EFFICIENCY AND PRODUCTIVITY CHANGES IN THE NON-LIFE INSURANCE INDUSTRY IN TAIWAN PRE- AND POST- WTO ACCESSION

Chang-Sheng Liao [1,2]

[1]College of Management, Samming University, Fujian, China

[2]Department of Finance and Cooperative Management, National Taipei University, Taiwan, Republic of China, E-mail:sheng2009tw@gmail.com

Abstract

This study investigates efficiency and productivity changes in the non-life insurance industry in Taiwan during per-and post-WTO accession. We use a data envelopment analysis to measure the efficiency of non-life insurers. The result finds that insurers' efficiency not improved after WTO accession. The mean total factor productivity change is close to one, implying that the productivity of non-life insurers barely improved and that the productivity change is mainly due to the technological factor, rather than to the efficiency factor. Is the pursuit of market share an appropriate strategy in the non-life insurers? The result shows that insurers with higher market shares cannot to improve efficiency. How does the minimum capital requirement policy affect insurers' efficiency? We find no relationship between equity capital and efficiency. Thus, we suggest that the government should not to intervene in corporate decisions with capital structure.

Key Words：Non-Life Insurance Industry, Data Envelopment Analysis (DEA), Malmquist index

JEL Classification：G22, L10

Acknowledgement

I would like to thank, without implicating, Dr. Fung-Shyung Shiau for their insightful and painstaking comments on an earlier draft which greatly improved the clarity and exposition of the paper. I am responsible for all remaining errors. I am also grateful for Financial support from Samming University (Grant No.16YG09S) enabling this research to be completed.

1. Introduction

During the past two decades, the Taiwanese insurance industry has experienced an unprecedented wave of degradation. Since the end of the 1980s, the government has followed the wave of financial liberalization in the world. The government has gradually allowed new, foreign-owned insurers to enter the domestic insurance market. The government allowed new, local firms to enter the non-life insurance market in 1992, and allowed foreign-owned insurers to enter the Taiwanese branch in 1994. In

addition, the non-life insurers provide many new finance businesses and services. In December of 2001, Taiwan successfully entered the WTO, and the two governments opened up their financial markets completely for foreign companies. Thus, how did WTO accession the affect the non-life insurance industry in Taiwan? Can insurers improve efficiency and productivity after WTO accession? If not, why? These problems are our study's investigatory objectives.

The Taiwanese non-life insurance industry provides an interesting case study of productivity and efficiency for four primary reasons. (1) The Taiwanese insurance penetration ratio ranked number one in 2007[1]; the insurance penetration ratio is very high (15.7%), implying that efficiency among non-life insurers would be increasing. In fact, despite fast economic growth, the non-life insurance industry remains underdeveloped relative to other sectors of the economy. Thus, we examine changes in non-life insurers' efficiency and productivity over the period from 1996 to 2007. (2) Financial institutions never willingly drop out of the market in Taiwan. Rather, the government will always protect enterprises in an attempt to avoid a chain of financial crises. The Taiwanese insurance environment is competitive and has undergone a myriad of changes over the past two decades. However, the government has not created a perfect environment or formulated appropriate policy, where this has led to insurers' inefficiency. Thus, we examine whether these policies were effective in supporting insurers' development. (3) Many foreign insurers have attached importance to the Taiwanese non-life insurance market in recent years. Examples include Sumitomo Mitsui's acquisition of Mingtai insurance company in 2006 and AIG's acquisition of Center Insurance Company in 2007. These transactions showed that market held valuable investment opportunities, but that larger insurers did not seem to share the same outlook. For example, Fubon greatly reduced capital (NT$ 20 billon) in 2007. Foreign and domestic insurers have a conflict in activity, and this is how we explain insurers' efficiency and productivity change from 1996 to 2007. (4) Because most prior studies of efficiency and productivity change in insurance have focused on developed countries, studying the Taiwan market provides evidence on whether relative efficiency and productivity changes are also applicable elsewhere. In particular, the development of the Taiwanese economy is a very successful case in emerging markets.

Relatively few studies have estimated the efficiency of the non-life insurance industry. Banking and insurance firms serve as the main financial intermediaries to channel savings and investment in the developed economics. Thus, any change in the productivity or efficiency of insurers has a direct impact on financial market development and, further, on economic development. In particular, there are few

[1] Swiss Re insurance Company Ltd. World insurance in 2007: emerging markets leading the way.

quantitative studies on the efficiency or performance of the insurance sector in Taiwan. Hwang and Kao (2006) used a two-stage DEA model to measure the efficiency of non-life insurance companies. They found that mean marketability efficiency is 0.849 and that profitability efficiency is 0.596. Regarding other countries studied, Cummins and Xie (2008) analyzed the productivity and efficiency effects of mergers and acquisitions in the US property-liability insurance industry. They considered the period 1994-2003 using data envelopment analysis and Malmquist productivity indices. Kasman and Turgutlu (2007) examine the cost efficiency and scale economies of Turkish insurance firms over the period 1990-2004. Yao et al. (2007) examine the efficiency score of the major insurance companies and identify the key determinants of efficiency scores. Related studies cover a variety of different countries: Weiss and Choi (2008) consider the US; Fenn et al. (2008) consider fourteen European countries; Choi and Weiss (2005) consider the US; Lai and Limpaphayom (2003) focus on Japan, as do Fukuyama and Weber (2001), Noulas et al.(2001)consider the Greece; and Toivanen (1997) examine the Finnish case.

