Loss Reserve Errors, Income Smoothing and Investment Income of Property/Casualty Insurance Companies in the U.S.

By

Chunyan Zhang

A dissertation submitted in partial fulfillment of

the requirements for the degree of

Doctor of Philosophy

(Business)

at the

UNIVERSITY OF WISCONSIN-MADISON

2014

Date of final oral examination: 12/01/2014

The dissertation is approved by the following members of the Final Oral Committee:

James Tyler Leverty, Advisor and Associate Professor, Risk Management and Insurance

Justin R. Sydnor, Assistant Professor, Risk Management and Insurance

Joan T. Schmit, Professor, Risk Management and Insurance

Edward W. Frees, Professor, Actuarial Science

Jean-Paul Chavas, Professor, Agricultural and Applied Economics

Acknowledgements

I have asked myself multiple times in the past: what have I gained during the process of pursuing the Ph.D. degree? Now I can confidently answer this question. Besides the professional knowledge and skills, I have earned friendship and I have had the opportunity to learn from the talented people around me. All these will be my lifetime treasure.

I tell people that I am fortunate to have had three advisors: Professor Tyler Leverty, Professor Mark Browne and Professor Justin Sydnor. First, I would like to thank my primary advisor, Dr. Tyler Leverty, who has continually and convincingly conveyed a spirit of adventure in regard to research. Ty became my primary advisor September 2014, but he has offered me advice on this research since 2011 when I met him at the American Risk and Insurance Association conference in San Diego. After the conference, we exchanged hundreds of emails discussing various topics related to loss reserving and risk management. Ty is remarkably knowledgeable in this research field. I was amazed by his expertise and benefited greatly from that. Without his guidance, I would not have successfully finished my dissertation.

I also would like to thank my first advisor Dr. Mark Browne and my co-advisor Dr. Justin Sydnor. Mark was the person who led me to the research field of loss reserving. He provided generous support at the early stage of my dissertation. Since leaving UW-Madison, he has continually encouraged me to work on this research project and given me valuable suggestions. Justin became my co-advisor after Mark. He is smart and enthusiastic, and full of innovative ideas. I was inspired by his generous feedback and comments. Every time I spoke with him, I gained new insight into the research. His advising has been critical to the new version of my dissertation.

Along with my advisors, I would like to thank all other committee members: Professor Joan Schmit, Professor Jed Frees and Professor Jean Paul Chavas. I have received valuable comments from the committee. I appreciate their time and efforts. Joan is an elegant and intelligent woman. She is respected and liked by all her students, and I am one of her admirers. Jed has impressed me by his in-depth knowledge in statistical modeling. My first advice to new students in our program is: improve your quantitative skills by taking Jed's General Business 806 on panel data analysis; this will benefit you in the long run, no matter if you are going to work in academia or in industry. Professor Chavas is a productive researcher in the field of agricultural risk management. I have learned many risk analysis methods from his course of Applied Risk Analysis and I appreciate his input into my dissertation.

I acknowledge that the support from my family is of equal importance for me to finish the Ph.D. degree. I would like to thank my father Chengjian Zhang and my mother Xiujian Hu, who always support my decisions and give me their love. I also want to thank my husband, Qin Cai. He has been the first reader of my paper. His positive attitude and love encourage me to overcome all the difficulties and work toward a bright future. My family always give me peace of mind, and I am sincerely grateful for that.

Next, I want to thank people who have worked with me or provided their help while I was working on the dissertation. I appreciate faculty members of our ASRMI program, Margie Rosenberg, Martin Helek, and Peng Shi. I especially want to thank Professor Dan Anderson who inspired me to choose the research topic. Dan generously shared his research experience with me, and offered good comments for the paper. I also want to thank our reliable librarian Peggy Smith, who is a

master of the insurance related database. She was the one who taught me how to use the NAIC database, and helped me to obtain various types of data, paper and reports from different resources.

A special thank goes to Belle Heberling, our Assistant Director for Ph.D. and Research Programs. Her diligent work benefits every Ph.D. student in the Business School, including me. I highly appreciate her assistance, ever since my first day at Madison.

Our program is a big family. I would like to thank my colleagues Cuncun Luan, Yi (Kitty) Yao, Yunjie (Winnie) Sun, Jiafen Sun, Xiaoli (Sherie) Jin and Xiao (Joyce) Lin, Gee Yul Lee, and Doug Bujakowski, for their support and friendship. I want to especially thank Cuncun and Kitty, who never turned down my request for help and offered me constructive advice on almost everything.

I have contacted several researchers/authors regarding their research and papers in the area related to my dissertation. I want to thank them for being so kind to answer my questions and/or give feedback on my work. This list includes Professor Yuluen Ma and Professor Yayuan Ren at Illinois State University, Professor J.D. Hammond at Pennsylvania State University, Professor Kathy Petroni at Michigan State University, and Professor Stephen Fier at University of Mississippi.

Last but not the least, I want to thank my trusted friend, Kit Duncan, who always made herself available to proofread my paper.

Abstract

Loss reserves, the largest liability on the balance sheet of property/casualty (P/C) insurers, are estimates of unpaid claims incurred as of the valuation date. Regulatory reporting rules require insurers to make revisions to their reported loss reserves over time. These revisions provide information about the inadequacy or redundancy of the initial loss reserve estimates. Revisions can be the result of new information about claims but they may also be driven by managerial incentives, such as income smoothing. Prior studies that investigate income smoothing in the P/C insurance industry focus on the relationship between loss reserves and reported underwriting or total income, with mixed findings. A challenge in this line of research is that loss reserve estimates determine reported income (higher losses lead to lower reported income) and thereby potentially bias the effects of income smoothing (Weiss 1985).

This paper circumvents this issue by examining the relationship between investment income and loss reserves. Unlike underwriting income, investment income is not determined by loss reserve estimates; however, like underwriting income, investment incomes provides managers an incentive to smooth income. One way that managers can smooth income is by over-stating their loss reserves when investment income is higher and under-stating loss reserves when investment income is low. Based on a sample of P/C insurers from 1996 to 2007, I find that P/C insurers over-state their loss reserves more (or under-state their loss reserves less) when reported investment income is higher. I also find that the effects of investment income on the magnitude of over-reserving are greater for mutual insurers than stock insurers. These findings are robust to using when different measures of investment income.

Contents

Chapter 1 Introduction

1.1 Research Questions

Accurate accounting reveals important information about a firm's performance to customers, shareholders, investors and analysts, and helps them make investment and purchase decisions. However, under both the Statutory Accounting Principle (SAP) and Generally Accepted Accounting Principles (GAAP) rules, firms have certain flexibilities in their financial reporting. They are motivated to smooth earnings by taking advantage of accounting choices.

This paper focuses on the artificial income smoothing behavior, defined as "*the repetitive selection of accounting measurement or reporting rules in a particular pattern, the effect of which is to report a stream of income with a smaller variation from trend than otherwise would have appeared*" (Copeland 1968). Income smoothing is regarded as a common practice in almost all industries (Grace 1990) and is one of the topics that is frequently discussed by the media, investors and researchers because it concerns the reliability of financial reporting to the public. This paper investigates whether property/casualty (P/C) insurance companies smooth their reported income by manipulating the estimations of unpaid liabilities, known as loss reserves.

Loss reserves, which are about two thirds of the total liabilities of a typical P/C insurer,[1] are the *estimates* of unpaid claims that incurred on or before the valuation date.[2] Due to the complexity of

[1] Loss reserves used in this paper include both unpaid losses (Line 1, "Losses") and unpaid loss adjustment expenses (Line 3, "Loss adjustment expenses"), reported on Page 2 of the Statutory Annual Statement of property/casualty insurance companies.

[2] The "*unpaid claims estimate includes five components: case outstanding on known claims, provision for future development on known claims, estimate for reopened claims, provision for claims incurred but not reported, and*

the claim process and modeling challenges, it is very difficult to provide an accurate point estimate of the ultimate payment for incurred losses. The determination of loss reserves involves significant subjectivity. Actuarial judgment is required to estimate the unpaid claims: determination of the types of claims data to be used, assessment of the effect of change of business operation on the claims data, and making selection of the reserve estimates (Berquist and Sherman 1977). Instead of a point estimate, actuaries provide a range of loss reserve values, which are obtained under different modeling assumptions and by various methodologies. Executives have a certain degree of latitude in deciding the amount of loss reserves to be reported in the financial statement. Many have argued that the executives may exercise discretion over loss reserves to smooth the reported income by over-stating loss reserves when the company is profitable and under-stating loss reserves when the income is low (e.g. Anderson 1971; Smith 1980; Weiss 1985; Grace 1990; Beaver et al. 2003. See reviews in Chapter 3).

Loss reserves in the insurance industry provide a unique opportunity to investigate income smoothing. The statutory annual statement requires insurers to display updates of the losses incurred and payments made over the past 10 years in the annual statement. We are able to use the revised estimates to evaluate the bias of the initially reported loss reserves on the balance sheet. The revised loss reserves are considered as the approximation of the "actual" reserve levels. "Loss reserve error" is measured by the difference between the initially reported loss reserves and the

provision for claims in transit (i.e., claims reported but not recorded)" (Friedland 2010, pp.14). A more detailed discussion of the definition of loss reserves can be found on Page 13-14 of "Estimating Unpaid Claims Using Basic Techniques, Version 3" by Jacqueline Friedland (2010), published by Casualty Actuarial Society.

revised loss reserves in the literature.[3] A positive loss reserve error indicates that the initially reported loss reserves are biased upward while a negative loss reserve error means the opposite.

Graham, Harvey, and Rajgopal (2005) indicates that most CFOs believe that earnings are the key metric considered by outsiders, and 78% of the 400 executives in their sample would rather sacrifice the long-term value to smooth reported earnings. However, the evidence in insurance is mixed (see Section 3.1.2). In addition, most of the prior studies on loss reserve errors and income smoothing focus on insurers' underwriting income or overall income, and investment income is not examined as a motivation of income smoothing. Existing empirical studies on the relationship between investment and underwriting focus mainly on rate making (e.g. Cooper 1974; Flanigan 1974; Caswell and Goodfellow 1976) and the insurers' choice of investment risk and underwriting risk (e.g. Ren et al. 2011). While some researchers realize the importance of investment income (e.g. Anderson 1971, Beaver et al. 2003) in income smoothing, no studies distinguish the role of different income sources nor investigate the relationship between the investment income and the over-statement or under-statement of loss reserves.

This paper investigates income smoothing incentives in the P/C insurance industry from a novel angle: we focus on the relationship between investment income and loss reserves. Several facts play important roles in this research.

(1) Reported underwriting income (thereby overall income) is partially determined by loss reserves, but investment income is not.

[3] More details about the definition of loss reserve error are covered in Section 2.2.

(2) The estimation of loss reserves are made independently of investment results. Investment income is not considered in loss reserving by actuaries in the P/C industry. Both Statutory Accounting Principle (SAP) and Generally Accepted Accounting Principles (GAAP) require that loss reserves not be discounted (Brown 1994). [4]

(3) Both investment income and underwriting income may provide incentives for managers to smooth income. The income of a typical P/C insurer is primarily generated from both underwriting and investment activities.[5] Investment income is a critical income component of P/C insurance companies, as we can see from Figure 1. In most of the sample years, the investment income makes up the losses from underwriting and leads to a positive overall income for the P/C insurance industry. It is therefore reasonable to suspect that lower (or higher) investment income may induce insurers to under-state (or over-state) loss reserves to boost the reported net income, in a similar manner as what the poor (or profitable) underwriting income does.

[Insert Figure 1 here]

(4) As we will see from Section 4.4, the major factors (e.g. inflation, interest rates, and underwriting standards) that can potentially influence both investment and loss reserves

[4] Statutory accounting practices (SAP) require that, with a few exceptions, loss reserves should be reported at the nominal value rather than the present value in the statutory financial statements. It makes an exception to this rule for workers' compensation loss reserves related to pension and long-term disability benefits (not permitted for medical benefits or for loss adjustment expenses), and for insurers who receive authorization from their domiciliary state to discount the loss reserves for other lines of insurance. Firms with more than 25% of premiums written in workers' compensation are excluded from the sample in this paper to limit the effect of discounting. If insurers with more than 10%, 5%, 1% and 0% of their business in workers' compensation are excluded from the model, then the significance of the effect of investment income increases (p-value decreases) and the magnitude of the coefficient increases.

[5] There is "other income" besides underwriting income and investment income, but they make up very small proportions of the net income (about 0.8% of the net income on average for P/C industry during 1996 to 2007), so I do not include other income in this paper.

simultaneously are very likely to introduce a negative relationship between investment income and incentive to over-state loss reserves. For a given average insurer, when the inflation/interest rate increases (or when the underwriting standard is relaxed), the investment income of the insurer increases while its underwriting income is negatively impacted.[6] Thus, the positive relationship found in this paper indicates that the income smoothing is the dominant effect.

In summary, the main research question of this paper is: *Do insurers over-reserve (or under-reserve) when investment returns are high (low)?*

This study overcomes the limitations of the prior literature that studies the income smoothing incentive of loss reserve management: (1) Univariate analyses such as F-test of variance of income streams with and without loss reserve errors has difficulty in controlling for various firm characteristics and other incentives reserve manipulation; (2) Multivariate analyses with reported underwriting income or reported overall income bias the income smoothing effects; (3) Investment income is largely determined by the financial market, which is out of the control of any individual company; thus it is plausibly exogenous and potentially a good identification tool of income smoothing.

1.2 Contribution

This research contributes to the literature in four ways.

(1) This paper investigates whether P/C insurers exercise their discretion over loss reserves to smooth out the impact of investment earnings on net overall income. After controlling for factors

[6] While most the factors can be controlled in the model, underwriting standards are hard to specify.

that influence both underwriting and investment (such as product mix, underwriting cycle), [7] if we find a significant positive relationship between loss reserve errors and investment income, it is implied that loss reserves are manipulated to smooth the reported overall income (not merely the underwriting income). The research conducted in this paper can provide a new and stronger evidence of income smoothing, and helps us to better understand the income smoothing behavior of P/C insurers. Specifically, it reveals whether or not managers exercise accounting discretion over loss reserves with consideration to the performance of another critical activity of insurers, the investment.

(2) In this paper, the loss reserve errors are decomposed into errors of the prior accident years (AY $< t$) and the current accident year (AY= t). The rationale for doing so is that the reserve levels of the current accident year might be negatively impacted by the investment of the current year through the change of underwriting standards, not due to income smoothing. With higher investment yield, insurers tend to reduce their premium rates or relax the underwriting standards. If the increased risk is not captured in loss reserving, it is very likely that under-estimate the unpaid losses. However, this effect only applies to a portion of the reserves of the current accident year (AY= t) due to the time lag of events involved (it takes time for insurers to realize that the investment is good/bad and to take actions toward underwriting standards). I find that the bias in the loss reserves of the current accident year is significantly associated with the investment income while the reserves of prior accident years is not.

[7] Investment income and loss reserve errors might be influenced by some common factors, such as the interest rates, inflation, underwriting cycle and business mix. Thus it is important to control them in the model, otherwise the relationship between loss reserve errors and investment income is superficial.

(3) This paper tests the effects for subgroups of mutual and stock companies, and finds varying results. Mutual insurers bias upward their loss reserves (reserves of prior accident years and current accident year components and the summation of the two) significantly with an increase of investment income, but stock companies do not. Mutual insurers reserve more conservatively than stock insurers (this manifests as over-state reserves more or under-state reserves less), and their reported underwriting income is generally lower than stock insurers. For investment strategy, mutual insurers invested more in common stocks during 1996 to 2007. Operating results of mutual insurers rely heavily on investment income. They are more likely to use loss reserves to smooth out the volatility of their reported income. Another interesting finding is that the reserve errors of mutual companies do not depend on their product mix, but are significantly associated with rate regulation and financial weaknesses. The findings about mutual and stock insurers highlight the difference in loss reserve management of insurers with different forms of ownership.

(4) This study contributes to the literature on the connection between underwriting and investment of insurance companies. The existing research about the relationship between underwriting and investment of the P/C insurers primarily focuses on risk choices of the two activities, with mixed findings. Hammond et al. (1976) tests the relationship between underwriting risk and investment risk, because "*Insurers are at once confronted with a dual risk exposure. Just as the underwriting and investment functions combine to affect insurer risk, they also unite to affect the rate of return to corporate net worth*." They find a negative relationship between underwriting risk and investment risk using a sample of 26 P/C insurers over the period of 1952 to 1967, and suggest that insurers are balancing the risks to obtain a desired overall risk level. Using the time-series of the P/C industry aggregate level data, Ren et al. (2011) find that insurers' investment risk-taking

is associated with the underwriting cycle: investment risk is higher when the insurance market is soft and lower when the insurance market is hard.[8] More specifically, they find larger underwriting losses are associated with larger proportion of risky assets investment (common stocks). A study conducted by Cummins and Sommer (1996) finds a positive correlation between underwriting risk and investment risk in the life insurance industry. But there are no similar results reported in the studies in the P/C insurance industry. Actually, some other studies argue that there is no major correlation between underwriting risk and investment risk, and argue that the dual risk exposures of investment and underwriting may be neglected or underestimated by the P/C insurance industry (Achleitner, Biebel, and Wichels 2002; Zou et al. 2012). This paper studies the relationship between underwriting and investment from the aspect of the income streams generated in the two activities, connected by the income smoothing incentive. The evidence of the income smoothing found in this paper indicates that managers of insurance companies are not treating investment income and underwriting income in isolation.

1.3 Outline

The remainder of this paper is organized as follows: Chapter 2 introduces the loss reserving and investment of P/C insurers. Chapter 3 is a literature review. Chapter 4 states limitations in previous literature when testing income smoothing and explains the development of hypotheses. Chapter 5 covers the model and variable selections. Data descriptions are presented in Chapter 6. Chapter 7 discusses the empirical results, and the final chapter is a summary of this study.

[8] In soft insurance market, the supply of insurance is adequate, competition is fierce, and the capital is ample for insurers. In hard insurance market, insurance is hard to obtain as supply drops, the underwriting losses are greater, and capital constrain is stronger.

Chapter 2 Background

In this chapter, I will cover the two subjects in this paper: loss reserve errors and investment income. For loss reserve errors, I start from basics of loss reserving process, then move to how to measure the errors in the loss reserve estimates. For the investment income, I will explore the investment strategy and investment income components of P/C insurers.

2.1 Loss Reserves of Property/Casualty Insurers

Two-thirds of an average property and casualty (P/C) insurance firm's liabilities are loss and loss adjustment expense (L&LAE) reserves[9] (Figure 2).

[Insert Figure 2 here]

The estimation of loss reserves can materially impact a firm's financial condition, including its surplus level, reported profit level, tax payments, pricing, capital allocation and various financial ratios, as well as the financial soundness and the business strategies that a firm is able to pursue (Anderson 1971). Statement of Statutory Accounting Principles (SSAP) No. 55 requires that "management's best estimate" of the liability for these items be recorded in the company's statutory financial statements. As stated by Berquist and Sherman (1977): …"*while certain general methods are widely accepted, actuarial judgment is required at many critical junctures to assure that reserve projections are neither distorted nor biased*".

[9] In this paper, for simplicity, the term "losses" represents "losses and loss adjustment expenses", and "loss reserves" represents the total of loss and loss adjustment expenses reserves.

The loss reserves referred to in this paper include both the case outstanding and the IBNR reserves. The case outstanding is the reserves for known and reported claims (excluding the development of known cases), and it is established by the claims department, third-party adjusters, or independent adjusters. The IBNR reserves are the reserves for incurred but not reported claims estimated by actuaries. More specifically, IBNR includes provision for future development on known claims, estimate for reopened claims, provision for claims incurred but not reported, and provision for claims in transit (Friedland 2010). The IBNR is normally derived as the difference between estimates of incurred losses and the total of cumulative payments and case outstanding. The estimation of incurred losses is the focus of loss reserving procedures. Actuaries generally establish estimates of incurred losses based on the cumulative (and/or incremental) paid claims amount and/or counts, and the case outstanding data, by lines of business.[10]

There are many methodologies developed in actuarial science to estimate the loss reserves, for example, the case reserve method, the Chain-ladder method, the Bornhuetter-Ferguson method, the Bayesian method, and the bootstrap method. These methods have their own advantages and disadvantages, and none of them is universal or "superior" as they are subject to assumptions and limitations. For example, the most popular method, Chain Ladder method, assumes that the future development of claims is similar to that of the past: the claim type mix, claim processing, policy limits, reinsurance and retention limits are consistent over time.

[10] The estimates of incurred losses, as presented in the Schedule P Part 2 of the statutory annual statement, are the total of three components: cumulative payments (Schedule P Part 3), case outstanding, and IBNR reserves (Schedule P Part 4). The Part 2, Part 3 and Part 4 of Schedule P are presented on the accident year and calendar year basis. Each row presents an accident year (the year in which the losses incurred) and the calendar year (the year in which the estimates of incurred losses are reported).

Different companies have different preferences in reserving methods, and are permitted to select their own methods, as long as they can justify it to the regulators. Forbes (1969) finds that the large insurers tend to rely upon statistical formulas in reserving incurred and reported claims, whereas the smaller insurers often use individual case estimates (sometimes in conjunction with minimum reserves) in reserving these claims. Usually more than one method is used to estimate the loss reserves, but even the best actuaries cannot guarantee the estimates will be equal to the ultimate payments. In fact, building a model with appropriate predictor variables and accurate estimates of the standard errors of the coefficients of the variables can be very difficult (Miller 1984). The correlation across multiple dimensions, such as lines of business, states, accident years/calendar years, and inflation rates, makes model building and accurate parameter estimating even more difficult; this is an especially severe problem when the available historical data are limited (Holmberg 1994; Beaver and McNichols 1998).

2.2 Loss Reserve Errors

Based on the discussion in Section 2.1.1, it is not a surprise that initial loss reserve are not perfect forecasts of future claim payments. The realization of the loss reserve errors does not emerge until claims are paid (closed), which may be 3 to 20 years after the reserve for a claim is initially posted.

2.2.1 Measurement of Loss Reserve Errors

Several ways have been developed to measure the reserve errors. Most measurements of reserve errors follow either Anderson (1971) or Kazenski, Feldhaus, and Schneider (1992) (known as "KFS error" in later literature). The KFS error can be regarded as an updated version of Anderson (1971): the format of Schedule P was different in the 1950s and 1960s for Anderson's sample, and

Kazenski et al. measurement is based on the 10-year run-off triangles in Schedule P, which I utilize in this paper. For loss reserves, the error is the difference between the initial estimate and the ultimate payment for unpaid losses. Theoretically the basic non-scaled loss reserve error is:

$$\text{Error}_{i,t} = \text{Reserve Estimate}_{i,t} - \text{Actual Unpaid Losses}_{i,t} \quad (2\text{-}1)$$

Where *i* denotes the company, *t* denotes the reporting year (calendar year).

In this formula, the *Reserve Estimate* is the value of the estimate of outstanding claims to be paid in the future, which is the difference between estimates of losses incurred[11] and cumulative claim payments by the end of the year *t*.

$$\text{Reserve Estimate}_{i,t} = \text{Losses Incurred}_{i,t} - \text{Cumulative Payments}_{i,t} \quad (2\text{-}2)$$

The $\textit{Losses Incurred}_{i,t}$ is an estimate of losses that incurred in all accident years (AY$\leq$ *t*), estimated by the end the calendar year *t* (it is not the actual losses incurred but rather an estimate).

And the - $\textit{Actual Unpaid Losses}_{i,t}$ is the value of the actual value of outstanding claims be paid in the future *which is unknown*, but can be approximated by the revised reserve estimate. The estimate of incurred losses of each accident year is revised in each calendar year to reflect new information about the claims that have been incurred. The revisions of losses incurred and cumulative payments are shown in Part-2 and Part-3 of the Schedule P in the NAIC Statutory Annual Statement. After *j* years, the updated estimate of incurred losses of insurer *i* is $\textit{Losses Incurred}_{i,t+j}$, which can be used

[11] The "losses incurred" (or "incurred losses") here is based on accident year; it is the estimate of ultimate losses incurred in a given accident year. It is different from the "losses incurred during the year" in section 4.2., which is the losses incurred during the reporting calendar year.

to obtain the updated reserve estimate. The updated estimate (Revised Reserve $Estimate_{i,t+j}$) is more accurate than the initial estimate; it is therefore used as an approximation of the *Actual Unpaid Losses*$_{i,t}$. Thus:

$$\text{Error}_{i,t} = \text{Reserve Estimate}_{i,t} - \text{Revised Reserve Estimate}_{i,t+j} \quad (2\text{-}3)$$

Where,

$$\text{Reserve Estimate}_{i,t+j} = \text{Losses Incurred}_{i,t+j} - \text{Cumulative Payments}_{i,t} \quad (2\text{-}4)$$

Because *Cumulative Payments*$_{i,t}$ is deducted by both Reserve $Estimate_{i,t}$ and Revised Reserve $Estimate_{i,t+j}$, the *KFS Error* (by Kazenski, Feldhaus, and Schneider 1992) is calculated as below.

$$\text{Error}_{i,t} = \text{Losses Incurred}_{i,t} - \text{Revised Losses Incurred}_{i,t+j} \quad (2\text{-}5)$$

$$\text{Error}_{i,t} = (\text{Losses Incurred}_{i,t} - \text{Revised Losses Incurred}_{i,t+j}) / \text{Total Assets} \quad (2\text{-}6)$$

In the equations above, *j* is the number of development years. The value most commonly used for *j* is 5, and I also use 5 years. The errors are usually scaled total assets to account for the size effect, as shown in Equation (5-7).

Appendix 1 provides an example of Schedule Part 2 and Part 3[12] excerpted from the 2005 Annual Statement of Allstate Insurance Company (NAIC Code 19232). Applying the method described above, the non-scaled loss reserve error of the year 2005 is:

$$\text{Error}_{2000} = \left(\text{Line 5: Rows 1 to 6}\right) - \text{(Line 10: Rows 1 to 6)} \qquad (2\text{-}7)$$

Plug in the numbers in the table, the calculated KFS loss reserve error is -$2,137,467 (= $69,914,290 - $72,051,757).

The feasibility of the KFS method relies on whether or not 5-year developed losses incurred are close enough to the ultimate payment.

Table 1 shows the percentage of losses paid over the development years on the industry level, using the NAIC Annual Statement database.

[Insert Table 1 here]

For accident year 1992, 44.39% of the total losses were paid by the end of the first development year. As payments are made over time, the cumulative payment converges to the ultimate total losses. The data show that on average, more than 92% of the claimed are paid by the end of the 6th development year. From calendar year t to t+5, the most recent accident year (t) has been

[12] For the Schedule P Part 3 "Prior" row, the loss and expense payments are those made since January I of the second calendar year shown along the column headings. For the 2005 Annual Statement, these are payments made since January 1, 1997(not January 1, 1995.). Part 2 "Prior" row = Part 3 Prior raw+ Reserves for all prior years, thus the difference between incurred losses (t) and developed incurred losses (t+5) still reflects the loss reserve errors.

developed for 5 to 6 years; and the oldest accident year shown in the triangle has developed for 9 to 10 years. Thus we can expect that most claims are paid after 5 years of development.

[Insert Table 2 here]

[Insert Figure 3 here]

Table 2 reports the link ratio of cumulative payment, and Figure 3 is a visualization of the table.

The link ratio (also known as age-to-age development factor) is calculated as:

$$\text{Link\_Ratio}_t = \frac{\text{Cumulative Payments}_t}{\text{Cumulative Payments}_{t-1}} \tag{2-8}$$

As we see from the Table and Figure, the change of the cumulative payments is much smaller after the 5th development year. This implies that the uncertainty in estimating incurred losses of each accident year decreased greatly after 5 years of development. Therefore, the difference between the initial estimate of loss reserves and developed loss reserves is appropriate to reflect the bias in loss reserve estimates.

Note that Table 1 and Table 2 are based on the industry average. The development pattern for individual companies varies by the lines of business the insurer writes. Table 3 displays the average linked ratio of accident years 1987 to 2007 of eleven liability lines. Figure 4 depicts the link ratios of those lines of business visually. The long-tail lines, such as product liability, other liability, and medical malpractice, take longer to develop to ultimate (i.e., when all claim payments are made), and their linked ratios are relatively higher than other lines such as homeowners/farmowners, private passenger auto liability, commercial auto liability and commercial multiple peril in each

column of Table 3. However, the linked ratios of all those lines suggest that the linked ratio is much more stable after 5 years of development.

[Insert Table 3 here]

[Insert Figure 4 here]

2.2.2 Loss Reserve Errors by Accident Year and Calendar Year

In Section 2.2.1, the loss reserve error measures are for the total loss reserve reported at calendar year t. As shown by Appendix 1, the incurred losses triangle Schedule P is displayed on the accident year (AY) and calendar year (CY) basis, thus we can decompose the reserve errors into each of the past 10 accident years. On Schedule P Part 2, each row below the "prior" row represents one accident year, and each column represents a calendar year when the incurred losses for every accident year are reported. Given an accident year, the changes of the values from the first available column to the last column reflects the revisions of any given insurer's new projection of the losses incurred in that accident year. The losses of each accident year are heterogeneous, depending on the nature of losses during that year.

As we will cover in Section 4.4, investment income may influence loss reserve errors through the change of underwriting capacity and standards. When investment income in higher, insurers have greater underwriting capacity. They may either relax the underwriting standards or drop the premium rates to attract more business. If the underwriting standards are relaxed but the reserving procedure fails to fully reflect this change, loss reserves for the most current accident year (t) may be under-stated. This under-statement is not related to the income smoothing incentive, but due to

the inability to accurately estimate the reserves. For reserves of prior accident years, however, the investment return of the current year has no such effect. Without income smoothing, the reserve errors of prior years are not very likely to be associate with the investment income of the current accident year.

$$\text{Error}_{i,t} = \sum_{s=t-D}^{t} Error_{i,t,s} \tag{2-9}$$

Where $\text{Error}_{i,t,s}$ is the reserve error for company *i* at calendar year *t* for losses incurred in accident year *s* ($s \leq t$). D is the number of prior years that are not fully developed (the reserve error is zero when the incurred losses of an accident year are fully developed).

The loss reserve error of the current accident year t in the calendar year t ($\text{Error\_CY}_{i,t}$) is:

$$\text{Error\_CY}_{i,t} = \text{Error}_{i,t,t} \tag{2-10}$$

The loss reserve error for all the prior accident years up to t-1 ($\text{Error\_PY}_{i,t}$) is:

$$\text{Error\_PY}_{i,t} = \sum_{s=t-D}^{t-1} \text{Error}_{i,t,s} \tag{2-11}$$

Applying the equations above to data in our Appendix 1, the reserve error for all accident years at the end of calendar year (also known as payment year) 2000 is:

$$\text{Error}_{2000} = \left(\text{Line 5: Rows 1 to 6}\right) - (\text{Line 10: Rows 1 to 6}) = - \$2{,}137{,}467$$

Reserve error for accident year 2000 in calendar year 2000 is:

$$\text{Error\_CY}_{2000} = \left(\text{Line 5: Row 6}\right) - (\text{Line 10: Row 6}) = -\$438{,}291$$

Reserve error for accident year 1999 and prior is:

$$\text{Error\_PY}_{2000} = \left(\text{Line 5: Rows 1 to 5}\right) - (\text{Line 10: Rows 1 to 5}) = -\$1{,}699{,}176$$

The example insurer under-reserves for the accident year 2000 by $438,291 in calendar year 2000. Similarly, we find that in calendar year 2000, this insurer under-reserves for the 2000, 1997 and 1996 and prior, and over-reserves for accident year 1998 and 1999. While it is possible that those reserve errors are associated with managerial discretion, it is also associated with the non-discretionary reasons, such as process error and parameter error. When scaled by total assets by the end of 2000 ($37,428,667) ($000 omitted), the total loss reserve error is -0.0571 (under-statement of reserves is 5.7% of total assets), loss reserve error of the current year and all prior accident years are -0.0117 (under-statement of reserves is 1.17% of total assets) and -0.0454 (under-statement of reserves is -4.54% of total assets) respectively.

2.2.3 The Non-Discretionary and Discretionary Loss Reserve Errors

Similar to income smoothing research in other industries, the bias of loss reserves in the insurance industry can also be divided into the non-discretionary and discretionary components.[13] Literature on loss reserve errors of the insurance industry recognizes that there are two primary reasons why reserve errors may occur: (1) misestimation (non-discretionary error);[14] and (2) managerial

[13] Most income smoothing literature are following the Jones model (1991) or modified Jones model (1995) to derive the discretionary and non-discretionary accruals, while the non-discretionary accruals are predicted by the

[14] Bartholomew (1975) and Pentikainen et al. (1989; 1992) identify three main sources of non-discretionary errors. Following the terminology by Pentikainen et al., the errors are: model error, parameter error and stochastic error. Model error arises because of the imperfection of the model, for example, inappropriate assumptions may undermine

discretion (discretionary error). For example, Petroni, Ryan, and Wahlen (2000) model the non-discretionary revisions of loss reserves as a function of the lines of business written, and the discretionary revisions of loss reserves as a function of taxes, regulatory capital, and profitability.

Nondiscretionary errors may occur for a variety of reasons. These include, but are not limited to, delays in the reporting of claims, changes in claims patterns, increases in claim settlement costs due to inflation, the effects of new regulatory or judicial decisions on loss amounts, and limitations in actuarial modeling techniques. The non-discretionary errors normally varies by lines of business.

The claim process of a typical non-life insurer can be illustrated in Figure 5 (Wütheich and Merz, 2008). The insurance company is usually unable to settle a claim immediately: the reporting of the claim may be delayed by years, and for the reported claims, it may take years to settle the claim. The claim may be reopened due to unexpected developments. The stochastic nature of the claim process makes it difficult to estimate the future payment of claims and loss reserves.

[Insert Figure 5 here]

On the other hand, insurers may over-reserve or under-reserve to achieve certain financial reporting goals. The calculation of loss reserves may not be merely a process of actuarial

---

the models. Parameter error, which is also called estimation error, emerges due to the fact that the parameters used to calculate the reserve are based on limited historical data. The main guideline of actuaries when estimating the reserve is to minimize the model error and parameter error while selecting the model that describes the stochastic process as accurately as possible.

estimation. Copeland (1968) identified five key characteristics of a "perfect smoother."[15] As described below, loss reserve estimation satisfies these criteria.

1) The loss reserves do not commit the firm to any particular future action. The executives still have the flexibility to adjust the loss reserves in the future when necessary.

2) The loss reserves are estimated based on the exercise of professional actuaries. The uncertainty of the loss claim process results in a range of loss reserves rather than point estimations suggested by actuaries. A certain degree of errors in loss reserves is accepted by regulators, as long as it is reasonable.

3) Loss reserve management leads to material shift. Our data show that between 1996 and 2007 the magnitude of 5-year developed loss reserve errors were, on average, more than 12% of the premium earned in the property and casualty insurance industry.

4) Loss reserve manipulation does not require a "real" transaction with second parties; it only relates to internal accounting balances.

5) Loss reserve adjustments can be conducted over consecutive years.

Loss reserves are therefore idea tools for insurers to smooth their reported earnings.

Besides income smoothing, there are some other incentives for managers to exercise discretion over loss reserves. A growing body of research on insurance company operations provides

[15] The criteria proposed by Copeland (1968) are criticized by other authors (e.g. Schiff, 1968; Beidleman 1973) as too strict, but loss reserve matches Copeland's criteria very well.

evidence to suggest that insurers strategically manage their reserves. Since the 1970s, there have been a number of studies that have tried to identify the incentives and potential impact of managerial discretion over loss reserves. The incentives discussed in the literature include income smoothing, tax deferral, financial weakness, rate regulation, executive compensation, and other reasons. We will discuss them in the literature review (Chapter 3).

There are connections between the uncertainty of the loss claim and the degree of manipulation. For some types of lines of business, there are more uncertainties in the future unpaid losses. For example, liability lines generally are more complicated and take longer to settle the claims than property lines. Due to the complexity of the loss claim process, insurance firms have a greater degree of flexibility in reporting their reserves when there is higher uncertainty in the claim process. Non-discretionary estimating has both direct and indirect effects on the estimation of loss reserves. It highlights the importance of controlling for the degree of loss claim uncertainty in different lines of business if we want to identify the effects of various managerial incentives on loss reserve estimation.

2.3 Investment of Property/Casualty Insurance Companies

The investment income is decided by the investment strategy and the return of financial market. In this section, I explore the investment income of P/C insurers. With the regulations of investment activities of P/C insurers, the change of investment income is largely dependent on the financial market.

Both the underwriting and investment activities of insurance companies are regulated. To protect the interests of the insured, the National Association of Insurance Commissioners (NAIC)

introduced the Investment of Insurers Model Act (Defined Limits Version) in 1996, and adopted the Defined Standards Version of Investment of Insurers Model Act in 1998. The model acts provide guidelines for state insurance commissions. The guidelines include general investment qualification, authorized investments, prohibited investments, valuation of investments, prudence evaluation criteria (to determine whether the investment is prudent or not).

Selected examples of the limitations on investments are shown in Appendix 3. For example, the Defined Standard Version of Investment of Insurers Model Act (1998) proposes that for non-life insurers, common stocks cannot be more than 25% of the admitted assets and the total amount of medium and lower grade investments cannot exceed 20% of the admitted assets. The restrictions which are aimed to reduce the investment risk also reduce the investment flexibility of insurers. Individual state insurance commissions have their own regulations rules; however, all states have established restrictions (with varying levels of flexibility) on risky investments of insurers because the investment performance materially influences the solvency and financial strength of the insurers. With such limitations, one would expect that the investment income is significantly dependent on the performance of the financial market, which indicates that the investment income is not endogenous. I will examine the influence of financial market on the investment income of P/C insurers in Section 6.4.

2.3.1 Allocation of the Invested Assets

Figure 4 presents the allocations of invested assets of the property-casualty insurer industry. The allocation of invested assets were relatively stable between 1996 and 2007. Bonds are the largest investments of the property and casualty insurance industry, about 60% of the invested assets are

in the form of bonds, followed by common stock accounting for 26% of the invested assets. Cash and short-term investments comprise about 6% of the invested assets on average. The average percentages of preferred stocks, real estate, and mortgage loans from 1996 to 2007 are 1.36%, 0.89% and 0.28% respectively.

[Insert Figure 6 here]

Since bonds comprise about 60% of the total invested assets and 50% of the total assets, the quality of bonds invested are also restricted by state insurance commissions. The NAIC SVO (Securities Valuations Office) Designation categorizes the bonds owned by insurers into six credit quality groups: rating from the highest credit rating Class 1 to lowest Class 6 (See Appendix 2). Among the six classes, Class 1 and Class 2 are higher credit quality with lower default risk; Class 3 to Class 6 are of lower credit quality and regarded as non-investment grade bonds.

Figure 7 presents the percentages of bonds by NAIC designation. More than 97% of the bonds held by U.S. P/C insurance companies are investment grade (Class 1 and Class 2). Although the proportion of the highest quality bonds (Class 1) show a "U" shape pattern over the period of 1996-2007, the total proportion of Class 1 and Class 2 bonds remain stable.

