Insurers' Underwriting Result and Investment Risk-Taking Behavior -- Evidence from U.S. Property and Casualty Insurance Industry

Abstract:

This paper presents an analysis about the impact of insurers' underwriting income on their investment risk-taking strategy using empirical evidence from U.S. property-casualty insurance industry. To see this effect, I raise two streams of hypotheses to test: capacity constraint hypothesis and gambling hypothesis. The empirical evidences are in favor of capacity constraint theory: insurers' investment in risky assets increase as their underwriting loss decrease. And I also find that insurers' investment in risky asset during soft market is slightly higher than hard market. I therefore conclude that insurer adjust their investment risk-taking decisions based on their underwriting results.

Key words: Investment, risk-taking behavior, underwriting cycle, property-casualty insurance industry.

1. Introduction and Motivation

Underwriting and investment are two core business activities of insurers' operation. Since they share the common pool of capital cushion, the change in risk on one side may lead to the change in risk appetite on the other side.

The existence of underwriting cycles is one unique features of property and casualty insurance market, which involves the alternation of hard and soft markets. (Cummins and Outreville, 1987; Harrington and Danzon, 1994; Lamm-Tenant and Weiss, 1997; Venezian and Leng, 2006) Cycles exist because insurers adjust their premiums to reflect the changing demands from the insureds and also to reflect the past and future expectations of losses. The corresponding adjustment of supply and demand move the equilibrium over years and form the cyclical pattern of profitability, which is the underwriting cycle we observe. While there is no unanimously accepted theory on the causes of underwriting cycles, many researchers have examined various potential internal and external factors, including internal rate-making processes, interest rates, inflation pattern, accounting lags and regulatory lags.

It is well-documented that insurers experience greater underwriting losses and face higher insolvency risks during hard markets than soft markets.[1] This study will focus on whether their investment behavior differ under different markets. Insurers' investment behavior could be revealed by their investment portfolio in the financial statements. Property and causality insurance companies usually invest in diversified portfolios of financial assets, including government and corporate bonds, common stocks, preferred stocks, real estate, and mortgage loans. Investment in risky assets generates higher revenue to cover insurers' claim payments and

[1] Many studies have provide evidence for this argument. See Cummins and Ountreville (1987), Niehaus and Terry (1993), Harrington and Danzon (1994), Lamm-Tennant and Weiss (1997), Chen, Wong, and Lee (1999) for further discussion.

underwriting expenses. However, excessive asset risk taking subjects insurers to a volatile environment that potentially weakens insurers' ability to pay back claims and even threatens their survival. So in this study, I'm trying to seek empirical evidence on the impact of insurers' underwriting performance on their asset investment risk-taking decisions. The specific research question is: will insurers intend to take on greater investment risk during the soft markets due to ample capital availability but become reluctant to pursue high profits and take on extra risk through investment because of the intense capital constraints during hard markets? Or will they opt to go for broke in making asset risk taking decisions?

I begin by showing the pattern of insurers' underwriting income and investment income over past few decades. The figure (Figure 1) plotting this pattern is shown at the end of paper. Despite continuous years' negative underwriting results, the majority of U.S. property and casualty insurers still could maintain a positive net income because of their positive investment income. To be specific, from 1977 to 2012, on the industry level, U.S. property-casualty insurers suffer from serious underwriting losses in most of the years, but their investment income is significantly above zero and remains quite stable over years during this period. This is highly consistent with Best's Aggregates and Averages (2003): from 1980 to 2002, property and liability insurance companies' operating expenses (i.e., combined loss and expense ratios) exceeded 100 percent for 22 years, with an average of 107.5 percent. Without investment returns insurers can hardly profit from the insurance business. It then raises an interesting question to understand the driving force of this phenomenon.

The remainder of the article is organized as follows. In Section 2, I review and discuss the related literature. Research design and data sample parts are described in Section 3. In Section 4 I report empirical results. Finally, I summarize and discuss the empirical findings, practical implications in Section 5.

2. Literature Review

A brief survey into the literature gives us extensive insights into insurers' underwriting cycle and investment risk-taking related issues.

Over past decades, the U.S. property & casualty insurance industry has experienced periodic changes in premium and profitability known as the underwriting cycles. (Cummins and Ountreville, 1987; Lamm-Tennant and Weiss, 1997; Chen, Wong, and Lee, 1999) According to those studies, insurance profit margins follow a second-order autoregressive model with a length of six years, which should be subject to change of lines and countries. Underwriting cycle creates hard market and soft market. (Niehaus and Terry, 1993; Harrington and Danzon, 1994) Hard markets occur when adverse investment or underwriting results cause shock to capital, reduction in supply and increase in price. During the hard market, competition is less intense, premium rates and insurance profits tend to rise. After hard markets come the soft markets. During soft markets, insurance companies vigorously compete for market share, premium rates are usually stable or falling, and insurance firms are less profitable.

Possible explanation of the cycle mentioned in the earlier studies include interest rate, inflation pattern, loss shock, accounting measure lag, and capital constraint. For instance, Venezian (1985) proposes that the autocorrelation inherent in cost prediction process could drive the profit cycles and tested it by a simple extrapolation model. Cummins and Outreville (1987) discuss the arbitrage theory and attributed the cyclical phenomenon to institutional and regulatory rigidity. Interest rates, general business cycles, and catastrophic losses are also believed to cause the underwriting cycle, as premiums reflect discounted future losses and incomes from investments. (Leng, 2006; Lamm-Tenant and Weiss, 1997) Doherty and Kang (1988) confirm the inverse relationship between interest rates and premiums, and relate the underwriting cycle to the fluctuation of interest rates. Moreover, Lai et al. (2000) develop a multi-factor model to explain the underwriting cycle and emphasizes the role of expectation changes in generating a cycle.

Besides those studies which are built upon the perfect market assumption and rational expectation, some other studies relate the cause of underwriting cycle with the capital adequacy. Within this, there are two main streams of theories: risky debt theory, (Cummins and Danzon, 1997) and capacity constraint theory. (Winter, 1994; Gron 1994) Capacity constraint theory predicts that high capital will imply relatively low price because of the slack capacity while risky debt theory claims that high capital is a signal of lower insolvency risk so insurers will charge relatively high price. While the assumptions and conclusions of these papers differ to some degree, the main messages are similar that the capital shock cause the price increase and quantity reduction in hard markets.

