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Essays on Strategic Risk Management

Sampan Nettayanun

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ESSAYS ON STRATEGIC RISK MANAGEMENT

BY

SAMPAN NETTAYANUN

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree

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ACCEPTANCE

This dissertation was prepared under the direction of the Sampan Nettayanun's Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctoral of Philosophy in Business Administration in the J. Mack Robinson College of Business of Georgia State University.

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ABSTRACT

Essays on Strategic Risk Management

BY

Sampan Nettayanun

March 31, 2014

Committee Co-Chair: Martin F. Grace and George H. Zanjani

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The goal of the first part of the dissertation is to explore the effects of the competition and market structure on the hedging strategies of companies within the property and liability insurance industry. Based on the available data (1989 to 2009), there is empirical evidence that insurers take competition and market structure into consideration in implementing their risk management policies. Market power, market positioning, diversification of lines and states, intensity of competition and the level of hedging in the industry all affect reinsurance purchase decisions. These results are robust under various econometric specifications.

The second part of the dissertation explores whether risk management adds value to the property and liability insurers. Moreover, it studies whether risk management adds value to insurance companies with good underwriting skills. Using the property and liability insurance data for the years 1989 to 2011, there is evidence that ceding a high proportion of the risks decreases profit efficiency

of insurers in general. In addition, there is evidence that using a very high level of hedging does not prove to be profitable for the insurers with an underwriting edge.

Finally, the last part studies strategic similarities within the property and liability insurance industry from 1989 to 2011. I find nine common strategic groups during the stable strategic time periods. The levels of performance, risk management, and predation vary among the strategic groups. Some strategic groups exhibit unique patterns of risk management compared to the industry as a whole. Moreover, the positioning within strategic groups influences the insurers' risk management activities. In addition, I find relationships among insurers' risk management tools.

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CHAPTER 1

Strategic Risk Management in the Property and Liability Insurance Industry

1.1. Introduction

According to Modigliani and Miller (1958), risk management adds no value to firms when there is no friction. However, by adding frictions to the framework, risk management becomes a constructive part of a company. Previous empirical studies, such as Mayers and Smith (1990), Tufano (1996), Dionne and Garand (2003) and Cole and McCullough (2006) focus their attention on financial considerations, such as agency cost, tax, firm size, costs of external financing, financial distress, organization form and the reinsurance market conditions. This study considers the existing literature by exploring frictions from the competition and the market structure that influence underwriting risk management in the property and liability insurance industry.

Maksimovic and Zechner (1991), Allayannis and Ihrig (2001), Mello and Ruckes (2008), Adam, Dasgupta, and Titman (2007) and Liu and Parlour (2009) present theoretical models of how market structure and competition factors affect risk management. In addition, there are several empirical studies that test these hypotheses such as Allayannis and Ihrig (2001), MacKay and Phillips (2005) and Adam and Nain (2013). These studies use non-financial firms to test their hypotheses. What makes my study stands out from these empirical studies is that it is the first to use financial firms. This study uses the National Association of Insurance Commissioners (NAIC) data from 1989 to 2009 of P&L insurers. By covering a 21-year period of data, my study eliminates any bias in the results toward any particular short period of time or any cycles that might over-influence hedging decisions. It also takes into account all the possible frictions within the industry for analysis.

This study shows that during 1989 to 2009, insurers took financial, competition, market structure and reinsurance market conditions into consideration when making hedging decisions. For the financial considerations, assets have a negative relationship with the hedging level, supporting the view that larger insurers get external financing more easily than their peers. Leverage also has a negative relationship with the hedging level, as supported by Rampini, Sufi, and Viswanathan (2014) who state that having more leverage or less resource reduces incentive to hedge. The study also finds that loss development has a positive relationship to the hedging level, suggesting that firms in a distress situation cede more risk. My analysis demonstrates that tax has a negative relationship with the hedging level. However, this is in contradiction to the view of Smith and Stulz (1985) that the smoothness of income from hedging on the tax payment benefits insurers. One possible explanation is that the tax schedule in reality might not be strictly convex as Smith and Stulz (1985) assume. Therefore, the tax and hedging relationship do not need to exhibit a positive relationship.

Besides financial consideration effects on hedging, competition and market structure play roles in risk management as well. My results show that market share has a negative relationship with hedging, which can be explained by Mello and Ruckes (2008). Insurers with higher market power or a higher competitive edge tend to hedge less to take advantage of their power in the market. This study finds that the Herfindahl Index by lines of business and by states has a negative correlation to the level of risk management. In addition, more focused insurers tend to hedge less, following the implication of the theory by Mello and Ruckes (2008). Companies who operate in less lines of business might have a competitive edge for those particular lines and, therefore, partially hedge. This is supported by Froot (2007) who states that insurers should hedge completely on the risks where they do not have a competitive edge. They retain the risk where they have an edge over their competitors.

The study also finds that the number of insurers and the concentration by state have a positive and a negative relationship with hedging, respectively. The evidence supports Allayannis and Ihrig (2001) and Adam, Dasgupta, and Titman (2007) who observe that the intensity of competition increases the level of hedging. At times when the intensity of competition is high, companies have more incentive to hedge as they have a higher chance to become insolvent. My study demonstrates that the hedging of each insurer has a positive relationship with the industry's hedging level, which may suggest that the hedging level of the industry affects individual hedging decisions. On average, individual insurers appear to follow the trend of hedging of the industry as a whole. The insurers that rely on brokerage networks at a different level from their peers seem to hedge less. However, Maksimovic and Zechner (1991) suggest that companies can substitute financial hedging with investing in technology at a similar level to their peers. One possible explanation is again from the discussion of Mello and Ruckes (2008) and Froot (2007). Insurers that do not use brokerage networks might tend to sell their policies by themselves, and as a result they have their own edge and are confident of the risk they write. This is similar to Berger, Cummins, and Weiss (1997) who note that insurers who implement direct selling in-house have higher revenue efficiency than insurers who use independent agents. Therefore, they do not need to hedge the risk as much, compared to the insurers that use brokers.

The structure of this paper is organized as follows: First, I identify and discuss the possible factors that affect hedging. Second, I describe the data used in this study. Third, I conduct an empirical investigation to test which factors affect risk management. Lastly, I summarize the study.

1.2. Risk Management in the P&L Insurance Industry

According to Modigliani and Miller (1958), risk management adds no value to firms in the market where there is no friction. However, risk management adds value when introducing frictions into the framework. Smith and Stulz (1985) argue that there are several factors that influence a firm's hedging decisions. These factors include taxation, contracting costs, and managerial behavior. In addition, Froot, Scharfstein, and Stein (1993) explain the expensive cost of external financing that leads management to develop different hedging policies. For example, the larger size firms have less asymmetric information problems, and are, therefore, expected to have less problems associated with the costs of external financing. The hedging levels in larger firms are, therefore, expected to be smaller. Following the theories about the influences on company hedging by Smith and Stulz (1985) and Froot, Scharfstein, and Stein (1993), Tufano (1996) shows that managerial behavior influences the hedging level in the gold mining industry and that gold mining companies hedge more if the management owns more shares of the company. Moreover, firms hedge less if the management team has more options in the company. A further empirical study in the gold mining industry, by Dionne and Garand (2003), using the same analysis as Tufano (1996), found that tax, financial distress, the cost of external financing and the ownership by managers all affect hedging decisions. However, these studies mainly focus on the financial factors that affect the risk management of the firms involved.

In addition to the effects of financial considerations on hedging decisions, competition and market structure also play key roles. According to Maksimovic and Zechner (1991) and MacKay and Phillips (2005), firms tend to compare their investment in technology to their peers within the industry. The level of financial hedging is reduced if the investment in technology is close to their peers, because the financial outcomes are going to be similar. Nain (2005), Adam, Dasgupta, and Titman (2007) and Mello and Ruckes (2008) predict that industry factors, such as the number of companies, the intensity of competition and the level of hedging of the whole industry all play a role in hedging decisions. Moreover, Liu and Parlour (2009) argue that firms with a better chance to win new business will be in a riskier situation if they do not hedge. Therefore, firms with a higher chance to win business tend to hedge more. In the same spirit as Allayannis and Ihrig (2001), MacKay and Phillips (2005) and Adam and Nain (2013), I will consider the effects of the market structure and competition on hedging activities. However, I will do this through the lens of the P&L insurance companies.

Next, I will explain each friction that could possibly lead insurers to hedge differently, and I will look at the relationship with its hedging level. I separate the effects into three categories, which are financial considerations, competition considerations and the state of the US reinsurance market. I will now discuss the variables that are possibly associated with the insurer's risk management strategy.

1.2.1. Financial Consideration for Risk Management.

- **Cost of External Financing**: According to Froot, Scharfstein, and Stein (1993), higher costs of external financing lead to more hedging. I expect the cost of capital to rise if the debt rating is at a distressed level. I have ranked the cost of external capital for each company using the rating from A.M. Best. If the rating starts with A, then the cost of external capital score is 1. If the rating starts with B, then the cost of external capital score is 2, etc. According to Froot, Scharfstein, and Stein (1993), firms with a specific project to invest in will likely use risk management to protect themselves from obtaining expensive external financing. Therefore, I expect to see more hedging activity when the cost of external financing is higher. I call this variable $COSTCAP$. Another variable that captures the cost of external capital is an unobserved propensity to fail, according to Grace and Leverty (2012). Similar to the rating by A.M. Best, if an insurer has a higher propensity to fail, it is harder for the insurer to obtain external financing. I call this variable $PFail$.

Accumulative knowledge that is related to a company's formulation of its strategy, includes information about its position and its competitors. Examples of accumulated knowledge, as discussed by Fiegenbaum and Thomas (2004), also include knowledge arising from strong brands, reputation and innovation. $COSTCAP$ (from the previous section) is the variable that I use to represent the reputation of insurer. A low $COSTCAP$ variable means that the company is in a good shape and, therefore, has a stronger reputation among the capital provider. It gives the policyholders confidence in the company. On the other hand, a high $COSTCAP$ variable means that the company is in distress. Hence, it will be harder to raise capital as investors will be reluctant to lend. In addition, the policy buyers will have less confidence to buy policies from a failing company.

• **Firm Size**: The relationship between asset and risk management activity is ambiguous from a theoretical point of view. Froot, Scharfstein, and Stein (1993) and Tufano (1996) argue that smaller firms have higher asymmetric information problems than the larger firms, at least for financing activities. The agency cost is higher for smaller insurers. Hence, in a soft market, smaller insurers need to protect themselves from the costs of outside financing by having protection of the underwriting risk. We should expect to see smaller firms more involved in risk management. Therefore, we should expect to have a negative relationship between firm size and risk management. Mayers and Smith (1990) find a negative relationship between size and the level of risk management of P&L insurers. Controlling for the log of the admitted asset, Hoyt and Khang (2000) also find a negative relationship between firm size and the amount of reinsurance purchased.

According to Liu and Parlour (2009), however, a firm is likely to hedge more if it expects to win new business. The firm will not hedge as much if it does not have enough available resource to take on a new business. This is because the firm will be in an overhedged position if it cannot win the business. The hedging position of a small firm will be wasted. In order to win new business, the firm will put in the effort to bid more. Hedging creates value for the firm if it wins new business. Since a bigger firm has more capacity and resource to win over the competition due to its scale in its setting, it can be expected to see a positive relationship between its size and hedging level. In addition, Stulz (1996) argues that the actual corporate use of derivatives does not align with the theory that larger firms hedge less than smaller firms. Large firms seem to have a higher hedging level than small firms. For all these reasons, it is interesting to empirically explore the relationship between firm size and hedging level. I use the log of the book value of assets as the measure of each firm's size. I call this variable $ASSET$.

- **Tax**: Smith and Stulz (1985), Stulz (1996) and Graham and Smith (1999) argue that a convex tax schedule leads to more hedging. Without hedging, a firm will have high volatility of income. Hence, the tax will be very high in high income years, and very low or zero in low income or loss years. Hedging will lower the volatility of the income. Hence, the theory predicts that on average, firms that hedge will pay less tax. Therefore, the value of the firm increases. Tufano (1996) uses the tax loss carried forward to check the relationship with the hedging level. He finds no apparent relationship between the tax loss carried forward and the hedging level. Dionne and Garand (2003) use both deferred tax, divided by assets, and the tax saved, as used by Graham and Smith (1999) to be their measure of the tax. They find evidence that both have a significant impact on the hedging levels of gold mining companies. Cole and McCullough (2006) use tax-exempt investment income, divided by the total investment income, to capture the tax effect on the reinsurance purchase level of P&L insurers. They do not find a relationship between the tax and the level of risk management. I use the federal and foreign income tax incurred, divided by the book value of assets, as a measure of relevance of tax on hedging. If the ratio between total income tax and book value of the asset is high, then managers tend to consider corporate income tax as a factor of the hedging level. Therefore, I expect to see a positive relationship between tax and the hedging level. I call this variable TAX.

- **Financial Distress and Leverage**: Tufano (1996) and Hoyt and Liebenberg (2011) use leverage to determine the level of risk management of firms. Both argue that low leverage can act as a substitute to the amount of the firm's hedging level. When the insurers are in a distress situation or have high leverage, they tend to buy more reinsurance. Taksar and Markussen (2003) argue that firms with a high level of capital or a low level of leverage tend to have a lower level of reinsurance. I expect an inverse relationship between the leverage and the hedging level. On the other hand, Rampini, Sufi, and Viswanathan (2014) argue that the firms with more financial constraints in a distressed situation will have less incentive and resource to buy more insurance products. It will be interesting to empirically see how the leverage and the financial distress play a role in the decisions for risk management. I use the ratio of the book value of the total liability over the total book value of assets, as used in the study by Hoyt and Liebenberg (2011). I call this variable $LEVERAGE$.

In addition to the $LEVERAGE$ variable, I also use the loss development to capture the distress of the company. According to Cole and McCullough (2006), an insurer that has positive loss development over the previous years has been under-reserved. Therefore, the insurer is in a distressed situation and requires more reinsurance contracts. I use the one-year loss development and loss expenses incurred, divided by total book value of assets, expressed as $LOSSDEVE$.

• **Under Investment Problem**: Under an assumption that a company finances its project only with equity, the firm should take the project when the net present value of the project is non-negative. However, if the capital structure consists of risky debt, there will be an underinvestment problem according to Myers (1977) and Mayers and Smith (1987). If the project turns out to be in a bad state, the firm will more likely go in to bankruptcy. The firm might have to forgo some investment opportunities due to the risky debt in the capital structure. The insurer can protect itself from falling into crisis by partially purchasing reinsurance contracts. Mayers and Smith (1990) and Powell and Sommer (2007) use leverage to test the hypothesis. They expect insurers with higher leverage to consider purchasing more reinsurance contracts. The higher leverage ratio indicates a higher probability that the insurer will go to bankruptcy. In addition, Cole and McCullough (2006) use profitability to capture the effect of underinvestment problems. They hypothesize that insurers with higher profitability consider purchasing less reinsurance contracts. For this study, I use both leverage and profitability to capture the problem of underinvestment. The additional variable for profitability is the return on assets, which is the net income, divided by the total book value of assets. I call this variable ROA.

• **Organizational Form**: This study also considers problems of organizational form. Various studies, such as Mayers and Smith (1981), Lamm-Tennat and Starks (1993), Mayers and Smith (1994) and Pottier and Sommer (1997) study the impact of organizational form on the risk levels of insurers. There are three main types of agents: policy holders, equity holders and managers. These agents have a conflict of interest according to the different forms of their organizations. This leads to different levels of risks in different companies. Most of the previous studies indicate that stock insurers engage in more risky lines of business than the mutual insurers. Therefore, stock insurers tends to purchase less reinsurance contracts and have higher risk compared to mutual insurers. In addition, Cole and McCullough (2006) hypothesize that stock insurers can be expected to have easier access to capital markets. Therefore, it is expected that they have less incentive to buy reinsurance to protect themselves from distressed conditions. I expect organization structures to have an impact on the risk management activity of the insurers. I use a dummy variable called $STOCK = 1$, if the insurer is a stock company, and $STOCK = 0$, if it is a mutual company.

1.2.2. Market Structure and Competition Effect on Risk Management.

I will now discuss the possible variables that capture the interdependence of insurers.

• **Market Share**: Managers compare their companies' position to competitors within the industry. For example, Fiegenbaum and Thomas (2004) argue that managers use other firms as a reference point before formulating a strategy. Market share is a good measure of a firm's positioning in the industry. According to Sommer (1996), the bigger companies tend to be healthier than the smaller ones in the insurance industry. This implies that customers are more willing to buy policies from the insurers with a bigger market share. The bigger insurers can charge higher prices than the smaller firms and face a lower insolvency risk. According to Mello and Ruckes (2008), firms with a competitive edge over their competitors tend to hedge less. By having the advantage of charging higher prices than the smaller players in the industry, insurers with a larger market share have less incentive to hedge. I expect to see a negative relationship between market share and the level of hedging. I call this variable $Marketshare$ to represent the market share. The market share is defined as,

$$MarketShare_{it} = \frac{\text{Net premium written of the insurer i at time t}}{\sum_{j=1}^{n} (\text{Net premium written of the company j at time t})} \tag{1.2.1}$$

where n is the total number of insurers in the industry.

• **Diversification**: Similar to Mayers and Smith (1990), Choi and Weiss (2005), Cole and McCullough (2006) and Leverty and Grace (2010), I have measured the concentration of the lines of business and the states they operate in, using the Herfindahl index to express both states and lines of business. The Herfindahl index has been used to characterize the market of each insurance company in terms of geography and business type. The state Herfindahl index for each company can be written as,

$$HerfindahlState_{it} = \sum_{j=1}^{n} (\text{\% share of direct premium written in state j at time t})^2 \tag{1.2.2}$$

where n is the total number of states. Under this definition, it represents several characteristics. First, if the $HerfindahlState$ is high, it means the company is focusing on particular states. On the other hand, if the $HerfindahlState$ is low, the company has diversified itself to many states, but might face more competition in many states compared to businesses with a higher value of the index. The insurer that has more concentration can enjoy the benefit of reinsurance as a means to diversify itself. However, the insurer that has less concentration does not need to buy more reinsurance.

Similar to the state Herfindahl index, the line Herfindahl index measures the concentration of competition by lines of insurance. I use the net premium written, instead of the direct premium, for the line Herfindahl index. The Herfindahl index by line captures the market structure of each company by line of business. The $HerfindahlLine$ is defined as,

$$HerfindahlLine_{it} = \sum_{k=1}^{m} (\text{\% share of net premium written in line k at time t})^2 \tag{1.2.3}$$

where k is the index for each line. The insurer with greater concentration can enjoy the benefits of reinsurance as a means to diversify itself. However, the insurer with less concentration does not need to buy more reinsurance. Cole and McCullough (2006) find that both Herfindahl by line of business and by state have a negative relationship with the hedging level of insurers. So, there is evidence that the diversification of lines and the geography have an impact on risk management decisions. We will see how insurers react to their own diversification in this study.

• **Level of Hedging in the Industry**: According to Nain (2005) and Adam, Dasgupta, and Titman (2007), firms decide to hedge according to the level of hedging within the industry[1].If the overall level of hedging in the industry is high, firms might not want to hedge on the revenue or cost volatility as much, to take advantage of their flexibility to produce. On the other hand, a company might hedge more if the benefit of the flexibility to produce is lower, compared to hedging. Therefore, it is interesting to see how the level of hedging of the industry as a whole affects the decisions made by individual insurers. I have measured the level of hedging of the industry for each year by calculating the median of the variable $Hedge$. I call this variable $IndHedging$.

• **Number of Firms**: Adam, Dasgupta, and Titman (2007) predict that when there are more companies within the industry, the incentive to hedge increases. One possible explanation to this is that a higher numbers of firms within the industry push down the margin between price and cost, and as a result, unhedged firms are likely to suffer as a result of the cost shock. Similar to the findings of Allayannis and Ihrig (2001), firms in a more competitive environment find it hard to adjust price according to changes in cost. Hence, firms in a more competitive landscape are exposed to more risks, and they tend to hedge more. On the other hand, Mello and Ruckes (2008) argue that the firms that tend to hedge less may be more exposed to competitive market conditions, but can benefit more from a higher cash flow state. This is in line with Adam and Nain (2013) who find that hedging has a negative relationship with the intensity of competition. I capture the competition level by considering the number of firms. I take a log of the number of insurers for each year to avoid the influence of magnitude of this variable, since there are more than 2,000 insurers each year. I call this variable $NumIns$, representing the total number of insurers at a given time.

• **Intensity of Competition in the Industry**: I capture the level of competition through the level of concentration within the industry. Similar to the relationship to the number of firms, we should expect that the level of hedging increases with the level of intensity of competition, according to Allayannis and Ihrig (2001) and Adam, Dasgupta, and Titman (2007). However, if

[1]Adam, Dasgupta, and Titman (2007) assume that each firm in the model decide to hedge fully or does not hedge at all.

the competition is intense, firms tend to hedge less, according to Mello and Ruckes (2008) and Adam and Nain (2013). Therefore, it is interesting to see the relationship between hedging and competition intensity. To capture the level of concentration in the industry, I use the method developed by Montgomery (1985) and followed by Liebenberg and Sommer (2008) to capture the industry concentration. First, I calculate the Herfindahl index for each line of business using the relationship,

$$Herf_{jt} = \sum_{i=1}^{n} \left(\frac{NPW_{ijt}}{NPW_{jt}} \right)^2 \tag{1.2.4}$$

NPW_{ijt} is the net premium written for a company i on line j at time t. NPW_{jt} is the particular line j total net premium written in the year t. Then we can find the weight for each line of business j for each insurer i by,

$$weight_{ijt} = \frac{NPW_{ijt}}{NPW_{jt}} \tag{1.2.5}$$

Therefore, a firm's exposure to the industry competition can be calculated as,

$$IndHerfLine_{it} = \sum_{j} weight_{ijt} * Herf_{jt}. \tag{1.2.6}$$

Each firm has its own intensity of exposure in the industry. The larger the value of $IndHerfLine_{it}$, the higher the concentration of competition the firm i faces at a given time t. In addition to the concentration by lines of business, I also calculate the concentration of the Herfindahl index by geography. I call this variable $IndHerfState$.

• **Positioning in the Industry**: Maksimovic and Zechner (1991) argue that the levels of risk management are based on the investment of technology by the insurers. The study implies that firms that have a similar level of technology have similar profit outcomes compared to their competitors, and therefore, have higher leverage than firms that have much higher or much lower technology than the industry. MacKay and Phillips (2005) shows that there is a reverse relationship of the differences from the median of industry's technology and debt level. These studies are in line with Fiegenbaum and Thomas (1995) where firms use a reference point to measure how it is doing compared to its peers. A firm's strategy changes according to its reference point. This study follows the approach of MacKay and Phillips (2005) to find the relationship of a firm's position in its industry and its risk management activity. I expect to see a positive relationship between the positioning and the risk management in the industry, if the prediction based on the theory is right.

In contrast to MacKay and Phillips (2005), an insurance company's capital usage is extensively based on human capital rather than fixed assets[2]. In this study, I use five measures of technology in considering the needs of insurance companies: 1) total salary, divided by total expense, 2) total agent expense, divided by total expense, 3) total brokerage expense, divided by total expense, 4) total data equipment and software assets, divided by total assets. 5) total advertising expense, divided by total expense. Using a similar method to MacKay and Phillips (2005), I define the positioning variable for each technology by using the following equation,

$$Positioning_{i,t} = \frac{|technology_{i,t} - median(\forall_j technology_{j,t})|}{\max\limits_h[|technology_{h,t} - median(\forall_j technology_{j,t})|]}. \tag{1.2.7}$$

where i is for the firm i, j is all the firms within the industry and t is for the year t. This positioning (for each technology) is the measure of how far each company invests in its technology in comparison to the median of the industry, divided by the range of the distance from the industry.

• **Product Type**: According to Winter (1994), the price of insurance depends on the type of the line of business each insurer offers. The theory implies that the price of more risky lines are expected to be higher. Therefore, the cost of acquiring a reinsurance contract in those lines tends to be higher. Hence, the incentive for buying insurance contracts for those particular lines of business tend to be lower. Therefore, it is expected that those product types have an impact on risk management activity. In addition, elasticity of demand and convexity of production costs of the products influence hedging activity, according to Adam, Dasgupta, and Titman (2007). Therefore, we expect that each product type will affect hedging activity differently. Mayers and Smith (1990) and Cole and McCullough (2006) also control for the product type in their studies of the demand by reinsurers for reinsurance contracts. Instead of controlling for each line of business, I categorize the lines into four categories, in a similar manner to the study by Phillips, Cummins, and Allen

[2]MacKay and Phillips (2005) analyzes the positioning and debt level of companies that are not in the financial industry. They mainly focus on the use of capital invested in fixed assets, such factories or properties.

(1998), according to the Table 1.1. For each category of business, I define these variables with their respective net premium written in each category, divided by the total premium written.

