	Reserve of the present year – Reserve of the last year

Table.2 The Input and Output of 16 Chinese Life Insurance Companies in 2003

Unit：Million Yuan

Company	X1(Expense)	X2 (Equity)	Y1(Benefit)	Y2(Add to Reserve)
1.China Life	22373.32	21153.03	32718.66	116301.75
2.Pacific	5330.67	2587.53	9239.27	21781.58
2.Ping An	9000	5525	10768	36604
3.Xing Hua	2263.09	1495.22	1614.01	13229.2
3.Tai Kang	2450.92	1328.77	1000.32	9814.74
4.Zhong Hong	220	222	32	302
4.An Tai	263.42	214.39	41.42	390.44
4.Anlian Dazhong	77.69	82.44	28.51	111.41
4.Jing Sheng	100	284	19	50
4.Kang Lian	20.98	157.28	6.36	22.41
4.Xing Cheng	218.45	379.17	67.33	146.41
4.Heng Kang	45.87	133.74	1.48	25.53
4.Tai Ping	623.21	689.27	98.1	2825.24
4.Zhong Yi	71.961	431.469	4.62	54.378
4.Guang Da	571.33	384.92	11.97	102.72
4.Hai Er	57.74	166.78	0.87	68.19

Graph.1 16 Chinese Life Insurance Companies Input and Output in 2003



5. Results and Analysis

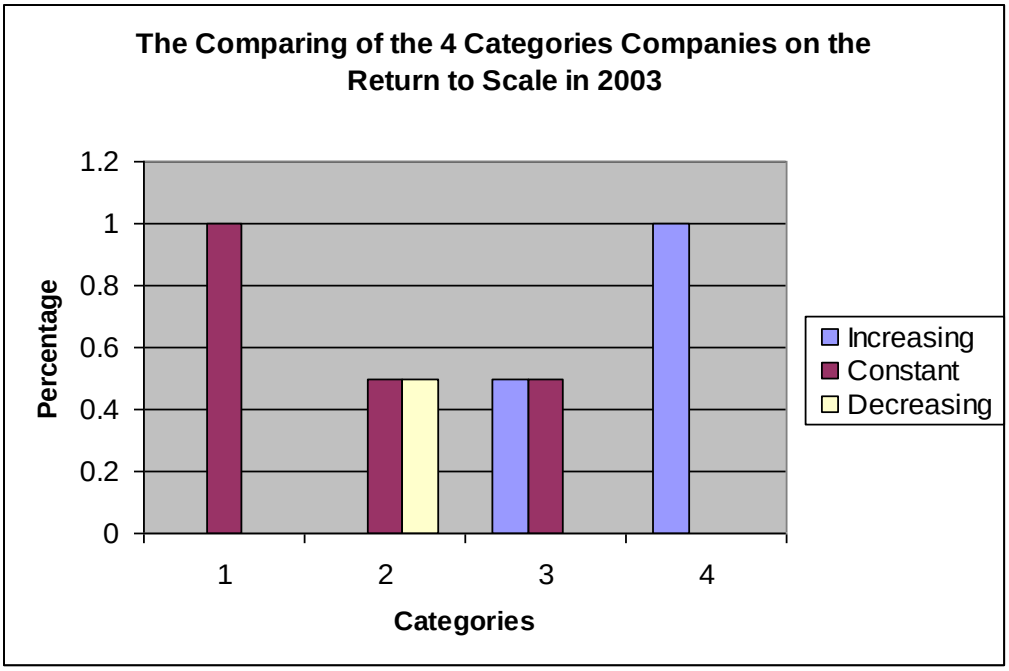
5.1. RESULTS

5.1.1. The Chinese life insurance technical and scale efficiency results

Table.7 The Chinese Life Insurance Efficiency Analysis in 2003

Company	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency	$\sum_{j=1}^{n}\lambda_j$	Return to Scale
1.China Life	1	1	1	1	Constant
2.Pacific	1	1	1	1	Constant
2.Ping An	0.852982	0.995281	0.857027	1.792752	Decreasing
3.Xing Hua	1	1	1	1	Constant
3.Tai Kang	0.834835	0.848517	0.983875	0.7419	Increasing
4.Zhong Hong	0.234829	0.486238	0.482952	0.022828	Increasing
4.An Tai	0.253556	0.524705	0.483236	0.029514	Increasing
4.Anlian Dazhong	0.270994	1	0.270994	0.002149	Increasing
4.Jing Sheng	0.11427	0.454441	0.251452	0.001719	Increasing
4.Kang Lian	0.206455	1	0.206455	0.000207	Increasing
4.Xing Cheng	0.177828	0.35406	0.502255	0.007287	Increasing
4.Heng Kang	0.095212	0.952092	0.100003	0.00193	Increasing
4.Tai Ping	0.775513	0.797187	0.972812	0.213561	Increasing
4.Zhong Yi	0.129269	0.370754	0.348665	0.00411	Increasing
4.Guang Da	0.030756	0.214174	0.143605	0.007765	Increasing
4.Hai Er	0.202028	0.776478	0.260186	0.005155	Increasing

Graph.2



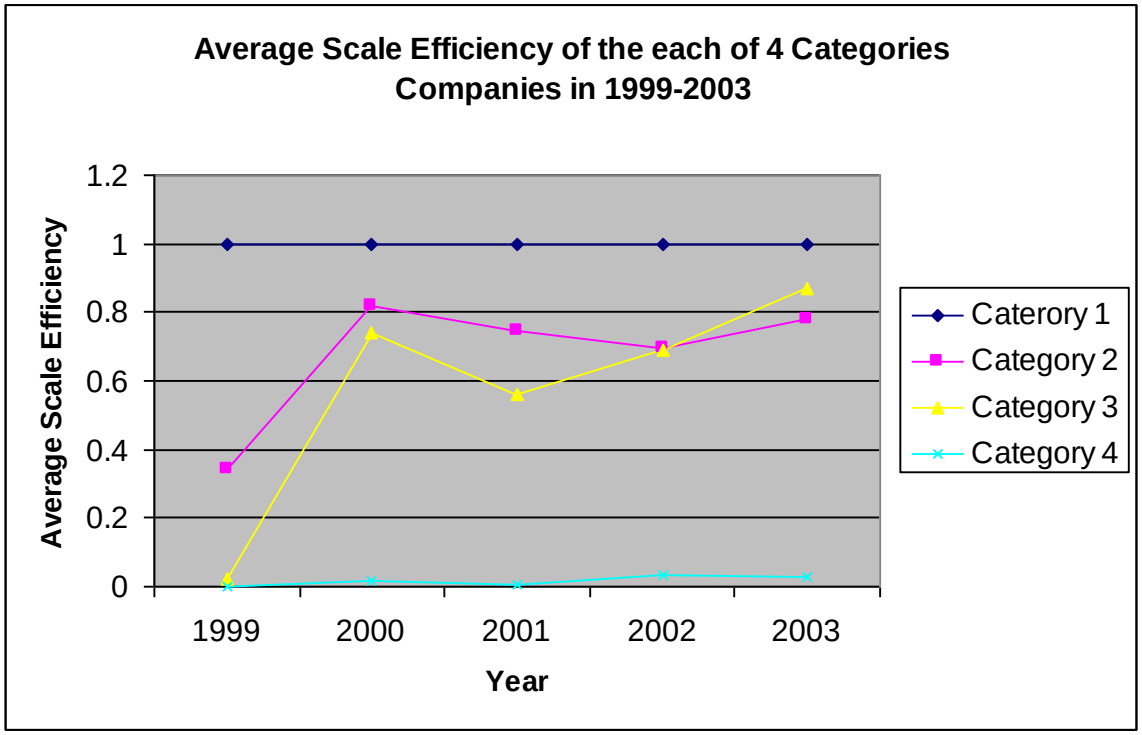
With LINDO (Linear Interactive and Discrete Optimizer) software calculation, we get the value of the Technical Efficiency, the Pure Technical Efficiency and the Scale Efficiency, shown in the Tables.7-Table.11 and Graph.2- Graph.7 in the Appendix. The meaning of the index and the analysis is shown as followings.