Some recent literature contributes to predictability and cyclicality in underwriting cycles from different angles and conclude with different findings. For instance, Higgins and Thistle (2000) imply that the long-run underwriting profits should positively depend on the level of capacity. Choi, Hardigree, and Thistle (2002) find a negative cointegrating relationship between the underwriting margin and the risk-free rate. Jiang and Niel (2012) investigate the dynamics of underwriting profits and prove the existence of a long-term underwriting profit equation regardless of whether the underlying variables are stationary. Boyer (2011) presents a behavioral model of insurance pricing to explain the presence of underwriting cycles and shows that cycles can be purely driven by irrational expectations about investment returns, court awards or the expected reinsurance premium. Boyer and Norden (2012) reinterpret the predictability and cyclicality of insurance profitability measures in the U.S. and surprisingly show that any evidence of underwriting cycles in the U.S. property-liability industry may be spurious. And there is little evidence that insurers are able to forecast underwriting cycles to make a profit.

Some researchers argue that insurers continuously balance their asset and underwriting risks to achieve an optimal portfolio. For example, Staking and Babbel (1995), Cummins and Sommer (1996) show that insurers balance between leverage, investment risk and underwriting risk to obtain a target insolvency risk level. Jawadi and Sghaier (2009) posit that insurers continually revise their reasoning and reactions, and adjust their prices on the basis of financial variable deviations. Chen et al. (2010) claim that insurers' underwriting risk, as measured by standard deviations of insurers' underwriting income and underwriting cash flow, have a strong impact on their risk-taking in corporate bond investment. Among other studies, the underwriting cycles have been proved to be related to insurers' operational activities and financial risk taking behavior. Cummins and Danzon (1997) document that insurers are more inclined to raise capital during hard markets. Gron and Lucas (1998), show that the capital market responds to insurers' equity financing decisions more favorably in hard markets. Ren et al. (2008) show that underwriting costs and insolvency risks faced by insurers are expected to be greater in hard markets than soft markets, therefore insurers may take on more asset risks in soft markets and discharge them in hard markets. Furthermore, Ren et al. (2011) also document that stock insurers are found to more actively reallocate assets along their underwriting cycles than mutual insurers.

Insurers' investment risk-taking behavior has also attracted long-time research interests. A number of theories have been proposed to explain the investment behavior in the banking and insurance literature. However, they often make contradictory predictions regarding the risk-taking behavior of financial institutions. For example, the risk-subsidy hypothesis[2] predicts that banks and insurers will engage in excessive risk taking when deposit insurance for banks or guarantee funds for insurers are non-risk based. Furthermore, risk-shifting hypothesis argues that

[2]The reason is that the deficit of deposits and insurance policies will be absorbed by government funds when these firms become insolvent, and thus the firms pay little cost for their high risk taking. Further discussion could be found in Lin, Lai, and Powers (2013).

managers of financially distressed firms have an incentive to increase the volatility of the firm's assets. (Jensen and Meckling, 1976) In contrast, another stream of theories regarding the risk-taking behavior of financial institutions, advocates that these firms will operate in a finite-risk paradigm if relatively large costs can result from high risk taking.

In relation to the extensive researches on the risk-taking behavior of banks, there are relatively a small number of studies investigating the risk-taking behavior of insurance sector. The empirical findings are also mixed. Cummins and Sommer (1996), and Baranoff and Sager (2003) document a positive relation between changes in risk and capital in the property-casualty insurance industry and life and health insurance industry, respectively. On the other hand, Jacques and Nigro (1997) find a negative relation between risk and capital, and this support the moral hazard hypothesis which maintains that the insurance guaranty fund is like a put option held by stockholders that gives stockholders incentives to exploit the subsidy. Lee, Mayer, and Smith (1997) posit that the existence of state guarantee funds generally encourages insurers to increase risk taking. Lin, Lai, and Powers (2013) assess the impact of regulation on insurers' risk taking and argue that there is a threshold effect of regulatory pressure on insurer risk taking. Some other studies have related the organizational form to insurers' risk-taking behaviors. For example, Mayers and Smith (1988, 1994) and Lamm-Tennant and Starks (1993) show that mutual insurers, where owners have little control over management, are more successful in less risky lines of insurance than stock insurers. Ho, Lai, and Lee (2013) expand this stream of study by including multiple dimensions of risk measure to evaluate the relationship.[3] Their results are also consistent with prior work.

Based on the above discussion, though we already have extensive studies on insurers'

[3] Prior literature, including Mayers and Smith (1986, 1988, 1990, 1992, 1994) and Lamm-Tennant and Starks (1993), often use the variance of loss ratio as a proxy for underwriting risk, but Ho et al. consider multiple dimensions of firm risk: firm's total risk, underwriting risk, investment risk and leverage risk.

underwriting cycle, the relationship between insurers' underwriting results and investment risk-taking behavior is still somehow a mystery. And this study mainly intends to fill this gap.

3. Research Design

3.1. Hypothesis Development

The cyclicality nature of insurers' underwriting profits might have some influence over insurers' investment risk-taking decisions. And insurers balance between their leverage, investment risk and underwriting risk to obtain a target insolvency risk level. (Staking and Babbel, 1995; Cummins and Sommer, 1996). To explore how insurers' underwriting income affect their investment risk-taking behavior, I raise two hypotheses with opposing predictions mainly based upon prior literature and discussions.

3.1.1. Capacity constraint hypothesis

According to Gron (1994), underwriting cycles are unexpected in a competitive industry where financial capital is the major determinant of the output capacity. Also supported by Winter (1994), prices and profitability are hypothesized to be inversely related to the supply of capital such that insurance prices are inflated when capital is scarce and decrease when capital is plentiful. This stream of studies unanimously indicate that capital shortages resulting from capital market imperfections cause the hard markets.