1.2.3. Reinsurance Market Specific Effects on Risk Management.

According to Cole and McCullough (2006), the condition of the reinsurance market has an effect on the level of the hedging strategy by the primary insurers. In this study, I define reinsurers as the businesses that assume a premium from their non-affiliates, which represent more than 75% of their direct business, including the reinsurance that is assumed from their affiliates. This is similar to the definition used by Cole and McCullough (2006). I will now discuss the variables that will be included for the reinsurance market.

• **Price**: Cole and McCullough (2006) conjecture that the price of reinsurance contracts has an effect on decisions to hedge, made by insurers. For example, a shock on the loss can limit the supply of the insurance contract, according to Winter (1994), Cummins and Danzon (1997) and Weiss and Chung (2004). After a wide loss, the price of the reinsurance contract is expected to increase, which discourages primary insurers from buying. Furthermore, Cole and McCullough (2006) find that the relationship between the reinsurance price and the hedging level are negative. This evidence suggests that the cost of reinsurance will deter the willingness to hedge. In my study, I use the ratio of the net premium written to the incurred losses for the current year as the measure of the price for reinsurers. The price variable for the reinsurance market is calculated by using the average price weighted by the net premium written of each reinsurer. The variable is called $RePrice$.

• **Development of Loss Reserves**: Cole and McCullough (2006) hypothesize that a ceding company will buy more(less) if the health of reinsurers is better(worse). Cummins and Danzon (1997) also suggest that the price of the insurance contracts will depend on the credibility of the reinsurers. This is because insurers have to take responsible for losses if the reinsurers become insolvent. Therefore, they need to buy policies from financially sound policy sellers. Cole and McCullough (2006) use the loss development to gauge this factor of the insurer's hedging decision. However, they do not find any relationship between the risk management level and the loss development among reinsurers. For this study, I still consider loss development to test the health of the reinsurance market. I use one year of loss development, divided by the total book value of assets of the reinsurers for each year to indicate whether the reinsurers are financially sound. This approach is similar to the variable used by Cole and McCullough (2006). I have shown the loss development for each reinsurer, and have also calculated the averaged loss development for the whole reinsurance industry weighted by the net premium written. This variable will be called *ReLossDeve*.

• **Liquidity**: Cole and McCullough (2006) argue that there are two reasons that the liquidity of reinsurers influence their hedging decisions. First, if the overall reinsurance market has more liquid assets, for example, cash and invested assets, scaled by liabilities, then the whole reinsurance market will tend to be more stable. Therefore, a stable market creates more incentive for primary insurers to buy insurance. In addition, liquidity is a sign of excess capacity in the reinsurance market. Hence, reinsurers are more willing to sell reinsurance to insurers, and the price of the insurance will be low compared to the lower liquidity environment. Under this excess liquidity condition, we should see that insurers tend to buy more reinsurance contracts. However, Cole and McCullough (2006) do not empirically find any relationship between liquidity of the reinsurers and the level of hedging of the insurers. I use the liquidity of the whole reinsurance industry as a variable for the level of hedging by insurers. Similar to the method used by Cole and McCullough (2006), I use the average cash and invested assets, divided by the total liability to measure the liquidity of the reinsurers weighted by the net premium written. This variable will be called *ReLiquidity*.

1.3. Hedging Level

This section defines the insurers' hedging level. I use data from the Underwriting and Investment (Exhibit Part 1B) to measure the hedging level. The reinsurance ceded is the sum of Column 4 and 5. These include the ceded premiums to affiliates and non-affiliates. The total gross premium is the sum of Column 1, 2 and 3. These columns include the direct business written, and reinsurance assumed from affiliates and non-affiliates. I denote the premium ceded, divided by the total premium written as *Hedge*.

In summary, the test will follow the equation,

$$Hedge_{it} = \alpha + \beta X_{it} + \gamma Z_t + \epsilon_{it}, \tag{1.3.1}$$

where,

$Hedge_{it}$ = reinsurance ceded/(total direct premium written + reinsurance assumed)

X_{it} = a vector of all the controlled variables which assumed to be exogenous for the i^{th} insurer in year t.

Z_t = a vector of all reinsurance condition effect variables in year t

The controlled variables and the expected sign of relevance to the risk management level are in Table 1.2.

1.4. Data

In this section, I explore the empirical evidence for factors that will have effects on the risk management activity in the P&L insurance industry using the NAIC data. The study focuses on each insurer individually, not at a group level. There are four outliers of the ceding level, which I expect to be the insurers who are liquidating or having accounting errors. Therefore, I have eliminated those observations. In total, there are 23,671 observations throughout the period of 1989 to 2009. The summary statistics for each variable are in Table 1.3. On average, insurers ceded about 38% during the period. This is in line with the median level of ceding which is about 35%.

1.5. Empirical Methodology

There are four main econometric issues that I need to address. First, the data is panel data because it consists of each company's variables and time period. Second, the panel data is not balanced, which means that the number of unique IDs will be different for each year. Third, there might be a firm's specific characteristic effect. Fourth, I assume that the independent variables on the right-hand side of the equation are all exogenous. To tackle all these requirements, I fitted random effects and fixed effects into the model. To compare with the previous studies based only on the financial considerations of hedging, such as Tufano (1996), I fitted the model with only financial consideration variables. Next, I fitted the model with all the variables that I have discussed. For each model, I use the Haussman test to choose between the random-effect regression and the fixed-effect regression. The result from the regressions is in the next section.

1.6. Multivariate Results

According to Table 1.4, the first and second panels, study the effects of financial considerations on risk management. The first panel shows a random-effect regression, whereas, the second panel shows a fixed-effect regression. According to the first two panels, the Haussman test gives the χ^2 statistics of 153.94 and the p-value of 0.000. Hence, it rejects the null hypothesis that the use of random-effect regression is appropriate. Therefore, I have focused on interpreting the results of the financial considerations on the risk management in Panel (2), which is the fixed-effect regression.

According to the result, leverage has a negative relationship with the hedging level. This finding supports the view of Rampini, Sufi, and Viswanathan (2014) that insurers who have more leverage or less resource will have less incentive to hedge. Loss development has a positive relationship to the hedging level. This result suggests that insurers in distressed situations cede more risks. Tax has a negative relationship with hedging. The result contradicts Smith and Stulz (1985) who argue that the smoothness of income from hedging on the tax payment will benefit insurers. One possible explanation is that the tax schedule in the insurance industry might not be strictly convex, as Smith and Stulz (1985) assume. Therefore, the tax and hedging relationship do not need to exhibit a positive relationship.

Now, we turn attention to the last two panels of the regressions. Panel (3) and (4) take into account the competition and the market structure of the P&L insurance industry and the health of the US reinsurance market. Panel (3) shows a random-effect regression. Panel (4) shows a fixed-effect regression. The Haussman test gives the χ^2 statistics of 214.99 and the p-value of 0.0057. Therefore, we can reject the null hypothesis that the random-effect panel regression is an appropriate model to fit this data. Hence, we focus on the interpretation of our result in Panel (4). The relationships of financial variables and hedging is similar to Panel (2).

Assets have a negative relationship with the hedging level, supporting Tufano (1996) who suggests that larger firms can get external financing more easily than their peers, and, therefore, have less incentive to hedge. Leverage, loss development and tax provide the same effect as the case where I consider the financial factors alone. Looking at the competition and market structure side, market share has a negative relationship with hedging. This supports the study by Mello and Ruckes (2008). Insurers with higher market power or competitive edge tend to hedge less to take advantage of their power in the market. The Herfindahl index figures by line of business and the Herfindahl index figures by state have negative relationships to the level of risk management. More focused insurers tend to hedge less. This can be explained by Mello and Ruckes (2008). Insurers, who operate in a particular line of business, might have a competitive edge, such as better customer service and reduced costs associated with searching for products for customers, compared to their competitors. Therefore, those businesses do not need to hedge as much, compared to more diversified insurers. The result is also in line with the study by Froot (2007). Insurers should hedge completely to avoid risk where they do not have an edge. They retain the risk where they have an edge over their competitors.

The number of insurers and the concentration by states have a positive and negative relationship with hedging, respectively. This evidence supports the findings of Allayannis and Ihrig (2001) and Adam, Dasgupta, and Titman (2007) that the intensity of competition increases the level of hedging. In periods where intensity of competition is high, insurers have more incentive to hedge because they have more chance to become insolvent. Therefore, hedging has a positive relationship with the industry's hedging level. It possibly implies that the hedging level of the industry affects individual hedging decisions. On average, insurers appear to go with the trend of hedging as an industry. Out of five positioning variables, there is only one that has a significant relationship with underwriting risk management. The positioning on brokerage network has a negative relationship with hedging. This result contradicts a prediction by Maksimovic and Zechner (1991). One possible explanation is, again, from the discussion of Mello and Ruckes (2008) and Froot (2007) that insurers that do not use brokerage networks tend to sell their policies directly themselves. They have their own edge on selling policies and are confident about the risk they write. This is similar to the view of Berger, Cummins, and Weiss (1997) that the insurers who implement direct selling in-house have higher revenue efficiency than insurers who use independent agents to sell them. Therefore, they might not need to hedge the risks as much as the insurers who use brokers.

The analysis also investigates the correlation between the conditions of the reinsurance market and the ceding levels of insurers. Cole and McCullough (2006) predict that hedging should have a reverse relationship with loss development in the reinsurance market. However, my findings indicate that hedging has a positive relationship with loss development in the reinsurance market. This might imply that reinsurers who are in a distressed situation tend to offer lower prices to gain more customers. Therefore, this increases the incentive for primary insurers to increase the purchase of reinsurance contracts. This is similar to the argument presented by Phillips and Sertsios (2013) who suggest that firms in a distressed situation tend to adjust price, quality and quantity of their products to survive.

1.7. Conclusion

In addition to the previous literature that explores why insurers have different hedging levels, I add competition and the market structure of the industry into the framework. Analysis of the available data (from 1989 to 2009), shows that insurers took financial factors, competition, market structure and the reinsurance market conditions into consideration when making risk management decisions. There is evidence that financial considerations, such as size, leverage, loss development and tax, influence hedging decisions. In addition, the evidence suggest that the competition and market structure influence hedging decisions, as expected.

The market power, market positioning, diversification of lines, intensity of competition and the level of hedging within the industry all play roles in risk management decisions. Insurers with a competitive edge, by having higher market power, rely on brokers differently from their peers, and by being more focused on lines of business, they tend to hedge less. This supports the studies by Froot (2007) and Mello and Ruckes (2008) that observe that firms with a competitive edge have less incentive to hedge. There is also evidence that a higher intensity of competition increases the level of hedging, as predicted by Allayannis and Ihrig (2001) and Adam, Dasgupta, and Titman (2007). By hedging within a more competitive market, insurers have less chance to fall into bankruptcy. It, therefore, appears that the hedging levels of the industry have a positive relationship with the firm's hedging decisions. This might suggest that the flexibility of production within insurance industry benefits insurers less than hedging.

The study implies that considering financial variables as the main driver for risk management does not provide a complete picture. Competition and market structure also influence the hedging decisions. The result confirms the findings of MacKay and Phillips (2005) and Adam and Nain (2013) that competition and market structure play roles in risk management activity. Therefore, risk managers in the insurance industry have to take into account these factors when implementing corporate risk management strategies.

TABLE 1.1. Categories of Business

Personal Short-Tail	**Personal Long-Tail**	**Commercial Short-Tail**	**Commercial Long-Tail**
3 Farmowners multiple peril	19.1 Private passenger auto liability	1 Fire	11.1 Medical malpractice–occurrence
4 Homeowners multiple peril	19.2 Private passenger auto liability	2 Allied lines	11.2 Medical malpractice–claims–made
21 Auto physical damage		5 Commercial multiple peril	16 Workers' compensation
		6 Mortgage guaranty	17.1 Other liability–occurrence
		8 Ocean marine	17.2 Other liability–claims–made
		9 Inland marine	18.1 Products liability–occurrence
		10 Financial guaranty	18.2 Products liability–claims–made
		12 Earthquake	19.3 19.4 commercial auto liability
		13 Group accident and health	22 Aircraft
		14 Credit accident and health (group and individual)	
		15 Other accident and health	
		23 Fidelity	
		24 Surety	
		26 Burglary and theft	
		27 Boiler and machinery	
		28 Credit	
		29 International	

Note: This table shows the insurance lines of business in the data. The categories include personal short-tail, personal long-tail, commercial short-tail and commercial long-tail lines of business.

Table 1.2. All Variables of Interest

Factors	Variable Names	Descriptions	Categories	Expected Signs
Strategy	$HEDGE$	Premium ceded/Total premium written	Strategy/Conduct	
Financial Consideration	$COSTCAP$	Rating from A.M. Best	Cost of External Financing/Reputation	+/-
	$PFail$	Propensity to fail	Cost of External Financing	+/-
	$ASSET$	Natural log of book value of total assets	Firm Size	+/-
	$LEVERAGE$	Book value of total debt/Book value of total assets	Financial Distress and Leverage	+/-
	$LOSSDEVE$	One year loss development/Book value of assets	Financial Distress and Leverage	+/-
	TAX	Total income tax/Book value of total assets	Tax	+
	$STOCK$	1 if stock and 0 mutual	Organizational Form	-
	ROA	Net income/Book value of total assets	Investment Incentive	-
Market Structure & Competition	$MarketShare$	Market share by net premium written	Market Position	-
	$ShortTailCom$	Total gross premium on short-tail commercial/Total gross premium on all the lines	Product Type	+/-
	$LongTailCom$	Total gross premium on long-tail commercial/Total gross premium on all the lines	Product Type	+/-
	$ShortTailPer$	Total gross premium on short-tail personal/Total gross premium on all the lines	Product Type	+/-
	$LongTailPer$	Total gross premium on long-tail personal/Total gross premium on all the lines	Product Type	+/-
	$HerfindahlLine$	The measurement of the diversification of the product lines for each insurer	Diversification/Competitors	+/-
	$HerfindahlState$	The measurement of the geographic diversification for each insurer	Diversification/Competitors	+/-
	$HerfIndLine$	The measurement of the exposure to the intensity of competition by product lines	Intensity of Competition	+/-
	$HerfIndState$	The measurement of the exposure to the intensity of competition by geography	Intensity of Competition	+/-
	$NumIns$	Number of insurers	Intensity of Competition	+
	$IndHedging$	Median of the industry's hedging level	Intensity of Competition	+/-
	$PosSalary$	Positioning based on salary expenses	Positioning	+
	$PosAgent$	Positioning based on agent expenses	Positioning	+
	$PosBroker$	Positioning based on broker expenses	Positioning	+
	$PosAdver$	Positioning based on advertising expenses	Positioning	+
	$PosSoftware$	Positioning based on electronic and software investment	Positioning	+
Insurance Specific Effect	$RePrice$	Net premium written/Incurred losses of reinsurers	Reinsurance Market's Price	-
	$ReLossDeve$	Average 1 year loss development for the reinsurers/Book value of total assets	Reinsurers' Strength	-
	$ReLiquidity$	Cash and invested assets/Total liability of the reinsurance industry	Reinsurers' Liquidity	+

Note: This table shows the variables that will be included as dependent and independent variables. The first column specifies the category of the variables. The second column indicates the name of each variable. The third column is the description of how I obtain each variable from the NAIC data and the A.M. Best data. The fourth column describes how each variable relates to the argument from previous studies. The last column specifies the relationship between each variable and the hedging level ($HEDGE$).

Table 1.3. Summary Statistics of All Variables

Variable	Mean	Std. Dev.	Min	Max
Strategy				
HEDGE	0.3834	0.2933	-7.6849	6.8586
Financial Factors				
COSTCAP	1.2494	0.5386	1.0000	6.0000
PFAIL	0.0035	0.0219	0.0000	0.9506
ASSET	18.5242	1.7596	13.5693	25.3757
LEVERAGE	0.5937	0.1726	-0.2308	2.5604
LOSSDEVE	-0.0054	0.0512	-2.7879	2.1134
TAX	0.0102	0.0202	-0.5406	0.8626
STOCK	0.7477	0.4343	0.0000	1.0000
ROA	0.0274	0.0672	-3.0617	4.0927
Market Structure and Competition Factors				
MarketShare	0.0697	0.3501	0.0000	9.1381
ShortTailCom	0.2457	0.3594	-29.8347	4.7274
LongTailCom	0.2870	0.5432	-7.7698	64.3899
ShortTailPer	0.2587	0.3145	-21.7012	2.8160
LongTailPer	0.1748	0.3326	-11.8540	31.2549
HerfindahlLine	0.4097	0.2625	0.0684	1.0000
HerfindahlState	0.5044	0.3746	0.0303	1.0000
HerfIndLine	0.0362	0.0159	0.0085	0.1892
HerfIndState	0.0224	0.0077	0.0094	0.1903
NumIns	7.9073	0.0210	7.8617	7.9484
IndHedging	0.3456	0.0230	0.3075	0.3907
PosSoftware	0.0173	0.0416	0.0000	1.0000
PosBroker	0.0071	0.0090	0.0000	0.2242
PosAgent	0.0018	0.0197	0.0000	0.9805
PosAdver	0.0073	0.0316	0.0000	0.9865
PosSalary	0.0096	0.0144	0.0000	0.2644
Reinsurance Market Factors				
Reprice	0.9630	4.1569	-16.8732	3.5364
ReLossDeve	0.0350	0.0897	-0.0066	0.4193
ReLiquidity	1.3085	0.2379	0.8327	1.5440

Note: The summary statistics of all variables are presented. The sample size is 23,671 and the years are from 1989 to 2009. This table consists of four variable types. The first type is our risk management strategy which is $HEDGE$. $HEDGE$ is defined by the premium ceded, divided by total premium written. The financial considerations are $COSTCAP$, $PFAIL$, $ASSET$, $LEVERAGE$, $LOSSDEVE$, TAX, $STOCK$ and ROA. $COSTCAP$, is as defined in the previous section, using A.M. Best rating. $PFAIL$ is the propensity to fail from Grace and Leverty (2012). $ASSET$ is the log of the book value of total assets. $LEVERAGE$ is the book value of total debt, divided by the book value of the total assets. $LOSSDEVE$ is one-year loss development, divided by the book value of the total assets. TAX is the total income tax, divided by the total book value of the assets. $STOCK$ is a dummy variable, which is 1 if the insurer is a stock company, and 0 if it is mutual. ROA is defined by the net income, divided by the total book value of the assets. Third, the market structure and competition variables are $Marketshare$, $ShortTailCom$, $LongTailCom$, $ShortTailPer$, $LongTailPer$, $HerfindahlLine$, $HerfindahlState$, $HerfIndLine$,$HerfIndState$, $NumIns$, $IndHedging$, $PosSoftware$, $PosBroker$, $PosAgent$, $PosAdver$, $PosSalary$. $Marketshare$ is the percentage of market share of each company compared to the whole industry by net premium written. $ShortTailCom$, $LongTailCom$, $ShortTailPer$, $LongTailPer$ are the product type variables, which are the total gross premiums on each line, divided by total gross premiums on all the lines. Similarly, $HerfindahlLine$, $HerfindahlState$, $HerfIndLine$,$HerfIndState$ represent the concentration by firm and industry, as defined in the previous section. $NumIns$ is the log of the total number of insurers for each year. $IndHedging$ is the median hedging level of the industry. $PosSoftware$, $PosBroker$, $PosAgent$, $PosAdver$ and $PosSalary$ are a firm's positioning on software, broker, agent, advertisement and salary, respectively. Lastly, $RePrice$, $ReLossDeve$ and $ReLiquidity$ are the variables for the reinsurance market. $RePrice$ is the weighted average of net premiums written, divided by the losses incurred of the reinsurers. $ReLossDeve$ is the weighted average of one-year loss development for the reinsurers, divided by the book value of assets for reinsurance policies. $ReLiquidity$ is the weighted average of cash and invested assets, divided by the total liability of the reinsurers. These weights are based on the reinsurers' net premiums written.

TABLE 1.4. Multivariate Results for the Year 1989 to 2009

VARIABLES	(1) RE	(2) FE	(3) RE	(4) FE
COSTCAP	-0.0040	0.0024	-0.0041	-0.0017
	(0.004)	(0.004)	(0.004)	(0.004)
PFAIL	0.0582	0.0383	-0.0071	-0.0602
	(0.066)	(0.070)	(0.065)	(0.068)
ASSET	-0.0030	-0.0010	-0.0348***	-0.0436***
	(0.002)	(0.002)	(0.003)	(0.003)
LEVERAGE	-0.1926***	-0.2222***	-0.1208***	-0.1314***
	(0.013)	(0.013)	(0.013)	(0.014)
LOSSDEVE	0.1551***	0.1408***	0.1343***	0.1248***
	(0.027)	(0.027)	(0.026)	(0.026)
TAX	-0.6334***	-0.5804***	-0.4139***	-0.3552***
	(0.077)	(0.078)	(0.077)	(0.078)
STOCK	0.0765***	0.0208	0.0538***	-0.0036
	(0.010)	(0.014)	(0.010)	(0.014)
ROA	-0.0218	-0.0174	0.0025	0.0053
	(0.022)	(0.022)	(0.022)	(0.022)
MarketShare			-0.1132***	-0.2026***
			(0.015)	(0.021)
ShortTailCom			-0.0212*	-0.0163
			(0.012)	(0.012)
LongTailCom			-0.0122	-0.0086
			(0.012)	(0.012)
ShortTailPer			-0.0262*	-0.0200
			(0.014)	(0.015)
LongTailPer			0.0075	0.0118
			(0.013)	(0.013)
HerfindahlLine			-0.1538***	-0.1449***
			(0.010)	(0.012)
HerfindahlState			-0.1300***	-0.1078***
			(0.009)	(0.010)
HerfIndLine			-0.3489**	-0.2066
			(0.141)	(0.150)
HerfIndState			-1.0855***	-1.1934***
			(0.254)	(0.268)
NumIns			0.5011***	0.6507***
			(0.085)	(0.090)
IndHedging			0.8515***	0.9082***
			(0.078)	(0.078)
PosSoftware			-0.0704*	-0.0581
			(0.037)	(0.038)
PosBroker			-1.7752***	-1.4240***
			(0.203)	(0.210)
PosAgent			-0.1603	0.0484
			(0.156)	(0.207)
PosAdver			-0.0494	-0.0080
			(0.049)	(0.051)
PosSalary			0.1479	0.0817
			(0.125)	(0.130)
Reprice			-0.0002	-0.0003
			(0.000)	(0.000)
ReLossDeve			0.1156***	0.1264***
			(0.017)	(0.017)
ReLiquidity			0.0044	0.0045
			(0.006)	(0.006)
Constant	0.5180***	0.5215***	-2.9867***	-4.0090***
	(0.037)	(0.045)	(0.648)	(0.673)
Observations	23,669	23,669	23,669	23,669
R^2		0.017		0.057
Number of id	1,962	1,962	1,962	1,962

Standard errors in parentheses
*** p < 0.01, ** p < 0.05, * p < 0.1

Note: This table represents the empirical results of the factors that affect risk management on the underwriting risk of the P&L insurers from 1989 to 2009. The dependent variable is the variable $HEDGE$, which is the premium ceded. The first panel consists of the financial considerations on hedging only. The method used in the first panel is random-effect panel regression. The second panel is the same, but with the fixed-effect panel regression. The third panel consists of financial considerations, competition, market structure and reinsurance market effects. I employ random-effect panel regression for the third panel. The last panel is the same as the third panel, but it uses fixed-effect panel regression.

CHAPTER 2

Competitive Edge and Risk Management

2.1. Introduction

Risk management is an integral part of the competitive strategy of insurers. Only a few studies explore the value added by risk management for firms that have competitive edge in particular areas of operation over their competitors. One example is the study by Tufano and Serbin (1993) that finds that American Barrick Resources Corporation hedged most of its gold price risk to reduce its revenue volatility. American Barrick has an edge of being a low-cost producer of gold. Its average cash cost of production was less than its competitors' average. Implementing that operational low-cost advantage, it hedged most of its gold price risk to focus on being a low-cost gold mining operator. As a result, it held onto the risk of being a gold mining operator. Risk management not only helped American Barrick to focus on what it was good at, it helped the company to signal to the market that it was actually a gold mining company instead of a gold trading company. By using this strategic risk management, it achieved superior profitability compared to its competitors during the 90's and its stock price outperformed its competitors. In the same vein as Tufano and Serbin (1993), the goal of this study is to focus on how hedging activities by insurers impact their business advantage. Specifically, this study tries to answer two questions. First, irrelevant to any competitive edge, does risk management add value to the insurers? Second, does risk management add value to insurers with a competitive edge?

Insurers should eliminate or transfer the risk that may not have a competitive edge (Froot (2007)). This implies that risk management activity should go along with the insurers competitive edge. In addition, Mello and Ruckes (2008)'s theoretical model implies that companies with a competitive edge have less incentive to hedge than their competitors. By leaving some exposure to risks, firms with a competitive edge can enjoy a higher chance to gain even more market share from their competitors. Therefore, leaving some risks, a company can benefit from a competitive edge because it has higher chance to win. To explore the competitive edge of insurers, the study specifies what operations are within an insurance company, similar to the value chain analysis in Porter (1980, 1985). Berger, Cummins, and Weiss (1997) classify operations of the insurers into three main tasks: 1) risk pooling and risk bearing, 2) real services relating to insured loss and 3) intermediation. This study focuses on the competitive edge within the risk pooling and risk bearing operations. I focus on the insurers that have the capability to underwrite policies better than their competitor. We call this type of competitive edge, "good underwriting". I capture the good underwriting capability with two definitions: low loss ratio and low loss development in the absolute term. Insurers with a competitive edge in the underwriting business tend to hold onto their risks, as implied by Froot (2007). It is inappropriate to cede the "good risks" that they write to the other reinsurers.

