

Using DEA Approach to Measure the Retention Efficiency of Cross-Strait Non-Life Insurance Companies

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Abstract

This study uses the traditional one-stage data envelopment analysis (DEA) method and a two-stage DEA method to measure the retention efficiency of 36 cross-strait (i.e., those operating in Taiwan and Mainland China) non-life insurance companies in the 2008–2013 period. The one-stage DEA results show that the average retention efficiency of companies in Taiwan is better than that of companies in Mainland China, under the traditional one-stage DEA method. By contrast, under the two-stage DEA method, we find that in the second stage, the average retention efficiency of companies in Mainland China is better than that of companies in Taiwan. However, in the first stage, the average marketing efficiency of companies in Taiwan is also better than that of companies in Mainland China. This study uses a Tobit regression model to examine the factors that significantly influence the retention and marketing efficiencies. Results reveal that the retention efficiency is significantly influenced by written premiums and the ratio of retained premiums and marketing efficiency is significantly influenced by time since establishment and the ratio of non-automobile insurance.

Keywords: DEA, efficiency, marketing, retention, Tobit regression

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1. Introduction

In the past 10 years, the performance of cross-strait insurance companies (i.e., those operating in Mainland China and Taiwan) is satisfactory in terms of total premium, insurance penetration rate, and insurance density. In particular, the business of insurance companies in China in the past 10 years has grown significantly, corresponding to the significant economic growth in China. In 2014, the total premiums earned by insurance companies in China and Taiwan were USD 328,440 and 95,622 million, respectively. In the same year, insurance companies in China and Taiwan ranked 4th and 11th in the world, respectively, in terms of total premium earned. The insurance penetration rates of insurance companies in Taiwan and China in 2014 were 18.9% and 3.2%, respectively. In the global context, insurance companies in Taiwan and China ranked 1st and 44th in the world, respectively, in terms of penetration rate. In particular, insurance companies in China moved from 49th in the world in 2013 to 44th in 2014 in terms of the penetration rate. Moreover, the insurance densities of insurance companies in Taiwan and China in 2014 were USD 4,072 and USD 235, respectively. The ranking of insurance density in Taiwan and China was 9th and 57th, respectively. China moved from 60th in the world in 2013 to 57th in 2014.

The total premium earned by insurance companies in Taiwan in 2014 was NT 29,033.5 billion (approximately RMB 5,852 billion). A significant difference exists in total premiums earned by non-life and life insurance companies in Taiwan: the proportion of total premium earned by non-life insurance companies to total premium earned by life insurance companies in Taiwan is 1:20.96. The total premium earned by insurance companies in Taiwan in 2014 was 1.84 times that earned in 2005 (i.e., NT 15,762,52 billion). Conversely, the total premium earned by insurance companies in China grew significantly from RMB 4,927.34 billion in 2005 to

RMB 20,234.81 billion in 2014. The business development of non-life and life insurance companies in China is more balanced than that of companies in Taiwan: the proportion of premiums earned by non-life and life insurance companies in China is 1:1.184.

The size of the non-life insurance market in China is much larger than that in Taiwan: premiums earned by non-life insurance companies in China are 27.3 times the premium earned by non-life insurance companies in Taiwan. Moreover, the total premium earned by life insurance companies in China is 2.33 times the total premium earned by life insurance companies in Taiwan. Furthermore, the total premiums earned by non-life and life insurance companies in China is 3.46 times the total premium earned by non-life and life insurance companies in Taiwan.

Non-life insurance companies underwrite many lines of non-life businesses and take liabilities of the claims. However, non-life insurance companies only keep the retention business. Therefore, when insurance companies measure the underwriting profit and combined ratio, the retention business must be considered to evaluate the financial performance of non-life insurance companies. Therefore, this study investigates the financial performance by examining the retention efficiency of cross-strait non-life insurance companies, including 14 and 22 non-life insurance companies in Taiwan and China, respectively.

This study adopted the data envelopment analysis (DEA) to evaluate the retention efficiency of cross-strait non-life insurance companies. We used a Tobit regression model to examine the factors that significantly influence the efficiency of cross-strait non-life insurance companies. The results of this study can be a good reference for (1) cross-strait non-life insurance companies when they consider methods to improve the retention efficiency and make important policies; (2) policymakers of government when they make policy decisions; (3) some Taiwan non-life



insurance companies whose branches are located in Mainland China to understand their advantages and disadvantages operating in Mainland.

2. Literature review

DEA is a method first proposed by Charners et al (1978) to analyze the efficiency of a decision making unit. Fecher et al. (1993) were the first to adopt DEA to evaluate the efficiency of non-life insurance companies. They used a parametric method (the stochastic frontier analysis) and a non-parametric method (DEA) to analyze the productive performance of 84 life and 243 non-life insurance companies, respectively, in France for the period of 1984 to 1989. Their study showed that there is a wide dispersion in the rates of inefficiency across insurance companies, and the value of efficiency is correlated with the characteristics of insurance companies. Donni and Fecher (1997) adopted intertemporal DEA to evaluate the productivity and efficiency of 15 insurance companies in the OECD countries for the 1983–1991 period. Donni and Fecher (1997) showed that the average efficiency levels appeared rather high and dispersed and that growth in productivity in all countries is imputable to the improvements in technical progress.

Moreover, Noulas et al (2001) adopted DEA to measure the performance efficiency of non-life insurance companies in Greece for the 1991–1996 period. Their results indicated that insurance firms were very inefficient and that large differences existed in the efficiency levels of insurance companies. Cummins and Xie (2008) used DEA to analyze the effects of conglomeration on productivity and efficiency. Their results showed that the market value of non-life insurance companies could be increased because of conglomeration, with acquiring companies earning higher returns and divesting companies earning lower returns.

In summary, the relation between efficiency performance and market characteristics can be

influenced by the different characteristics of countries and the environmental conditions under which the insurance industry operates. However, in the past 20 years, many studies on the efficiency performance of insurance sectors were limited to certain countries or regions because of the difficulty in gathering reliable data and the existence of different operating environments. An exception is the study by Huang and Eling (2013), who utilized a multi-stage input-oriented DEA and analyzed the efficiency of non-life insurance companies in four of the fastest-growing markets in the world—the BRIC countries (i.e., Brazil, Russia, India, and China)—in the 2000–2008 period.

Hwang and Kao (2005) employed adopted the two-stage DEA to measure the managerial performance of 24 non-life insurance companies in Taiwan by segregating the productivity process of non-life insurance companies into two stages: the marketability stage and the profitability stage. Their study showed that marketability is influenced by the proportion of field personnel, proportion of professional staff, proportion of premium retained, deposit ratio, and proportion of investment and that profitability is influenced by size of the insurance company and proportion of premium retained. Her (2006) used DEA and the DuPont Equation to measure the financial efficiency of 22 non-life insurance companies operating in Taiwan. Their study indicated that the financial performance of foreign insurance companies is better than that of domestic insurance companies.

In recent years, as non-life insurance companies have underwritten risks with a larger variation and with a higher frequency of catastrophe than before, the primary way for non-life insurance companies to manage risk is through “risk transfer.” The maximum amount of risk retained by an insurer is called retention. Beyond this maximum amount, the insurer cedes the excess risk to a reinsurer. Retention level is determined by the lines of insurance, financial condition, number



of insurance contracts, premium income for the entire year, and degree of risk.

Mayers and Smith (1990) examined the demand for insurance from the reinsurance market and found that size, business concentration, geographic concentration, ownership structure, credit standing (from A+ to C), lines of business, subsidiaries, and group members were the factors affecting the demand for insurance. Lin (2002) showed that capital, reserve funds, special reserves, undistributed earnings, volume of business, degree of risk exposure, reinsurance price and condition, and operating strategy were the factors affecting the retention decision. Ou (2003) proposed an evaluation of risk retention from the viewpoint of shareholders, the underwriting manager, and the finance manager. Chang (2008) concluded that the size of an insurance company, its return on assets, business concentration, shock of loss retained, financial leverage, income volatility, and reinsurance price were the key factors affecting the demand for reinsurance.