With less capital, insurers cannot shoulder riskier asset portfolios or provide safer returns to its stakeholders. (Gatzert and Schmeiser, 2008) Several other studies have also documented the relationship between capital adequacy and firm's risk taking behavior. To illustrate, Cummins and Sommer (1996) use an option pricing model and find out that there exists a positive relationship between capital and risk to achieve their desired overall insolvency risk. The results also show that insurers are likely to restrain their risk taking due to policyholders' demand for safety when the protection of guarantee funds is incomplete. In addition, the regulatory rules also pose restrictions on insurers' investment. For example, the introduction of the Insurance Regulatory Information System (IRIS) in the 1970s, the Financial Analysis and Surveillance Tracking (FAST) system in the early 1990s, and the enactment of the model investment law and the risk-based capital requirement in the mid-1990s have increased the regulatory oversight on investment.

Therefore, if the risk-taking behavior is truly related to capital constraint, then following the loss shock, in order to provide safer return to their policyholders, insurers become more conservative over their investment risk-taking strategies. The different pricing and capital availability in different periods could naturally affect insurers' operational behavior including investment risk-taking decisions.

Combining the above findings, I hypothesize that hard markets induce tight capital constraints and deteriorate underwriting results so insurers are more conservative and resistant to make investments into risky asset. On the contrary, soft markets are accompanied with adequate capacity and intense competition, so insurers have greater desires to pursue more profitable but riskier investments. This develops into H1, which tests whether the restricted capital constraints would discourage insurers from taking on risky investment during hard markets.

> ***Hypothesis 1****:* Capital adequacy plays a role in insurers' investment risk-taking decisions. All else equal, insurers' investment into risky asset decrease during hard market due to the capital constraints associated with hard markets.

3.1.2. Gambling Hypothesis

According to literature, insurers may sometimes opt to go for broke through taking excessive risk in asset investment. Insurers have limited liabilities to policyholders and this may give rise to moral hazard problems. So standard option pricing theory predicts that equity holders of levered firms are inclined to assume excessive risks and expropriate wealth from policyholders. Yu et al. (2008) find that insurers' going-for-broke incentives strongly affect insurers' asset risk taking incentives.

Consistent with risk-shifting hypothesis, which argues that managers of financially distressed firms have an incentive to increase the volatility of the firm's assets. (Jensen and Meckling, 1976) I raise a gambling hypothesis which contends that insurers might choose to take on more aggressive investment risk-taking strategies following hard markets when faced with limited capital; and those firms that are more capital constrained would be even more responsive in the gambling in risky investment for high return. Based on the above discussions, I develop the gambling incentive hypothesis H2, which is stated as follows:

> ***Hypothesis 2:*** Poor underwriting performance incentivize insurers to involve in gambling. All else equal, insurers would pursue investment risk during hard market due to these gambling incentives.

These two hypotheses are not necessarily competing with each other, as the underwriting cycle is a complicated phenomenon caused by multiple factors and have impact on different operations within a firm. It is an empirical issue to what extent and under what scenario it affects insurers' investment risk-taking behavior.

3.2. Data

To empirically examine the above two hypotheses, I use data provided by National Association of Insurance Committee (NAIC) database and A.M. Best's Key Rating Guide. Most firm-specific characteristics is derived from NAIC, with the exception of distribution system data and organizational type data, which is obtained from Best's Key Rating Guide.[4] In addition, I also use News Release Report of Council of Insurance Agents & Brokers to obtain information on industry-wide underwriting cycle. Further, I use annualized U.S. three-month Treasury-bill rates as risk-free rate, which is reported in the St. Louis Federal Reserve's Federal Reserve

[4] The NAIC codes provided by the Best's Rating data are used to link these two data sets. These codes are available for nearly 85 percent of the companies in the NAIC database. Because Best's Key Rating Data losses information on insurers' with cocode below 10000.

Economic Data (FRED).

The time span for this study is from 2000 to 2012, 13 consecutive years in total. The sample includes only insurers that meet the following criteria: contain data for all of the variables under consideration; have positive values for total assets, net premium written and loss ratio. Then, I winsorize the data that fall within 1% and 99% quantiles for each of the variables. Finally, I detect outliers and delete observations with studentized residuals from OLS in excess of four. The remaining number of observation is 15137.[5]

3.3 Measuring Investment Risk

The primary measure of insurers' investment risk-taking behavior in this study is the percent of their investment into risky asset. Risky investments may generate greater returns; however, they may also foster greater volatility in such returns. Following method mentioned in Yu et al. (2008), I define the risky investment as t proportion of invested assets in common stock and risky bonds (defined as class 4 to class 6 bonds in the NAIC annual statement). Then for robustness check, I have also used alternative measures for this variable: the percentage of investment in stock; the percentage of investment in common stock; the percentage of investment in stock, mortgage loans and real estate.

The riskiness of assets reported in the balance sheets of property and casualty insurance companies in NAIC may vary across their types. Theoretically, all the investment have risk: stocks have price risk but bonds also pose interest rate risk, duration risk and yield risk. Here I view stock as risky investment compared with other forms because of their striking differences: according to the Statutory Accounting Principles (SAP), bond value is based on a bond's amortization cost where any premium or discount is amortized over its remaining life. However,

[5] After deleting the outliers, the remaining sample is 82% of total observations. I then believe this sample is reliable and therefore could stand for the whole property & casualty insurance industry.

the value of common stocks is determined based on the per share market values shown in the NAIC Valuation of Securities Manual.[6] Therefore, though bond also pose risk[7] which could hurt bond value and expose insurers under financial risk, stock investments are believed to be associated with higher volatility risk and market price risk than bond investment. This variable definition method is extensively used in prior studies to estimate an insurer's asset portfolio risk (see Harrington and Danzon, 1994; Gaver and Pottier, 2005).

3.4. Measuring Underwriting Performance

The key independent variable in this model is loss ratio. Loss ratio is defined as the ratio of total losses incurred divided by the total premiums earned. It is an overall measurement of insurers' underwriting profitability. Firms will incur underwriting losses if their combined ratio, which is the summation of loss ratio and expense ratio, is great than 1. Otherwise they will have underwriting gains. Insurers' underwriting results are more directly captured by their loss ratio so I use it as the key explanatory variable in this study, but I will also use combined ratio as an alternative measure in the robustness check part to consider insurers with different expense ratios.

Hard market dummy (HM) is another explanatory variable, which captures the impact of underwriting cycle on firm's investment risk-taking behavior. Hard markets are associated with limited capacity, less competition intensity, and greater regulatory scrutiny, which imposes tighter capital constraint than soft market. So we add this variable to test if how insurers behave under hard and soft markets.