[Insert Figure 7 here]

The duration of P/C insurer liabilities is much shorter than that of life insurers. Accordingly, P/C insurers primarily invest in short and middle term bonds.[16] Figure 8 shows that about 40% of bonds have less than 5 years to maturity, 30% are 5-10 year maturity, and about 30% are of the

[16] The duration of bonds are not reported in the statutory annual statement. "Years to maturity" is used as an instrument.

two longest maturity categories (10-20 year and greater than 20 years). The proportion of long term bonds is slightly decreasing from 1996 through 2007.

[Insert Figure 8 here]

Longer maturity is associated with greater interest risk. Under statutory accounting, because unrealized capital gains are not recognized as net income and the majority of long-term bonds are reported in the amortized book value,[17] long-term bonds show low risk and high return under statutory accounting annual statement (CAS 2002). However, long-term bonds are riskier assets: the values of the long-term bonds are much more sensitive to the change of interest rate than short-term bonds. Because the analyses of this paper are based on data from SAP annual statements, the volatility of income generated by bonds is smaller than that of common stocks.

Common stocks are the second largest investment for P/C insurers. Common stocks are considered risky assets. The proportion of common stocks in invested assets are used as a measure of asset risk in some of the literature (e.g. Lee, Mayers, and Smith Jr 1997; Ren et al. 2011; Zou et al. 2012).

[17] The rating the NAIC's Security Valuation Office (SVO) assigns to the bonds determines the applicability of the bases at which the bonds are recorded: either the amortized cost or the lesser of fair value and amortized cost. Amortized cost represents the actual cost of the bond adjusted for the amortization of any premium or discount from the face amount (as described in the paragraphs above). Fair value generally refers to the value that an asset could be sold for in the open market. There are six ratings from NAIC 1 to NAIC6, while the first two rating classes (NAIC 1 and NAIC 2) are investment grade bonds, and NAIC3 or lower classes are of lower quality. Bonds with the two highest ratings (NAIC 1 and 2) are carried at amortized cost, while bonds with ratings NAIC 3 ("medium quality") and below are carried at the lower of amortized cost or fair value. The amount at which a bond is recorded, following these criteria, is referred to as the adjusted carrying value (CAS 2013). More than 95% of the bonds in Property/Casualty industry are invested in the investment grade bonds based on our data of 1996-2007.

The allocation of investments at the industry level is fairly stable from1996 to 2007. For each firm, I take the average of the time-series of proportion of invested assets, and do the similar steps to get the standard deviations. Table 4 shows the summary statistics for time-series variations of bonds and common stocks investment allocations for each firm.[18] The data is based on 1244 companies. There are 1533 companies in my sample, but I exclude 189 companies that have less than three years of observations to keep the value of standard deviation meaningful. Henceforth in this paper, I refer to this time-series variations for each company as "within-company" variations.

[Insert Table 4 here]

For the proportion of investment in bonds, the average value of the within-company standard deviations is only about 13% and the coefficient of variation is 0.18. For proportion of invested assets in common stocks, the average of within-company standard deviation is about 5% and the coefficient of variations is 0.42. Thus, we may assume that given a company, their investment strategies are relatively stable. However, the investment strategy of individual companies varies cross-sectional within each year (see Figure 12). There is sufficient cross-sectional variations of investment strategies.

2.3.2 Reported Investment Income and Unrealized Capital Gains/Losses

The investment income reported by insurers includes two parts: investment income earned and realized capital gains/losses.[19] Investment income earned is mainly from interest and dividends,

---

[18] The standard deviations and means are based on firms with at least 3 observations.

[19] Investment income earned from all forms of investment, including investment, fees earned relating to uninsured accident and health plans. Dividends from SCA entities, joint ventures, partnerships, and limited liability companies:

deducted by depreciation on real estate and interest paid for money borrowed. Realized capital gains or losses are commonly reported when an insurer sells the invested assets.

If the insurer still holds the assets in its portfolio, it may have unrealized capital gains/losses. Unrealized capital gains/losses are the change in any valuation allowance between the current period and previous period-end amount, which are excluded from net income and not taxable until they are realized. The difference between realized capital gains/losses and unrealized capital gains/losses relies on whether the insurers sell or hold the security. The unrealized capital gains/losses are not included in net investment income, although they are recognized as an equity component in the policyholders' surplus.

Depending on the types of investment, some invested assets may have no unrealized capital gains/losses. Under SAP, investment grade bonds will be valued at amortized value and have no reported unrealized capital gains/losses.[20] Non-investment grade quality bonds (SVO 3 to SVO 6), are valued at the lower of amortized cost and fair value and unrealized capital gains/losses might incur if the fair value is different from the amortized cost. Given the small proportion of non-investment grade bonds, the unrealized capital gains/losses are not very important for bonds. In contrast, common stocks are valued at market value and their unrealized capital gains/losses fluctuate with the performance of the financial market.

---

minus investment expenses, taxes (excluding federal income taxes), licenses, fees, depreciation on real estate and other invested assets. Investment income credited to uninsured accident and health plans. Interest on borrowed money.

[20] Under GAAP, the investments are valued differently. For bonds, GAAP divides bonds into three categories: available for sale, trading securities, and held to maturity. Bonds that held to maturity are valued at amortized cost, other bonds are valued at market value. Both GAAP and SAP recognize unrealized capital gains/losses as a separate component of the equity. As institutional investors of bonds, insurers tend to hold bonds until maturity.

On average, the net investment income earned as a percentage of the invested assets is about 4.5%, the net realized capital gains/losses are less than 1% of the invested assets, and the rate of unrealized capital gains on the invested asset is slightly more than 1% but with much larger variations.

As we can see from Figure 9, realized capital gains and investment income earned are less volatile than changes in unrealized capital gains. At the industry aggregate level the unrealized capital gains/losses as a percentage of total invested assets ranges from as low as -3.06% in 2002 to as high as 4.95% in 1997. When we combine the unrealized capital gains and reported investment income, the volatility of investment income increases dramatically.

[Insert Figure 9 here]

The components of investment earned and capital gains/losses differs. Most of the investment income earned are from bonds, and most of the variations in capital gains are from common stocks.

[Insert Figure 10 here]

Figure 10 shows that during the sample period, 1996 to 2007, on average about 72% of the investment income earned is from bonds and 18% is from common stocks. For the remaining 20% of the investment income earned, 5% is from cash and short-term investments, 3% is from real estate, 2% is from preferred stocks, only 0.02% is from mortgage loans, and 7% is from other investments such as contract loans, derivative instruments, aggregate write-ins and other invested assets. The investment expenses, fees and depreciation on real estate and other invested assets deduct 9% of the pre-income-tax investment income earned.

[Insert Figure 11 here]

However, common stocks make a great contribution to capital gains, as Figure 11 shows. The industry aggregate amount of capital gains/losses as a percentage of total invested assets generated by common stocks ranges from -2.65% (in 2002) to 5.7% (in 1997).

Given the relatively stable invested asset allocation in the P/C insurance industry (see Figure 6), one will expect that a great portion variation of investment performance (especially when unrealized capital gains are considered) is explained by the performance of the financial market (bond market and stock market), which is outside of the control of any individual insurer. The exogeneity characteristic is beneficial for this research. Because the exogeneity of investment income implies that insurers cannot overcome the shocks from the financial markets; and they may have larger incentive to use loss reserves to smooth out the fluctuations of net income brought by the financial market.

Chapter 3 Literature Review

There has been considerable research on the causes of reserve errors and the strategic incentives for insurers to manage loss reserves. Prior research has focused on the following incentives to exercise discretion over loss reserves: income smoothing (Anderson 1971; Smith 1980; Weiss 1985; Grace 1990; Petroni 1992; Beaver, McNichols, and Nelson 2003), the influence of unanticipated inflation and interest rates (Weiss 1985), tax deferral (Grace 1990; Petroni 1992; Gaver and Paterson 1999; Nelson 2000), financial distress and solvency/regulatory (Forbes 1970; Petroni 1992; Nelson 2000; Gaver and Paterson 2004), rate regulation (Nelson 2000; Grace and Leverty 2010), executive compensation (Browne, Ma, and Wang 2009; Eckles and Halek 2010; Hoyt and McCullough 2010), and the purchase of reinsurance purchase (Browne, Ju, and Lei 2012). The paper by Grace and Leverty (2012) investigates most of the incentives discussed by the prior literature (including income smoothing, taxes, financial weakness, rate regulation and reinsurance).[21]

This chapter will be organized as follows: first, I will explain the reasons why firms want to smooth their income; then I will summarize the existing literature on income smoothing of P/C insurers; after that, I will cover the studies on incentives other than income smoothing that I have mentioned in the above paragraph.

[21] The analysis of Grace and Leverty (2012) does not include: unanticipated inflation, executive compensation or reinsurance in the way that Browne Ju and Lei look at it.

3.1 Income Smoothing

Income smoothing has been studied in the finance, accounting and risk management literature for more than one hundred years. Income-smoothing behavior by factories, mines and industrial undertakings was first identified in the 1890s (Matheson 1893; Dicksee 1895, 1903). Many studies find evidence of income smoothing in various industries (Copeland and Licastro 1968; Simpson 1969; Dascher and Malcom 1970; White 1970; Barefield and Comiskey 1972; Jones 1991; Liu and Ryan 2006; Shuto 2007). Because insurers have great flexibility in the estimation of loss reserves, studies have been conducted to investigate whether insurers intentionally manipulate loss reserves to stabilize their reported earnings (e.g. Anderson 1971; Smith 1980; Weiss 1985; Grace 1990, Petroni 1992; Beaver, McNichols, and Nelson 2003).

3.1.1 Reasons for Income Smoothing

Many empirical studies have found a negative relationship between earnings volatility and firm value (e.g. Lambert 1984; Minton and Schrand 1999; Rountree, Weston, and Allayannis 2008). It is believed that income smoothing is motivated by reducing tax payments, projecting a better managerial image (Hepworth 1953), attracting investors, increasing stock price, lowering the cost of financing, reducing the risk premiums of capital assets, and all of which increase firm value.[22] Other researchers have found income smoothing to be associated with the income-based compensation package of the executives (Watts and Zimmerman 1978; Ronen and Sadan 1981).

[22] Some researchers, such as Imhoff (1875, 1981), argue that income smoothing can only increase firm value temporarily. Shareholders, investors and analysts will not be fooled in the long run.

A study conducted by Graham, Harvey, and Rajgopal (2005) indicates when the manager of a firm has the option to choose the time when income is recognized, he or she may prefer the accounting measurement and reporting rules that are expected to result in more smoothed income streams. Executives perceive that small earnings volatility can bring good benefits to the firm, while high income variation decreases the firm value mainly for the following reasons:

First, low income volatility increases firm value because it is preferred by both individual and institutional investors. It enhances the reputation and credibility of the firm, and maintains or increases a firm's stock price. High earning volatility increases the likelihood of negative earnings surprises, which may hurt the stock price of the company, as investors overreact if the firm fails to meet benchmark earnings (Brav et al. 2005; Graham, Harvey, and Rajgopal 2005). The investors may suspect that there are hidden problems in the operation of the company and become less optimistic toward its future performance. Studies show that low earnings volatility is especially attractive to institutional investors (Ronen and Sadan 1981; Badrinath, Gay, and Kale 1989), as low earnings volatility is perceived as a signal of the robust operation of a company. Income smoothing masks the volatility of underlying earnings, thus lowering the perceived probability of bankruptcy and bringing favorable terms to the transactions of the firm (Titman 1984). Consequently, outside investors may over-evaluate the price of the firm's stock as the volatility is "masked", which will artificially increase the stock price of the firm.

Second, many researchers suggest that low earnings/cash flow volatility increases firm value by reducing the firm's dependence on costly external finance (Shapiro and Titman 1985; René M

1990; Lessard 1991; Froot, Scharfstein, and Stein 1993). Activities that reduce earnings volatility helps ensure that a corporation has sufficient internal funds available to take advantage of attractive investment opportunities. Minton and Schrand (1999) suggest that higher cash flow volatility not only increases the firm's need to access expensive external capital market, but also forces the firm to forgo valuable investment opportunities. In another study, Geczy, Minton, and Schrand (1997) find empirical evidence suggesting that firms with high value investment opportunities and low access to internal and external financing are more likely to reduce variations in cash flow or earnings.

Third, low earning volatility decreases the probability and magnitude of forecast errors, thus making the firm more attractive for investment analysts to follow. A larger number of analysts following a firm implies more resources are spent on private information acquisition about the firm (Bhushan 1989) and increases investors' perception of the firm value. Lang, Lins, and Miller (2003) find that the number of analysts following a firm and forecast accuracy positively affect firm market values.

Some researchers find that income smoothing activities are associated with managers' compensation (e.g. Watts and Zimmerman 1978; Koch 1981; Ronen and Sadan 1981; Lambert 1984; Fudenberg and Tirole 1995). Managers may smooth the income for other concerns. Fudenberg and Tirole (1995) show that managers prefer to smooth income when they are concerned about keeping their position or avoiding interference. Koch (1981) finds that smoothing is greater when management is more diverse, and the income reported by owner-controlled firms shows more variations than manager-controlled companies.

3.1.2 Income Smoothing and Loss Reserves in the Insurance Industry

Income smoothing incentive in the insurance industry has been discussed by Anderson(1971), Balcarek (1975), Ansley (1979), Smith(1980), Weiss (1985), Grace (1990), Beaver, McNichols, and Nelson (2003), Grace and Leverty (2012), and some other recent studies. Most of the early research finds that loss reserves are either over-stated or under-stated in different time periods to decrease the volatility of reported underwriting income or overall income that include both investment and underwriting income, including combined ratio, loss ratio, underwriting income, net income, or policyholders' surplus. In an early study, Anderson (1971) examines the effects of reserve errors on policyholders' surplus based on a sample of 36 stock companies over 1955 to 1964. He finds that there is a distinct tendency for the sample companies to move from a heavily over-reserved position in the early years of his analysis to a less over-reserved or even under-reserved position in later years, suggesting that reserve errors have a stabilizing effect on underwriting income. Balcarek (1975) discovers continued loss reserve deficiency in the 1960s, and suspects that this is associated with poor underwriting results. Ansley (1979) confirms the loss reserve inadequacy trends found in Anderson (1971) and Balcarek (1975), but he does not find significant relationship between loss ratio and reserve margins, and he concludes that managers are not manipulating loss reserves. Smith (1980) studies nine large auto liability insurers for the years 1955 to 1974, and concludes that insurers may manage loss reserves to smooth underwriting results.

Using a multivariate analysis, Weiss (1985) finds that exogenous economic developments (inflation and interest rates) and smoothing activities significantly affect loss reserve errors in the automobile liability insurance line in 1950s through 1970s. Grace (1990) develops a general model

in which she hypothesizes that income smoothing is an important constraint when an insurer maximizes discounted cash flow. And she finds a negative association between the average net income during the past three years and loss reserve errors. Beaver, McNichols, and Nelson (2003) find a discontinuity of frequency of firm-year observations around zero earnings. They document that property-casualty insurers with small positive earnings are more motivated to understate loss reserves than insurers with small negative earnings; for firms with high earnings, the income-decreasing reserve accruals are commonly reported. Similar to Beaver et al. (2003), Browne, Ma, and Wang (2009) find that firms with positive income over-state loss reserves more than other insurers. Grace and Leverty (2010) discover that firms with small profit tend to under-reserve more than those who report losses, while insurers with high profit over-reserve to decrease the reported income. In another study, Grace and Leverty (2012) find no significant association between loss reserve errors and income distribution indicators.

3.2 Other Studies on Incentive of Loss Reserve Errors

3.2.1 Taxes

Reserve errors may arise as an insurer tries to reduce its federal tax bill, because loss estimates are associated with the determination of tax liabilities. By over-estimating future losses attributable to current premiums the insurer reduces its current tax liability. The insurers cannot eliminate any taxes by over-reserving, but they can benefit from the deferral of tax payments: the portion of over-stated loss reserves can be regarded as an interest-free loan from the government. Accurate estimation of loss reserves is therefore sought by the Internal Revenue Service (IRS). If the IRS finds that the insurer is over-state loss reserves, the insurer will be penalized by an increase in

federal tax (Grace 1990). Nonetheless, deferral of the tax bill remains an important incentive to over-reserve.

Grace (1990) finds that insurers over-reserve more when their taxable income is higher. Cummins and Grace (1994) construct a model which predicts that property-casualty insurers will use loss reserves to shelter taxable investment income. Their empirical findings are consistent with the theoretical model. The 1986 Tax Reform Act (TRA) requires insurers to report the present value of future claim costs on their tax returns. One purpose of TRA (1986) is to lessen the degree to which taxes are affected by reserve manipulation. However, Bradford and Logue (1999) find that tax rules, especially the changes of tax rules, created a relatively strong incentive to overstate reserves from 1985 to 1987. Nelson (2000) also finds that insurers with a high tax rate implicitly discount loss reserves at a lower rate than other insurers. Different from the findings above, other studies failed to find a significant relationship between tax incentive and loss reserve errors, such as Petroni (1992) and Browne et al (2009).

3.2.2 Financial weakness

Insurance regulators have adopted a series of ratios to monitor the financial conditions of insurers, such as the Insurance Regulatory Information System (IRIS). It is hypothesized that weak insurers tend to under-state loss reserves to manipulate the values of regulatory financial ratios, in order to avoid regulatory intervention (Petroni 1992; Gaver and Paterson 2004). Grace and Leverty (2012) argue that insurers are not necessarily manipulating reserves, but that weak insurers are more likely to understate reserves and thus appear like they are trying to manipulate reserves.

IRIS uses thirteen[23] financial ratios to monitor the leverage, profitability, liquidity and reserving of P/C insurers. If a ratio is outside of the usual range predetermined by the National Association of Insurance Commissioners (NAIC), it is considered unusual. If the insurer has more than three unusual ratios, it may receive special regulator attention and intervention: a team of specialists may examine the statutory statement of the firm and decide if the firm is in need of "immediate regulatory attention" or "targeted regulatory attention" by state regulators.

Based on the calculation formulas of IRIS ratios, under-reserving can reduce the number of abnormal IRIS ratios. Thus it is believed that financially troubled insurers have stronger incentives to under-state loss reserves to avoid penalties or intervention from the regulators. The empirical tests by Petroni (1992) show that managers of financially weak insurers under-reserve more than other insurers. She also finds that insurers "close" to receiving regulatory attention understate reserve estimates to an even larger degree. Gaver and Paterson (2004) achieve a similar conclusion that firms manage loss reserves to avoid violating certain test ratio bounds that are used by regulators for solvency assessment. By adjusting loss reserves, two-thirds of their sampled companies that are close to receiving regulation intervention successfully limit the number of unusual ratios to three or less, which is the cut-off number to receive stringent intervention by IRIS.

Grace and Leverty (2012) repeated the analysis of Gaver and Paterson (2004) and find consistent evidence. They argue, however, that the evidence is not sufficient to conclude that financially weak insurers are under-reserving to avoid regulatory scrutiny. There are other incentives that can drive

[23] There were eleven ratios before 1993, and two new ratios were introduced in 1993 and 2002 respectively. Now there are thirteen IRIS ratios.

insurers to under-reserve (such as income smoothing) which reduce the number of abnormal IRIS ratios, but are irrelevant to the regulation avoidance hypothesis. Grace and Leverty (2012) measure financial weakness using the probability of failure, which is obtained by an insolvency model following Cummins, Grace, and Phillips (1999). Their results suggest that insurers with higher probability of failure under-estimate loss reserves to a greater extent than other firm. But they emphasize that this correlation should not be interpreted as an evidence that weak insurers under-reserve to avoid the interventions from regulators.

3.2.3 Rate Regulation

State regulators may place restrictions on the underwriting and pricing policies of insurers for certain lines of business. In some states, the regulator may restrict discriminative pricing based on certain characteristics, such as age, race, and certain pre-existing conditions. This is especially common for certain P/C lines of business such as auto insurance and workers' compensation, in which universal coverage, mandatory coverage or social influence are the concerns of the regulators. Such regulations may motivate the insurers to strategically manage their reserves.

Research regarding the impact of rate regulation on reserve management can be divided into two groups. One group maintains that stringent rate regulation is positively correlated with under-reserving behavior, while the other group suggests over-reserving behavior. The first group assumes that insurers implicitly discount their loss reserves to account for the time value of money (Lowe and Philbrick 1986; Nelson 2000).

Nelson (2000) hypothesizes that the P&C industry is highly competitive. Using data from the 1989-1993 statutory annual reports of 755 P&C insurers, she suggests that insurers tend to report

the present value of expected future claim payments by implicitly discounting and under-reserving, such that they can satisfy the requirement of regulators and win more customers and market share (at the cost of lower real profitability); the incentive is stronger if the rate regulation is more stringent. The implicit discount results in lower reported loss reserve levels on the firms' financial statements. That is, under more stringent rate regulation, the insurers are more likely to under-reserve.

Alternatively, stringent rate regulation may also drive the reported loss reserves upward. Grace and Leverty (2010, 2011, 2012) argue that the empirical evidence on stringent rate regulation is that it suppresses rates below the economic cost of writing business, and therefore the incentive in this environment is for managers to over-reserve in an attempt to reduce the effect of rate suppression. They find empirical evidence for this hypothesis.

3.2.4 Other Studies

Other theories supplement the literature on reserve manipulations, such as the managerial compensation (e.g. Lin and Lai 1998; Browne, Ma, and Wang 2009; Eckles and Halek 2010), the choice of audit firms and actuarial firms (Petroni and Beasley 1996; Gaver and Paterson 2001; Grace and Leverty 2014), and the purchase of reinsurance (Browne, Ju, and Lei 2012).

Managers may manage loss reserves to maximize the value of their compensation. Lin and Lai (2008) find evidence that the managers who are rewarded with a great amount of stocks and options tend to under-reserve when they have the opportunity to sell the stocks or exercise the options in the next period. Browne, Ma, and Wang (2009) explore whether or not the awarding of stock options to insurance company executives is associated with the loss-reserving practices. They find

that the greater sensitivity of option-based compensation on stock prices is associated with more under-reserving errors or less over-reserving errors. Eckles and Halek (2010) find that managers who receive bonuses that are capped or no bonuses tend to over-state reserves for current-year incurred losses. However, managers who receive bonuses that are not capped tend to under-reserve for current-year incurred losses. They also find that managers who exercise stock options tend to under-reserve in the current period.

Auditors and actuaries are external monitors of insurers. Reputational monitors may have more ability and a stronger sense of responsibility to report accurate reserve. Petroni and Beasley (1996) explore whether the audit firm type is associated with the accuracy of insurers' estimation of loss reserves. Although in the model based on the entire sample they find no significant difference of accuracy of reserving or conservativeness among insurers with different types of auditors, they do find that the subset of financially stressed insurers that use Big Eight auditors are reserving much more conservatively than other insurers. Similarly, Gaver and Paterson (2001) find that the financially distressed insurers that use auditors and actuaries from the Big Six accounting firms are less likely to under-reserve. Moreover, the usage of non–Big Six actuaries (regardless of whether the auditor is a member of the Big Six) is associated more with the under-reserving behavior of weak insurers. They conjecture that these results are related to the fact that Big Six actuaries are more conservative in loss reserving and they are more attuned to the liability exposure of the auditor. Grace and Leverty (2014) find that high technology capacity can significantly reduce the extent of managerial discretion and the independence of the external monitor alone has no significant effect.

Browne, Ju, and Lei (2012) assert that more accurate reserve estimation helps insurers obtain better terms from reinsurers and maintain better relationship with brokers/agents. They find that the purchase of reinsurance and payment of contingent commissions to intermediaries by property and casualty insurers are negatively associated with smaller over-reserving errors, but the association is insignificant for under-reserving errors.

Chapter 4 Hypothesis Development

4.1 Limitations of Prior Research in Income Smoothing

Previous studies (e.g. Anderson, 1971; Smith, 1980; Weiss, 1985; Grace, 1990; Beaver, McNichols, and Nelson, 2003) which investigate income smoothing incentive of loss reserves in insurance industry are subject to limitations. However, the prior studies focus either on the underwriting income, or the total income, without distinguishing the role of investment income.

The prior studies in the related literature can be summarized into two categories. The first group of research focus on the underwriting results. The early studies are based on univariate analysis, represented by Anderson (1971) and Smith (1980), and later emerged multivariate analysis is represented by Weiss (1985). The second group of studies focus on the total income (combines both underwriting and investment income) but do not differentiate the effects of the two major sources of income (Grace 1990, Beaver et al. 2003).

Both Anderson (1971) and Smith (1980) compare the reported underwriting results with the reserve error-adjusted underwriting results. To investigate whether loss reserves were altered to stabilized underwriting experience, Anderson (1971) conducts a correlation analysis of the "loss reserve difference" [24] and "adjusted loss ratios", and an additional test that compares the standard deviation of "adjusted loss ratios" and reported loss ratios. The "loss reserve difference" is a

[24] Due to the different reporting format of loss reserves in the 1950s and 1960s, the loss reserve difference is the reserve difference of incurred losses for one given accident year t in calendar year t and developed calendar year t+4, instead of all prior accident years. He also developed another term "loss reserve adjustment", which is the difference between incurred losses in calendar year t and t+1 for all accident years prior to t+1. Smith (1980) adopts definitions of loss reserve difference and loss reserve adjustment of Anderson (1971) in his paper.

measure of the loss reserve error. "Adjusted loss ratio" is obtained by removing the loss reserve difference from the reported loss ratio. The correlation analysis presents a significant and negative relationship between the reported and adjusted loss ratios, and the variance test shows that standard deviation of the reported loss ratios is significantly lower than that of the adjusted loss ratios. Both findings support that the reserve margins are used to smooth the underwriting results.

Smith (1980) adopts the measurement of "loss reserve difference" from Anderson (1971) and finds largely similar results. He conducts the runs test for detecting non-randomness of loss reserve differences for each company in his sample, and concludes that the bias in loss reserves was not random for most companies included in his sample. Similar to Anderson (1971), Smith performs the variance tests and correlation tests, but obtains different results. The F-tests for variance do not support the hypothesis that auto insurers manage loss reserves to smooth income over time: although the spatial and temporal standard deviations of adjusted combined ratios are higher than the standard deviation of reported combined ratio, the difference lacks of significance. The results of the correlation analysis are consistent with Anderson (1971). While the correlations between loss reserve difference and reported combined ratio are insignificant, the correlations between loss reserve difference and adjusted combined ratio are very significant and negative. The limitation of the research above is that they do not control various firm characteristics and other important incentives such as tax deferral and financial distress. Because other factors are not controlled, Smith (1980) acknowledges that "*Statistical evidence that insurers intentionally manage loss reserve estimates in order to smooth reported underwriting results is presented but it is not convincing.*"

In her multivariate analysis model, Weiss (1985) includes the error adjusted combined ratio of auto liability insurers as a measure of income smoothing. She finds a significant negative association between this variable and loss reserve errors. However, in this case one may argue that one of the independent variables (error adjusted combined ratio) will be contemporaneously correlated with the dependent variable (loss reserve errors). As Anderson points out in his paper:

> *"The analysis using the adjusted figures is not free of difficulties. Due to the fact that one value (the loss reserve difference) is being compared to another value (the adjusted loss ratio) which contains the first value, a statistical bias is included in the calculations which virtually guarantees significant negative correlation will be found. Yet, one can still argue that the adjusted loss ratio is a much more reliable figure"* (Anderson 1971, pp.599).

For the second group of studies, there are two different methods, represented by Grace (1990) and Beaver et al. (2003) respectively. Grace (1990) applies a multivariate analysis to control for firm characteristics (mutual or stock, and whether the company is part of a holding company) and other potential reasons for the bias in reserves, including the tax incentive and unexpected inflation. Income smoothing is measured by the average net income of the past three years scaled by the net premiums earned. Her results suggest that insurers tend to under-reserve to a greater extent if past income was high. Grace concludes that the correlation indicates income smoothing because insurers are motivated to keep in line with past income levels. Thereafter, this method is adopted by most studies in loss reserve errors.[25] However, as pointed out by Grace and Leverty (2012), this method has its limitations. After 3 years of high income, the 4th year may still be a good year.

[25] Some of those studies scaled the reported net income by total assets, which is called rate of return (ROA).

Thus it is not necessary for the insurer to under-reserve to maintain the income level. And after three poor years, insures are not likely to over-reserve to under report profit. Grace and Leverty (2012) do not find evidence of income smoothing using the smooth measurement introduced by Grace (1990). However, the negative relationship found by Grace (1990) may be due to the effects of underwriting capacity (see Section 4.4.2). If a company makes good income in the prior years, its underwriting capacity increases, and it may reduce its premium rates or relax the underwriting standards to obtain more business, which may lead to under-reserving in future years.

Beaver, et al. (2003) based on their analysis on the distribution of reported earnings. They create indicator variables according to the insurer's position - in the distribution of reported earnings. They find that the observations in the earning distribution group that are immediately above zero under-state loss reserves to avoid reporting losses. They also find that those that reported high income significantly over-state loss reserves when compared to those on the lower end of the earning distribution. Browne et al. (2009) follow the smooth measures in Beaver et al. (2003) and find that insurers with higher income have greater over-reserving errors. However, unlike Beaver, et al. (2003) and Browne et al. (2009), Grace and Leverty (2012) do not find evidence of income smoothing using earning distribution indicator as smooth measures.

One potential problem with the earning distribution indicator method is that the indicators are based on reported income. It can only identify the income smoothing on certain range of the reported earning distribution: immediately around zero, and the upper and lower tails. For the income reported in the middle range, it may not work properly to detect income smoothing based on the reported income because the reported income of the firm is the ex-post result of reserve manipulation. For instance, an insurer that makes lower profit than its normal level may

intentionally under-state loss reserves to increase the reported income while another firm with high pre-managed may over-reserve to obtain the same level of reported income. The consequence is that it may change its position in the income distribution from "loss" to the "profit" or "small profit" category after the reserve manipulation. Thus we may find some companies report moderate profit level under-reserve while some other companies that report similar level of profit over-reserve. Table 5 is an illustration of why using reported income as a smooth measure can lead to problematic conclusions.

[Insert Table 5 here]

In this hypothetical illustration, the three observations can be regarded as records for the same company in different years, which simplifies the “all else equal” requirement. The pre-managed income is the income without loss reserve errors. Reported income is the income with loss reserve errors, which can be regarded as a target income level or close to the target income level by managers.

Suppose, for example, that the three observations have the same benchmark income of $100 million, which is reflected in the reported income. By under-reserving of $10 million, the reported income of Observation 1 matches the benchmark level. For the second observation, there is no reserve error because the income is at the desired level. Observation 3 has an over-reserving error of $15 million, as the company is doing better than the targeted level. The relationship between reported income and loss reserve error is not conclusive for income smoothing. However, it is obvious that the pre-managed income is positively correlated with loss reserve errors. Both

Anderson (1971) and Smith (1980) find there is no significant relationship between the reserve errors and the reported combined ratio/loss ratio.

In a summary, the prior studies in income smoothing are either focus on underwriting income or the total income, with limitations in the methodology, and the role investment income in income smoothing is under-researched. This paper explores the possibility of income smoothing from a new angle: while underwriting income is determined by loss reserve errors, investment income is not. Since investment income is also a big component of net income, the relationship between investment income and loss reserve errors may provide new insights about income smoothing.

4.2 Loss Reserve Errors and Underwriting Income

In this section I will discuss the how loss reserves influence the statutory financial reporting of P/C insurance companies and the role of income benchmark in income smoothing.

The analysis in section 4.2.1 is based on the income statement and "Underwriting and Investment Exhibit, Part 2 – Losses Paid and Incurred" of the Statutory Annual Statement. I will introduce the pre-managed underwriting income, pre-managed net income (the income before reserve errors of the calendar year t) and benchmark income. A new smooth measure based on the difference between pre-managed income and the benchmark can overcome the limitations of smooth measure of Grace (1990) as pointed out by Grace and Leverty (2012). And the use of investment income can avoid the problem caused by the earning distribution of reported income.

4.2.1 Pre-managed Underwriting Income

As exhibited in the income statement, the underwriting income is reported as the difference between premiums earned and underwriting deductions. The deductions include losses and loss adjustment expenses incurred during the year, and other deductions during the reporting year. Thus:

$$\begin{aligned}&\text{Reported Underwriting Income}_t \\ &= \text{Premiums Earned}_t - \text{Losses Incurred During the Year}_t - \text{Other Deductions}_t\end{aligned} \tag{4-1}$$

Losses incurred are losses paid during the year plus estimates of future loss payments. Reserve development is the difference between estimates of future loss payments at the end of year t and estimates at the end of year t-1.[26]

$$\begin{aligned}&\text{Losses Incurred During the Year}_t \\ &= \text{Paid Losses During the Year}_t + \text{Reserve Estimate}_t - \text{Reserve Estimate}_{t-1}\end{aligned} \tag{4-2}$$

Note that $\text{Reserve Estimate}_t$ is obtained from last year's annual statement, which is out of the discretion of insurers when they report the incurred losses of the current year.

From Equation (2-3),

$$\text{Error}_t = \text{Reserve Estimate}_t - \text{Revised Reserve Estimate}_{t+j} \tag{4-3}$$

[26] This is reported in "Underwriting and Investment Exhibit, Part 2 – Losses Paid and Incurred" of the Statutory Annual Statement.

In year *t*, the insurers cannot change loss reserves and loss reserve errors of prior years, and the manageable accrual is the loss reserve of year *t*. We call this income as *pre-managed underwriting income*, following Beaver et al. (2003):[27]

$$\text{Reported Underwriting Income}_t = \text{Premanaged Underwriting Income}_t - \text{Error}_t \quad (4\text{-}4)$$

Rearrange the equation:

$$\text{Premanaged Underwriting Income}_t = \text{Reported Underwriting Income}_t + \text{Error}_t \quad (4\text{-}5)$$

The pre-managed underwriting income has been adopted in all the previous studies to measure the before-error underwriting results (e.g. Anderson 1971; Smith 1980, Weiss 1985, and Beaver et. al 2003). I will use this pre-managed underwriting income (or the so called "adjusted underwriting income" by Anderson (1971)) in this paper.

4.2.2 Income Benchmark

The objective of income smoothing is to decrease the volatility of income around the desired income. There are different ways to define income smoothing, but one of the key components is the "desired level of income". For example, Weil and Davidson (1994) define income smoothing as "*the reduction in earnings variability over a number of periods, or, within a single period, as a movement* ***towards an expected level of reported earnings***" (emphasis added).

[27] Beaver et al. defines the "discretionary loss reserve accrual" (*DEV*) as the difference between the revised loss reserves and the initial reported loss reserves. *DEV* is similar to the loss reserve error in this paper, but takes opposite direction: it is negative if over-reserve and positive if under-reserve. Thus, his pre-managed income is obtained by subtracting *DEV* from the reported income.

It is important to acknowledge that the pre-managed underwriting income is generated prior to the reported income (or, put in another way, the reported income is generated after the realization of pre-managed income). Pre-managed income is determined by the nature of the loss payment process, premiums earned, and losses incurred during the period. Depending on how far the pre-managed income is from the income benchmark, managers may apply a "reserve margin" to loss reserves. It is possible that some firms determine the expected level of reported earnings form their past performance, while other base it of industry averages.[28] We denote this benchmark as BM_UI (benchmark of underwriting income).

$$\begin{aligned} &\text{Reported Underwriting Income}_t - \text{BM\_UI}_t \\ &= (\text{Premanaged Underwriting Income}_t - \text{BM\_UI}_t) - \text{Error}_t \end{aligned} \tag{4-6}$$

To match the benchmark, that is, to maintain a small difference between the reported income and the benchmark, $Error_t$ is positively correlated with the difference between pre-managed underwriting income and the benchmark. For example, in a given year, if an insurer makes less income than in prior years, does it under-reserve more? The answer also depends on the benchmark. If the whole industry suffers from a reduction of profitability, the motivation to under-state loss reserves will be much smaller for this insurer. If its reduction of income is relatively smaller than the industry average, this insurer may over-reserve.

Note that the reported income may not be exactly the same as the benchmark. It is, however, favorable to insurers if the reported income meets the benchmark as closely as possible. Thus, if

[28] Firms are not able to know exact average and variation of reported income of the industry when they file the financial report, but they can make judgment based on the release information from other resources, such as quarterly financial statement of other firms, and predictions by certain financial institutions.

an insurer is smoothing the underwriting income toward the benchmark, its reserve margins will depend on how far away the pre-managed underwriting income is from the benchmark. Additionally, if an insurer does not have any intention to smooth its income, the loss reserve error will be random and independent of the pre-managed underwriting income, especially if we control other incentives such as tax deferral.

4.3 Income Smoothing Driven by Investment Income

In Section 4.2.2, I illustrated that the difference between pre-managed underwriting income and its benchmark plays a role in income smoothing. In this section, I will include the investment income in the analysis. The benchmark of investment income is denoted as *BM_II* and the benchmark of the overall net income is denoted as *BM_NI*:

$$\begin{aligned}&\text{Net Income}_t - \text{BM\_NI}_t \\ &= \text{Underwriting Income}_t + \text{Investment Income}_t - \text{BM\_UI}_t - \text{BM\_II}_t \\ &= (\text{Premanaged Underwriting Income}_t - \text{BM\_UI}_t) + (\text{Investment Income}_t - \text{BM\_II}_t) - \text{Error}_t\end{aligned} \tag{4-7}$$

Where $\text{BM\_NI}_t = \text{BM\_UI}_t + \text{BM\_II}_t$.

Thus, similar to the analysis in the last section, if managers want to minimize the distance between reported net income and its benchmark, $Error_t$ is positively correlated with:

$$(\text{Premanaged Underwriting Income}_t - \text{BM\_UI}_t) + (\text{Investment Income}_t - \text{BM\_II}_t)$$

Equation (4-9) highlights the importance of controlling the underwriting income in this study. Given the difference between pre-managed underwriting income and its benchmark, the magnitude of discretion over reserves depends on the difference between the investment income and its benchmarks. If the investment income is higher than its benchmark, it will increase the incentive to over-state reserves. However, this relationship exists only if insurers manipulate loss reserves to smooth the reported overall net income. If the insurers treat investment income and underwriting income in isolation and they only want to smooth the underwriting income (*UndwtIncome*), or there is no income smoothing, we may not find a significant relationship between loss reserve errors and income smooth measures.

Thus, I hypothesize that:

If P/C insurers manage loss reserves to smooth the overall reported income, insurers will over-state (under-state) loss reserves when the difference between investment income and its benchmark is greater. But if they only manage loss reserves to smooth the underwriting income or they are not involved in income smoothing, investment income and loss reserve errors will be uncorrelated.

4.4 Other Linkages between Loss Reserve Errors and Investment Income

There are several other channels that could lead to a relationship between investment income and loss reserve errors. (1) Unexpected inflation may influence both activities simultaneously. (2) Interest rates positively influence the investment income and negatively influence the underwriting income. (3) An increase in investment income could positively influence underwriting capacity which may influence underwriting standards and premium rates, thus indirectly affecting the

reserve errors.[29] The analysis in this Section 4.4 shows that the factors above introduce a negative relationship between loss reserve errors and investment income. We can apply modeling techniques to control the effects of most of those factors. In circumstances when the effects cannot be controlled, the relationship between loss reserve errors and investment income is decided by the dominant effect.