This study aims to examine the efficiency and the change in productivity of non-life insurers in Taiwan, following Cummins and Xie (2008) and Yao et al. (2007). We employ the data envelopment analysis (DEA) method and the Malmquist index to measure the efficiency and productivity of non-life insurers in the sample period of 1996 to 2007. Finally, we identify the determinants of insurers' efficiency, and answer two questions regarding firms' strategy and governmental policy. First, is the pursuit of market share an appropriate strategy in the non-life insurance industry? Second, how does governmental policy affect insurers' efficiency? The remainder of this paper is organized as follows. Section 2 briefly describes the DEA method and Malmquist index model and defines the input and output variables. Section 3 reports the efficiency and productivity results of the non-life insurers using the DEA model and Malmquist index method. It also attempts to identify the determinants of non-life insurers' efficiency. Finally, the last section presents the empirical results, concludes, and provides suggestions.

2. Methodology

This chapter has three sections. First, it briefly describes the data envelopment analysis (DEA) model. Second, we used the two input and two output model to measure non-life insurers' efficiency. The chapter also contains a description of the insurers sample and the data source. Finally, this section examines the determinants of non-life insurers' efficiency.

2.1 DEA model and Malmquist index

This study employs the DEA method to estimate the efficiency of non-life insurers and the dynamic nature of efficiency changes in Taiwan. In previous studies, researchers have relied on parametric, non-parametric and financial ratio approaches to estimate firms' efficiency. As Havrylchyk (2006) explained, the chief advantage of using DEA to estimate firms' efficiency is that it performs well with only a small number of observations. This is important for us, since we want to assess efficiency separately for each year in order to detect the effects of technological or regulatory changes. We only obtain balance sample of 12 domestic non-life insurers with annual data for the period 1996 to 2007, the sample yields a total of 144 observations. In order to ensure that estimates are reliable, the parametric approach necessitates a large sample size. For this reason, we used the DEA to estimate non-life insurers' efficiency.

We briefly describe the data envelopment analysis (DEA) method. Coined by Charnes et al. (1978), DEA is a linear programming technique for constructing external piecewise frontiers. The frontiers constructed are non-parametric in the sense that they are constructed through the envelopment of the decision making units (DMUs) with the "best practice" DMUs forming the non-parametric frontier (Drake, 2001). Applying the DEA model to calculate overall technological efficiency (assuming constant returns to scale) and pure technological efficiency (assuming variable returns to scale).Through input-oriented DEA, we can dwell on the sources of input waste in non-life insurers and draw some policy conclusion, the constant returns to scale input-oriented model is as follows:

s.t. $\min \ \Theta$

$$\sum_j \lambda_j X_{ij} \le \Theta X_{i0} \qquad i = 1, 2, ...m;$$

$$\sum_j \lambda_j Y_{rj} \le Y_{r0} \qquad r = 1, 2, ...s;$$

$$\lambda_j \le 0 \qquad j \in 1, 2, ...n. \qquad (1)$$

where x_{ij} and y_{rj} are the amounts of the *i*th input consumed and amount of the *r*th output generated by the *j*th securities firms, respectively. The variable Θ indicates solving this linear programming to obtain the efficiency results from the optimum value for each non-life insurers. The value Θ represents overall technological efficiency for each non-life insurer.

The variable return to scale input-oriented model is as follows:

s.t. $\min \ \pi$

$$\sum_j \lambda_j X_{ij} \le \pi X_{i0} \qquad i = 1, 2, \ldots\ldots m;$$

$$\sum_j \lambda_j Y_{rj} \le Y_{r0} \qquad r = 1, 2, \ldots\ldots s;$$

$$\sum \lambda_j = 1$$

$$\lambda_j \le 0 \qquad j \in 1, 2, \ldots\ldots n. \qquad (2)$$

The symbol definition corresponds to that outlined above, where the value π represents pure technological efficiency for each non-life insurer. Scale efficiency (SE) can be calculated by overall technical efficiency (OTE) divide by pure technical efficiency (PTE) for each non-life insurer, and SE can be used to determine how close a non-life insurer is to the most productive scale size.

Cost efficiency is the product of technical efficiency and allocative efficiency. More specifically, firms can have higher costs than represented by the frontier if they do you use the most efficient technology or if they do not use a cost minimizing input mix. Cost and technical efficiency enables us to back out estimates of allocative efficiency using the following relationship: CE=TE*AE, where CE=cost efficiency, TE=technical efficiency and AE=allocative efficiency. Both technical and allocative efficiency are bounded by 0 and 1, with fully efficient insurers having efficiencies equal to one (Cummins et al, 1999).