I assign this dummy variable HM to be value one if the change in industry's annual average premium is positive. The data used to obtain information on industry annual average premium is from News Release Report of Council of Insurance Agents & Brokers. A figure

[6] Note that most states have statutory rules and regulations that limit investment in each asset type. If an insurer's investment exceeds the limitations, the excess is a non-admitted asset and is charged against policyholders' surplus.
[7] Bond also pose duration risk, volatility risk, and yield risk.

showing this trend is provided at the end of this paper (Figure 2): the vertical axis represents the change in average premium. If the change is positive, it means the market is tightening, indicating a hard market. Otherwise it is a soft market. As shown from the figure, the hard market began from the end of 1999 and was hardened in third quarter of 2001 following September 11 attack. Till the first quarter of 2004, the property-casualty insurance market started to ease across most lines, which marked as the beginning of soft market. Then starting from 2011, the market switch to hard market. A string of natural disasters and the residual effects of the economic downturn have been the main causes for this change in the insurance cycle from soft to hard market.

3.5. Methodology

I mainly employ fixed-effect model[8] to test the relationship between the insurer's underwriting performance and their investment behavior.[9] Pooled ordinary least squares (OLS) regressions are also conducted as a reference.

Given that a firm's decision to invest in risky assets may be affected by its prior year's performance, I estimate regression model using a lag structure by regressing firm performance in year t-1 on company attributes in year t to correct for potential endogeneity.[10] As a result for this lagged structure, the data and variables for firms' characteristics span the time period from 1999 to 2011. The fixed-effect regression model to test these hypotheses can be written in the following form:

[8] Fixed effects model explores the relationship between predictor and outcome variables within an entity. It assumes that something within the individual may impact or bias the predictor or outcome variables and I need to control for this. Fixed effects model remove the effect of those time-invariant characteristics so we can assess the net effect of the predictors on the outcome variable.

[9] I run a Hausman test where the null hypothesis is that the preferred model is random effects against the alternative the fixed effects. The Hausman's test result suggests that fixed-effect models are superior to random-effect models. For additional discussion on the fixed-effect model, see Greene (1997).

[10] Another potential solution for correcting endogeneity is to use a two-stage modeling methodology. However, that approach is not adopted here due to a lack of supporting literature. The use of the lagged-structure models is appropriate also because it is reasonable to expect that effects of underwriting results are reflected in the operational behavior in the subsequent year.

$$Y_{it} = \alpha_1 + \beta_1 LR_{i,t-1} + \boldsymbol{\beta}_3 \boldsymbol{X}_{i,t-1} + \beta_4 InterestRate_t + \mu_i + v_t + \varepsilon_{it} \quad (1)$$

where Y_{it}= the percentage of invested assets in stocks;

$LR_{i,t-1}$ = loss incurred divided by total premium earned;

$\boldsymbol{X}$ is a vector of control variables including: firms' size= log(total admitted asset); reinsurance utilization= reinsurance premium ceded divided by direct premium written plus reinsurance premiums assumed; catastrophe risk exposure= premiums written from homeowners line in gulf area and coastal states and earthquake line nationwide divided by total premiums written; line-of business Herfindahl =Herfindahl index of premiums written by business lines; Geographic HHI=Herfindahl index of premiums written by states; group affiliation dummy= 1 if the insurers is single unaffiliated company and 0 otherwise, stock insurer dummy= 1 if the insurer is a stock company and 0 otherwise, direct writer dummy= 1 if the insurer is a direct writer and 0 otherwise;

μ_i = firm-fixed effects;

v_i = year-fixed effects;

ε_{it}= random error term.

Then, to see whether this effect is significant on industry level, I use hard market dummy (HM) variable instead of loss ratio to measure the underwriting performance. Since the insurers' loss ratio tend to be higher in hard market than in soft market,[11] those two variables could be closely correlated to some extent. So I replace loss ratio with HM, holding others unchanged. The regression model is as follows:

$$Y_{it} = \alpha_2 + \beta_2 HM_{i,t-1} + \boldsymbol{\beta}_3 \boldsymbol{X}_{i,t-1} + \beta_4 InterestRate_t + \mu_i + v_t + \varepsilon_{it} \quad (2)$$

where HM=1 if the change in industry's average premium is positive and 0 otherwise.

3.6. Other Variable Definitions

This section provides a conceptual discussion of other independent variables, including firms' size, reinsurance utilization, line-of-business Herfindahl (HHI), geographical Herfindahl (GHHI), catastrophe risk exposure, group affiliation dummy, stock insurer dummy, and direct writer dummy. In addition, I also add interest rate to control for capital market's impact.

[11] This is also consistent with our empirical data, which is available in the Table2 with summary statistics.

Firstly, firm size is measured as natural log of firm’s total net admitted assets. In insurance industry, size of an insurer is a very important criterion for policyholders to select the insurer. As indicated in Cummins and Xie (2008), large and more diversified firms are good at gaining economics of scale and reduce the unit cost of production. Moreover, according to the law of large numbers, the expected loss becomes more predictable as the insured pool tends to be larger and more diversified, which requires less capital per policy written from insurers. This could help insurers overcome surplus shortage problem during hard markets. Insurers with larger assets (holding normalized liabilities constant) are more capable of paying losses, possibly signaling greater financial quality to their counterparties. Consider that size is an important signal to their customers, I would expect a positive relationship between firm’s propensity to take on risky investment and its firm size due to scale of economies and reasons discussed above.

Secondly, I add the reinsurance utilization variable to take into account of the impact of reinsurance arrangement. This variable provides direct information about the quantity of reinsurance transactions between an insurer and its reinsurance counterparties. Following Cummins, Feng, and Weiss (2012)’s method, I define reinsurance utilization as the ratio of reinsurance premiums ceded to the sum of direct premiums written and reinsurance assumed. It is widely acknowledged that reinsurance contracts provides an upper layer protection for insurers against the risk of its own defaulting, especially in the financial crisis periods. Reinsurers are believed to be equipped with better risk management skills, which could help insurers recovering from adverse shocks (Cummins and Weiss, 2000, 2011). Also according to Cummins and Song (2007), when the natural value hedge between asset and liability is not too strong, more usage of reinsurance can release the company's capital to tolerate more risk taking on the asset investment side. Therefore, combining the above discussions, I expect that the use of reinsurance would be positively related to insurers’ risky asset investment.