$\theta = 1$ means the objective life insurance company is Technical Efficient. $\theta < 1$ means the objective life insurance is Technical Inefficient. The difference between θ and 1 means the distance between the objective DMU and the efficiency frontier. So the smaller the θ, the less the Technical Efficiency.

$\theta_t = 1$ means the objective life insurance company is Pure Technical Efficient. $\theta_t < 1$ means the objective life insurance is Pure Technical Inefficient. The difference between θ_t and 1 means the distance between the objective DMU and the efficiency frontier. So the smaller the θ_t, the less the Pure Technical Efficiency.

θ_s =1 means the objective life insurance company is Scale Technical Efficient. θ_s <1 means the objective life insurance is Scale Technical Inefficient. The difference between θ_s and 1 means the distance between the objective DMU and the efficiency frontier. So the smaller the θ_s, the less the Scale Technical Efficiency.

Graph.7



$\sum_{j=1}^{n} \lambda_j$ = 1 means the Constant Return to Scale. These companies do not need to adjust the scale. Their strategy should be keeping the stability and sustainable development. These companies, which include China Life, Pacific and Xing Hua, have already owned the large scale of properties and occupied the large market shares. They are appropriate to keep the present operation, business and market, and keep the constant input and output. These are mainly the first and second category of companies.

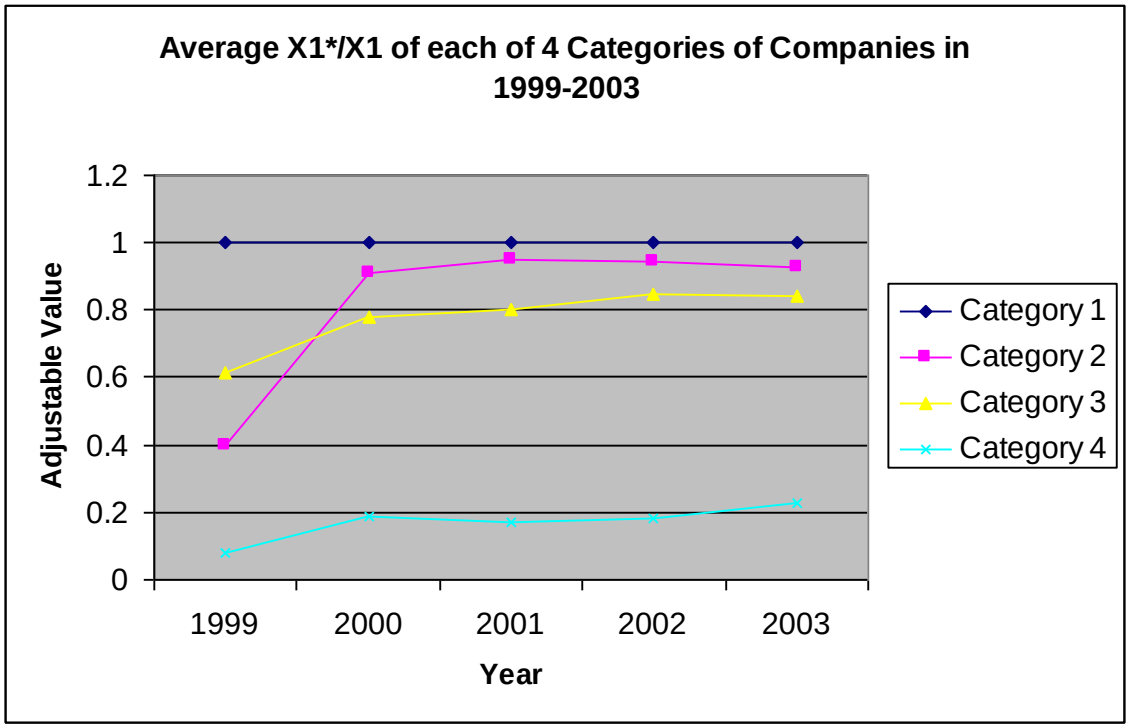
$\sum_{j=1}^{n} \lambda_j < 1$ means the Increase Return to Scale. These companies should increase the production scale, and increase the Input and Output. Then they can obtain more efficient evaluation. Most companies with this property are the third and the fourth category. These companies are established later, and some of them are joint venture companies. Their market share is small, and their business is not stable, with much pressure. The suggestions for these companies are diversifying their products & services, increasing the scale, looking for the segment market and developing the comparative advantage in management, technology and sales.

$\sum_{j=1}^{n} \lambda_j > 1$ means the Decrease Return to Scale. Such companies should control the expansion rate, reduce the unconstrained large scale of Input, and avoid the Mergers and Acquisition. In this way, the companies can improve the efficiency. Some companies of the second category, which are Domestic Stock Enterprise founded early, are in this condition. These companies have occupied enough market shares and the market shares cannot be increased anymore only by company scale increasing. The company should improve the inner management and develop the core competitive advantage.

5.1.2. The Chinese life insurance adjustable variables results

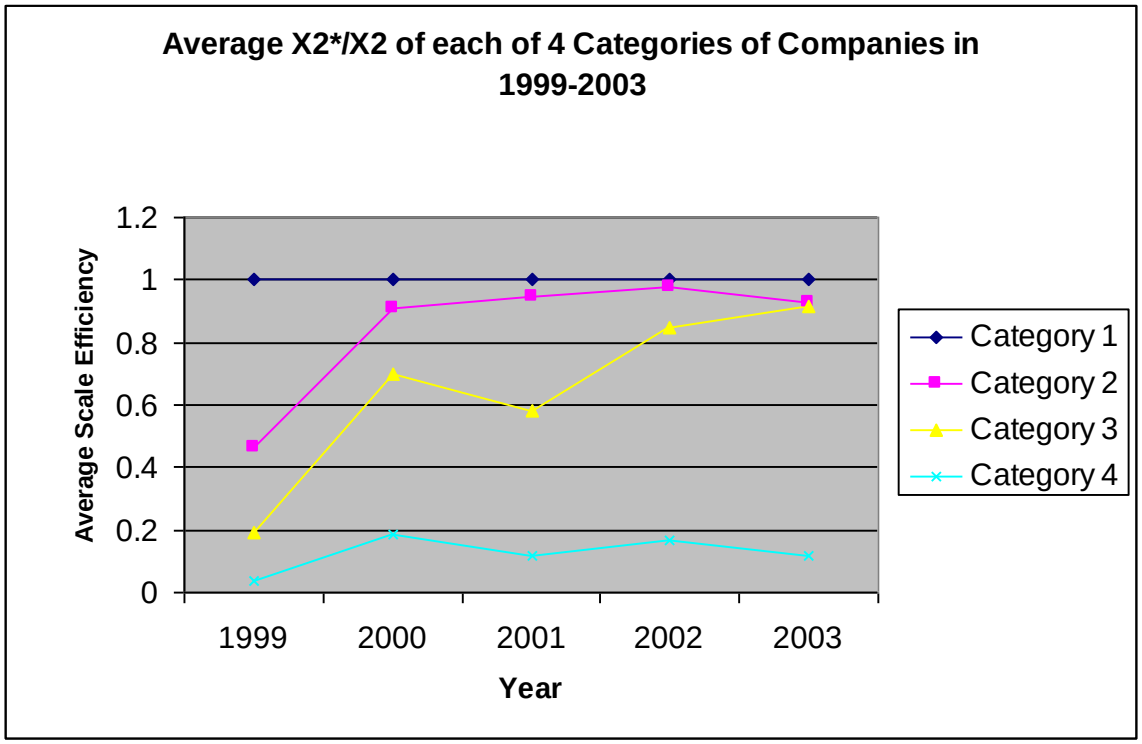
From Table.12 to Table.16, $X^* = \theta X_0 - S^-$, $Y^* = Y_0 + S^+$, X*, Y* means the Input and Output on the Efficient Frontier. Efficient Frontier represents the theoretical production function, in which the Input and Output is the idealistic condition and the DMUs are perfectly efficient. So, X*, Y* give the standard condition that the company can adjust itself to reach. If X0 gets more close to X*, Y0 gets more close to Y*, or X1*/X1，X2*/X2，Y1/Y1*，Y2/Y2* get more close to 1, then the actual Input and Output of the DMU get more close to the Efficient Frontier. So we can get the conclusion:

Graph.8



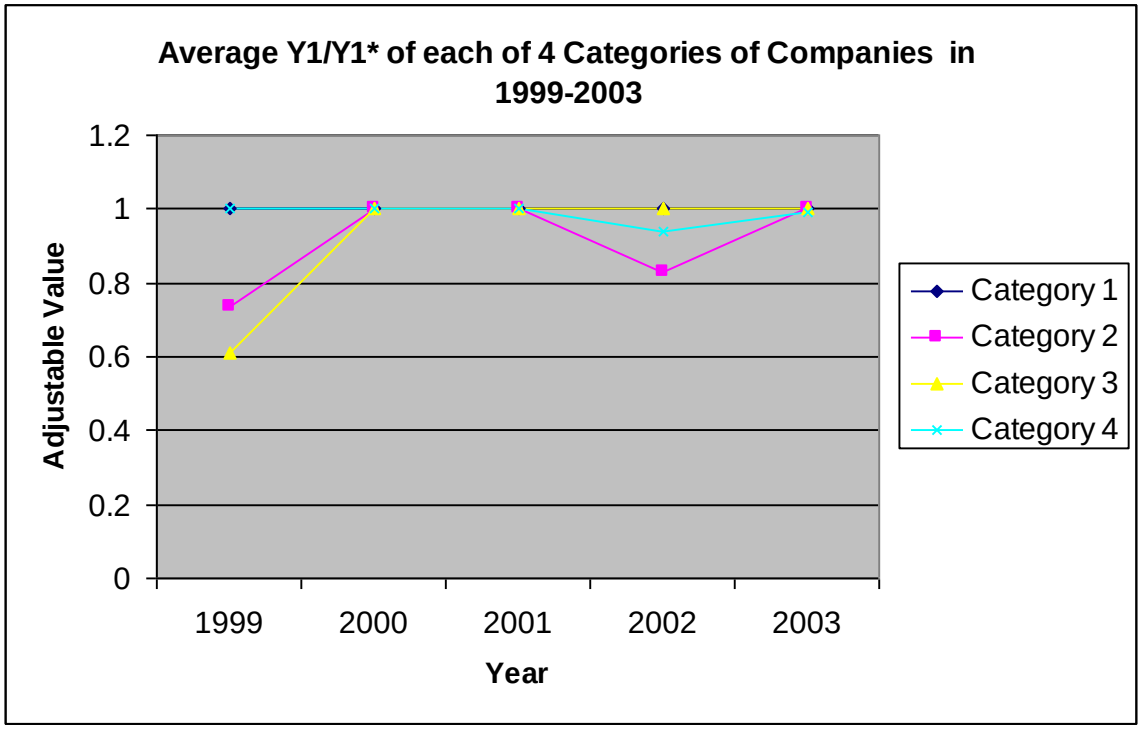
(1) X1*/X1 < means the inefficiency of the company is partly caused by that the expense (including the fees, wages and other expense) exceeds the standard condition. So the company will be better off by optimizing the product line and organization, reducing the waste of the operation process, controling the cost of the agents and cutting off the excess job position, etc.

Graph.9



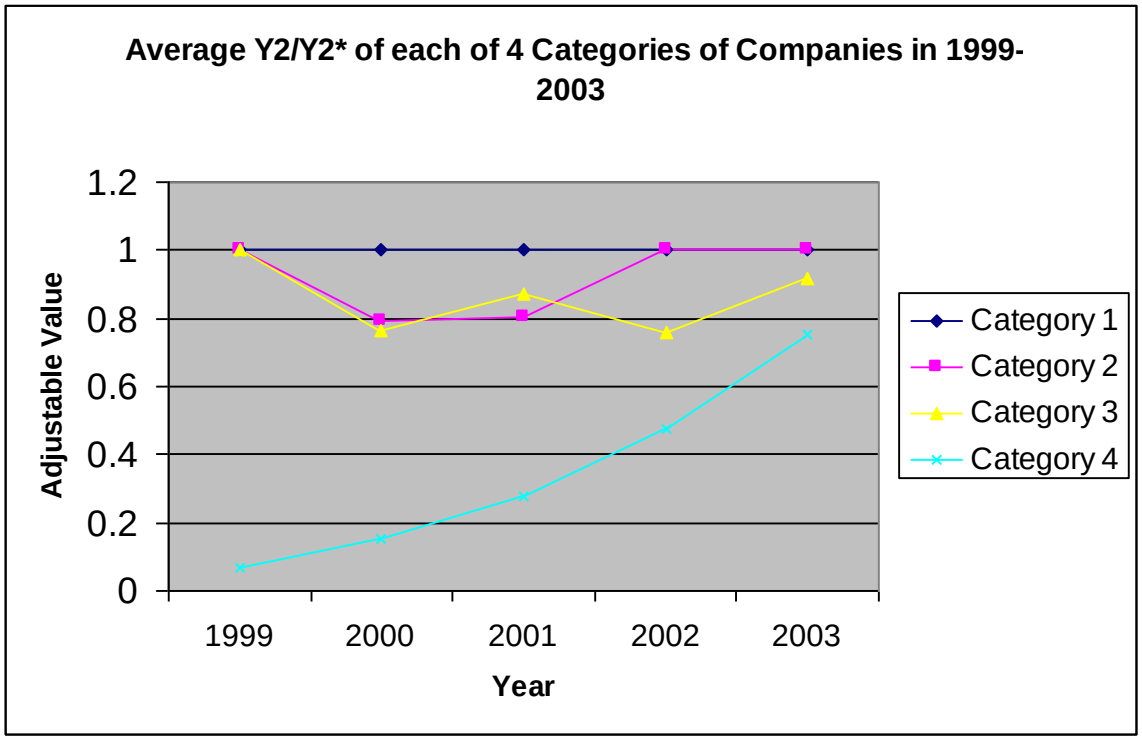
(2) X2*/X2 < 1 means the inefficiency of the company is partly caused by that the equity input exceeds the standard condition. The company does not make the efficient use of the equity. Given the condition that the amount of the equity satisfies the requirement of the China Insurance Regulation Committee, the company will better off by reducing the input of the equity, increasing the financial leverage.