Following Isik and Hassan (2003), using Farrell's distance function and the Fare et al. (1994) definition of productivity,[2] we specify the Malmquist total factor productivity change index (TFPCH) and decompose productivity into the catch-up effect (product of efficiency change, EFFCH) and the frontier-shift effect (technology change, TECHCH). The catch-up effect indicates the how much closer an insurer gets to the efficient frontier and the frontier-shift effect indicates the how much the benchmark production frontier shifts with each insurer's observed input mix:

$$\text{TFPCH (t, t+1)} = \overbrace{\underbrace{\frac{D_{t+1}^{VRS}(x_{t+1}, y_{t+1})}{D_t^{VRS}(x_t, y_t)}}_{PECH} \times \underbrace{\left[\frac{D_{t+1}^{CRS}(x_{t+1}, y_{t+1}) / D_{t+1}^{VRS}(x_{t+1}, y_{t+1})}{D_t^{CRS}(x_t, y_t) / D_t^{VRS}(x_t, y_t)}\right]}_{SECH}}^{EFFCH}$$

$$\times \underbrace{\left[\frac{D_t^{CRS}(x_{t+1}, y_{t+1})}{D_{t+1}^{CRS}(x_{t+1}, y_{t+!})} \times \frac{D_t^{CRS}(x_t, y_t)}{D_{t+1}^{CRS}(x_t, y_t)}\right]^{1/2}}_{TECHCH} \qquad (3)$$

[2] Fare et al. (1994) specifies an output-based Malmquist productivity change index. For further explanation of efficiency and TFP CH indices, please refer Fare et al. (1994).

A TFPCH index can attain a value greater than, equal to, or less than unity, depending upon whether the insurers experience productivity growth, stagnation or productivity declines, respectively, between the t and t+1. The catch-up (EFFCH) index takes a value greater than one for an efficiency increase, zero for no efficiency change, and less than one with a decrease in efficiency. The frontier-shift (TECHCH) index attains a value greater than one for technical progress, zero for technical stagnation, and less than one for technical regression. Furthermore, EFFCH is decomposed into a pure technical efficiency change (PECH) and a scale efficiency change (SECH), thus implying variable returns to scale (VRS), where TFPCH=TECHCH×PECH×SECH. We use DEAP 2.1 to measure a DEA-type Malmquist TFP index and analyze its component parts for non-life insurance industry in Taiwan.

2.2 Input-Output specifications

There are fewer publications on non-life insurance industry productive efficiency compared with other financial services, such as banking. Thus, the first problem is how to define the input-output variables in the non-life insurance industry. The non-life insurance industry is a multiproduct industry, where outputs have often proven difficult to measure. Kasman and Turgutlu (2007) explained that the definition and measurement of output in the insurance industry has always been difficult. Indeed, output measurement is one of the major differences among studies of cost efficiency in the industry. Fukuyama and Weber (2001) define reserves, loans and investment as output in the Japanese non-life insurance industry. Yao et al. (2007) argue that Chinese non-life insurance outputs can be measured by premium revenues, benefits and claims costs, and investment income. Kasman and Turgutlu (2007) defined the two outputs of insurance firms as the total paid loses plus additions to reserves and total investment assets. The insurance literature on estimate efficiency has not agreed on which measure of output to use. We measure insurance output by net incurred claims plus additions to reserves (y_1) and total invested assets (y_2)[3]. All outputs are measured in millions of NT dollars, expressed in real terms and deflated by the consumer price index (CPI) indexed to 2001 (2001 =100).

As in other financial industries, insurance companies mainly use labour cost (x_1) and capital cost (x_2) when providing insurance services. This convention was adopted by many previous studies, such as Cummins et al. (1999), Fukuyama and Weber (2001), Yao et al. (2007), Kasman and Turgutlu (2007), and Fenn et al. (2008). The labour cost is defined to be the total salary expense. The capital expense is measured

[3] A similar output definition was used in previous studies, e.g. Cummins and Weiss (1993), Berger et al. (1997), Kasman and Turgutlu (2007), and Fenn et al. (2008).

as the operation expense minus the salary expense. The price of labour (p_1) is computed by dividing the total salary expense by the number of employees. The price of the capital (p_2) is computed by dividing the capital expense by the amount of total fixed assets. This study uses balanced panel data gathered for 12 domestic non-life insurance firms in Taiwan. The primary data source for this study was the Taiwan Economics Journal (TEJ). The data covers the period from 1996 to 2007. We replace missing data using the "*Annual report of Bank Business Statistics*" published by the Central Bank of the Republic of China (Taiwan) and the non-life insurance company "*Annual reports*". Descriptive statistics of the output and input variables are provided in Table 1.

<Table 1 is inserted about here>

2.3 Regression on the determinants of non-life insurance firms' efficiency

We relied on regression analysis to investigate the determinants of non-life insurance industry efficiency. Few studies have explored the determinants of non-life insurers' efficiency in previous research. We refer to some previous non-life insurance industry studies that used the cost efficiency estimate derived from DEA estimations as the dependent variable and constructed the regression model for the determinants of non-life insurance industry efficiency as follows:

$$EFF = f(MANAGE, SIZE, EQUIT, ROA, MS, CONC, CAPIT, GROWTH) \quad (4)$$

where MANAGE indicates the insurers management ability, SIZE indicates the log non-life insurers firms' assets, EQUIT indicates the total equity divided by total assets, ROA indicates the return on the asset, MS indicates the market share for each insurer, CONC indicates the market concentration, CAPIT indicates the operating revenue divided by total equity, and GROWTH indicates the insurer's annual operating revenue growth ratio.