Lee (2012) investigated the determinants of non-life insurers' retention in Taiwan from the perspective of firm-specific and macroeconomic factors. The results showed that the return on assets, liquidity ratio, line of business concentration, return on investments, financial holdings, and business combination positively affected the retention ratio. Firm size, underwriting risk, and market share negatively affected the retention ratio. Furthermore, Chen (2014) analyzed the factors affecting retention ratio and the relation between the retention ratio and the factors using data from 30 OECD countries over the 1999–2008 period.

In summary, the retention level is influenced by two parts: financial conditions and business conditions. Financial conditions include capital, return rate of total capital and investment, income volatility, and price of reinsurance. Business conditions include business concentration, geographic concentration, and

operating strategy.

3. Methodology and data

3.1 Data Envelopment Analysis (DEA)

In this study, DEA was used to examine the marketability efficiency and retention efficiency of non-life insurance companies operating in Taiwan and Mainland China. Unlike the stochastic frontier, DEA can incorporate multiple inputs and outputs into a single index of efficiency without requiring any assumption of functions. DEA can either be input or output oriented and is capable of being specified under different scenarios-CRS (constant return to scale) and VRS (variable return to scale). The former examines whether the decision making unit (DMU) has already minimized the amount of inputs for any given level of output, and the latter determines whether output has been maximized for any given input. In this study, the output-oriented DEA model was used to study the efficiency measure of non-life insurance companies based on a given input level.

In DEA, the CCR and BCC models have been widely adopted to evaluate the efficiency of a firm. The CCR model, which was named after its developers Charners et al. (1978) is the first and fundamental DEA model. The BCC model allows for variable returns to scale. The only difference between the two models is their respective assumption for returns to scale, which is either constant or variable. In the following, the output-oriented CCR model is explained first to serve as an introduction to the BCC model.

The CCR model system assumes that there are N number of units to be assessed and that X_{ik} and Y_{rk} represent the amount of i th input and the amount of r th output of the k th DMU, respectively. Each DMU uses m different inputs and produces s different outputs. This means that the efficiency of the k th DMU can be determined using the following mathematical linear programming model: where $1/g_k$ is the relative efficiency measure of the k th DMU, u_r , v_i are the weights of the r th output and i th input, respectively, n



is the number of units being assessed, m is the number of input, r is the number of output, and ϵ is an arbitrarily small positive value. The efficiency measure of each DMU falls between the interval $(0, 1)$, with 1 representing the most efficient efficiency measure.

If we add the term v_0 to the CCR model shown in (1), it can be considered as the BCC model shown in (2), and v_0 can be used to determine the locations of returns to scale in the assessed units from an input/output perspective, ϵ is infinitesimal non-Archimedean quantity. In this model, $v_0 < 0$ indicates increasing returns to scale, $v_0 = 0$ indicates constant returns to scale, and $v_0 > 0$ indicates decreasing returns to scale.

$$\begin{aligned} \text{Min } \frac{1}{g_k} &= \sum_{i=1}^m v_i X_{ik} & (1) \\ \text{s. t. } & \sum_{r=1}^s u_r Y_{rk} = 1 \\ & \sum_{i=1}^m v_i X_{ij} - \sum_{r=1}^s u_r Y_{rj} \geq 0, j = 1, \dots, n \\ & u_r, v_i \geq \epsilon > 0, r=1, \dots, s, i=1, \dots, m \end{aligned}$$

$$\begin{aligned} \text{Min } \frac{1}{g_k} &= \sum_{i=1}^m v_i X_{ik} + v_0 & (2) \\ \text{s. t. } & \sum_{r=1}^s u_r Y_{rk} = 1 \\ & \sum_{i=1}^m v_i X_{ij} - \sum_{r=1}^s u_r Y_{rj} + v_0 \geq 0, j = 1, \dots, n \\ & u_r, v_i \geq \epsilon > 0, r=1, \dots, s, i=1, \dots, m \end{aligned}$$

The CCR model calculates an overall efficiency under the assumption of constant return to scale, and the BCC model calculates pure technical efficiency. If the efficiencies obtained by the CCR model are divided by the efficiency measures obtained by the BCC model, the scale efficiency of the firm being assessed can be derived.

The production activities of a company in the non-life insurance industry can be divided broadly into business activities and investment activities shown in

Figure 3-1. Business activities consist of earning income from premiums primarily through marketing and solicitation. To determine if marketing is successful, we generally apply a measurement index based on the growth of income from premiums and underwriting profits obtained from underwriting, claims processing, and reinsurance arrangements.

In this paper, we adopted a one-stage and two-stage DEA. In the two-stage DEA, the inputs are operational and management expenses as well as commission and underwriting expenses because they are the main costs in the marketing process in the non-life insurance industry. The outputs are the written premiums generated by insurance policies issued by the insurance company as well as the reinsurance premium income of reinsurance companies from the primary insurers who cede a portion of its business to the reinsurance companies. In the second stage, retained underwriting income and reinsurance commission earned are used as outputs, and written premium and reinsurance premium income are used as inputs. In the one-stage DEA, the operational and management expenses as well as the commission and underwriting expenses are used as inputs, and retained underwriting income and reinsurance as well as reinsurance commission earned are used as outputs. The definitions of inputs and outputs are summarized in Table 3-1.

The descriptive statistics of both inputs and outputs of non-life insurance companies in Taiwan over the 2008–2013 period used in this paper are presented in Table 3-2. The table indicates that relatively low levels of operational management, commission, and underwriting expenses were observed during the financial crisis. At the same time, written premium income also exhibited a declining trend. This finding highlights that companies managed their operational expenses relatively stringently and that underwriting income was not as high as it had been in the previous years during the financial crisis.



Aside from exhibiting a declining trend of retained underwriting income in 2009 and 2010, retained underwriting income generally showed an increasing trend, and reinsurance commission earned generally exhibited a decreasing trend.

We further examine the correlation among inputs and outputs, as shown in Table 3-3. The correlation analysis indicates that each input and output is positively correlated and that this result complies with the principles of isotonicity set out for conducting the DEA method. Therefore, the increases in a given input term should not result in decreases in the corresponding output term, and the variable should be removed when the positive correlation between an input and output term is not high. We can infer from Table 3-3 that the selection of inputs and outputs described above is appropriate.

3.2 Explaining the efficiency measures using a Tobit regression model

To explore the factors affecting the efficiency of insurance companies, we apply a Tobit regression model to conduct our analysis. As the efficiency measures calculated by the DEA model fall between (0, 1) and sometimes fall as a group at the upper bound, applying the ordinary least squares regression model is not suitable. Using the Tobit regression model is more appropriate to deal with the efficiency measures near the upper threshold of 1.