Graph.10



(3) Y1/Y1* < 1 means the inefficiency of the company is partly caused by that the company does not well satisfy the requirement of the claims payment. As a result, the company does not perform well for its liability of risk-pooling and risk-sharing. The company should improve on the payment settlement and customer service.

Graph.11



(4) Y2/Y2* < 1 means the company's Addition to Reserve should be improved. One possible approach is to increase the return of investment. The company should improve the technology and skills of the professional investment team, make better use of the financial product, enhance the asset liability management. The improvement of the Addition to Reserve helps the company to perform well in accumulating the asset, liquidating the financial market, and contributing to infrastructure construction and GDP growth.

According to the Table 12.-Table 16, and Graph.8-Graph.11, we can analyze how the inefficient life insurance company can adjust the Input and Output in the above four aspects and reach an efficient standard. The company can set up strategy and develop in the right direction according to the analysis. Every company wants to improve the performance and become more efficient. The DEA analysis helps to find out the bottle neck and provides a clear direction for the company.

5.2. ANALYSIS

By the DEA method, we come to the result of the evaluation for the technical and scale efficiency of the companies in different categories. We also reach the solution on how to adjust the Input & Output to improve the efficiency. From the result, we can conclude the problems of the Chinese life insurance companies in the following three aspects: the scale problem, the cost problem and the investment problem.

5.2.1. The scale analysis of the Chinese life insurance industry

The difference of the scale between the State-Owned Enterprise, Domestic Stock Enterprise and the Joint Venture is significant, as shown in the Graph.1. The China Life, the state-owned enterprise, occupies most resource of the industry and also provides more than half of the products and services. This category 1 company is on the constant return to scale period, according to the result of $\sum_{j=1}^{n} \lambda_j = 1$. On one hand, the company should not be too greedy to occupy much more market share and increase the size blindly, which may lead to the waste of the resources and the low efficiency due to the market monopoly. On the other, the company does not deserve the over restriction from the China Insurance Regulation Committee, which worries on the unbalance of the market share and the formation of the uncompetitive market. It is not necessary to cut down the share, since the scale effect is good to the performance of the life insurance company. One important role of the life insurance company is transferring the risk from individual to the pool. Diversifying and sharing the risk in the pool is benefit from the scale effect. And the other role is gathering the money and reinvesting to gain high rate of return by the scale effect. So the regulation committee can formulate the policy from the value of $\sum_{j=1}^{n} \lambda_j$ to supervise the growth rate of the company and to guide the company to achieve the constant rate of return.

The recently established Domestic Stock Enterprise and Joint Venture Enterprises, belonging to the category 3 and category 4 companies, achieve less than 20% of the market share in total. The value of $\sum_{j=1}^{n} \lambda_j$ is less than 1, which means the company is on the stage of

increase return to scale, and far away from the optimal efficient scale. These companies are lack of the brand awareness, the product diversification, the professional employees, and the sufficient equity, which cause the lack of competitive advantage comparing to the large companies in category 1 and category 2. On this stage, the technical efficiency is mainly caused by the scale efficiency. So the companies are compelled to reduce the price to attract the customers, which may result in the price war in the industry and the following reduction of the service quality and the vicious circle. So the regulation institution should provide good circumstances and policies to facilitate the development of the small companies and cultivate the market. The scale inefficient companies should explore their potential and segment the market to find new value driver for the company. The approaches include the Merger & Acquisition, and the establishment of the group corporation.

Merger & Acquisition. In 1996, globally, 382 insurance companies involved in the M&A and the total value reached 41 billion dollars. During 1997-2001, 5114 M&A cases occurred globally and the total value reached 110 billion dollars. The merger and acquisition occurred frequently in insurance industry all over the world. This is an effective approach to solve the problem of inefficiency for the small companies, which can be introduced to the Chinese life insurance companies. When the small companies incur extreme losses, they may apply for the bankruptcy, or turn to the last resort of the government, or be purchased (M&A) by other companies. Generally speaking, the M&A is the best way to mitigate the shock to the whole industry and relieve the burden of the government. Besides, M&A is the most rapid way to increase the scale to improve the efficiency, which integrates the resource advantage of the companies, diversifies the product and services, assembles the market and increases brand awareness of the companies. From the micro perspective, M&A improves the scale efficiency of the company. From the macro perspective, M&A ameliorate the resources allocation.

The establishment of the Group Corporation. The well known insurance companies around the world are mainly formed as the structure of group, with the subsidiary of the life insurance, the Property and Liability insurance and etc. The establishment of the group corporation is a way for small size companies to integrate the brand resource, the business strategy, the distribution channel and the information, which reduce the input and generate more output.

5.2.2 The expense analysis of the Chinese life insurance industry

From the data of X1*/X1 in Table.12 – Table.16, we can figure out the expenses of most companies in category 2-category 4 are over the efficient condition. So the companies encounter the problem of over consuming of the resources. It is a common problem in the Chinese life insurance industry. The expense of the good example of the foreign life insurance company is controlled less than 6% in the premium, while the data of that in China is around 10%. The agent fee is an important component in the expense, which is the payment to the agent proportional to the premium. <Chinese Insurance Company financial Policy> rules the percentage of the agent fee, depending on the different insurance type and different policy. The maximum percentage is limited up to 8%. However, in the real world, the insurance company pays higher percentage to the agents, because of the pressure of the market competition. It can be explained as a form of the price war, which may lead to the vicious circle and destroy the market principle.

To prevent the price war, every life insurance company needs to restrict the vicious competition and control the fees and expenses. The regulation institution should require the companies to establish reasonable principle-agent incentive policy and financial policy to restrict the agent fee. The self discipline and industry regulation can cooperate to reduce the excess fees.

5.2.3. The investment analysis of the Chinese life insurance industry

From the data of Y2*/Y2 in Table.12- Table.16, we can figure out that the companies in category 3 and category 4 are weak in producing the Add to Reserve. The main reason is the weakness in investment and the low rate of return. On one hand, the company does not perform well in the investment management. Especially, the relatively small companies overlook the reinvestment return of the premium and cannot generate the higher rate of return by the scale effect. On the other, the whole investment circumstance is not positive, the investment channel is limited and the return/risk is low for the financial instruments. The problems in the investment process of the life insurance companies include the followings:

The investment strategies and instruments. The most commonly used investment instruments for the life insurance company are the banking deposit and the treasury bonds. The investment portfolio weight for these two financial tools is between 71.3-88%. The risk of the

banking deposit and the treasury bonds is low, and the rate of return is also low as a result. Besides, the China central bank has reduced the interest rate in the recent years, which leads to the relatively lower rate of return to the companies.

The regulations on the investment. The China Insurance Regulation Committee constricts the investment of the premium seriously, including the investment range and proportion. For example, China Insurance Regulation Committee publishes <Inform on the restrictions of the life insurance company on the purchasing of convertible bonds>, which rules "The quota for the insurance company to purchasing the convertible bonds is included in the quota to purchasing the corporate bonds, which in total cannot excess 20% of the insurance company asset at the end of last month. The quota for each type of the convertible bonds can't excess 15% of the total issued value, or 2% of the insurance company asset at the end of last month." The strict regulation on the investment of the company leads to the narrow choices of investment instruments and proportion.