The study design is as follows. First, it studies whether risk management adds value to insurers in general. Instead of using a dummy variable to specify which insurers use risk management, as used in previous literature, I explore how different hedging levels affect the performance of insurers. In addition, I study how each of these hedging intervals add value to insurers that are good underwriters. Using the property and liability insurance data for the years 1989 to 2011, by slicing hedging into intervals, it can give more information about which intervals of hedging benefited the insurers. On average, using very high hedging proves to be unprofitable to the insurers. This might be due to the fact that reinsurance is expensive, corresponding to the studies by Taksar and Markussen (2003) and Froot (2007). Using a very high level of reinsurance purchases might hurt the profit results. In addition, I find that risk management does not seem to add value to the insurers with good underwriting skill. High levels of hedging have a negative relationship with profit. This is in line with the studies by Froot (2007) and Mello and Ruckes (2008) that suggest insurers with a competitive edge over their competitors have less incentive to hedge or should not hedge fully. The results are similar when using a continuous hedging variable and controlling for various specifications.

The structure of the paper is organized as follows. First, I explain the competitive edge of insurers. Second, I discuss how risk management can be implemented to the insurers' advantage. Third, I show how to measure the profit efficiency as a performance of the insurers. Fourth, I explain the econometric models used in the study. Fifth, I describe the data. Sixth, I give some results corresponding to the models I specified. Seventh, I discuss the extensions of the study. Lastly, I summarize the study.

2.2. Competitive Edge of Insurers

There are three main operations of an insurance company according to Berger, Cummins, and Weiss (1997); the risk pooling and risk bearing operation, real services relating to the insured losses operation, and the intermediation operation. First, the risk pooling and risk bearing operation, pools all the risk of the policyholder's property and liability losses. The insurer holds the shareholder's equity capital to bear the risks against the potential losses. Second, real services relating to insured losses provide a service in processing losses, such as risk surveys, policy coverage design, loss prevention and settlement claims. The policyholders benefit from the experience of the insurance company to provide the service. Third, the intermediation operation gathers all the premiums up-front before paying out the claims, called a float. The float money will be invested into the securities market to get the investment return on the available funds. This study focuses the attention on the insurer's competitive edge within the risk pooling and risk bearing operation.

One candidate for an insurer's competitive edge is being a good underwriter. Good underwriters are insurers who have good track record of profitable underwriting over the long term. Some successful companies in the insurance industry focus their attention on being good underwriters. For example, Warren Buffett, who is well known for being a successful investor and owns many insurance companies, such as GEICO, National Indemnity, etc., argues that to be profitable in the insurance industry, insurers have to focus on implementing a profitable underwriting strategy. In his annual letter to Berkshire shareholders in 2011, Buffett highlights some basic principles of being a good underwriter:

"At bottom, a sound insurance operation needs to adhere to four disciplines. It must (1) understand all exposures that might cause a policy to incur losses; (2) conservatively evaluate the likelihood of any exposure actually causing a loss and the probable cost if it does; (3) set a premium that will deliver a profit, on average, after both prospective loss costs and operating expenses are covered; and (4) be willing to walk away if the appropriate premium can't be obtained.

Many insurers pass the first three tests and flunk the fourth. They simply can't turn their back on business that their competitors are eagerly writing. That old line, "The other guy is doing it so we must as well," spells trouble in any business, but in none more so than insurance...[1]*"*

Economically, a good underwriting strategy can be explained in the following way. Good underwriters strictly sell the policy's premium higher than the expected loss. They do not sell until the price of the policy is high enough. Good underwriters are willing to sacrifice short-term market share and wait until the premiums are high enough. Loss ratio is a good measure to capture this action. The loss ratio can be obtained from the A.M. Best annual reports, and it is defined by the ratio of total losses incurred, divided by the total premiums earned. Hence, we should expect to observe that good underwriters have a lower loss ratio than their competitors. Most insurers within Berkshire Hathaway, such as National Indemnity or Berkshire Reinsurance, are examples of good underwriters. They are conservative in underwriting insurance policies resulting in low loss ratios. Some insurers might be lucky in a particular year instead of being a good underwriter. We might observe that they have a low loss ratio in one particular year that could bias our definition of being good underwriters. To tackle this problem, I average the loss ratio for three years to make sure that they are good underwriters in the long-term instead of being lucky. I define good underwriters as having an average of three-year loss ratios that are less than the industry's average.

In addition, another competitive edge for being a"good underwriter" is to be able to accurately assess risks. By being able to assess the risks, insurers will have the ability to reserve the right amount for loss incurred in each accident year. By correctly predicting their loss reserve, insurers tend to have an edge by having a lower probability of going into bankruptcy, and hence they reduce their cost of external capital (Froot, Scharfstein, and Stein (1993) and Froot and Stein (1998)), they reduce their predation level (Bolton and Scharfstein (1990)) and they also increase their prices (Cummins and Danzon (1997)). Every year, insurers adjust their reserves/loss incurred, corresponding to their prediction of their loss. This adjustment is called loss development. A long term loss development that is close to zero in absolute terms, indicates that the insurer is a good underwriter. Insurers with low loss development can assess the risk more accurately, which results in less loss development for the reserve over time. Therefore, I define good underwriters

[1]See the 2011 Warren Buffett's Letter to Berkshire Shareholders of Berkshire Hathaway Inc., p. 9.

as having an average of three years of loss development within a specified range from zero. Next, I discuss how risk management can add value to insurers, in particular focusing on insurers with good underwriting skills.

2.3. How Risk Management Adds Value to Insurers with Competitive Edge

Risk management adds no value to a firm if there is no friction according to Modigliani and Miller (1958). However, by introducing frictions into the framework, risk management adds value. For example, risk management reduces the cost of risk by reducing tax and bankruptcy costs (Smith and Stulz (1985) and Stulz (1996)), reducing the cost of external financing (Froot, Scharfstein, and Stein (1993) and Froot and Stein (1998)), reducing underinvestment problems (Mayers and Smith (1987)). Though, the empirical findings are mixed, enterprise risk management has a positive relationship to the value, among 118 publicly traded insurers from 1998 to 2005 (Hoyt and Liebenberg (2011)). Corporate risk management has a positive relationship to the value, among 34 oil refiners from 1984 to 2004 (MacKay and Moeller (2007)). According to a review study by Smithson and Simkins (2005), the value of risk management is also mixed. Cyree and Huang (2004), Allayannis, Ihrig, and Weston (2001), Bartram, Brown, and Fehle (2009), Nain (2005), Kim, Mathur, and Nam (2006), Allayannis, Lel, and Miller (2004) and Carter, Rogers, and Simkins (2006) find that there is evidence that risk management is associated with higher firm value. However, Callahan (2002) finds that gold price hedging actually has a negative relationship with the value of gold producers. Lookman (2004) and Jin and Jorion (2006) find no relationship between risk management and firm value. Though, Lookman (2004) finds that risk management is associated with lower values among undiversified firms. On the other hand, risk management is associated with higher firm values among diversified firms.

This study takes a step further than the previous literature. First, it explores how each level of hedging is associated with firm value. By defining the levels of hedging on liability risk management as the proportion of insurance ceded, divided by the total premium written, we can identify the intervals of hedging among insurers. I use these intervals to explore whether they affect a firm's value. This is a standard way to measure the level of hedging in the insurance industry (as in Mayers and Smith (1990) and Cole and McCullough (2006)). This method of measuring hedging is different from the previous literature in non-financial companies because most of them use dummy variables to specify if a firm uses risk management. By using more detail of risk management, it becomes possible to discover more about the interaction between risk management and the performance of firms. Second, the study explores how levels of hedging are associated with an insurers' competitive edge. To achieve these goals, I use econometric procedures to find a relationship between each hedging level and the performance of insurers, given that they are good underwriters.

There are two theoretical frameworks that can explain the interaction between the competitive edge and risk management. According to Froot (2007), insurers should hedge completely on the risks in which the insurers do not have a competitive edge. In line with Mello and Ruckes (2008), the theory suggests that insurers with a competitive edge will have less incentive to hedge compared to their competitors. The benefit of hedging is to protect a firm from going into a distress situation, which increases the cost of external financing. However, the benefit of remaining unhedged is that firms can enjoy a higher chance to gain market share and win over the competition. Firms with a competitive edge will have a higher chance of having the benefit of gaining market share, if it remains unhedged. Therefore, it suggests that risk management adds little or no value to companies with a competitive edge. In this study, I specify good underwriting as a possible competitive edge. Therefore, I expect to see that risk management does not benefit good underwriting insurers. Next, I outline how I measure the profit of insurers.

2.4. Performance of the Insurers

In this study, I use the new profit efficiency (NPE) approach to measure the profitability of each insurance company in each year. The new profit efficiency is different from the standard profit efficiency because it allows for the differences in price and costs among insurers. The fully efficient firm will be 1. The lowest efficient firm will be measured as 0. I estimate the profit efficiency using the Data Envelopment Analysis (DEA), as used by Leverty and Grace (2010). The DEA is a mathematical program, setup in accordance with Cooper, Seiford, and Tone (2006).

Let e be a vector of 1's. Let x_j be a vector of a company j where $x_j = (x_{1j}, x_{2j}, \ldots, x_{sj})$ is the input vectors of all s inputs. Let y be the output vectors where $y_j = (y_{1j}, y_{2j}, \ldots, y_{kj})$ for the total k outputs. Let $c_j = (c_{1j}, c_{2j}, \ldots, c_{sj})$ be the cost of all the inputs. Let $p_j = (p_{1j}, p_{2j}, \ldots, p_{kj})$ be the price of the outputs for the company j. One advantage of using the NPE instead of the original profit efficiency (PE) is that it takes into account the difference in prices and costs of the outputs and inputs, respectively. The PE does not take into account these differences. Let $\bar{x}_j = (c_{1j}x_{1j}, \ldots, c_{kj}x_{kj})$ and $\bar{y}_j = (p_{1j}y_{1j}, \ldots, p_{sj}y_{sj})$. Then the formulation of the problem is,

$$
\begin{aligned}
e\bar{y}_0^* - e\bar{x}_0^* &= \operatorname*{Max}_{\bar{x},\bar{y},\lambda}\ e\bar{y} - e\bar{x} \\
\text{subject to} & \\
\bar{x} &= \bar{X}\lambda \le \bar{x}_0 \\
\bar{y} &= \bar{Y}\lambda \ge \bar{y}_0 \\
e\lambda &= 1,
\end{aligned}
\tag{2.4.1}
$$

where λ is a multiplier vector of the problem. The $\bar{x}_0$ and $\bar{y}_0$ are the given data of inputs and outputs, respectively. The NPE is defined as,

$$
NPE = \frac{e\bar{y}_0 - e\bar{x}_0}{e\bar{y}_0^* - e\bar{x}_0^*}. \tag{2.4.2}
$$

I need to consider what the inputs and the outputs of the problem are. Leverty and Grace (2010) use the valued approach to estimate various efficiency measures of the property and liabilities insurers instead of the flow approach. The value approach is in line with the traditional profitability measures, such as return on assets and return on equity. In addition, Berger, Cummins, and Weiss (1997) argue that the value approach is an appropriate tool to find the profit and cost efficiency among the different distribution systems of the insurers. Therefore, the use of the valued approach with DEA seems to be appropriate to measure how well a firm performs. The valued approach of the inputs and the outputs are summarized based on each year by the Table 2.1.

I screen out the one percent of the biggest and the smallest of each loss category to take into account the outliers. The price of the insurance loss for each line will sometimes be negative. DEA calculation does not take into account the negative price of the inputs and the outputs. To eliminate the negativity of the price in the DEA calculation, I subtract the price of the insurance loss for each category by the smallest price in that category. This will eliminate the negativity problem of the prices. The classification of each category of the loss outputs is similar to Phillips, Cummins, and Allen (1998) in Table 2.2,

2.5. Econometric Models

This section explains the econometric models used to test whether risk management adds value to insurers in aggregate and to insurers with a competitive edge. There are four main econometric challenges that I need to address. First, the data is panel. The data consists of a firm's variables and the time period. Second, the panel data is not balanced, which means that the number of unique ID's will be different for each year. Third, there might be a firm's specific characteristic effects. Fourth, I assume that explanatory variables are exogenous. To tackle all these requirements, I fit the model using random-effect and fixed-effect regressions. I use the Haussman test to choose between the random effect and the fixed effect. In the following subsection, I explain the model I use for each test.

2.5.1. Exogenous Econometric Models.

This section presents the models to test whether liability risk management adds value to a company. I measure the impact of risk management on the performance of insurers. Model 1 is to test if each hedging interval has any relationships with the profit efficiency of insurers. The variable $H_{it}^{(0,25\%)}$, $H_{it}^{[25\%,50\%)}$, $H_{it}^{[50\%,75\%)}$ and $H_{it}^{[75\%,100\%]}$ are the dummy variables if the three-year average ceding level is within $(0, 25\%)$, $[25\%, 50\%)$, $[50\%, 75\%)$, and $[75\%, 100\%]$ respectively[2]. I analyze the data using the random effect and fixed effect. I use the Haussman test to test whether RE or FE is appropriate. Specifically, Model 1 is written as,

- **Model 1:**

$$Eff_{it} = \beta_0 + \beta_1 H_{it}^{(0,25\%)} + \beta_2 H_{it}^{[25\%,50\%)} + \beta_3 H_{it}^{[50\%,75\%)} + \beta_4 H_{it}^{[75\%,100\%]} + \beta^c X_{it} + \epsilon_{it}, \quad (2.5.1)$$

[2]Notice that the first interval does not include zero because it is our omitted group of hedging. I eliminate the negative average ceding level, which contains about 25 observations and the average hedging of more than one which contains only one observation. Therefore, I have the base case of the average ceding that has a zero hedging level. These are the insurers that do not use risk management at all.

where,

$$Eff_{it} = \text{Profit efficiency of each insurer i at time t}$$

$$H_{it}^{(0,25\%)} = 1 \text{ if the level of reinsurance} \in (0, 25\%) \text{ and 0 otherwise}$$

$$H_{it}^{[25\%,50\%)} = 1 \text{ if the level of reinsurance} \in [25\%, 50\%) \text{ and 0 otherwise}$$

$$H_{it}^{[50\%,75\%)} = 1 \text{ if the level of reinsurance} \in [50\%, 75\%) \text{ and 0 otherwise}$$

$$H_{it}^{[75\%,100\%]} = 1 \text{ if the level of reinsurance} \in [75\%, 100\%] \text{ and 0 otherwise}$$

$$X_{it} = \text{a vector of all the controlled variables which assumed}$$

$$\text{to be exogenous for the i th insurer in year } t.$$

I fit this model using the whole sample. In addition, I perform random-effect and fixed-effect regression on samples given that insurers are good underwriters. For robustness, the study offers four ways to select the good underwriters. First, the sample consists of insurers that have an average loss ratio for three years of less than 50 %. Second, the sample consists of insurers that have an average loss ratio for three years of less than 30%. Third, the sample consists of 10% of insurers that have an average of one-year loss development for three years of around zero. Lastly, the sample consists of 5% of insurers that have an average one-year loss development for three years of around zero[3]. The coefficients of $H_{it}^{(0,25\%)}$, $H_{it}^{[25\%,50\%)}$, $H_{it}^{[50\%,75\%)}$ and $H_{it}^{[75\%,100\%]}$ will show how each level of hedging has a relationship with the profit efficiency of insurers. The drawback of this model is that I needed to eliminate some observations that were not of good underwriters, when analyzing the impact of hedging on good underwriters. I solve this issue by using Model 2. Model 2 is a slightly different version of Model 1 because it includes the interaction terms between being a good underwriter and the hedging intervals. By using a marginal effect of each hedging interval, we can use the whole sample throughout the four definitions of good underwriting. Model 2 is written as,

[3]First, I slice the sample by percentile based on a three-year average of one-year loss development, divided by the book value of the assets. The zero ratio of loss development is at about the 65 percentile. Therefore, I use the sample that has the loss development ratio from 60 percentile to 70 percentile for the 10% case. I also use the sample that has the loss development ratio from 62.5 percentile to 67.5 percentile for the 5% case.

- **Model 2:**

$$Eff_{it} = \beta_0 + \beta_1 GUW_{it} + \sum_{k=1}^{4} \beta_{k+1} H_{it}^{I_k} + \sum_{k=1}^{4} \beta_{k+5} H_{it}^{I_k} * GUW_{it} + \beta^c X_{it} + \psi_{it}, \qquad (2.5.2)$$

where,

$$\begin{aligned}
Eff_{it} &= \text{Profit efficiency of each insurer i at time t} \\
H_{it}^{I_k} &= 1 \text{ if the level of reinsurance} \in I_k \text{ and 0 otherwise} \\
I_1 &= (0, 25\%), I_2 = [25\%, 50\%), I_3 = [50\%, 75\%), I_4 = [75\%, 100\%] \\
GUW_{it} &= 1 \text{ if the insurer is a good underwriter(using 4 definitions) and 0 otherwise} \\
X_{it} &= \text{a vector of all the controlled variables which assumed} \\
&\quad \text{to be exogenous for the i th insurer in year } t.
\end{aligned}$$

Again, we need to do four regressions of Model 2 since there are four definitions of good underwriting, as previously discussed. The random effect and fixed effect will be chosen based on the Haussman test. The marginal effects of each hedging level reflect the relationship with profit efficiency, irrespective of whether insurers are good underwriters.

2.5.2. Endogenous Econometric Models.

There are some possibilities that hedging dummies are endogenous variables. This section explores this problem by fitting two models that incorporate the endogeneity issues. Model 3 is the same as Model 1 but specifies all the hedging dummies to be endogenous. Model 4 is the same as Model 2 but specifies all the hedging dummies to be endogenous as well. I employ two-stage least squares (2SLS) to fit the model. Therefore, there is a need to find a good set of instruments that correlate to the endogenous variables and be exogenous to the residuals. I employ Hansen J statistics to test whether instruments are exogenous. Second, I use the Kleibergen-Paap test to verify whether instruments correlate to endogenous variables. The possible instruments that can be expected to correlate to hedging levels, and are exogenous to the residuals, are as follows.

• **ROA**: Under an assumption that a company finances its project only with equity, then it should take the project when the net present value of the project is non-negative. However, if the capital structure consists of risky debt, then there will be an underinvestment problem, according to Myers (1977) and Mayers and Smith (1987). If the project turns out poorly from a financial perspective, then the firm will likely to go into bankruptcy. The firm might want to forgo some investment opportunities due to the risky debt in the capital structure. Partially purchasing insurance can resolve this issue to protect the firm from falling into crisis. Mayers and Smith (1990) and Powell and Sommer (2007) use leverage to test the hypothesis. They expect insurers with higher leverage to consider purchasing more reinsurance contracts. The higher leverage ratio will indicate a higher chance for the insurer to go into bankruptcy. In addition, Cole and McCullough (2006) use profitability to capture the effect of the underinvestment problem. They hypothesize that insurers with higher profitability will consider purchasing less reinsurance contracts. I use the return on assets to capture the profitability of insurers.

• **Product Type**: According to Winter (1994), the price of insurance depends on the types of the lines of business that each insurer offers. The theory implies that the price of more uncertain lines is expected to be higher. Therefore, the cost of acquiring reinsurance contracts in those lines tends to be higher. Hence, the incentive for buying insurance contracts for those particular lines of business tends to be lower. Therefore, it is expected that product type has an effect on risk management activity. In addition, elasticity of demand, convexity of production costs of products influence the hedging activity of firms, according to Adam, Dasgupta, and Titman (2007). Therefore, I expect each product type to affect hedging activity differently. Mayers and Smith (1990) and Cole and McCullough (2006) also control for product type in their studies of the demand of the reinsurance contracts by insurers. Instead of controlling for each line of business, I categorize the lines into four categories, similar to Phillips, Cummins, and Allen (1998), according to the Table 2.2. For each category of business, I define these variables with the net premium written in each category, divided by the total premium written.

• **Market Share**: Managers compare their firm's position to their competitors within the industry. For example, Fiegenbaum and Thomas (2004) argue that firms use their competitors' positions and their own position as a reference point before formulating a strategy. Market share is a good measure of a firm's positioning in the industry. According to Sommer (1996), the bigger firms tend to be healthier than the smaller ones in the insurance industry. This implies that customers are more willing to buy policies from an insurer with a big market share than a smaller one. It can charge higher prices than the smaller firms, since it faces lower insolvency risk. Therefore, it has less incentive to buy reinsurance. According to Mello and Ruckes (2008), firms with a competitive edge over their competitors tend to hedge less. By having the advantage of charging higher prices than smaller players in the industry, insurers with larger market share have less incentive to hedge.

• **Reinsurance's Price**: Cole and McCullough (2006) conjecture that the price of reinsurance contracts will have an effect on the insurers decisions to hedge. For example, the shock on the loss can limit the supply of insurance contracts, as studied by Winter (1994), Cummins and Danzon (1997) and Weiss and Chung (2004). After a wide loss, the price of the reinsurance contract can be expected to increase, and therefore, discourage primary insurers from buying the reinsurance contracts. Furthermore, Cole and McCullough (2006) find that the relationship between the reinsurance price and hedging levels are negative. This evidence suggests that the cost of reinsurance will deter the willingness to hedge. I use the ratio of the net premium written to the incurred loss as the measure for the price of the reinsurers. There is a price variable for each reinsurer. Then, I calculate the average price of the industry weighted by the net premium written. The variable is called $RePrice$.

• **Reinsurance's Development of Loss Reserves**: Cole and McCullough (2006) hypothesize that the ceding company will buy more(less) if the health of the reinsurers are better(worse). Cummins and Danzon (1997) also suggest that the price of the insurance contracts will depend on the credibility of the reinsurers. This is because the insurer has to take responsible for losses if the reinsurers become insolvent. They need to buy the policies from financially sound policy sellers. Cole and McCullough (2006) use the loss development to gauge this factor of the insurers' hedging decisions. However, they do not find any relationship between the risk management level and the loss development among reinsurers. For this study, I still control for the loss development to test the health of the reinsurance market. I use the loss development, divided by the total book value of the assets of the reinsurers for each year to indicate whether the reinsurers are financially sound, similar to the method used by Cole and McCullough (2006). There is a loss development for each reinsurer, and I calculate the averaged loss development for the whole reinsurance industry weighted by the net premium written. This variable will be called *ReLossDeve*.

• **Reinsurance's Liquidity**: Cole and McCullough (2006) argue that there are two reasons that liquidity of the reinsurers influences the hedging decisions of the insurer. First, if the overall reinsurance market has more liquid assets, such as cash and invested assets, scaled by total liability, on hand, then the whole reinsurance market tends to be more stable. Therefore, this creates more incentive for primary insurers to buy insurance because of the stability of the reinsurance market. In addition, liquidity is a sign of excess capacity in the reinsurance market. Hence, reinsurers are more willing to sell reinsurance to the insurers. The price of the insurance will be low compared to the lower liquidity environment. Under this excess liquidity condition, we should see that the insurer tends to buy more reinsurance contracts. However, Cole and McCullough (2006) do not empirically find any relationship between liquidity of the reinsurers and the level of hedging of the insurer. I use the liquidity of the whole reinsurance industry to control for the level of hedging by insurers. Similar to Cole and McCullough (2006), I use the average cash and invested assets, divided by the total liability to measure the liquidity of the reinsurers. Again, there is a weighted average sum of this variable by the net premium written. This variable will be called *ReLiquidity*.

2.5.3. Controlled Variables.

I discuss the possible factors that will affect the performance of the P&L insurers in this section. The candidate variables associated with the insurers' performance are as follows.

• **Firm Size**: The insurers' size has an impact on the profitability according to the various literature. Sommer (1996) argues that the healthier insurers, that have a lower probability of falling into bankruptcy, can charge higher price. According to Liebenberg and Sommer (2008), if the bigger size insurers have a lower probability of insolvency, then they are able to set their premiums at a higher price than the smaller firms. Therefore, I expect size to have a positive relationship with the profitability of the insurers. Browne, Carson, and Hoyt (1999), Cummins and Nini (2002), and Liebenberg and Sommer (2008) find a positive relationship between insurers' size and profitability. I use the natural log of the book value of assets as the measure of firm size. I call this variable $ASSET$.

• **Capitalization**: Similar to the size of the insurers, I expect an insurer with lower a probability of falling into insolvency to command a higher price, according to Sommer (1996). If the higher leverage insurer has a higher chance of getting into the insolvency stage, I expect the higher leverage ratio to have a negative relationship with the profitability. Liebenberg and Sommer (2008) find a negative relationship between leverage and profitability[4]. I use the book value of the total liability, divided by the book value of total assets as a measure of capitalization. I call this variable $LEVERAGE$.