4.4.1 Unexpected Inflation and Interest Rates

Weiss (1985) finds that both unexpected inflation and interest rates are associated with the under-statement of loss reserves. Generally, nominal investment returns rise as the interest rates and/or inflation increase. The following two subsections discuss the roles of the two factors.

4.4.1.1 Unexpected Inflation

Unexpected inflation may introduce a negative correlation between investment income and loss reserve errors. Actuaries make assumptions for inflation when estimating the nominal ultimate payments of losses and loss reserves. When the unexpected inflation (difference between realized inflation and expected inflation) is high, the initial estimate of reserves will be lower than the ultimate outstanding payments, and non-discretionary under-reserving errors will be found.

The effects of inflation on investment income depend on the type of investment. Generally, when inflation increases, prices of stocks and inflation-indexed bonds reflect the change of the inflation rate and their nominal investment income is inflated, although the purchase power of the non-

[29] Deloitte in its "2013 Property and Casualty Insurance Industry Outlook" also indicates that the low interest rates and investment income pressured insurers to pay closer attention to underwriting. Insurers tend to invest more in predictive analytics, apply stricter underwriting, and raise premium rates for insurance coverage.

inflation-indexed fix-income securities decreases.[30] Thus, the general (unexpected) inflation is negatively associated with loss reserve errors and positively correlated with (nominal) investment income. A negative relationship between reserve error and investment income might be introduced.

In addition, the inflation measurements depend on the lines of business. For example, the inflation associated with auto liability is the medical care cost index while the inflation for auto physical damage is related to the automobile maintenance and repair index (Gron 1994). So in certain cases, the unexpected inflation only influences reserving accuracy but may have no impact on the nominal interest rates and investment income. For inflation that influences both reserve adequacy and investment, we can control the effects by introducing the year dummies.

4.4.1.2 Interest Rates

Interest rates can also introduce a negative relationship between investment income and loss reserve errors. The premium collection occurs before the claim payout. Theoretically interest rates have a negative effect on premium prices, thus negatively affect the underwriting margins. As shown by Haley (1993), the insurance Capital Assets Pricing Model (CAPM), the discounted cash flow models and option pricing models all predict a negative relationship between the real risk-free interest rate and underwriting profitability of the insurers. The predictions of these theories are supported by the empirical findings based on the cointegration time-series analysis (Haley 1993; Choi, Don, and Thistle 2002; Haley 2007).

[30] If insurers hold the fixed-income security to maturity, the nominal dividends/interests are not influenced by change of interest rates.

Those studies, however, do not discuss the relationship between the interest rates and loss reserve accuracy. Normally higher interest rates bring higher investment income.[31] Thus one potential effect is that if insurers manage reserves to smooth the underwriting margin, there will also be a negative relationship between interest rates (and/or investment income) and loss reserve errors. However, this effect can be controlled for by including the smooth measure for the pre-managed underwriting income.

High investment income/interest rate induces a lower underwriting return because high investment income can offset the loss in underwriting, enabling insurers to write their business at lower premium rates and with relaxed underwriting standards (Caswell and Goodfellow 1976; Gron 1994). According to Weiss (1985), the increase of interest rate induces insurers to relax the underwriting standards, and "*if loss reserve estimates did not fully reflect the effects of the relaxed standards, the accuracy of loss reserves might be affected. The result would be an inverse relationship between the loss reserve error and interest rates.*" As the interest rate positively influences the investment return, it leads to a negative relationship between investment income and the level of loss reserve estimation.

4.4.2 Underwriting Capacity/Standards

Although the relationship between investment income and loss reserve errors is not explicitly tested by Weiss (1985), her finding on interest rates implies a negative relationship between

[31] Higher interest rates decrease the capital gains of bonds, but accompanied with higher income from common stocks or newly invested bonds. Since insurance company normally hold the bond until maturity, and the majority of bonds are recorded by either book value or amortized value rather than market value (the change in unrealized capital gains of bonds are not reflected in statutory financial statement), higher interest rates is associated with more favorable investment income.

investment income and loss reserve errors. As we have discussed above, the effects through premium rates can be controlled by including the underwriting income in the model. However, it is not easy to quantify the influence of underwriting standards on loss reserves.

To address this potential indirect negative effect of the investment income, the method proposed by this paper is to differentiate loss reserve errors of prior accident years (AY< *t*) from current accident year (AY= *t*). Only loss reserves of the accident year *t* might be under-stated if an insurer fails to capture the effects of relaxed underwriting standards. The investment income of year t may also influence the underwriting in the future years, although this is not the focus in this paper. For all the prior accident years (AY < *t*), the loss reserve accuracy are not influenced by the change of the underwriting standards in year *t*. Only income smoothing can explain the positive relationship between investment income of current year and loss reserve errors of prior accident years (with control for other incentives). Therefore, a positive relationship between loss reserve errors of prior accident years and investment income of current year indicates income smoothing:

Loss reserve errors of the prior accident years (AY < t) and investment income of current year (t) will be positively related if P/C insurers manage loss reserves to smooth the overall reported income.

Note that the two variables above may not be associated if insurers do not manage loss reserves with respect to the investment income.

For the loss reserves of the current accident year (AY=*t*), its correlation with investment income is positive if the income smoothing incentive dominants the negative underwriting standard effects. If the correlation is positive and significant, it still supports the income smoothing theory. However,

if the correlation is not significantly positive or even negative, it does not deny the income smoothing effect; it may due to that the other effects are stronger.

4.5 A Note on Asset-Liability Management (ALM)

Both assets and liabilities of the financial companies are influenced by some common factors such as the interest rates. Corporations attempt to protect surplus against changes in interest by asset-liability management (ALM). Although there are other factors (such as catastrophes, unemployment rates) that can influence both the assets and liabilities values, the focus of ALM is on interest rate risk. One common practice of ALM is duration match; when the durations of asset and liability are properly matched, the fluctuation of surplus with change of interest rates will be reduced. Moreover, most life and property/casualty insurers adopt the liability driven ALM, that is, the asset strategy is driven by liabilities the companies. Investments are "managed" to match the liabilities, with consideration to the characteristics of the insurance product mix which also impact the loss and claim payment patterns. With ALM, it is possible that both investment income and loss reserve errors are connected by the nature of business mix.

The assets liability management is important to both loss reserve errors and investment income. However, the direction of the effect of ALM on the relationship between the two components is unclear. On the underwriting side, loss and payment patterns determine the duration of liabilities as well as how accurate the loss reserves can be. Reserves of long-tail lines are more difficult to estimate. Insurers may have a tendency to reserve conservatively by applying a risk margin, thus

insurers with more business in long-tail lines have higher reserve levels.[32] On the investment side, long-tail/short-tail business may be matched with long-term/short-term assets. For companies that write most business in short-tail lines, short-term investments are preferred, but for companies that write business mainly in long-tail lines, long-term investments are appropriate.[33] Holding more or less long-term assets may either benefit or hurt the investment income. The results depend a great deal on the performance of the financial market. For instance, long-term bonds generate higher yield, but are riskier than short-term bonds: their values are sensitive to the interest rates. However, by deciding to invest in longer-duration and higher-yielding assets, the company does not increase its overall value immediately. It cannot create or destroy values simply by owning a different portfolio of assets with the same market value. The portfolio may prove to have a greater value over time if events play out well, but that is not given at the time that the company purchases them.

Additionally, although insurers can choose the investment strategy under the investment regulation, the ALM cannot overcome the unexpected exogenous shocks to investment income from the economy and financial market. In section 6.4, we will show that the change of investment income is highly dependent on the return of the financial market. We can partially control for the effect of ALM by accounting for insurer product mix, especially the business in long-tail lines.

[32] However, accuracy, instead of conservativeness, is preferred by the regulators and IRS. This is especially important with the Solvency II, as reserves under Solvency II are adjusted to reflect the time-value of money of future payment cash-flow, as well as the risk margin.

[33] Studies have also shown that insurers deliberately mismatch asset/liability maturities in order to generate higher spreads (CAS 1989; Doherty and Garven 1995; CAS 2002; Ahlgrim, D'Arcy, and Gorvett 2004). Doherty and Garven (1995) find that most P/C insurers' assets have higher durations than liabilities. Given that insurers usually have good cash-flow liquidity from the premiums collected from the ongoing business, they are less likely to suffer from the cash-flow problem caused by mismatch of durations.

4.6 Summary of Hypothesis

As we discussed in this chapter, investment income may induce insurers to manipulate loss reserves to smooth the overall net income around the benchmark. The income smoothing incentive depends on the pre-managed underwriting income, the investment income and the income benchmarks.

The income smoothing hypothesis predicts that all else being equal, insurers will bias their loss reserves upward if investment income is relatively higher and if insurers want to smooth its overall income rather than merely underwriting income.

Several other factors may harm the identification of the income smoothing effect, such as unexpected inflation, interest rates, underwriting capacity and standards, as well as asset liability management. I show that most of these factors introduce a negative correlation between investment income and magnitude of over-statement of loss reserves. I attempt to control for these confounding factors, but if the control variables are imperfect then the presence of these factors will bias the results away from finding evidence that insurers use their discretion over loss reserves to smooth investment income.

Chapter 5 Models and Variables

5.1 Basic Model Settings

To test our hypotheses, the following basic model is estimated:

$$Error_{i,t} = \alpha + \delta_1 Invest_{i,t} + \delta_2 Underwrite_{i,t} + \theta Z_{i,t} + \beta X_{i,t} + \gamma YearDummies_t + \varepsilon_{i,t} \quad (5\text{-}1)$$

In this model, $Error_{i,t}$ is the loss reserve error of company *i* in calendar year t. $Invest_{i,t}$ is the measure of investment income, $Underwrite_{i,t}$ is the measure of the underwriting income. $X_{i,t}$ is a vector of firm characteristic variables; and $Z_{i,t}$ is a vector of incentive variable tested in previous literature (tax, financial strength, rate regulation, and reinsurance purchase). $YearDummies_t$ are dummy variables. They absorb the effects of factors which only change over time and invariant cross-sectional, such as unanticipated inflation rates.[34]

I will discuss the definitions of all the variables in the remaining sections of Chapter 5. Note that the Equation (5-1) offers the basic information on the dependent and independent variables to be adopted in this paper. More details about empirical methodology are covered in Section 7.2.1.

[34] The choice of whether include firm fixed-effects are discussed in in Section 7.2.1.

5.2 Measurement of Investment Income

A few details must be considered when constructing the measurement of investment income: the numerator, the denominator and the benchmark. We begin with the numerator. I use two measures for the investment income numerator: (1) reported investment income, and (2) investment income with unrealized capital gains/losses.

The first measure includes the net investment income earned and realized capital gains/losses during the reporting calendar year on the statutory financial statement. The reported investment income is net of investment expenses, depreciation of invested assets, investment taxes and fees, but excluding federal income taxes.

The second measure includes the reported investment income and the unrealized capital gains. Unrealized capital gains are not included in net income, but it influences the underwriting decisions as it is a part of the surplus. And unrealized capital gains are not taxed until they are realized. The reported investment income is more likely to be associated with the incentive to smooth income, and the investment income with unrealized capital gains influences underwriting capacity.

The second task is to select a denominator. Investment income is scaled to account for differences in firm size. There is a wide variety of choices of the divider: total invested assets, average invested assets, total assets, surplus, net premiums earned, and more.

Total assets are used to adjust the size effect of the underwriting income and loss reserve errors in this paper. This method is more appropriate and will be used for this paper based on the following reasons. (1) This research focuses on income streams, so scaling all income streams by the same

variable makes the comparison more comparable with each other. (2) Some of the assets are not invested, but theoretically all assets are investable. It is the insurer's own decision to choose how much of the total assets are invested.

Investment income measures without and with unrealized capital gains/losses ($InvIncome_{i,t}$ and $InvIncome\_U_{i,t}$) are:

$$\text{InvIncome}_{i,t} = \frac{\text{Net Investment Income}_{i,t}}{\text{Total Assets}_{i,t}} \tag{5-2}$$

$$\text{InvIncome\_U}_{i,t} = \frac{\text{Net Investment Income}_{i,t} + \text{Unrealized Capital Gains/Losses}_{i,t}}{\text{Total Assets}_{i,t}} \tag{5-3}$$

The last component of the income measure is the benchmark. Both temporal and spatial benchmarks are considered. An insurer may want to beat its own records reported in the past year(s), so the temporal benchmark is the expected investment income predicted by the investment income of past three years[35] based on a two-way fixed-effect model with time effects and company effects.

The similar procedure is taken for both investment income measures. Then we have:

$$\text{Temp\_InvIncome}_{i,t} = \text{InvIncome}_{i,t} - \text{Predicted InvIncome}_{i,t} \tag{5-4}$$

[35] I also tried to use the average investment income of the past three years as the temporal benchmark. The results are similar.

$$\text{Temp\_InvIncome\_U}_{i,t} = \text{InvIncome\_U}_{i,t} - \text{Predicted InvIncome\_U}_{i,t} \quad (5\text{-}5)$$

A low investment income might not be considered inadequate if it surpasses its peers in the industry. The spatial benchmark is constructed based on the income distribution in each year. Several steps are taken to calculate the spatial benchmark. (1) The first step is based on investment income distributions for each year, we obtain the average and standard deviations of the earnings. (2) For the second step, instead of dummy variables for loss/small loss/small profit/profit insurers, I use the z-score of each insure. A high z-score indicates that the insurer is performing better than the industry average, and a low z-score indicates that the insurer is not profitable as others. Similar procedures are implemented for reported investment income and investment income with unrealized capital gains/losses.

$$\text{Spt\_InvIncome}_{i,t} = \frac{\text{InvIncome}_{i,t} - (\text{Average of InvIncome}_{i,t} \text{ of Year t})}{\text{Standard Deviation of InvIncome}_{i,t} \text{ of Year t}} \quad (5\text{-}6)$$

$$\text{Spt\_InvIncome\_U}_{i,t} = \frac{\text{InvIncome\_U}_{i,t} - (\text{Average of InvIncome\_U}_{i,t} \text{ of Year t})}{\text{Standard Deviation of InvIncome\_U}_{i,t} \text{ of Year t}} \quad (5\text{-}7)$$

5.3 Measurement of Underwriting Income

To measure underwriting income, the denominator we use is the total assets, but we have to decide the numerator and the benchmark.

The reported underwriting income ($UndwtIncome_{i,t}$) is the underwriting gains/losses reported on the statement of income. The pre-managed underwriting income ($UndwtIncome\_PM_{i,t}$), is the summation of reported income and loss reserve error, as defined in Section 4.2.1.

$$\text{UndwtIncome}_{i,t} = \frac{\text{Reported Underwriting Income}_{i,t}}{\text{Total Assets}_{i,t}} \tag{5-8}$$

$$\text{UndwtIncome\_PM}_{i,t} = \frac{\text{Reported Underwriting Income}_{i,t} + \text{Reserve Error}_{i,t}}{\text{Total Assets}_{i,t}} \tag{5-9}$$

The temporal and spatial benchmarks are constructed similarly to those of the investment income. As discussed in Chapter 4, the underwriting income to be included in this model must reflect the income before any discretion over loss reserves, thus only the pre-managed underwriting income and its smooth measures will be used in the model.

For the temporal benchmark, predicted underwriting income is based on *reported* underwriting income of the prior three years using a two-way fixed effects model. The difference between the underwriting income (for pre-managed underwriting income ($UndwtIncome\_PM_{i,t}$) and the benchmark (predicted reported underwriting income) is our temporal smooth measure for underwriting income.

$$\text{Temp\_UndwtIncome\_PM}_{i,t} = \text{UndwtIncome\_PM}_{i,t} - \text{Predicted UndwtIncome}_{i,t} \tag{5-10}$$

The spatial underwriting income smooth measure is constructed as Z-score based on the income distribution of *reported* underwriting income in each year.

$$\text{Spt\_UndwtIncome\_PM}_{i,t} = \frac{\text{UndwtIncome\_Pre}_{i,t} - (\text{Average of UndwtIncome}_{i,t} \text{ of Year t})}{\text{Standard Deviation of UndwtIncome}_{i,t} \text{ of Year t}} \quad (5\text{-}11)$$

Note that the benchmarks for temporal and spatial smooth measures of pre-managed underwriting income are the predicted reported underwriting income. The reason for this is that the purpose of income smoothing is to smooth the reported income.

5.4 Control Variables

The control variables measure the uncertainty of the loss claim process, which is the main source of the non-discretionary loss reserve errors.

5.4.1 Business Characteristics

Higher uncertainty of the claim process makes it more challenging for the actuaries to estimate the ultimate payment; therefore more reserve errors may occur. On the other hand, it gives the insurers more managerial discretion over reserves.

Higher uncertainty of the claim process makes it more challenging for the actuaries to estimate the ultimate payment; therefore more reserve errors may occur. On the other hand, it gives the insurers more managerial discretion over reserves.

I control the underwriting risk through the risk characteristics in different lines of business. In particular, I identify the percent of business in long tail lines. Following Petroni et al.(2000) and Beaver et al. (2003), I measure the long-tail business (*Longtail*) as the net premiums written in liability lines of product liability, other liability, and medical malpractice as a percentage of total net premiums written. Those liability lines are longer than other long-tail lines. Those lines of

business are prone to exogenous ex-post shocks (Beaver, McNichols, and Nelson 2003), including the impact of changing contract interpretations and legal environment. Thus *Longtail* is expected to be associated with a larger degree of reserve errors.

The line of business Herfindahl index (*BusHerf*) and the geographic Herfindahl index (*GeoHerf*) are included to measure the insurer diversification across the lines of business and the 50 states. A higher Herfindahl index implies less diversification of the risk therefore insurers might be more precautious and more likely to over-reserve (Browne, Ju, and Lei 2012). However, an insurer with higher business or geographic concentration may be more professional on the lines of business or geographic areas it focuses on, so the insurer is able to establish loss reserves more accurately(Browne, Ju, and Lei 2012).

$$\text{BusHerf} = \sum_i \left(\frac{\text{Net Premiums Written in Business } i}{\text{Total Net Premiums Written}}\right)^2 \tag{5-12}$$

$$\text{GeoHerf} = \sum_j \left(\frac{\text{Net Premiums Written in State } j}{\text{Total Net Premiums Written}}\right)^2 \tag{5-13}$$

Growth rate of business (*Growth*) is the 1-year growth rate of written premiums. Insurers may increase the underwriting risk and lower the premiums to increase its business growth. Thus, higher growth rates may induce an incentive to under-reserve (Harrington and Danzon 1994).

5.4.2 Investment Strategy

Fluctuations in the financial market do not affect all companies uniformly. Companies with a greater percentage of their assets invested in common stock are more likely to be exogenously influenced by the financial market.

To control the investment portfolio of insurers, the following variables are included in the model:

$$\text{Bond}_{i,t} = \frac{\text{Invested Bonds}_{i,t}}{\text{Invested Assets}_{i,t}} \tag{5-14}$$

$$\text{CommonStock}_{i,t} = \frac{\text{Invested Common Stocks}_{i,t}}{\text{Invested Assets}_{i,t}} \tag{5-15}$$

$Bond_{i,t}$ is the proportion of invested assets in bonds, and $CommonStock_{i,t}$ is the proportion of invested assets in common stocks, which is used as a measure of investment risk in prior literature (Ren et al. 2011).

5.5 Other Hypotheses in Literature

In this paper, I also test the following four hypothesized incentives for exercising discretion over loss reserves: (1) taxes, (2) financial weakness, (3) rate regulation, and (4) reinsurance purchase.

5.5.1 Tax Deferral Incentive

Loss reserves are deductions from pre-tax overall income. By over-reserving, an insurer can defer its tax payment and/or move itself to a lower tax bracket.

In the literature the tax incentive is generally measured two ways: (1) using a measure of the tax shield (Grace 1990); or (2) using a tax indicator variable to measure the incentive of tax deduction incentive. As shown below, those two variables are not appropriate in this study.

One of the most commonly used measures is the tax shield (*TaxShield*) variable introduced by Grace (1990).

$$\text{TaxShield}_{i,t} = \frac{\text{Net Income}_{i,t} + \text{Reserve}_{\text{i,t}}}{\text{Total Assets}_{i,t}} \tag{5-16}$$

However, this variable is directly associated with both income and reserves, and not appropriate for the research purpose of this paper. This is because models in this paper control for both investment income and pre-managed underwriting income; when the pre-managed income is included, the tax shield variable will be negatively correlated with the loss reserve errors. The tax shield variable will therefore not be adopted in this research.

$$\text{(Reported) Net Income} = \text{Pre-managed Net Income} - \text{Error} \tag{5-17}$$

Another measure used in the literature is the tax indicator variable (Petroni, 1992).[36] Based on Scholes et al. (1990), an insurer is considered to have a low tax rate if it has net operating loss (NOL) carryforward. NOL carryforward can be applied to any of the 20 years after the year of net operating loss. Tax indicator variable equals one if the tax rate is high and is zero if the tax rate is low. The tax indicator is questioned by researchers who argue that the NOL does not accurately

[36] The tax indicator is one in year *t* if insurer *i* either paid taxes or received a refund of prior taxes, otherwise zero as per description of Petroni (1992), pp 495.

reflect true marginal tax rates (e.g. Beatty, Chamberlain, and Magliolo 1995; Chen and Daley 1996). For the insurance industry, the NOL carry-forward information is not directly available, and it is approximated by whether or not an insurer pays no taxes or receives tax return from prior years, further weakening the reliability of this variable (Gaver and Paterson 1999).

In this study, I use the marginal tax rate (*TaxRate*) based on the taxable income. The calculation of *TaxRate* is based on the following stepts: (1) Using paid federal income tax to obtain the taxable income, and (2) pre-managed taxable income = taxable income+0.9*Error, then (3) use tax table to obtain the pre-managed marginal tax rate. Higher marginal tax rate implies greater benefits of over-reserving marginally. One potential problem that I acknowledge is the endogeneity of the tax measures that related to income of the insurers. The income tax is based on the overall income which is influenced by the loss reserve errors. However, since the reserve errors will impact so many aspects of the insurer, there was no other way to do our studies without having that situation. The tax rate based on pre-managed taxable income partially handle the endogeneity problem because the pre-managed taxable income is not directly used in the tax status measure, and the marginal tax schedule is not monotonic. Some alternative measures of tax status (such as the tax indicator) will be tested in the robustness check section.

5.5.2 Financial Weakness

Petroni (1992) and Gaver and Paterson (2004) suggest that financially weaker insurers under-reserve in an attempt to avoid regulatory scrutiny – as under-reserving to reduces the number of unusual IRIS ratios. A firm is defined as weak if it has more than one unusual non-reserve IRIS financial ratios. Grace and Leverty (2012) argue that the intent behind under-reserving may not be

due to a desire to reduce the number of unusual IRIS ratios, but rather that weak firms are weak. Grace and Leverty follow the insolvency literature (Cummins, Grace, and Phillips 1999) and measure firm financial weakness using an estimate of the firm's probability of failure. Bowne, Ju and Lei (2012) use the NAIC risk-adjusted capital ratio (RBC) to measure the financial strength of the insurers.

I follow Grace and Leverty (2012) and measure financial weakness using the probability of failure.[37] The variable is estimated by regressing the failure indicator on regulatory solvency tools (Financial Analysis Solvency Tools (FAST) ratios) and firm characteristics (see Appendix 5).

Weaker insurers are more likely to under-reserve loss reserves since they appear more solvent by doing so (Petroni 1992; Gaver and Paterson 2004). However, weak insurers, which have higher insolvency risk, also have strong incentive to over-reserve: by over-reserving, insurers can: (1) reduce their dependency on costly external financing and maintain a reasonable rate of return on equity (Myers and Majluf 1984), (2) strengthen their real solvency.

If a financially weak insurer under-reserves to mask its solvency problems, it benefits the firm in the short-run, but costs the firm in the long-run. This is due to two reasons. (1) As payments are made over time, the weak insurer has to utilize its surplus to cover those payments, so future profitability may be reduced. (2) Lower reserves may lead to lower premium rates in the future, which further reduces the underwriting profitability and worsens the financial conditions of the

[37] Data for values of the variable "probability of failure" (*Prob_Fail*) is obtained from Professor Tyler Leverty at University of Wisconsin, Madison. See Appendix 5 for details of the calculation of this variable.

weak firm. Thus, it is possible that that insurers with higher probability of failure may overstate loss reserves to reinforce their solvency in the future years.

Due to the competing hypotheses for this variable, there is no predicted relationship between probability of failure and loss reserve errors.

5.5.3 Rate Regulation

Rate regulation of P/C insurance differs by state and line of business. Like Grace and Leverty (2012), I measure the stringency of rate regulation using an index that weights the premiums written under strict regulation by state and product line for each year of the sample. The information on rate regulation is available from the *NAIC's Compendium of State Laws on Insurance Topics: Rate Filling Methods for P/C Insurance, Workers' Compensation, Title* (various years). A particular line in a specific state in a given year is defined as under stringent rate regulation if the state has either commissioner set-rates, prior approval law, modified prior approval, flex rating with a narrow flex band (for example, prior approval of rates required if the rate increasing is more than 10% of the previous filed rates). The rate regulation is defined as not stringent if the law is either file-and-use, use-and-file, flex rating with a large flex band (for example, prior approval of rates required if the rate increasing is more than 20% of the previous filed rates), or no file.

Appendix 6 shows the definitions of the rating laws. Throughout our sample years from 1996 to 2007, only a few states made changes to their rating laws with switches between stringent and non-stringent laws. Connecticut changed from modified prior approval laws to file-and-use laws in 2000. Washington D.C. changed from prior approval laws to file-and-use laws for property lines

and auto lines since 2001. Nebraska adopted file-and-use laws for most commercial lines, excess and large deductible workers' compensation and flex rating (40%) for medical malpractice. For the majority of the states, the rating laws were stable over the sample years.

The rate regulation index (*RateReg*) for insurer *i*, line of business *l*, in state *s* and year *t* is calculated as the proportion of premiums written under stringent rate regulation, following Grace and Leverty (2012).

$$\text{RateReg}_{i,t} = \frac{\sum_{l,s} \text{Premiums Written}_{i,l,s,t} * \text{Stringent Rate Regulation Law}_{l,s,t}}{\text{Total Premiums Written}_{i,t}} \quad (5\text{-}18)$$

Where $\text{Stringent Rate Regulation Law}_{l,s,t}$ is an indicator that equals one if in state *s* and in year *t*, the line *l* is under stringent rating laws, otherwise it equals zero.

The predictions and findings of the effects of rate regulation on loss reserve errors are mixed: if the insurers are motivated to convince regulators that they are able to afford lower rates then they will under-reserve (Nelson 2000) but if insurers want to reduce the effect of stringent rate regulation, they will tend to over-reserve (Grace and Leverty 2010 and 2012).

5.5.4 Reinsurance Purchase

Reinsurance purchases (*Reinsurance*) is measured as the reinsurance ceded as a proportion of gross premiums written. Reinsurance purchases are found to be associated with higher accuracy of loss reserves to obtain better reinsurance terms and rates (Browne, Ju, and Lei 2012). By selling liabilities to other insurers, the primary insurers can also reduce leverage and hide under-reserving (Harrington and Danzon 1994).

5.5.5 Demographics

Several firm level demographic measures are considered, including size, ownership structure (stock or mutual), and group affiliation. *Size* is the natural logarithm of total assets. Companies of a larger size are hypothesized to be able to reserve more accurately. *Stock* is an indicator set equal to one if the insurer is a stock company, and zero otherwise. Managers of stock companies may have more incentives to manipulate loss reserves while mutual companies are more conservative in reserving and tend to over-reserve (He and Sommer 2010; Browne, Ju, and Lei 2012; Grace and Leverty 2012). *Group* is the indicator that equals one if the firm is affiliated to a group company.

[Insert Table 6 here]

Chapter 6 Data

6.1 Data and Sample

The data in this research are obtained from NAIC Annual Statement, for the years 1993 to 2012. Because loss reserve errors are calculated using data five years after the initial loss reserve estimation, the end of the sample period for my analysis is 2007. Because I use the past three years to predict benchmark income, the beginning of the sample period for my analysis is 1996.

Consistent with the literature, the following screening of the raw data is conducted:

(1) Total assets, the losses incurred, and loss reserves are required to be greater than zero. This screening ensures that the insurer is still actively writing business. After the screens above, there are 25,895 insurer-year observations in the sample.

(2) Revised loss reserves developed 5 years after initial statement year exist and larger than zero. Reserves errors can therefore be calculated.

(3) I use the NAIC demographic variable of "company status" to further exclude inactive companies.[38] Only companies with a status of "Active – No regulatory action in process" are included in the sample.

[38] Valid values for Company Status are:
0 Active - Conservatorship
1 Active - No regulatory action in process
3 Inactive - Merged or combined into another company
4 Active - Rehabilitation, permanent or temporary receivership
5 Inactive - Voluntarily out of business
6 Active - Being liquidated or has been liquidated
7 Inactive - Estate has closed
8 Inactive - Charter is inactive

(4) Insurer-years are for either stock or mutual companies domiciled in the United States.

(5) Direct premiums written must be non-negative. This will exclude firms that only write reinsurance. The reserves of reinsurance assumed are mainly decided by the ceding company thus reinsurers have less discretion over loss reserves (Petroni, 1992).

(6) Insurer-years with more than 25% of net premiums in Accident and Health, Surety and Fidelity, Credit, Title, and Mortgage insurance lines are excluded. These lines are short-tail lines and as a result there is less opportunity for insurers to under- or over-state the loss reserves (Petroni 1992). In addition, these lines are different from the traditional P/C insurance lines, and the incurred losses of those lines are greatly influenced by the performance of the financial market.

(7) Insurer-years with more than 25% of net premiums in workers' compensation insurance are excluded. This is because loss reserves of workers' compensation are discounted to present values while loss reserves of other lines are reported at nominal values.

---

9 Inactive - Combined statement filer

Only companies with code 1 are kept.

After Step (1), there are 25,859 insurer-year observations. For Status 3, if a firm is merged to a new firm and still active, they will still be in the sample and file annual statement as individual companies. The distribution of company status is as below:

Company Status	0	1	3	4	5	6	8	9	Total
N	13	25,375	194	64	77	131	4	1	25,859
Percentage	0.05%	98.13%	0.75%	0.25%	0.30%	0.51%	0.02%	0.00%	100.00%

After Step (2), there are 23,546 insurer-year observations. The distribution of company status is as below:

Company Status	0	1	4	5	6	Other	Total
N	5	23,492	41	3	5	0	23,546
Percentage	0.02%	99.77%	0.17%	0.01%	0.02%	0.00%	100.00%

(8) Firms with extreme loss reserve errors are excluded.[39]

(9) The final requirement is that the firm have no non-missing values for the independent and dependent variables.

After the screen, the sample includes 11,210 insurer-year observations.[40] The sample contains 1,533 unique insurers, with an average time period of 7.3 years.[41] The sample accounts for approximately 60% of the total admitted assets, and 70% of total net written premiums, in the property and casualty insurance industry from 1996 to 2007. Further examination indicates that the loss ratio, expense ratio and investment income ratio of the sample is not very different from those of industry at the aggregate level. The average loss ratio, expense ratio and investment income ratio of the industry are 75.8%, 26.7% and 13.7% respectively, while the ratios for the sample are 75.4%, 26.5% and 13.0% respectively.

The reduction in sample size during the screen process is detailed in Table 7.

[Insert Table 7 here]

[39] I define an extreme loss reserve error as those that have a difference between developed loss reserve and original loss reserve that is more than 50% of the original reserve, similar to Beaver et al. (2003) and Grace and Leverty (2012).

[40] The sample size per year is comparable to other studies with similar screens, including Beaver et al. (2003) and Grace and Leverty (2012). The average sample size per year of this paper (934 insurer-years per year from 1996 to 2007) is between Grace and Leverty (2012) (851 insurer-years per year from 1989 to 1997) and Beaver et al (2003) (1,146 insurer-years per year from 1988 to 1997).

[41] There are 346 unique mutual insurers and 1,218 unique stock insurers in the sample, with 31 insurers switched their mutual/stock status during 1996-2007.

There are several extreme large or small values for some of the variables, I have winsorized the extreme values at the bottom and top of the distributions of those variables in the sample (up to 20 observations of each tail).

6.2 Summary Statistics

Panel A in Table 8 displays the descriptive statistics for the loss reserve errors by year. Over the sample period, the average insurer over-reserves by about 1% of the total assets ($7.7 million). For comparison, loss reserve errors are about one third of the net income of P/C insurers. Average net income is roughly 3.4% of the total assets. Sixty-three percent of the observations over-reserve. For the insurer-years that under-reserve (4,117 observations), the average magnitude of under-reserving is 5.1% of total assets ($40 million). For the insurer-years that over-reserve (7,093 observations), the average over-reserving is 4.5% of the total assets ($34.6 million).

[Insert Table 8 here]

There is an upward trend in reserve errors from 1996 to 2001 and a downward trend from 2002 to 2006. Both the reserve errors of prior accident years (*Error_PY*, Panel B of Table 8) and reserve errors of the most recent accident year (*Error_CY*, Panel C of Table 8) have similar trends. I compare the means of the two components of loss reserves using a Paired t-test for dependent samples. The magnitude of reserve errors in the most recent accident year (*Error_CY*) is significantly higher than the reserve errors of the prior accident years (*Error_PY*) (p-value<0.00001). The F-tests for variance indicate that the *Error_PY* has a significantly higher variation (p-value<0.00001). The data also suggest that before 2001 the average level of *Error_CY* is lower than *Error_PY*, but it reverses after 2001.

[Insert Table 9 here]

Table 9 reports the descriptive statistics for the sample after screening. In our sample, 74.6% of the insurer-years in the sample are associated with stock companies and 25.4% of the insurer-yeas are associated with mutual companies. The stock firm-year observations take 72.6% of the overall net premiums written, while the mutual firm-year observations take 28.4% of the overall net premiums written. A large proportion (76.7%) of insurers are affiliated with group companies. The average insurer has total assets of $770.53 million and has been in business for 49 years, with an annual net premiums growth rate of 11%.

For the income measures, a paired t-test for the sample means suggests that reported investment income (*InvIncome*) is significantly lower than income with unrealized capital gains/losses (*InvIncome_U*) (p-value<0.00001); and the former has smaller variations according to the F-test for variance (p-value<0.00001). The average firm reports investment income of 4.4% of total assets ($33.9 million), and an underwriting loss (*UndwtIncome*) of 0.8% of the total assets ($6.2 million). Pre-managed underwriting income is a gain of 0.2% of the total assets ($1.5 million).

For investment strategies, the average insurer in the sample allocates about 65.7% of invested assets in bonds and 12.9% in common stocks.

The average insurer in our sample has 14.2% of business in the long-tail liability lines (*Longtail*). The average insurer cedes 38.7% of their premiums to reinsurers (*Reinsurance*). For diversification, the average business Herfindahl index (*BusHerf*) is 43.3% and the average geographic Herfindahl index (*GeoHerf*) is 52.2%. This means that an average P/C insurer write business in 2.5 lines of business and in 2 states.

The average marginal tax rate is 0.235. In the process of calculating the marginal tax rates, I find that the average value of income generated from tax-exempt bonds is about $ 8 million, which is about 22% of the total investment income, or 30% of the net income. The high proportion of income from tax-exempt bonds indicates that those bonds may play an important role in decreasing the tax deferral incentive. The average probability of failure predicted by the discrete hazard model is 0.003, and it ranges from 0.000 to 0.417. About 40% of the business is subject to strict rate regulation.

6.3 Within-Company Variations of Investment Income

There must be enough variations of the investment income measures in order to study the effects of investment income on loss reserve errors. In this section, I will explore the within-company variations of investment income.

At the aggregate level, the reported investment income is relatively stable over time (see Figure 1). Table 10, Panel A shows the summary statistics for the means and standard deviations of time-series of investment income for each company included in our sample. There are 1,533 companies in our sample, but I exclude 189 companies that have less than three years of observations to keep the value of standard deviation meaningful. The average within-company standard deviation of reported investment income (*InvIncome*) of the remaining 1,244 insurers is 0.016, which is about 37% of the mean value of reported investment income (0.043). Panel B of Table 10 exhibits the summary statistics of the range of within-company investment income measures. One advantage of using the within-company range to measure the variability of investment income is that we can retain more firms in the sample (1,391 firms). The average range of investment income (*InvIncome*)

is 0.043, which is almost the same as the average investment income. There are still some variations in investment income within the company for us to identify the effects of investment income.

The table also shows that the variation is greater for investment income with unrealized capital gains. This is consistent with our findings on the industry aggregate level data, since there are more variations in unrealized capital gains as we see from Figure 9.

[Insert Table 10 here]

Checking the sufficiency of within-company variation of investment income is important if we want to apply the fixed effects model at the firm level (Section 7.2).

6.4 Investment Income and Financial Market

In this sub-section, I explore the sources of shocks to investment income. Doing so can help with mitigating the endogenous problem caused by the liability driven asset-liability management (ALM). The investment income is a function of the firm's investment strategy and the performance of the financial market. However, the investment strategy might be endogenous. As we have discussed in Section 2.2, the allocation of invested assets for insurance companies are very stable over time, partially due to the restrictions on investments by regulators.

Figure 12 shows the Kernel Density plots of the invested bonds/common stocks as a percentage of average invested assets. The shape of Kernel Density plots is similar over time. If the investment strategy is stable over time, we can expect that the change of investment return of insurers will be substantially dependent on the return of the financial market.

[Insert Figure 12 here]

The upper graph of Figure 13 shows that investment income earned from interests and dividends evolves in a similary patter as the long term government bond yield. The lower graph shows that the investment income with unrealized capital gains (*InvIncome_U*) evolves in a similar way as the market return index, which is constructed as the sum product of the proportion of invested assets in common stocks and other assets (including bonds, real estate, mortgage loans, cash, short-term investments, and other miscellaneous assets) and market returns in the 3-month T-bill and S&P 500 index. The simple linear regression shows that at the industry aggregate level, 88.8% of the variations in investment return can be explained by the constructed market return index. For firm-year level data, the R-square is about 0.30. Both the reported investment income and the investment income with unrealized capital gains are greatly dependent on the financial market.

[Insert Figure 13 here]

For the return on the two major types of investment, I calculate the rate of return on bonds and common stocks for insurers. The pattern of return on common stocks follows that of the return on the S&P 500 index, and the pattern of return on bonds follows that of T-bill rates (Figure 14).

[Insert Figure 14 here]

The performance of the financial market is beyond the control of individual insurers. We can therefore assume that a great proportion of the changes in investment income are exogenous.

Chapter 7 Empirical Results

7.1 Descriptive and Univariate Results

In this section, I will compare the trends and volatilities of reported and the pre-managed income streams.

7.1.1 Comparison of Income Streams at the Industry Level

First, I examine loss reserve errors for the industry to see if industry aggregate loss reserve errors exhibit a pattern. To make the comparison meaningful, both investment income and underwriting income are scaled by total assets.