To control for the effect of diversification on insurers' investment risk-taking decisions, I will add two Herfindahl index variables: HHI and GHHI.[12] Both of the two Herfindahl indexes are based on net premiums written by lines of business and states, respectively.[13] Firms with lower Herfindahl index would demonstrate a more diversified composition, either in line of business written or in geographic areas involved, and this might enable insurers to pursue higher investment through stock markets. Conversely, Mayers and Smith (1988) argue that operating across many geographic regions will require firms to allow for greater managerial discretion, thereby incurring higher costs in monitoring, resulting in reduced financial performance. Thus the predictions on Herfindahl indexes' impact on firms' investment risk-taking behavior is undefined at this moment.

In addition, I also include catastrophe risk exposure variable to proxy for insurer's underwriting portfolio risk. Since firms that write more business in catastrophe-prone areas, such as hurricane and earthquake prone zones, are more likely to suffer from catastrophic events and huge claim payments if such a catastrophe peril occurs. In this way they will face higher underwriting risk. Zanjani (2002) demonstrates that the optimal capital holding by line of business is determined by the volatility of the underlying loss distribution. Hence, for property and casualty insurance companies who provide protection against catastrophes, the capital requirement is usually extremely high.

To take this factor into account, I use catastrophe exposure as a proxy for underwriting portfolio risk,[14] which is defined as the percentage of insurer's premiums in the earthquake line

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[12] These two Herfindahl Indexes are widely used as control variables in literature. See Mayers and Smith (1988, 1994), and Pottier and Sommer (1997).

[13] They are calculated as: $HHI = \sum_{i=1}^{N} s_i^2$ and $GHHI = \sum_{i=1}^{N} s_j^2$, where s_i = the proportion of net premium written in line i divided by total premium; and s_j = the proportion of net premium written in state j divided by total premium.

[14] I follow Cummins, Feng and Weiss (2012)'s method to define Catastrophe Risk Exposure variable.

nationwide and in the home-owners line in the Gulf area and East coast states divided by the total premium written. Since firms that write more business in catastrophe-prone areas are more likely to suffer from catastrophe shock and face higher underwriting risk, my expectation is that higher catastrophe risk exposure would shift firm's investment strategy away from risky assets to safer assets. So the expected sign of the catastrophe risk exposure variable would be negative.

Finally, in order to control for time-fixed firm characteristics' impact, I include three additional dummy variables. One common feature of all these three variables is that their catch-all nature. First of all I add a stock dummy because it controls for the organizational form. A stock dummy is assigned to be one if the firm is operated as a stock, and zero otherwise. There are two primary types of insurance firms: stock companies and mutual companies. Stock companies are owned by their shareholders, who bear the risk of the company earning negative profits. This might result in a loss in the shareholder value if insurer becomes insolvent. Mutual companies, on the other hand, are owned by their policyholders. So they are not able to issue stock to raise capital but can only raise capital through retained earnings, writing new policies, or by issuing debt, among which the retained earnings is the principal source of capital.

There are reasons to believe stock and mutual insurers need to be treated differently in terms of their response in investment risk-taking behavior to their underwriting results. Firstly, managerial discretion problems differ between stock and mutual insurers.[15] Mutual insurers are more likely to succeed when policyholder-owner conflicts are serious while stock insurers are better at dealing with manager-owner conflicts in that they are associated with superior mechanism to incentivize the managers. Second, mutual insurers generally face greater costs of raising new capital than stock insurers in the presence of financial distress due to their limited

[15] Jensen and Meckling (1976) and Jensen (1986) suggests that managers who are not closely monitored and/or whose objectives are not aligned with those of the owners may take distorted actions.

access to capital market and this might restrict them taking on risky investment.[16] Hence there are systemic differences between those two types of business organizations which may be correlated with the firm's investment strategy and outcome, so will include this variable in the model to control this factor.

Distribution system is another commonly used control variable in insurance literature. The direct writer dummy variable is assigned the value one for direct-writing insurer; and zero otherwise. Berger, Cummins, and Weiss (1997) investigate the coexistence of different distribution system and claim that the direct writers are more cost efficient than independent agency insurers but there are no significant differences in profit efficiency between two forms of firms. Cummins and Doherty (2006) also examine and document the differences between different market types. These systemic differences in the market type might be carried into their investment strategy and risk-taking behavior. So, I will include this dummy variable to test whether there is a significant difference between different types of firms in terms of their decision to make investment into risky asset.

The last dummy variable, group affiliation dummy, is assigned value one if insurers belongs to a group of insurers under common ownership. Generally, group members may be considered to be more financially viable if the parent company would contribute additional resources when the reinsurer developed financial problems or if other differences are perceived for insurers that are members of a group. (Weiss and Chung, 2004) In order to test whether the impact of group affiliation is significant or not, I add this dummy variable in the regression model. To sum up, Table 1 presents how I define each of the variable in the model.

4. Empirical Results

4.1. Summary Statistics

[16] See discussions in Mayers and Smith, 1988, 1992, 1994; Harrington and Niehaus, 2002

Table 2 reports the summary statistics (mean, standard deviation, minimum and maximum) of all the variables I used. As we can see from Table 2, during sample period from 2000 to 2012, U.S. property-casualty insurers on average invest 9.9% of their assets in common stocks, 22.7% in speculative bonds and 32.6% in the combination of risky assets defined as the summation of stock and speculative bonds. The average loss ratio (not including the expense ratio) for this sample is 66.3%. The average reinsurance utilization is 0.4 and the mean of catastrophe risk exposure is 0.1. In addition, other variables also have exhibited very similar summary statistics and pattern, compared with prior literature.

Table 3 presents the Pearson correlation matrix of all those explanatory variables, and Table 4 presents the sub-sample summary statistics under hard markets and soft markets, which gives us a first indication of the differences between soft markets and hard markets. According to Table 4, not surprisingly, the insurers' average loss ratio is significantly higher during hard market than soft market. In addition, the table also shows that insurers invest more into risky asset during soft markets than hard markets. Also, insurers are more concentrated through line and use less reinsurance coverage in soft market. These simple results would give us an impression about firms' characteristics under different market conditions.