We use the following regression model to model the marketability efficiency and retention efficiency of cross-strait non-life insurance companies.

$$EFF_i = b_0 + b_1X_{i1} + b_2X_{i2} + \dots + b_7X_{i7} + \varepsilon_i \quad (3)$$

where $i = 1, \dots, 36$, and EFF_i are the marketability efficiency and the retention efficiency measures of 14 Taiwanese non-life insurance companies and 22 Mainland Chinese insurance companies, respectively. X_{i1}, \dots, X_{i7} are the independent variables, b_0 is the intercept, b_1, \dots, b_7 are the regression coefficients, and

ε_i is the random error term. We use the marketing and retention efficiency measures of insurance companies as the dependent variables. The selection of independent variables (X_{i1}, \dots, X_{i8}) is described below:

- (1) Time since establishment (X_{i1}): Here, we use a dummy variable of 0 to indicate that a company has been established for less than 10 years and 1 to indicate that the company has been established for more than 10 years. Mainland China's insurance industry consists of several long-established companies, and given the market's development in recent years, currently there are many newly established insurance companies as well. Companies with longer histories may have a distinct competitive advantage in terms of market reputation, brand image, and amount of capital. Therefore, time since establishment is selected as an independent variable to determine if it affects the efficiency of a company's operations.
- (2) Written premium (X_{i2}): This variable refers to the scale of business operations. A larger scale of business shows that a company conducts a higher volume of business, but it may not necessarily indicate higher profits.
- (3) Postgraduate rate (X_{i3}): This variable is the number of employees with at least a postgraduate qualification (college diploma) divided by the total number of employees, excluding those without a junior college level qualification. This variable measures the effect of educational level on efficiency. Educational level plays a critical role in company management. A higher level of education should have a positive effect on company management and development.
- (4) Specialized staff ratio (X_{i4}): Insurance is an intangible good, and staff specializing in underwriting, claim processing, and actuarial duties is an important asset for an insurance company. These duties include front-end risk



assessment, determining premium rates, and handling claims for risks insured. A better quality of specialized staff can lead to the better control and management of business.

- (5) Ratio of non-automobile insurance (X_{i5}): This variable refers to the proportion of non-automobile insurance premiums in the overall premium collected. For insurers in Mainland China and Taiwan, premium of non-automobile insurance collected makes up about 30% and 50% of the total premium collected, respectively. Moreover, as non-automobile insurance businesses, such as enterprise property and engineering insurance, show large variations in terms of premium collected, their dependence on reinsurance to transfer risks is relatively high. Therefore, we use this variable to assess the effects of automobile and non-automobile insurance marketability and retention on a company's reinsurance efficiency.
- (6) Financial holdings background (X_{i6}): This study uses the dummy variables of 0 and 1 to distinguish holding companies that possess a relatively greater pool of internal resources from others. If these resources are properly utilized, they are expected to have a positive effect on a company's operations. We define X_{i6} as 1 if this insurance company belongs to a holding company and 0 otherwise.
- (7) Ratio of retained premiums (X_{i7}): This variable is the value of retained premiums divided by the sum of written premiums and reinsurance premium income. Here retained premiums are written premiums plus reinsurance premium income minus reinsurance premium expenditure.
- (8) Nationality (X_{i8}): This variable equals 1 for Taiwan insurance companies, and 0 otherwise. Summary statistics (mean, standard deviation, median, minimum, and maximum) for independent variables used in the Tobit regression

are shown in Table 4-4.

4. Results

4.1. Efficiency results of cross-strait non-life insurance companies

We assess the efficiency of 36 insurance companies: 14 from Taiwan and 22 from Mainland China, for the 2008–2013 period. These insurance companies were viewed as a whole for conducting an analysis of efficiency. The results are shown in Table 4-1. Value of 1 in red color shown in Tables 4-1~4-3 represents a company is located at the efficiency frontier, and value highlighted in yellow represents the mean of efficiency in the same year. The analysis reveals that China Export and Credit Insurance Corporation (0.968) has an efficiency measure far higher than that of other firms in the industry and tops the second ranking South China Insurance (0.655) by a large margin. Tainan Insurance Company, with an efficiency measure of 0.608, ranks third. Moreover, Taiwanese insurance companies tend to have higher efficiency than Mainland Chinese insurance companies. In terms of individual years, excluding China Export and Credit Insurance Corporation, TLG insurance company is a relatively efficient company in 2011, and Mingtai Insurance is comparatively more efficient in 2012.

Table 4-2 presents the efficiency measures in the marketability stage in the two-stage DEA. China Export and Credit Insurance Corporation operating in Mainland China are the most efficient companies in the marketability stage, followed by Mingtai Insurance operating in Taiwan. Overall, non-life insurance companies operating in Taiwan have a higher marketing efficiency than those in Mainland China. Moreover, the dispersion in efficiency measures of non-life insurance companies operating in Taiwan is not as severe as that of non-life insurance companies operating in Mainland China.

Furthermore, non-life insurance companies operating in Taiwan are clearly affected by the 2008



financial crisis and begin to recover in 2012. Mainland China's market is vast by comparison and is still at a stage of rapid growth. This condition perhaps contributes to the marketing efficiency measures continuing to grow in Mainland China despite the shock of the financial crisis.

The efficiency measures in the retention stage in two-stage DEA method are given in Table 4-3. China Export and Credit Insurance Corporation is the best performer, followed by TLG insurance operating in Taiwan. Non-life insurance companies operating in Mainland China have a higher efficiency measure than those in Taiwan. Assessing the retention efficiency should be done until the end of the year. Therefore, waiting for at least one year before conducting an assessment is normal. As the financial crisis began in September 2008 and lasted more than a year, assuming that its effects appeared in 2010 is reasonable. Therefore, the mean of retention measures of cross-trait non-life insurance companies in 2010 is lower than that in previous years.

In addition, we used t-test to examine if there are significant differences in the efficiency results from six scenarios: (1) the efficiency results of one stage between Taiwan and Mainland China; (2) the efficiency results of marketability stage between Taiwan and Mainland China; (3) the efficiency results in the retention stage between Taiwan and Mainland China; (4) the efficiency results between one stage and marketability stage; (5) the efficiency results between one stage and retention stage; (6) the efficiency results between marketability and retention stages. The results of the first three scenarios would help us to analyze if there are significant differences of efficiency between Taiwan and Mainland China. The results of the last three scenarios would help us to analyze if there are significant differences of efficiency among one-stage, marketability, and retention stages. Results of these six scenarios are shown in Table 4-5. From the results shown in Table

4-5, there is a significant difference in the marketability stage between Taiwan and Mainland insurance companies.

4.2 Factors affecting the efficiency of non-life insurance companies in Taiwan

In this section, we examine the effect of different independent variables on efficiency measures in the marketability and retention stages by adopting marketing efficiency and retention efficiency measures in 2008–2013 as the dependent variables in the Tobit regression model.

The estimated parameters of the Tobit regression model when the dependent variable is marketability efficiency are given in Table 4-6. Written premiums have a significant and positive effect on the marketability efficiency of an insurance company operating in Taiwan at the significance level of 0.1. This finding implies that the underwriting business of an insurance company reaches a high level when the written premium also reaches a high level. The underwriting business also has a positive effect on brand recognition and thus has a positive and significant effect on business expansion.

Retained premiums are insurers' own committed liability; generally, the higher the premium commitment is, the more carefully the related costs need to be controlled. The ratio of retained premiums has a significant and negative effect on the marketability efficiency of an insurance company operating in Taiwan at the significance level of 0.1. Therefore, this result implies that there is considerable room for improvement in balancing the related cost and premium collection of Taiwanese insurance companies.

The estimated parameters of the Tobit regression model when the dependent variable is retention efficiency are given in Table 4-7. The specialized staff ratio and the ratio of retained premium have a significant and positive effect on retention efficiency. As the ratio of specialized staff increases, the better the



business quality control, thus increasing retention efficiency. We also find that the higher ratio of non-automobile insurance is, the higher the company's retention efficiency rates. Furthermore, the higher the ratio of retained premium is, the higher the company's retained premiums. At this time, if an insurance company also has a better quality of underwriting staff, retained underwriting incomes will increase. As shown in Table 4-5, written premiums have a significant and negative effect on retention efficiency. The written premium is the scale of the business. The greater a firm's business scale is, the greater its underwriting business and the lower its retention efficiency.