[Insert Figure 15 here]

Using data from *Best's Aggregates & Averages for the P/C Industry*, Figure 15 displays aggregate loss reserve errors for the industry scaled by total industry assets for the years 1982 to 2007. It shows that the reserve errors follow cyclical patterns over time. Similar to Smith (1980), I run a test of randomness. The null hypothesis is rejected with p-value 0.0003, suggesting that the time-series of industry level loss reserve errors is not random. However, the non-random pattern of loss reserve errors does not necessarily mean that loss reserves are manipulated. The pattern may be correlated with outside forces, such as the underwriting cycle.

[Insert Figure 16 here]

[Insert Figure 17 here]

Figure 16 compare the reported and pre-managed operating ratio, and Figure 17compares the report and pre-managed combined ratio (with components of loss ratio and expense ratio), and investment income ratio (all of which are components of the operating ratio) of the P/C insurance industry during the time 1996 to 2007.

Reported combined and loss ratios are smoother than the pre-managed ratios. However, the investment income ratio is relatively stable when compared to the pre-managed combined ratio and loss ratio. The comparison of reported and pre-managed operating ratios suggests that the pre-managed operating ratio is more volatile. At the industry level, the coefficient of variation for pre-managed and the reported operating ratio are 0.19 and 0.07 respectively. The average coefficient of variation over the sample period on the company level is 0.41 for the pre-managed operating ratio, almost twice as large as the reported operating ratio (0.21). Comparing with Figure 15, the operating ratio of the P/C insurance industry increases and the magnitude of under-reserving grows from 1996 to 2001. Conversely, from 2002 to 2007 the operating ratio decreases and insurers tend to bias the reported loss reserves upward to a great extent.

[Insert Figure 18 here]

Figure 18 displays the average reported income streams and the pre-managed income streams of the sample.[42] Similar to what we have observed with the operating ratio, the fluctuation of overall income is much higher without reserve error. Moreover, the reported investment income stream is more stable than the underwriting income. There is a downward trend of investment ratio from

[42] By adding the reserve errors to the reported income, the pre-managed underwriting income and overall net income can be obtained (without taking into consideration the change of tax and dividend to policyholders' due to the income change). All the income streams are scaled by total assets.

1996 to 2002 and an upward trend from 2002 to 2007, but the trends are not very dramatic. The relationship between investment income and loss reserve errors is not obvious to us from Figure 18.

7.1.2 Comparison of Earning Distributions at the Firm Level

In the previous section, I compared the volatility of reported and pre-managed earnings at the industry aggregate level. In this section, I will present the reported and pre-managed earning distributions at the firm level. Similar to our findings at the industry level, variation in net income is greater on a pre-managed basis.

As shown in Figure 19 and Figure 20, the distribution of reported income is less dispersed than that of pre-managed income. This is consistent with the hypothesis of income smoothing.

[Insert Figure 19 here]

[Insert Figure 20 here]

The lower graph of Figure 20 exhibits the reported and pre-managed net income on an annual basis. Similar to Beaver et al. (2003), there is a discontinuity around zero reported net income, but the pre-managed net income is smooth and approximately normally distributed.

To illustrate the difference in distribution of pre-managed income and reported income quantitatively, I compared the proportion of net income for different range: (1) less than 0%; (2) between 0% and 5%; and (3) greater than 5% respectively. The results are shown in Table 11.

[Insert Table 11 here]

There is a significantly higher proportion of observations with reported net income between 0% and 5%, than there is with pre-managed net income. Among the 11,210 firm-year observations, 56% of reported net income is within the 0% to 5% range, but only 28% of the pre-managed net income. There are significantly less observations reporting either negative earnings or larger than 5% net income (as a percentage of total assets). These findings suggest that insurers manage reserves to avoid reporting negative net income or large net income.

In addition, Figure 20 shows that the distribution of the pre-managed net income is left skewed, with more observations on the right tail. This means that before reserve errors, there are more insurer-year observations that make positive income than firm-year observations that suffer from losing money (generally the P/C insurance industry is making profit). The comparison of the distributions of pre-managed net income and reported net income also suggests that there are more observations which over-reserve than those under-reserve, and the income smoothing incentive might be asymmetric. However, the distribution comparison is a univariate analysis, it does not separate out other effects, such as taxes, we cannot make further conclusions on whether there is more over-reserving for income smoothing than under-reserving.

Following methods by Anderson (1971) and Smith (1980), I test whether the variance of pre-managed net income is larger than the variance of reported net income for each sample year. The results in Table 10 show that it is significantly larger. This is evidence consistent with income smoothing. Beaver et al. (2003) argue, however, that because developed reserves reflect new information there may be less uncertainty in them, which may explain the difference in variance. Nevertheless, the discontinuity around zero reported net income is strong evidence that insurers manipulate loss reserves to avoid reporting losses.

[Insert Table 12 here]

However, as argued by Beaver et al. (2003), the developed reserves reflect the new information which reduces the uncertainty involved. The distribution of pre-managed income is supposed to be less dispersed even without manipulation of loss reserves. Therefore, the evidence from comparison of dispersion of earning distributions is consistent with income smoothing hypothesis, but not very convincing.

7.1.3 Univariate Analysis of the Effects of Investment Income

In this section, using univariate analyses I investigate the preliminary evidence for the following question:

> *Do P/C insurers reserve less in years when investment income is low than in years when the investment income is high?*

To identify the income smoothing incentive provided by investment income, it is important to have the similar level of pre-managed under-writing income. If the magnitudes of the pre-managed underwriting income are not the same, it is very hard to tell if the difference in loss reserve errors is motivated by the investment income or underwriting income.

To find the years that the pre-managed underwriting income is similar, I conduct sixty-six Kolmogorov-Smirnov equality-of-distributions tests for all pairs of sample years. The Kolmogorov-Smirnov tests identified three pairs of years in which the distributions of the pre-managed underwriting income were considered equal: 1998 and 2003, 2000 and 2001, and 2005 and 2007. I further compare the sample means using t-test for two-sample means. The t-tests

suggest that the pre-managed underwriting income of 2000 is different from 2001. So two pairs of years were selected for further analysis: 1998 and 2003, and 2005 and 2007.

The two-sample mean-comparison t-tests for investment income suggest that the investment income in 1998 (mean value is 0.056) is greater than the investment income in 2003 (mean value is 0.036) at the 0.0001 level; and that the investment income in 2007 (mean value is 0.037) is greater than the investment income in 2003 (mean value is 0.033) at the 0.0001 level. Based on the income smoothing hypothesis, we expect that insurers are more likely to report income-increasing reserves (i.e. greater under-statement of loss reserves) in 2003 (or 2005) than in 1998 (or 2007).

I have tested the reserve error of all accident years (*Error*), reserve errors of prior accident years (*Error_PY*) and current accident year (*Error_CY*) for both pairs of years (1998 and 2003; 2005 and 2007), and the results are consistent[43]. Since the difference of investment income between 1998 and 2003 is greater than that of 2005 and 2007, here I only show the results for comparison of loss reserve errors in 1998 and 2003 (see Figure 21).

[Insert Figure 21 here]

As presented in Figure 21, the kernel density estimation curves of pre-managed underwriting income are similar in 1998 and 2003, however, the investment income is higher in 1998 than in

[43] The comparisons for both pairs of years all show consistent results: *Error_PY* is significantly greater in years that *InvIncome* is high (2003 and 2007) than in years that *InvIncome* is low (1998 and 2005); and *Error_CY* is higher in 1998 (and 2005) than in 2003 (and 2007).

2003. Insurers under-reserve more (over-reserve less) in 2003, this is consistent with the income smoothing hypothesis on investment income.

The last two kernel density curves of Figure 21 show that the loss reserve errors of the current accident year (*Error_CY*) is lower in 1998 than in 2003, while the loss reserve error of prior accident years (*Error_PY*) is higher in 1998 than in 2003. This is consistent with our predictions: given similar pre-managed underwriting income, when investment income is higher, insurers will over-reserve for prior accident years.

To return to the question at the beginning of this section, there are some preliminary evidences that insurers tend to report income increasing loss reserves in years when investment income is low than in years when the investment income is high. However, those results only apply to several years of observations.

Another method to control the pre-managed income while maintaining a representative sample is the added variable plots. The following steps are taken to show the relationship between investment income and loss reserve errors:

(1) Calculate the within-company means of reserve error (*Error*), pre-managed underwriting income (*UndwtIncome_PM*) and investment income (*InvIncome*), and demean the three variables within each insurer respectively, we obtain three variables *Diff_Error*, *Diff_UndwtIncomePM*, and *Diff_InvInvcome*. The demean process is helpful to remove the heterogeneity of the insures.

(2) Regress *Diff_Error* on *Diff_UndwtIncomePM*, obtain residual *Res_Error*; and regress *Diff_InvIncome* on *Diff_UndwtIncomePM*, and obtain residuals *Res_InvIncome*. So the effect of pre-managed underwriting income is controlled.

(3) Draw the binned scatter plot of *Res_Error* (vertical axis) and *Res_InvIncome* (horizontal axis): divide *Res_InvIncome* into bins of equal size, within each bin, draw the mean value of Res_Error. [44]

The binned scatter plot with control of covariates of pre-managed underwriting income is shown in Figure 22.

[Insert Figure 22 here]

The benefit of the binned scatter plot is that it can visualize the relationship between two variables when the data set is large. The plot shows that there is a positive and approximately lines relationship between loss reserve errors and investment income, while controlling for the pre-managed underwriting income.

7.2 Multivariate Model Results

Univariate analyses do not control a variety of other important factors, such as firm characteristics and other incentives to manipulate loss reserves. The results from the multivariate analysis are

[44] Binscatter is produced by STATA –binscatter-, developed by Michael Stepner (2014). It "*generates binned scatterplots, and is optimized for speed in large datasets. Binned scatterplots provide a non-parametric way of visualizing the relationship between two variables. With a large number of observations, a scatterplot that plots every data point would become too crowded to interpret visually. binscatter groups the x-axis variable into equal-sized bins, computes the mean of the x-axis and y-axis variables within each bin, then creates a scatterplot of these data points. It provides built-in options to control for covariates before plotting the relationship"*, per description of the help documents provided by author.

more reliable. This section reports the empirical results of the study based on multivariate analysis. There is evidence to support the hypothesis that insurers over-reserve more when investment income is higher, and under-reserve more if the investment income is lower. And as shown in this section, the evidence is robust to a variety of model settings.

7.2.1 Empirical Methodology

The start model is the ordinary least square (OLS) model, applying to Equation (5-1). The dependent variable is the loss reserve errors of all accident years (*Error*) and the income measures are without benchmark. White's general test (White 1980) for heteroskedasticity rejects the null hypothesis that the variances of residuals are equal (p-value<0.00001), indicating that the residuals are heteroskedastic in the OLS model. Several tests are conducted to decide if the companies are heterogeneous. The pooling F-tests for heterogeneity (based on pooled OLS and firm-fixed effects model) reject the null hypothesis that the intercepts are common for all companies (p-value<0.00001). To compare the random effects model and pooled OLS model, the Breusch and Pagan Lagrangian Multiplier (LM) test for random effects is conducted. The LM test rejects the null hypothesis that the variances across companies are zero (p-value<0.00001), indicating that the random effects model is more appropriate than the pooled OLS. Thus, the fixed effects model and the random effects model are preferred to the pooled OLS. The Hausman chi-square test rejects the null hypothesis that the difference in coefficients of the random effects model and fixed effects model is not systematic, thereby suggesting that the fixed effect model is preferred to the random effect model.

Tests suggest that the residuals are heteroskedatic across firms and auto-correlated within firms over time. The modified Wald test for firm-wise heteroskedasticity rejects the null hypothesis of homoscedasticity in the residuals of fixed effect models (p-value<0.001), which indicates that the residual is heteroskedastic across different firms. The Wooldridge F-test for autocorrelation in panel data (Wooldridge 2002; Drukker 2003) rejects the null hypothesis of no serial correlation of residuals (p-value<0.0001) indicating the existence of auto correlation of residuals.

With both heteroskedasticity and auto-correlation of the residual terms, the primary model applied by this paper is the clustered (by firm) fixed-effects model. The model calculates the Huber/White/ sandwich VCE estimator by clustering on the panel variable (firm ID) (Williams 2000; Arellano 2003; Wooldridge 2009). The Huber/White/sandwich VCE estimator is a consistent estimator when the disturbances are not identically distributed over the panels or there is serial correlation in $\varepsilon_{i,t}$ (Williams 2000; Arellano 2003; Wooldridge 2009). With the fixed effect, Equation (5-1) can be rewritten as

$$Error_{i,t} = \alpha + \delta_1 Invest_{i,t} + \delta_2 Underwrite_{i,t} + \theta Z_{i,t} + \beta X_{i,t} + \gamma YearDummies_t + u_i + \varepsilon_{i,t} \quad (7\text{-}1)$$

Where *Error* is any one of the measure of loss reserve error measures (*Error*, *Error_PY*, *and Error_CY*). *Invest* is a vector of investment income measures (*InvIncome or its* smooth measures). *Underwrit*e is vector of underwriting income measures (*UndwrtIncome_PM* or its smooth measures). Z is a vector of investment strategy (*Bond* and *CommonStock*), underwriting control variables (*Longtail*, *BusHerf*, *GeoHerf, Growth*), and firm demographics (*Size*, *Group*, *Stock*). X contains factors tested in the literature: taxes, financial weakness, rate regulation, and reinsurance

purchase. α is the average fixed-effects and u_i is the firm fixed effects intercept with restriction of $\sum u_i = 0$, and $\varepsilon_{i,t}$ is the random error.

The two-way fixed-effects model requires within-firm variation as well as cross-sectional variation. Some firm characteristics such as stock/mutual ownership may lack variation. Thirty-one firms in our sample changed firm ownership, most of them demutualized to stock companies during the early 2000s. Ninety-four firms changed their group affiliation status. The effects are still identified.[45]

The year dummies control some of the common panel invariant factors such as interest rates that influence all the companies in the same time period. The values of the macro-economy variables are commonly the same for all individual companies, so the year dummies can absorb the effects of those factors. The maximum variance inflation factor (VIF) for all independent variables is less than 5, suggesting that there is not a multicollinearity problem with our data.

7.2.2 Reported Investment Income and Loss Reserve Errors

There are two investment income measures: reported investment income (*InvIncome*) and investment income with unrealized capital gains/losses (*InvIncome_U*). I will test the effects for both alternatives. Since income smoothing is associated with reported income (*InvIncome*), I focus

[45] The results are robust to holding out *Group* and *Stock* from the model. I also conduct robustness tests using the random effects model. The random effects model suggests a significant negative relationship between *Stock* and reserve error and a weak positive relationship for *Group*.

my discussion of the results this variable. I discuss the results for the investment income with unrealized capital gains/losses (*InvIncome_U*) in Section 7.2.4.

[Insert Table 13 here]

[Insert Table 14 here]

[Insert Table 15 here]

Table 13, 12, and 13 report the results of our multivariate analysis for *Error*, *Error_PY* and *Error_CY,* respectively. In each table, the first model reports the results using the income measures without the benchmark. The second model reports the results using the temporal benchmark income smoothing measure, which is the difference between income in the current year and predicted income from the past three years. And the third table shows the results using the spatial benchmark income smoothing measure, which is the Z-score for the insurers income in the current year (the full sample of observations in the same year are used to construct the income distribution).

The empirical results offer support for our hypothesis that insurers manage loss reserves to smooth the effect of investment income on reported net income. The coefficients on the variables of interest are consistent with income smoothing effects on *Error* and *Error_CY* (Model 1 to 6 in Table 13 and Table 15). The positive effects of investment income on *Error_CY* indicates that the income smoothing effect dominants the underwriting standards effect. The underwriting standards effect is limited, may due to the inability of insurers to adjust their services within the same time period when investment income changes. But for loss reserve errors of the prior accident years

(Error_PY), only the spatial smooth measure of investment income is significant (Model 9 in Table 14).

The results in Table 13, Model 1 suggests that for every 1% increase of investment income as a percentage of total assets (*InvIncome*), the average insurer overstates results by 0.051% of total assets. In monetary terms, the average insurer inflates loss reserves by $0.39 million. Model (2), which uses the temporal benchmark, yields a similar interpretation: a 1% increase in investment income implies the average over-reserve by 0.046% of total assets ($0.36 million). This is because the demean process of fixed-effect model. However the demean process is based on the average of all available years for each company, instead of prediction of the recent years. Model (2) uses investment income with a spatial benchmark. The results indicate that if the Z-score increases by 1 (a one standard deviation increase in investment returns), insurers over-reserve by 0.18% of total assets ($1.4 million). Given the average cross-sectional standard deviation of *InvIncome* (0.024), for 1% increase of InvIncome relative to the industry average income, an average insuer will over-state loss reserves by 0.063% as a percentage of total assets, which is about $0.48 million in monetary terms. Turning underwriting income, a 1% increase in pre-managed underwriting income (*UndwtIncome_PM*) implies the average insurer will over-reserve by 0.48% as a percentage of total assets ($3.72 million in monetary terms). The pre-managed underwriting income is significant at the 0.001 level in this model. However, it is not our central interest.

Table 12 shows that there are no significant effect of the investment income on loss reserve errors for prior accident years (*Error_PY*). However, as we will see in Section 7.2.3, for mutual insurers, Error_PY is significantly associated with investment income measures. Because the errors in loss reserves of prior accident years are not influenced by the underwriting standards of the current

year, this positive correlation indicates that mutual insurers are involved in income smoothing behaviors.

Overall, the findings suggest that when the reported investment income is higher, insurers tend to over-state their loss reserves to a greater extent. The results are consistent when different benchmarks are used. When the investment income of an insurer is better than the predicted investment income from its history records, or its income level is at a higher position in the earning distributions, there are more incentives to over-reserve.

The proportion of invested assets in bonds and common stocks are negatively correlated with loss reserve errors. However, the coefficients on these variables are only significant to current year loss reserve errors. The investment strategy is not our central concern here.

For the characteristics of lines of business, more premiums written in long-tail liability lines (*Longtail*) are associated with greater over-reserving errors for *Error* and *Error_CY*. The long-tail feature of liability insurance not only increases the uncertainty in estimating the loss reserves, but also gives managers more room to practice discretion. Loss reserve errors of prior accident years (*Error_PY*) are not significantly associated with *Longtail* of the current calendar year *t*.

Both business Herfindahl index (*BusHerf*) and geographic Herfindahl index (*GeoHerf*) are positively correlated with over-reserving errors, but only the effect of geographic Herfindahl is statistically significant. This indicates that insurers that focus on certain lines of business are more professional and able to reserve more accurately, so they can mitigate the reserve errors brought by the exposure of catastrophic shocks in the concentrated lines. Insurers with higher geographic concentration tend to be more conservative and over-reserve due to the lack of diversification. For

the expanding of business (*Growth*), the model results suggest that insurers with rapid premiums growth tend to have less over-reserving errors. *Growth* is positively correlated with *Error_BY* but negatively correlated with *Error_CY*.

Insurers tend to over-reserve more when the marginal tax-rate is higher. The effect is significant when the benchmarks are considered in the investment income measure. Based on Table 13, for 1% increase of tax rate, the average insurer inflate loss reserves by about 0.039% of the total assets (approximately $0.3 million in monetary terms).

The probability of failure is positively associated with the magnitude of over-reserving, indicating that financially weak insurers over-reserve relative to strong insurers. This is likely due to their desire to strengthen their solvency status and to reduce the cost of financing by over-reserving. For every 1 percent increase in the probability of failure, the average insurer inflates loss reserves by $3.96 million. The study by Grace and Leverty find that the probability of failure is associated with less over-reserving (more under-reserving).[46] The difference between results of this research and Grace and Leverty (2012) might be caused by the different time frame of the study.[47] The results of this paper suggest that during the mid-1990s to mid-2000s, financially weak insurers are more likely to over-reserve when investment income increases than healthy insurers. This is a correct action to take and benefit the insurer in the long run.

[46] To check the robustness of the conclusion about financial weakness, I also tested the effect of the RBC ratio. The result is consistent with the results when using probability of failure. Higher RBC ratios (financially strong firms) are associated with more under-reserving.

[47] There were more failed property/casualty insurers during 1989-1997 (A.M. Best 2011). There were 351 impaired P/C insurers in the 9 years period between 1989 and 1997, but only 315 impaired P/C insurers in the 12 years period between 1996 and 2007.

There is no evidence of the influence of rate regulation on loss reserves in this research. This might be due to the mix of incentives to under-reserve to convince the regulator that the insurer can afford low rates and the incentive to over-reserve to defy the rate regulation during the sample period.

Reinsurance purchase (*Reinsurance*) is negatively correlated with the *Error_CY*, which is consistent with the predictions of Browne, Ju, and Lei (2012) and Grace and Leverty (2012). Loss reserve errors of the prior accident years are not significantly related to reinsurance ceded. A 1% increase of gross premiums ceded to a reinsurer is associated with the mean insurer under-stating reserves in the current accident year (*Error_CY*) by 0.006% of total assets, which is about $50 thousand in monetary terms.

Stock insurers incur more under-reserving errors. All else being equal, on average, the stock insurers under- reserve by 0.02% of the total assets ($0.15 million).

7.2.3 Comparison of Mutual and Stock Companies

In this section I will compare the model results for mutual and stock insurers. Managerial incentive to smooth in come varies by different ownership structures. For example, stock insurers offer stock-based compensation to managers but mutual insurers do not. Both stock insurers and mutual insurers have incentives to smooth reported income. For stock companies, Lambert (1984) shows that if both the principle (firm owners) and agent (managers) are rational then income smoothing is an optimal equilibrium behavior. For mutual insurers who lack of access to capital market, Lambert demonstrates that a risk-averse manager who cannot access the capital markets has the incentive to smooth reported income. Trueman and Titman (1988) report that in their economic

model setting, if the firm cannot borrow from capital markets, even if managers are not risk-averse, income smoothing still increases the firm's market value.

The interaction terms of Stock and hypothesized incentives are included in the model. The model results with non-benchmark income measures are shown in Table 16. The most important finding from the results is that the investment income is positively and significantly associated with loss reserve errors *(Error, Error_BY, and Error_CY*) for mutual insurers, and the effects is smaller and insignificant for stock insurers. In addition, the coefficients of investment income on loss reserve errors in all three models are about one third (Model 11) to almost the same level (Model 12) as the coefficient for underwriting income. The coefficients of the interaction between stock and investment income are negative, and almost the same as the coefficient for *InvIncome*. This indicates that mutual insurers manage loss reserves with regard to the performance of investment activities to a greater extent than stock insurers. For every 1% increase of investment income (*InvIncome*), the average mutual insurer increases its loss reserves by 0.28% of total assets ($2.14 million). The effect of *InvIncome* is significant on both *Error_BY* and *Error_CY*. For 1 percentage increase of investment income, the mean mutual insurer over-states *Error_PY* by $0.8 million and over-states *Error_CY* by $1.4 million. The effect is close to zero for stock companies. For a 1 percent increase in underwriting income as a percentage of total assets, the average mutual insurer inflates it loss reserves by 0.64% of the total assets, which is about $4.94 million in monetary terms.

While the other coefficients are largely consistent with the large sample for both mutual and stock companies, the effects of other hypothesized incentives in Model 11 differ from that of Model 12. The differences are listed as below.

(1) The tax incentive of mutual insurers is insignificant in all models in Table 16. The interaction term between *Stock* and *TaxRate is* positive and significant, which suggests that stock companies have more incentive than mutual insurers to over-state loss reserves when the tax deferral benefit increases.

(2) Probability of failure (*Prob_Fail*) has a positive effects on the over-statement of loss reserves by mutual insurers. However, the effect is smaller for stock companies, because the coefficient of interaction term between *Stock* and *Prob_Fail* is significant and negative. This suggests that weak stock insurers over-reserve to a smaller extent than mutual insurers.

(3) The effect of rate regulation is not significant for all models in Table 13, Table 14, and Table 15 and Model 10 in Table 16, but significant when we distinguish *Error_BY* and *Error_CY* from *Error*. One interesting result is that the rate regulation motivates mutual insurers to increase over-statement for loss reserves of prior accident years (*Error_BY*) but decrease the incentive to over-reserve for the current accident year (*Error_CY*). This suggests that it is possible that mutual insurers over-state reserve for prior accident years to defy the effect of rate regulation; but they under-reserve for the current accident year to signal the competence of writing business under rate regulation. The difference of the effect of rate regulation between mutual and stock insurers is significant, and the magnitude of coefficients indicates that the effect is not strong for stock insurers.

(4) The direction of the effect of reinsurance purchase is similar to that of rate regulation. The effect is not significant in the first six models and Model 10, but significant for Error_CY,

Model 11 and Model 12. Insurers tend to over-state reserves for the prior accident years, but under-state reserves for the current accident year.

To explore the effects of investment strategy and lines of business of mutual insurers and stock insurers, I further compare their reserve errors, investment strategies and lines of business they cover. I find that mutual companies and stock companies invest and reserve differently during the sample period. Mutual companies invest more in common stocks while they over-reserve more than stock companies during 1996 to 2007 (see Figure 23 and Figure 24). Before 1996, especially in the 1960s and 1970s, mutual insurers invest less in common stocks than stock insurers (see Figure1 Panel B and Panel C of Ren at el. 2011).

[Insert Figure 23 here]

[Insert Figure 24 here]

To examine the difference of mutual companies and stock companies, the interaction terms of *Stock* and investment strategy, underwriting covariates and hypothesized incentives are included in the model. While the coefficients of investment income are still significantly positive, the interaction terms between *Stock* and investment strategies, as well as the interaction term s between *Stock* and underwriting covariates are all insignificant. This indicates that the difference of the effects of investment income on loss reserve errors are not driven by either investment strategy or underwriting related risk. Since the variable *LongTail* may neglect the difference in the lines of business mix of mutual insurers and stock insurers, I divide the lines of business into four groups: the long-tail personal lines (*LongTail_Persn*, includes homeowners, farmowners, and private passenger auto liability), the long-tail commercial lines (*LongTail_Comm*, includes commercial

multiple peril, commercial auto liability, workers compensation, medical malpractice, products liability, other liability, ocean marine, aircraft, boiler and machinery, international insurance and reinsurance), the short-tail personal lines (*ShortTail_Persn*, includes private passenger auto physical damage, earthquake, and other accident and health) and short-tail commercial lines (*ShortTail_Comm*, which includes all other lines not listed in the prior three groups). The proportion of net premiums written in the first three groups, as well as their interaction terms with the Stock are included in the model. Although not presented here, the interactions are insignificant in both the two-way fixed-effects model and random-effects model, which confirms that the difference of the effect of investment income is not driven by the lines of business.

Thus, the feasible explanations of the findings for mutual and stock insurers are:

(1) Unlike stock insurers, the mutual insurers lack efficient monitoring devices ((Mayers and Smith 1988). Stock insurers are monitored by investors, rating agencies, as well as board of directors. They have less incentive to manage reserves when their investment income changes.

(2) Mutual insurers lack the access to capital market when comparing to stock insurers. Loss reserves are one important source of capital for mutual insurers. Mutuals are more likely to over-reserve in good years and free-up the reserves in bad years. The cost of capital from the reserves is much lower than the cost of external sources in capital market.

(3) The owner of the mutual insurance company is also the policyholders, thus they have larger concerns about the solvency of the company and tend to increase the level of loss reserves

when they have good income, as doing so can decrease the probability of insolvency when the performance is bad.

Due to the limitation of the data, the effects of investment income on loss reserve errors for two types of stock insurers, private and publicly traded insurers, are not examined in this paper. Given the results from mutual and stock insurers, we can expect that privately held stock insurers may behave is a similar way as mutual insurers.

7.2.4 Effect of Investment Income with Unrealized Capital Gains/Losses

Although not shown here, models of investment income with unrealized capital gains (*InvIncome_U*) do not find evidence that *InvIncome_U* is significantly associated with loss reserve errors. This is potentially because: (1) The unrealized capital gains are not part of the reported net income. (2) The investment income with unrealized capital gains (*InvIncome_U*) has critical influence on the underwriting capacity of the company, which reinforce the indirect negative effect of investment income on loss reserve errors through relaxed underwriting. (3) Realized capital gains are taxed by capital gain tax while unrealized capital gains are not, and unrealized capital gains have no impact on net income, which reduces the effect of unrealized capital gains on loss reserve errors.

7.3 Robustness

Several alternative model specifications and model methods are applied to check the consistency of the effects of investment income on loss reserve errors. Unless otherwise stated, all the covariates used in the two-way fixed effects model are included in the models of the robustness checks.

7.3.1 Investment Yield Ratio

In the models shown in Section 7.2., the investment income is scaled by total assets. Alternatively, I replace the investment income measure with the IRIS investment yield ratio and a variable which controls the size of invested assets in total asset (*SizeInvest*).

$$\text{InvestYield}_{i,t} = \frac{\text{Net Investment Income}_{i,t}}{\text{Average Invested Assets}_{i,t}} \tag{7-2}$$

Where $\text{Average Invested Assets}_{i,t} = (\text{Invested Assets}_{i,t} + \text{Invested Assets}_{i,t-1}) / 2$.

The advantage of this measure is that it reflects the profitability of investment more appropriately. This is because the non-invested assets[48] are not used to generate income and including non-invested assets in the denominator will distort the degree of profitability of investment. It also makes the investment rate of return (on invested assets) comparable with returns of financial market indices (e.g. treasury-bill rates and S&P 500 index). Our data show that on average about 85% of the total assets are invested by P/C insurers. The disadvantage of this measurement is that the comparison of investment income to underwriting income might be distorted.

$$\text{SizeInvest}_{i,t} = \text{Average Invested Assets}_{i,t} / \text{Average Total Assets}_{i,t} \tag{7-3}$$

Where $\text{Average Total Assets}_{i,t} = (\text{Total Assets}_{i,t} + \text{Total Assets}_{i,t-1}) / 2$.

[48] The non-invested assets, include but are not limited to, uncollected premiums, reinsurance recoverable from reinsurers, funds held by or deposited with reinsured companies, guaranty funds receivable or on deposit, equipment, and receivables from parents, subsidiaries and affiliates, and other receivables.

The results (see Line (1.a) of Table 17) are consistent with the results shown in Table 13, with comparable magnitude of coefficients of investment income measures.

7.3.2 Alternative Measures of Taxes

Two alternative tax measurements are used: the marginal tax rate based on the CAS study note on calculation of taxable income using SAP annual statement (*TaxRate2)*, and the tax-indicator variable (*TaxIndicator*). Both alternatives result in positive and significant coefficients for investment income measures.

For *TaxRate2,* the taxable income is calculated based on the SAP annual statements, following the steps instructed by the study notes of Casualty Actuarial Society (Feldblum 2007).[49] The calculation of taxable income includes adjustments for unearned premium reserves, loss reserve discount, tax-exempt investment income, and dividends received from unaffiliated entities.

- The tax basis premium revenue is the written premium minus 80% of the change in the unearned premium reserve. So 20% of the change in unearned premiums is taxable.

- Incurred losses are offsets to underwriting income. The tax basis incurred losses over the reporting year are paid losses plus the change in discounted loss reserves. The discount rate

[49] According to the study notes, I calculate the taxable income as:
Net Underwriting Gains
+ 0.2 * (Unearned Premium Reserves (t) – Unearned Premium Reserves (t-1))
+ 0.1 * (Loss Reserves (t) – Loss Reserves (t-1))
+ Net Investment Income Gain
− 0.85 * Tax-exempt Bond Income
− 0.595 * Dividends Received from unaffiliated entities
+ 0.9* Loss Reserve Errors (t)
More details see: Feldblum, Sholom. 2007. Computing Taxable Income for Property-Casualty Insurance Companies. CAS Study Note. http://www.casact.org/admissions/syllabus/TextReferences/index.cfm?fa=exam6US

is approximately 90% to 92%.[50] I use the 90% discount rate in this paper, then 10% of the change of loss reserves is taxable.

- 85% of the income of tax-exempt bonds is deducted from the net income, because the Tax Reform Act (1986) adds 15% of tax-exempt income to insurers' regular taxable income.

- 40.5% of dividends received from unaffiliated entities is taxable.

Because I am interested in pre-managed taxable income, I depart from the CAS procedure and add 90% of the loss reserve errors to the calculated taxable income. I then obtain the marginal tax rate based on the federal corporate income tax rates table (1994-2012) as shown in Appendix 4.

The tax indicator (*TaxIndicator*) is valued at one (high tax rate) if the pre-managed taxable income is positive, and zero if the pre-managed taxable income is zero or negative.

With the alternative measures of taxes status (see Line 1.b and 1.c of Table 17), the effect of investment income is consistent with the results of the two-way fixed-effects model.

7.3.3 Workers' Compensation

Workers' Compensation (*WComp*) is the net premiums written for workers' compensation as a percentage of total net premiums written. Although workers' compensation is a long-tail line of business, part of the loss reserves for workers' compensation is discounted to present value based

[50] Based on the study manual "Computing Taxable Income for Property-Casualty Insurance Companies by the Casualty Actuarial Society (CAS), we can estimate the taxable income of insurer using the Statutory Annual Statement. Since loss reserves are not discounted under SAP, a discount factor is applied to estimate its tax deductions. The most commonly used discount factor is 90%. So if the insurer over-reserves $100, it will decrease the taxable income by $90.

on tabulated discount.[51] The initial loss reserves for workers' compensation is therefore lower than the future payments (Petroni, Ryan, and Wahlen 2000; Beaver, McNichols, and Nelson 2003). Because of this, our sample excludes insurers with more than 25% of their premiums in workers' compensation. We can expect that there are more under-statement of loss reserves when the proportion of net premiums written on workers' compensation increases.

Due to the screening for workers' compensation and the fact that workers' compensation is commonly under stringent regulation by state regulators, the effects of investment income in sub-samples for insurers that write no more than 10% of net premiums in workers' compensation and sub-sample for insurers that write no positive net premiums in workers' compensation are tested.

Line 1.d.1 and 1.d.2 of Table 17 presents the results. For sample insurers with lower proportion of premiums in workers' compensation, the effect of investment income is more significant and the magnitude of the effect is greater.

7.3.4 Sub-Sample by Business in Short-Tail lines

For insurers who write more business in short-tail lines, there is less room to exercise discretion because more than 90% of the losses of short-tailed lines (the property lines) are paid within the first two years (as a results, statutory annual statement only requires insurers to report the run-off of losses of the recent two accident/calendar years). Consistent with the expectation, the investment income is not significant for the sub-sample with higher proportion of premiums written in short-tail lines in the two-way fixed effects model (Line (1.g.1) and (1.g.2) in Table 17).

[51] "The tabular reserve discounts are permitted on the indemnity portion of workers' compensation long term disability claims (pension cases) and on long term disability claims from accident and health insurance policies." (CAS 2011).

Although not shown here, the effects for the sub-sample of observations with no more than 25% premiums in short-tail lines is significant with p-values of 0.04 to 0.06 in the random-effects model.

7.3.5 Long-Tail/Short-Tail and Commercial/Personal Business

Models in Table 13 used the business in extra-long-tail lines to control the effects of lines of business. In this sub-section, I include the proportion of premiums in the three categories of business as discussed in Section 7.2.3: long-tail personal lines (LongTail_Persn), long-tail commercial lines (LongTail_Comm), and short-tail personal lines (ShortTail_Persn), as well as the interaction between the ownership indicator Stock and the three variables, all other independent variables are the same as in Table 13.

Line (1.f) in Table 17 shows that the effects of investment income are still significant and consistent with other models in magnitudes of the coefficients.

7.3.6 Sub-sample of 1996-2001 and 2002-2007

Considering the difference the trend of underwriting cycle before and after 2001, the two-way fixed effects model is applied to different sub-sample panels: 1996 to 2001 and 2002 to 2007. As shown in Figure 16, Figure 17 and **Figure** 18, the overall underwriting profitability of the P/C industry has a decreasing trend from 1996 to 2001 and an increasing trend from 2002 to 2007. In 2001, the market turned from a soft market to a hard market.

The results are displayed on Line (1.g.1) to (1.g.4) of Table 17. The investment income is significant and positively associated with loss reserve errors during 1996 to 2001, but the overall effect is not significant during the period of 2002 to 2007. However, as we have learned from the

comparison of mutual insurers and stock insurers, the effect of investment income on loss reserves is not significant for stock insurers. An examination of the mutual insurers shows that the effect is still significant in both sub-periods.

7.3.7 Other Model Estimation Methods

Other models besides the fixed-effects model are adopted to check the effects of investment income. These methods include the robust least squares (robust OLS),[52] the random effects model, multilevel mixed effects model and the dynamic model (Arellano–Bond model). As shown in Table 17, the coefficients investment income and its alternatives are positive and significant in almost all model settings.

The multilevel mixed effects model has the advantage of detecting the effects of group affiliation. The highest level is financial group level, the second level is the unique firms, and the first level is the firm-year observations.

The dynamic model is also a suitable method due to the dynamics of loss reserve errors over time. Both the first and second lag terms are included in the model. Due to the concern of endogeneity of pre-managed underwriting income, the first and second lagged terms of underwriting income are used as instruments. The details of the model results are presented in Table 18. Both the first and second lag terms of loss reserve errors ($Error_{t-1}$ and $Error_{t-2}$) are significantly associated

[52] The robust standard error is calculated based on the HC3 heteroscedasticity consistent covariance matrix estimator by Davidson and MacKinnon (1993): $\hat{\sigma}_j = \sqrt{u_j^2 / (1-h_{j,j})^2}$, where u_j is the calculated residual for the jth observation; $h_{j,j}$ is the diagonal element of the hat (projection) matrix: $h_{j,j} = x_j (X'X) x_j^{'}$. The (HC3) estimator is reported to produce better results when the model is heteroskedastic (Davidson and MacKinnon 1993).

with the dependent variable $Error_t$, while the correlation is positive for $Error_{t-1}$ and negative for $Error_{t-2}$. The effects of investment income are consistent with other models, with slightly higher magnitude and improved significance. There are two noticeable changes when comparing the dynamic model with the fixed-effects model. Under the dynamic context, the effect of reinsurance is negative and significant, but the effect of *Stock* disappears. The significant negative effect of reinsurance purchase in the dynamic model indicates that insurers have less incentive to over-reserve when they can use reinsurance as a source of capital. The insignificant effect of *Stock* in the dynamic model indicates the difference of mutual and stock insurers may be due to the temporal smoothing.

Chapter 8 Conclusions

In this paper, I have investigated whether or not P/C insurers manage their loss reserves to smooth the fluctuations of reported income brought by investment income. The relationship between the two variables depends on the positive direct effects of income smoothing incentive and the negative indirect effects of common factors that influences both variables (interest rates, unexpected inflation, underwriting capacity and underwriting standards).