4.2. Regression Results

Table 5 presents results for multiple regression using empirical data from 2000 to 2012. Column 1 and 2 give results for equation (1) using pooled OLS model and column 3 and 4 give results using fixed-effect model for equation (2), respectively.

Consistent with capacity constraint hypothesis, the lagged loss ratio is negative and significant in model 1 and model 3, which means that increase in loss ratio will lead to a drop in insurers' investment in common stock and speculative bonds. Since lower loss ratio indicates lower underwriting losses and better underwriting performance, this would be a piece of evidence to support hypothesis H1 that bad performance in underwriting business would shift insurers away from risky investment to safer assets.

Hard market dummy in model 2 and 4, is also significant and negative, still consistent with capacity constraint hypothesis that insurers would put less investment into risky asset during soft markets than hard markets. Those results again are also consistent with the univariate analysis which shows that risky investment significantly inflate during soft markets.

As for the control variables, firm size is positive and significant, indicating larger firms are more likely to involve in the risky investment than smaller firms, others being equal; catastrophe risk exposure is not significant in the fixed effects model, which suggests that the catastrophe risk exposure is not significantly related to the risky investment. Reinsurance utilization variable is significant but negative, which is inconsistent with the expectation. Still it is not convincing to draw the conclusion that the use of reinsurance would discourage insurers from taking on great investment risk. In the follow-up studies, I will add some new variables such as reinsurance exposure and reinsurance concentration, to see how reinsurance arrangement would affect the outcome. GHHI is negative and significant, which suggests that more geographically diversified firms would take on more risk through stock investment. But HHI is not significant. The mixed but interesting results here give us more incentives to explore more into this topic.

As for the dummy variables, the stock insurer dummy turns out to significant and positive. This conveys that stock insurers are more inclined to involve in the risky investment than insurers using other forms of organization, while others are held equal. Direct writer dummy is significant and negative, indicating that insurers using direct writer would be less likely to invest in stock. Also based on model estimation, single insurer dummy is not significant. This conveys there is no significant difference between single unaffiliated insurer and group affiliated insurer.

In addition, the adjusted R^2 for these models is only approximately 0.05 for both fixed effects models. Anyway, these are just the preliminary results for my analysis. More sophisticated models and results would be available in future versions.

4.3. Robustness Check

In this part, I will discuss some potential econometrics issues in model. My first concern is the accuracy of my variable measurement. For the dependent variable, I will consider alternative measures: the percentage of investment in common stock only; the percentage of investment in stock, mortgage loans and real estate. For other explanatory variables capturing insurers' underwriting performance, I will use combined ratio to compare insurers with different expense ratios.

Another concern is the omitted variable bias. Throughout the discussion, I assume the cost of capital is the same across years, which might not hold in the real world scenario. During hard market, the scarce capital availability will make it more difficult for insurers to raise capital than soft market, thus the cost of capital might increase. And this should be taken into account by adding a capital ratio variable. Also, I will add more relevant variables in the future studies.

5. Conclusion and Discussion

This paper presents an analysis of the relationship between U.S. property-casualty insurers' underwriting income and investment risk-taking behavior and some related issues employing appropriate methodologies based on a conceptual framework grounded in finance and insurance theories.

The particular interest of this study is to investigate the sensitivity of insurers' investment risk-taking behavior to its underwriting performance so that we will know whether insurers are actively adjusting their capital structure and investment portfolio based on their underwriting results. The study could also be viewed as a test towards the capacity constraint hypothesis and gambling hypothesis under on insurers' investment risk-taking behavior. After collecting data and constructing the variables, I use fixed-effect regression model to estimate the equations.

As for the regression results, the negative coefficient on both the firm's lagged loss ratio and HM dummy confirms insurers do actively balance their investment activities according to their underwriting losses. Furthermore, the results support capacity constraint hypothesis against gambling hypothesis that insurers would increase their investment into risky assets as their underwriting income increase. So far, taken altogether, we can believe that insurers adjust their investment risk-taking behavior based on their underwriting performance and the underwriting cycle would also affect insurers' investment allocation into risky assets and others.

For future studies, I will do more in-depth studies. Firstly, I will use alternative measures and models to test its robustness. Secondly, I will do sub-sample and sub-period analysis to see whether the pattern is driven by a specified group of insurers or a specified period of time. Thirdly, I want to expand the topic to further examine the role of investment income to insurers and explore how they can maintain strongly positive over years. There is still a long way to go into this field before I can fully understand these research questions. I hope that my results would have some practical implications for both insurers and regulators.

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Figure 1
Underwriting Income and Investment Income for U.S. P-C insurers from 1977 to 2012[17]