4.3 Factors affecting efficiency of non-life insurance companies in Mainland China

The estimated parameters of the Tobit regression model when the dependent variable is the marketability efficiency of Mainland Chinese insurers are given in Table 4-6. The marketability efficiency of Mainland Chinese insurers depends on time since establishment, written premium, ratio of non-automobile insurance, and financial holding background. The longer the companies have been established, the greater the advantages of their market niche and position. In addition, a high ratio of non-automobile insurances corresponds to enhanced marketability efficiency. In other words, a high ratio of automobile insurance corresponds to poor marketability efficiency. Therefore, increasing the proportion of non-automobile insurance business in an insurance company has a significant and positive effect on business expansion. We expect that companies with financial holdings have a great pool of resources and can make interactive use of overlapping marketing and data, sell their products through different channels, provide customers with differentiated services, and thus improve marketability efficiency. However, as shown in Table 4-6, the effect of financial holding background is not significant.

The estimated parameters of the Tobit regression

model when the dependent variable is the retention efficiency of Mainland Chinese insurers are given in Table 4-7. The factors significantly affecting retention efficiency are written premium, postgraduate ratio, and ratio of non-automobile insurance. A high proportion of postgraduates indicates that the education of a company's staff is above a particular level. The key difference between Taiwan and Mainland China insurers is that the ratio of non-automobile insurance affects retention efficiency negatively in China but positively in Taiwan.

4.4 Factors affecting efficiency of cross-strait non-life insurance companies

The estimated parameters of the Tobit regression model when the dependent variable is the marketability efficiency of cross-strait non-life insurers are given in Table 4-6. Time since establishment and ratio of non-automobile insurance have a significant and positive impact on marketability efficiency.

The estimated parameters of the Tobit regression model when the dependent variable is the retention efficiency of cross-strait non-life insurers are given in Table 4-7. The results of the Tobit regression model indicate that written premiums and the ratio of retained premiums significantly affect retention efficiency. We also find that regardless of whether Taiwanese and Mainland Chinese insurers are individually assessed or an overall cross-strait assessment is conducted, written premiums, and ratio of retained premiums are important determinants of the retention efficiency of both.

From the results of Tobit regression, we find that (1) ratio of non-automobile insurance significantly affects the marketability efficiency of Mainland China, and cross-strait non-life insurance companies; (2) written premium significantly affects retention efficiency of Taiwan and Mainland China non-life insurance companies when they are individually assessed; (3) nationality significantly affects retention



efficiency of cross-strait non-life insurance companies.

T-test is applied to examine if there are significant differences of dependent variables used in Tobit regression between Taiwan and Mainland China. From the results of t-test shown in Table 4-8, there are significant differences in written premium, postgraduate rate, specialized staff ratio, and ratio of retained premium between Taiwan and Mainland China non-life insurance companies.

4.5 Discussions

Based on the results of cross-strait non-life insurance companies in the two-stage DEA. We classify cross-strait non-life insurance companies into 4 categories shown in Figure 4-1 according to the mean of efficiency in the marketing and retention stages of cross-strait non-life insurance companies.

Category 1

These companies have high marketability and retention efficiency. These types of companies, the efficiency measure for both marketing and retention stage of which are higher than those of others in the industry, can adjust their operating strategies and policies according to market changes and business development conditions at any time to maintain their lead in the industry. This is especially true for China Export and Credit Insurance Corporation, the efficiency measure of which for both stages is higher than those of others in the industry. These companies set a valuable example for other insurance companies to learn from.

Category 2

These companies experience a high level of retention efficiency but low marketability efficiency. This combination represents companies that do not excel at business promotion, but the quality of their underwriting business is superior to others in the industry. These companies should strengthen their promotional channels, thereby increasing their premium income, or focus on reducing their operating costs and control-related expenditures.

Category 3

These companies have high marketability

efficiency but low retention efficiency. The operations of these companies have expanded rapidly but failed to be prudent with the underwriting business, thus leading to poor retention efficiency. These companies need to increase their retained underwriting income either by increasing the premium income or by being more prudent in underwriting operations.

Category 4

These companies show inferior performance both in the marketability efficiency and retention efficiency. These companies should place more emphasis on activities of increasing the retention efficiency and market attractiveness.

For Taiwan non-life insurance companies, it will be helpful to increase marketability efficiency from increasing written premium, and increase retention efficiency from increasing specialized staff ratio, ratio of retained premium and decreasing written premium. For Mainland China non-life insurance companies, it will be helpful to increase marketability efficiency from increasing ratio of non-automobile insurance, and increase retention efficiency from increasing written premium, postgraduate rate, and decreasing ratio of non-automobile insurance.

5. Conclusion

In this paper, we employed DEA to analyze the overall efficiency measure of cross-strait non-life insurance companies. By adopting DEA, we found that the overall efficiency measure of non-life insurance companies in Taiwan was higher than that in China. These results are consistent with those found by using the two-stage DEA (marketability stage and retention stage). In addition, when we decomposed the productivity process into marketability and retention stages, we found that (1) the efficiency measure in the retention stage of non-insurance companies was higher than that in the marketability stage both in China and Taiwan and that (2) the efficiency measure in the retention stage of non-life insurance companies in China was higher than that of non-life insurance companies in Taiwan.



The operating efficiency of cross-strait non-life insurance companies after 2009 was influenced by the financial crisis of 2008. From the perspective of overall efficiency, the retained underwriting income earned by non-life insurance companies in Taiwan dropped during the financial crisis, and non-life insurance companies in Taiwan managed their operating costs more carefully. In addition, the efficiency measure in 2010 was generally lower than that in the earlier and later periods because the retention efficiency was calculated after the business year ended. Non-life insurance companies in Mainland China were also shocked by the financial crisis of 2008, and the decrease in their overall efficiency measure was 0.033. However, non-life insurance companies in China recovered from the financial crisis of 2008 faster than those in Taiwan because the overall efficiency of non-life insurance companies in China returned to the original level in 2010. In addition, the two-stage DEA revealed that the efficiency measure in the marketability stage of non-life insurance companies in China increased steadily. Therefore, the financial crisis of 2008 had a stronger influence on the non-life insurance companies in Taiwan than on those in China because the Chinese insurance market was still in a growth stage compared with the Taiwanese insurance market.

This study provides a valuable comparison and assessment for cross-strait non-life insurance companies and thus can be a good reference for cross-strait non-life insurance companies when they consider improving the marketing and retention efficiency. For example, as non-life insurance companies in Taiwan underwrote high lines of the automobile insurance business, efficiency in the marketability stage was better than that in the retention stage when the loss ratio of automobile insurance was higher. Non-life insurance companies in China underwrote higher lines of the non-automobile insurance business; thus, their efficiency in the

marketability stage was better than that in the retention stage. Increasing the ratio of the non-automobile insurance business positively affected the marketability and negatively affected the efficiency in the retention stage.



Table 3-1 Definition of inputs and outputs

		Variables	Description
Stage One	Inputs	Operational and management expenses	Operational expenses and other operating costs
		Commission and underwriting expenses	Commission expenses: expenditure incurred on solicitation of business Underwriting expenses: expenditure incurred during underwriting operations
	Outputs	Written premium income	Total fees collected by the company's underwriting business
		Reinsurance premium income	Premium earned by an insurance company, when, in order to transfer risk, the primary insurer cedes part or all of the risks to other insurance companies
		Reinsurance commission earned	Commission earned by the insurance company by ceding part or all of risks to a reinsurance company

Table 3-1 Continued

		Variables	Description
Stage Two	Inputs	Written premium income	Same as above
		Reinsurance premium income	Same as above
	Outputs	Retained underwriting income	$\text{Retained premiums} - \text{retained indemnities} = (\text{written premiums} + \text{reinsurance premium income} - \text{reinsurance premium expenditure}) - (\text{written claims} + \text{reinsurance claims} - \text{the proportion of entire claim collected from the reinsurance company})$
		Reinsurance commission earned	Commission earned by the insurance company by ceding part or all of risks to a reinsurance company