I find a significant positive relationship between loss reserve errors and different measures of investment income while controlling for pre-managed underwriting income, business characteristics associated with reserve accuracy, and other hypothesized incentives for managerial discretion over reserves (taxes, financial weakness, rate regulation and insurance purchase). The results show insurers increase loss reserves when investment income is high, which is evidence consistent with the income smoothing hypothesis. The effects of investment income on loss reserve errors are relatively smaller than that of the underwriting income in monetary terms. A further exploration of mutual and stock insurers reveals that mutual insurers practice more investment income smoothing than stock insurers in my sample covering the period from1996 to 2007.

As suggested by the model results, 1% increase of investment income (which is $7.7 million for an average insurer) is associated with $0.4 million over-statement of loss reserves. For mutual insurers, 1% increase of investment income as a percentage of total assets is associated with $2.1 million inflation of the loss reserves. The economic magnitude of the influence lies in the influence to the pre-tax income of the insurers. The average pre-income tax income for an average insurer is $33 million ($21.8 million for mutual insurers and $37 million for stock insurers). The effects of

investment income are significant for mutuals at the 0.01 level, but not significant for stock insurers. And for an average mutual insurer, $2.1 million is about 10% of its pre-tax net income, the impact is not economically small, at least for mutual insurers.

The investment income is the result of both investment strategies and returns of financial markets. In the insurance industry, while the investment strategy is relatively stable over time, the shocks to investment income are largely exogenous. The unexpected investment income will trigger the income smoothing behavior: managers may exercise discretion over loss reserves to stabilize the overall net income reported on the financial statement.

This study also suggests that the negative indirect effect of investment income of the past three years may not reflect income smoothing. Many authors in the literature use the income smoothing measure proposed by Grace (1990). Most of them find a negative relationship between the loss reserve errors and the smooth measure (the average reported underwriting income of the past three years) and interpret it as evidence of income smoothing. However, this relationship can be explained by the indirect effects of underwriting capacity as well. With higher investment income, insurers are able to reduce their premium rates or relax their underwriting standards. If the reserve procedure fails to count for the adverse development of incurred loss due to the deteriorated risk of the insured, the outstanding losses will be under-estimated (Weiss 1985).[53] This may prevent us from detecting the income smoothing. This paper finds that investment income in calendar year *t* is positively associated with *Error_CY*, indicating the negative effect of investment income through the linkage of underwriting standards is dominated by the income smoothing effect. The

[53] In the alternative model, I also find that prior 3 years' average net income is negatively and significantly correlated with loss reserve errors, which is consistent with the result found by Grace (1990).

effect of investment income on *Error_PY* is significance for mutual insurers, which is a strong evidence of income smoothing. As the indirect underwriting standards effect will not influence the loss reserve errors of the prior accident years, the positive relationship between the investment income of current year and loss reserve errors of prior accident years for mutual insurers supports the income smoothing hypothesis.

Moreover, the model results suggest that the income smoothing incentive is related to the investment income reported on statutory financial statement (*InvIncome*) rather than the investment income with unrealized capital gains (*InvIncome_U*). The investment income with unrealized capital gains is different from the reported investment income: it is not taxable until realized, and it is not included in the reported income but recognized in the surplus. Therefore the investment income with unrealized capital gains is more likely to be associated with the underwriting capacity than the reported investment income.

This study contributes to a better understanding of loss reserve management and income smoothing of property/casualty insurance companies. One implication of this study is that if insurers manage reserves to smooth income, posted loss reserves are also a function of their investment performance. Another implication is that if loss reserve is used as a smoothing tool, the smoothing target is the overall income, rather than merely the underwriting income.

This study also finds consistent evidence to support the hypotheses of tax deferral incentive (*TaxRate*) and reinsurance purchase (*Reinsurance*). The literature finds them under-reserve to mask their financial problems. However, the results of this paper suggest that financially weak insurers are more likely to over-state their loss reserves compared to insurers with a lower

probability of failure. This implies that financially weak insurers may use over-reserving to strengthen the financial condition of the firm in the long run. The paper does not find significant effect of rate regulation for stock companies.

Further study is desired to explore the possibility and magnitude of income smoothing through the realization of capital gains, as insurers have the flexibility to allocate the investment gains/losses into either realized capital gains/losses or unrealized capital gains/losses.[54] Unrealized capital gains can be another tool of income smoothing. It also possible that insurers will choose to realize the capital gains when the profitability is low and choose to delay the realization of capital gains when the profitability is good. This area is not well documented in the literature.

[54] Gaver and Paterson (1999) find a weak evidence that capital gains are timed to achieve tax relief by P/C insures.

Bibliography

Achleitner, Paul M., Jorg H. Biebel, and Daniel Wichels. 2002. Does WTC Matter for the Investment Policy of P/C Insurance Companies? *Geneva Papers on Risk & Insurance - Issues & Practice* 27 (2):275.

Ahlgrim, Kevin C., Stephen P. D'Arcy, and Richard W. Gorvett. 2004. The Effective Duration and Convexity of Liabilities for Property-Liability Insurers Under Stochastic Interest Rates. *GENEVA Papers on Risk & Insurance Theory* 29 (1):75-108.

Anderson, Dan R. 1971. Effects of under and Overevaluations in Loss Reserves. *The Journal of Risk and Insurance* 38 (4):585-600.

Ansley, Craig F. 1979. Automobile Liability Insurance Reserve Adequacy and the Effect of Inflation. *CPCU Journal* 31:105-112.

Arellano, Manuel. 2003. *Panel Data Econometrics*. Oxford: Oxford University Press.

Badrinath, S. G., Gerald D. Gay, and Jayant R. Kale. 1989. Patterns of Institutional Investment, Prudence, and the Managerial "Safety-Net" Hypothesis. *The Journal of Risk and Insurance* 56 (4):605-629.

Balcarek, Rafal J. . 1975. Loss Reserve Deficiencies and Underwriting Results. *Best's Review-Property Casualty* 76:21-22.

Barefield, Russell M., and Eugene E. Comiskey. 1972. The Smoothing Hypothesis: An Alternative Test. *The Accounting Review* 47 (2):291-298.

Bartholomew, D. J. 1975. Errors of Prediction for Markov Chain Models. *Journal of the Royal Statistical Society. Series B (Methodological)* 37 (3):444-456.

Beatty, Anne, Sandra L. Chamberlain, and Joseph Magliolo. 1995. Managing Financial Reports of Commercial Banks: The Influence of Taxes, Regulatory Capital, and Earnings. *Journal of Accounting Research* 33 (2):231-261.

Beaver, William H., and Maureen F. McNichols. 1998. The Characteristics and Valuation of Loss Reserves of Property Casualty Insurers. *Review of Accounting Studies* 3 (1):73-95.

Beaver, William H., Maureen F. McNichols, and Karen K. Nelson. 2003. Management of the loss reserve accrual and the distribution of earnings in the property-casualty insurance industry. *Journal of Accounting and Economics* 35 (3):347-376.

Berquist, James R., and Richard E. Sherman. 1977. Loss Reserve Adequacy Testing: A Comprehensive Systematic Approach. *PCAS* LXVII:123-184.

Bhushan, Ravi. 1989. Firm characteristics and analyst following. *Journal of Accounting and Economics* 11 (2-3):255-274.

Bradford, David F., and Kyle D. Logue. 1999. The Influence of Income Tax Rules on Insurance Reserves. In *The Financing of Catastrophe Risk*, edited by K. A. Froot. Chicago: University of Chicago Press.

Brav, Alon, John R. Graham, Campbell R. Harvey, and Roni Michaely. 2005. Payout policy in the 21st century. *Journal of Financial Economics* 77 (3):483-527.

Brown, Robert L. 1994. Variability of Loss Reserves. In *Variability in Reserves Prize Program Papers*.

Browne, Mark J., Lan Ju, and Yu Lei. 2012. Reinsurance Purchases, Contingent Commission Payments and Insurer Reserve Estimation. *The Geneva Papers on Risk and Insurance - Issues and Practice* 37 (3):452-466.

Browne, Mark J., Yu-Luen Ma, and Ping Wang. 2009. Stock-Based Executive Compensation and Reserve Errors in the Property and Casualty Insurance Industry. *Journal of Insurance Regulation* 27 (4):35-54.

CAS. 1989. A Study of the Effects of Asset/Liability Mismatch on Property/Casualty Insurance Companies. *Financial Analysis Committee, Casualty Actuarial Society*.

CAS. 2002. Interest Rate Risk An Evaluation of Duration Matching as a Risk-Minimizing Strategy for Property-Casualty Insurers. *Casualty Actuarial Society Forum* Summer (Valuation, Finance and Investments Committee (VFIC)):135-168.

CAS. 2013. *Financial Reporting Through the Lens of a Property/Casualty Actuary*: Casualty Actuarial Society.

Caswell, Jerry W., and Steve C. Goodfellow. 1976. Effect of Including Investment Income in Ratemaking upon Profitability of Non-Life Insurers. *The Journal of Risk and Insurance* 43 (2):305-315.

Chen, Peter, and Lane Daley. 1996. Regulatory Capital, Tax, and Earnings Management Effects on Loan Loss Accruals in the Canadian Banking Industry*. *Contemporary Accounting Research* 13 (1):91-128.

Choi, Seungmook, Hardigree Don, and Paul D. Thistle. 2002. The Property/Liability Insurance Cycle: A Comparison of Alternative Models. *Southern Economic Journal* 68 (3):530-548.

Cooper, R.W. 1974. *Investment return and property-liability insurance ratemaking*: Published for the S. S. Huebner Foundation for Insurance Education by R. D. Irwin.

Copeland, Ronald M. 1968. Income Smoothing. *Journal of Accounting Research* 6:101-116.

Copeland, Ronald M., and Ralph D. Licastro. 1968. A Note on Income Smoothing. *The Accounting Review* 43 (3):540-545.

Cummins, J. David , and David W. Sommer. 1996. Capital and risk in property-liability insurance markets. *Journal of Banking & Finance* 20 (6):1069-1092.

Cummins, J. David, and Elizabeth Grace. 1994. Tax management and investment strategies of property-liability insurers. *Journal of Banking & Finance* 18 (1):43-72.

Cummins, J. David, Martin F. Grace, and Richard D. Phillips. 1999. Regulatory Solvency Prediction in Property-Liability Insurance: Risk-Based Capital, Audit Ratios, and Cash Flow Simulation. *The Journal of Risk and Insurance* 66 (3):417-458.

Dascher, Paul E., and Robert E. Malcom. 1970. A Note on Income Smoothing in the Chemical Industry. *Journal of Accounting Research* 8 (2):253-259.

Davidson, Russell , and James G. MacKinnon. 1993. *Estimation and Inference in Econometrics*: Oxford University Press.

Dicksee, L.R. 1895. Profits available for dividend. In *Four lectures delivered to the Institute of chartered accountants in England & Wales during the years 1894 and 1895*. London: Gee and Co.

Dicksee, L.R. 1903. *Depreciation, Reserves, and Reserve Funds*: Arno Press.

Doherty, Neil A., and James R. Garven. 1995. Insurance Cycles: Interest Rates and the Capacity Constraint Model. *The Journal of Business* 68 (3):383-404.

Drukker, David M. 2003. Testing for serial correlation in linear panel-data models. *Stata Journal* 3 (2):168-177.

Eckles, David L., and Martin Halek. 2010. Insurer Reserve Error and Executive Compensation. *Journal of Risk and Insurance* 77 (2):329-346.

Feldblum, Sholom. 2007. Computing Taxable Income for Property-Casualty Insurance Companies. *CAS Study Note*.

Flanigan, George B. 1974. Investment Income in Rate-Making and Managerial Investment Attitudes. *The Journal of Risk and Insurance* 41 (2):229-237.

Forbes, Stephen W. 1969. Automobile Bodily Injury Liability Loss Reserving Techniques and Simulation. *The Journal of Risk and Insurance* 36 (5):597-614.

Forbes, Stephen W. 1970. Loss Reserving Performance within the Regulatory Framework. *The Journal of Risk and Insurance* 37 (4):527-538.

Friedland, Jacqueline. 2010. *Estimating Unpaid Claims Using Basic Techniques, Version 3*: Casualty Actuarial Society.

Froot, Kenneth A., David S. Scharfstein, and Jeremy C. Stein. 1993. Risk Management: Coordinating Corporate Investment and Financing Policies. *The Journal of Finance* 48 (5):1629-1658.

Fudenberg, Drew, and Jean Tirole. 1995. A Theory of Income and Dividend Smoothing Based on Incumbency Rents. *Journal of Political Economy* 103 (1):75-93.

Gaver, Jennifer J., and Jeffrey S. Paterson. 1999. Managing Insurance Company Financial Statements to Meet Regulatory and Tax Reporting Goals. *Contemporary Accounting Research* 16 (2):207-241.

Gaver, Jennifer J., and Jeffrey S. Paterson. 2001. The Association between External Monitoring and Earnings Management in the Property-Casualty Insurance Industry. *Journal of Accounting Research* 39 (2):269-282.

Gaver, Jennifer J., and Jeffrey S. Paterson. 2004. Do insurers manipulate loss reserves to mask solvency problems? *Journal of Accounting and Economics* 37 (3):393-416.

Geczy, Christopher, Bernadette A. Minton, and Catherine Schrand. 1997. Why Firms Use Currency Derivatives. *The Journal of Finance* 52 (4):1323-1354.

Grace, Elizabeth V. 1990. Property-Liability Insurer Reserve Errors: A Theoretical and Empirical Analysis. *The Journal of Risk and Insurance* 57 (1):28-46.

Grace, Martin F., and J. Tyler Leverty. 2010. Political Cost Incentives for Managing the Property-Liability Insurer Loss Reserve. *Journal of Accounting Research* 48 (1):21-49.

Grace, Martin F., and J. Tyler Leverty. 2011. Full Information Reserve Errors and Their Relation to Auditor and Actuary Quality. In *ARIA 2011 Anual Meeting*. San Diego, CA.

Grace, Martin F., and J. Tyler Leverty. 2012. Property–Liability Insurer Reserve Error: Motive, Manipulation, or Mistake. *Journal of Risk and Insurance* 79 (2):351-380.

Graham, John R., Campbell R. Harvey, and Shiva Rajgopal. 2005. The economic implications of corporate financial reporting. *Journal of Accounting and Economics* 40 (1-3):3-73.

Gron, Anne. 1994. Capacity Constraints and Cycles in Property-Casualty Insurance Markets. *The RAND Journal of Economics* 25 (1):110-127.

Haley, Joseph D. 1993. A Cointegration Analysis of the Relationship between Underwriting Margins and Interest Rates: 1930-1989. *The Journal of Risk and Insurance* 60 (3):480-493.

Haley, Joseph D. 2007. Further Considerations of Underwriting Margins, Interest Rates, Stability, Stationarity, Cointegration, and Time Trends. *Journal of Insurance Issues* 30 (1):62-75.

Hammond, J. D., E. R. Melander, and N. Shilling. 1976. Risk, Return, and the Capital Market: The Insurer Case. *The Journal of Financial and Quantitative Analysis* 11 (1):115-131.

Harrington, Scott E., and Patricia M. Danzon. 1994. Price Cutting in Liability Insurance Markets. *The Journal of Business* 67 (4):511-538.

He, Enya, and David W. Sommer. 2010. Separation of Ownership and Control: Implications for Board Composition. *The Journal of Risk and Insurance* 77 (2):265-295.

Hepworth, S.R. . 1953. Periodic income smoothing. *The Accounting Review* 28 (1):32-39.

Holmberg, Randall D. . 1994. Correlation and the measurement of loss reserve variability. *CAS Forum Spring*:247 - 278.

Hoyt, Robert E., and Kathleen A. McCullough. 2010. Managerial Discretion and the Impact of Risk-Based Capital Requirements on Property-Liability Insurer Reserving Practices. *Journal of Insurance Regulation* 28 (2):207-228.

Jones, Jennifer J. 1991. Earnings Management During Import Relief Investigations. *Journal of Accounting Research* 29 (2):193-228.

Kazenski, Paul M., William R. Feldhaus, and Howard C. Schneider. 1992. Empirical Evidence for Alternative Loss Development Horizons and the Measurement of Reserve Error. *The Journal of Risk and Insurance* 59 (4):668-681.

Koch, Bruce S. 1981. Income Smoothing: An Experiment. *The Accounting Review* 56 (3):574-586.

Lambert, Richard A. 1984. Income Smoothing as Rational Equilibrium Behavior. *The Accounting Review* 59 (4):604-618.

Lang, Mark H., Karl V. Lins, and Darius P. Miller. 2003. ADRs, Analysts, and Accuracy: Does Cross Listing in the United States Improve a Firm's Information Environment and Increase Market Value? *Journal of Accounting Research* 41 (2):317-345.

Lee, Soon-Jae, David Mayers, and Clifford W. Smith Jr. 1997. Guaranty funds and risk-taking evidence from the insurance industry. *Journal of Financial Economics* 44 (1):3-24.

Lessard, Donald R. 1991. GLOBAL COMPETITION AND CORPORATE FINANCE IN THE 1990s. *Journal of Applied Corporate Finance* 3 (4):59-72.

Lin, Wen-chang, and Yi-hsun Lai. 2008. Equity-based Compensation, Corporate Governance and Loss Reserve Management of Property-Liability Insurers. Paper read at American Risk and Insurance Association Annual Meeting, at Portland, Oregon.

Liu, Chi-Chun, and Stephen G. Ryan. 2006. Income Smoothing over the Business Cycle: Changes in Banks' Coordinated Management of Provisions for Loan Losses and Loan Charge-Offs from the Pre-1990 Bust to the 1990s Boom. *The Accounting Review* 81 (2):421-441.

Lowe, Stephen P. , and Stephen W. Philbrick. 1986. Issues Associated with the Discounting of Property/Casualty Loss Reserves. *Journal of Insurance Regulation* 4 (4):72 - 102.

Matheson, E. 1893. *The Depreciation of Factories, Mines, and Industrial Undertakings and Their Valuation*, *History of Accounting*: Arno Press.

Mayers, David, and Clifford W. Smith, Jr. 1988. Ownership Structure across Lines of Property-Casualty Insurance. *Journal of Law and Economics* 31 (2):351-378.

Miller, Alan J. 1984. Selection of Subsets of Regression Variables. *Journal of the Royal Statistical Society. Series A (General)* 147 (3):389-425.

Minton, Bernadette A., and Catherine Schrand. 1999. The impact of cash flow volatility on discretionary investment and the costs of debt and equity financing. *Journal of Financial Economics* 54 (3):423-460.

Myers, Stewart C., and Nicholas S. Majluf. 1984. Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics* 13 (2):187-221.

Nelson, Karen K. 2000. Rate Regulation, Competition, and Loss Reserve Discounting by Property-Casualty Insurers. *The Accounting Review* 75 (1):115-138.

Pentikainen, Teivo, H. Bonsdorff, and M. Pesonen. 1989. *Insurance Solvency and Financial Strength*: Finnish Insurance Training and Pub Company, Helsinki.

Pentikainen, Teivo, and Jukka Rantala. 1992. A Simulation Procedure for Comparing Different Claims Reserving Method. *ASTIN Bulletin International Actuarial Association - Brussels, Belgium* 22 (2):191-216.

Petroni, Kathy, and Mark Beasley. 1996. Errors in Accounting Estimates and Their Relation to Audit Firm Type. *Journal of Accounting Research* 34 (1):151-171.

Petroni, Kathy R., Stephen G. Ryan, and James M. Wahlen. 2000. Discretionary and Non-Discretionary Revisions of Loss Reserves by Property-Casualty Insurers: Differential Implications for Future Profitability, Risk and Market Value. *Review of Accounting Studies* 5 (2):95-125.

Petroni, Kathy Ruby. 1992. Optimistic reporting in the property- casualty insurance industry. *Journal of Accounting and Economics* 15 (4):485-508.

Ren, Yayuan, Qixiang Sun, Zhenzhen Sun, and Tong Yu. 2011. Do Underwriting Cycles Affect Property/Casualty Insurer Investment Risk-taking? *Journal of Insurance Regulation* 30.

René M, Stulz. 1990. Managerial discretion and optimal financing policies. *Journal of Financial Economics* 26 (1):3-27.

Ronen, Joshua, and Simcha Sadan. 1981. *Smoothing Income Numbers: Objectives, Means and Implications*: Addison-Wesley Educational Publishers Inc.

Rountree, Brian, James P. Weston, and George Allayannis. 2008. Do investors value smooth performance? *Journal of Financial Economics* 90 (3):237-251.

Scholes, Myron S. , G. Peter Wilson, and Mark A. Wolfson. 1990. Tax Planning, Regulatory Capital Planning, and Financial Reporting Strategy for Commercial Banks. *The Review of Financial Studies* 3 (4):625-650.

Shapiro, Alan C., and Sheridan Titman. 1985. An integrated approach to corporate risk management. *Midland Corporate Finance Journal* 3 (2):41 - 56.

Shuto, Akinobu. 2007. Executive compensation and earnings management: Empirical evidence from Japan. *Journal of International Accounting, Auditing and Taxation* 16 (1):1-26.

Simpson, Richard H. 1969. An Empirical Study of Possible Income Manipulation. *The Accounting Review* 44 (4):806-817.

Smith, Barry D. 1980. An Analysis of Auto Liability Loss Reserves and Underwriting Results. *The Journal of Risk and Insurance* 47 (2):305-320.

Titman, Sheridan. 1984. The effect of capital structure on a firm's liquidation decision. *Journal of Financial Economics* 13 (1):137-151.

Watts, Ross L., and Jerold L. Zimmerman. 1978. Towards a Positive Theory of the Determination of Accounting Standards. *The Accounting Review* 53 (1):112-134.

Weil, R.L., and S. Davidson. 1994. *Accounting: The Language of Business*. 9 ed: T. Horton and Daughters.

Weiss, Mary. 1985. A Multivariate Analysis of Loss Reserving Estimates in Property-Liability Insurers. *The Journal of Risk and Insurance* 52 (2):199-221.

White, Gary E. 1970. Discretionary Accounting Decisions and Income Normalization. *Journal of Accounting Research* 8 (2):260-273.

White, Halbert. 1980. A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica* 48 (4):817-838.

Williams, Rick L. 2000. A Note on Robust Variance Estimation for Cluster-Correlated Data. *Biometrics* 56 (2):645-646.

Wooldridge, J. M. 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.

Wooldridge, Jeffrey M. . 2009. *Introductory Econometrics: A Modern Approach, Fourth Edition*. Cincinnati, OH: South-Western.

Zou, Hong, Min-Ming Wen, Charles Yang, and Mulong Wang. 2012. Underwriting and investment risks in the property-liability insurance industry: evidence prior to the 9-11 event. *Review of Quantitative Finance & Accounting* 38 (1):25-46.

Appendix

Appendix 1: NAIC Property/Casualty Statement Schedule P Part 2 and Part 3

Excerpt from the 2005 Annual Statement of the All State Insurance Company (NAIC Code 19232)

SCHEDULE P - PART 2 - SUMMARY

Years in Which Losses Were Incurred	INCURRED NET LOSSES AND DEFENSE AND COST CONTAINMENT EXPENSES REPORTED AT YEAR END ($000 OMITTED)										DEVELOPMENT	
	1	2	3	4	5	6	7	8	9	10	11	12
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	One Year	Two Year
1. Prior	9,007,699	8,451,168	8,153,179	8,045,357	7,935,080	7,917,663	8,154,942	8,748,097	9,380,776	9,661,834	281,058	913,737
2. 1996	12,930,430	12,832,227	12,543,818	12,375,958	12,288,849	12,289,713	12,303,277	12,311,452	12,315,726	12,319,400	3,674	7,948
3. 1997	XXX	11,881,098	11,591,006	11,433,961	11,348,172	11,351,311	11,356,016	11,367,494	11,350,884	11,355,010	4,126	(12,484)
4. 1998	XXX	XXX	11,946,010	11,866,938	11,803,522	11,764,534	11,779,668	11,805,978	11,770,072	11,748,167	(21,905)	(57,811)
5. 1999	XXX	XXX	XXX	12,509,371	12,476,870	12,469,222	12,508,156	12,510,396	12,467,204	12,467,258	54	(43,138)
6. 2000	XXX	XXX	XXX	XXX	14,061,797	14,496,116	14,591,047	14,587,441	14,514,281	14,500,088	(14,193)	(87,353)
7. 2001	XXX	XXX	XXX	XXX	XXX	14,097,696	14,445,693	14,433,905	14,339,958	14,329,885	(10,073)	(104,020)
8. 2002	XXX	XXX	XXX	XXX	XXX	XXX	13,641,857	13,499,599	13,329,105	13,276,962	(52,143)	(222,637)
9. 2003	XXX	XXX	XXX	XXX	XXX	XXX	XXX	13,523,155	13,080,280	12,894,498	(185,782)	(628,657)
10. 2004	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	13,199,732	12,776,860	(422,872)	XXX
11. 2005	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	16,993,357	XXX	XXX
										12. Totals	(418,056)	(234,415)

SCHEDULE P - PART 3 - SUMMARY

Years in Which Losses Were Incurred	CUMULATIVE PAID NET LOSSES AND DEFENSE AND COST CONTAINMENT EXPENSES REPORTED AT YEAR END ($000 OMITTED)										11	12
	1	2	3	4	5	6	7	8	9	10	Number of Claims Closed With Loss Payment	Number of Claims Closed Without Loss Payment
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005		
1. Prior	000	2,190,983	3,774,575	4,725,671	5,511,803	6,008,062	6,498,083	6,746,519	6,972,904	7,310,807	XXX	XXX
2. 1996	7,611,314	9,876,324	10,799,446	11,472,722	11,836,844	12,066,165	12,189,825	12,235,589	12,265,289	12,282,059	XXX	XXX
3. 1997	XXX	6,744,129	8,920,109	9,879,259	10,523,412	10,925,433	11,144,905	11,231,382	11,281,573	11,308,342	XXX	XXX
4. 1998	XXX	XXX	7,107,859	9,429,360	10,368,865	10,992,437	11,388,065	11,562,087	11,645,350	11,685,172	XXX	XXX
5. 1999	XXX	XXX	XXX	7,762,331	10,216,301	11,172,895	11,763,108	12,094,046	12,265,431	12,337,857	XXX	XXX
6. 2000	XXX	XXX	XXX	XXX	8,974,493	12,072,615	13,151,948	13,761,081	14,103,850	14,262,186	XXX	XXX
7. 2001	XXX	XXX	XXX	XXX	XXX	8,912,523	11,989,415	13,028,657	13,608,008	13,931,626	XXX	XXX
8. 2002	XXX	XXX	XXX	XXX	XXX	XXX	8,306,746	11,027,292	11,989,661	12,550,771	XXX	XXX
9. 2003	XXX	XXX	XXX	XXX	XXX	XXX	XXX	8,040,984	10,652,731	11,564,391	XXX	XXX
10. 2004	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	7,722,449	10,308,811	XXX	XXX
11. 2005	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	9,736,934	XXX	XXX

$Error_{2000}$ = (Part 2 Line 5: Rows 1 to 6) - (Part 2 Line 10: Rows 1 to 6) Part 2

$Error\_PY_{2000}$ = (Part 2 Line 5: Rows 1 to 5) - (Part 2 Line 10: Rows 1 to 5)

$Error\_CY_{2000}$ = (Part 2 Line 5: Row 6) - (Part 2 Line 10: Row 6)

Appendix 2: NAIC SVO Designation

Credit Category[55]	Description
NAIC 1 (Highest Quality)	Interest, principal or both will be paid in accordance with the contractual agreement and that repayment of principal is well protected.
NAIC 2 (High Quality)	For the present, the obligation's protective elements suggest a high likelihood that interest, principal or both will be paid in accordance with the contractual agreement, but there are suggestions that an adverse change in circumstances or economic, financial or business conditions will affect the degree of protection and lead to a weakened capacity to pay.
NAIC 3 (Medium Quality)	The likelihood that interest, principal or both will be paid in accordance with the contractual agreement is reasonable for the present, but an exposure to an adverse change in circumstances or economic, financial or business conditions would create an uncertainty about the issuer's capacity to make timely payments.
NAIC 4 (Low Quality)	The likelihood that interest, principal or both will be paid in accordance with the contractual agreement is low and that an adverse change in circumstances or business, financial or economic conditions would accelerate credit risk, leading to a significant impairment in the issuer's capacity to make timely payments.
NAIC 5 (Lower Quality)	The likelihood that interest, principal or both will be paid in accordance with the contractual agreement is significantly impaired given any adverse business, financial or economic conditions.
NAIC 6 (In or near default)	Payment of interest, principal or both is not being made, or will not be made, in accordance with the contractual agreement.

Source: NAIC Securities Valuations Office (SVO).

[55] Details see "NAIC Designation", link: http://www.naic.org/documents/svo_naic_public_listing.pdf

Appendix 3: Examples of Investment Limitations Proposed by NAIC

A. From NAIC Defined Standards Version of Investment of Insurers Model Act (1998)

Type of Investment	Limitations
Bonds or Debt-like Preferred Stock	• The aggregate amount of medium and lower grade investments, ≤20% of admitted assets; • The aggregate amount of lower grade investments, 10% of admitted assets; • The aggregate amount of investments rated 5 or 6 by the SVO, ≤5% of admitted assets; • The aggregate amount of investments rated 6 by the SVO, ≤1% of admitted assets; or • The aggregate amount of medium and lower grade investments that receive as cash income less than the equivalent yield for Treasury issues with a comparative average life, ≤1% of admitted assets; • Bonds or other evidences of indebtedness of international development organizations of which the United States is a member, ≤1% of admitted assets.
Loans	• Loans secured by mortgages, trust deeds, or other security interests in real property located in the United States or Canada or secured by insurance against default issued by a government insurance corporation of the United States or Canada or by an insurer authorized to do business in this state, ≤25% of admitted assets.
Common Stock or Equity-like Preferred Stock	• ≤25% of admitted assets.
Real Estate	• Real property necessary for the convenient transaction of the insurer's business: ≤10% of admitted assets; • Real property, together with the fixtures, furniture, furnishings and equipment pertaining thereto in the United States or Canada, which produces or after suitable improvement can reasonably be expected to produce substantial income: ≤10% of admitted assets.
Other	• Loans, securities, or other investments in countries other than the United States and Canada, ≤20% of admitted assets.

Source: NAIC Investment of Insurers Model Act-Defined Standards Version, April 1998.

Appendix 3 (Continue): Examples of Investment Limitations Proposed by NAIC

B. From NAIC Defined Limits Version of Investment of Insurers Model Act (1996)[56]

Type of Investment	Limitations
Bonds	• The aggregate amount of all medium and lower grade investments then held by the insurer, ≤20% of admitted assets; • The aggregate amount of lower grade investments then held by the insurer, ≤10% of admitted assets; • The aggregate amount of investments rated 5 or 6 by the SVO then held by the insurer, ≤5% of admitted assets; • The aggregate amount of investments rated 6 by the SVO then held by the insurer, ≤1% of admitted assets.
Preferred Stocks	• Not exceed 20% of its admitted assets; • Preferred stocks which are not sinking fund stocks or rated P1 or P2 by the SVO, 10% of its admitted assets.
Equity Interests	• Not exceed 25% of admitted assets or 100% of policyholders' surplus; • An insurer shall not short sell equity investments unless the insurer covers the short sale by owning the equity investment or an unrestricted right to the equity instrument exercisable within 6 months of the short sale.
Mortgage Loans and Real Estate	• Mortgage Loans, not exceed: (1) 1% of its admitted assets in mortgage loans covering any one secured location; and (2) 0.25% of admitted assets in construction loans covering any one secured location or 1% of admitted assets in construction loans in the aggregate; • Mortgage loans and income producing real estate plus the guarantees, ≤25% of admitted assets; • Real Estate for the Accommodation of Business, ≤10% of admitted assets.
Derivatives	• The aggregate statement value of options, caps, floors and warrants not attached to another financial instrument purchased and used in hedging transactions, ≤7.5% of admitted assets; • The aggregate statement value of options, caps and floors written in hedging transactions, ≤3% of admitted assets; and • The aggregate potential exposure of collars, swaps, forwards and futures used in hedging transactions, ≤6.5% of admitted assets.

Source: NAIC Investment of Insurers Model Act-Defined Limits Version, October 1996.

[56] According to NAIC (2014), all the 50 states have adopted the limits version model act and 9 states have adopted both the standard version and limits version model acts.

Appendix 4: Federal Corporate Income Tax Rates (Income Years 1994-2012)

Rate Brackets or Exemptions	Tax Rate	Tax is
First $50,000	15%	15%
$50,000 to $75,000	25%	$7,500 + 25%
$75,000 to $100,000	34%	$13,750 + 34%
$100,000 to $335,000 (a)	39%	$22,250 + 39%
$335,000 to $10,000,000	34%	$113,900 + 34%
$10,000,000 to $15,000,000	35%	$3,400,000 + 35%
$15,000,000 to $18,333,333 (b)	38%	$5,150,000 + 38%
Over $18,333,333[57]	35%	$6,416,667+ 35%

(a) An additional 5 percent tax, not exceeding $11,750, is imposed on taxable income between $100,000 and $335,000 in order to phase out the benefits of the lower graduated rates.

(b) An additional 3 percent tax, not exceeding $100,000, is imposed on taxable income between $15,000,000 and $18,333,333 in order to phase out the benefits of the lower graduated rates.

Source: Treasury Department; Commerce Clearing House (CCH); Tax Foundation

[57] The effective tax rate when taxable income is greater than $18,333,333 is 35%, which implies that the tax rate is 35% for each $1 increase of taxable income for this income bracket.

Appendix 5: Estimating the Probability of Failure of Property/Casualty Insurers

The probability of failure is estimated using a Discrete-Time Hazard Model. The independent variables include firm characteristics and selected FAST ratios.

Panel A: Hazard Model Results

Variable:	Coef.	Std. Err.	X^2 Statistic	
Size: Ln(Total Assets)	-0.389	0.047	68.89	***
Dummy = 1 if insurer is a mutual	-1.396	0.250	31.30	***
Net Premium Written (NPW) to Policyholder Surplus (PHS)	0.341	0.067	25.85	***
Surplus Aid to PHS	0.638	0.136	22.13	***
Investment Yield (%)	-15.476	4.657	11.04	***
1 Yr Growth in PHS (%)	-2.717	0.576	22.22	***
1 Yr Change in Gross Expenses (%)	0.236	0.111	4.53	**
1 Yr Change in Liquid Assets (%)	-1.283	0.427	9.03	***
Reinsurance Recoverable on Paid Losses to PHS	1.432	0.312	21.00	***
Reinsurance Recoverable on Unpaid Losses to PHS	-0.131	0.034	14.92	***
Premiums in Long-tailed Lines to Total Premiums	1.211	0.285	c	***
Receivables from Affiliates to PHS	2.423	0.609	15.84	***
Misc. Recoverables to PHS	1.440	0.312	21.30	***
Non-investment Grade Bonds to PHS	4.283	2.148	3.98	**
Other Invested Assets to PHS	2.327	0.715	10.59	***
Dummy = 1 if insurer has a large single agent	0.165	0.186	0.79	
N	35552			
Pseudo R^2 (%)	0.29			
Log Likelihood Function Value	-1020.43			

Note: This table presents the results of a discrete-time hazard model for the years 1989 to 2009. The dependent variable is equal to one if the insurer is subject to formal regulatory proceedings for conservation of assets, rehabilitation, receivership, or liquidation in either year t+1 or t+2, and zero otherwise. There are 35,312 healthy firm-year observations and 240 insolvent company observations. The ratios come from the description of FAST in Grace et al. (1998). Intercept and year indicators are omitted from the table to conserve space. ***, **, and * indicate two-tailed statistical significance at 0.01, 0.05, and 0.10 levels.

Panel B: Predicted Probability of Insolvency

Firm Type	N	Mean	Median	Std. Dev.	1st Percentile	99th Percentile
Solvent	35,312	0.60%	0.17%	2.45%	0.00%	7.63%
Insolvent	240	11.79%	4.12%	18.67%	0.05%	88.58%

Source: Data obtained from research of Dr. Tyler Leverty at University of Wisconsin, Madison.

Appendix 6: Definition of Rating Laws (Property/Casualty)

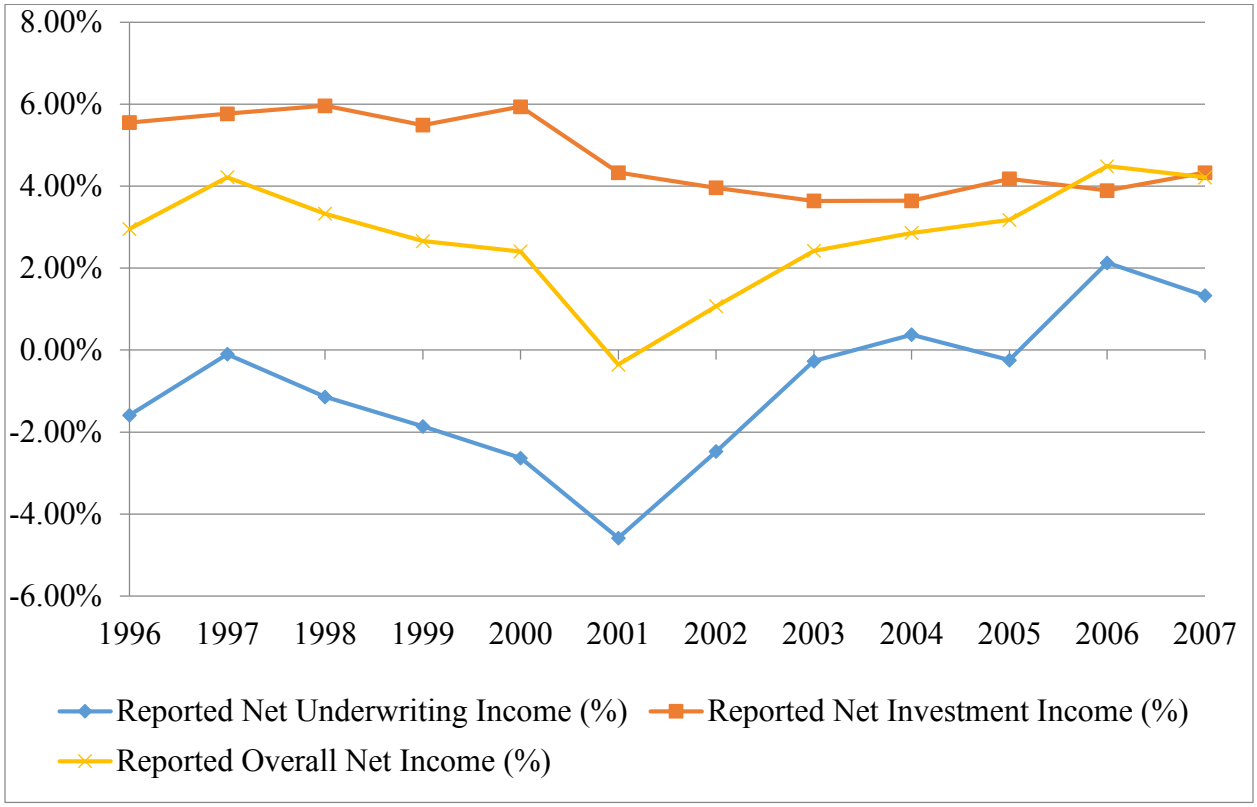
Prior Approval	Rates must be filed with and approved by the state insurance department before they can be used. Approval can be by means of a deemer provision, which indicates approval if rates are not denied within a specified number of days.
Modified Prior Approval	Rate revisions involving change in expense ratio or rate relativity require prior approval. Rate revisions based on experience only are subject to "file and use" laws.
Flex Rating	Prior approval of rates required only if they exceed a certain percentage above (and sometimes below) the previously filed rates.
File and Use	Rates must be filed with the state insurance department prior to their use. Specific approval is not required but the department retains the right of subsequent disapproval.
Use and File	Rates must be filed with the state insurance department within a specified period after they have been placed in use.
No File	Rates are not required to be filed with or approved by the state insurance department. However, the company must maintain records of experience and other information used in developing the rates and make these available to the commissioner upon his request.