Investment professional talent. Most small companies, belonging to category 3 and category 4, are in lack of the investment professional talent and overlook the importance of the investment. A large proportion of the portfolio is in the short term investment which leads to mismatching of the asset and the liability, which remarkably affects the payment cability and expected return in the future. In these life insurance companies, the investment department is not separated from the parent company to form a specialized institution. So it is unable to manage large amount of premium and control the risk involving in the complicated financial instrument.

The possible approaches to solving these problems include the following:

First, the life insurance company should be allowed to invest in real estate, especially the infrastructure construction. In many developed countries, the real estate investment is one of the most important investment instruments for the life insurance companies. For instance, in 1996, the real estate investment proportions are 5.2%, 8.5%, 9.02% for Japan, Korea and Taiwan, respectively, and keep constant for a long period. China will concentrate on the western and north eastern area development for the next decades, so the infrastructure construction investment demanding is large. But the government fiscal is limited. The gap between them is exactly a good opportunity for the life insurance company which has large amount of premium without sufficient

investment instruments. Besides, the risk for the investment is relatively low, and the long term return is relatively stable, which is appropriate for the requirement of the premium investment.

Second, the financial regulation institutions should help to cultivate the capital market and investment circumstance, and also allow the companies to invest in larger range of the capital market. The rate of return for stock and corporate bonds is relatively higher. Take OECD countries as example, the rate of return in the currency market, bond market and stock market in U.S are 3.7%, 5%, 10.3% respectively, in last 20 years. The rate of return in the currency market, bond market and stock market in Germany are 3.5%, 7.9% and 14.4, respectively, in the last 30 years. So, one approach to improve the rate of return is to increase the proportion invested in stock market. But the stock market in China is not mature and generates higher risk. So the regulation institution ought to relieve the restrictions to allow the premium to invest in foreign market and employ derivatives to hedge the risk.

Third, the life insurance companies need to improve the investment skill. The companies need to cultivate the investment professional talent, establish a series of investment management policies, and design appropriate investment strategy and portfolio, even set up the controlled company to focus on the premium investment.

6. Conclusion

In this paper, we provide an efficiency analysis research on the Chinese Life Insurance Industry from 1999-2003, involving 16 main life insurance companies. We want to measure the efficiency that the companies make use of the resources and contribute to the whole financial system and macro economy. The analysis results indicate the approaches to improve the efficiency through adjusting the Input and Output of the companies. Meanwhile, we try to compare the efficiency between 4 categories of life insurance companies established in different periods with different regulation policies. It helps to make strategy and development goal for different categories of life insurance companies, including the state-owned enterprises, large domestic stock enterprises, medium domestic stock enterprises and joint ventures.

The state-owned enterprises were founded before 1980. The scale is huge and the brand awareness is high. They were once the monopoly of the market and still own large share (more than half) of the market today. The large stock enterprises were founded during 1990. They have the advanced ownership structure, the management system and the competitive market incentive. As a result they have developed rapidly and dominated most of the life insurance market except the state-owned enterprises. The medium stock enterprises were founded around 1995. The first three categories occupy more than 80% of the market. A large amount of joint venture enterprises enter the Chinese life insurance industry around 2000. The joint ventures absorb the advantage in management, technology and operation from the foreign companies, and also learn from the local market experience of the Chinese companies. The joint ventures have much potential, but now they do not perform as outstanding as expected due to the lack of market experience and insufficient brand awareness. Their market share in total is less than 15%.

We apply the DEA (Data Envelope Analysis) method to solve this problem. In the DEA method, we consider every company in the industry as a DMU (Decision Making Unit), which has similar type of Input & Output and performs the similar function as the others in the industry. So the DMUs can be compared with each other. We set the criteria for efficiency evaluation as the ratio of Output/Input. The higher the ratio, the more efficient the company. Through the linear

transformation, the above criteria ratio turns to be an equal one: If we can find the replication of the objective company with the other companies, to make the replicated one has the same output but less input as the objective one. If so, the objective company is inefficient. With this principle, we set the Input and Output proxy variables as X1 (Expense), X2 (Equity), Y1 (Benefit), Y2 (Add to Reserve). We use the linear programming to solve the efficient value for every company and compare the 4 categories with each other from the perspective of the technical efficiency, the scale efficiency, and the adjustable Input & Output variables.

We discuss the efficiency analysis results from three perspectives, including the scale effect, the expense and the investment of the company. From the scale perspective, the China Life, as an example of the State-Owned Enterprise, is constant return to scale. On one hand, it should not be too greedy to occupy the market and increase the size blindly, which may give rise to the waste of resources and low efficiency due to the market monopoly. On the other, it does not deserve the over restriction from the China Insurance Regulation Committee, which worries on the unbalance of the market share and the form of uncompetitive market. The recent established Domestic Stock Enterprise and Joint Venture Enterprises, belonging to the category 3 and category 4, occupy less than 20% of the market share in total and have increasing return to scale. So the regulation institution should provide good circumstances and policies to promote the growth of the small companies and cultivate the market. The scale inefficient companies need to explore the potential and segment the market to find new value driver for the company and cultivate the core competitive advantage by scale increasing. The approaches include the Merger & Acquisition, and establishment of the group corporation.

From the expense perspective, we can figure out the expense of most category 2-category 4 companies are over the efficient condition. It is a common problem in the Chinese life insurance industry. The expense of the good example of foreign life insurance company is controlled less than 6% of the premium, while the percentage of that in China is around 10%. The agent fees are an important component in the expense, which is the payment to the agent proportional to the premium. The life insurance companies need to restrict the vicious competition and control the fees and expense. The regulation institution should strengthen the restriction on the agent fees to cultivate the market.

From the investment perspective, we can figure out that the category 3 and category 4 companies are weak in producing the Add to Reserve, the main reason of which is the weakness in investment and the low rate of return. On one hand, the company does not do well in the investment management. Especially, the relatively small company ignores the reinvestment of the premium and cannot produce higher rate of return from the scale effect. On the other, the whole investment circumstance is not good, the investment channel is limited and the return/risk is low for the financial instruments. The problems in the investment process of the life insurance company include the low rate of return for the investment instruments, the over restricted regulation on the investment and the lack of the professional intelligence in investment. The approaches to solve the problem are suggested as the following: the regulation institution allows the life insurance company to invest in real estate, especially the infrastructure construction; the regulation institution helps to cultivate the capital market and investment circumstances and allows the companies to invest in the foreign capital market; the companies need to improve the investment skills.