We construct an econometric model with two inputs and two outputs, using cost efficiency (CE) as the dependent variable. We define the determinant of the non-life insurer's efficiency as follows. MANAGE is managerial ability, following Sinkey's (1975) approach of measuring firm efficiency by using managerial ability, measured by operation expense divided by operating income, but we used a inverse measure method to represent insurers' managerial ability. SIZE is the natural logarithm of each non-life insurance firm's total assets. Lai and Limpaphayom (2003) found that the relationship between profitability and size is significantly negative, though this result was not supported by Yao et al. (2007). Previous empirical results on the effect of size the efficiency of financial institutions are mixed. Thus, we do not expect size to impact insurers' efficiency.

EQUIT is a proxy for the non-life insurers' owned capital ratio, and is measured by total equity divided by total assets. CAPIT is measured by operating revenue divided by total equity, where the insurers' capital ability is a proxy for the firms' ability to utilize owned capital to increase the firms' operating revenue. Insurance firms hold equity capital as a guarantee against possible unexpected losses, so greater equity capital is associated with high efficiency, as insurers' financial structure is stable and fit. However, Kasman and Turgutlu (2007) found that equity capital does not influence efficiency. The government formulated a policy called the "minimum capital requirement", requesting that insurers increase owned capital to NT$2 billion within 10 years in order to avoid insolvency crises and enhance the stability of insurers' financial structures. How does the minimum capital requirement policy affect insurers' efficiency? This study hopes to explain the impact on insurers' efficiency. ROA indicates the insurers' profitability. We expect the relationship between efficiency and ROA to be positive. GROWTH indicates the insurers' operating revenue growth ratio. In general, a higher growth ratio is associated with higher profitability and efficiency.

Is the pursuit of market share an appropriate strategy in the financial service industry? This problem is still a puzzle, as the empirical results of previous studies have reached no agreement regarding the financial service industry. This study explains the market share-efficiency association in non-life insurance industry, answering this question. MS indicates the market share for each insurer and CONC indicates market concentration measured using the Herfindahl-Hirschman index (HHI). Choi and Weiss (2005) found that the positive signs for the concentration variable support the structure-conduct-performance (SCP) hypothesis in the US non-life insurance industry. Kasman and Turgutlu (2007) find that higher concentration in the Turkish insurance industry resulted in lower cost inefficiency. The concentration variable is an important factor for insurers' efficiency, reflecting the market structure condition. Positive relationships were expected in both cases.

3. Empirical Results

The empirical analysis is divided into three sections. The first section estimates the efficiency of non-life insurers using the DEA model. The second section estimates the productivity change of non-life insurers using the Malmquist index model. The third section focuses on the determinants of non-life insurers' efficiency by using OLS, Fixed effect model (FM), and Random effect model (RM). In addition, we also use the Tobit regression model as well, owing to the limited nature of our efficiency measure, which ranges from 0 to 1.

3.1 Results of non-life insurance insurers efficiency

This section reports the results of estimating non-life insurers' efficiency using a DEA model. The results of the insurers' efficiency are presented in Table 2. The mean cost efficiency score is 0.8228, which is significantly higher than those found for other countries[4], implying that the efficiency of non-life insurers benefited from rapid growth in the ratio of insurance penetration. The cost efficiency score is stable, ranging from 0.78 to 0.89 over the period 1996 to 2004. Mean cost efficiency is decreased from 2005 to 2007 (0.762, 0.776, and 0.775, respectively). Hwang and Kao (2006) found a mean OTE of 0.651 over the period 2001-2002, which is significantly different result due to the adoption of different input-output varieties to measure it. Our study adopts labour input to measure insurers' efficiency, though former study relied on business and administrative expenses. The results show that the gap in cost efficiency among insurers is gradually increasing. Taiwanese insurers have faced keen competitive pressure after deregulation, though they have offered highly homogeneous products and fairly closed insurance premiums. Thus, the insurers have needed to adopt a low price strategy. Furthermore, the sales departments have adopted the operating method of returning commissions to customers in order to expand their businesses. These inappropriate competitive strategies make the insurers inefficient.

This finding - that the mean allocative efficiency (0.8967) is higher than overall technological efficiency (0.8182) - implies that technological inefficiency is a major source of cost inefficiency. Technological efficiency can be decomposed into pure technological efficiency and scale efficiency. The mean PTE (0.9143) is slightly higher than the SE (0.8965) over the period 1996-2007. Mean PTE has been decreasing since 2003 and, in contrast, mean SE has been increasing. Thus, we calculate mean PTE (0.89) and SE (0.954) over the period 2004-2007. This indicates that the pure technological efficiency is a more important source of technological inefficiency than scale efficiency, implying that the insurers' inefficiency can be attributed to under-utilization of inputs or the incorrect selection of input combinations. Scale efficiency is lowest in 1997. This value has increased year by year, showing that the insurers have improved returns to scale. We find that most non-life insurers operated in the range of increasing or decreasing returns to scale. Only three insurers exhibited constant returns to scale. This shows that the scale return has improved, but that firms are still not operating in the appropriate scale.