• **Ownership Structure**: There are various studies on the relationship among ownership structure and profitability. There are three types of agents for the insurance companies, which are policyholders, managers and investors. According to Mayers and Smith (1981), stock companies have a conflict of interest between investors and policyholders. However, a stock company will have better control of the management by the owners than mutual companies. Although mutual companies eliminate the conflict between investors and policyholders, they have a less effective mechanism for the policyholders to monitor the managers. Berger, Cummins, and Weiss (1997) find no relationship between the structure of an insurance company and profitability. Cummins, Weiss, and Zi (1999) find that mutual companies have a higher cost than the stock companies. On the contrary, Greene and Segal (2004) find no relationship between the cost and the structure of insurers. Liebenberg and Sommer (2008) find that the mutual insurers will be less profitable than stock insurers. It is interesting to see how the organizational structure affects the profitability of insurers. I define $STOCK$ as equal to one, if an insurer is a stock company and zero if the insurer is a mutual company.

• **Geographic Diversification**: There are advantages and disadvantages of being geographically diverse or geographically focused. First, geographic diversification gives an insurer with lower risk the same expected financial returns. The lower risk implies that insurance companies can charge higher prices, according to Sommer (1996). However, being a diversified firm can lower profitability due to the high cost of monitoring. An insurance company that operates in more states tends to have higher monitoring costs. On the other hand, focused insurers tend to have higher

[4]Liebenberg and Sommer (2008) use the book value of the surplus, divided by the book value of the total admitted assets, to arrive at a positive relationship between the capitalization and the profitability. Instead, I use the leverage as the measure of capitalization. Therefore, the sign of the coefficient will be opposite to Liebenberg and Sommer (2008) but the interpretation should be the same.

risks due to the lower number of states they operate in. However, they will benefit from product specialization and avoid monitoring costs, according to Winton (1999). Therefore, it is interesting to add geographic diversification as a variable to see how it affects the profitability of the insurers. Liebenberg and Sommer (2008) find a positive relationship between geographic focus and the profitability. I use the Herfindahl index for each insurer to measure the level of diversification of the firms. Similar to Mayers and Smith (1990), Choi and Weiss (2005), Cole and McCullough (2006) and Leverty and Grace (2010), I measure the geographic diversification of the business using the state Herfindahl index. The state Herfindahl index will characterize the market of each insurance company in terms of geography. The state Herfindahl index for each company can be written as,

$$HerfindahlState_{it} = \sum_{j=1}^{n} (\text{\% share of direct premium written in state j at time t of the insurer i})^2 \tag{2.5.3}$$

where n is the total number of states. Under this definition, it represents some characteristics. First, if the $HerfindahlState$ is high, it means the company focuses on particular states at that particular time. On the other hand, if the $HerfindahlState$ is low, it means the company has diversified into many states. It is expected to have more competitors from many states than if it had a higher value of the index.

- **Product Diversification**: Using the same argument as the geographic diversification, I also include product diversification in the model. Liebenberg and Sommer (2008) find that more lines of business will result in the less profitability for the insurers. On the contrary, Meador, Ryan, and Shellhorn (2000) find a positive relationship between product diversification and profitability. Berger, Cummins, Weiss, and Zi (2000), use different technology assumptions to study focused and diversified firms and find that the focused strategy is more profitable in some lines of business, and the diversified strategy delivers benefits to the other lines of business. I use the line Herfindahl index for each company to capture the diversification of the lines of business. The line Herfindahl index for each company can be written as,

$$HerfindahlLine_{it} = \sum_{j=1}^{m} (\text{\% share of net premium written in line j at time t of the insurer i})^2 \tag{2.5.4}$$

where m is the total number of lines of business.

• **Industry's Concentration**: According to the structure-conduct-performance (SCP) paradigm, market structure has an impact on a firm's profitability, according to Liebenberg and Sommer (2008). A market where there are many competitors will prove to be less profitable for insurance firms. On the other hand, the firms that operate in more concentrated markets tend to benefit from less competition. They may collude with competitors and be more profitable. Chidambaran, Pugel, and Saunders (1997) find a positive relationship between the market concentration and the price of the insurance. I measure the geographic and product concentration compared to the industry concentration. More specifically, I use the method developed by Montgomery (1985) and followed by Liebenberg and Sommer (2008) to capture the industry concentration. First, I calculate the Herfindahl index for each line of business using the relationship,

$$Herf_{jt} = \sum_{i=1}^{n} \left(\frac{NPW_{ijt}}{NPW_{jt}} \right)^2 \tag{2.5.5}$$

NPW_{ijt} is the net premium written for a company i on lines j during the year t. NPW_{jt} is the particular line j total net premium written in the year t. Then we can find the weight for each line of business j for each insurer i by,

$$weight_{ijt} = \frac{NPW_{ijt}}{NPW_{jt}} \tag{2.5.6}$$

Therefore, the firm's exposure to the industry competition can be calculated as,

$$IndHerfLine_{it} = \sum_{j} weight_{ijt} * Herf_{jt}. \tag{2.5.7}$$

Each firm has its own intensity exposure within the industry. The higher value of $IndHerfLine_{it}$ means the higher the concentration that the firm i will face, during the year t. In addition to the concentration by lines of business, I calculate the concentration by Herfindahl index for geography as well. I call this variable $IndHerfState$.

2.6. Data

There are the total of 31,520 observations throughout 1989 to 2011. The study focuses on each insurer individually, not at a group level. I report the summary statistics of all variables that I use in the analysis in the Table 2.3. There are 31,520 observations. On average, insurers are about 59% efficient. The ceding level of the industry is about 36 %. The average loss ratio of the industry is about 70%. The average one year loss development, scaled by the book value of the assets is about 3.81 %. Next, I will report the findings of the multivariate results.

2.7. Multivariate Results

First, I will discuss the result from the panel regression analysis. Model 1 presents the relationships between the levels of hedging and the performance of insurers, with exogenous assumptions on hedging dummy variables. Model 2 presents the marginal effects of hedging levels on good underwriting, with exogenous assumptions on hedging dummy variables. Model 3 presents the relationships between the levels of hedging and the performance of insurers, with endogenous assumptions on hedging dummy variables. Model 4 presents the marginal effects of hedging levels on good underwriting with endogenous assumptions on hedging dummy variables.

- **Model 1:** According to Table 2.4, I fit Model 1 with either a fixed effect or a random effect based on the Huassman test. The first panel consists of the whole sample. The second panel consists of the insurers that have a three-year average loss ratio less than or equal to 50%. The third panel analyzes only the insurers that have a three-year average loss ratio less than or equal to 30%. The fourth panel considers only about 10% of insurers that have their loss development weighted by total assets of around zero. The last panel considers only about 5% of insurers that have their loss development weighted by total assets of around zero. In each column, random-effect (RE) and fixed-effect (FE) regressions have been used. The Haussman test is performed choosing either RE or FE. The Huassman tests result in four fixed-effect regressions and one random-effect regression. The models include controlled variables specified in the previous sections including year dummies.

According to Table 2.4, the first panel suggests that purchasing reinsurance benefits insurers in general. All intervals of hedging are significant and positive. However, good underwriters, who are defined by having a low loss ratio, benefit less from hedging. The coefficient of each hedging interval is not always significant according to the second and third panel. Using loss development as a definition of good underwriting skill, purchasing reinsurance seems to benefit insurers throughout all intervals. These results suggest that risk management adds value to insurers overall. However, by being a good underwriter, using the definition of a low loss ratio, there is less evidence that risk management adds value. On the other hand, by using the loss development definition of good underwriting, risk management seems to add value to insurers. By focusing on observations of good underwriters, it foregoes some information due to the drop of observations. For example, according to the third panel, the study focuses on insurers that are good underwriter, and the observations drop from 19,394 to 881. The results shown in the panel might be bias based on this small sample. Therefore, we need to look further at Model 2, where I use the whole sample and use marginal effects to show the significance of the risk management value.

- **Model 2:** Table 2.5 finds the marginal effects of hedging levels on the efficiency of P&L insurers, according to Model 2. These methods use all of the observations to analyze the impact of hedging levels. There are four ways to define a good underwriter: having a three-year average loss development ratio that is less than or equal to 50%, having a three year average loss ratio less than or equal to 30%, about 10% of insurers that have loss development weighted by total assets of around zero, and about 5% of insurers that have loss development weighted by total assets of around zero. Random-effect (RE) and fixed-effect (FE) regressions have been used to find marginal effects for each definition. The Haussman test is performed, and a result I used FE in all cases. The models include controlled variables specified in the previous section, including year dummies. The R^2 are about 19% in all regressions. The results suggest that all risk management levels add value regardless of good underwriting. Using the low loss ratio definition as a good underwriter, the benefit of risk management is lowest at the interval $[25\%, 50\%)$ for good underwriters. By using low loss development, the extreme intervals of risk management seem to add more value than the medium levels. Next, I endogenize the hedging dummy variables because the hedging might be driven by other factors. This might result in the effect of risk management on the performance of insurers. The endogenous versions are in Model 3 and Model 4.

• **Model 3:** Table 2.6 presents the impact of hedging levels on the efficiency of P&L insurers according to Model 3. The first panel consists of the whole sample. The second panel consists of the insurers that have a three-year average loss ratio less than or equal to 50%. The third panel analyzes only the insurers that have a three-year average loss ratio less than or equal to 30%. The fourth panel considers only about 10% of insurers that have a loss development weighted by total assets of around zero. The last panel considers only about 5% of insurers that have a loss development weighted by total assets of around zero. In each column, two-stage least squares (2SLS) is used to take into account the endogeneity of the hedging level dummy variables. For each panel, the table reports the Kleibergen-Paap underidentification test. Instruments are proper under the alternative hypothesis. The instruments are loss development, tax, return on assets, allocation of net premium written for each product type, and market share, which I discussed in the previous section. The instruments are valid when we use the whole sample. The Kleibergen-Paap test gives a statistic of 13.33 and a p-value of 3.81%. Therefore, we can reject the null hypothesis that the instruments do not correlate with the endogenous regressors. The table also reports Hansen J statistics for the overidentification test. Instruments are proper under the null hypothesis. According to the table, the Hansen J statistics for the whole sample is 7.80%. Therefore, it cannot reject the null hypothesis that the endogenous regressors are exogenous to the error terms at the 5% confidence level. Other regressions do not provide valid instrument tests due to the number of observation changes. Therefore, I focus my interpretation of the results in only the first panel. According to the first panel, there is no evidence that risk management adds value for the interval of $(0\%, 25\%)$, $[25\%, 50\%)$, and $[50\%, 5\%)$. On the other hand, risk management has a negative relationship with profit efficiency when insurers use a very high level of hedging. Since the study is intended to find the effect of risk management on good underwriting, we need to use marginal effects in Model 4. Since we preserve the observations in Model 4, the instruments are still valid throughout.

• **Model 4:** Table 2.7 presents the marginal effects of hedging levels on the efficiency of P&L insurers according to Model 4. This method uses the whole sample to analyze the impact of hedging levels. There are four ways to define a good underwriter: having a three-year average loss ratio less than or equal to 50%, having a three-year average loss ratio less than or equal to 30%, about 10% of insurers that have a loss development weighted by total asset around zero, and about 5% of insurers that have a loss development weighted by total asset around zero. Two-stage least squares (2SLS) is used to take into account the endogeneity of the hedging level dummy variables. The instruments are the same as in Model 3 and are still valid under the underidentification and overidentification tests. The models include the controlled variables, as specified in the previous section. According to Table 2.7, it appears that risk management does not add value whether or not the insurer are good underwriters. Using a high level of hedging has a negative relationship with profit efficiency when insurers are not good underwriters.

The results from Models 1,2 and 3,4 are different by the assumption of the exogeneity of hedging variables. Therefore, I test whether hedging level variables are endogenous. I use the Sargan-Hansen test for endogeneity and get a statistic of 471.563 and a p-value of 0.000. This rejects the null hypothesis that these variables are exogenous. Therefore, I interpret the results mainly in Model 3 and Model 4 by assuming that hedging levels are endogenous. Overall, risk management does not seem to add value to the P&L insurers. In fact, it has a negative relationship with profit efficiency when using at very high level of hedging. This result supports Taksar and Markussen (2003) and Froot (2007) that reinsurance is expensive due to transaction costs. It is costly to transfer the existing risk to reinsurers. Therefore, using a high level of hedging does not benefit insurers in general. In addition, risk management does not seem to add value to insurers that have a competitive edge. Using a high level of hedging has a negative relationship with profit efficiency for good underwriters. This is in line with Froot (2007) and Mello and Ruckes (2008) who suggest that companies with a competitive edge should not fully hedge their risks.

2.8. Extensions

This section extends the analysis from the previous sections. First, it uses a continuous hedging level instead of dummy variables. Second, it defines good underwriting using the loss ratio, but it controls for different lines of business. To make sure that it controls the lines of business, I regress loss ratio on the lines of business variables, which consist of the expense on commercial short-tail, commercial long-tail, personal short-tail, and personal long-tail over the total expense. Then I calculate the residuals from the regression. The residuals that are negative mean that, on average, insurers write business that has a lower loss ratio than the model predicts. Therefore, it shows their ability to be good underwriters. I define good underwriters as having residuals less than or equal to zero. I also define the lower half of the negative residuals as good underwriters. This focuses on insurers that have much lower loss ratio compared to what the model predicts. Third, instead of using the current year residual, I use the one-year lagged residual to eliminate the chances that the residuals will correlate with the incurred loss in the profit efficiency calculation. Lastly, I control for the group effect. I include the dummy variable, specifying if each insurer belongs to a group. This way, we can control for the effect of being a member of a group on its profit efficiency. The analysis still assumes that the hedging variable is endogenous. More specifically, there are two models that I estimate. Model 5 uses the impact of hedging on the profit efficiency of all of the insurers, while Model 6 uses the interaction terms with the newly developed loss ratio definitions of good underwriting. I assume that hedging variables are endogenous. Model 5 and Model 6 are as follows,

- **Model 5:**

$$Eff_{it} = \beta_0 + \beta_1 Hedge_{it} + \beta_2 Hedge_{it}^2 + \beta^c X_{it} + \psi_{it}, \tag{2.8.1}$$

where,

$$\begin{aligned} Eff_{it} &= \text{profit efficiency of each insurer i at time t} \\ Hedge_{it} &= \text{3 year-average level of reinsurance purchase} \\ X_{it} &= \text{a vector of all the controlled variables which assumed} \\ &\quad \text{to be exogenous for the i th insurer in year } t. \end{aligned}$$

- **Model 6:**

$$Eff_{it} = \beta_0 + \beta_1 GUW_{it} + \beta_2 Hedge_{it} + \beta_3 Hedge_{it}^2 + \beta_4 GUW * Hedge_{it} + \beta_5 GUW * Hedge_{it}^2 + \beta^c X_{it} + \psi_{it}, \tag{2.8.2}$$

where,

$$Eff_{it} = \text{profit efficiency of each insurer i at time t}$$

$$Hedge_{it} = 3 \text{ year-average level of reinsurance purchase}$$

$$GUW_{it} = 1 \text{ if the insurer is a good underwriter and 0 otherwise}$$

$$X_{it} = \text{a vector of all the controlled variables which assumed}$$

$$\text{to be exogenous for the i th insurer in year } t.$$

According to Figure 2.1, I plot the point estimates and confidence intervals of the marginal effects of hedging on profit efficiency. Overall, the result is similar to Model 3 and 4. Ceding high levels of risk has a negative relationship with profit efficiency for insurers in general. In addition, ceding high levels of risk evidently decreases the insurers profit efficiency, if they are good underwriters. In addition to this result, being a good underwriter has a significant positive relationship with profit efficiency. Moreover, there is evidence that a group variable also has a positive relationship with profit efficiency given that the insurers are good underwriters, when using a regression with an interaction term of being a good underwriter and being a member of a group. Therefore, this suggests that being a member of a group benefits insurers. Controlling for a group membership though, does not change the overall marginal effect of hedging on profit efficiency.

2.9. Conclusion

This study explores whether risk management adds value to the P&L insurers. In addition, it studies if risk management adds value to insurers with a competitive edge. Slicing hedging into intervals can give more information about which intervals of hedging benefit firms. On average, using a very high level of hedging proves to be unprofitable for the insurers. This might be due to the fact that reinsurance is expensive, corresponding to studies by Taksar and Markussen (2003) and Froot (2007). Insurers might need to carefully consider taking a lot of risk, as thinking that they can transfer the risks later hurts the profit efficiency of a company.

Risk management does not seem to add value to the insurers with good underwriting skill and even has a negative relationship with profit efficiency. This is in line with Froot (2007) and Mello and Ruckes (2008). The literature suggests that insurers with a competitive edge over their competitors should not hedge fully. The results imply that managers have to identify if it they have a competitive edge before they consider hedging, similar to the example by American Barrick in Tufano and Serbin (1993). By taking these strategic considerations, an insurer can successfully maximize its own value.

Table 2.1. Input and Output Variables for Insurer Efficiency

Variable	Mean	Std. Dev.	Min	Max
Input Quantities				
Administrative labor	271.04	1704.25	-3472.60	65311.30
Agent labor	342.45	2324.62	-14009.70	83759.55
Materials and business services	1056.70	6497.07	-7865.86	247819
Financial equity capital	1.46E+08	1.15E+09	-3.02E+09	6.93E+10
Policy holder-supplied debt capital	1.76E+08	9.37E+08	-1.95E+09	2.91E+10
Input Costs				
Administrative labor	53499.10	12767.83	35273.48	76896.13
Agent labor	42768.25	9831.42	27864.55	57934.36
Materials and business services	47400.90	12686.91	29843.09	71957.78
Financial equity capital	0.105	0.003	0.102	0.113
Policy holder-supplied debt capital	0.057	0.002	0.050	0.059
Output Quantities				
Personal short-tail	2.26E+07	2.32E+08	-1.07E+07	9.79E+09
Personal long-tail	2.04E+07	2.50E+08	-1.03E+08	1.38E+10
Commercial short-tail	1.38E+07	7.74E+07	-9.70E+07	3.07E+09
Commercial long-tail	1.80E+07	1.11E+08	-4.72E+08	3.95E+09
Intermediation	3.07E+11	2.36E+12	0	1.15E+14
Output Prices				
Personal short-tail	0.827	0.423	0	2.873
Personal long-tail	1.912	1.234	0	10.357
Commercial short-tail	3.910	1.897	0	19.345
Commercial long-tail	14.511	6.783	0	55.773
Intermediation	0.050	0.020	0	0.132

Note: This table consists of all the variables used for calculating the efficiency of each insurer. There are a total of 56,474 data samples. The variables are the inputs and outputs.

Inputs: Similar to Leverty and Grace (2010), the inputs and outputs are as follows. Administrative labor quantity is the sum of the salaries, payroll taxes and employee relations and welfare from the Underwriting and Investment Exhibit, Part 3 Expense, divided by the administrative labor cost. The cost of the administrative labor is from the US Department of Labor NAICS 524126: Direct Property and Liability Insurance Carriers. The agent labor quantity is the sum of net commissions, brokerage fees and allowances for agents from the Underwriting and Investment Exhibit, Part 3 Expense, divided by the agent labor cost. The agent labor price is from the US Department of Labor NAICS 524210: Insurance Agencies and Brokerages. The material and business service quantity is the sum of all the non-labor expenses from the Underwriting and Investment Exhibit, Part 3 Expense, divided by the materials and business service cost. The materials and business service cost is from the US Department of Labor NAICS 524298: All Other Insurance Related Activities. The available data is from 2001 to 2011, all the expenses from the years 1989 to 2000 are estimated from the growth rate of the expenses. The cost of the equity capital is the large company stocks' long-term average rate of return from 1926 up to time t from the SBBI 2007 Classic Edition Yearbook. The estimated cost of the equity capital of the year 2008 and up are estimated to be the same as the year 2007. The quantity of the policy holder-supplied debt capital is the sum of real loss reserves and real unearned premium reserves from the surplus and liability statement. I use the long-term corporate bond's average annual returns up to time t from the SBBI 2007 Classic Edition Yearbook to be the cost of policy holder-supplied debt capital. For this version, I use the same return for the year 2008 and up as the year 2007.

Outputs: According to Berger, Cummins, and Weiss (1997), insurance company operations consist of three types, which are risk pooling and risk bearing, real services relating to insured losses, and intermediation. The measurement that they use to measure the risk pooling and risk bearing, and the services, are the present value of the loss This is in line with Leverty and Grace (2010). In addition, they separate the business into four lines, which are personal short-tail, personal long-tail, commercial short-tail and commercial long-tail. The short-tail is the unpaid loss less than two years, and the long-tail is the unpaid loss that may be unpaid for 10 to 15 years. The classification of lines is in Table 2.2. Instead of using the present value of loss, I use the current year of incurred losses as the quantity of the outputs. The price of the loss in each line is defined in Berger, Cummins, and Weiss (1997). The other output is the investment return. I use the total book value of cash and invested assets as the quantity, and the weighted average return of stock and debt as the price. The weighted average return is defined by the proportion of stock and debt in the portfolio of each insurance company. The weight of stock will be multiplied by the long-term stock return, up to each particular year. The weight of debt will be multiplied by the long-term debt return up to that year. I sum up these numbers to be the total price of each company's portfolio. The return of stock and debt, up to the time specified, are from the SBBI 2007 Classic Edition Yearbook. The price of stock and debt of the year 2008 and up are the same as the year 2007.

Table 2.2. Categories of Line of Business

Personal Short-Tail	Personal Long-Tail	Commercial Short-Tail	Commercial Long-Tail
3 Farmowners multiple peril	19.1 Private passenger auto liability	1 Fire	11.1 Medical malpractice–occurrence
4 Homeowners multiple peril	19.2 Private passenger auto liability	2 Allied lines	11.2 Medical malpractice–claims–made
21 Auto physical damage		5 Commercial multiple peril	16 Workers' compensation
		6 Mortgage guaranty	17.1 Other liability–occurrence
		8 Ocean marine	17.2 Other liability–claims–made
		9 Inland marine	18.1 Products liability–occurrence
		10 Financial guaranty	18.2 Products liability–claims–made
		12 Earthquake	19.3 19.4 commercial auto liability
		13 Group accident and health	22 Aircraft
		14 Credit accident and health (group and individual)	
		15 Other accident and health	
		23 Fidelity	
		24 Surety	
		26 Burglary and theft	
		27 Boiler and machinery	
		28 Credit	
		29 International	

Note: This table shows the insurance lines of business in the data. The categories include personal short-tail, personal long-tail, commercial short-tail and commercial long-tail.

TABLE 2.3. Summary Statistics of the Data

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Eff	0.586	0.406	0	1
CEDE	0.363	0.312	-7.684	18.536
LossRatio	70.851	60.004	-12.658	5005.852
LossDeve	0.038	7.346	-23.283	1303.211
Leverage	0.564	0.205	-0.231	2.249
Asset	17.982	1.986	11.394	25.472
Stock	0.754	0.431	0	1
HerfindahlLine	0.486	0.304	0.068	1
HerfIndLine	0.038	0.023	0.009	0.452
HerfindahlState	0.601	0.383	0.030	1
HerfIndState	0.023	0.017	0.009	0.433
Tax	0.010	0.022	-0.460	0.863
ROA	0.024	0.074	-3.817	4.093
Personal Short-Tail	0.256	0.261	-1.275	10.050
Personal Long-Tail	0.168	0.229	-0.368	6.139
Commercial Short-Tail	0.266	0.342	-16.630	16.061
Commercial Long-Tail	0.280	0.352	-5.964	4.072
MarketShare	0.050	0.287	0	9.138

Note: The data is from the NAIC database from 1989 to 2011. It consists of 31,520 observations. Eff is the measure of the performance of firms, using the profit efficiency calculation. $CEDE$ is the reinsurance level of insurers defined by the premium ceded, divided by total premium written. *LossRatio* is the loss incurred, divided by the net premium earned. *LossDeve* is the one-year loss development, scaled by the total book value of the assets. *Leverage* is the total book value of liability, divided by the total book value of assets. *Asset* is the log of the total book value of assets. *Stock* equals one, if it is a stock company and zero otherwise. $HerfindahlLine$ is the Herfindahl index for individual companies by lines of business. $HerfIndLine$ is the industry Herfindahl index by lines of business. $HerfindahlState$ is the Herfindahl index for individual companies by state. $HerfIndState$ is the industry Herfindahl index by state. Tax is the income tax, divided by the total expense. ROA is the net income, divided by the book value of the assets. $Personal\ Short-Tail$ is the net premium written in personal short-tail, divided by the total net premium written. $Personal\ Long-Tail$ is the net premium written in personal long-tail, divided by the total net premium written. $Commercial\ Short-Tail$ is the net premium written in commercial short-tail, divided by the total net premium written. $Commercial\ Long-Tail$ is the net premium written in commercial long-tail, divided by the total net premium written. $MarketShare$ is a firm's net premium written, divided by the net premium written of the whole industry, multiplied by 100 to make the scale more appropriate.