Appendix

Table.3 China 15 Life Insurance Companies Input and Output in 2002

Unit：Million Yuan

Company	X1(Expense)	X2 (Equity)	Y1(Benefit)	Y2(Add to Reserve)
1.China Life	21198.05	8990.81	27034.87	86610.62
2.Pacific	3835.7	2838.56	4767.71	16780.35
2.Ping An	12022	4736	14004	30919
3.Xing Hua	653.54	1449.25	846.95	4662.91
3.Tai Kang	1458.88	1185.78	676.53	4837.79
4.Zhong Hong	192	296	22	164
4.An Tai	241.93	294.03	39.79	237.03
4.Anlian Dazhong	65.8	121.6	4.97	96.23
4.Jing Sheng	69	337	4	44
4.Kang Lian	22.01	167.51	0.91	4
4.Xing Cheng	146.22	422.47	22.58	74.42
4.Heng Kang	40.41	155.74	0.44	12.67
4.Tai Ping	268.58	393.44	7.5	1464.23
4.Zhong Yi	47.912	169.397	0.78	12.042
4.Guang Da	86.67	133.49	0.12	6.07

Table.4 China 12 Life Insurance Companies Input and Output in 2001

Unit: Million Yuan

Company	X1(Expense)	X2 (Equity)	Y1(Benefit)	Y2(Add to Reserve)
1.China Life	16779.32	7941.32	27462.01	42068.63
2.Pacific	2594.36	2107.17	3260.7	9235.86
2.Ping An	9971	6450	7899	27240
3.Xing Hua	456.9	1442.01	1309.98	781
3.Tai Kang	508.42	1492.79	285.27	1094.32
4.Zhong Hong	139	116	16	162
4.An Tai	141.27	72.07	9.19	111
4.Anlian Dazhong	45.74	160.12	0.81	44.84
4.Jing Sheng	79	91	2	30
4.Kang Lian	20.41	183.08	0.13	1.46
4.Xing Cheng	92.62	160.5	2.79	54.09
4.Heng Kang	32.23	181.92	0.4	1.25

Table.5 China 9 Life Insurance Companies Input and Output in 2000

Unit: Million Yuan

Company	X1(Expense)	X2 (Equity)	Y1(Benefit)	Y2(Add to Reserve)
1.China Life	13704.29	6995.49	21320.32	32098.13
2.Pacific	3406.89	3172.91	6128.96	5013.08
2.Ping An	7645	5738	5649	15060
3.Xing Hua	273	1459	406	1044
3.Tai Kang	233.31	1770.42	101.7	499.71
4.Zhong Hong	105	155	4	87
4.An Tai	79	124	3	48
4.Anlian Dazhong	34.66	186.76	0.09	19.88
4.Jing Sheng	67	133	2	9

Table.6 China 7 Life Insurance Companies Input and Output in 1999

Unit: Million Yuan

Company	X1(Expense)	X2 (Equity)	Y1(Benefit)	Y2(Add to Reserve)
1.China Life	14307.45	5261.1	19827.05	29000.52
2.Pacific	2588.18	3181.39	6294.84	4952.96
2.Ping An	5921	4722	7250	9949.44
3.Xing Hua	184	660	675	397
3.Tai Kang	144.2	676.51	286.14	344.03
4.Zhong Hong	80	142	2	45
4.An Tai	39	167	1	21

Table.8 China Life Insurance Efficiency Analysis in 2002

Company	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency	$\sum_{j=1}^{n}\lambda_j$	Return to Scale
1.China Life	1	1	1	1	Constant
2.Pacific	0.971859	0.972284	0.999563	1.149612	Decreasing
2.Ping An	0.983365	0.995575	0.987736	0.517998	Increasing
3.Xing Hua	1	1	1	1	Constant
3.Tai Kang	0.698629	0.711408	0.982037	0.375643	Increasing
4.Zhong Hong	0.1427	0.434282	0.328587	0.026611	Increasing
4.An Tai	0.1804	0.462655	0.389923	0.030613	Increasing
4.Anlian Dazhong	0.224765	1	0.224765	0.018111	Increasing
4.Jing Sheng	0.089376	0.486757	0.183614	0.009436	Increasing
4.Kang Lian	0.031903	1	0.031903	0.001074	Increasing
4.Xing Cheng	0.11916	0.371157	0.321051	0.02666	Increasing
4.Heng Kang	0.043944	0.962037	0.045678	0.002717	Increasing
4.Tai Ping	0.93109	1	0.93109	0.227008	Increasing
4.Zhong Yi	0.035227	0.867763	0.040595	0.002583	Increasing
4.Guang Da	0.011705	0.91093	0.01285	0.000984	Increasing

Graph.3

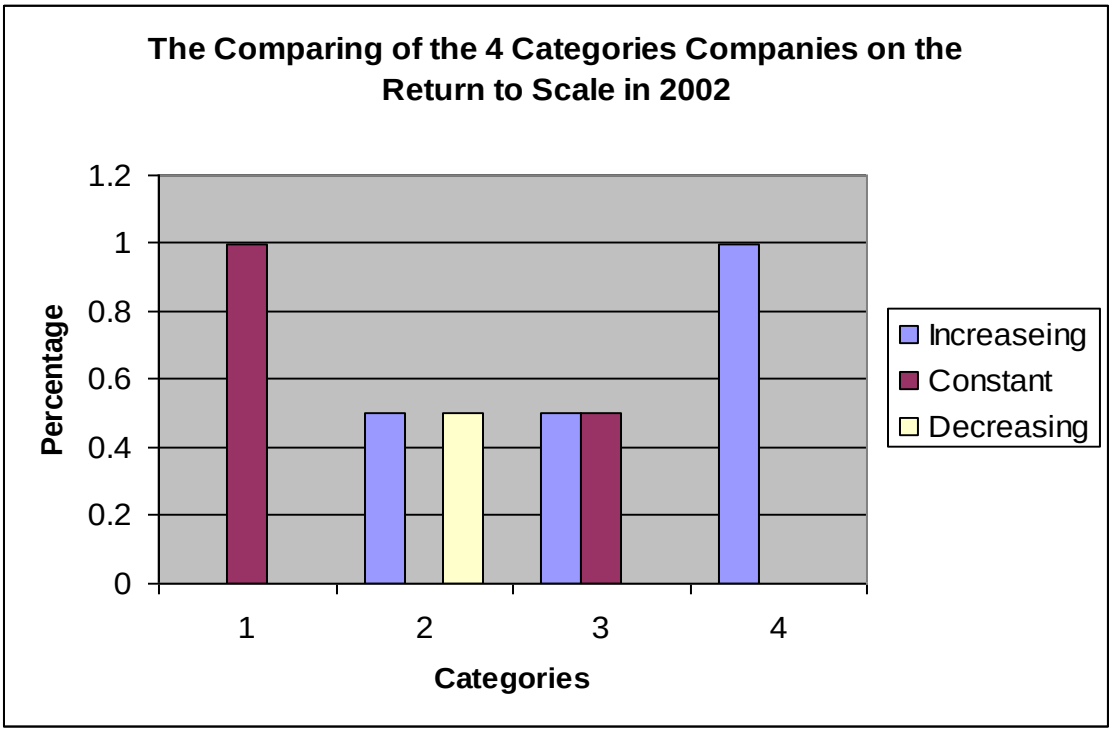


Table.9 China Life Insurance Efficiency Analysis in 2001

Company	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency	$\sum_{j=1}^{n} \lambda_j$	Return to Scale
1.China Life	1	1	1	1	Constant
2.Pacific	1	1	1	1	Constant
2.Ping An	0.89677	1	0.89677	2.025248	Decreasing
3.Xing Hua	1	1	1	1	Constant
3.Tai Kang	0.604609	0.639291	0.945749	0.118486	Increasing
4.Zhong Hong	0.327381	0.926105	0.353503	0.01754	Increasing
4.An Tai	0.2997	1	0.2997	0.004024	Increasing
4.Anlian Dazhong	0.275374	1	0.275374	0.004855	Increasing
4.Jing Sheng	0.106671	1	0.106671	0.003248	Increasing
4.Kang Lian	0.020094	1	0.020094	0.000158	Increasing
4.Xing Cheng	0.164046	0.763432	0.214879	0.005857	Increasing
4.Heng Kang	0.010894	0.925115	0.011776	0.000135	Increasing