We start by assessing whether the relative insurer's efficiency in Taiwan has improved from 1996 to 2008, to identify the effect of WTO accession in the form of

[4] For instance, Cummins and Xie(2008) used the DEA to measure the non-acquiring and acquiring firms' efficiency in US, over the period 1994 to 2003, they found that mean cost efficiency are 0.49 and 0.52,respective.

an upward or downward trend in the insurers' efficiency post-2001. We divide the entire sample period into sub-period the per-WTO accession (1996-2001) and post-WTO accession (2002 to 2008). Results of compared the between pre- and post-WTO accession insurers' efficiency reported in Table 3. This finding that three efficiency values different are insignificant, i.e., cost efficiency is 0.8232 versus 0.8223 for per- and post- WTO accession. This indicates that insurers' efficiency not improved after WTO accession, financial industry could increase efficiency from globalization, foreign-insurer entry domestic market with technological innovation and Know-how post-WTO accession, but accompany generates an intensely competitive insurance environment, insurers' profitability and efficiency is decline may been have result of more competitive market.

<Table 2 is inserted about here>

<Table 3 is inserted about here>

3.2 Results of productivity change

In line with previous studies that decompose the components of productivity changes, we use the abbreviated letters TFPCH (Malmquist index of total factor productivity), TECHCH (technical change), EFFCH (efficiency change), PECH (pure technical efficiency change), and SECH (scale efficiency change). The total factor productivity change indexes of non-life insurers are presented in Table 3.

These data demonstrate that the mean values of TECHCH and SECH are greater than one, indicating that insurers have positive scale efficiency growth and technical progress. The mean values of TFPCH, EFFCH and PECH are less than one, showing that they are unable to manage resourcing problems. The mean value of TFPCH is close one (0.999), indicating that the productivity of non-life insurers is barely unimproved. The same holds for EFFCH and SECH. The mean value of TECHCH is 1.002 over this period, although the average technological progress has 0.2 percent, showing that the productivity change is mainly due to the technological factor. We suggest that the insurers increase productivity by more effectively utilizing input resources or management factors. This result is consistent with prior studies. Weiss (1991) found that insurers provide a condition for technological regression. Fukuyama and Weber (2001) and Yao et al. (2007) both found evidence of technological progress in their studies. The mean value of SECH is great than one, indicating that the insurers have moved towards their optimal size. This implies that the insurers' scale has gradually adjusted to their optimal size. The non-life insurance market has undergone many changes in recent years, including developments like mergers and acquisitions (M&A) and an increase in foreign-owned insurer investment in domestic insurers. Even with the largest insurer's decision to reduce capital by NT10 billion in

2007, the non-life insurance industry is still experiencing improved returns to scale.

Since the deregulation of the insurance market in the 1990s, the government has been devoted to solve firms' inefficiency problems. After joint the WTO in 2001, Taiwan has opened its insurance market to foreign-owned insurers. The insurance market has become more liberalized and international while market competition has heated up. Thus, it is interesting to compare insurers' productivity changes before and after joining the WTO and to explain how joining the WTO impacts efficiency. We find that all indices decline after joining the WTO. The insurers registered negative productivity growth in Taiwan. The decline is efficiency is mainly due to the lack of innovations (TECHCH) as opposed to improvements in efficiency (EFFCH). This shows that, despite facing competition from foreign-owned insurers, Taiwanese non-life insurers cannot keep increasing productivity. In general, the entry of most foreign financial institutions would increase competition for financial institutions in the home country, compelling domestic financial institutions to operate more efficiently. Unfortunately, some non-life insurers faced bankruptcy risk due operating mistakes, implying negative productivity after joining the WTO.

We find that THCHCH increases when EFFCH decreases (except with 2001-02). Cummins et al. (1999) point out that the opportunity for efficiency increases would be lower in a relatively efficient line. As the line is already highly efficient and competitive, firms have a strong incentive to adopt new technology in order to increase their competitive advantage over rivals. Yao et al. (2007) found that lower efficiency insurers experience greater technological progress. This implies that, while the non-life insurance industry adopted new technology and skills, the insurers ignored the limited resources in Taiwan. Thus, productivity did not significantly increasing all the time.

<Table 4 is inserted about here>

3.3 Results of determinants of non-life insurers' efficiency

This section reports the results concerning the determinants of an insurer's efficiency. The dependent variable is the cost efficiency of the insurers, measured using a DEA model. The results of the regression analysis are presented in Table 4. We explore the individual coefficient below. From Table 4, the coefficient of MANAGE is significantly positive, consistent with our expectations. This implies that the insurers have a better managerial ability to control input-output allotment. The insurers' cost efficiency increased.

The coefficient on SIZE is significantly positive. Except with the FM model, this result is consistent with both our expectations and the results of Yao et al. (2007). However, it is inconsistent with Lai and Limpaphayom (2003) and Weiss and Choi

(2008)[5]. Previous studies report results that are inconsistent with respect to the relationship between assets and efficiency. In theory, large firms tend to be more efficient than small firms are, as the former have the advantage of scale and scope economies. We explain this difference in the empirical results. The latter studies are concerned with developed economies, implying that the size factor does not play an important role in a mature insurance market. A mature market provides a perfectly competitive environment. Thus, even small firms without the advantage of scale have a competitive strategy to improve efficiency[6]. In an emerging market, the marketing network problem implies that the efficiency of smaller insurers is decreasing. They face higher operating costs than large insurers because they need to rely on brokerage and agents to sell their products.