This chart does not constitute a formal legal opinion by the NAIC staff on the provisions of state law and should not be relied upon as such. Every effort has been made to provide correct and accurate summaries to assist the reader in targeting useful information. For further details, the statutes and regulations cited should be consulted. The NAIC attempts to provide current information; however, readers should consult state law for additional adoptions.

Source: NAIC's Compendium of State Laws on Insurance Topics: Rate Filling Methods for Property/Casualty Insurance, Workers' Compensation, Title (various years).

Figures

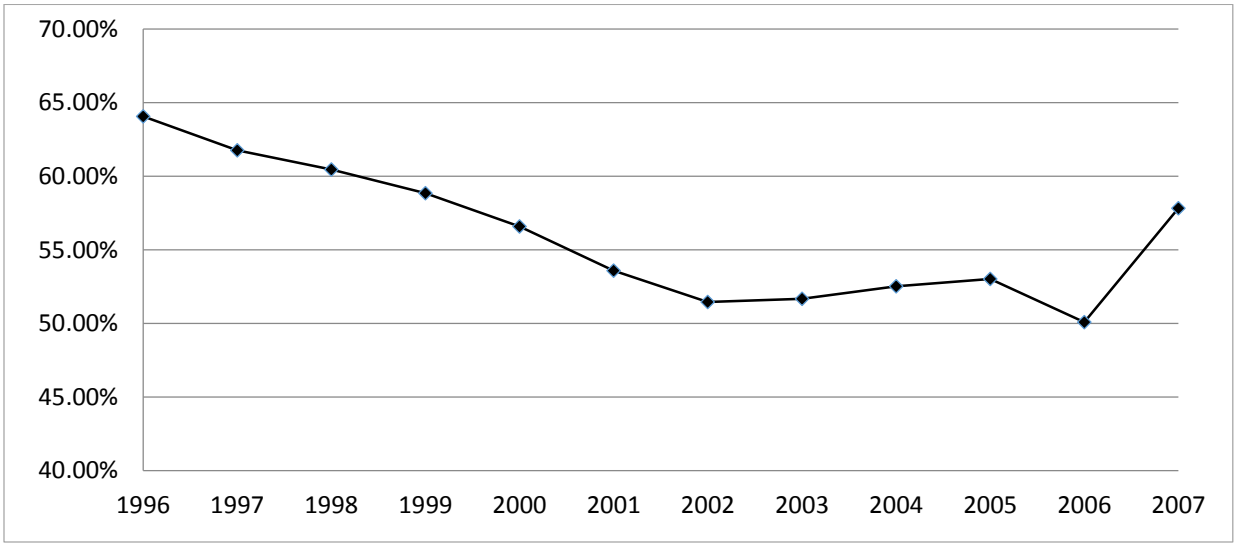
Figure 1: Reported Income of Property and Casualty Insurance Industry



Data source: NAIC P&C Annual Statement Database (1996 to 2007).

Note: *Income streams are scaled by total assets.*

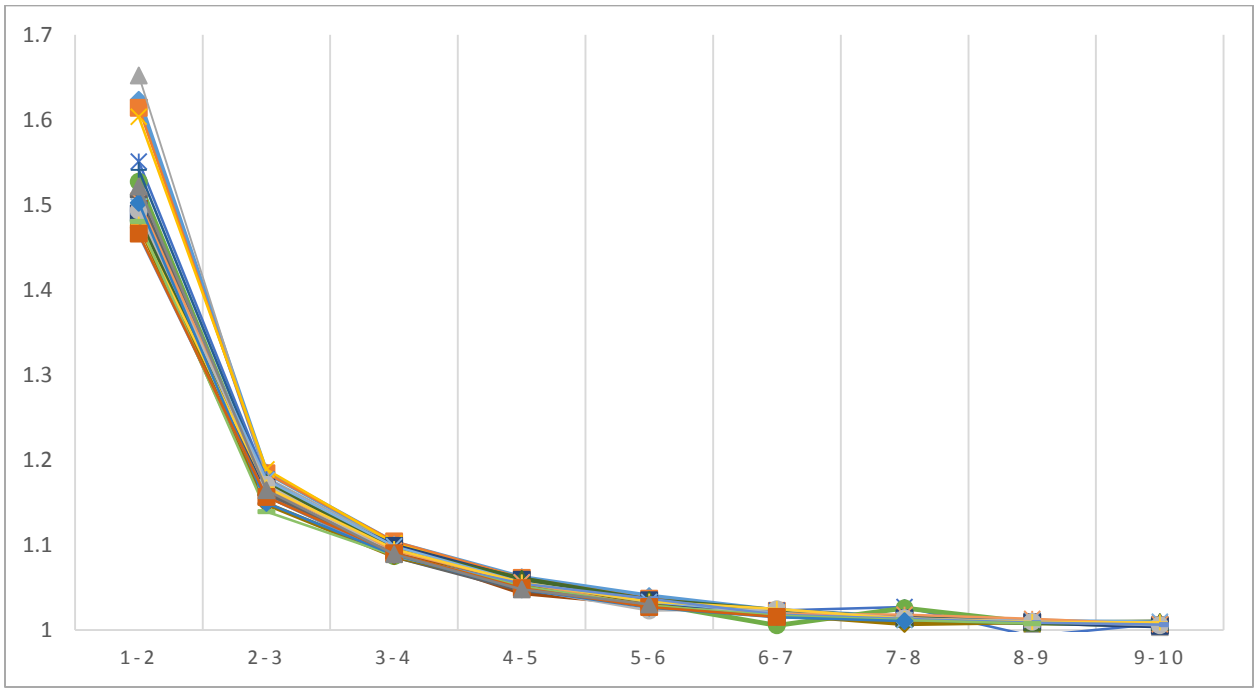
Figure 2: Loss Reserve to Liability Ratio of Property/ Casualty Insurance Industry



Data source: Balance Sheets (Page 1 and Page 2), NAIC Property/Casualty Annual Statement Database (1996 to 2007).

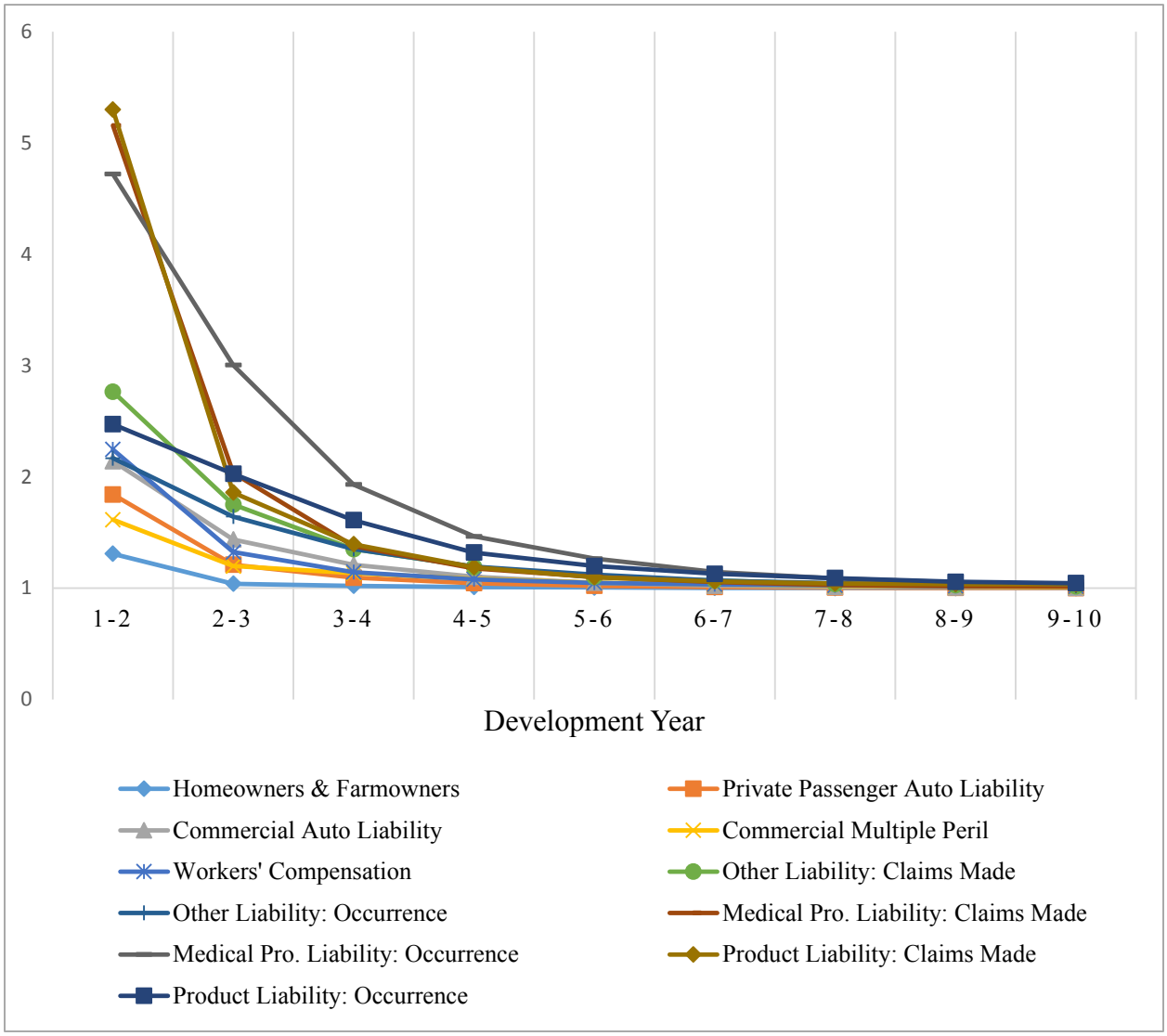
Note: *Loss Reserve to Liability Ratio* is Loss reserves/Liabilities *100%.

Figure 3: Link Ratio for Cumulative Paid Claims (By Accident Year: 1987-2007)



Data source: Schedule P Part 2 and Part 3(Summary), NAIC Property/Casualty Annual Statement Database (1996 to 2012).

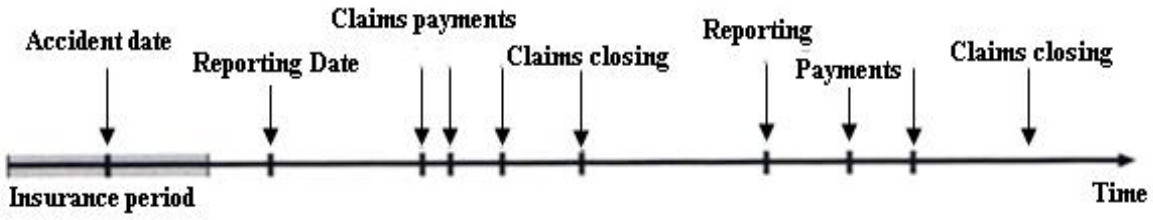
Figure 4: Average Link Ratio for Cumulative Paid Claims (By Lines of Business)



Data source: Best's Aggregates & Averages - Property/Casualty (1996 to 2012).

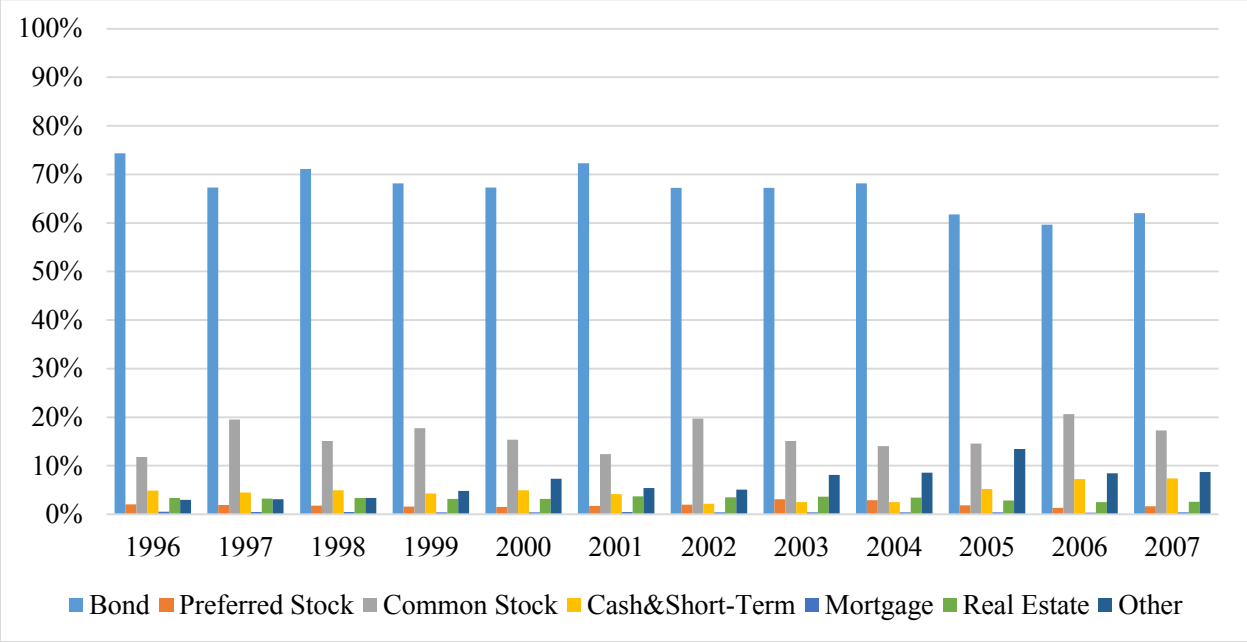
Note: Average link ratio for cumulative paid claims is the average value of link ratios for accident years 1987 to 2007, by lines of business.

Figure 5: Typical Timeline of a Non-life Insurance Claim



Source: "Stochastic claims reserving methods in insurance," by Mario V. Wütheich and Michael Merz, Willey Finance, 2008, page 2.

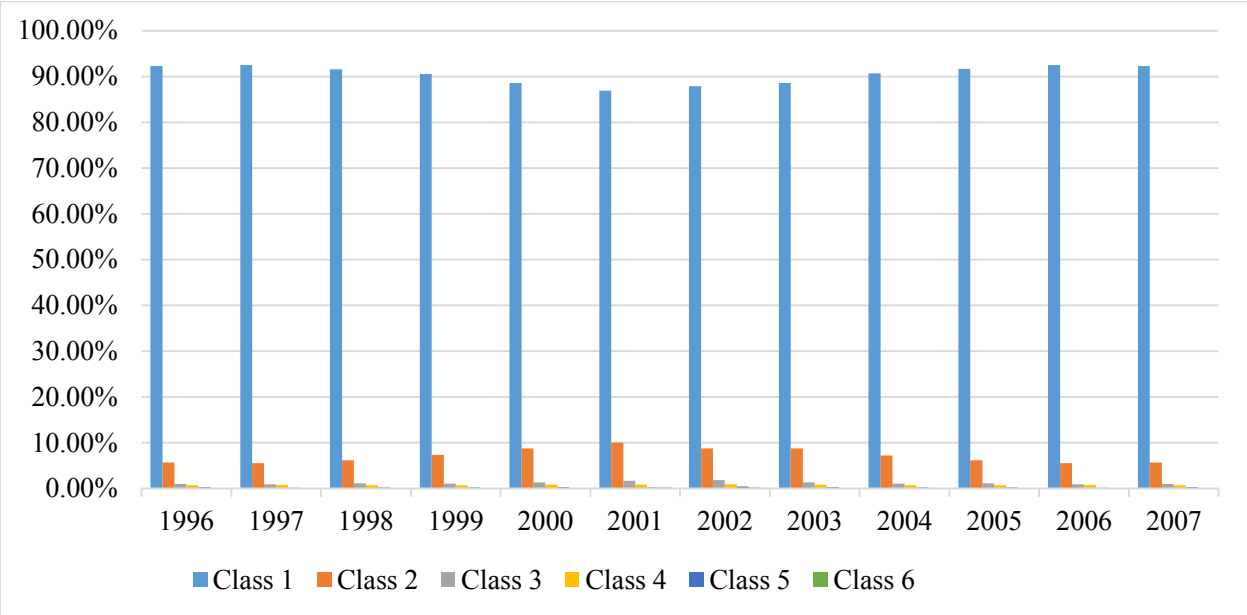
Figure 6: Allocations of Invested Assets (Industry Aggregate)



Data source: Balance Sheet-Assets (Page 1), NAIC Property/Casualty Annual Statement Database (1996 to 2007).

Note: The amount of invested assets of each category is scaled by total invested assets *100%.

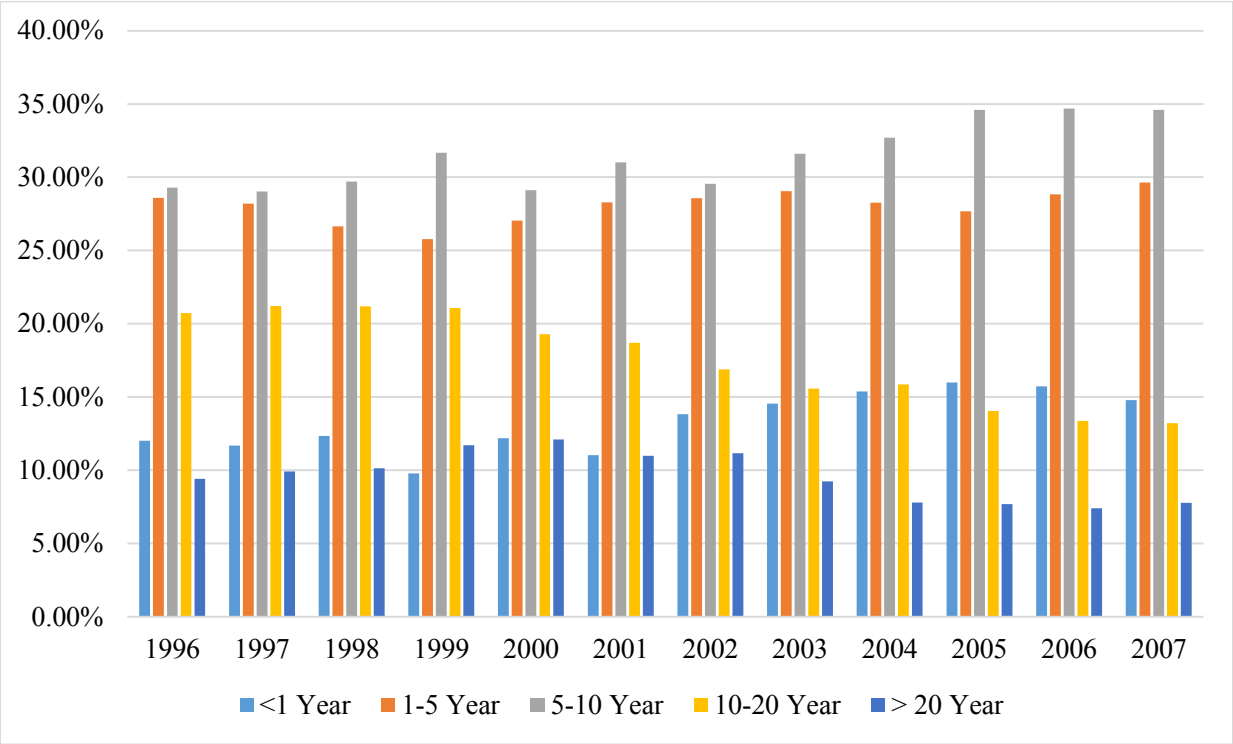
Figure 7: Allocations of Bonds by NAIC SVO Designation (Industry)



Data source: Schedule D-Part 1A-Section 1, NAIC Property/Casualty Annual Statement Database (1996 to 2007).

Note: The amount of bonds of each class is scaled by total of assets in bonds. Information about NAIC SVO Designation is in Appendix 2.

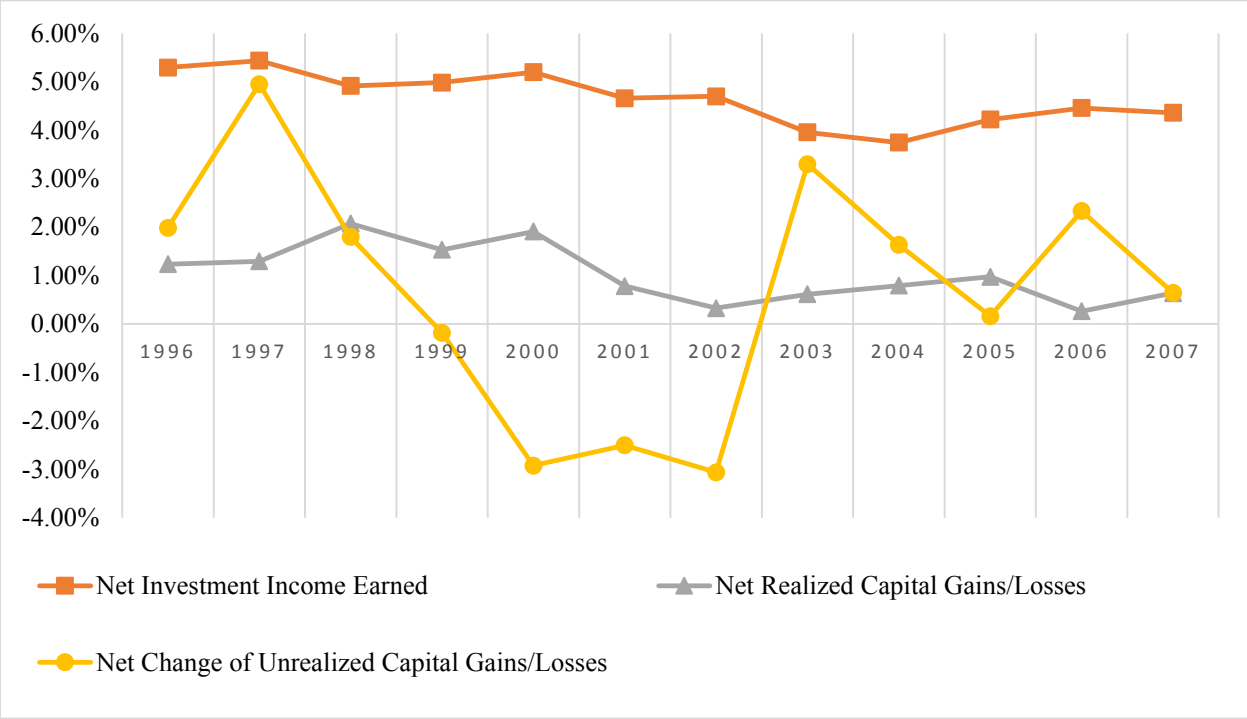
Figure 8: Allocations of Bonds by Years to Maturity



Data source: Schedule D-Part 1A-Section 1, NAIC Property/Casualty Annual Statement Database (1996 to 2007).

Note: The amount of bonds of different maturities are scaled by total assets in bonds.

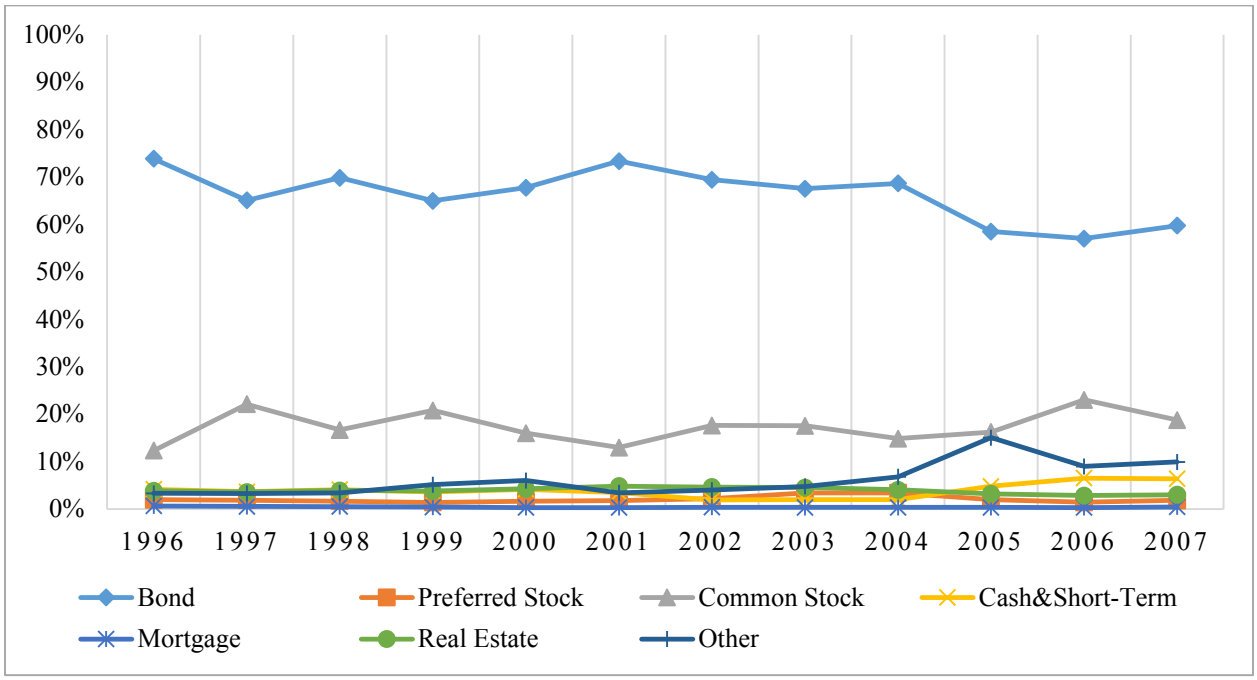
Figure 9: Investment Income Earned and Capital Gains/Losses



Data source: Exhibit of Net Investment Income, Exhibit of Capital Gains (Losses), NAIC Property/Casualty Annual Statement Database (1996 to 2007).

Note: Values are net of capital taxes and scaled by total invested assets *100%.

Figure 10: Investment Income Earned by Invested Assets Type



Data source: Exhibit of Net Investment Income, NAIC Property/Casualty Annual Statement Database (1996 to 2007).

Note: The amount of investment income earned (interests and dividends) of each invested assets category is scaled by the total investment income earned.

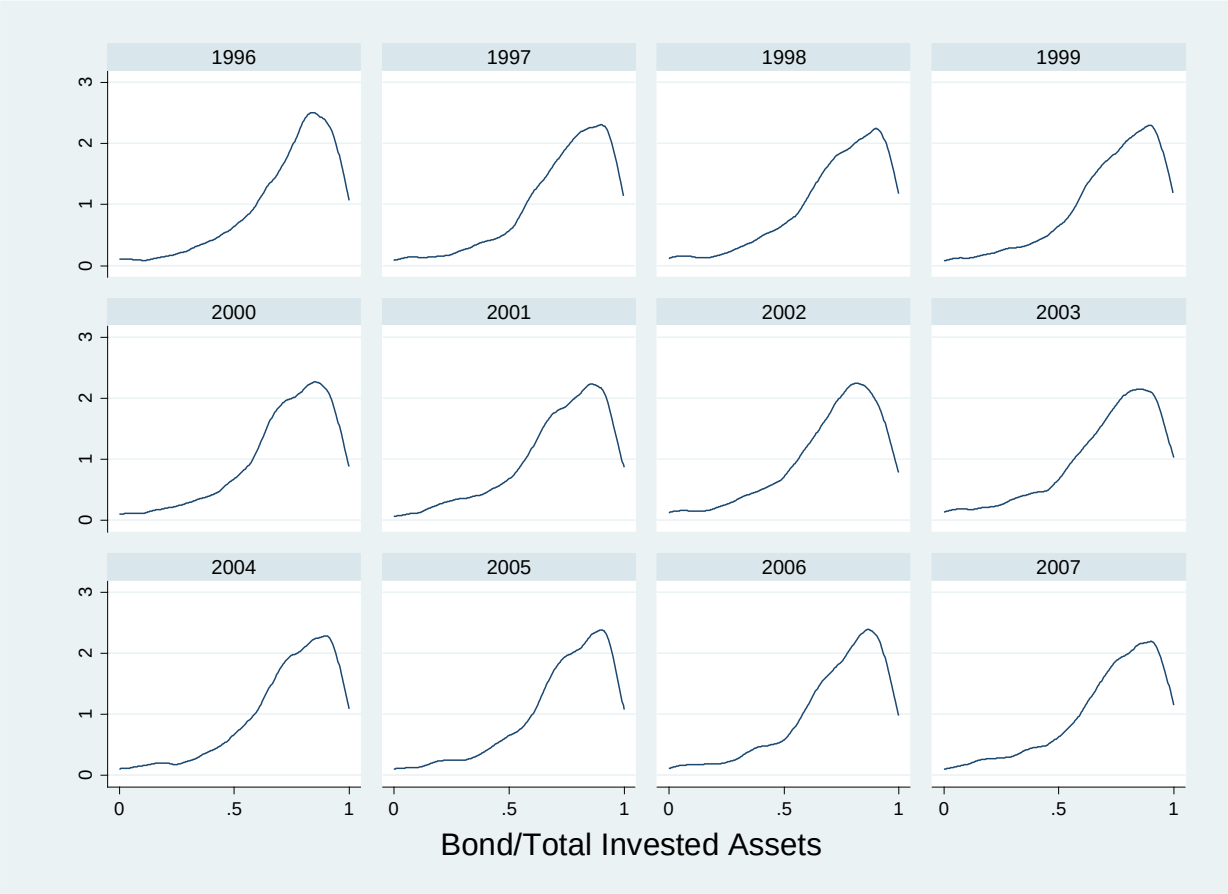
Figure 11: Capital Gains (Losses) by Invested Assets Type (Include Realized & Unrealized Capital Gains/Losses)

Data source: Exhibit of Capital Gains (Losses), NAIC Property/Casualty Annual Statement Database (1996 to 2007).

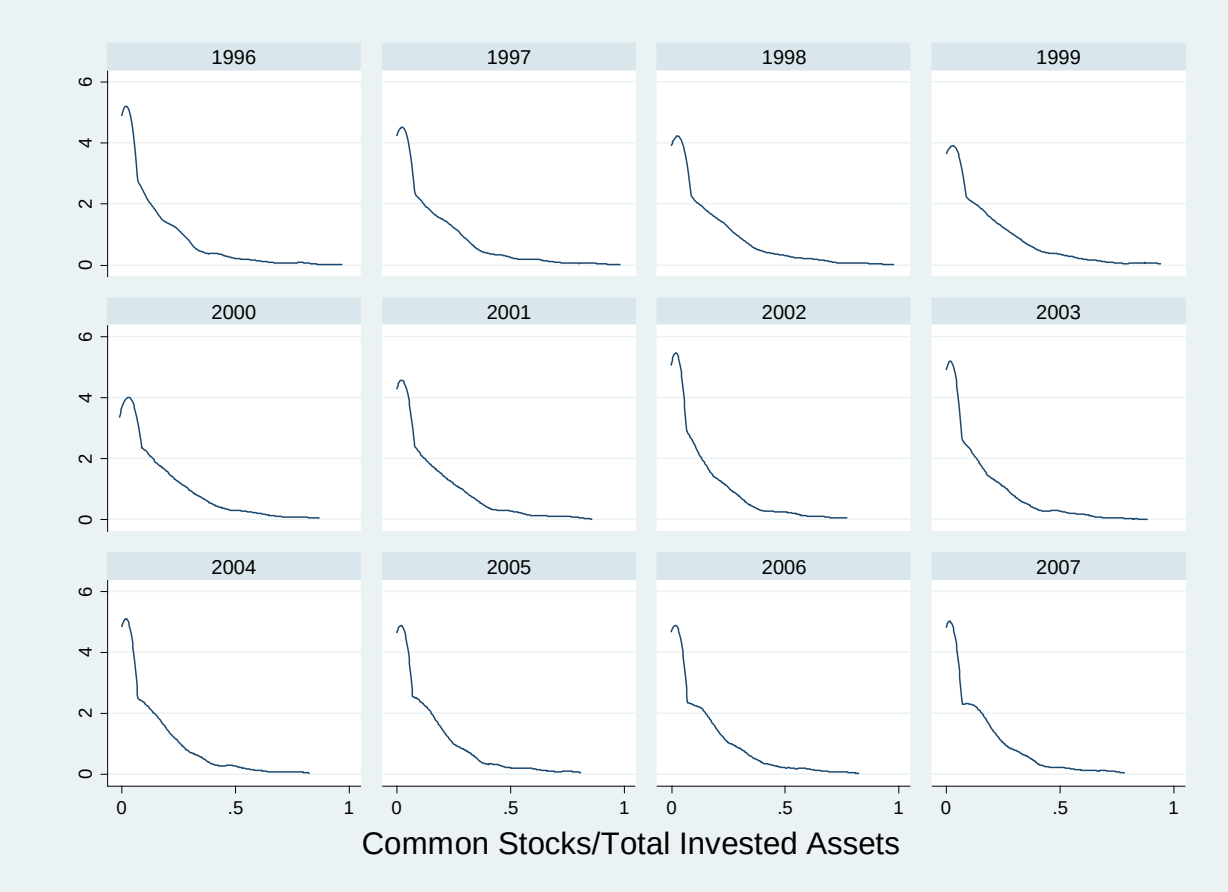
Note: Values are scaled by total invested assets.

Figure 12: Kernel Density of Allocation of Invested Assets (1996-2007)

Part A: Investment in Bonds (Scaled by Total Invested Assets)

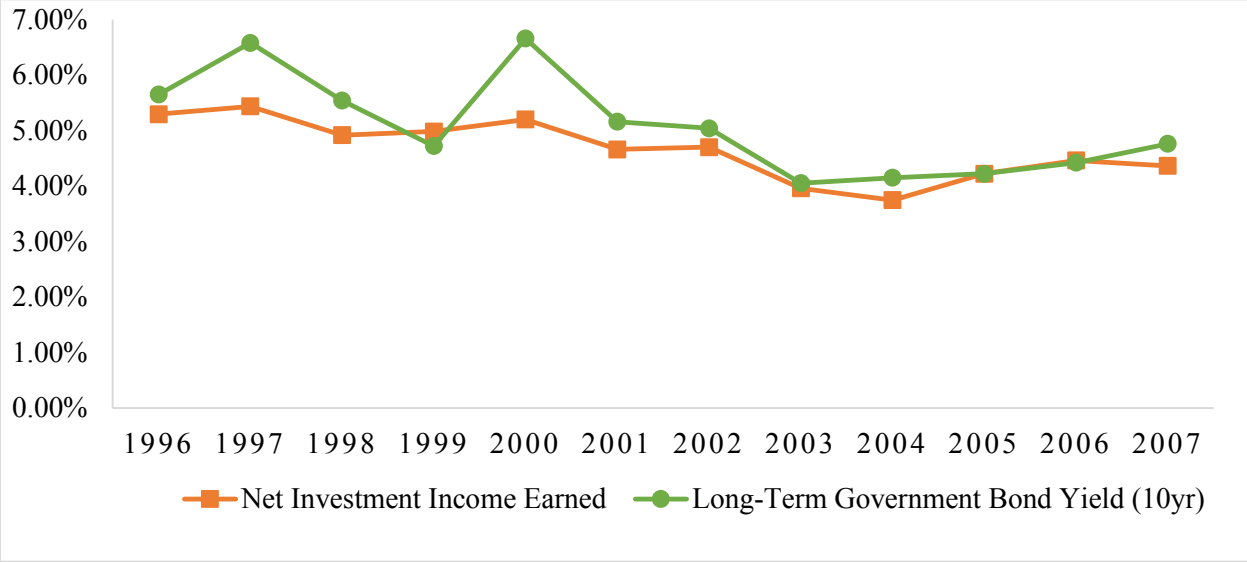


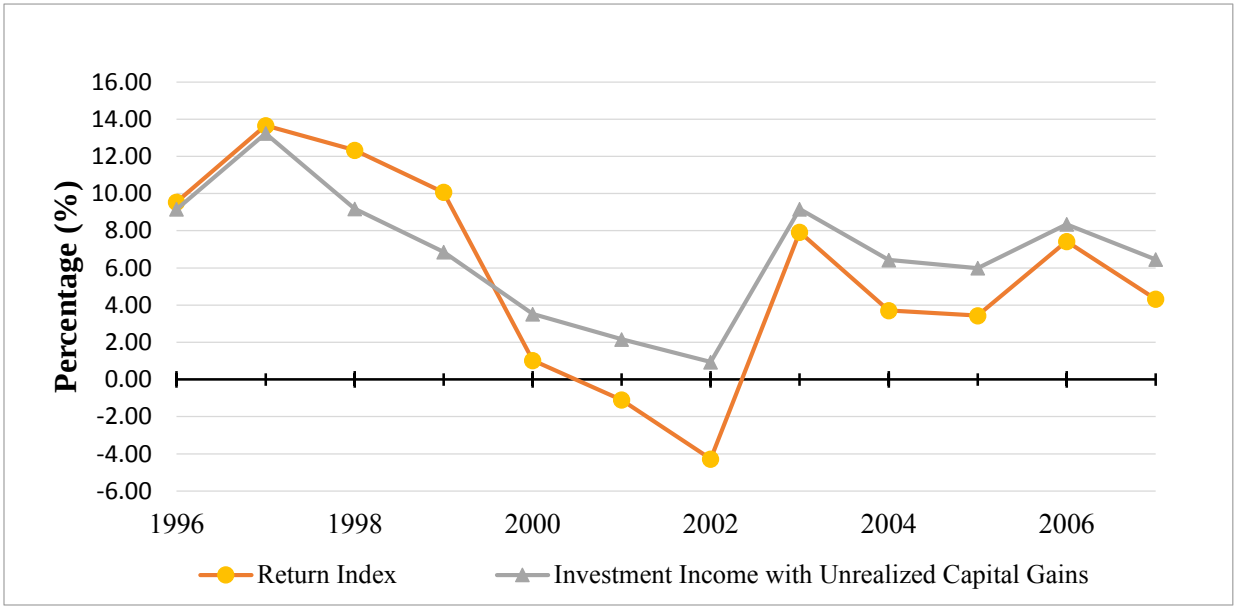
Part B: Investment in Common Stocks (Scaled by Total Invested Assets)



Note: Some firms have negative components of invested assets (especially cash and short-term investments), therefore the ratios on the right tail is larger than 100% and some ratios on the left tail are negative.