Table 2.4. Hedging Intervals and Performance (Exogenous)

Variable	(1) All Observations **FE**	(2) LossRatio$\leq$ 50% **FE**	(3) LossRatio$\leq$ 30% **RE**	(4) LossDeve10% **FE**	(5) LossDeve5% **FE**
$H^{(0,25\%)}$	0.0807***	0.1150**	-0.0145	0.4025***	0.5006***
	(0.024)	(0.053)	(0.045)	(0.083)	(0.143)
$H^{[25\%,50\%)}$	0.0982***	0.0695	-0.0598	0.4432***	0.4282***
	(0.025)	(0.059)	(0.053)	(0.090)	(0.155)
$H^{[50\%,75\%)}$	0.1042***	0.1937***	0.1062	0.4907***	0.5219***
	(0.026)	(0.068)	(0.071)	(0.097)	(0.170)
$H^{[75\%,100\%]}$	0.1156***	0.1643*	-0.1015	0.5565***	0.6360***
	(0.028)	(0.091)	(0.085)	(0.106)	(0.181)
ASSET	0.0278***	-0.0086	-0.0389***	-0.0006	0.1241*
	(0.007)	(0.025)	(0.014)	(0.030)	(0.064)
LEVERAGE	0.2966***	0.0796	0.2679***	0.0909	-0.1442
	(0.027)	(0.098)	(0.088)	(0.122)	(0.227)
STOCK	-0.0107	0.0358	0.0634	0.0097	0.0315
	(0.027)	(0.146)	(0.064)	(0.164)	(0.459)
HerfindahlState	0.1220***	0.2524***	0.1374**	0.0168	0.1713
	(0.021)	(0.076)	(0.056)	(0.109)	(0.220)
HerfindahlLine	-0.0826***	-0.2091**	-0.2089**	0.0799	0.0451
	(0.027)	(0.088)	(0.086)	(0.121)	(0.222)
IndHerfState	0.3251	-1.1159	0.8343	-0.6214	0.9499
	(0.410)	(1.345)	(1.240)	(1.989)	(3.094)
IndHerfLine	-1.3763***	-1.6417**	1.0867**	-0.8937	2.7990*
	(0.280)	(0.680)	(0.470)	(0.977)	(1.644)
Constant	0.1112	0.3670	0.6552***	0.3392	-1.9667*
	(0.121)	(0.432)	(0.253)	(0.506)	(1.074)
Observations	19,394	2,413	881	1,938	971
R-squared	24.80%	14.70%	21.96%	17.80%	15.00%
Number of id	2,453	602	205	1,003	593
Hausman, $\chi^2_{(28)}$	136.48	59.21	33.34	56.01	57.97
P-Value	0.000	0.001	0.223	0.001	0.001

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Note: This table presents the impact of hedging levels on the efficiency of the P&L insurers according to Model 1. The first panel consists of the whole sample. The second panel consists of the insurers that have a three-year average loss ratio less than or equal to 50%. The third panel analyzes only the insurers that have a three-year average loss ratio less than or equal to 30%. The fourth panel considers only about 10% of insurers that have a loss development weighted by total assets around zero. The last panel considers only about 5% of insurers that have a loss development, weighted by total assets around zero. In each column, random-effect (RE) and fixed-effect (FE) regressions have been used. The Haussman test is performed, choosing either RE or FE. The models include controlled variables as specified in the previous section, including year dummies.

TABLE 2.5. Marginal Effects of Hedging Intervals on Performance (Exogenous)

	GUW: LossRatio $\leq 50\%$						**GUW: LossRatio** $\leq 30\%$					
	GUW = 0			**GUW = 1**			**GUW = 0**			**GUW = 1**		
	ME	**SE**	**p-Value**	**ME**	**SE**	**p-Value**	**ME**	**SE**	**p-Value**	**ME**	**SE**	**p-Value**
$H^{(0,25\%)}$	0.053	0.028	0.062	0.126	0.035	0.000	0.060	0.027	0.023	0.159	0.044	0.000
$H^{[25\%,50\%)}$	0.072	0.029	0.013	0.119	0.037	0.001	0.080	0.027	0.003	0.100	0.052	0.052
$H^{[50\%,75\%)}$	0.070	0.030	0.018	0.216	0.042	0.000	0.086	0.028	0.002	0.148	0.068	0.029
$H^{[75\%,100\%]}$	0.082	0.032	0.009	0.207	0.054	0.000	0.097	0.030	0.001	0.161	0.084	0.057
	FE, Haussman, $\chi^2_{(33)}$=202.45, p-Value 0, R^2=18.69%						FE, Haussman, $\chi^2_{(33)}$=169.1, p-Value 0, R^2=18.72%					

	GUW: LossDEVE around 10%						**GUW: LossDEVE around 5%**					
	GUW = 0			**GUW = 1**			**GUW = 0**			**GUW = 1**		
	ME	**SE**	**p-Value**	**ME**	**SE**	**p-Value**	**ME**	**SE**	**p-Value**	**ME**	**SE**	**p-Value**
$H^{(0,25\%)}$	0.069	0.025	0.006	0.138	0.042	0.001	0.062	0.025	0.014	0.240	0.052	0.000
$H^{[25\%,50\%)}$	0.089	0.026	0.001	0.134	0.043	0.002	0.082	0.026	0.001	0.204	0.054	0.000
$H^{[50\%,75\%)}$	0.094	0.027	0.000	0.145	0.044	0.001	0.088	0.027	0.001	0.201	0.056	0.000
$H^{[75\%,100\%]}$	0.100	0.029	0.001	0.186	0.046	0.000	0.094	0.029	0.001	0.276	0.056	0.000
	FE, Haussman, $\chi^2_{(33)}$=147.18, p-Value 0, R^2=18.67%						FE, Haussman, $\chi^2_{(33)}$=148.71, p-Value 0, R^2=18.70%					

Note: This table presents the marginal effects of hedging levels on the efficiency of P&L insurers, according to Model 2. This method uses the whole sample to analyze the impact of hedging levels. There are four ways to define good underwriting: having a three-year average loss ratio less than or equal to 50%, having a three-year average loss ratio less than or equal to 30%, about 10% of insurers that have loss development weighted by total assets of around zero, and about 5% of insurers that have loss development weighted by total assets of around zero. Random-effect (RE) and fixed-effect (FE) regressions have been used to find marginal effects for each definition. The Haussman test is performed, choosing either RE or FE. All of these definitions use FE to fit the model. The models include controlled variables as specified in the previous section, including year dummies. I report the marginal effect of each hedging level on profit efficiency. This is for the insurers that are not good underwriters. ($GUW = 0$) I also report the marginal effect of each hedging level on profit efficiency for the insurers that are good underwriters ($GUW = 1$).

Table 2.6. Hedging Intervals and Performance (Endogenous)

Variable	(1) All Observations	(2) LossRatio≤ 50%	(3) LossRatio≤ 30%	(4) LossDeve10%	(5) LossDeve5%
$H^{(0,25\%)}$	-3.2168	1.8496**	3.0899	1.3599*	0.6738
	(2.176)	(0.726)	(2.380)	(0.711)	(1.171)
$H^{[25\%,50\%)}$	0.3139	1.8225*	1.1687	0.9114	0.9122
	(1.503)	(0.932)	(1.786)	(0.692)	(1.201)
$H^{[50\%,75\%)}$	-1.1125	-0.4148	5.1910	1.1893*	1.6982
	(2.004)	(1.244)	(8.147)	(0.720)	(1.271)
$H^{[75\%,100\%]}$	-8.5888***	-0.8825	12.6801	0.8597	1.8908*
	(2.588)	(1.368)	(14.938)	(0.841)	(1.063)
ASSET	-0.1450***	-0.1576**	-0.0062	-0.1545***	-0.1750*
	(0.056)	(0.069)	(0.171)	(0.044)	(0.104)
LEVERAGE	-0.4732	-0.1054	-0.2059	0.4826	0.6001
	(0.297)	(0.286)	(0.759)	(0.297)	(0.669)
STOCK	0.2789	0.0998		-0.0602	0.1304*
	(0.223)	(0.280)		(0.155)	(0.069)
HerfindahlState	-0.1410	0.3617*	0.8967	0.0698	0.0730
	(0.271)	(0.210)	(0.609)	(0.231)	(0.555)
HerfindahlLine	-0.0557	-0.1478	0.4474	0.2326	0.5978
	(0.287)	(0.256)	(1.048)	(0.275)	(0.643)
IndHerfState	-7.9863**	-1.9253	5.5617	2.5381	5.8707
	(3.560)	(2.643)	(6.307)	(3.381)	(4.006)
IndHerfLine	5.7330**	-3.9501**	-5.5832	-0.4909	4.0366**
	(2.364)	(1.827)	(4.598)	(1.916)	(1.625)
Observations	18,936	2,193	803	1,364	557
Kleibergen-Paap, $\chi^2_{(6)}$	13.332	8.064	2.025	5.123	8.104
P-Value	0.038	0.234	0.917	0.528	0.231
Hansen J, $\chi^2_{(5)}$	7.797	20.390	3.849	34.823	N/A
P-Value	0.168	0.001	0.571	0.000	N/A
Number of id	2,213	427	149	448	192

Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Note: This table presents the impact of hedging levels on the efficiency of P&L insurers, according to Model 3. The first panel consists of the whole sample. The second panel consists of the insurers that have a three-year average loss ratio less than or equal to 50%. The third panel analyzes only the insurers that have a three-year average loss ratio less than or equal to 30 %. The fourth panel considers only about 10% of insurers that have a loss development weighted by total assets of around zero. The last panel considers only about 5% of insurers that have a loss development weighted by total assets of around zero. In each column, two-stage least squares (2SLS) is used to take into account the endogeneity of the hedging level dummy variables. For each panel, the table reports the Kleibergen-Paap underidentification test. Instruments are proper under the alternative hypothesis. It also reports Hansen J statistics for the overidentification test. Instruments are proper under the null hypothesis. The instruments are the return on assets, the reinsurance industry's average price, the reinsurance industry's average one-year loss development, the reinsurance's industry average liquidity ratio, allocation of net premium written for each product type, and market share, which I discussed in the previous section. The models include controlled variables, as specified in the previous section.

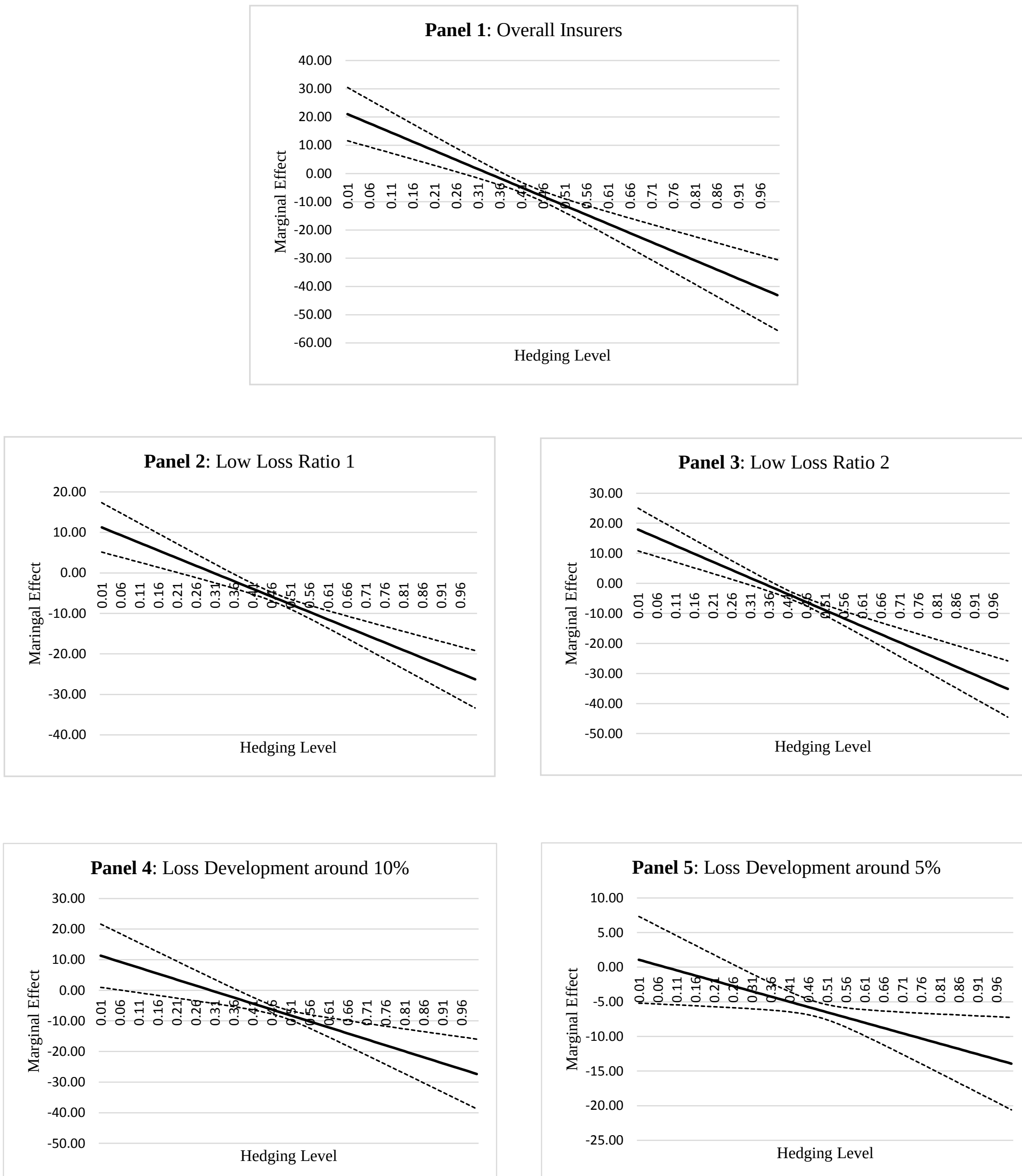
Table 2.7. Marginal Effects of Hedging Intervals on Performance (Endogenous)

	GUW: LossRatio $\leq 50\%$						GUW: LossRatio $\leq 30\%$					
	GUW = 0			**GUW = 1**			**GUW = 0**			**GUW = 1**		
	ME	**SE**	**p-Value**	**ME**	**SE**	**p-Value**	**ME**	**SE**	**p-Value**	**ME**	**SE**	**p-Value**
$H^{(0,25\%)}$	0.383	1.615	0.812	0.633	1.238	0.609	-1.555	1.490	0.297	0.503	0.729	0.490
$H^{[25\%,50\%)}$	1.830	1.532	0.232	1.533	1.222	0.210	0.099	1.093	0.928	1.275	0.944	0.177
$H^{[50\%,75\%)}$	1.287	1.482	0.385	2.685	1.733	0.121	-0.457	1.523	0.764	1.983	1.603	0.216
$H^{[75\%,100\%]}$	**-3.670**	**1.758**	**0.037**	**-8.047**	**3.281**	**0.014**	**-5.968**	**1.801**	**0.001**	**-4.156**	**1.241**	**0.001**
	K-P $\chi^2_{(6)}$= 13.26 p-value=0.04 : Hansen J $\chi^2_{(5)}$=9.05 p-value=0.11						K-P $\chi^2_{(6)}$=13.60 p-value=0.03 : Hansen J $\chi^2_{(5)}$=7.88 p-value=0.16					

	GUW: LossDEVE around 10%						GUW: LossDEVE around 5%					
	GUW = 0			**GUW = 1**			**GUW = 0**			**GUW = 1**		
	ME	**SE**	**p-Value**	**ME**	**SE**	**p-Value**	**ME**	**SE**	**p-Value**	**ME**	**SE**	**p-Value**
$H^{(0,25\%)}$	0.186	1.792	0.917	0.327	1.096	0.765	-1.612	1.900	0.396	0.286	1.011	0.777
$H^{[25\%,50\%)}$	1.796	1.684	0.286	1.065	1.071	0.320	0.980	1.393	0.482	1.133	1.032	0.272
$H^{[50\%,75\%)}$	0.734	1.614	0.649	0.308	1.224	0.801	-0.700	1.783	0.694	-0.429	1.369	0.754
$H^{[75\%,100\%]}$	**-3.788**	**1.798**	**0.035**	**-3.038**	**1.113**	**0.006**	**-5.742**	**2.169**	**0.008**	**-2.831**	**1.214**	**0.020**
	K-P $\chi^2_{(6)}$=13.31 p-value=0.04 : Hansen J $\chi^2_{(5)}$=7.98 p-value=0.16						K-P $\chi^2_{(6)}$= 13.31 p-value=0.04 : Hansen J $\chi^2_{(5)}$=8.11 p-value=0.15					

Note: This table presents the marginal effects of hedging levels on the efficiency of P&L insurers according to Model 4. This method uses the whole sample to analyze the impact of hedging levels. There are four ways to define good underwriting: having a three-year average loss ratio less than or equal to 50%, having a three-year average loss ratio less than or equal to 30%, about 10% of insurers that have loss development weighted by total assets of around zero, and about 5% of insurers that have loss development weighted by total assets of around zero. I report the marginal effect of each hedging level on profit efficiency. This is for the insurers that are not good underwriters. ($GUW = 0$) I also report the marginal effect of each hedging level on profit efficiency for the insurers that are good underwriters ($GUW = 1$). Two-stage least squares (2SLS) is used to take into account the endogeneity of the hedging level dummy variables. For each sub-table, the table reports the Kleibergen-Paap underidentification test. Instruments are all proper under the alternative hypotheses. It also reports Hansen J statistics for the overidentification test. Instruments are proper under the null hypothesis. The instruments are the return on assets, the reinsurance industry's average price, the reinsurance industry's average one-year loss development, the reinsurance's industry average liquidity ratio, allocation of net premium written for each product type, and market share, which I discussed in the previous section. The models include controlled variables specified in the previous section.

FIGURE 2.1. Marginal Effects of Hedging Intervals on Performance (Extension)



Note: These plots present the marginal effects of hedging levels on the efficiency of P&L insurers, according to Model 5 and Model 6. This method uses the whole sample to analyze the impact of hedging levels. Panel 1 represents Model 5. Panel 2 to Panel 5 represents Model 6 where there are four ways to identify good underwriters: having one-year lagged residuals from regression of the loss ratio on product types less than zero, and the lower half of insurers that have one-year lagged negative residuals from regression of the loss ratio on product type less than zero, about 10% of insurers that have loss development weighted by total assets of around zero, and about 5% of insurers that have loss development weighted by total assets of around zero. The horizon axis represents the hedging level. The vertical axis represents the marginal effects of hedging on the profit efficiency. The point estimates and their confidence intervals are plotted. The instruments for Model 5 are the return on assets, the price of the reinsurers, the reinsurers' loss development and the reinsurers' liquidity. The instruments for Model 6 are the same except the return on assets. The Kleibergen and Paap statistics are as follows, Panel 1: $\chi^2_{(3)}$=10.02, p-value=0.02, Panel 2: $\chi^2_{(3)}$=23.08, p-value=0.00, Panel 3: $\chi^2_{(3)}$=21.99, p-value=0.00, Panel 4: $\chi^2_{(3)}$=25.51, p-value=0.00 and Panel 5: $\chi^2_{(3)}$=25.56, p-value=0.00. The Hansen J statistics are Panel 1: $\chi^2_{(2)}$=4.45, p-value=0.11, Panel 2: $\chi^2_{(2)}$=3.06, p-value=0.22, Panel 3: $\chi^2_{(2)}$=3.05, p-value=0.22, Panel 4: $\chi^2_{(2)}$=3.77, p-value=0.15 and Panel 5: $\chi^2_{(2)}$=3.64, p-value=0.16. Therefore, the instruments are valid under these tests.

CHAPTER 3

Strategic Groups, Risk Management, Performance and Predation

3.1. Introduction

Various theories (such as Titman (1984), Brander and Lewis (1986), Maksimovic (1988), Bolton and Scharfstein (1990), Maksimovic and Zechner (1991), Nain (2005), Adam, Dasgupta, and Titman (2007), Mello and Ruckes (2008), Liu and Parlour (2009)) suggest that competition affects risk management. Indeed, several empirical studies find that competition among firms affect risk management decisions. However, these empirical studies define pools of competition within the industry (as in MacKay and Phillips (2005), Adam and Nain (2013)) or specific segments (as in Zingales (1998)). Even though the industry as a whole affects risk management activity, in a big industry, such as the property and liability insurance industry, a firm might not consider that every firm in its industry or even in its segment is one of its main competitors. Even though the nature of the insurance business is homogeneous, i.e., the insurer collects the premium up front, bears the risks, services the losses, and uses the collected premiums to invest in productive assets for profit, the insurance industry is hugely heterogeneous. The industry contains many lines of business and operates across different states. Insurers with different lines of business have different product types and different underwriting capabilities to write insurance policies. There are more than 30 lines of business and more than 50 states to operate in. There should be smaller pools of competition within the industry, because insurers might not think that all other insurers are their competitors. This study employs another methodology to explore more direct competition within the industry, using the "strategic group" principle.

Strategic groups are sets of companies within an industry that exhibit similar characteristics in some of their key attributes. Firms with similar characteristics are in the same pool of competition. They might collude or compete with each other. Empirical studies employ clustering algorithms to cluster firms into groups. The clustering algorithm uses key attributes to find the similarities among firms. These key attributes have to be aligned with the management's strategic decisions within a specific industry. I use variables such as the lines of business, size, and diversification as the key attributes for clustering, which follows Fiegenbaum and Thomas (1990) and follow the criteria by Chittoor and Ray (2007). These attributes should represent key managerial decisions of insurers when they formulate their strategy to compete with their competitors. By using this technique, the study is able to capture more direct competition than the industry level. Using a crisper way of defining competition is more appropriate to test the implications that derive from the theories.

The study not only contributes to the financial literature[1], but it also adds several dimensions of strategic group analysis into the strategic management literature. First, there is some debate whether strategic groups are necessary to be considered when formulating a firm's strategy. This study can show that strategic groups are an important factor for a firm to formulate its strategy, if the strategic group affects risk management. Most empirical studies in the strategic management literature use performance to show that strategic grouping is an important element of strategic consideration. However, this study attempts to show that firms might use risk management according to their technology investment positioning within their strategic group. Second, the study is the first to measure the performance among members of strategic groups by using their profit efficiency. By using this newly developed method of measuring the profitability among insurers, it properly identifies different levels of performance among strategic groups. Third, most of the strategic group literature studies small numbers of companies within an industry. It is quite easy to find some common strategic groups over a period of time. This study however, has more than 1,000 companies in the sample. Finding common groups that exist over a period of time by looking at the clustering results is a tedious task. Hence, this study offers a new systematic way to classify which group is a common group that exists over a period of time.

By studying the relationship between strategic groups and risk management, the study answers the following questions. First, what are the common strategic groups in the P&L insurance industry over a period of time? Second, which strategic groups outperform the industry's average? Third, what is the characteristic of risk management in each group through time? Fourth, which group

[1]in terms of the effects of competition on capital structure and risk management

has higher predation levels(as in Bolton and Scharfstein (1990))? Fifth, how do insurers adjust their risk management, based on their strategic group's position? Using the property and liability insurance industry data from 1989 to 2011, there are nine common strategic groups within the industry. I find that the levels of risk management on debt, reinsurance and the stock proportion of their investment portfolio are different across strategic groups. There are some groups that show a higher risk management level than the industry as a whole, and some groups that emphasize less than the industry. For example, the group that focuses on commercial long-tail insurance and particular lines of business has a lower leverage and a higher ceding level than the industry level from 1992 to 1999. After 1994, insurers within special line groups used less leverage than the industry, as predicted by Maksimovic and Zechner (1991) and Titman and Wessels (1988).

Moreover, performances measured by the profit efficiency are different across the strategic groups. Some groups outperform the industry's average either consistently or during a particular period of time. At the same time, some strategic groups have lower performance than the industry's average. For example, the group with large firms that have diversified, by both states and by lines of business, has a higher efficiency level than the industry average. The group that focuses on personal lines of business has higher efficiency than the industry from 1993 to 2011. The group that focuses on commercial long-tail and also focuses on particular lines of business has lower performance than the industry from 1992 to 1998. I define the predation, according to Bolton and Scharfstein (1990), using debt level and debt level adjusted by the reinsurance purchased. It shows that the levels of predation are different across the groups. Insurers in the commercial short-tail group have lower predation levels in both leverage and leverage adjusted measures than the industry throughout the SSTP. This means that insurers are exposed to lower levels of predation than the industry average throughout the SSTP. On the other hand, the group that contains large insurers which diversified by lines and by states, and the group that diversified by states, and the group that diversified by lines and by states have higher levels of predation.

In addition, I find that the insurers' position within their strategic groups influences the use of risk management. If the investment in its technology deviates from their peers, insurer might have a greater chance to go into insolvency. However, if the investment in technology is closely aligned to their peers, the probability of going into insolvency is similar to their peers. There is evidence that the positioning of investment on software, broker and salary, all influence risk management activity. The results suggest that strategic grouping is an important element in formulating risk management strategy. This result is similar to the findings of MacKay and Phillips (2005), but I use the strategic group levels to define the competition pools, instead of using the industry level. In addition, there are some relationships among the risk management tools. Leverage has a negative relationship with reinsurance purchasing and a positive relationship with stock levels. Stock proportion has a positive relationship with the level of reinsurance purchasing.