Table 3-2 Statistics of inputs and outputs of non-life insurance companies in Taiwan over the 2008-2013 period

Year	Operational and management expenses	Commission and underwriting expenses	Written premium income	Reinsurance premium income	Retained underwriting income	Reinsurance commission earned
2008	22,018,473	14,233,033	104,360,949	8,047,472	35,637,227	7,299,661
2009	21,992,117	12,470,532	100,649,307	7,371,304	33,930,775	6,535,573
2010	22,213,231	12,855,963	103,504,473	6,020,248	32,281,002	5,679,468
2011	22,872,222	13,631,315	110,517,810	5,546,598	35,492,571	6,274,489
2012	23,774,420	14,433,012	117,822,071	6,213,923	38,080,795	6,066,315
2013	25,538,904	15,026,648	122,273,014	6,192,127	42,702,609	5,844,336

Note: values are expressed as NT thousands

Table 3-3 Correlation analysis between inputs and outputs

	Operational and management expenses	Commission and underwriting expenses	Written premium income	Reinsurance premium income	Retained underwriting income	Reinsurance commission income
Operational and management expenses	1					
Commission and underwriting expenses	0.9998	1				
Written premium income	0.9995	0.9997	1			
Reinsurance premium income	0.9998	0.9998	0.9998	1		
Retained underwriting income	0.9999	0.9998	0.9998	0.9999	1	
Reinsurance commission income	0.9995	0.9995	0.9989	0.9994	0.9995	1



Table 4-1 Efficiency measures of cross-strait non-life insurance companies using the one-stage DEA method

Non-life insurance companies in Taiwan								
DMU	Company	2008	2009	2010	2011	2012	2013	Average
1	Taiwan Fire and Marine	0.532	0.354	0.328	0.335	0.351	0.313	0.369
2	Chung Kuo	0.704	0.618	0.568	0.508	0.534	0.499	0.572
3	Fubon	0.343	0.324	0.248	0.25	0.228	0.235	0.271
4	Zurich	0.18	0.171	0.151	0.152	0.149	0.136	0.157
5	Taian	0.596	0.624	0.576	0.641	0.645	0.563	0.608
6	Mingtai	0.827	0.59	0.341	0.301	1	0.353	0.569
7	Central	0.242	0.316	0.381	0.435	0.347	0.284	0.334
8	The First	0.401	0.349	0.27	0.343	0.272	0.278	0.319
9	Union	0.515	0.497	0.52	0.729	0.708	0.662	0.605
10	ShingKong	0.511	0.405	0.364	0.42	0.378	0.298	0.396
11	South China	0.747	0.742	0.62	0.632	0.567	0.619	0.655
12	Cathay Century	0.187	0.171	0.161	0.163	0.169	0.169	0.170
13	Dragon Newa	0.259	0.255	0.25	0.257	0.242	0.262	0.254
14	TLG	0.142	0.196	0.533	1	0.7	0.974	0.591
	Mean of Efficiency	0.441	0.400	0.379	0.400	0.449	0.403	0.419
	Number of Efficient DMU	0	0	0	1	1	0	



Table 4-1 Continued

Non-life insurance companies in Mainland China								
DMU	Company	2008	2009	2010	2011	2012	2013	Average
15	PICC	0.292	0.378	0.292	0.435	0.284	0.251	0.322
16	China Life	0.298	0.223	0.298	0.248	0.232	0.24	0.257
17	China Continent	0.249	0.354	0.249	0.207	0.185	0.183	0.238
18	China Taiping	0.178	0.185	0.178	0.166	0.288	0.238	0.206
19	China Export & Credit	1	1	1	1	0.923	0.884	0.968
20	Sunshine	0.252	0.175	0.252	0.065	0.152	0.164	0.177
21	China Pacific	0.369	0.363	0.369	0.342	0.286	0.329	0.343
22	Ping An	0.303	0.265	0.303	0.28	0.24	0.28	0.279
23	Huatai	0.311	0.23	0.311	0.691	0.326	0.352	0.393
24	Tianan	0.292	0.135	0.292	0.544	0.313	0.155	0.395
25	Yong An	0.158	0.13	0.158	0.174	0.157	0.14	0.387
26	Alltrust	0.32	0.422	0.32	0.514	0.369	0.274	0.392
27	AAIC	0.538	0.219	0.538	0.135	0.118	0.19	0.402
28	Anhua	0.219	0.161	0.219	0.259	0.166	0.198	0.393
29	Tianping	0.438	0.33	0.438	0.277	0.281	0.184	0.385
30	Sunlight	0.289	0.161	0.289	0.525	0.408	0.071	0.387
31	Bohai	0.111	0.125	0.111	0.131	0.108	0.133	0.391
32	Dubon	0.139	0.156	0.139	0.135	0.117	0.145	0.381
33	China Huanong	0.084	0.13	0.084	0.14	0.149	0.183	0.38
34	Ming An	0.163	0.14	0.163	0.29	0.211	0.152	0.368
35	Ancheng	0.202	0.218	0.202	0.16	0.207	0.153	0.377
36	Bank of China	0.217	0.179	0.217	0.223	0.235	0.317	0.382
Mean of Efficiency		0.292	0.258	0.292	0.316	0.262	0.237	0.373
Number of Efficient DMU		1	1	1	1	0	0	



Table 4-2 Efficiency measures in the marketability stage of cross-strait non-life insurance companies in the two-stage DEA method

Non-life insurance companies in Taiwan								
DMU	Company	2008	2009	2010	2011	2012	2013	Average
1	Taiwan Fire and Marine	0.493	0.364	0.414	0.469	0.475	0.465	0.447
2	Chung Kuo	0.57	0.531	0.512	0.488	0.504	0.493	0.516
3	Fubon	0.435	0.428	0.396	0.408	0.412	0.422	0.417
4	Zurich	0.242	0.265	0.241	0.245	0.249	0.214	0.243
5	Taian	0.432	0.563	0.495	0.519	0.538	0.483	0.505
6	Mingtai	0.467	0.388	0.39	0.406	1	0.891	0.59
7	Central	0.256	0.222	0.276	0.307	0.149	0.14	0.225
8	The First	0.487	0.454	0.44	0.464	0.456	0.448	0.458
9	Union	0.433	0.421	0.395	0.379	0.439	0.428	0.416
10	ShingKong	0.496	0.439	0.438	0.457	0.477	0.458	0.461
11	South China	0.484	0.491	0.491	0.49	0.508	0.474	0.49
12	Cathay Century	0.354	0.329	0.339	0.338	0.342	0.33	0.339
13	Dragon Newa	0.432	0.429	0.437	0.453	0.437	0.424	0.435
14	TLG	0.236	0.296	0.309	0.341	0.306	0.357	0.308
	Mean of Efficiency	0.416	0.401	0.398	0.412	0.449	0.431	0.417
	Number of Efficient DMU	0	0	0	0	1	0	