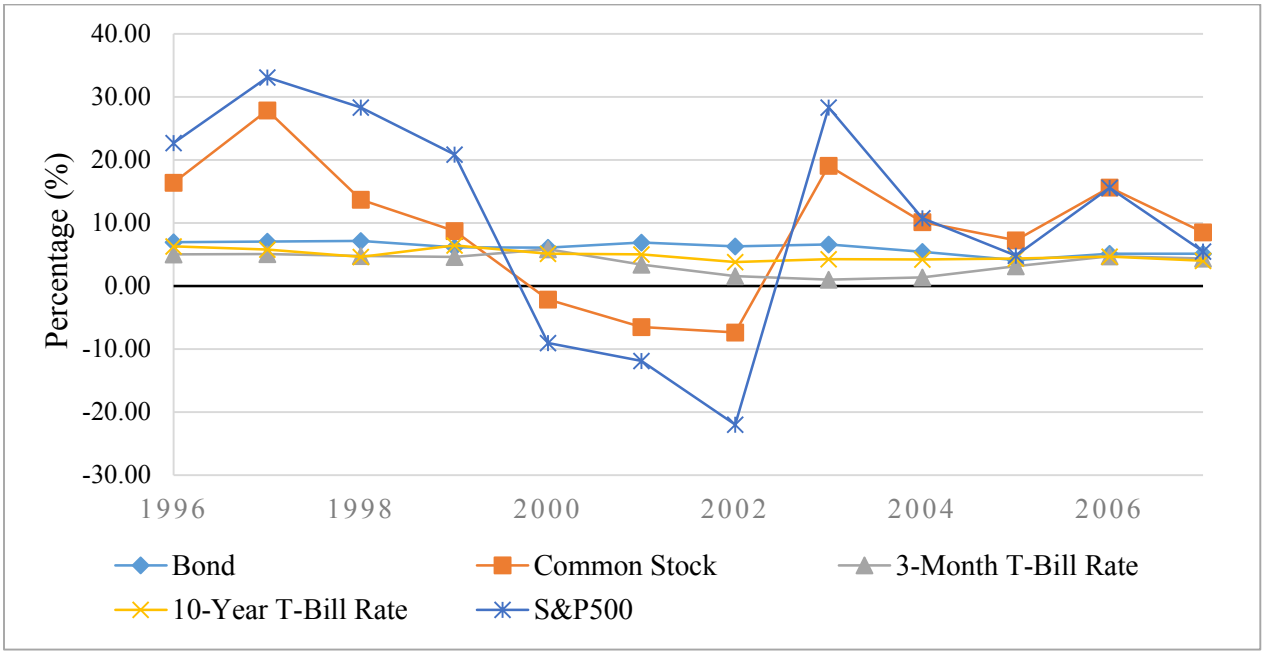
Figure 13: Investment Income and Financial Market Returns





Note: **Return Index** = Proportion of invested assets in common stocks*Annualized return of SP500 index + Proportion of other invested assets * Annualized 3-month-T-Bill rate

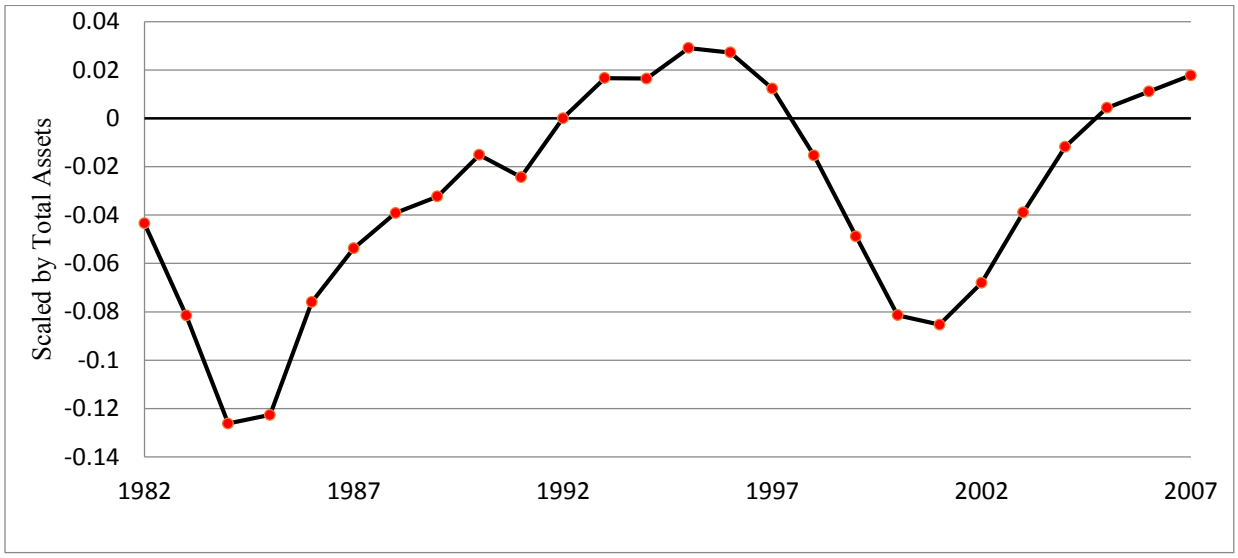
Figure 14: Returns of Bonds and Common Stocks of Property/Casualty Insurers versus Market Returns of T-Bills and S&P500 Index



Data Source: NAIC Annual Statements and Yahoo Finance database (include dividends), 1996-2007.

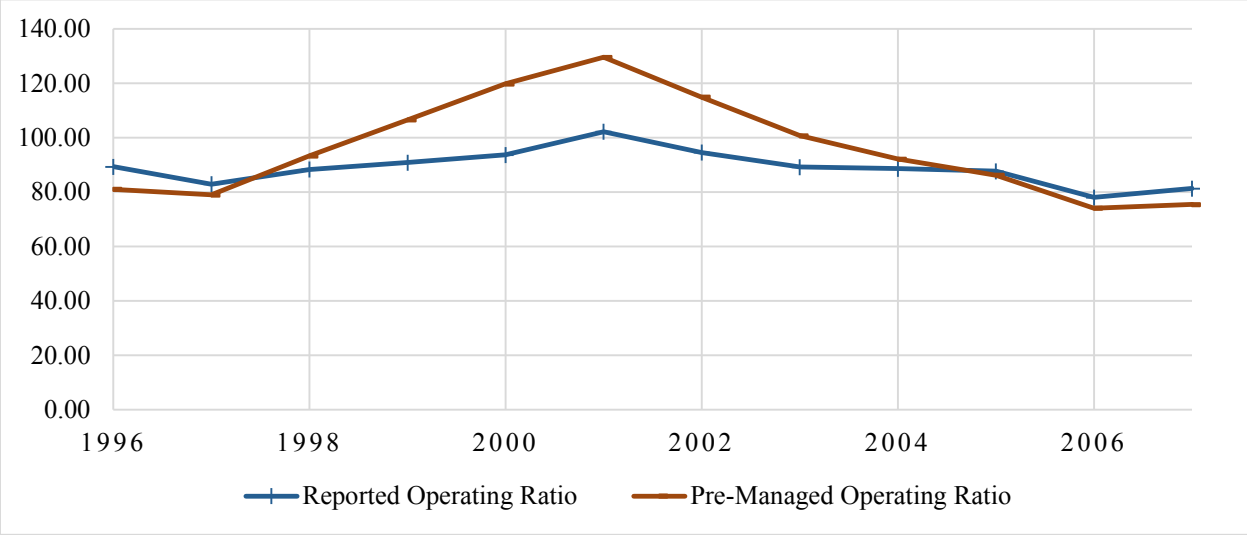
Note: Return of bonds is calculated as: (investment income earned from bonds + capital gains of bonds)/average invested bonds *100%, where average invested bonds=(total invested bonds of the current year and prior year)/2; return of common stock = (investment income earned from common stocks + capital gains/losses of common stocks)/average invested common stocks*100%, where average invested common stocks=(total invested common stocks of the current year and prior year)/2.

Figure 15: Loss Reserve Errors of U.S. P/C Insurance Industry (1982-2007)



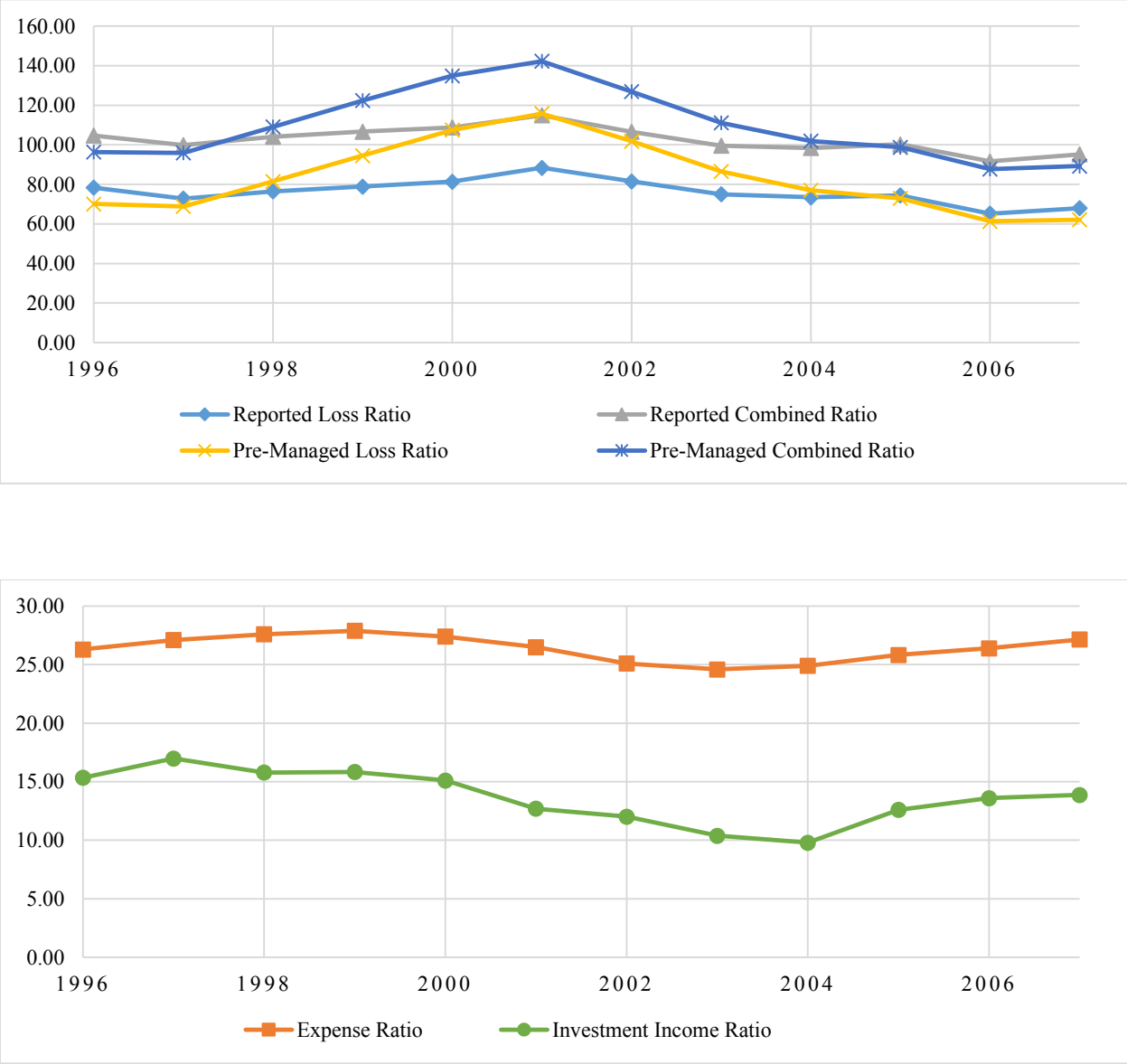
Data Source: Best's Aggregates & Averages - Property/Casualty (1987-2012).

Figure 16: Reported and Pre-Managed Operating Ratios of P/C Insurance Industry (1996-2007)



Data Source: Best's Aggregates & Averages - Property/Casualty (1996-2012).

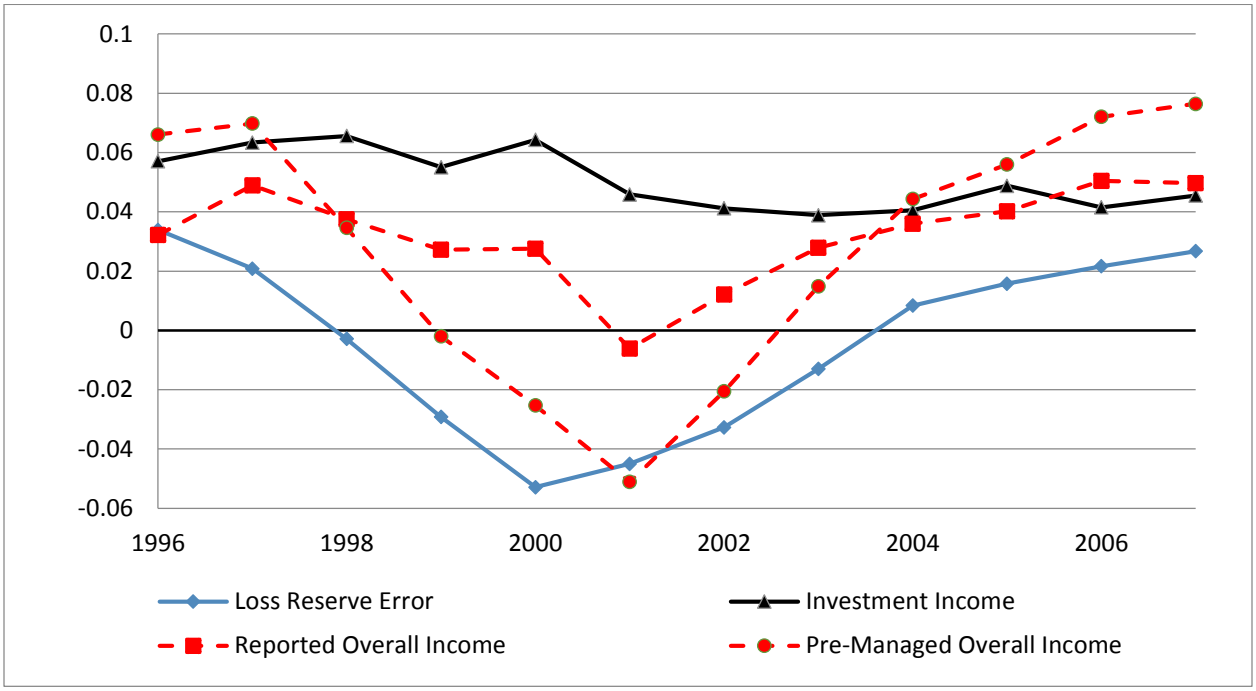
Figure 17: Reported and Pre-Managed Operating Ratio Components of P/C Insurance Industry (1996-2007)



Data Source: Best's Aggregates & Averages - Property/Casualty (1996-2012).

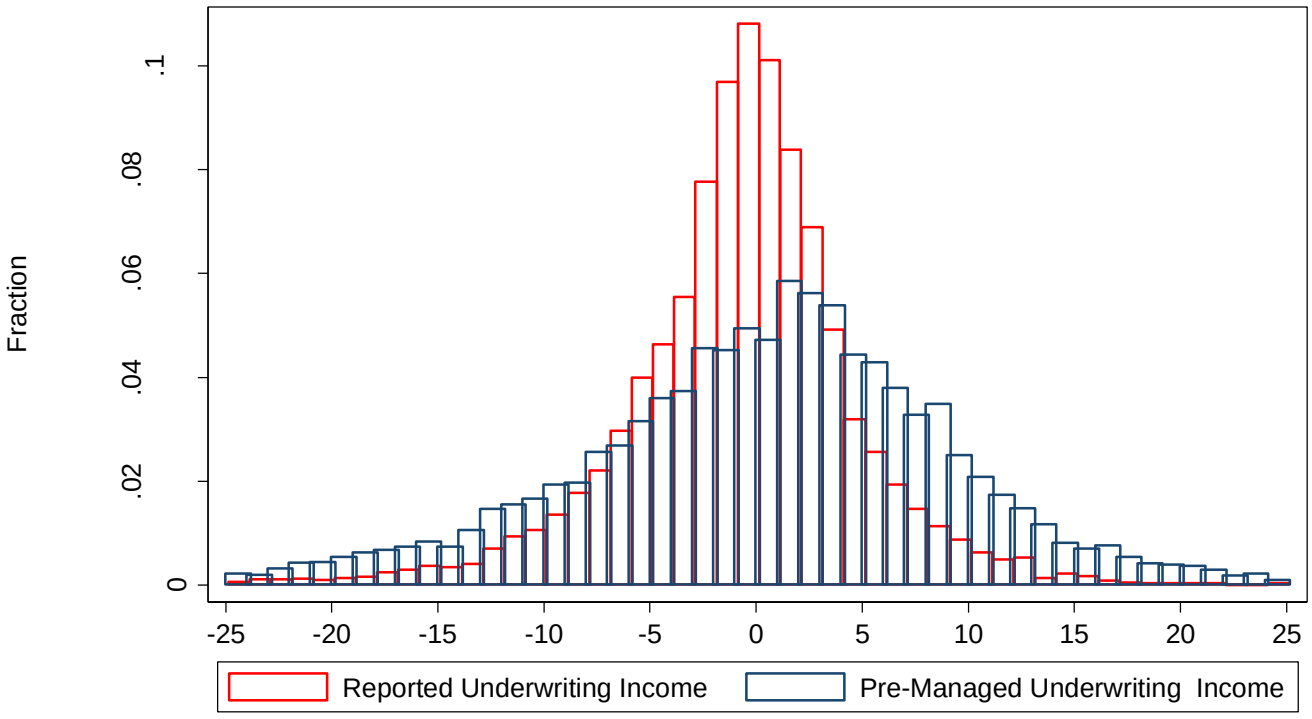
Note: The ratios for sample are not different from ratios of industry.

Figure 18: Loss Reserve Errors and Income Streams



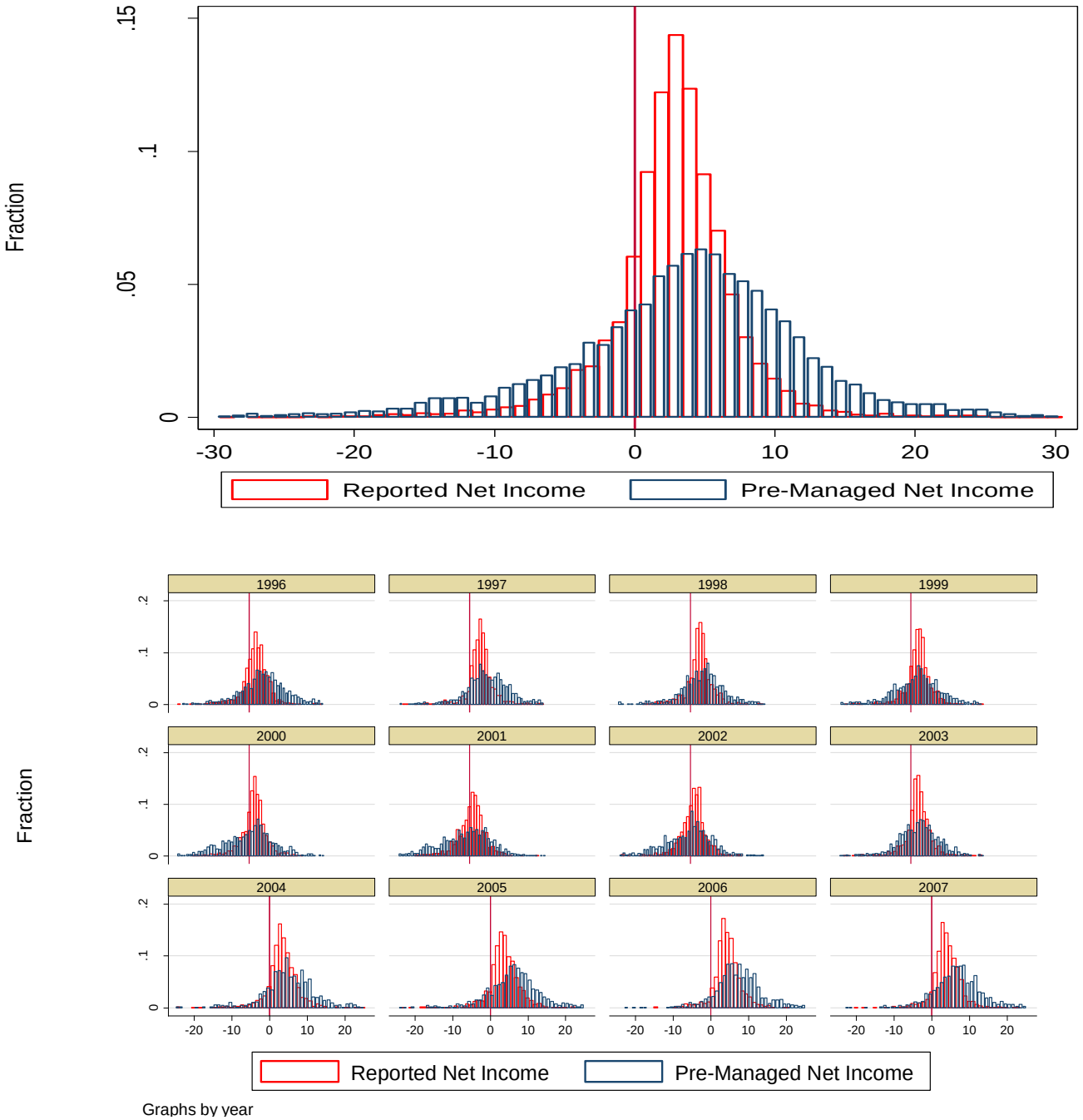
Note: All income streams are scaled by total assets.

Figure 19: Distribution of Reported Underwriting Income V.S. Pre-Managed Underwriting Income (1996-2007)



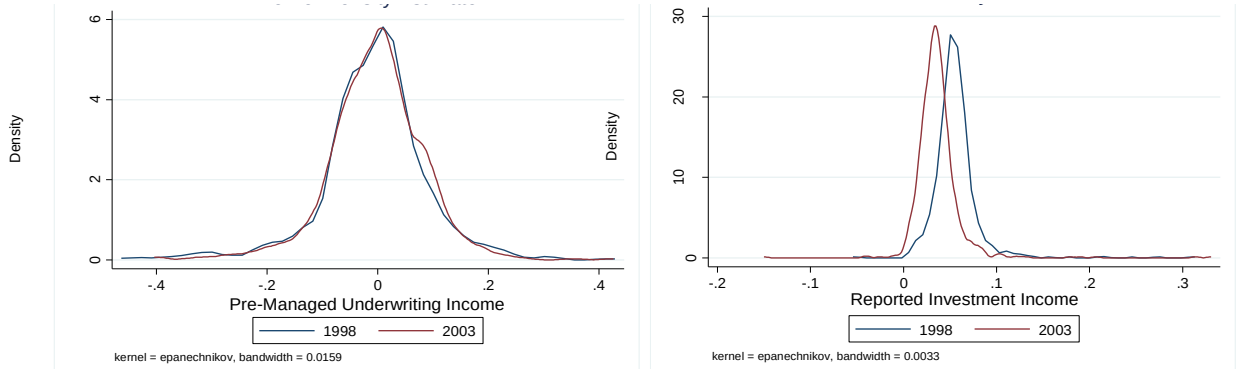
Note: Income streams are scaled by total assets, displayed in percentages.

Figure 20: Distributions of Reported and Pre-Managed Net Income (1996-2007)

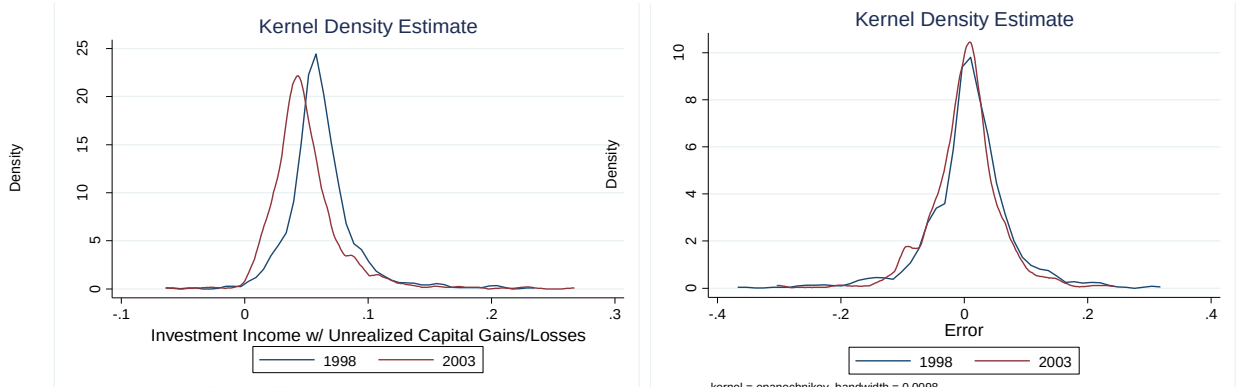


Note: Income streams are scaled by total assets, displayed in percentages. The vertical reference line of each figure is 0. About 41.25 of the observations have reported net income between -5% and 5%; about 70.14% of the observations have pre-managed income between -5% and 5%.

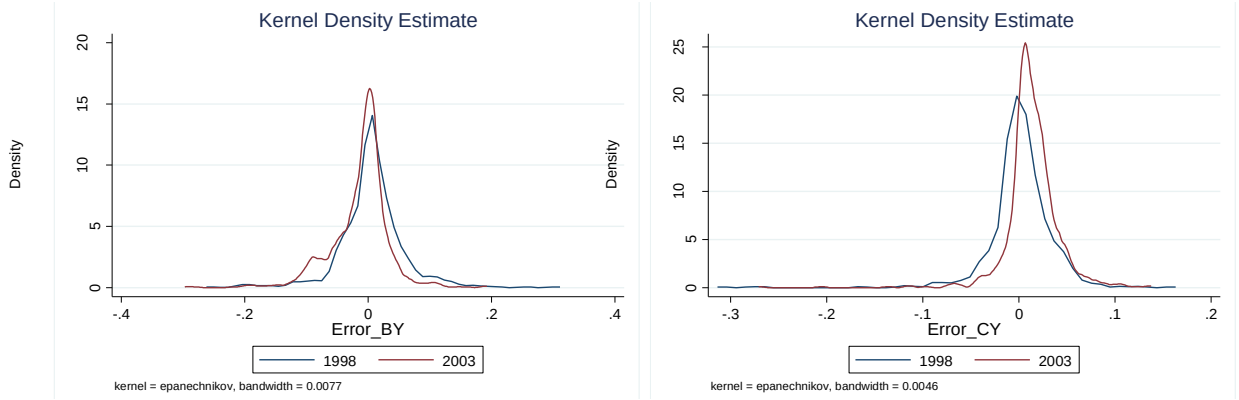
Figure 21: Kernel Density of Reported Investment Income, Investment Income with Unrealized Capital Gains/Losses, Pre-Managed Underwriting Income and Loss Reserve Errors (1998 and 2003)



t-test for means of pre-managed underwriting income: 1998 = 2003, p-value= 0.3124.
t-test for means of reported investment income: 1998 > 2003, p-value=0.000.

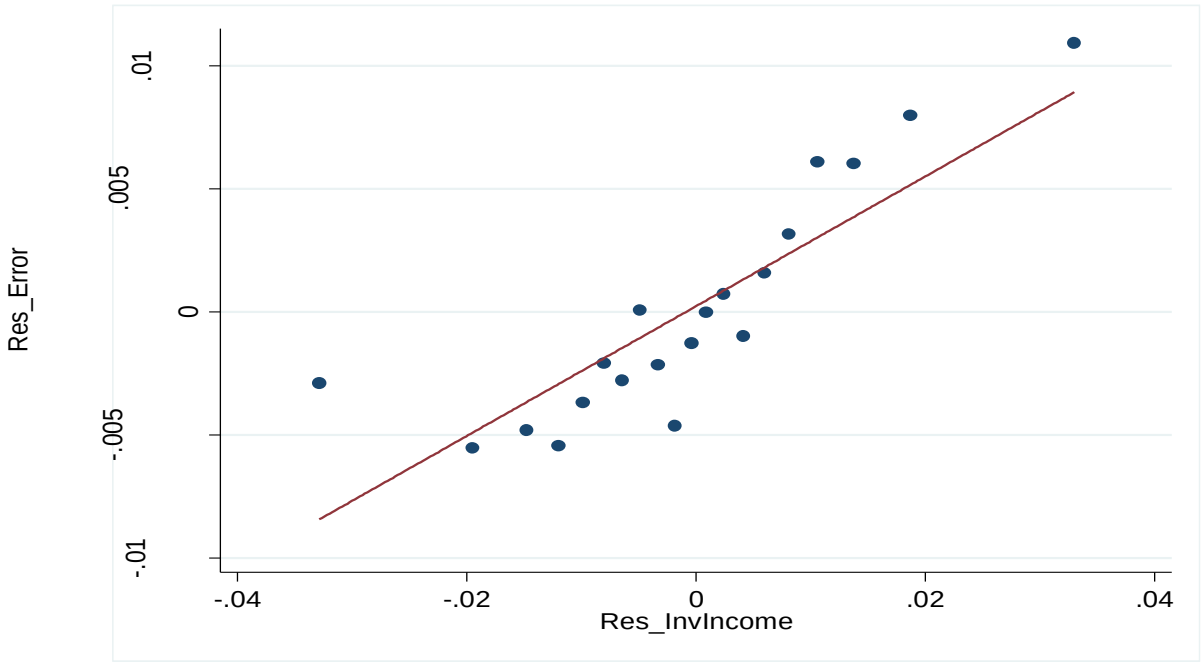


t-test for means of investment income w/ unrealized capital gains: 1998 > 2003, p-value=0.000.
t-test for means of loss reserve errors of all accident years: 1998 > 2003, p-value=0.0078.



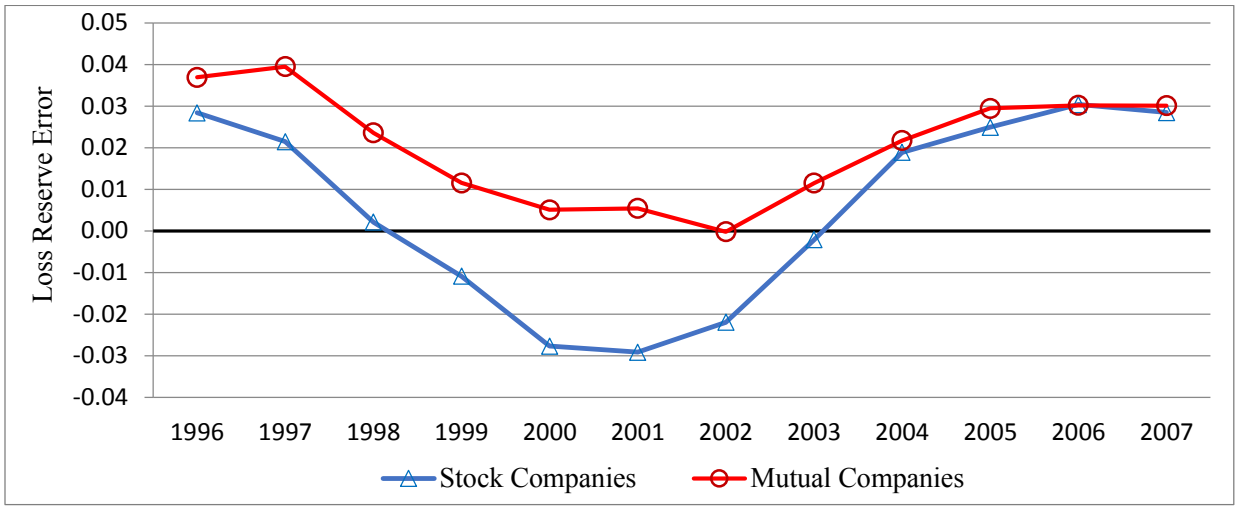
t-test for means of loss reserve errors of prior accident years: 1998 < 2003, p-value=0.000.
t-test for means of loss reserve errors of current accident years: 1998 > 2003, p-value=0.000.

Figure 22: Binscatter plot of Loss Reserve Errors and Investment Income



Note: The covariate of pre-managed underwriting income is controlled.

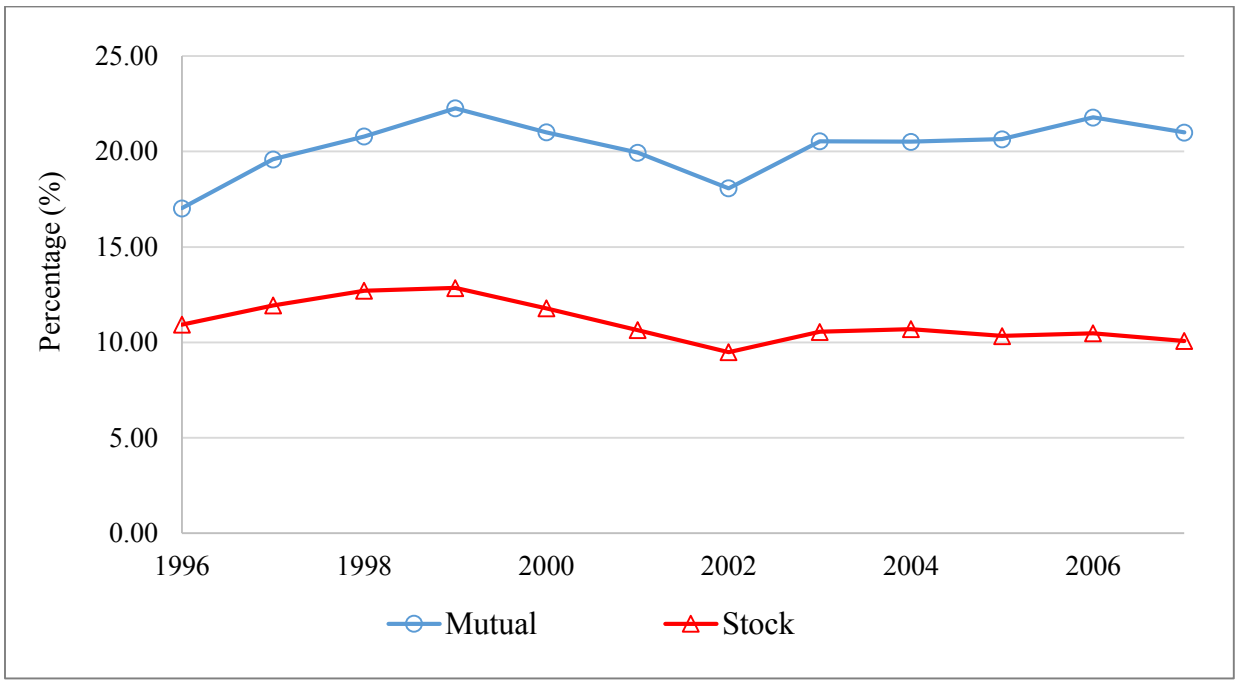
Figure 23: Loss Reserve Errors of Stock Companies and Mutual Companies



Data Source: NAIC Property/Casualty Annual Statement Database (1996 to 2012).

Note: Loss Reserve Error is scaled by total assets.

Figure 24: Proportion of Invested Assets in Common Stocks of Mutual and Stock Insurers (1996-2007)



Note: The vertical axis presents the investment in common stocks as a percentage of total invested assets.