The coefficient of EQUIT and CAPIT are both negative and insignificant, except with OLS. The EQUIT and CAPIT variables are to measure the effect by increasing equity capital. This finding demonstrates that there is no relationship between equity and efficiency. The OLS analysis shows that, while the equity to asset ratio is increasing, insurers' efficiency is decreasing. This result is consistent with Kasmam and Turgutlu (2007)[7]. After allowing new firms into the non-life insurance market, the government formulated a policy called the "minimum capital requirement". According to our estimations, this policy cannot to improve efficiency, and is a waste of input-capital. The individual insurers have different optimal capital structures and face business- and product-specific decisions. We suggest that the government should not intervene in corporate capital structure decisions, but only serve the role conscientious supervisor.

The coefficient on ROA is significantly negative. This is inconsistent with our expectation and with Kasman and Turgutlu (2007). The notion that more efficient firms enjoy greater profitability is consistent with popular economics. Nevertheless, our result indicates that insurers do not raise the ratio of assets to improve insurers' efficiency. If the non-life insurance market is a competitive oligopoly, insurers profit not from individual efficiency but from oligopoly profit, even though inefficiency firms might be able to gain profit in competitive oligopoly. Through financial system reform and other deregulation policies, the government wants to create a more efficient financial market and enhance financial technology. However, the improved efficiency of non-life insurers is not seen in other financial sectors. The insurers do

[5]Weiss and Choi (2008) show that the relationship between the size and efficiency is not significant, implying that increasing asset sizes cannot improve efficiency.

[6] Small service firms that follow a focus-differentiation strategy by providing customized and exclusive service to customers located in specific market segments can be as profitable as large service firms (Schwalbach, 1991).

[7]Kasmam and Turgutlu (2007) found that the relationship between inefficiency and equity to assets is significantly negative.

not research and develop new insurance businesses or improve service skills. They thus lose the chance to enhance industry efficiency and productivity growth.

The coefficient of MS is significantly negative, implying that insurers with a higher market share cannot improve efficiency. In theory, the cost efficiencies of firms with high market shares lead to greater profitability (Demsetz, 1973, Peltzman, 1977, Smirlock, 1985). However, this result is inconsistent with our expectations. Although the non-life insurance industry underwent significant change in Taiwan, the market structure is still a competitive oligopoly. On the other hand, the coefficient on CONC is significantly positive. This result is inconsistent with Kasman and Turgutlu (2007). Under the structure-conduct-performance (SCP) hypothesis, we expect a positive association between concentration and performance (Stigler, 1964). We find that concentration in the non-life insurers market is very highly. Thus, collusive behaviour is likely. The non-life insurance industry enjoys a high degree of concentration, and collusion raises insurers' efficiency. We suggest that the government push new reform policies to improve insurers' efficiency, creating a perfect market structure for non-life insurers.

The coefficient on GROWTH is positive and significant with FM. However, the estimated coefficient is very small, indicating that the operating revenue growth ratio is of slight importance in increasing insurers' efficiency. This result reflects the fact that the insurance penetration ratio is very high, but that the insurers' operating revenue is characterized by slow growth. Insurers often return commission to customers in order to increase their operating revenue. This can effectively embellish insurers' balance sheets without benefiting their efficiency. Such strategies make insurers inefficient.

<Table 5 is inserted about here>

4. Conclusions

This study aims to examine the efficiency and change in productivity of non-life insurers in Taiwan. We find that the mean cost efficiency score is 0.8228, significantly higher than found for other countries, implying that the efficiency of non-life insurers benefited from the rapid growth of the ratio of insurance penetration. The mean values of TECHCH and SECH are greater than one, indicating that insurers experience positive productivity growth and technical progress. The mean values of TFPCH, EFFCH and PECH are less than one, implying that they are unable to manage resourcing problems. The mean value of TFPCH is close one, implying that the productivity of non-life insurers is barely unimproved. The same is seen for EFFCH and SECH. The mean value of TECHCH is 1.002 in this period, although

technological progress averages only 0.2 percent, showing that productivity changes are mainly due to the technological factor. Thus, we suggest that the insurers increase productivity by more effectively utilizing input resources.

This study identifies the determinants of insurers' efficiency and answers two questions regarding firms' strategy and government policy. First, is the pursuit of market share an appropriate strategy in the non-life insurance industry? The result shows the relationship between market share and insurers' efficiency is significantly negative. This implies that insurers with higher market share cannot improve efficiency. Thus, emphasis on the pursuit of market share is not an appropriate strategy in the non-life insurance industry. Though the non-life insurance industry underwent much change in Taiwan, the market structure is still a competitive oligopoly. The relationship between market concentration and efficiency is significantly positive. We find that concentration in the non-life insurers market is very highly. Thus, collusive behaviour seems likely. The non-life insurance industry enjoys a high degree of concentration. Is the efficiency can be increased through collusive behaviour? The results may have been caused by larger insurers have a lower cost from effect of scale and scope economies and learning effect. We suggest that the government push reform policies in order to improve insurers' efficiency and create a perfect competitive market structure for non-life insurers.

How does the minimum capital requirement policy affect insurers' efficiency? This result finds that equity capital and efficiency are unrelated. After allowing new firms into the non-life insurance market, the government formulated a policy called the "minimum capital requirement". According our estimate results, this policy cannot improve efficiency and is a waste of input-capital. Individual insurers have different optimal capital structures and face business- and product-specific decisions. Thus, we suggest that the government should not intervene in corporate decisions regarding capital structure, but should remain a conscientious supervisor.