Table 4-2 Continued

Non-life insurance companies in Mainland China								
DMU	Company	2008	2009	2010	2011	2012	2013	Average
15	PICC	0.291	0.432	0.418	0.468	0.36	0.337	0.384
16	China Life	0.157	0.301	0.32	0.314	0.313	0.352	0.293
17	China Continent	0.244	0.573	0.339	0.319	0.295	0.314	0.347
18	China Taiping	0.193	0.242	0.235	0.248	0.282	0.262	0.244
19	China Export & Credit	0.37	1	0.943	1	1	0.807	0.853
20	Sunshine	0.154	0.249	0.299	0.282	0.254	0.266	0.251
21	China Pacific	0.2	0.313	0.349	0.396	0.334	0.35	0.324
22	Ping An	0.164	0.343	0.364	0.376	0.301	0.344	0.315
23	Huatai	0.178	0.242	0.261	0.724	0.266	0.311	0.33
24	Tianan	0.231	0.271	0.275	0.346	0.257	0.27	0.275
25	Yong An	0.284	0.287	0.286	0.273	0.251	0.251	0.272
26	Alltrust	0.158	0.282	0.31	0.451	0.261	0.258	0.287
27	AAIC	0.741	0.283	0.97	0.264	0.256	0.303	0.47
28	Anhua	0.235	0.41	0.35	0.396	0.291	0.278	0.327
29	Tianping	0.155	0.383	0.421	0.373	0.286	0.264	0.314
30	Sunlight	0.718	0.474	0.626	0.584	0.57	0.554	0.588
31	Bohai	0.254	0.173	0.201	0.22	0.201	0.214	0.211
32	Dubon	0.26	0.231	0.234	0.234	0.215	0.218	0.232
33	China Huanong	0.143	0.144	0.141	0.182	0.193	0.224	0.171
34	Ming An	0.12	0.192	0.197	0.256	0.221	0.231	0.203
35	Ancheng	0.127	0.263	0.272	0.267	0.312	0.223	0.244
36	Bank of China	0.199	0.261	0.282	0.32	0.259	0.363	0.281
Mean of Efficiency		0.253	0.334	0.368	0.377	0.317	0.318	0.328
Number of Efficient DMU		0	1	0	1	1	0	



Table 4-3 Efficiency measures in the retention stage of cross-strait non-life insurance companies in the two-stage DEA method

Non-life insurance companies in Taiwan								
DMU	Company	2008	2009	2010	2011	2012	2013	Average
1	Taiwan Fire and Marine	0.374	0.337	0.273	0.242	0.251	0.248	0.288
2	Chung Kuo	0.475	0.427	0.403	0.377	0.385	0.359	0.404
3	Fubon	0.273	0.265	0.262	0.25	0.243	0.263	0.259
4	Zurich	0.38	0.304	0.313	0.302	0.307	0.328	0.322
5	Taian	0.458	0.374	0.39	0.41	0.4	0.392	0.404
6	Mingtai	0.602	0.522	0.292	0.247	0.148	0.129	0.323
7	Central	0.353	0.509	0.501	0.522	0.934	0.855	0.612
8	The First	0.283	0.263	0.214	0.245	0.211	0.219	0.239
9	Union	0.44	0.42	0.447	0.661	0.547	0.518	0.506
10	ShingKong	0.35	0.308	0.275	0.303	0.262	0.242	0.29
11	South China	0.523	0.511	0.426	0.429	0.372	0.432	0.449
12	Cathay Century	0.264	0.262	0.205	0.237	0.242	0.249	0.243
13	Dragon Newa	0.29	0.285	0.271	0.268	0.261	0.293	0.278
14	TLG	0.286	0.383	0.6	1	0.767	0.928	0.661
Mean of Efficiency of non-life insurance companies in Taiwan		0.382	0.369	0.348	0.392	0.381	0.39	0.377



Table 4-3 Continued

Non-life insurance companies in Mainland China								
DMU	Company	2008	2009	2010	2011	2013	2013	Average
15	PICC	0.474	0.29	0.33	0.377	0.278	0.254	0.334
16	China Life	0.666	0.293	0.328	0.39	0.378	0.354	0.402
17	China Continent	0.482	0.29	0.347	0.293	0.251	0.275	0.323
18	China Taiping	0.405	0.298	0.332	0.321	0.348	0.335	0.34
19	China Export & Credit	1	0.707	1	0.599	0.36	0.36	0.671
20	Sunshine	0.781	0.346	0.411	0.079	0.287	0.301	0.368
21	China Pacific	0.62	0.4	0.356	0.344	0.284	0.321	0.388
22	Ping An	0.87	0.364	0.393	0.353	0.275	0.297	0.425
23	Huatai	0.585	0.332	0.398	0.39	0.404	0.388	0.416
24	Taanan	0.823	0.244	0.823	0.616	0.412	0.273	0.532
25	Yong An	0.291	0.234	0.263	0.313	0.3	0.266	0.278
26	Alltrust	0.681	0.496	0.347	0.583	0.495	0.36	0.494
27	AAIC	0.347	0.367	0.265	0.257	0.253	0.343	0.305
28	Anhua	0.515	0.189	0.348	0.275	0.313	0.272	0.319
29	Tianping	1	0.466	0.425	0.366	0.44	0.545	0.54
30	Sunlight	0.222	0.187	0.254	0.45	0.395	0.052	0.26
31	Bohai	0.206	0.238	0.228	0.302	0.293	0.297	0.261
32	Dubon	0.469	0.36	0.326	0.281	0.299	0.342	0.346
33	China Huanong	0.196	0.307	0.204	0.379	0.399	0.389	0.312
34	Ming An	0.524	0.348	0.319	0.446	0.312	0.316	0.378
35	Ancheng	0.764	0.392	0.356	0.289	0.321	0.331	0.409
36	Bank of China	0.455	0.272	0.321	0.322	0.314	0.412	0.349
Mean of Efficiency		0.563	0.337	0.381	0.365	0.337	0.322	0.384
Mean of Efficiency (cross-strait non-life insurance companies)		0.492	0.35	0.368	0.376	0.354	0.348	0.381



Table 4-4 Summary statistics of independent variables used in the Tobit regression

(a) Summary statistics of independent variables used in Tobit regression (Taiwan)

independent variables	Mean	St. dev	Min	Max	Median
Time since establishment(X_1)	0.773	0.429	0.000	1.000	1.000
Written premium (X_2)	18493.21	37992.49	267.42	166527.3	4778.39
Postgraduate rate (X_3)	0.428	0.166	0.224	0.851	0.365
Specialized staff ratio (X_4)	0.141	0.124	0.027	0.581	0.100
Ratio of non-automobile insurance (X_5)	0.307	0.264	0.015	1.000	0.196
Financial holding background (X_6)	0.364	0.492	0.000	1.000	0.000
Ratio of retained premium (X_7)	0.596	0.288	0.156	0.188	0.123

(b) Summary statistics of independent variables used in Tobit regression (Mainland China)

	Mean	St. dev	Min	Max	Median
Time since establishment(X_1)	0.773	0.429	0.000	1.000	1.000
Written premium (X_2)	18493.213	37992.486	267.422	166527.300	4778.391
Postgraduate rate (X_3)	0.428	0.166	0.224	0.851	0.365
Specialized staff ratio (X_4)	0.141	0.124	0.027	0.581	0.100
Ratio of non-automobile insurance (X_5)	0.307	0.264	0.015	1.000	0.196
Financial holding background (X_6)	0.364	0.492	0.000	1.000	0.000
Ratio of retained premium (X_7)	0.872	0.059	0.739	0.969	0.882

Table 4-5 T-test of efficiency results

Comparison	Efficiency mean	Std Dev	df	t-statistics(p-value)
one stage:	Taiwan: 0.4192	0.175		
Taiwan & Mainland China	Mainland China: 0.3728	0.149	24.48	0.8182(0.4211)
marketability:	Taiwan: 0.4178	0.104		
Taiwan & Mainland China	Mainland China: 0.328	0.1482	33.53	2.1278**(0.0479)
retention stage:	Taiwan: 0.377	0.1362		
Taiwan & Mainland China	Mainland China: 0.3740	0.1006	21.96	-0.1677(0.8683)
One stage and marketability stage	one stage: 0.3909	0.1592	68.7	0.7946(0.4296)
one stage and retention stage	marketability stage: 0.3629	0.1387	63.39	0.2935(0.77)
marketability and retention stage	retention stage: 0.38133	0.1139	67.46	-0.6145(0.5409)



Table 4-6 Factors affecting the marketability efficiency of non-life insurance companies in Taiwan, Mainland China, and cross-straits, respectively by Tobit regression. Time since establishment is the age of an insurance company. Written premium is the total amount of written premium of an insurance company at the end of the year. Postgraduate rate is the number of employees with at least a postgraduate qualification (college diploma) divided by the total number of employees, excluding those without a junior college level qualification. Specialized staff ratio is the number of staff specializing in underwriting, claim processing, and actuarial duties divided by the number of total staff. Ratio of non-automobile insurance is the proportion of non-automobile insurance premiums in the overall premium collected. Financial holdings background is to distinguish if an insurance company is affiliated to a financial holding company or not. Ratio of retained premiums is ratio of retained premiums divided by the sum of written premiums and reinsurance premium received. In Table 4-6, 1, *and ** indicate p-value, the significance level at 10% and 1%, respectively.