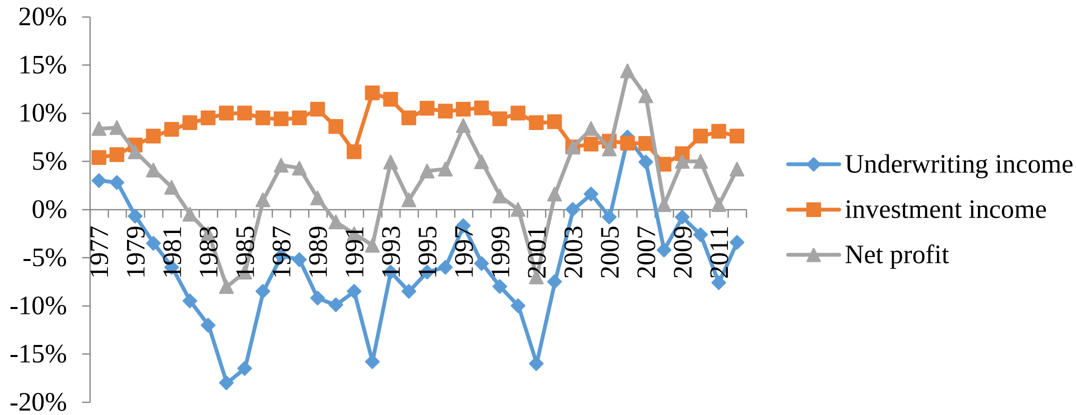
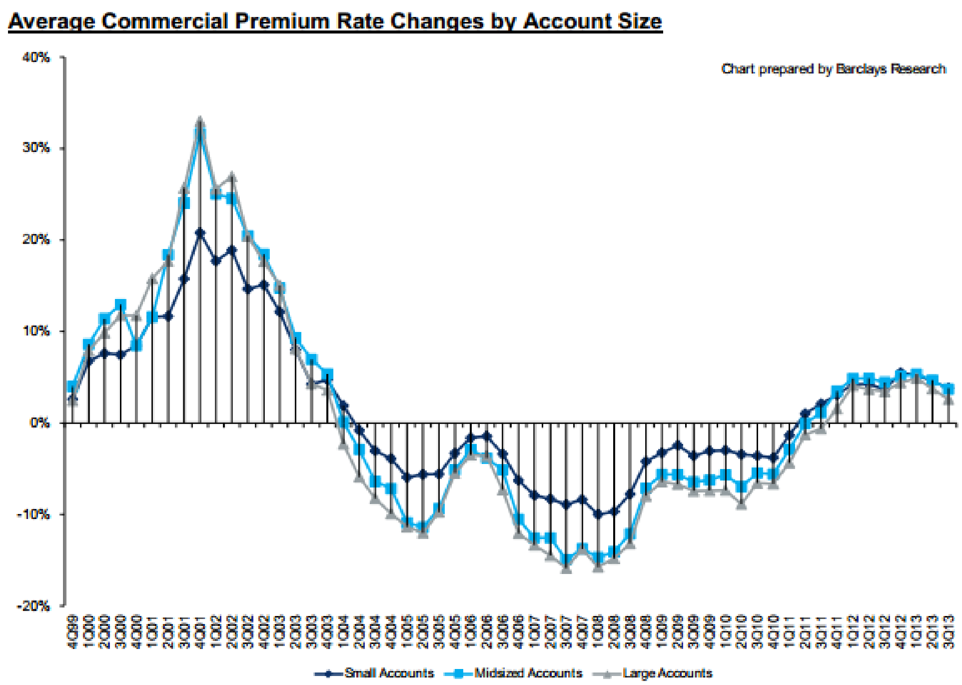


Figure 2
Underwriting Cycle data from 1999 to 2013



Source: The Council of Insurance Agents & Brokers. Chart prepared by Barclays Research.

Note: Data source is from News Release Report of Council of Insurance Agents & Brokers

[17] The data used to plot this figure is from NAIC database, Schedule P.

Table 1
Summary of Variables and Definitions

Variable	Definition
Percentage of Risky investment	Percentage of invested assets in common stock and speculative bonds
Loss Ratio	Lagged incurred losses divided by total premium earned
Hard Market Dummy	A dummy variable equals to one if the change in industry's average premium is positive and zero otherwise
Firm Size	Natural log of total admitted asset
Catastrophic Risk Exposure	Premiums written from homeowners line in gulf area and coastal states and earthquake line nationwide divided by total premiums written
Stock Insurer Dummy	A dummy variable equals to one if the insurer is a stock company and zero otherwise
Single Insurer Dummy	A dummy variable equals to one if the insurers is single unaffiliated company and zero otherwise
Direct Writer Dummy	A dummy variable equals to one if the insurer is a direct writer
Reinsurance Utilization	Reinsurance premium ceded divided by direct premium written plus reinsurance premiums assumed
HHI	Herfindahl index of premiums written by business lines
GHHI	Herfindahl index of premiums written by states
Risk-free rate	Three-month Treasury-bill rate reported in FRED

Table 2
Pearson Correlation between Independent Variables

	Loss Ratio	LogAsset	GHHI	Direct	Stock	Single	CAT	HHI	Utilization	HM	Interest rate
Loss Ratio	1	0.114	0.009	0.019	-0.001	-0.080	-0.002	-0.013	0.028	0.096	-0.008
LogAsset		1	-0.409	0.039	0.098	-0.393	-0.060	-0.269	-0.029	-0.056	0.001
GHHI			1	0.040	-0.253	0.277	0.212	0.192	-0.217	0.009	-0.013
Direct				1	-0.066	-0.045	-0.063	0.172	-0.109	0.039	0.032
Stock					1	-0.343	-0.230	-0.045	0.019	0.019	0.025
Single						1	0.024	0.324	-0.280	0.001	-0.045
CAT							1	-0.153	0.009	0.003	-0.026
HHI								1	-0.256	-0.009	-0.043
Utilization									1	0.001	-0.006
HM										1	-0.197
Interest rate											1

*Note: This is the descriptive statistics for all these 11 explanatory variables used in this study for the sample period.

*Risky investment is measured as percentage of invested assets in stock, including common stock and speculative bonds; Loss ratio is measured as lagged incurred losses divided by total premium earned; Hard market dummy equals to one if the change in industry's average premium is positive and zero otherwise; Firm size is measured as natural log of total admitted asset; Catastrophic risk exposure is measured as premiums written from homeowners line in gulf area and coastal states and earthquake line nationwide divided by total premiums written; Stock insurer dummy equals to one if the insurer is a stock company and zero otherwise; Single Insurer Dummy equals to one if the insurers is single unaffiliated company and zero otherwise; Direct Writer Dummy equals to one if the insurer is a direct writer; Reinsurance utilization is measured as reinsurance premium ceded divided by direct premium written plus reinsurance premiums assumed; HHI is Herfindahl index of premiums written by business lines; GHHI is Herfindahl index of premiums written by states; Risk-free rate is three-month Treasury-bill rate reported in FRED.