References

Berger, A.N., Cummins J.D., and Weiss M.A. ,1997. The coexistence of multiple distribution systems for financial services: the case of property-liability insurance. *Journal of Business*, 70, 515-546.

Charnes, A., Cooper, W.W., and Rhodes E. ,1978. Measuring the efficiency of decision-making units. *European Journal of Operational Research*, 12, 429-444.

Cummins, J.D. and Weiss M.A. ,1993. Measuring cost efficiency in the property-liability insurance industry. *Journal of Banking and Finance*,17, 463-481.

Cummins, J.D., Tennyson S. and Weiss M.A. ,1999. Consolidation and efficiency in

the US life insurance industry. *Journal of Banking and Finance*. 23, 325-357.

Cummins, J.D., Weiss M.A. and Zi H.,1999. Organizational form and efficiency: the coexistence of stock and mutual property-liability insurers. *Management Science*,45, 1254-1269.

Cummins, J.D. and Xie X.,2008. Mergers and acquisitions in the US property-liability insurance industry: productivity and efficiency effect. *Journal of Banking and Finance*.32,30-55.

Choi, B.P. and Weiss, M.A.,2005. An empirical investigation of market structure, efficiency, and performance in property-liability insurance. *Journal of Risk and Insurance*, 72,635-673.

Demsetz, H.,1973. Industry structure, market rivalry, and public policy. *Journal of Law and Economics*, 16,1-19.

Drake, L., 2001.Efficiency and productivity change in UK banking. *Applied Financial Economics*, 11, 557-571.

Fare, R., Grosskopf, S., Norris, M., and Zhang Z. ,1994. Productivity growth, technical progress, and efficiency change in industrialized countries. *American Economics Review*, 84, 66-83.

Fenn, P., D. Vencappa, S. Diacon, P. Klumpes, and O'Brien, C. ,2008. Market structure and the efficiency of European insurance companies: A stochastic frontier analysis. *Journal of Banking and Finance*, 32, 86-100.

Fukuyama, H., and Weber W.L.,2001. Efficiency and productivity change of non-life insurance companies in Japan. *Pacific Economic Review*,6, 129-146.

Hwang, S.N., and Kao, T.L.,2006, Measuring managerial efficiency in non-life insurance companies: an application of two-stage data envelopment analysis. *International Journal of Management*, 23, 699-720.

Havrylchyk, O., 2006. Efficiency of the Polish banking industry: Foreign versus domestic banks. *Journal of Banking and Finance*, 30, 1975-1996.

Isik I., and Hassan M.K., 2003. Financial deregulation and total factor productivity change: an empirical study of Turkish commercial banks. *Journal of Banking and Finance*, 27, 1455-1485.

Kasman, A., and Turgutlu, E.,2007. Cost efficiency and scale economies in the Turkish insurance industry. *Applied Economics*,1-9, iFirst.

Lai, G.C. and Limpaphayom, P.,2003.Organizational structure and performance: evidence from the nonlife insurance industry in Japan. *Journal of Risk and Insurance*, 70, 735-757.

Noulas, A. G., John T.H., and Katerina L. ,2001.Non-parametric production frontier approach to the study of efficiency of non-life companies in Greece. *Journal of Financial Management and Analysis*, 14,9-26.

Peltzman, S. ,1977. The gain and losses from industrial concentration. *Journal of Law and Economics,* 20, 229-63.

Schwalbach, J. ,1991. Profitability and market share: a reflection on the functional relationship. *Strategic Management Journal*, 12,299-306.

Smirlock, M. ,1985. Evidence on the (non) relationship between concentration and profitability in banking. Journal *of Money, Credit, and Banking*, 17, 69-83.

Sinkey, J. F. ,1975. A multivariate statistical analysis of the characteristic of problem banks. *Journal of Finance,* 30, 301-319.

Stigler, G.L. ,1964. A theory of oligopoly. *Journal of Political Economy*, 72, 44-61.

Toivanen, O. ,1997. Economies of scale and scope in the Finnish non-life insurance industry. *Journal of Banking and Finance,* 21,759-779.

Weiss, M.A. ,1991. Efficiency in the property-liability insurance industry. *Journal of Risk and Insurance*, 58, 452-479.

Weiss, M.A. and Choi B.P. ,2008. State regulation and structure, conduct, efficiency and performance of US auto insurers. *Journal of Banking and Finance,* 32, 134-156.

Yao, S., Han, Z. and Feng, G. ,2007, On technical efficiency of China's insurance industry after WTO accession. *China Economic Review*, 18, 66-86.

Table 1 Descriptive Statistics (Unit: million)

Variable	Means	SD.
Output-input variables		
y_1 =Total paid loses plus additions to reserves	660.481	492.162
y_2 =Total invested assets	493.452	879.726
x_1 =Labour expense	67.936	48.437
x_2 =Capital expense	116.641	308.4
p_1 =Price of Labour	742.28	27.164
p_2 =Price of Capital	5.4635E-3	29.174E-3
Empirical function		
MANAGE	10.5475	3.7807
SIZE	16.2027	0.6328
EQUIT	0.3034	0.1459
ROA (%)	1.9638	4.0586
MS (%)	6.8282	4.6922
CONC (%)	786.943	163.861
CAPIT	3.4851	10.4111
GROWTH (%)	7.8277	45.2459

Note: The cost function used two inputs-two outputs variables. Control variables as follow: MANAGE SIZE, EQUIT, ROA, MS, CONC, CAPIT, and GROWTH.