The structure of the paper is organized as follows: First, I review the previous literature and setup hypotheses on strategic groups, performance, risk management, predation and the insurer's positioning. Second, I show the overall study design. Third, I discuss the efficiency of insurance companies. Fourth, I conduct the clustering analysis to construct strategic groups. Fifth, I describe the data of the property and liability insurers. Sixth, I discuss the results. Seventh, I discuss the regression with regards to the relevance of risk management and strategic group positioning. Eighth, I discuss the robustness of the clustering algorithm. Lastly, I summarize the study.

3.2. Related Theories and Hypotheses

Competition is one of the factors that influences the use of risk management. Theories offer some explanations. More specifically, Titman (1984) shows that the relationship between firms, customers and suppliers affect debt level. Brander and Lewis (1986) and Maksimovic (1988) add product market into the framework to show that it affects debt-level considerations. Bolton and Scharfstein (1990) argue that firms with a higher cost of external financing might use lower debt levels, if predation exists. Maksimovic and Zechner (1991) suggest that investments in technologies among firms affect financial risk management. Nain (2005), Adam, Dasgupta, and Titman (2007) and Mello and Ruckes (2008) show that levels of hedging of competitors affect a firm's hedging decision. Firms with different chances of acquiring new investment projects hedge differently, according to Liu and Parlour (2009). MacKay and Phillips (2005) and Adam and Nain (2013) classify firms by industry to find the effect of competition. In addition, Zingales (1998) uses the trucking industry to find the effect of competition on the survival of companies by segment. This study, however, uses a different method to define the competition, by using strategic group methodology to properly capture the effect of competition on the risk management activity of insurers.

There are various studies on strategic groups, for example, Cool and Schendel (1987) in the U.S. pharmaceuticals industry, Kim and Lim (1988) in industries in rapidly developing countries, Fiegenbaum and Thomas (1990) in the U.S. insurance industry, Porac, Thomas, Wilson, Paton, and Kanfer (1995) in the Scottish knitwear industry, Bogner, Thomas, and McGee (1996) in the European pharmaceutical industry, operating in the U.S., Nair and Kotha (2001) in the Japanese steel industry, Athanassopoulos (2003) in the U.K. retail grocery industry, Peng, Tan, and Tong (2004) in Chinese companies, and Chittoor and Ray (2007) in the Indian pharmaceutical industry. All of these studies identify strategic groups within each industry and then discuss performances across those strategic groups. However, none have focused attention on the interaction between risk management and strategic groups.

This study attempts to study the interaction between strategic groups and risk management. More specifically, it explores five main questions. First, what are the common strategic postures in the P&L insurance industry? Second, which group outperforms the others? Third, what are the characteristics of risk management in each group? Fourth, which groups have a higher level of predation? Fifth, how does positioning in strategic groups affect risk management? In the following five subsections, I review the related literature, state possible hypotheses and give a possible way to explore these questions.

3.2.1. Common Strategic Groups.

Fiegenbaum and Thomas (1990) studied strategic groups of 30 leading[2] insurance companies from 1970 to 84. They found three common strategic groups that appeared during the stable strategic time periods (SSTP). These groups are characterized by looking at the average attribute values. They characterized the common strategic groups into three categories, which were diversified, life insurance and personal lines. Their study is similar to most other studies of strategic groups. Most strategic group studies cluster firms using a small numbers of companies. In contrast to Fiegenbaum and Thomas (1990), I use the whole sample of the property and liability industry.

[2]by asset size in the A.M. Best annual report

There are on average about 1,000 companies[3]. By using a large dataset, finding a common group for each SSTP is challenging. I developed a systematic way to find the common strategic groups that appear in most of the time periods. The algorithm to find the common strategies is explained later.

3.2.2. Differences of Performance Across Strategic Groups.

There should be differences of the performance across strategic groups due to mobility barriers created by members of each group. There are several studies described in the literature that support the differences in performance across groups, including Caves and Porter (1977), Cool and Schendel (1987), Fiegenbaum and Thomas (1990), Ferguson, Deephouse, and Ferguson (2000) and Nair and Kotha (2001). In addition, the incumbents aggressively react to the new entrants in the strategic groups, and as a result the performance among the groups are different (Porter (1980, 1985), Más-Ruiz, Nicolau-Gonzálbez, and Ruiz-Moreno (2005), Más-Ruiz, Ruiz-Moreno, and Ladrón de Guevara Martinez (2014)). Another explanation might be a characteristic of the product and the regulations. The groups that focus on different lines of product will have different risk characteristics. Different characteristics of risk can affect the performance of an insurer. If a strategic group focuses on particular states, the differences in regulation between those states might directly affect pricing and performance.

Some studies suggests that the level of performance is similar among strategic groups. This is because the heterogeneity of performance within a group is far larger than the performance between the groups. Therefore, we cannot see the different levels of performance across the groups. Cool and Schendel (1988), Lawless, Bergh, and Wilsted (1989) and McNamara, Deephouse, and Luce (2003) find no difference in the performance between strategic groups. The rivalry within a group is so high that the performance can be very different within a group, (Hatten and Hatten (1987), Cool and Dierickx (1993) and Más-Ruiz and Ruiz-Moreno (2011)). Performance differences within a group mask the performance differences among the groups. Capabilities in each firm might play another role in creating differences in performance within a group (Lawless, Bergh, and Wilsted (1989)). The capabilities of firms can influence their performance and outcast the performance across groups. In addition, leverage might play a role in the performance of firms within a group. According to

[3]These companies are group level and individual companies which are independent.

the literature of the interaction between capital ratio and competition, such as Brander and Lewis (1986) and Maksimovic (1988), firms take leverage into consideration and produce according to the leverage level. In addition, Fudenberg and Tirole (1986) and Bolton and Scharfstein (1990) predict a positive relationship between the level of leverage and the level of performance. Brander and Lewis (1986), Maksimovic (1988) and Rotenberg and Scharfstein (1990) imply that leverage has a negative relationship with performance. Due to the limited liability of debt contracts, firms within the pool of a strategic group compete fiercely. As a result, the performance varies within a group compared to the performance across groups.

It is interesting to see if there are differences in performance among strategic groups using the efficiency of insurers as a measure. I employed the ANOVA test and the weighted least-squared test[4] to test the differences in performance among strategic groups. Moreover, I used the t-test to test the performance of each group compared to the industry's average. This test is performed for each group in the industry. It is performed for each SSTP. Thereby, allowing us to explore the patterns of performance and differences across the SSTP.

3.2.3. Demand of Risk Management among Strategic Groups.

After deriving common strategic groups in the insurance industry, it would be sensible to ask how each group manages its risks. Do we see different risk management activities among different strategic groups in the insurance industry? There are various studies of companies and their characteristics that affect the demand for risk management, such as tax and bankruptcy cost, by Smith and Stulz (1985) and Stulz (1996), the cost of external financing by Froot, Scharfstein, and Stein (1993) and Froot and Stein (1998), and underinvestment problems by Mayers and Smith (1987). There are also empirical studies by Tufano (1996), Mayers and Smith (1990), and Cole and McCullough (2006). However, there is no empirical study based on strategic group levels and the decision on risk management. It is interesting to see how the characteristics of strategic groups influence the risk management activities.

There are some studies based on the competition that can affect hedging decisions. According to MacKay and Phillips (2005), financial variation is within an industry rather than between an

[4]By using ANOVA test, it is assumed that each group has the same variance. Therefore, I used the weighted least-square test to take into account the heterogeneity of variance among groups.

industry. The level of hedging within the whole industry will have an impact on a firm's hedging decisions. A firm or a strategic group with bigger-size characteristics tends to hedge more, according to Liu and Parlour (2009). Brander and Lewis (1986) predict that oligopolies have higher leverage ratios than monopolists or firms in a competitive market. Firms with special lines of product have less debt than businesses with more standardized products, according to Maksimovic (1988) and Titman and Wessels (1988). Lastly, firms in a more concentrated group have a higher and a less disperse financial leverage level.

In this study, I define risk management using three variables, which are the leverage ratio, the stock percentage in the investment portfolio and the ceding level. To see the different risk management levels among groups, I first used the ANOVA test and then weighted least-square for all groups to see if the levels of risk management are the same for each risk management measure. In addition, I used the t-test for each group, comparing it to the whole industry. These tests indicate how each strategic group uses risk management compared to the industry as a whole.

3.2.4. Predation Level among Strategic Groups.

Fudenberg and Tirole (1986) and Bolton and Scharfstein (1990) argue that there exists predation within an industry. Bolton and Scharfstein (1990) focuses on how firms prey on competitors who are restricted by the costs of external financing. Poorly financed firms will be preyed by cash-rich firms. After a high-leverage firm is in distress, it is hard to get external financing because its financing costs are too high. In addition, a firm in distress can become more distressed because customers are reluctant to buy products from the company, according to Titman (1984). It is a good time for low-debt firms to prey since the low-debt firms have low costs of external capital. Therefore, high-leverage firms tend to be preyed upon by low-leverage firms within a strategic group.

In addition, Poitevin (1989) argues that low-cost producers will issue debt, signaling their cost structure when they enter an industry. However, a high-cost structure firm is forced to issue equity because it needs to reduce its probability of insolvency. The incumbents with low levels of debt will observe the entrants and act aggressively to prey on the high-debt firms. Therefore, studying the level of predation is vital to understand strategic groups, and vice-versa.

I define the level of predation among groups by calculating the variance of leverage within each group. If the variance is large, there might be high levels of preying, and vice-versa. I also measured the level of predation, adjusting the hedging, using the variance of leverage ratio, subtracted by the ceding ratio. To test the level of predation, I employed the test conducted by Levene (1960) and Brown and Forsyth (1974). First, I tested to see if the variances of leverage are the same for all the groups in each SSTP. Then, I tested to see if each group has a higher or lower leverage variance than the industry. In addition, I adjusted the leverage by subtracting the ceding levels and then conducted both tests again. By doing this test, we can explore the level of predations among strategic groups in the P&L insurance industry.

3.2.5. Firm's Position in Strategic Group and Risk Management.

Maksimovic and Zechner (1991) imply that levels of leverage are based on different technology investment decisions made by firms. The study implies that firms that have similar levels of technology investment to their competitors have similar financial outcomes to their competitors. Therefore, they can have higher leverage than firms that have much higher or much lower technology investment than the industry. MacKay and Phillips (2005) show that there is a reverse relationship of the deviation from the median of the industry's technology investment and debt level. These studies are in line with Fiegenbaum and Thomas (1995) where firms use strategic groups as a reference point to measure how they are doing compared to their peers. The strategy changes according to their reference point, and this study follows MacKay and Phillips (2005) to find the relationship of a firm's position within a strategic group and its risk management activity. I expect to see a positive relationship between the distance of positioning and risk management. I also expect a negative relationship between the distance of positioning and risk-taking activity.

In contrast to MacKay and Phillips (2005), the capital usage of insurance companies is extensively based on human capital rather than fixed assets [5]. Therefore, I use five measures of technology in this study which are 1) total salary, divided by total expense, 2) total agent expense, divided by total expense, 3) total brokerage expense, divided by total expense 4) total advertising expense, divided by total expense, and 5) total data equipment and software assets, divided by total

[5]MacKay and Phillips (2005) analyze the positioning and debt level using non-financial industry companies. They mainly focus on the use of capital invested in fixed assets such factories or properties.

assets. Similar to MacKay and Phillips (2005), I define the positioning variable for each technology by using the following equation:

$$POSITION_{i,j,t} = \frac{|technology_{i,j,t} - median(\forall_k technology_{k,j,t})|}{\max_h[|technology_{h,j,t} - median(\forall_k technology_{k,j,t})|]}. \tag{3.2.1}$$

where i is for the firm i, j is for the strategic group j, and t is for the year t. This positioning variable is the measure of how far each company invests in its technology compared to the median of its strategic group, scaled by the range of the distance within the group. To measure the impact of strategic groups to the levels of risk management, the following system of equations are estimated:

$$\begin{aligned}
\Delta LEVERAGE_{ij} &= \beta_0 + \beta_1 \Delta CEDE_{ij} + \beta_2 \Delta STOCK_{ij} + \beta^p \Delta POSITION_{ij} + \beta^* \Delta control_{ij} + \epsilon_{1ijt} \\
\Delta CEDE_{ij} &= \alpha_0 + \alpha_1 \Delta LEVERAGE_{ij} + \alpha_2 \Delta STOCK_{ij} + \alpha^p \Delta POSITION_{ij} + \alpha^* \Delta control_{ij} + \epsilon_{2ijt} \\
\Delta STOCK_{ij} &= \psi_0 + \psi_1 \Delta LEVERAGE_{ij} + \psi_2 \Delta CEDE_{ij} + \psi^p \Delta POSITION_{ij} + \psi^* \Delta control_{ij} + \epsilon_{3ijt}
\end{aligned} \tag{3.2.2}$$

where Δ of variables is the change by year. The variable in year t is subtracted by the variable in the year $t-1$ to take into account the fixed effect. For the system of equations, i is for the company i, j is for the strategic group j, and t is for the year t. $CEDE$ is the level of reinsurance for each insurer, which is the level of the reinsurance purchases, divided by the total premium written. $STOCK$ is the stock proportion of each insurer using the level of the book value of stock, divided by the book value of admitted invested assets. *control* is the control variables. The control variables consist of the strategic group level and the individual level, similar to MacKay and Phillips (2005). I use the $EFFICIENCY$ as profitability and $Size$ to measure the size, which is the log of the book value of the assets. Diversification measures are the Herfindahl index figures by lines and the Herfindahl index by states.

First, I estimated the coefficient using OLS regression. I fitted the OLS to each equation. In addition, I fitted the equations simultaneously. I employed the generalized method of moment (GMM) and three stage least-square (3SLS). By using the GMM and 3SLS, the coefficient should be consistent and more efficient than the OLS methodology. The instrumental variables for GMM and 3SLS are the second-lagged of the control variables, similar to MacKay and Phillips (2005). I verified the instruments by using Hansen (1982)'s overidentification test.

3.3. Study Design

The study's procedures are shown in Figure 3.1. After collecting all the data of the P&L industry from 1989 to 2011, first, I identified the stable strategic time periods (SSTP). Second, I used a clustering analysis to cluster insurers into groups for each SSTP. Third, I specified the algorithm to find common strategic postures throughout the time periods. Fourth, I used the profit efficiency measure to find the different performances among strategic groups. Fifth, I used risk management measures to find the different risk management levels among strategic groups. Sixth, I used the levels of debt and a specified index to calculate the levels of predation among the strategic groups. Seventh, I used GMM and 3SLS to find a relationship between distance of positioning and risk management activities.

3.4. Efficiency Measure of the Insurers

In this study, I used the new profit efficiency (NPE) approach to measure the profitability of each insurance company during each year. According to my knowledge, there is only one study, by Athanassopoulos (2003), which uses technical efficiency to measure the performances in the retail grocery industry in a strategic group setting. The new profit efficiency is different from the standard profit efficiency because it allows for the differences in price and cost among insurers. A fully efficient firm will be 1. The least efficient firm will be measured as 0. I employ the Data Envelopment Analysis (DEA) method to estimate the profit efficiency, similar to the method used by Leverty and Grace (2010). The DEA is mathematical programming, set up according to the method used by Cooper, Seiford, and Tone (2006).

Let e be a vector of 1's. Let x_j be a vector of a company j where $x_j = (x_{1j}, x_{2j}, \ldots, x_{sj})$ is the input vectors of all s inputs. Let y be the output vectors where $y_j = (y_{1j}, y_{2j}, \ldots, y_{kj})$ for the total k outputs. Let $c_j = (c_{1j}, c_{2j}, \ldots, c_{sj})$ be the cost of all the inputs. Let $p_j = (p_{1j}, p_{2j}, \ldots, p_{kj})$ be the price of the outputs for the company j. One advantage of using the NPE instead of the original profit efficiency (PE) is that it takes into account the difference in prices and costs of the outputs and inputs, respectively. The PE does not take into account these differences. Let $\bar{x}_j = (c_{1j}x_{1j}, \ldots, c_{kj}x_{kj})$ and $\bar{y}_j = (p_{1j}y_{1j}, \ldots, p_{sj}y_{sj})$. Then the formulation of the problem is,

$$\begin{aligned} e\bar{y}_0^* - e\bar{x}_0^* &= \underset{\bar{x},\bar{y},\lambda}{\text{Max}}\ e\bar{y} - e\bar{x} \\ \text{subject to} & \\ \bar{x} &= \bar{X}\lambda \leq \bar{x}_0 \\ \bar{y} &= \bar{Y}\lambda \geq \bar{y}_0 \\ e\lambda &= 1, \end{aligned} \tag{3.4.1}$$

where λ is a multiplier vector of the problem. The $\bar{x}_0$ and $\bar{y}_0$ are the given data of input and output, respectively. The NPE is defined as,

$$NPE = \frac{e\bar{y}_0 - e\bar{x}_0}{e\bar{y}_0^* - e\bar{x}_0^*}. \tag{3.4.2}$$

I need to consider what the inputs and the outputs of the problem are. Leverty and Grace (2010) use a valued approach to estimate various efficiency measures of the property and liabilities insurers, instead of the flow approach. The value approach is in line with the traditional profitability measures such as return on assets and return on equity. In addition, Berger, Cummins, and Weiss (1997) argue that the value approach is an appropriate tool to find the profit and cost efficiency within the different distribution systems of the insurers. Therefore, the use of a valued approach with DEA seems to be appropriate to measure how well each insurer performs. The valued approach of the inputs and the outputs are summarized, based on each year, as shown in the Table 3.1.

The prices of the insurance loss for each line are sometimes negative. DEA calculation eliminates the observations containing the negative price of the inputs and the outputs. Therefore, this study takes into account the insurers that have positive prices for each line. The classification of each category of the loss outputs is shown in Table 3.2,

3.5. Clustering Analysis

3.5.1. Attribute Usage.

In order to analyze strategic groups using clustering analysis, we need to be able to identify the attributes to classify the insurers into groups. This study follows the criteria to choose attributes provided by Fiegenbaum and Thomas (1990) and Chittoor and Ray (2007). First, each attribute has to be subjected to the influence of the top managers of the insurers. Second, it has to capture the strategy of insurers. Third, it has to reflect strategic choices rather than environmental changes or the industry's norms. Lastly, it should allow consistency of measurements across all the firms in the sample. Considering these factors, I follow the attributes for the property and liability used in the study by Fiegenbaum and Thomas (1990) with some adjustments. The attributes are the scope and the resource deployment, similar to Cool and Schendel (1987). First, the scope attributes consist of product types, product diversification, and size. There are four product types which are classified in Table 3.2. For each category, I use the net premium written in a particular category, divided by the total net premium written in all lines of business. The diversification is by geography and by lines of business. I calculate diversification using the Herfindahl index for each company. The Herfindahl index for geography is calculated as,

$$HerfindahlState_i = \sum_{j=1}^{n} (\text{\% share of direct premium written in state j of the insurer i})^2 \quad (3.5.1)$$

where n is a total number of states. In addition to the geographic Herfindahl index, I calculate the Herfindahl index for the lines of business as,

$$HerfindahlLine_i = \sum_{k=1}^{m} (\text{\% share of net premium written in line k of the insurer i})^2 \quad (3.5.2)$$

where k is an index for each line. The insurer who has a higher Herfindahl index will have more concentration in a particular state or a line of business.

Size is the book value of assets for each company. Resource deployment attributes are production expenses. There are four key resource deployments in the insurance industry. These attributes are the broker expenses, agent expenses, advertising expenses and salary expenses. I use the expense in each category, divided by the total expense. These variables give some ideas of how insurers allocate resources to particular departments. The variables that I study are risk management and profit efficiency. Risk management variables consist of the debt level, reinsurance ceding, and the proportion of stock in the investment portfolio. Reinsurance is the total premium ceded, divided by the total premium written. The proportion of stock is the total admitted common stock holdings, divided by the total admitted cash and invested assets. The profit efficiency is the measure of performance of a firm described in the previous section.

3.5.2. Stable Strategic Time Periods (SSTP).

In accordance with Cool and Schendel (1987) and Fiegenbaum, Sudharshan, and Thomas (1987), I need to identify the SSTP before clustering the insurers into groups. The SSTP show how long the structure of strategic groups last over time. According to Fiegenbaum, Sudharshan, and Thomas (1987), the analysis ignores the change of strategy between periods and the interrelationships among the strategic attributes, if we collapse the time horizon into one period. On the other hand, clustering firms year-by-year will imply that 1) one year is a strategic time period of the industry, 2) shifts from one year to another year are meaningful and 3) strategic implementation of insurers is only one year. This study does not assume the stable strategic time period to be one year or all the years. It relies on the algorithm to test the stable strategic time periods, in line with Fiegenbaum, Sudharshan, and Thomas (1987) and Fiegenbaum and Thomas (1990). The algorithm will compare the similarity between covariance matrices of attributes between each year. More specifically, the strategic groups are stable for the year i to t if the following tests do not reject the following null hypotheses:

$$\begin{aligned}
H_0&: \ \Sigma_i = \Sigma_t \\
H_0&: \ \Sigma_{i+1} = \Sigma_t \\
H_0&: \ \Sigma_{i+2} = \Sigma_t \\
&\ \ \vdots
\end{aligned}$$

.

$$\begin{aligned}
H_0 &: \ \Sigma_{t-2} = \Sigma_t \\
H_0 &: \ \Sigma_{t-1} = \Sigma_t \\
\text{against } H_1 &: \ \text{at least one equation is not equal (for each } H_0).
\end{aligned}$$

Σ_s is the covariance matrix of attributes in year $s = i \dots t$. The test is the Bartlett test which is a likelihood-ratio test. It assumes that the sample of each year are of multivariate normal distribution. It uses the likelihood-ratio statistic, which is χ^2 distribution, but it can also be estimated by the χ^2 approximation and F approximation. The result of SSTP is presented in the Table 3.4. According to Table 3.4, there are 15 stable strategic time periods. Out of 15 SSTP, there are five periods that contain more than one year. One possible explanation to the breaks between time periods is that there are various catastrophic events interrupting the industry as a whole. These events force insurers to readjust their strategies. The insurance industry experienced Hurricane Andrew in 1992, which cost insurers about $27.0 billion, according to A.M. Best (2009). This coincides with the break of the SSTP in 1992. In addition, insurers experienced another break in the time periods, which might have resulted from the Northridge earthquake. This earthquake resulted in about $20 billion in losses, according to A.M. Best (2009). During the years 2003 to 2006, the insurance industry structure did not exhibit a stable structure. Specifically, hurricane Katrina and Wilma cost the insurance industry about $59.4 billion, according to A.M. Best (2009). Interestingly, during the financial crisis, insurers had a stable time throughout the years (2007 to 2009).

3.5.3. Clustering Algorithm.

This study uses Ward's hierarchical clustering algorithm to cluster insurers into strategic groups, similar to Bogner, Thomas, and McGee (1996) and Short, Ketchen, Palmer, and Hult (2007). The Euclidean distances of attributes are used to measure the distance between the insurers. For each iteration, each cluster merges with the other cluster which gives the lowest variance within a cluster. All the attributes for each company are standardized using the Z-scores. Therefore, the very large or very small values of variables do not overemphasize the clustering analysis. There are various ways to identify the number of groups. Milligan and Cooper (1985) test about 30 stopping rules and found that Calinski and Harabasz (1974) provides one of the best stopping rules.

Therefore, I used the index of Calinski and Harabasz (1974) to find the number of groups. Suppose we have n attributes and k clusters, the Calinski and Harabasz (1974)'s index can be written as,

$$CH_k = \frac{SSB/(k-1)}{SSW/(n-k)} \tag{3.5.3}$$

where SSB is the sum-of-squares between the clusters. SSW is the sum-of-squares within each cluster. I then picked the number of clusters that maximize the value of CH_k. The clustering became meaningful when we observed the relationships and explained the uniqueness of each group. During some years, the CH_k criteria produced very small numbers of groups. To have a meaningful clustering throughout the SSTP, I picked the maximum CH_k in the range of 8 to 15 groups. After identifying the groups and the members of each group, I found the common strategic groups that appeared most frequently in the SSTP.

3.5.4. Common Strategic Group Algorithm.

Fiegenbaum and Thomas (1990) analyze the strategic groups' formation using the 30 biggest insurers. By analyzing small numbers of companies, it is easy to see the movement and common strategic groups within the industry. My study uses all the P&L insurance companies. Hence, with over 1,000 insurers per year, spotting the common strategic group is not a trivial task. Therefore, I developed an algorithm to transform the clustering results and find the common strategic groups throughout the SSTP. First, I found the sample mean of attributes for each group. Since each attribute is standardized, the sample mean equals 0 and standard deviation equals 1. I labeled each sample mean for each attribute as 1 if the sample mean is greater than or equal to 1. I labeled -1 if the sample mean value is less than -1. I labeled the attribute as 0 otherwise. Therefore, if the group focuses on a particular attribute for that particular year, the attribute is 1. If the group does not focus on any particular attribute at all, the attribute value will be -1. The result is a table of -1, 0, and 1 for attributes and for each strategic group. The example can be seen in the Table 3.6.