Graph.4

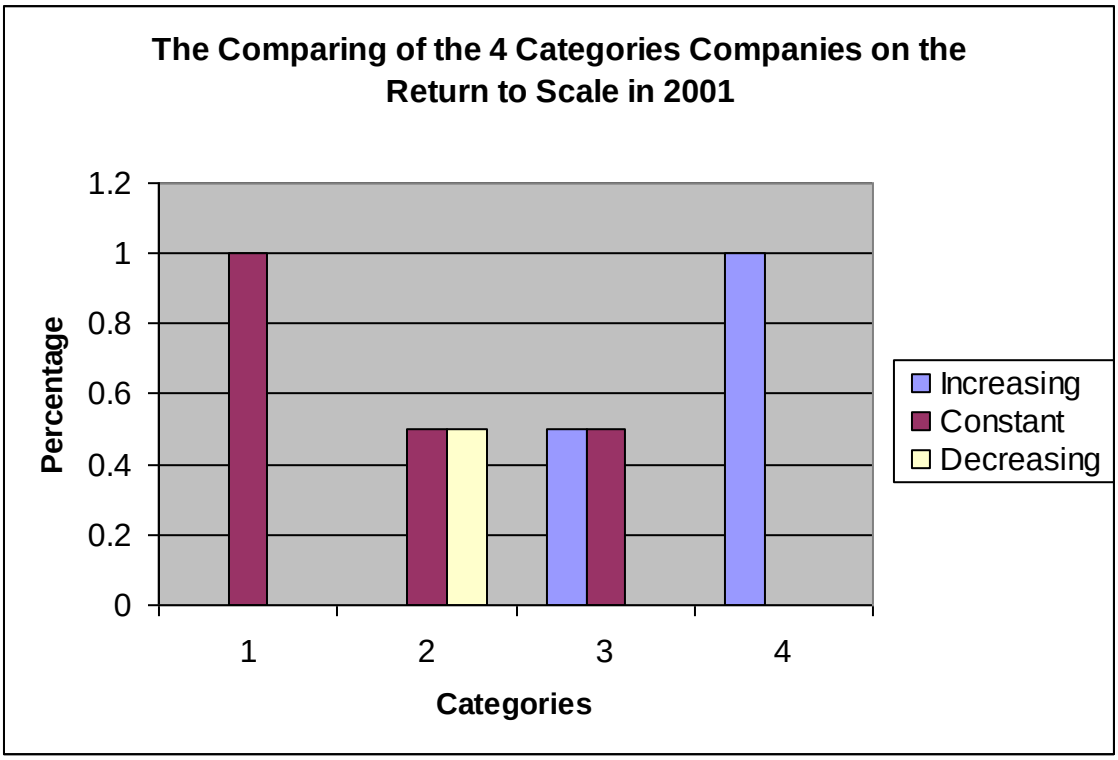

The Comparing of the 4 Categories Companies on the Return to Scale in 2001
1.2
1
0.8
0.6
0.4
0.2
0
Percentage
1
2
3
4
Categories
Increasing
Constant
Decreasing

Table.10 China Life Insurance Efficiency Analysis in 2000

Company	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency	$\sum_{j=1}^{n} \lambda_j$	Return to Scale
1.China Life	1	1	1	1	Constant
2.Pacific	1	1	1	1	Constant
2.Ping An	0.815428	0.828658	0.984034	1.5665	Decreasing
3.Xing Hua	1	1	1	1	Constant
3.Tai Kang	0.560076	0.627188	0.892995	0.478649	Increasing
4.Zhong Hong	0.314058	0.887184	0.353995	0.026058	Increasing
4.An Tai	0.227827	1	0.227827	0.015471	Increasing
4.Anlian Dazhong	0.149986	1	0.149986	0.019042	Increasing
4.Jing Sheng	0.048072	1	0.048072	0.003762	Increasing

Graph.5

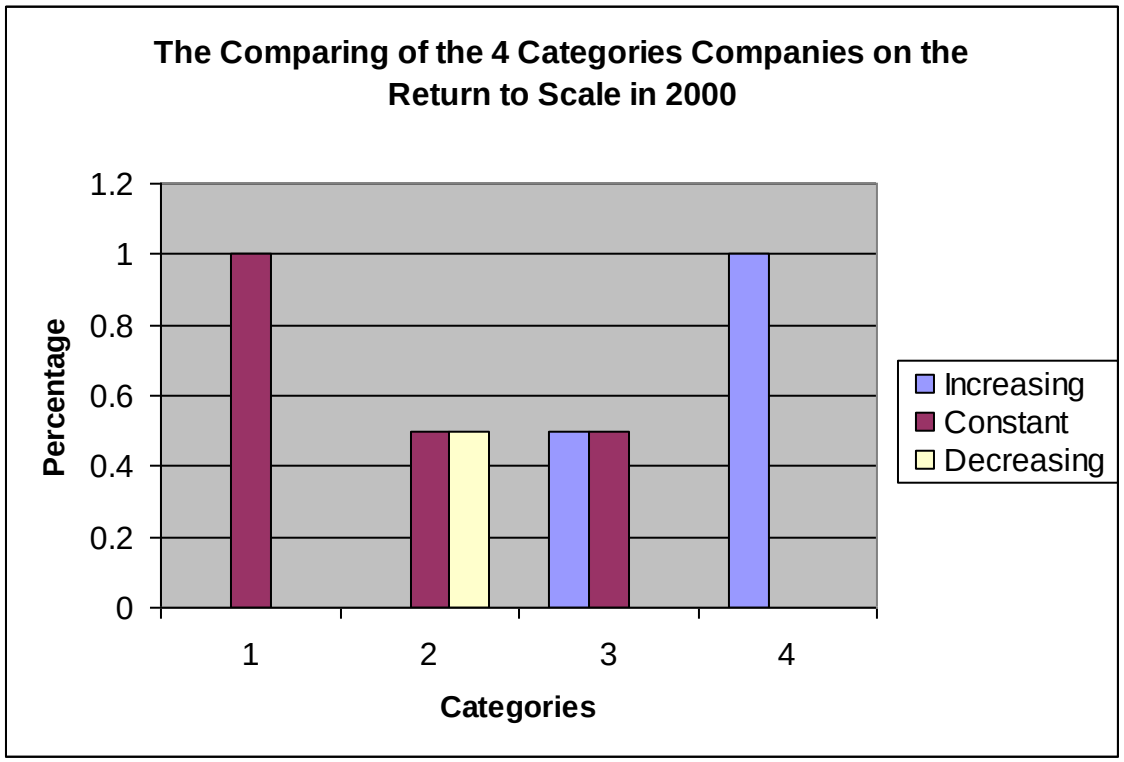


Table.11 China Life Insurance Efficiency Analysis in 1999

Company	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency	$\sum_{j=1}^{n} \lambda_j$	Return to Scale
1.China Life	1	1	1	1	Constant
2.Pacific	0.528387	0.555385	0.951389	0.317488	Increasing
2.Ping An	0.407409	0.426415	0.955427	0.365662	Increasing
3.Xing Hua	0.796981	1	0.796981	0.034044	Increasing
3.Tai Kang	0.431098	0.696064	0.619336	0.014432	Increasing
4.Zhong Hong	0.083548	1	0.083548	0.001552	Increasing
4.An Tai	0.079978	1	0.079978	0.000724	Increasing