Tables

Table 1: Percentage of Losses Paid by Years of Development for Accident Years 1992-2007 in Property/Casualty Insurance Industry

	Years of Development									
Accident Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1987	39.12%	63.51%	75.27%	83.02%	88.16%	91.67%	93.75%	95.16%	95.97%	96.70%
1988	39.62%	63.94%	75.71%	83.59%	88.70%	91.96%	94.01%	95.28%	96.17%	96.70%
1989	39.45%	65.17%	76.87%	84.59%	89.43%	92.50%	94.41%	95.72%	96.38%	96.70%
1990	40.08%	64.28%	76.41%	84.20%	89.03%	91.96%	93.88%	95.40%	96.06%	96.70%
1991	42.44%	65.82%	77.48%	84.77%	89.36%	92.03%	94.15%	96.68%	95.97%	96.70%
1992	44.39%	67.79%	78.64%	85.48%	89.67%	92.49%	92.99%	95.37%	96.20%	96.70%
1993	43.19%	66.56%	77.95%	85.07%	90.02%	92.33%	94.00%	95.29%	96.06%	96.70%
1994	44.95%	67.58%	78.26%	85.60%	89.35%	92.05%	93.95%	95.16%	96.04%	96.70%
1995	44.64%	67.42%	78.27%	85.08%	89.07%	92.02%	93.80%	95.15%	96.03%	96.70%
1996	46.35%	68.48%	78.64%	85.47%	90.02%	92.78%	94.51%	95.18%	96.08%	96.70%
1997	44.17%	65.81%	76.82%	84.42%	89.39%	92.50%	94.06%	95.37%	96.25%	96.70%
1998	43.91%	65.10%	76.32%	83.50%	88.53%	91.63%	93.73%	94.99%	95.80%	96.70%
1999	43.44%	65.06%	76.54%	84.06%	88.76%	91.69%	93.56%	94.64%	95.78%	96.70%
2000	43.92%	66.10%	77.11%	84.31%	89.04%	91.42%	93.15%	94.83%	96.06%	96.70%
2001	44.88%	67.02%	78.47%	85.50%	89.67%	91.72%	93.94%	95.25%	96.17%	96.70%
2002	44.41%	65.59%	76.59%	83.87%	88.52%	91.48%	93.73%	94.94%	95.83%	96.70%
2003	45.92%	67.26%	77.80%	84.55%	89.14%	92.42%	94.09%	95.31%	96.11%	96.70%
2004	46.74%	69.21%	78.83%	85.73%	90.15%	92.74%	94.29%	95.39%	96.11%	
2005	46.02%	69.13%	79.46%	86.47%	90.60%	92.97%	94.37%	95.35%		
2006	46.61%	68.34%	79.04%	86.17%	90.40%	92.84%	94.25%			
2007	44.55%	67.78%	78.90%	85.94%	90.04%	92.75%				
Average	43.75%	66.52%	77.59%	84.83%	89.38%	92.19%	93.93%	95.29%	96.06%	
Std Dev	2.306%	1.632%	1.161%	0.915%	0.645%	0.471%	0.378%	0.403%	0.150%	

Table 2: Link Ratio for Cumulative Paid Claims (By Accident Year: 1987-2007)

	Years of Development								
Accident Year	**1-2**	**2-3**	**3-4**	**4-5**	**5-6**	**6-7**	**7-8**	**8-9**	**9-10**
1987	1.6236	1.1852	1.1030	1.0619	1.0399	1.0227	1.0150	1.0085	1.0076
1988	1.6139	1.1842	1.1040	1.0611	1.0367	1.0224	1.0134	1.0094	1.0055
1989	1.6519	1.1795	1.1005	1.0573	1.0343	1.0207	1.0138	1.0070	1.0033
1990	1.6037	1.1887	1.1019	1.0575	1.0329	1.0209	1.0162	1.0069	1.0066
1991	1.5509	1.1770	1.0942	1.0541	1.0299	1.0230	1.0269	0.9927	1.0076
1992	1.5270	1.1601	1.0870	1.0490	1.0315	1.0054	1.0256	1.0087	1.0052
1993	1.5412	1.1710	1.0913	1.0582	1.0257	1.0181	1.0137	1.0080	1.0067
1994	1.5036	1.1580	1.0938	1.0438	1.0302	1.0206	1.0129	1.0093	1.0068
1995	1.5104	1.1610	1.0869	1.0470	1.0331	1.0193	1.0144	1.0093	1.0070
1996	1.4776	1.1483	1.0869	1.0533	1.0306	1.0186	1.0071	1.0095	1.0064
1997	1.4900	1.1674	1.0989	1.0589	1.0348	1.0168	1.0140	1.0092	1.0047
1998	1.4824	1.1725	1.0940	1.0602	1.0351	1.0229	1.0134	1.0085	1.0094
1999	1.4977	1.1763	1.0983	1.0558	1.0331	1.0203	1.0115	1.0121	1.0096
2000	1.5052	1.1666	1.0934	1.0561	1.0267	1.0189	1.0181	1.0129	1.0067
2001	1.4933	1.1708	1.0896	1.0487	1.0228	1.0242	1.0140	1.0096	1.0055
2002	1.4767	1.1677	1.0951	1.0555	1.0334	1.0246	1.0129	1.0093	1.0091
2003	1.4646	1.1568	1.0867	1.0543	1.0368	1.0180	1.0130	1.0084	1.0061
2004	1.4805	1.1391	1.0875	1.0515	1.0288	1.0167	1.0116	1.0076	
2005	1.5022	1.1494	1.0882	1.0478	1.0261	1.0150	1.0104		
2006	1.4662	1.1565	1.0901	1.0491	1.0270	1.0153			
2007	1.5213	1.1642	1.0891	1.0478	1.0301				
Average	1.4962	1.1616	1.0911	1.0523	1.0304	1.0183	1.0138	1.0094	1.0069
Std. Dev.	0.0210	0.0097	0.0040	0.0047	0.0038	0.0045	0.0040	0.0014	0.0015

Table 3: Average Link Ratio for Cumulative Paid Claims (By Lines of Business)

	Years of Development								
Line of Business	**1-2**	**2-3**	**3-4**	**4-5**	**5-6**	**6-7**	**7-8**	**8-9**	**9-10**
Homeowners & Farmowners	1.3096	1.0399	1.0213	1.0099	1.0059	1.0024	1.0009	1.0014	1.0008
Private Passenger Auto Liability	1.8416	1.2108	1.0948	1.0451	1.0203	1.0098	1.0048	1.0025	1.0014
Commercial Auto Liability	2.1411	1.4373	1.2103	1.1023	1.0482	1.0228	1.0106	1.0059	1.0036
Commercial Multiple Peril	1.6146	1.1988	1.1343	1.0844	1.0509	1.0324	1.0197	1.0136	1.0097
Workers' Compensation	2.2463	1.3246	1.1440	1.0794	1.0472	1.0336	1.0247	1.0184	1.0151
Other Liability: Claims Made	2.7659	1.7505	1.3505	1.1911	1.1015	1.0683	1.0380	1.0278	1.0174
Other Liability: Occurrence	2.1671	1.6430	1.3518	1.1946	1.1218	1.0683	1.0448	1.0297	1.0224
Medical Pro. Liability: Claims Made	5.1575	2.0361	1.3772	1.1775	1.0995	1.0537	1.0288	1.0188	1.0145
Medical Pro. Liability: Occurrence	4.7211	3.0042	1.9319	1.4660	1.2655	1.1461	1.0857	1.0528	1.0324
Product Liability: Claims Made	5.3005	1.8598	1.3945	1.1885	1.0985	1.0612	1.0428	1.0369	1.0358
Product Liability: Occurrence	2.4730	2.0278	1.6115	1.3194	1.1988	1.1287	1.0897	1.0572	1.0453

Note: Average link ratio for cumulative paid claims of is the average value of link ratios for accident years 1987 to 2007, by lines of business.

Table 4: Within-Company Variations of Invested Assets in Bonds and Common Stocks (1996-2007)

Invested Assets Type	Within Company	Mean	Std. Dev.	Min	Q1	Median	Q3	Max
Bonds	Mean	73.35%	20.39%	0.00%	63.24%	76.93%	88.12%	114.86%
	Std.	**13.34%**	8.87%	0.00%	6.60%	10.81%	18.57%	54.81%
Common Stocks	Mean	12.51%	15.01%	-0.02%	0.54%	7.66%	18.79%	83.26%
	Std.	**5.25%**	5.94%	0.00%	0.81%	3.69%	7.27%	49.41%

Note: The investment of bonds and common stocks are scaled by invested assets (*100%). The sample size is 1244 (companies with more than two years of observations).

Data source: Balance Sheets-Assets (Page 1), NAIC Property/Casualty Annual Statement Database (1996 to 2007).

Table 5: Example of Reported Income, Pre-Managed Income and Reserve Errors

Observation	Pre-Managed Income	Reported Income	Loss Reserve Error
1	$90 Million	$100 Million	-$10 Million
2	$100 Million	$100 Million	$0 Million
3	$115 Million	$100 Million	$15 Million

Table 6: Demographic Control Variables

Firm demographic variables (X)	
$Size_{i,t}$	= natural logarithm of total assets of insurer *i* in year *t*
$Group_{i,t}$	= 1 if the insurer *i* is a member of a group in year *t*
$Stock_{i,t}$	= 1 if the insurer *i* is a stock company in year *t*, = 0 otherwise

Table 7: Sample Selection of the 11,210 P/C Insurer-Years

	Insurers	Insurer-years
Step (1)		
Initial (all observations with positive total assets)	3,522	32,492
Positive losses incurred	3,129	26,266
Positive reserves	3,090	25,859
Step (2)		
Loss reserves errors are available	2,729	23,546
Step (3)		
Active firms	2,724	23,492
Step (4)		
Stock or mutual insurers domiciled in the United States	2,440	21,413
Step (5)		
Direct premiums written is positive	2,323	20,022
Step (6)		
Exclude insurer-years that with more than 25% of net premiums in Accident and Health, Surety and Fidelity, Credit, Title, and Mortgage insurance	2,233	18,913
Step (7)		
Exclude insurer-years with more than 25% of net premiums in workers' compensation insurance	2,021	16,648
Step (8)		
Exclude insurer-years with extreme reserve errors[58]	1,909	14,179
Step (9)		
Non-missing values for all dependent and independent variables	1,533	11,210

[58] According to Beaver et al. (2003), after excluding extreme reserve errors, their sample size decreased from 13,807 to 11,460 (1988-1997). The reduction of sample size in step (8) of this paper is comparable to that of Beaver et al. (2003).

Table 8: Summary Statistics: Loss Reserve Errors by Year

Panel A: Loss Reserve Error of All Accident Years (Error)

Year	N	Mean	Std Dev	Min	Q1	Median	Q3	Max
1996	991	0.030	0.071	-0.281	-0.002	0.025	0.066	0.323
1997	913	0.025	0.066	-0.301	-0.007	0.020	0.059	0.366
1998	863	0.008	0.068	-0.357	-0.018	0.008	0.039	0.308
1999	872	-0.004	0.071	-0.363	-0.035	0.001	0.031	0.318
2000	879	-0.018	0.076	-0.344	-0.054	-0.003	0.021	0.236
2001	901	-0.020	0.072	-0.305	-0.054	-0.006	0.019	0.246
2002	957	-0.016	0.068	-0.302	-0.052	-0.002	0.020	0.271
2003	991	0.001	0.058	-0.304	-0.026	0.003	0.029	0.244
2004	965	0.020	0.057	-0.304	-0.007	0.015	0.044	0.307
2005	934	0.026	0.051	-0.303	0.002	0.022	0.046	0.287
2006	960	0.030	0.052	-0.293	0.004	0.025	0.054	0.301
2007	984	0.029	0.052	-0.302	0.004	0.023	0.054	0.307
Total	11210	0.010	0.067	-0.363	-0.016	0.012	0.041	0.366

Panel B: Loss Reserve Error of Prior Accident Years (Error_PY)

Year	N	Mean	Std Dev	Min	Q1	Median	Q3	Max
1996	991	0.019	0.056	-0.269	-0.003	0.015	0.044	0.339
1997	913	0.016	0.055	-0.255	-0.005	0.009	0.037	0.445
1998	863	0.006	0.052	-0.255	-0.017	0.005	0.028	0.303
1999	872	-0.002	0.054	-0.301	-0.018	0.001	0.020	0.324
2000	879	-0.011	0.058	-0.294	-0.035	-0.002	0.015	0.219
2001	901	-0.018	0.058	-0.249	-0.041	-0.005	0.012	0.240
2002	957	-0.020	0.056	-0.281	-0.041	-0.005	0.009	0.200
2003	991	-0.013	0.047	-0.297	-0.031	-0.002	0.010	0.193
2004	965	0.000	0.045	-0.286	-0.016	0.002	0.017	0.311
2005	934	0.009	0.040	-0.286	-0.004	0.007	0.021	0.286
2006	960	0.014	0.040	-0.283	0.000	0.011	0.029	0.235
2007	984	0.017	0.042	-0.284	0.000	0.012	0.033	0.302
Total	11210	0.002	0.052	-0.301	-0.015	0.004	0.023	0.445

Table 8: Summary Statistics: Loss Reserve Errors by Year (continue)

Panel C: Loss Reserve Error of Current Accident Years (Error_CY)

Year	N	Mean	Std Dev	Min	Q1	Median	Q3	Max
1996	991	0.011	0.030	-0.178	-0.001	0.009	0.023	0.208
1997	913	0.009	0.030	-0.300	-0.003	0.007	0.023	0.158
1998	863	0.002	0.033	-0.309	-0.010	0.002	0.016	0.159
1999	872	-0.003	0.033	-0.287	-0.016	0.000	0.015	0.132
2000	879	-0.008	0.034	-0.281	-0.024	-0.004	0.010	0.146
2001	901	-0.002	0.028	-0.250	-0.013	0.000	0.012	0.114
2002	957	0.003	0.026	-0.215	-0.008	0.005	0.015	0.132
2003	991	0.014	0.028	-0.271	0.003	0.012	0.026	0.138
2004	965	0.019	0.026	-0.177	0.006	0.016	0.032	0.153
2005	934	0.017	0.023	-0.095	0.005	0.014	0.030	0.123
2006	960	0.017	0.021	-0.085	0.004	0.013	0.026	0.135
2007	984	0.012	0.020	-0.135	0.003	0.011	0.021	0.090
Total	11210	0.008	0.029	-0.309	-0.004	0.008	0.022	0.208

Table 9: Summary Statistics

Variable	Mean	Std. Dev.	Min	Q1	Median	Q3	Max
Panel A: Loss Reserve Error Measures							
Error	0.010	0.067	-0.363	-0.016	0.012	0.041	0.366
Error_PY	0.002	0.052	-0.301	-0.015	0.004	0.023	0.358
Error_CY	0.008	0.029	-0.309	-0.004	0.008	0.022	0.208
Panel B: Investment Income and Underwriting Income Measures							
InvestYield	0.053	0.026	-0.16	0.04	0.051	0.062	0.434
InvIncome	0.043	0.024	-0.150	0.031	0.041	0.053	0.360
InvIncome_U	0.046	0.030	-0.265	0.032	0.043	0.058	0.285
UndwtIncome	-0.008	0.062	-0.483	-0.034	-0.004	0.022	0.458
UndwtIncome_PM	0.002	0.098	-0.500	-0.049	0.010	0.060	0.460
Temp_InvIncome	0.000	0.018	-0.152	-0.007	-0.001	0.005	0.252
Temp_InvIncome_U	0.000	0.024	-0.250	-0.009	0.000	0.008	0.237
Temp_UndwtIncome_PM	0.010	0.081	-0.485	-0.029	0.013	0.054	0.460
Spt_InvIncome	0.000	0.999	-7.958	-0.417	-0.066	0.290	9.803
Spt_InvIncome_U	0.000	1.000	-11.577	-0.457	-0.050	0.379	11.493
Spt_UndwtIncome_PM	0.141	1.509	-10.317	-0.587	0.230	0.978	10.286
Panel C: Investment Portfolio							
Bond	0.726	0.216	0.000	0.623	0.774	0.887	1.294
CommonStock	0.129	0.163	-0.012	0.000	0.072	0.196	0.984
Panel D: Underwriting Related Risk measures							
Longtail	0.142	0.270	0.000	0.000	0.021	0.114	1.000
BusHerf	0.433	0.239	0.090	0.245	0.375	0.541	1.000
GeoHerf	0.522	0.383	0.000	0.130	0.461	1.000	1.000
Growth	0.112	0.388	-0.906	-0.032	0.053	0.169	3.395
Panel E: Other Hypothesized Incentives							
TaxRate	0.235	0.162	0.000	0.000	0.340	0.350	0.390
Prob_Fail	0.003	0.011	0.000	0.000	0.001	0.003	0.417
RateReg	0.407	0.330	0.000	0.104	0.378	0.617	1.000
Reinsurance	0.387	0.283	0.000	0.138	0.335	0.613	1.000
Panel F: Firm Demographics							
Age	48.910	42.948	4	17	31	73	215
Total Assets ($Million)	770.53	3848.6	0.493	30.729	102.49	349.31	105000
Size	11.628	1.785	6.201	10.333	11.538	12.764	18.468
Group	0.767	0.423	0.000	1.000	1.000	1.000	1.000
Stock	0.746	0.436	0.000	0.000	1.000	1.000	1.000

Note: Sample Size = 11210, Sample Year = 1996-2007. ***Error*** is the loss reserve error (the difference between initial reported loss reserve and the 5-year developed loss reserve) scaled by total assets; ***Error_CY*** is the loss reserve error of the most recent accident year (same as calendar year); ***Error_PY*** is the sum of loss reserve errors of all prior years; ***InvestYield*** is the investment yield ratio, which is the investment income scaled by average invested assets; ***InvIncome*** is the reported investment income on statutory annual statement scaled by the total assets; ***InvIncome_U*** is the investment income plus change in unrealized capital gains/losses scaled by total assets; ***UndwtIncome*** is the reported underwriting income scaled by total assets; ***UndwtIncome_PM*** is the pre-managed underwriting income scaled by total assets; ***Temp_InvIncome*** is the investment income with temporal benchmark, calculated as difference between the *InvIncome* and predicted *InvIncome* from the past three years; ***Spt_InvIncome*** is investment income with spatial benchmark, which is the Z-score of *InvInvome* in the earning distribution within each year; ***Temp_InvIncome_U*** is the difference between the *InvIncome_U* and predicted *InvIncome_U* from the past three years (temporal benchmark); ***Spt_InvIncome_U*** is the Z-score of *InvInvome_U* in its earning distribution within each year; ***Temp_UndwtIncome_PM*** is the difference between the pre-managed underwriting income (*UndwtIncome_PM)* and predicted *UndwtIncome* from the past three years (temporal benchmark); ***Spt_UndwtIncome_PM*** is the Z-score of *UndwtIncome_PM* in the earning distribution of reported underwriting income within each year; ***Bond*** is the proportion of invested assets in bonds; ***CommonStock*** is the proportion of invested assets in common stocks; ***Longtail*** is the proportion of net premiums written in long-tail liability lines (product liability, other liability and medical malpractice liability) (Beaver, McNichols, and Nelson 2003); ***BusHerf*** is the business line Herfindahl index; ***GeoHerf*** is the geographic Herfindahl index; ***Growth*** is the one year growth rate of net premiums written; ***TaxRate*** is the marginal tax rate based on pre-income-tax taxable income and adjustment for loss reserve errors; ***Reinsurance*** is the premiums ceded to reinsurers scaled by total gross premiums; ***Age*** is the firm age (displayed for data description purpose, not used in model); ***Size*** is natural logarithm of total assets ($000); ***Total Assets*** is the total admitted assets ($million) by the end of the year *t* (displayed for data description purpose, not used in model); ***Group*** is an indicator of whether an insurer is an affiliate to a group company; ***Stock*** is an indicator of whether an insurer is a stock company.

Table 10: Within-Company Variations of Investment Income Measures (1996-2007)

Panel A: Within-Company Mean and Standard Deviation (Sample Size: 1,244 Insurers)

Variable		Mean	Std. Dev.	Min	Q1	Median	Q3	Max
InvIncome	Mean	0.043	0.014	-0.023	0.035	0.043	0.051	0.125
	Std.	0.016	0.015	0.001	0.008	0.012	0.018	0.168
InvIncome_U	Mean	0.045	0.015	-0.027	0.037	0.045	0.053	0.140
	Std.	0.021	0.021	0.001	0.010	0.015	0.024	0.196
Temp_InvIncome	Mean	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Std.	0.014	0.016	0.000	0.006	0.010	0.015	0.200
Temp_InvIncome_U	Mean	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Std.	0.019	0.018	0.001	0.010	0.013	0.021	0.166
Spt_InvIncome	Mean	-0.020	0.530	-2.990	-0.300	-0.040	0.260	3.500
	Std.	0.600	0.580	0.010	0.280	0.420	0.670	5.530
Spt_InvIncome_U	Mean	-0.020	0.540	-2.110	-0.300	-0.030	0.230	4.040
	Std.	0.690	0.650	0.060	0.350	0.490	0.750	6.020

Panel B: Within-Company Range (Sample Size: 1,391 Insurers)

Variable	Mean	Std. Dev.	Min	Q1	Median	Q3	Max
InvIncome	0.043	0.043	0.000	0.019	0.032	0.050	0.328
InvIncome_U	0.057	0.061	0.000	0.021	0.040	0.068	0.547
Temp_InvIncome	0.038	0.043	0.000	0.016	0.026	0.045	0.392
Temp_InvIncome_U	0.053	0.054	0.000	0.024	0.037	0.059	0.440
Spt_InvIncome	1.646	1.668	0.000	0.688	1.161	1.942	11.256
Spt_InvIncome_U	1.885	1.874	0.001	0.867	1.348	2.153	17.570

Note: ***InvIncome*** is the reported investment income on statutory annual statement scaled by the total assets; ***InvIncome_U*** is the investment income plus change in unrealized capital gains/losses scaled by total assets; ***Temp_InvIncome*** is the investment income with temporal benchmark, calculated as difference between the *InvIncome* and predicted *InvIncome* from the past three years; ***Spt_InvIncome*** is investment income with spatial benchmark, which is the Z-score of *InvInvome*

in the earning distribution within each year; ***Temp_InvIncome_U*** is the difference between the *InvIncome_U* and predicted *InvIncome_U* from the past three years (temporal benchmark); ***Spt_InvIncome_U*** is the *Z*-score of *InvInvome_U* in its earning distribution within each year.

Table 11: Comparison of Reported and Pre-managed Net Income

		Reported		Pre-Managed		Reported		Pre-Managed		Reported		Pre-Managed	
Year	N	Number of Obs	%	Number of Obs	%	Number of Obs	%	Number of Obs	%	Number of Obs	%	Number of Obs	%
		< 0%				0% to 5%				> 5%			
1996	991	225	23%	226	23%	**554**	**56%**	**252**	**25%**	212	21%	513	52%
1997	913	81	9%	143	16%	**542**	**59%**	**257**	**28%**	290	32%	513	56%
1998	863	135	16%	231	27%	**502**	**58%**	**226**	**26%**	226	26%	406	47%
1999	872	159	18%	310	36%	**529**	**61%**	**260**	**30%**	184	21%	302	35%
2000	879	223	25%	398	45%	**520**	**59%**	**246**	**28%**	136	15%	235	27%
2001	901	344	38%	467	52%	**437**	**49%**	**220**	**24%**	120	13%	214	24%
2002	957	337	35%	449	47%	**496**	**52%**	**292**	**31%**	124	13%	216	23%
2003	991	180	18%	338	34%	**594**	**60%**	**293**	**30%**	217	22%	360	36%
2004	965	128	13%	165	17%	**556**	**58%**	**317**	**33%**	281	29%	483	50%
2005	934	106	11%	144	15%	**524**	**56%**	**214**	**23%**	303	32%	576	62%
2006	960	67	7%	92	10%	**527**	**55%**	**232**	**24%**	365	38%	636	66%
2007	984	83	8%	114	12%	**547**	**56%**	**229**	**23%**	354	36%	641	65%
Total	11210	2,068	18%	3077	27%	**6,328**	**56%**	**3,038**	**27%**	2,812	25%	5,095	45%

Note: The proportion of observations with pre-managed income between 0% and 5% is significantly larger than the proportion of observations with reported net income between 0% and 5% at the 0.001 level.

Table 12: Test for Variance -Reported and Pre-Managed Net Income (1996-2007)

	Reported Net Income		Pre-Managed Net Income		
Year	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**F-Ratio**
1996	0.023	0.053	0.053	0.091	2.912***
1997	0.040	0.055	0.066	0.094	2.872***
1998	0.031	0.050	0.039	0.093	3.469***
1999	0.025	0.045	0.020	0.094	4.359***
2000	0.017	0.050	-0.002	0.096	3.690***
2001	0.006	0.050	-0.014	0.090	3.273***
2002	0.009	0.047	-0.008	0.085	3.358***
2003	0.026	0.053	0.027	0.083	2.446***
2004	0.031	0.068	0.050	0.093	1.880***
2005	0.037	0.051	0.063	0.074	2.132***
2006	0.044	0.054	0.074	0.076	2.042***
2007	0.040	0.055	0.068	0.082	2.202***

Note: F-ratios are the ratio of variance of pre-managed net income and reported net income. Net income is scaled by total assets.

Table 13: Model Results (1) –Loss Reserve Errors (*Error*)

Dependent Variable: Loss Reserve Errors of All Accident Years (Error)									
	Model (1) No Benchmark			Model (2) Temporal Benchmark			Model (3) Spatial Benchmark		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
Smoothing									
InvIncome	0.0506	0.0243	**	0.0464	0.0255	*	0.0015	0.0006	**
UndwrtIncome_PM	0.4836	0.0190	***	0.4821	0.0200	***	0.0293	0.0011	***
Other Hypothesized Incentives									
Taxrate	0.0390	0.0050	***	0.0433	0.0051	***	0.0430	0.0050	***
Prob_Fail	0.5144	0.0884	***	0.5197	0.0937	***	0.5181	0.0852	***
RateReg	-0.0008	0.0048		-0.0003	0.0044		-0.0002	0.0048	
Reinsurance	-0.0023	0.0041		-0.0035	0.0038		-0.0028	0.0041	
Investment Strategy									
Bond	-0.0070	0.0051		-0.0038	0.0054		-0.0076	0.0053	
CommonStock	-0.0113	0.0084		-0.0082	0.0080		-0.0112	0.0084	
Underwriting Covariates									
Longtail	0.0165	0.0077	**	0.0157	0.0074	**	0.0142	0.0077	*
BusHerf	0.0062	0.0058		0.0060	0.0055		0.0044	0.0060	
GeoHerf	0.0135	0.0037	***	0.0137	0.0035	***	0.0135	0.0038	***
Growth	0.0013	0.0012		0.0014	0.0012		0.0011	0.0012	
Firm Characteristics									
Size	-0.0026	0.0021		-0.0018	0.0019		-0.0024	0.0021	
Group	0.0028	0.0041		0.0035	0.0039		0.0025	0.0042	
Stock	-0.0190	0.0059	***	-0.0169	0.0055	***	-0.0192	0.0059	***
Year Dummies		Yes			Yes			Yes	
Constant	0.0481	0.0257	*	0.0260	0.0244		0.0383	0.0261	
Sample Size	11,210			11,210			11,210		
Log-likelihood	23,256			23,395			23,205		
AIC	-46,461			-46,738			-46,358		
BIC	-46,270			-46,547			-46,168		

***: Significant at the 0.01 level; **: Significant at the 0.05 level; *: Significant at the 0.1 level.

Note: Results are based on the two-way fixed effects model.

Table 14: Model Results (1) –Loss Reserve Errors of Prior Accident Years (*Error_PY*)

Dependent Variable: Loss Reserve Errors of Prior Accident Years (Error_PY)									
	Model (4) No Benchmark			Model (5) Temporal Benchmark			Model (6) Spatial Benchmark		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
Smoothing									
InvIncome	0.0179	0.0203		0.0141	0.0211		0.0007	0.0005	
UndwrtIncome_PM	0.3495	0.0174	***	0.3454	0.0180	***	0.0212	0.0011	***
Other Hypothesized Incentives									
Taxrate	0.0284	0.0044	***	0.0323	0.0045	***	0.0311	0.0045	***
Prob_Fail	0.3810	0.0676	***	0.3825	0.0698	***	0.3837	0.0655	***
RateReg	0.0003	0.0041		0.0006	0.0039		0.0007	0.0041	
Reinsurance	0.0045	0.0034		0.0037	0.0033		0.0041	0.0034	
Investment Strategy									
Bond	0.0010	0.0042		0.0033	0.0044		0.0006	0.0043	
CommonStock	0.0060	0.0068		0.0081	0.0067		0.0061	0.0069	
Underwriting Covariates									
Longtail	0.0032	0.0079		0.0026	0.0079		0.0015	0.0080	
BusHerf	0.0007	0.0054		0.0007	0.0053		-0.0006	0.0056	
GeoHerf	0.0092	0.0036	***	0.0094	0.0035	***	0.0092	0.0036	***
Growth	0.0033	0.0011	***	0.0033	0.0011	***	0.0032	0.0011	***
Firm Characteristics									
Size	-0.0032	0.0018	*	-0.0027	0.0017		-0.0031	0.0018	*
Group	0.0003	0.0035		0.0008	0.0034		0.0001	0.0036	
Stock	-0.0105	0.0040	***	-0.0089	0.0038	**	-0.0107	0.0040	***
Year Dummies		Yes			Yes			Yes	
Constant	0.0404	0.0220	*	0.0232	0.0215		0.0325	0.0224	
Sample Size	11,210			11,210			11,210		
Log-likelihood	24,689			24,734			24,659		
AIC	-49,327			-49,416			-49,267		
BIC	-49,136			-49,225			-49,076		

***: Significant at the 0.01 level; **: Significant at the 0.05 level; *: Significant at the 0.1 level.

Table 15: Model Results (1) –Loss Reserve Errors of Current Accident Year (*Error_CY*)

Dependent Variable: Loss Reserve Errors of Current Accident Year (Error)						
	Model (7) No Benchmark		Model (8) Temporal Benchmark		Model (9) Spatial Benchmark	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
Smoothing						
InvIncome	0.0326	0.0136 **	0.0322	0.0136 **	0.0008	0.0004 **
UndwrtIncome_PM	0.1445	0.0090 ***	0.1480	0.0092 ***	0.0090	0.0006 ***
Other Hypothesized Incentives						
Taxrate	0.0083	0.0027 ***	0.0085	0.0027 ***	0.0085	0.0028 ***
Prob_Fail	0.1465	0.0420 ***	0.1513	0.0442 ***	0.1510	0.0419 ***
RateReg	-0.0008	0.0033	-0.0006	0.0033	-0.0006	0.0033
Reinsurance	-0.0061	0.0027 **	-0.0065	0.0026 ***	-0.0062	0.0027 **
Investment Strategy						
Bond	-0.0083	0.0029 ***	-0.0074	0.0029 ***	-0.0086	0.0029 ***
CommonStock	-0.0194	0.0063 ***	-0.0183	0.0062 ***	-0.0193	0.0062 ***
Underwriting Covariates						
Longtail	0.0141	0.0067 **	0.0138	0.0066 **	0.0133	0.0066 **
BusHerf	0.0062	0.0043	0.0061	0.0042	0.0056	0.0042
GeoHerf	0.0048	0.0024 **	0.0048	0.0024 **	0.0047	0.0024 **
Growth	-0.0018	0.0008 **	-0.0017	0.0008 **	-0.0018	0.0008 **
Firm Characteristics						
Size	0.0015	0.0015	0.0018	0.0015	0.0016	0.0015
Group	0.0024	0.0025	0.0026	0.0025	0.0023	0.0025
Stock	-0.0090	0.0037 **	-0.0083	0.0036 **	-0.0091	0.0037 **
Year Dummies		Yes		Yes		Yes
Constant	-0.0022	0.0182	-0.0077	0.0178	-0.0040	0.0180 **
Sample Size	11,210		11,210		11,210	
Log-likelihood	28,072		28,150		28,105	
AIC	-56,093		-56,248		-56,157	
BIC	-55902		-56,057		-55,967	

***: Significant at the 0.01 level; **: Significant at the 0.05 level; *: Significant at the 0.1 level.

Table 16: Model Results (2) – Mutual and Stock Companies

Income Measures: No Benchmark									
	Model (10) *Error*			Model (11) *Error_PY*			Model (12) *Error_CY*		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
Smoothing									
InvIncome	0.2780	0.0484	***	0.1075	0.0391	***	0.1835	0.0339	***
UndwrtIncome_PM	0.4650	0.0352	***	0.3174	0.0344	***	0.1728	0.0222	***
*Stock*InvIncome*	-0.2864	0.0541	***	-0.1158	0.0444	***	-0.1854	0.0365	***
Stock UndwrtIncome_PM*	0.0637	0.0380	*	0.0738	0.0363	**	-0.0265	0.0221	***
Other Hypothesized Incentives									
Taxrate	-0.0019	0.0052		-0.0043	0.0048		-0.0008	0.0034	***
Prob_Fail	1.6957	0.4301	***	1.1965	0.3150	***	0.5955	0.2999	***
RateReg	0.0126	0.0163		0.0266	0.0119	**	-0.0128	0.0095	***
Reinsurance	0.0056	0.0088		0.0218	0.0063	***	-0.0156	0.0054	***
*Stock*Taxrate*	0.0173	0.0061	***	0.0114	0.0055	**	0.0058	0.0036	***
*Stock*Prob_Fail*	-1.1746	0.4367	***	-0.8101	0.3208	***	-0.4539	0.3014	***
*Stock*RateReg*	-0.0139	0.0165		-0.0276	0.0121	**	0.0126	0.0095	***
*Stock*Reinsurance*	-0.0088	0.0096		-0.0193	0.0071	***	0.0105	0.0060	***
Investment Strategy									
Bond	-0.0066	0.0052		0.0014	0.0042		-0.0084	0.0029	***
CommonStock	-0.0126	0.0084		0.0045	0.0068		-0.0190	0.0062	***
Underwriting Covariates									
Longtail	0.0145	0.0074	**	0.0016	0.0078		0.0139	0.0066	***
BusHerf	0.0063	0.0058		0.0008	0.0053		0.0062	0.0042	***
GeoHerf	0.0134	0.0037	***	0.0093	0.0036	***	0.0046	0.0024	***
Growth	0.0017	0.0012		0.0036	0.0011	***	-0.0019	0.0008	***
Firm Characteristics									
Size	-0.0028	0.0020		-0.0032	0.0018	*	0.0013	0.0015	***
Group	0.0023	0.0040		-0.0004	0.0035		0.0026	0.0024	***
Stock	0.0000	0.0098		0.0098	0.0065		-0.0091	0.0062	***
Year Dummies		Yes			Yes			Yes	
Constant	0.0407	0.0262		0.0285	0.0220		0.0025	0.0186	***

Table 16 (Continue)

Sample Size	11,210	11,210	11,210
Log-likelihood	23,296	23,279	23,095
AIC	-46,527	-46,505	-46,139
BIC	-46,293	-46,315	-45,948

***: Significant at the 0.01 level; **: Significant at the 0.05 level; *: Significant at the 0.1 level.

Table 17: Model Results of Robustness Checks

Dependent Variable: Loss Reserve Errors of All Accident Years (Error)						
	Without Benchmark		Temporal Benchmark		Spatial Benchmark	
Model	**Coef.**	**Std. Err**	**Coef.**	**Std. Err**	**Coef.**	**Std. Err**
(1) Two-Way Fixed-Effects Model						
(1.a)	*Investment Yield Ratio* (alternative investment income measure)					
	0.0454	0.0188 **	0.0399	0.0188 **	0.0017	0.0006 ***
(1.b)	*TaxRate2* (alternative tax measure)					
	0.0630	0.0261 **	0.0550	0.0274 **	0.0018	0.0007 ***
(1.c)	*TaxIndicator* (alternative tax measure)					
	0.0511	0.0244 **	0.0468	0.0255 *	0.0015	0.0006 **
(1.d.1)	Sub-sample: *Wcomp* ≤ 10%					
	0.0802	0.0248 ***	0.0764	0.0254 ***	0.0022	0.0006 ***
(1.d.2)	Sub-sample: *Wcomp* ≤ 0%					
	0.1052	0.0309 ***	0.1031	0.0321 ***	0.0029	0.0008 ***
(1.e.1)	Sub-sample: *ShortTail* ≤ 25%					
	0.0566	0.0332 *	0.0522	0.0340	0.0016	0.0009 *
(1.e.2)	Sub-sample: *ShortTail* ≥ 75%					
	0.0342	0.0711	0.0375	0.0718	0.0010	0.0017
(1.f)	With Interactions of Stock and long tail commercial, long tail personal, short tail commercial					
	0.0485	0.0242 **	0.0444	0.0254 *	0.0014	0.0006 **
(1.g.1)	Sub-sample for 1996-2001					
	0.0568	0.0276 **	0.0477	0.0259 *	0.0013	0.0007 *
(1.g.2)	Sub-sample for 2002-2007					
	0.0195	0.0338	0.0202	0.0344	0.0008	0.0008
(1.g.3)	Sub-sample for 1996-2001 (mutual insurers)					
	0.1534	0.0604 ***	0.1765	0.0610 ***	0.0047	0.0015 ***
(1.g.4)	Sub-sample for 2002-2007 (mutual insurers)					
	0.2246	0.0754 ***	0.2186	0.0778 ***	0.0047	0.0015 ***
(2) Robust pooled regression (HC3)						
	0.0738	0.0249 ***	0.0794	0.0233 ***	0.0018	0.0006 ***
(3) Random-Effects Model						
	0.0568	0.0244 **	0.0619	0.0291 **	0.0016	0.0006 ***
(4) Multilevel Mixed-Effects Model (with AR 1 residuals)						
	0.0292	0.014 **	0.0346	0.0151 **	0.0009	0.0003 ***
(5) Dynamic Model (Arellano-Bond Model)						
	0.0647	0.0307 **	0.0493	0.0297 *	0.0019	0.0008 **

Note:

(1) Two-Way Fixed-Effects Model

(1.a) Use Investment Yield Ratio as to measure the investment income (sample size = 11,210)
(1.b) Alternative of the marginal tax rate variable: *TaxRate2* based on CAS Exam 6 study notes (sample size = 11,210)
(1.c) Alternative of tax measure: *TaxIndicator* (defined as1 if the pre-managed taxes to be paid >0, =0 otherwise) (sample size = 11,210)
(1.d.1) Sub-sample with insurers who write no more than 10% of premiums in Workers' Compensation (sample size = 9,324)
(1.d.2) Sub-sample with insurers who write no more than 0% of premiums in Workers' Compensation (sample size = 6,484)
(1.e.1) Sub-sample of insurers who write no more than 25% of premiums in short-tail lines (sample size = 5,494)
(1.e.2) Sub-sample of insurers who write no less than 75% of premiums in short-tail lines (sample size = 709)
(1.f) With interactions between of *Stock* ownership and long-tail personal lines (*LongTail_Persn*), long-tail commercial lines (*LongTail_Com*m), and short-tail personal lines (*ShortTail_Persn*) (sample size = 11,210)
(1.g.1) Sub-sample for 1996-2001 (sample size= 5,419)
(1.g.2) Sub-sample for 2002-2007 (sample size = 5,791)
(1.g.3) Sub-sample for 1996-2001 (mutual insurers) (sample size = 1,446)
(1.g.4) Sub-sample for 2002-2007 (mutual insurers) (sample size = 1,406)

(2) Robust pooled regression with Heteroskedasticity-Consistent estimator (HC3) (Davidson and MacKinnon. 1993) (sample size = 11,210)

(3) Random-Effects Model (sample size = 11,210)

(4) Multi-Level Mixed-Effects Model (Level 1: firm-year observation; Level 2: firm; Level 3: insurance group) (sample size = 11,210)

(5) Dynamic Model (Arellano-Bond Model) with endogeneity of explanatory variable for underwriting income (sample size = 6,122)

Table 18: Model Results: Dynamic Model

Dependent Variable: Loss Reserve Errors of All Accident Years (Error)									
	Model (1) No Benchmark			Model (2) Temporal Benchmark			Model (3) Spatial Benchmark		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
Error_Lag									
Error(t-1)	0.7786	0.0402	***	0.8066	0.0422	***	0.7691	0.0399	***
Error(t-2)	-0.1972	0.0230	***	-0.1882	0.0236	***	-0.1920	0.0218	***
Smoothing									
InvIncome	0.0647	0.0307	**	0.0493	0.0297	*	0.0019	0.0008	**
UndwrtIncome_PM	0.1523	0.0259	***	0.1021	0.0234	***	0.0094	0.0014	***
Other Hypothesized Incentives									
Taxrate	0.0203	0.0051	***	0.0242	0.0052	***	0.0183	0.0052	***
Prob_Fail	0.4804	0.1421	***	0.4472	0.1496	***	0.4801	0.1652	***
RateReg	0.0001	0.0085		-0.0021	0.0083		0.0010	0.0084	
Reinsurance	-0.0193	0.0074	***	-0.0179	0.0074	**	-0.0191	0.0073	***
Investment Strategy									
Bond	-0.0086	0.0073		-0.0085	0.0065		-0.0097	0.0072	
CommonStock	0.0081	0.0154		-0.0029	0.0157		0.0072	0.0147	
Underwriting Covariates									
Longtail	0.0326	0.0168	**	0.0370	0.0173	**	0.0308	0.0156	**
BusHerf	-0.0042	0.0107		-0.0072	0.0108		-0.0068	0.0108	
GeoHerf	-0.0006	0.0069		0.0043	0.0068		0.0014	0.0070	
Growth	-0.0025	0.0023		-0.0027	0.0023		-0.0028	0.0023	
Firm Characteristics									
Size	0.0071	0.0043	*	0.0078	0.0044	*	0.0077	0.0042	*
Group	0.0042	0.0050		0.0035	0.0048		0.0026	0.0048	
Stock	-0.0138	0.0114		-0.0153	0.0116		-0.0159	0.0111	
Year Dummies		Yes			Yes			Yes	
Constant	-0.0806	0.0511		-0.0892	0.0540	*	-0.0854	0.0508	*
Obs in Model	11,210			11,210			11,210		
Sample Size	6,122			6,122			6,122		

***: Significant at the 0.01 level; **: Significant at the 0.05 level; *: Significant at the 0.1 level.

Note: Model is estimated by two step Arellano-Bond Model with robust VCE. Standard error is the Windmeijer (2005) WC-robust estimator. *UndwrtIncome_PM* is set as endogenous and the IVs are its first and second lag terms.