Subsequently, I put all periods in the SSTP together. I ranked the frequencies that occur for about more than 50% of the SSTP which is more than or equal to 7.5. I labeled it as a common strategic group characteristic. The example is illustrated in Table 3.7.

According to Table 3.7, the insurers that focus mainly on commercial long-tail[6] is a possible common strategic group because it happens for 11 periods out of 15 periods of SSTP. In addition, the group that focuses on commercial long-tail and particular lines of business[7] occurs 10 times. Therefore, this strategy can be another common group. At the end of this algorithm, I ended up having nine strategic groups based on the assumption that the group should happen more than around 50 % of SSTP. Though, there is one strategic group that exists seven times, the main strategy of that group is to diversify by states. I also included it since it represents a meaningful strategic group interpretation. The common strategic groups are shown in Table 3.8 within the results section.

3.6. Data

This study uses the data from the property and liability insurance industry from the NAIC database. The data is from 1989 to 2011. The data contains all the insurance companies in the P&L insurance industry. Therefore, there is no sample selection bias. To understand the strategic decisions of insurers as a whole, the analysis considers the group level, including the independent individual insurers. I use the group-level data because the strategic group analysis should take into account the overall strategy, instead of each insurer that belongs to a certain group. There are 19,205 observations. I report the summary statistics for each variable in Table 3.9.

According to Table 3.9, there are two types of attributes that will be used to cluster. The first type is the scope of insurers. It consists of the product of the businesses, diversification and size. On average, insurers have about 26% written premiums in the commercial long-tail. They have about 27%, 33% and 12% in the commercial short-tail, personal and specialist business, respectively. The second type of attributes is the resource deployment. The insurance business is a business that uses human capital as the main input. I capture the expenses on the brokers, agents, advertising and salaries as the attributes of resource deployment.

The other set of variables is the risk management. These variables are the leverage ratio, reinsurance levels and the proportion of stock in the investment portfolio. On average, insurers

[6] This is when the CL column is 1 and other column is 0.
[7] This is when the CL column is 1 and the Herf Line is 1 and the other column is 0.

have about 55% debt ratio. They cede about 25% of the total premium written. In addition, insurers invest about 12% of their assets in stock and preferred stock. The overall efficiency of the insurers is 4%. Next, I discuss some results from the econometric analysis.

3.7. Results

3.7.1. Result: Common Strategic Group.

Table 3.8 illustrates the common strategic groups of the property and liability insurers from 1989 to 2011. There are nine strategic groups that occur in more than half of the SSTP.[8] The group that focuses on personal lines appears in all of the SSTP. The insurers that focus on the commercial short-tail lines appear 14 times in the SSTP. The next group is the large insurers that that have diversified by lines and by states. This group appears 13 times in the SSTP. The strategic group that focuses on special lines of business appear 11 times in the SSTP. The strategic group that has an average of all the dimensions of attributes appears 11 times in the SSTP. The strategic group that focuses only on commercial long-tail policies appears 11 times in the SSTP. The strategic group that focuses on commercial long-tail and concentrates in particular lines of business appears 10 times in the SSTP. The other group is a group that diversifies by states and lines of business. This group appears eight times in the SSTP. The group exists during the time period from 1997 to 2006, except the period from 2000 to 2002, which is after the dot-com bubble. Lastly, the group that diversifies by states appears mostly in the beginning of the 1990s and disappears afterward. This group appears seven times in the SSTP. I also include this group because it has an intuitive interpretation of the group even though it appears for slightly less than 7.5 years.

3.7.2. Result: Different Risk Management among Groups.

This section tests whether the risk management levels (leverage, reinsurance level and stock proportion) are the same among strategic groups. In addition, I tested if each common group has higher or lower risk management levels than the industry. First, I tested for the same level of risk management among all the groups for each year. According to Table 3.10, ANOVA and the

[8]There are 15 SSTP during 1989 to 2011. Therefore, I pick the common strategic groups that appear more than eight times.

weighted least-square tests suggest that there are differences in the level of risk management on every risk management measure. Next, I tested, for each common group, to see if they used risk management either more or less than the industry as a whole.

Table 3.11 shows the test of risk management levels for each group compared to the industry. There are some interesting patterns of the risk management levels among the insurer's strategic groups. The group that focuses on commercial long-tail and particular lines of business has lower leverage, higher ceding levels than the industry, and a higher stock proportion from 1992 to 1999. The commercial short-tail group uses more leverage than the industry's average. After 1994, the special lines group uses less leverage than the industry, as predicted by Maksimovic (1988) and Titman and Wessels (1988). Even though the special lines group has a lower leverage, it has a higher stock proportion of the portfolio than the industry after 1994. This suggests that the special lines group reduces the risk on liability, but increases the risk on assets via increasing the stock proportion in their investment portfolios. The group for the big insurers that have diversified by both states and lines has lower leverage than the industry. The group that has diversified by states has a lower leverage than the industry, when it does not disappear from the SSTP. From 1989 to 1998, the average strategy on every attribute group has more leverage than the industry.

3.7.3. Result: Performance Level among Strategic Groups.

The performance among strategic groups are different. First, I tested the same level of performance among all the groups for each year. According to Table 3.12, the ANOVA and weighted least-square tests suggest the differences in levels of performance. There are two SSTP that do not exhibit significant differences which are from 2000 to 2002 and 2005, for the ANOVA test. However, adjusting for the different performance variances for each group, there is one year when there are no differences in performance, which is in 1999. Overall, the results suggests that there are differences in performance throughout the SSTP among strategic groups. Hence, the result supports Caves and Porter (1977), Cool and Schendel (1987), Fiegenbaum and Thomas (1990) Ferguson, Deephouse, and Ferguson (2000) and Nair and Kotha (2001). Next, I analyze how each group's performance is more or less than the industry.

In accordance with Table 3.13, I tested whether each group has a different level of efficiency from the industry. There are some patterns that can be observed from the tests. For example, the group that focuses on commercial long-tail and particular lines of business had lower performance than the industry from 1992 to 1998. The group that focuses on personal lines of business had higher efficiency than the industry from 1993 to 2011. The group of large insurers who diversified by states and lines of business has, on average, higher efficiency than the industry, and this result supports the theory that diversified companies can generally benefit more by diversifying the risks. According to Sommer (1996), insurers with lower risk can charge higher prices. Therefore, they tend to have higher profit than the insurers that do not have as much diversification. In addition, being large increases the revenue of insurers and lowers the probability of going into insolvency, according to Sommer (1996) and Liebenberg and Sommer (2008). The group that averaged on all attributes, posed higher performance than the industry from 1989 to 1998, although the performance of this group does not persist afterward. In the next section, I analyze the predation levels among the insurers' strategic groups.

3.7.4. Result: Level of Predation among Strategic Groups.

According to Table 3.14, there are different levels of predation within the property and liability insurers throughout the SSTP from 1989 to 2011. Every test shows there are significant variances of leverage, and the variances of leverage adjusted by ceding level are different among strategic groups. Bolton and Scharfstein (1990) implies that predation within each group in the insurance industry throughout the SSTP are different. I will now compare the levels of predation in each group to the industry average.

According to Table 3.15, there is evidence of different predation levels among groups of insurers in the industry. Insurers in the commercial short-tail group have lower predation levels in both leverage and leverage adjusted measures than the industry throughout the SSTP. This means that insurers are exposed to lower levels of predation than the industry average throughout the SSTP. On the other hand, the group that contains large insurers which diversified by lines and by states, and the group that diversified by states, and the group that diversified by lines and by states have higher levels of predation.

Table 3.15 shows some implications for the managers of insurers. It highlights the opportunity for predators to prey. The predator[9] might benefit to move from a low level of predation to a high

[9]The insurers who have a low level of debt or debt adjusted

level of predation if the marginal benefits of preying are higher than the marginal cost of moving. On the other hand, the prey[10] might want to move away from the group that has high level of predation to a low level of predation.

3.8. Relevance of Strategic Groups and Risk Management

This section studies the impact of strategic groups on the insurer's risk management. According to Table 3.16, there are two regression methods that I use to find the significant correlation between risk management and positioning variables. The first three columns represent the OLS regressions. These results come from the fact that I estimate the relationship equation by equation. To take into account the simultaneous equations, I use the 3SLS.[11] Since there are several endogenous variables as we previously discussed, I used the two period lagged variables as their instruments. To verify that the instruments are good instruments, I performed the Hansen-Sargan overidentification test for 3SLS. The test gives a statistics of $\chi^2_{(4)} = 2.640$ and the p-value of 0.6198. This result suggests that we cannot reject the null hypothesis that the instruments are exogenous to the errors. I also included a dummy variable of the groups as an instrument, but the test rejects the null hypothesis. Therefore, I used the second-lagged variables to be the instruments of the system. I also included these variables in the first OLS to fit the regression. The first, second and third columns give the adjusted R^2 of 9.92%, 4.69% and 3.38% respectively. For the fourth to sixth columns, I report the χ^2 values of the test if all the coefficients are zero. I also included the p-value of each equation at the bottom of the table. In addition, I tested whether the instruments are relevant to each equation using Shea (1997), similar to MacKay and Phillips (2005). The relevance is small and gives similar results as MacKay and Phillips (2005).

Comparing between the OLS and 3SLS results, the signs of coefficients in OLS and 3SLS are different. The relationships between dependent variables in the OLS are different from those in the 3SLS. Especially for the positioning, the results are different between OLS and 3SLS. Since 3SLS takes into account the simultaneous nature of the system of equations, the coefficients are consistent and more efficient than the OLS. Therefore, I focus my interpretations on the 3SLS.

[10]The insurers who have a high level of debt or debt adjusted

[11]I tried to use GMM to fit the equations, but the method is infeasible with this data. GMM does not converge.

First, the result supports the finding of Maksimovic and Zechner (1991) and MacKay and Phillips (2005). According to Maksimovic and Zechner (1991), firms that invest in key technologies far from their peers increase their risk of going into bankruptcy. In this case, using a higher leverage and a higher stock proportion are seen as increasing risks. However, purchasing reinsurance contracts reduces risks for insurers. According to Table 3.16, positioning on software has a negative relationship with leverage and ceding, and has a positive relationship with stock proportion. These results imply that insurers with higher deviations than their peers increase their risks by having a higher stock proportion and a decrease of reinsurance purchases. They decrease their risks by reducing leverage. The positioning by brokers and salaries exhibit opposite characteristics. This positioning has a positive relationship with leverage and reinsurance purchases. However, it has a negative relationship with the stock proportion. These results suggest that insurers that have a high distance of positioning, increase their risks by having higher leverage. However, they reduce their risk by purchasing reinsurance contracts and reducing the stock proportion in their investing portfolio. Overall, these results suggest that insurers use their position within their strategic group to make decisions on risk management activity.

This study is different from MacKay and Phillips (2005) because I focus on a strategic group level of analysis rather than the industry analysis. This gives us a closer view of the direct competition among insurers. In addition, MacKay and Phillips (2005) use positioning based on the investment in properties, which is the fixed capital. It is proper to use fixed capital for non-financial firms, as in the study by MacKay and Phillips (2005). In this study, however, I look at the positioning in terms of the investment in software, advertising, agents, brokers and salaries, because most assets of insurers are in human capital and data processing. I find that the key positioning is based on software, broker and salary investments. Investment in agents does not pose any influences on risk management.

The other interesting result is the interaction between leverage, reinsurance and stock proportion in the investing portfolio. These risk management measures have significant relationships among them. According to Tufano (1996), Taksar and Markussen (2003) and Hoyt and Liebenberg (2011), hedging should have a positive relationship with debt levels. Firms with more leverage have a higher probability of default, and by using reinsurance contracts they can reduce that probability. On the other hand, Rampini, Sufi, and Viswanathan (2014) argue that debt and hedging levels should have an inverse relationship. This is due to the fact that firms will have less resources to collateralize hedging contracts if they have a higher leverage ratio. In line with Rampini, Sufi, and Viswanathan (2014), I find that leverage and reinsurance purchases have an inverse relationship. However, the stock proportion in the portfolio has a positive relationship with the ceding ratio. This supports the idea from Tufano (1996), Taksar and Markussen (2003) and Hoyt and Liebenberg (2011) that insurers increase the risk in their stockholdings, but hedge that risk, by purchasing more reinsurance contracts. Finally, leverage and stock have a positive relationship. This means that insurers who increase the leverage will increase their portfolio's risk by purchasing more stock at the same time, and vice versa.

Overall, there is evidence that the insurers consider their competitive position in the strategic group's position. This result comes from the fact that the insurers consider their positioning on the investment of their employees when making decisions on risk management. In addition, I find some relationships between several risk management tools. Reinsurance purchase has a positive relationship with the stock proportion, but has a negative relationship with the debt level. Stock proportion has a positive relationship with leverage.

3.9. Robustness of Clustering Algorithm

In order to check for a possible bias in the clustering algorithm toward any results of the analysis, I follow the outline for validating clustering analysis by Ketchen and Shook (1996). First, in addition to Ward's algorithm, I used various clustering algorithms to classify insurers into strategic groups. I employed single linkage, average linkage, complete linkage, weighted-average linkage, median linkage, centroid linkage and Ward's linkage. The different natures of each linkage is how we define the distances among clusters and the objective that we use to minimize the distances. The result is in line with previous strategic group literature. Ward's linkage seems to produce the best result. Other clustering algorithms do not classify the insurers in a satisfying way. For example, most of them classify insurers into about 10 groups. The problem occurs because almost all the insurers are bundled in one particular group. The rest have a maximum of two members.

Therefore, Ward's algorithm is the only clustering algorithm that classify insurers in a more robust way. Almost all of the previous studies in strategic groups, as far as I know, use Ward's algorithm to classify firms. By using Ward's algorithm, I not only classify insurers in a meaningful way, but I can also use it to compare to previous studies in the insurance industry that use the same clustering algorithm, such as Fiegenbaum and Thomas (1990).

Second, I use various tests and several variables to test my hypotheses. These variables are "external" in the sense that they are not included in the attribute for the clustering algorithm. I employ both ANOVA and weighted least-square tests to compare the mean of performance and the mean of risk management among strategic groups. I use three variables for capturing the risk management activity, such as leverage, stock proportion in the investing portfolio and reinsurance purchase. The tests from these variables give a similar conclusion, that the use of risk management among groups are different. I employ three tests for the predation level following Levene (1960) and Brown and Forsyth (1974). I also use two measures of predation level, based on leverage, and leverage adjusted by the reinsurance purchased. The results from the tests are similar with various variables. The predation levels are different among strategic groups.

3.10. Conclusion

In this study, I classify property and liability insurers into strategic groups. This clustering algorithm enables me to robustly analyze the firms' interaction within the insurance industry. By using a newly developed measure of performance of insurers, I find that firms have different performances across the strategic groups, in line with Caves and Porter (1977), Cool and Schendel (1987), Fiegenbaum and Thomas (1990) Ferguson, Deephouse, and Ferguson (2000) and Nair and Kotha (2001). In addition, I show the relationship of product type and the risk management level. More specialized firms tend to have less level of leverage, as in Maksimovic (1988) and Titman and Wessels (1988). I define the predation using debt level and debt level, adjusted by reinsurance purchase. It shows that the levels of predation are different across the groups, according to Bolton and Scharfstein (1990).

Moreover, I study the relevance of the interaction between insurers at the strategic group level, rather than the industry level. The result is in line with MacKay and Phillips (2005). There is evidence that insurers take their position in their strategic group into consideration when making risk management decisions. I also find the significant relationships among various measures of risk management. By looking at these results, they suggest that studying strategic groups gives a systematic and insightful way to analyze the interaction among insurers, and their implication on risk management, predation and performance within the insurance industry.

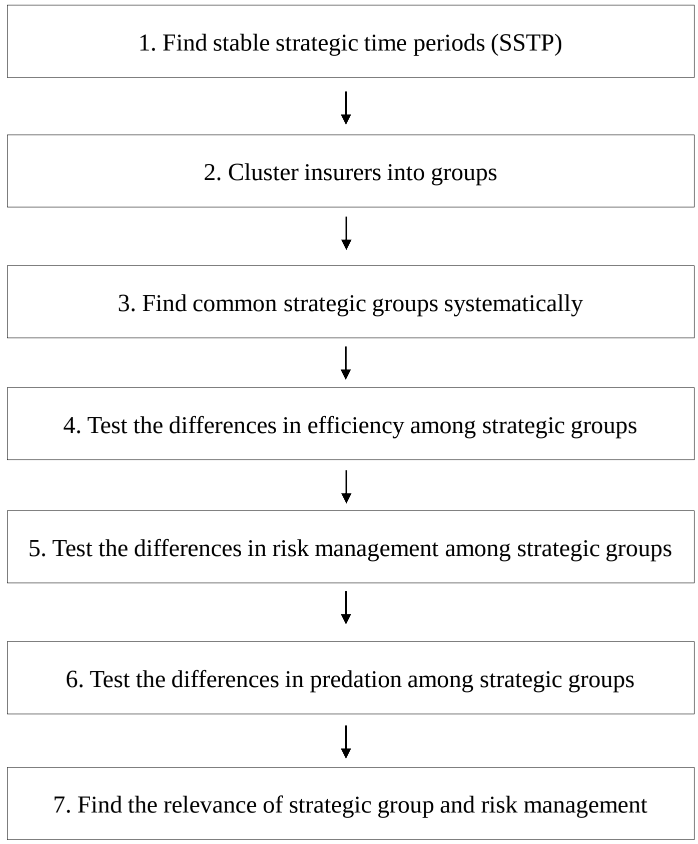


FIGURE 3.1. The chart shows a study design for strategic groups within the P&L insurance industry, and their performance, risk management, predation and positioning.

Table 3.1. Input and Output Variables for the Property and Liability Insurer Efficiency

Variables	Mean	Std. Dev.	Min	Max
Input Quantities				
Administrative labor	759.732	4320.241	-38.05101	96755.23
Agent labor	935.0175	5734.573	-8509.221	132746.2
Materials and business services	2906.099	16336.63	-1450.674	363087
Financial equity capital	4.11E+08	2.53E+09	-1.19E+09	9.48E+10
Policy holder-supplied debt capital	6.22E+08	2.91E+09	-1.95E+09	6.79E+10
Input Costs				
Administrative labor	57115.08	12795.8	35273.48	76896.13
Agent labor	45538.78	9559.086	27864.55	57934.36
Materials and business services	50963.4	12682.68	29843.09	71957.78
Financial equity capital	0.1051299	0.0028322	0.102	0.113
Policy holder-supplied debt capital	0.0576131	0.002035	0.05	0.059
Output Quantities				
Special	4.84E+07	3.44E+08	-4.25E+08	1.27E+10
Personal	3.18E+07	1.78E+08	-3.95E+07	5.07E+09
Commercial short-tail	1.29E+08	1.10E+09	-3.19E+07	3.35E+10
Commercial long-tail	8932965	8.50E+07	-2.10E+08	3.58E+09
Intermediation	2.32E+07	4.84E+08	64	3.79E+10
Output Prices				
Special	-447.867	41850.88	-4165986	1216042
Personal	11.49856	998.7675	-46264.2	81271
Commercial short-tail	214.9567	18792.5	-56357.67	2183837
Commercial long-tail	16.20851	1232.959	-46621.63	108641.7
Intermediation	0.0633397	0.0077534	0.0517734	0.1104425

Note: This table consists of all variables used for calculating the efficiency of each insurer. There is a total of 17,099 observations. The variables are inputs and outputs.

Inputs: Similar to the study by Leverty and Grace (2010), the inputs and outputs are as follows. Administrative labor quantity is the sum of the salaries, payroll taxes and the employee relations and welfare costs from the Underwriting and Investment Exhibit, Part 3, Expense, divided by the administrative labor cost. The cost of the administrative labor is from the US Department of Labor NAICS 524126: Direct Property and Liability Insurance Carriers. The agent labor quantity is the sum of net commissions, brokerage fees and the allowance for agents from the Underwriting and Investment Exhibit, Part 3, Expense, divided by the agent labor cost. The agent labor cost is from the US Department of Labor NAICS 524210: Insurance Agencies and Brokerages. The material and business service quantity is the sum of all the non-labor expenses from the Underwriting and Investment Exhibit, Part 3 Expense, divided by the materials and business services cost. The materials and business services cost is from the US Department of Labor NAICS 524298: All Other Insurance Related Activities. The available data is from 1998 to 2011, but all the expenses from the year 1989 to 1998 are estimated from the growth rate of the expenses. The cost of the equity capital is the large company stocks' long-term average rate of return from 1926 up to time t from the SBBI 2007 Classic Edition Yearbook. The estimated cost of the equity capital for the years 2008 to 2011 are the same as the year 2007. The quantity of the policy holder-supplied debt capital is the sum of real loss reserves and real unearned premium reserves from the surplus and liability statement. I use the long-term corporate bond's average annual returns up to time t from SBBI 2007 Classic Edition Yearbook as the cost of policy holder-supplied debt capital. The costs for years 2008 to 2011 are the same as the year 2007.

Outputs: According to Berger, Cummins, and Weiss (1997), the operations of insurance companies consist of three types, which are risk pooling and risk bearing, real services relating to insured losses, and intermediation. The measurement that they use to measure risk pooling, risk bearing and the services are the present value of losses. This is in line with Leverty and Grace (2010). I separate the business into four lines, which are special, personal, commercial short-tail and commercial long-tail. The classification of lines is shown in Table 3.2. Instead of using the present value of loss, I use the current year incurred loss as the quantities of the outputs. The price of the loss in each line is defined in Berger, Cummins, and Weiss (1997), which is the net premium written, subtracted by incurred loss, all over the incurred loss. The other output is the investment return. I use the total book value of cash and invested assets as the quantity and the weighted average return of stock and debt as the price. The weighted average return is defined by the proportion of stock and debt in the portfolio of each insurance company. The weight of stock will be multiplied by the long-term stock return up to each particular year. The weight of debt will be multiplied by the long-term debt return up to that year. I sum up these numbers to provide the total price of each company's portfolio. The return of stock and debt up to the time specified are from the SBBI 2007 Classic Edition Yearbook. The price of stock and debt for the years 2008 to 2011 is the same as 2007.

Table 3.2. Categories of Lines of Business

Personal	Special	Commercial Short-Tail	Commercial Long-Tail
3 Farmowners multiple peril	6 Mortgage guaranty	1 Fire	16 Workers' compensation
4 Homeowners multiple peril	10 Financial guaranty	2 Allied lines	17.1 Other liability–occurrence
19.1 Private passenger auto liability	11.1 Medical malpractice–occurrence	5 Commercial multiple peril	17.2 Other liability–claims–made
19.2 Private passenger auto liability	11.2 Medical malpractice–claims–made	8 Ocean marine	18.1 Products liability–occurrence
21 Auto physical damage	27 Boiler and machinery	9 Inland marine	18.2 Products liability–claims–made
	28 Credit	12 Earthquake	19.3 19.4 Commercial auto liability
	29 International	13 Group accident and health	22 Aircraft (all perils)
		14 Credit accident and health (group and individual)	
		15 Other accident and health	
		23 Fidelity	
		24 Surety	
		26 Burglary and theft	

Note: This table shows the insurance lines of business. The categories include personal, special, commercial short-tail and commercial long-tail.

Table 3.3. Attributes Used in Clustering and Variables of Interest

Type	**Attribute**	**Description**
Scope	Product 1: Commercial short-tail	$\frac{\text{Commercial short-tail NPW}}{\text{Total NPW}}$
	Product 2: Commercial long-tail	$\frac{\text{Commercial long-tail NPW}}{\text{Total NPW}}$
	Product 3: Personal	$\frac{\text{Personal lines NPW}}{\text{Total NPW}}$
	Product 4: Special	$\frac{\text{Special lines NPW}}{\text{Total NPW}}$
	Line Diversification	Herfindahl index by lines of business
	Geographic Diversification	Herfindahl index by states
	Size	Book value of assets
Resource Deployment	Broker	$\frac{\text{Commission and brokerage expenses}}{\text{Total expenses}}$
	Agent	$\frac{\text{Manager and agents expenses}}{\text{Total expenses}}$
	Advertising	$\frac{\text{Advertising expenses}}{\text{Total expenses}}$
	Salary	$\frac{\text{Salaries expenses}}{\text{Total expenses}}$
Variables of Interest	Debt	$\frac{\text{Book value of total liabilities}}{\text{Book value of total assets}}$
	Reinsurance	$\frac{\text{Premium ceded}}{\text{Total premium written}}$
	Stock	$\frac{\text{Book value of stock}}{\text{Total admitted invested assets and cash}}$
	Performance	DEA profit efficiency

Note: This table represents the attributes used to classify insurers into groups. NPW is the net premium written. In addition, it shows the variables of interests after clustering.

Table 3.4. Stable Strategic Time Periods of the Property and Liability Insurance Industry

Period	1	2	3	4	5	6	7	8
Years	1989-91	1992	1993	1994	1995-96	1997-98	1999	2000-02
Period	9	10	11	12	13	14	15	
Years	2003	2004	2005	2006	2007-09	2010	2011	

Note: The table represents the stable strategic time periods of the P&L industry. The period is defined using the comparison of the covariance matrices of attributes. There are 15 SSTP from 1989 to 2011.