Table 3
Summary Statistics for Variables affecting Insurers' Investment Risk-taking Behavior from 2000 to 2012

Variable	Mean	STD	Min	Max
$Risky\_Inv_t$	0.3263	0.6658	0	1
Loss $Ratio_{t-1}$	0.6628	0.2346	0	1.7362
Log $Asset_{t-1}$	18.4065	1.7075	15.0003	22.998
$Direct_{t-1}$	0.1441	0.3512	0	1
$Stock_{t-1}$	0.7164	0.4508	0	1
$ReinsUti_{t-1}$	0.3888	0.2976	0	1
$Single_{t-1}$	0.3037	0.4599	0	1
$CatExposure_{t-1}$	0.1110	0.1943	0	0.9964
HHI_{t-1}	0.4805	0.3070	0	1
$GHHI_{t-1}$	0.5596	0.3806	0.0387	1
HM_{t-1}	0.4653	0.4988	0	1
Interest $Rate_{t-1}$	0.0212	0.0201	0.0004	0.0589

Number of observations: 15137

*Risky investment is measured as percentage of invested assets in common stock and speculative bonds; Loss ratio is measured as lagged incurred losses divided by total premium earned; Hard market dummy equals to one if the change in industry's average premium is positive and zero otherwise; Firm size is measured as natural log of total admitted asset; Catastrophic risk exposure is measured as premiums written from homeowners line in gulf area and coastal states and earthquake line nationwide divided by total premiums written; Stock insurer dummy equals to one if the insurer is a stock company and zero otherwise; Single Insurer Dummy equals to one if the insurers is single unaffiliated company and zero otherwise; Direct Writer Dummy equals to one if the insurer is a direct writer; Reinsurance utilization is measured as reinsurance premium ceded divided by direct premium written plus reinsurance premiums assumed; HHI is Herfindahl index of premiums written by business lines; GHHI is Herfindahl index of premiums written by states; Risk-free rate is three-month Treasury-bill rate reported in FRED.

Table 4
Summary Statistics based on Univariate Test from 1990 to 2012

	Hard Market	Soft Market	Difference
$Risky\_Inv_t$	0.2972	0.3469	***
Loss $Ratio_{t-1}$	0.6972	0.6331	**
Log $Asset_{t-1}$	18.3031	18.4973	**
$Direct_{t-1}$	0.1591	0.1316	**
$Stock_{t-1}$	0.7246	0.7083	*
$ReinsUti_{t-1}$	0.3920	0.3856	*
$Single_{t-1}$	0.3038	0.3038	
$CatExposure_{t-1}$	0.1121	0.1108	
HHI_{t-1}	0.4770	0.4829	*
$GHHI_{t-1}$	0.5642	0.5570	*
Interest $Rate_{t-1}$	0.0169	0.0249	***
N	6279	8858	

*Note: Statistical significance at the 1, 5, and 10 percent levels are denoted by ***, **, and * respectively.
*Risky investment is measured as percentage of invested assets in common stock and speculative bonds; Loss ratio is measured as lagged incurred losses divided by total premium earned; Hard market dummy equals to one if the change in industry's average premium is positive and zero otherwise; Firm size is measured as natural log of total admitted asset; Catastrophic risk exposure is measured as premiums written from homeowners line in gulf area and coastal states and earthquake line nationwide divided by total premiums written; Stock insurer dummy equals to one if the insurer is a stock company and zero otherwise; Single Insurer Dummy equals to one if the insurers is single unaffiliated company and zero otherwise; Direct Writer Dummy equals to one if the insurer is a direct writer; Reinsurance utilization is measured as reinsurance premium ceded divided by direct premium written plus reinsurance premiums assumed; HHI is Herfindahl index of premiums written by business lines; GHHI is Herfindahl index of premiums written by states; Risk-free rate is three-month Treasury-bill rate reported in FRED.

Table 5
Regression Results for Insurers' Investment Risk-taking Behavior

Variable	Model 1	Model 2	Model3	Model 4
Loss Ratio$_{t-1}$	-0.1069***		-0.0608**	
	(-4.18)		(-2.45)	
Ln(Asset)$_{t-1}$	0.0873***	0.0820***	0.0774***	0.0755***
	(13.91)	(13.29)	(12.58)	(12.57)
ReinsUti$_{t-1}$	-0.1711***	-0.1773***	-0.1849***	-0.1883***
	(-5.29)	(-5.49)	(-7.40)	(-7.60)
Cat Exposure$_{t-1}$	0.0873***	0.0896*	0.0578	0.0583
	(1.84)	(1.89)	(1.55)	(1.57)
Single$_{t-1}$	0.0340	0.0374	0.0153	0.0173
	(1.46)	(1.62)	(0.89)	(1.01)
Stock$_{t-1}$	0.0469**	0.0506**	0.0466***	0.0475***
	(2.18)	(-2.35)	(3.03)	(3.08)
Direct $_{t-1}$	-0.0627**	-0.0598**	-0.0316***	-0.0315*
	(-2.45)	(-2.33)	(-1.67)	(-1.67)
HHI$_{t-1}$	-0.0114	-0.0186	-0.0512**	-0.0544**
	(-0.36)	(-3.65)	(-2.02)	(-2.15)
GHHI$_{t-1}$	-0.0892***	-0.0977***	-0.094***	-0.0989***
	(-3.33)	(-3.65)	(-3.80)	(-3.95)
HM$_{t-1}$		-0.0595***		-0.1084**
		(-3.33)		(-2.13)
Interest Rate$_t$	-4.007***	-0.9819***	-5.614***	-5.671***
	(-9.52)	(-7.35)	(-11.67)	(-11.73)
Adjusted R^2	0.0300	0.0303	0.0460	0.0457
Number of observations: 15137				

*Note: Statistical significance at the 1, 5, and 10 percent levels are denoted by ***, **, and * respectively.
*Risky investment is measured as percentage of invested assets in common stock and speculative bonds; Loss ratio is measured as lagged incurred losses divided by total premium earned; Hard market dummy equals to one if the change in industry's average premium is positive and zero otherwise; Firm size is measured as natural log of total admitted asset; Catastrophic risk exposure is measured as premiums written from homeowners line in gulf area and coastal states and earthquake line nationwide divided by total premiums written; Stock insurer dummy equals to one if the insurer is a stock company and zero otherwise; Single Insurer Dummy equals to one if the insurers is single unaffiliated company and zero otherwise; Direct Writer Dummy equals to one if the insurer is a direct writer; Reinsurance utilization is measured as reinsurance premium ceded divided by direct premium written plus reinsurance premiums assumed; HHI is Herfindahl index of premiums written by business lines; GHHI is Herfindahl index of premiums written by states; Risk-free rate is three-month Treasury-bill rate reported in FRED.
*Test for fixed effect: F_value=30.49, so I reject the null hypothesis that the preferred model is random effects against the alternative the fixed effects. Statistics of Hausman test for no random effect=115.69, with P-value=0.00.