Table 2 Results of DEA Efficiency Estimates

	Average annual change				
Year	**OTE**	**PTE**	**SE**	**AE**	**CE**
1996	0.853	0.926	0.923	0.932	0.862
1997	0.646	0.918	0.706	0.87	0.811
1998	0.773	0.957	0.808	0.862	0.829
1999	0.775	0.871	0.886	0.89	0.781
2000	0.916	0.957	0.955	0.875	0.845
2001	0.853	0.923	0.926	0.876	0.811
2002	0.787	0.927	0.853	0.904	0.844
2003	0.825	0.932	0.884	0.945	0.883
2004	0.878	0.915	0.958	0.979	0.894
2005	0.829	0.887	0.939	0.868	0.762
2006	0.851	0.893	0.956	0.867	0.776
2007	0.833	0.865	0.964	0.892	0.775
Mean	0.8182	0.9143	0.8965	0.8967	0.8228

Note: OTE=Overall technological efficiency, PTE=Pure technological efficiency, SE=scale efficiency, AE=Allocative efficiency, CE=Cost efficiency. The “mean” indicates the average the entire sample value over the period 1996 to 2007

Table 3 Results of Compared the Between Pre-and Post- WTO Accession

	OTE	AE	CE
Pre-	0.9253	0.8841	0.8232
Post-	0.903	0.9092	0.8223
T value	1.1	-0.929	0.0028
F value	1.21	0.863	0.001
Mann-Whitney	2402	2415.5	2543.5

Note: OTE=Overall technological efficiency, AE=Allocative efficiency, CE=Cost efficiency. T value is measured by independent sample T test, F value is measured by one way ANOVE test, Mann-Whitney value indicates the Mann-Whitney U value.

Table 4 Total Factor Productivity Changes

	Average annual change				
	EFFCH	**TECHCH**	**PECH**	**SECH**	**TFPCH**
1996-97	0.733	1.361	0.99	0.74	0.997
1997-98	1.224	0.862	1.048	1.168	1.054
1998-99	1.002	1.227	0.904	1.108	1.229
1999-00	1.199	0.712	1.105	1.085	0.854
2000-01	0.932	1.231	0.963	0.968	1.147
2001-02	0.901	0.925	0.999	0.902	0.833
2002-03	1.065	0.871	1.01	1.054	0.927
2003-04	1.058	1.015	0.972	1.088	1.073
2004-05	0.944	1.116	0.966	0.978	1.054
2005-06	1.034	0.821	1.013	1.021	0.849
2006-07	0.975	1.082	0.966	1.01	1.055
mean	0.997	1.002	0.993	1.004	0.999
1996-01	1.018	1.0786	1.002	1.0138	1.0562
2002-07	0.9962	0.9717	0.9876	1.0088	0.9652

Note: The “mean” indicates the average the entire sample value over the period 1996 to 2007. TFPCH indicates the total factor productivity index and EFFCH the catch-up indicates the insurers efficiency change, Frontier-shift indicates the technology change, THCHCH, PECH are pure technical efficiency change, and SECH is the scale efficiency change.

Table 5 Regression Results, Dependent Variable is Cost Efficiency

	Four estimate models			
	OLS	**FM**	**RM**	**TB**
Con.	-0.3714		-0.6793	-2.9454
	(-0.5633)		(-0.9887)	(-0.5513)
MANAGE	0.3261	0.0303	0.0307	0.2731
	(10.5546)***	(8.5455)***	(9.5564)***	(9.1822)***
SIZE	0.0831	0.8302	0.0949	0.6795
	(1.8631)*	(1.548)	(2.0772)**	(1.8703)*
EQUIT	-0.3236	-0.0972	-0.1596	-2.675
	(-2.7564)***	(-0.7572)	(-1.3464)	(-2.7759)**
ROA	-0.0028	-0.0068	-0.0065	-0.0247
	(-0.863)	(-1.7476)*	(-1.8098)*	(-0.9128)
MS	-0.097	-0.0466	-0.0716	-0.8064
	(-6.9856)***	(-2.38)**	(-4.3859)***	(-6.602)***
CONC	0.0039	0.0016	0.0027	0.0328
	(7.7132)***	(1.9494)*	(4.3518)***	(7.1811)***
CAPIT	-0.0003	-0.931E-4	-0.0001	-0.0026
	(-0.2801)	(-0.0982)	(-0.1273)	(-0.2923)
GROWTH	0.0002	0.0004	0.0003	0.0018
	(0.8849)	(1.6678)*	(1.4152)	(0.9424)
R^2	0.6294	0.7438	0.6058	
Log likelihood function				98.44712

Notes: MANAGE=Managerial ability, SIZE=log securities firms' asset, EQUIT=Total Equity divide by total assets, ROA=return of asset. MS=market share, CONC=market concentration. CAPIT=net operating revenue divide by total equity, GROWTH=operating revenue growth ratio. OLS=ordinary least square, FM=Fixed effect model, RM=Random effect model. TB=Tobit regression. *α=0.1 significant at the 10% level, **α=0.05 significant at the 5 % level, ***α=0.01 significant at the 1% level.