Table 3.5. Number of Clusters for Each SSTP

Period	**1989-91**	**1992**	**1993**	**1994**	**1995-96**	**1997-98**	**1999**	**2000-2002**
# of Groups	14	14	14	14	12	14	15	9
Period	**2003**	**2004**	**2005**	**2006**	**2007-09**	**2010**	**2011**	
# of Groups	14	14	13	15	10	15	12	

Note: The table represents the number of clusters for each stable strategic time period of the P&L industry.

Table 3.6. Finding Common Strategy Illustration

Group	CL	CS	Personal	Special	Herf Line	Herf State	Asset	Broker	Agent	Adver	Salary
1	-0.41	**1.40**	-0.83	-0.32	0.18	**-1.34**	-0.12	0.11	0.02	-0.09	-0.05
2	-0.55	**1.68**	-0.88	-0.34	0.60	0.61	-0.19	-0.12	-0.07	-0.05	-0.31
3	0.41	-0.30	0.12	-0.21	**-1.31**	**-1.85**	**7.83**	-0.11	-0.06	-0.15	-0.29
4	-0.43	0.54	0.02	-0.35	0.69	0.37	-0.18	0.11	-0.18	**7.79**	**1.30**
5	-0.57	0.90	-0.61	0.33	0.98	0.27	-0.19	**10.00**	-0.14	-0.24	0.01
6	-0.57	**1.79**	-0.96	-0.35	**1.27**	**-1.08**	-0.19	**-3.22**	**17.55**	-0.30	-0.70
7	-0.51	0.69	0.00	-0.35	-0.08	0.70	-0.18	0.28	-0.08	0.12	**3.26**
8	**1.65**	-0.53	-0.66	-0.33	0.05	-0.86	-0.14	-0.24	0.57	-0.16	-0.56
9	**2.49**	-0.85	-0.95	-0.34	**1.18**	0.68	-0.08	-0.33	-0.10	-0.11	-0.40
10	-0.38	-0.79	-0.91	**2.62**	0.72	**-1.35**	0.06	-0.37	-0.11	0.00	-0.30
11	-0.55	-0.86	-0.96	**3.02**	**1.20**	0.59	-0.12	-0.42	0.02	-0.10	-0.66
12	-0.22	-0.37	0.79	-0.33	-0.91	**-1.21**	0.18	0.09	-0.13	-0.12	0.05
13	-0.56	-0.78	**1.52**	-0.35	0.11	0.64	-0.16	0.08	-0.13	-0.13	0.12
14	-0.26	-0.01	0.46	-0.35	-0.94	0.66	-0.17	0.08	-0.13	-0.06	0.25
1	0	**1**	0	0	0	**-1**	0	0	0	0	0
2	0	**1**	0	0	0	0	0	0	0	0	0
3	0	0	0	0	**-1**	**-1**	**1**	0	0	0	0
4	0	0	0	0	0	0	0	0	0	**1**	**1**
5	0	0	0	0	0	0	0	**1**	0	0	0
6	0	**1**	0	0	**1**	**-1**	0	**-1**	**1**	0	0
7	0	0	0	0	0	0	0	0	0	0	**1**
8	**1**	0	0	0	0	0	0	0	0	0	0
9	**1**	0	0	0	**1**	0	0	0	0	0	0
10	0	0	0	**1**	0	**-1**	0	0	0	0	0
11	0	0	0	**1**	**1**	0	0	0	0	0	0
12	0	0	0	0	0	**-1**	0	0	0	0	0
13	0	0	**1**	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0

Note: This is an illustration of the labeling of the sample mean of attributes in the year 1992 into -1, 0, and 1. The above section is the sample mean of each attribute for each group. The lower section is the labeling part, which I transform the sample mean value of attributes to be -1, 0, and 1. If the sample mean is less than or equal to -1 then I label it -1. If the sample mean is more than or equal to 1, then I label it 1. Otherwise, I label it 0.

Table 3.7. Finding Common Strategies with Ranking

CL	CS	Personal	Special	Herf Line	Herf State	Asset	Broker	Agent	Adver	Salary	Year Occurred
1	0	0	0	0	0	0	0	0	0	0	1989-91
1	0	0	0	0	0	0	0	0	0	0	1992
1	0	0	0	0	0	0	0	0	0	0	1993
1	0	0	0	0	0	0	0	0	0	0	1999
1	0	0	0	0	0	0	0	0	0	0	2000-02
1	0	0	0	0	0	0	0	0	0	0	2003
1	0	0	0	0	0	0	0	0	0	0	2004
1	0	0	0	0	0	0	0	0	0	0	2005
1	0	0	0	0	0	0	0	0	0	0	2006
1	0	0	0	0	0	0	0	0	0	0	2007-09
1	0	0	0	0	0	0	0	0	0	0	2011
1	0	0	0	0	-1	0	0	0	0	0	1997-98
1	0	0	0	0	-1	0	0	0	0	0	2006
1	0	0	0	1	0	0	0	0	0	0	1992
1	0	0	0	1	0	0	0	0	0	0	1993
1	0	0	0	1	0	0	0	0	0	0	1994
1	0	0	0	1	0	0	0	0	0	0	1995-96
1	0	0	0	1	0	0	0	0	0	0	1997-98
1	0	0	0	1	0	0	0	0	0	0	1999
1	0	0	0	1	0	0	0	0	0	0	2003
1	0	0	0	1	0	0	0	0	0	0	2004
1	0	0	0	1	0	0	0	0	0	0	2010
1	0	0	0	1	0	0	0	0	0	0	2011
1	0	0	0	1	-1	0	0	0	0	0	1994
0	0	1	0	-1	-1	1	0	0	0	0	2004
0	0	0	0	-1	0	0	0	0	0	0	2003
0	0	0	0	-1	0	0	0	0	0	0	2004
0	0	0	0	-1	0	0	0	0	0	0	2005
0	0	0	0	-1	0	0	0	0	0	0	2006
.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.

Note: This is an illustration of the ranking to find common strategies throughout the SSTP. This table is ranked by the commercial long-tail attribute. The group that focuses only on commercial long-tail is a possible common strategy because it occurs in 11 periods in the SSTP. Next, the insurers that focus on commercial long-tail and on lines of business occur 10 times. This occurrence is in more than half of the SSTP. Therefore, we can have these strategies as another common group.

Table 3.8. Common Strategy in the Property and Liability Insurance Industry

Strategy	**Number of Occurences in the SSTP**
1. Focused Commercial Long-Tail + Concentrate on Line of Business	10
2. Focused Commercial Short-Tail	14
3. Focused Personal	15
4. Focused Special Line	11
5. Diversified by Line and By State and Big Size	13
6. Diversified by State	7
7. Diversified by Line and By State	8
8. Average Strategy on Everything	11
9. Focused Commercial Long-Tail	11

Note: There are total of nine common strategic groups that appear in more than half of the SSTP. The left column shows the characteristics of each strategic posture. The second column represents the number of times that each group appears in the SSTP.

TABLE 3.9. Summary Statistics for the Strategic Groups Analysis

Variables	Mean	Std. Dev.	Min	Max
	Attributes for Clustering			
Scope				
Commercial Long-tail	0.256	0.396	-14.469	8.800
Commercial Short-tail	0.267	0.379	-1.626	15.410
Personal	0.334	0.386	-0.353	2.528
Special	0.121	0.317	-0.053	2.237
Line Diversification	0.610	0.316	0.066	1
Geographic Diversification	0.694	0.373	0.032	1
Size (Assets)	7.84E+08	5.50E+09	55759	1.72E+11
Resource Deployment				
Broker Expenses	0.054	0.125	-1.707	2.874
Agent Expenses	0.006	0.041	-0.311	1.949
Advertising Expenses	0.002	0.009	-0.002	0.804
Salary Expenses	0.043	0.047	-0.001	1.871
	Variables of Interest			
Risk Management				
Leverage	0.545	0.230	-0.093	5.002
Reinsurance	0.254	0.260	-1.266	14.281
Proportion of Stock	0.116	0.153	-0.012	1
Performance				
Efficiency	0.035	0.184	0	1

Note: The data is the NAIC database from 1989 to 2011. There are 19,205 observations. There are two types of attributes for the clustering analysis. First, scope attributes consist of product types, diversification and size. There are four types of products which are classified in the Table 3.2. I use the net premium written in a particular category, divided by the total net premium written in all the lines. The diversification indexes are by lines and by geography. I calculate the diversification using the Herfindahl index for each company. Size is the book value of assets. The second type of attribute is resource deployment. Broker expense is the expense of brokers, divided by the total expense. Agent is the expense of agents, divided by the total expense. Advertising is the the total advertising expenditure, divided by the total expense. Salary is the salary expense, divided by the total expense. There are four variables of interest. Leverage is defined as the book value of the total liability, divided by the book value of assets. Reinsurance is the total premium ceded, divided by the total premium written. Proportion of stock is the total admitted common stockholdings, divided by the total admitted cash and invested asset. The profit efficiency is the measure of the performance of a firm, as described in the previous section.

Table 3.10. Test of Equal Risk Management Levels among Strategic Groups

Period	1989-91	1992	1993	1994	1995-96	1997-98	1999	2000-2002
Leverage								
ANOVA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	***	***	***	***	***	***	***	***
WLS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	***	***	***	***	***	***	***	***
Reinsurance								
ANOVA	0.227	0.000	0.000	0.000	0.000	0.000	0.000	0.008
	X	***	***	***	***	***	***	***
WLS	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
	***	***	***	***	***	***	***	***
Stock Proportion								
ANOVA	0.000	0.000	0.000	0.002	0.000	0.000	0.020	0.000
	***	***	***	***	***	***	**	***
WLS	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
	***	***	***	***	***	***	***	***

	2003	2004	2005	2006	2007-09	2010	2011
Leverage							
ANOVA	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	***	***	***	***	***	***	***
WLS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	***	***	***	***	***	***	***
Reinsurance							
ANOVA	0.000	0.000	0.068	0.000	0.000	0.000	0.007
	***	***	*	***	***	***	***
WLS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	***	***	***	***	***	***	***
Stock Proportion							
ANOVA	0.000	0.000	0.000	0.000	0.000	0.095	0.001
	***	***	***	***	***	*	***
WLS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	***	***	***	***	***	***	***

Note: This table represents the test if risk management levels are all equal among the groups. There are three types of risk management. The first measure is capital structure, which is the leverage ratio. The second is the amount of ceding. Finally, stock is the proportion of common and preferred stock-holding in the investment portfolio. ANOVA is the test, based on the assumption that the strategic groups' variances are the same. WLS is the test, based on the assumption that each group's variances are different. *, **, *** are for 0.1, 0.05 and 0.01 level of significance, respectively.

Table 3.11. Risk Management Levels among Strategic Groups

Period	1989-91	1992	1993	1994	1995-96	1997-98	1999	2000-2002	2003	2004	2005	2006	2007-09	2010	2011
Leverage															
CL + Line	NA	- - -	- - -	- - -	- - -	- - -	- - -	NA	#	#	NA	NA	NA	#	-
CS	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	NA	+++	#	+++
Personal	+++	#	#	#	#	#	#	++	#	#	#	#	+++	#	-
Special	NA	NA	NA	NA	- - -	- - -	- -	- - -	- - -	#	- -	- -	- - -	- - -	- - -
Big Div Line + State	- - -	NA	- - -	- - -	#	- - -	- - -	- - -	- - -	NA	- - -	- - -	- - -	- - -	- - -
Div State	- - -	- - -	- - -	- - -	- - -	NA	NA	- - -	NA	NA	NA	NA	NA	- - -	NA
Div Line + State	NA	NA	- - -	NA	NA	- - -	- - -	NA	- - -	- - -	- - -	- - -	NA	NA	- - -
Average	+++	++	+++	++	+++	++	#	- - -	NA	NA	NA	+++	- - -	+++	NA
CL	- -	- -	- -	NA	NA	NA	+++	- -	#	#	- - -	- -	- -	NA	- - -
Reinsurance															
CL + Line	NA	++	++	+++	+++	+++	+++	NA	++	#	NA	NA	NA	#	+++
CS	#	-	++	-	-	#	#	#	#	+	#	NA	- -	#	++
Personal	#	#	#	#	#	#	#	- -	+++	+++	- -	#	#	#	#
Special	NA	NA	NA	NA	+++	#	#	#	#	#	#	#	#	#	#
Big Div Line + State	++	NA	++	#	#	+++	+++	#	++	NA	#	+	++	++	#
Div State	++	+++	++	#	#	NA	NA	-	NA	NA	NA	NA	NA	- -	NA
Div Line + State	NA	NA	#	NA	NA	+	#	NA	-	- -	#	#	NA	NA	-
Average	-	- - -	- - -	- - -	- - -	#	#	+++	NA	NA	NA	- - -	- -	- - -	NA
CL	+	#	#	NA	NA	NA	#	+	#	#	#	+++	+++	NA	-
Stock															
CL + Line	NA	+++	+++	+++	+++	+++	#	NA	+++	#	NA	NA	NA	#	#
CS	#	+	#	#	#	#	++	#	#	#	#	NA	-	#	#
Personal	+	#	- - -	#	#	- -	-	- - -	- - -	#	+	#	- -	+	#
Special	NA	NA	NA	NA	+++	+++	#	+++	+++	+++	+++	+++	+++	#	+++
Big Div Line + State	- -	NA	- -	-	-	- -	-	- -	- -	NA	#	#	-	-	#
Div State	- - -	- - -	- -	#	- -	NA	NA	#	NA	NA	NA	NA	NA	#	NA
Div Line + State	NA	NA	- -	NA	NA	#	#	NA	#	- -	#	-	NA	NA	#
Average	- - -	- - -	-	#	#	- - -	- -	- -	NA	NA	NA	#	#	#	NA
CL	#	+++	+++	NA	NA	NA	++	+++	#	+++	+++	+	#	NA	#

Note: This table presents each strategic group's risk management level compared to the industry's risk management level. The risk management measures include the ceding level, debt ratio and stock percentage in the portfolio. +, ++, + + + represent that the group's mean is larger than the industry's mean with 0.1, 0.05, and 0.01 level of significant respectively. −, −−, − − − represent that the group's mean is lower than the industry's mean with 0.1, 0.05, and 0.01 level of significance, respectively. # represents that the group's mean is not significantly lower or higher than the industry's mean. NA represents that the group disappears during that SSTP.

Table 3.12. Test of Equal Performance Levels among Strategic Groups

Period	1989-91	1992	1993	1994	1995-96	1997-98	1999	2000-2002
Efficiency								
ANOVA	0.001	0.007	0.000	0.000	0.000	0.002	0.004	0.101
	***	***	***	***	***	***	***	X
WLS	0.031	0.021	0.007	0.000	0.000	0.016	0.343	0.005
	**	**	***	***	***	**	X	***
	2003	**2004**	**2005**	**2006**	**2007-09**	**2010**	**2011**	
Efficiency								
ANOVA	0.019	0.011	0.532	0.001	0.001	0.070	0.051	
	**	**	X	***	***	*	*	
WLS	0.000	0.000	0.001	0.002	0.002	0.003	0.049	
	***	***	***	***	***	***	**	

Note: This table represents the test if efficiency levels are all equal among the groups. ANOVA is the test based on the assumption that each group's variances are the same. WLS is the test based on the assumption that the strategic groups' variances are different. *, **, *** are for 0.1, 0.05 and 0.01 level of significance, respectively.

TABLE 3.13. Performance Levels among Strategic Groups

Period	**1989-91**	**1992**	**1993**	**1994**	**1995-96**	**1997-98**	**1999**	**2000-2002**	**2003**	**2004**	**2005**	**2006**	**2007-09**	**2010**	**2011**
Eff															
CL + Line	NA	-	- -	- - -	- -	-	#	NA	#	#	NA	NA	NA	- -	+++
CS	#	#	#	#	#	#	#	#	#	#	#	NA	#	#	#
Personal	#	#	+++	#	+++	++	+++	+++	++	+++	++	+++	++	+	+++
Special	NA	NA	NA	NA	- - -	#	- -	#	- -	#	-	#	- - -	- -	-
Big Div Line + State	+++	NA	+++	+++	+++	+++	+++	#	+++	NA	+++	+++	#	+++	#
Div State	#	+++	+++	#	#	NA	NA	#	NA	NA	NA	NA	NA	+++	NA
Div Line + State	NA	NA	#	NA	NA	+++	#	NA	#	#	#	#	NA	NA	#
Average	+++	+++	+++	+++	+++	+++	#	++	NA	NA	NA	+	#	#	NA
CL	-	#	#	NA	NA	NA	#	-	#	#	#	#	#	NA	#

Note: This table presents each strategic group's performance level compared to the industry's performance level. The performance is the efficiency for each insurer. +, ++, + + + represent that the group's mean is greater than the industry's mean, with 0.1, 0.05, and 0.01 levels of significance, respectively. −, −−, − − − represent that the group's mean is lower than the industry's mean with 0.1, 0.05, and 0.01 level of significance, respectively. # represents that the group's mean is not significantly lower or higher than the industry's mean. NA represents that the group disappears during that SSTP.

Table 3.14. Test of Equal Predation Levels among Strategic Groups

Period	**1989-91**	**1992**	**1993**	**1994**	**1995-96**	**1997-98**	**1999**	**2000-2002**
Leverage								
W0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	***	***	***	***	***	***	***	***
W50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	***	***	***	***	***	***	***	***
W10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	***	***	***	***	***	***	***	***
Leverage-Cede								
W0	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	**	***	***	***	***	***	***	***
W50	0.185	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	X	***	***	***	***	***	***	***
W10	0.147	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	X	***	***	***	***	***	***	***
Period	**2003**	**2004**	**2005**	**2006**	**2007-09**	**2010**	**2011**	
Leverage								
W0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	***	***	***	***	***	***	***	
W50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	***	***	***	***	***	***	***	
W10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	***	***	***	***	***	***	***	
Leverage-Cede								
W0	0.000	0.000	0.001	0.000	0.000	0.000	0.002	
	***	***	***	***	***	***	***	
W50	0.000	0.000	0.001	0.000	0.000	0.000	0.005	
	***	***	***	***	***	***	***	
W10	0.000	0.000	0.001	0.000	0.000	0.000	0.003	
	***	***	***	***	***	***	***	

Note: This table represents the test if variances of leverage and adjusted leverage are all equal among the groups. W_0 is the test based on the mean as a central tendency in Levene (1960). W_{10} and W_{50} are the same tests, but they use the median as the central tendency as in Brown and Forsyth (1974). *, **, *** are for 0.1, 0.05 and 0.01 levels of significance, respectively.

Table 3.15. Predation Levels among Strategic Groups

	1989-91	1992	1993	1994	1995-96	1997-98	1999	2000-2002	2003	2004	2005	2006	2007-09	2010	2011
Predation (Leverage Variance)															
CL + Line	NA	++	++	++	+++	#	++	NA	#	-	NA	NA	NA	#	#
CS	- - -	- -	-	- - -	#	- - -	- -	- - -	- - -	- - -	- - -	NA	- - -	#	- - -
Personal	++	#	++	#	++	++	+++	+++	+++	+++	#	+++	+++	#	++
Special	NA	NA	NA	NA	+++	#	#	#	#	#	#	-	++	#	#
Big Div Line + State	+++	NA	#	+	#	++	++	++	+++	NA	+++	++	+++	++	++
Div State	+++	+++	+++	+++	+++	NA	NA	+++	NA	NA	NA	NA	NA	+++	NA
Div Line + State	NA	NA	+++	NA	NA	+++	+++	NA	+++	+++	+++	+++	NA	NA	+++
Average	+++	+++	#	+	+++	+++	+	+++	NA	NA	NA	- - -	+++	#	NA
CL	#	#	++	NA	NA	NA	#	#	#	#	#	#	#	NA	+
Predation (Leverage-Cede Variance)															
CL + Line	NA	+++	#	#	#	#	+++	NA	++	- -	NA	NA	NA	#	+
CS	+++	- -	#	- - -	- - -	- - -	#	- -	- - -	-	- -	NA	- - -	#	- - -
Personal	+++	#	++	++	#	++	+++	++	+++	+++	#	+	+++	#	++
Special	NA	NA	NA	NA	+++	#	#	#	- - -	#	#	- -	-	-	#
Big Div Line + State	+++	NA	+++	+++	#	+++	+++	+++	+++	NA	++	+++	+++	+++	++
Div State	+++	+++	+++	+++	+++	NA	NA	+++	NA	NA	NA	NA	NA	+++	NA
Div Line + State	NA	NA	+++	NA	NA	+++	+++	NA	+	++	+++	+++	NA	NA	+++
Average	+++	+++	#	+++	+++	+++	- -	+++	NA	NA	NA	- - -	++	#	NA
CL	+++	#	#	NA	NA	NA	#	#	+	+	#	++	++	NA	-

Note: This table presents each strategic group's predation level compared to the industry's predation level. The predation level measures are debt ratio and the debt ratio adjusted by the ceding ratio. +, ++, +++ represent that the group's mean is greater than the industry's mean, with 0.1, 0.05, and 0.01 levels of significance, respectively. −, −−, −−− represent that the group's mean is lower than the industry's mean, with 0.1, 0.05, and 0.01 levels of significance, respectively. # represents that the group's mean is not significantly lower or higher than the industry's mean. NA represents that the group disappears during that SSTP.

Table 3.16. How does Positioning in a Strategic Group affect Risk Management?

VARIABLES	OLS	OLS	OLS	3SLS	3SLS	3SLS
Dep Variable	Δleverage	Δcede	Δstock	Δleverage	Δcede	Δstock
Δleverage		-0.0858***	-0.1184***		**-1.2567*** **	**0.6406*** **
		(0.021)	(0.016)		(0.262)	(0.041)
Δcede	-0.0360***		-0.0108	**-0.7859*** **		**0.5048*** **
	(0.009)		(0.011)	(0.098)		(0.056)
Δstock	-0.0816***	-0.0178		**1.5599*** **	**1.9750*** **	
	(0.011)	(0.017)		(0.118)	(0.431)	
Δsoftware	2.2481	1.4498	0.9163	**-272.15** **	**-344.06** **	**174.47** **
	(1.627)	(2.512)	(1.960)	(122.92)	(164.97)	(78.27)
Δbroker	-0.0305	0.1822	0.1478	**5.2367* **	**6.6143* **	**-3.3560* **
	(0.089)	(0.138)	(0.108)	(2.982)	(3.980)	(1.901)
Δagent	92.8705*	31.1819	-21.5800	1,631.43	2,060.18	-1,045.28
	(51.343)	(79.279)	(61.859)	(1,668.18)	(2,145.36)	(1,065.61)
Δadver	-11.6572**	-3.1415	-2.7401	303.03	382.69	-194.11
	(4.826)	(7.453)	(5.816)	(398.77)	(509.95)	(254.74)
Δsalary	0.1593	-0.0229	-0.0604	**21.88** **	**27.67** **	**-14.02** **
	(0.138)	(0.213)	(0.166)	(10.37)	(13.90)	(6.59)
Δeff	-0.0041	0.0089	0.0096**	0.5993	0.7623	-0.3846
	(0.004)	(0.006)	(0.005)	(0.589)	(0.741)	(0.376)
Δsize	0.0756***	-0.0645***	0.0340***	**-1.4323** **	**-1.8145** **	**0.9184** **
	(0.005)	(0.008)	(0.006)	(0.669)	(0.892)	(0.424)
Δherfline	-0.0529***	-0.0522**	-0.0170	-4.9838*	-6.3060	3.1953*
	(0.014)	(0.021)	(0.017)	(2.956)	(3.853)	(1.884)
Δherfstate	-0.0423***	-0.0381	0.0252	4.8342	6.1069	-3.0977
	(0.016)	(0.025)	(0.020)	(3.892)	(5.068)	(2.483)
Constant	0.0217**	0.0747***	0.0189	0.1167*	0.1478*	-0.0748*
	(0.011)	(0.017)	(0.013)	(0.061)	(0.082)	(0.039)
Observations	5,447	5,447	5,447	5,447	5,447	5,447
Adjusted R^2	9.92%	4.69%	3.38%			
χ^2				465.42	16.02	490.23
P-Value				0	0.0991	0
Shea (1997) Adjusted R^2				0.80%	1.74%	0.03%

Note: This table presents the relevance on the insurer's position in its strategic group and its risk management activity. The first three panels are for OLS regressions with the controlled variables. The first panel's dependent variable is the differences between the time periods of debt level. The second panel's dependent variable is for differences in time for the ceding level. The third panel is for differences in time in the stock proportion of the investment portfolio. Each regression includes the second-lagged variables. Each of these three panels report the adjusted R^2 value. The fourth to sixth panels are for three stage least-square estimation, which regress three equations simultaneously. I use the second-lagged variables to be the instruments for the endogenous variables. The χ^2 value represents the statistics of the test, and whether coefficients for each equation are significantly different from zero for each column. The p-values are corresponding values for the χ^2. I provide the Shea (1997) adjusted R^2 to show how the instruments are relevant to the endogenous variables, similar to MacKay and Phillips (2005). For all regressions, *, **, *** are for 0.1, 0.05 and 0.01 levels of significance, respectively.

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