Factors affecting the marketability efficiency of non-life insurance companies in Taiwan	
Variables	Parameters
$R^2=0.6164$	
Intercept	0.0447(0.9279) ¹
Time since establishment (X_1)	-0.1586(0.4949)
Written premium (X_2)	1.71E-07**(0.0764)
Postgraduate rate (X_3)	2.5805(0.2106)
Specialized staff ratio (X_4)	-1.3315(0.1136)
Ratio of non-automobile insurance (X_5)	0.67848(0.4346)
Financial holding background (X_6)	-0.0306(0.8411)
Ratio of retained premium (X_7)	-1.5350352
Factors affecting the marketability efficiency of non-life insurance companies in Mainland China	
Variables	Parameters
$R^2=0.7591$	
Intercept	0.1270*(0.0972) ¹
Time since establishment (X_1)	0.0294(0.5603)
Written premium (X_2)	8.75E-07(0.9336)
postgraduate rate (X_3)	0.0871(0.6168)
Specialized staff ratio (X_4)	-0.1199(0.6268)
Ratio of non-automobile insurance (X_5)	0.4722**(0.0028)
Financial holding background (X_6)	0.0220(0.6990)
Ratio of retained premium (X_7)	-1.3E-07(0.9886)
Factors affecting the marketability efficiency of cross-strait non-life insurance companies	
Variables	Parameters
$R^2=0.635$	
Time since establishment(X_1)	0.06202 (0.160) ¹
Written premium (X_2)	5.578E-09 (0.326)
postgraduate rate (X_3)	0.1056 (0.389)
Specialized staff ratio (X_4)	-0.002928(0.986)
Ratio of non-automobile insurance (X_5)	0.4006*** (3.41E-07)
Financial holding background (X_6)	0.008541 (0.809)
Ratio of retained premium (X_7)	-0.0234(0.946)
Nationality(X_8)	-0.1704(0.642)



Table 4-7 Factors affecting the retention efficiency of non-life insurance companies in Mainland China, and cross-straits, respectively by Tobit regression. The definition of each variable shown in Table 4-7 is the same as that shown in Table 4-6.

Factors affecting the retention efficiency of non-life insurance companies in Taiwan	
Variables	Parameters
$R^2=0.8317$	
Intercept	0.1649(0.6949) ¹
Time since establishment (X ₁)	0.2837(0.2378)
Written premium (X ₂)	-3.2E-07**(0.0065)
Postgraduate rate (X ₃)	-2.4936(0.2209)
Specialized staff ratio (X ₄)	1.9490*(0.0341)
Ratio of non-automobile insurance (X ₅)	1.8858(0.0572)
Financial holding background (X ₆)	0.0309(0.8378)
Ratio of retained premium (X ₇)	35.7158**(0.0067)
Factors affecting the retention efficiency of non-life insurance companies in Mainland China	
Variables	Parameters
$R^2=0.8955$	
Intercept	0.2278(1.12E-06) ¹
Time since establishment (X ₁)	-0.0182(0.3619)
Written premium (X ₂)	1.13E-05*(0.0143)
postgraduate rate(X ₃)	0.5099**(2.3E-06)
Specialized staff ratio (X ₄)	-0.0909(0.35233)
Ratio of non-automobile insurance (X ₅)	-0.2623**(0.0001)
Financial holding background (X ₆)	0.0104(0.6422)
Ratio of retained premium (X ₇)	-1.1677E-07
Factors affecting the retention efficiency of cross-strait non-life insurance companies	
Variables	Parameters
$R^2=0.471$	
Time of establishment (X ₁)	-0.09597*(0.02803)
Written premium (X ₂)	-4.773E-10(0.9323)
postgraduate rate (X ₃)	0.2399*(0.04782)
Specialized staff ratio (X ₄)	-0.04967(0.7638)
Ratio of non-automobile insurance (X ₅)	0.0768(0.3232)
Financial holding background (X ₆)	-0.0153(0.6624)
Ratio of retained premium (X ₇)	-0.9956**(0.0060)
Nationality(X ₈)	-0.6954*(0.0402)



Table 4-8 T-test of independent variables used in Tobit regression

Comparison	df	t-statistics(p-value)
X1 between Taiwan and Mainland China	33.998	1.343(0.1882)
X2 between Taiwan and Mainland China	13.001	4.9026*** (0.0002)
X3 between Taiwan and Mainland China	23.932	-9.2394*** (2.311e-09)
X4 between Taiwan and Mainland China	33.723	1.6941*(0.0994)
X5 between Taiwan and Mainland China	31.217	-1.6452(0.11)
X6 between Taiwan and Mainland China	30.751	-0.9646(0.3422)
X7 between Taiwan and Mainland China	27.474	-39.089*** (<2.2e-16)