Graph.6

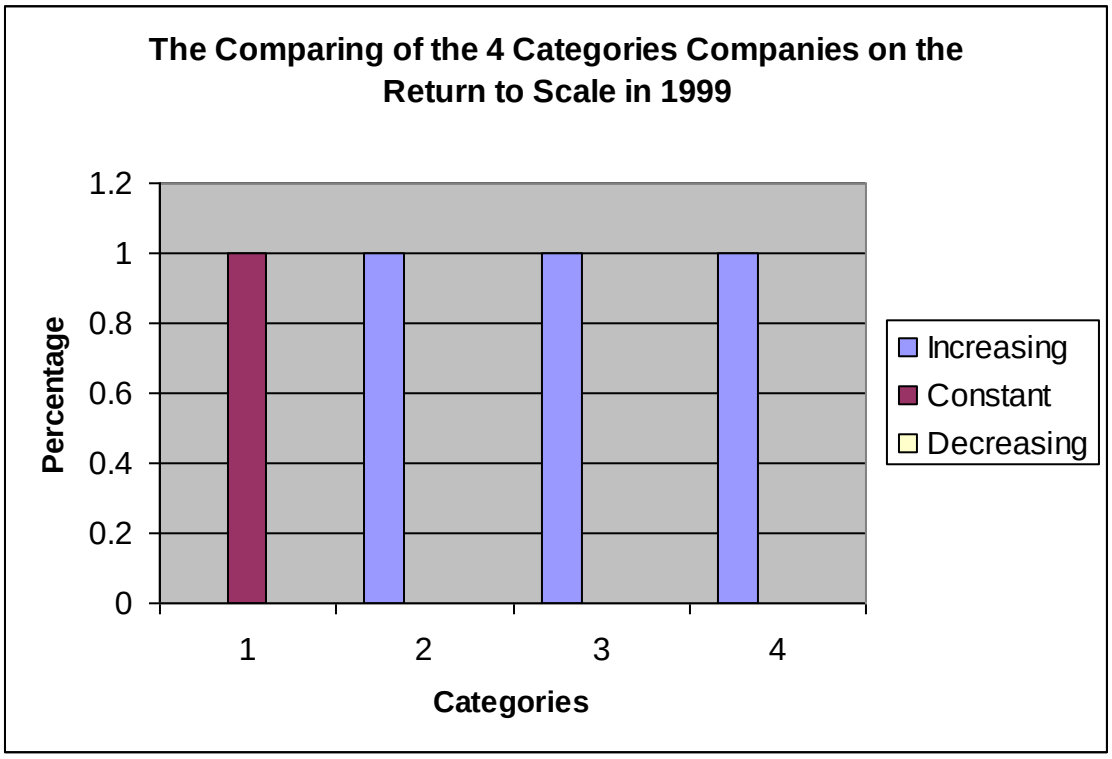


Table.12 China Life Insurance Adjustable Variables Analysis in 2003

Company	X1*/X1	X2*/X2	Y1/Y1*	Y2/Y2*
1.China Life	1	1	1	1
2.Pacific	1	1	1	1
2.Ping An	0.852982	0.852982	1	1
3.Xing Hua	1	1	1	1
3.Tai Kang	0.685043	0.834835	1	0.835386
4.Zhong Hong	0.234829	0.153754	1	0.868501
4.An Tai	0.253556	0.205836	1	0.869527
4.Anlian Dazhong	0.270994	0.230946	1	1
4.Jing Sheng	0.11427	0.024349	1	1
4.Kang Lian	0.206455	0.025759	1	1
4.Xing Cheng	0.177828	0.04973	0.922381	1
4.Heng Kang	0.095212	0.021576	1	0.475158
4.Tai Ping	0.775513	0.463274	1	0.284604
4.Zhong Yi	0.129269	0.014244	1	0.69638
4.Guang Da	0.030756	0.030162	1	0.955139
4.Hai Er	0.202028	0.046211	1	0.104575

Table.13 China Life Insurance Adjustable variables Analysis in 2002

Company	X1*/X1	X2*/X2	Y1/Y1*	Y2/Y2*
1.China Life	1	1	1	1
2.Pacific	0.971859	0.971859	0.973737	1
2.Ping An	0.913371	0.983365	0.68917	1
3.Xing Hua	1	1	1	1
3.Tai Kang	0.698629	0.698629	1	0.518651
4.Zhong Hong	0.1427	0.1427	1	0.623335
4.An Tai	0.1804	0.1804	1	0.709802
4.Anlian Dazhong	0.224765	0.224765	1	0.26016
4.Jing Sheng	0.089376	0.04058	1	0.500503
4.Kang Lian	0.031903	0.009296	0.798398	1
4.Xing Cheng	0.11916	0.091456	0.598641	1
4.Heng Kang	0.043944	0.025285	1	0.191194
4.Tai Ping	0.93109	0.93109	1	0.023298
4.Zhong Yi	0.035227	0.022094	1	0.356611
4.Guang Da	0.011705	0.011705	1	0.091825

Table.14 China Life Insurance Adjustable variables Analysis in 2001

Company	X1*/X1	X2*/X2	Y1/Y1*	Y2/Y2*
1.China Life	1	1	1	1
2.Pacific	1	1	1	1
2.Ping An	0.89677	0.89677	1	0.612562
3.Xing Hua	1	1	1	1
3.Tai Kang	0.604609	0.167251	1	0.738377
4.Zhong Hong	0.327381	0.318625	1	0.279751
4.An Tai	0.2997	0.2997	1	0.136059
4.Anlian Dazhong	0.275374	0.063891	1	0.051167
4.Jing Sheng	0.106671	0.075215	1	0.188832
4.Kang Lian	0.020094	0.001819	1	0.252207
4.Xing Cheng	0.164046	0.076889	1	0.146101
4.Heng Kang	0.010894	0.001568	1	0.906393

Table.15 China Life Insurance Adjustable variables Analysis in 2000

Company	X1*/X1	X2*/X2	Y1/Y1*	Y2/Y2*
1.China Life	1	1	1	1
2.Pacific	1	1	1	1
2.Ping An	0.815428	0.815428	1	0.583745
3.Xing Hua	1	1	1	1
3.Tai Kang	0.560076	0.394454	1	0.523332
4.Zhong Hong	0.314058	0.314058	1	0.078662
4.An Tai	0.227827	0.227827	1	0.108185
4.Anlian Dazhong	0.149986	0.14876	1	0.011641
4.Jing Sheng	0.048072	0.048072	1	0.404576

Table.16 China Life Insurance Adjustable variables Analysis in 1999

Company	X1*/X1	X2*/X2	Y1/Y1*	Y2/Y2*
1.China Life	1	1	1	1
2.Pacific	0.528387	0.525033	0.537938	1
2.Ping An	0.266014	0.407409	0.938238	1
3.Xing Hua	0.796981	0.27138	0.402105	1
3.Tai Kang	0.431098	0.112234	0.821997	1
4.Zhong Hong	0.083548	0.05749	1	0.065008
4.An Tai	0.079978	0.022813	1	0.069651

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