Figure 3-1 Production activities of an insurance company

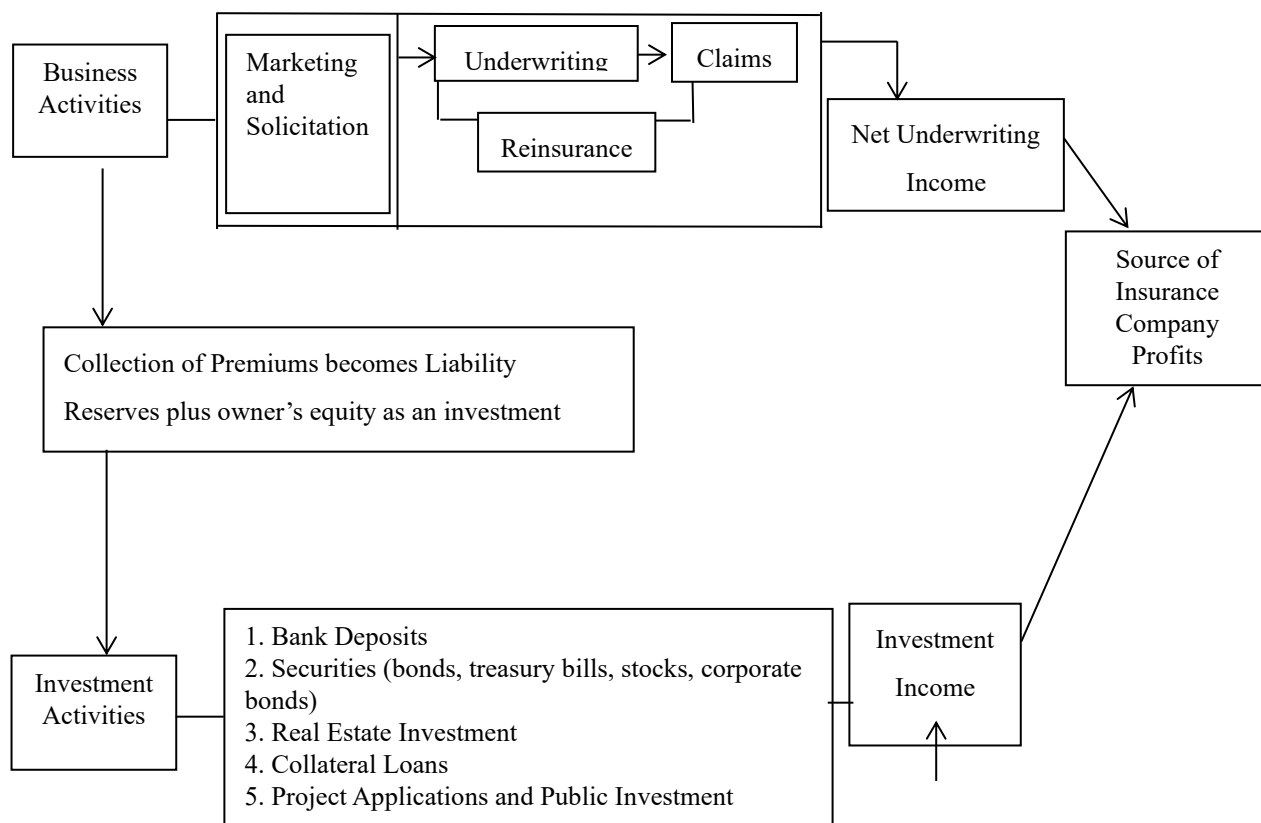
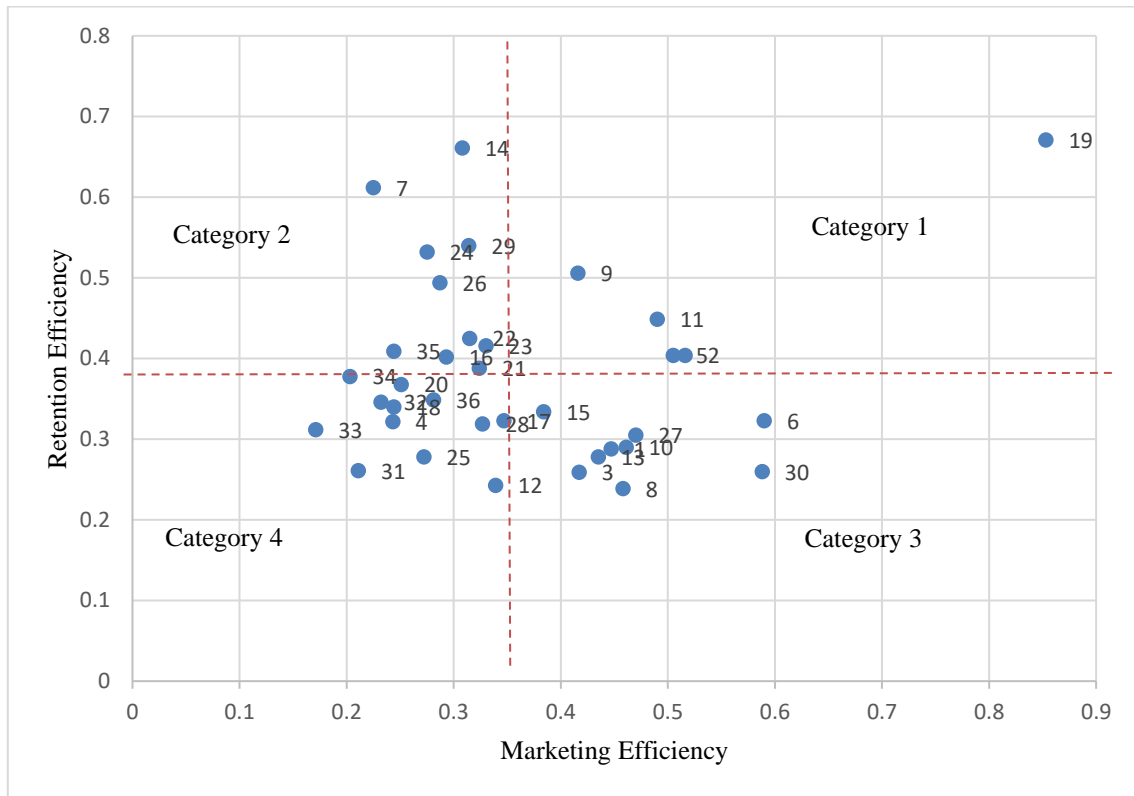


Figure 4-1 Four categories based on retention and marketing efficiencies



References

1. A. Charnes, W.W. Cooper, E. Rhodes, Measuring the Efficiency of Decision Making Units (1978), *European Journal of Operational Research*, vol. 2(6), pp. 429-444.
2. D. Cummins, X. Xie, Mergers and acquisitions in the US property-liability insurance industry: Productivity and efficiency effects (2008), *Journal of Banking and Finance*, vol. 32(1), pp. 30-55.
3. M-H Chang (2008), master's thesis, An Empirical Study of the Demand for Reinsurance: The Case of Taiwan Property-Liability Insurance Firms, Altheia University.
4. C-F Chen (2014), master's thesis, A Study of Impact Factors on Retention from OECD Countries, Shih Chien University.
5. O. Donni and F. Fecher (1997), Efficiency and Productivity of the Insurance Industry in the OECD Countries, *The Geneva Papers on Risk and Insurance*, vol. 22 (84), pp. 523-535.
6. M. Eling and W. Huang (2013), An efficiency comparison of the non-life insurance industry in the BRIC countries, *European journal of operational research*, vol. 226, pp. 577-591.
7. F. Fecher, D. Kessler, S. Perelman and P. Pestieau (1993), Productive Performance of the French Insurance Industry, *The Journal of Productivity Analysis*, vol. 4(1), pp. 77-93.
8. T-H Her (2006), master's thesis, A Study of Financial Performance of Non-Life Insurance Companies in Taiwan -The Comparison of Dupont Equation and DEA Approach, Tamkang University.
9. S-N Hwang and T-L Kao (2005), Measuring Managerial Efficiency of Non-Life Insurance Company in Taiwan: An Application of Two-Stage DEA Approach, *Insurance Monograph*, vol. 21(1), pp.1-23.
10. C-Y Lee (2012), Ph. D. dissertation, A Study of Business Performance Analysis and Enhancement in Taiwan's Property-Liability Insurance Industry- From Financial and Non-Financial Perspective, Tamkang University.
11. W-H Lin (2002), master's thesis, Correlation Analysis of Retained Ratio and Retained Loss for Property Insurance, National Chengchi University.
12. D. Mayers and C. Smith (1990), On the Corporate Demand for Insurance: Evidence from the Reinsurance Market, *The journal of business*, vol. 63(1), pp. 19-40.
13. A. G. Noulas, T. Hatzigayios (2001), J. Lazaridis and K. Lyroudi, "Non-Parametric Production Frontier Approach to the Study of Efficiency of Non-Life Companies in Greece," *Journal of Financial Management and Analysis*, vol.14 (1), pp. 19-26.
14. J-Y Ou (2003), master's thesis, A Study of underwriting risk retained and reinsurance, National Chengchi University.



運用 DEA 法評估兩岸產險業之自留業務效率

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摘 要

本論文運用傳統一階段及兩階段資料包絡分析法，衡量兩岸 36 家產險公司 2008 年至 2013 年期間之自留業務效率。研究結果發現在傳統一階段資料包絡分析法中，臺灣整體的自留業務效率值高於大陸。惟若改用兩階段資料包絡分析法進行評估時，則顯示第一階段的行銷效率值臺灣雖然高於大陸，但在第二階段的自留業務效率值，則大陸優於臺灣。此外，本論文亦運用 Tobit 迴歸方法探討影響上述效率值之關鍵因素，採用的變數包括公司成立時間長短、簽單保費收入、教育程度大學以上比率、專業人員比率、非車險業務比率、金控與否及自留比率等七項自變數。結果發現，顯著影響行銷效率之因素為成立時間長短及非車險比重；顯著影響自留業務效率之因素則為簽單保費和自留保費比率。

關鍵字：產險業、自留業務、經營績效、資料包絡分析法、Tobit 迴歸

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