Loss Reserve Manipulation: Incentives and the Impact of Governance Structure

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Abstract

This study analyzes the determinants of U.S. listed P&C insurer's reserve error, with a particular focus on whether the level of financial distress affects the loss reserve evaluation, and investigates the relationship between loss reserve manipulation and corporate governance structure. This study reports four main results: first, we find strong evidence in favor of tax shield and smoothing hypotheses, although unlike previous studies, we used a more effective smoothing variable; second, we highlight that executive compensation structure produces weak effects on loss reserve manipulation; third, we reject the solvency incentives hypothesis and propose the prudential hypothesis: riskier insurance companies may have incentives to increase the loss reserve in order to retain cash flows and to make their financial structure more robust in the following years; finally, we find that insurers with smaller boards and more active audit committees are more likely to report enhancing loss reserve.

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1. Introduction

The earnings management practices of firms are widely documented in the accounting and financial literature, and there is strong evidence that managers manipulate earnings in response to specific incentives and to achieve a firm's goals and/or gain personal benefits. Earnings management is a robust phenomenon that extends across several countries, business sectors (some studies focus on non-financial firms, others on banks and insurance companies), and time periods.

With regard to insurance firms, the literature suggests that an effective way to manipulate income is to over- or underestimate the loss reserve, which represents the amount of money the insurer expects to pay out when insured events occur. The loss reserve represents one of the main items on the balance sheet of a Property and Casualty (P&C) insurer, and as there is no objective way of estimating future liabilities exactly, the loss reserve is affected by individual discretion; consequently, its estimation can be used as a key tool to pursue goals other than a fair representation of the paid cumulative losses.

The existing literature in this field measures the misestimation of loss reserve through the reserve error and identifies two primary methods for calculating it. According to Weiss (1985), it is the difference between the originally reported reserve and the cumulative developed losses paid at a future point in time (*Error_W*), while Kazenski et al. (1992) calculate it as the difference between the originally reported reserve and the re-estimated reserve at a given later period (*Error_K*).

With respect to the determinants of reserve error, the literature provides several incentives to explain the reasons why insurers might over- or underestimate the loss reserve:

1) smoothing incentives: insurers could manage their earnings to achieve long run profit goals. In particular, with the aim of overrunning the earnings procyclicality, insurers under- or overestimate the reserve when profits are significantly high (low) at the end of the fiscal year (Weiss, 1985; Grace, 1990; Petroni, 1992; Grace and Leverty, 2010);

2) tax incentives: because loss estimates are used to quantify tax liabilities, the reserve may be overestimated by insurers to increase the benefits of the tax shield (Grace, 1990; Petroni, 1992; Grace and Leverty, 2010);

3) solvency incentives: given the potential costs of non-compliance with solvency requirements, insurers have strong incentives to show an apparent financial soundness (Petroni, 1992; Harrington and Danzon, 1994; Penalva, 1998; Gaver and Paterson, 2004; Grace and Leverty, 2010);

4) executive compensation incentives: insurance managers could manipulate the loss reserve to obtain personal benefits. Following this idea, some emerging studies (Browne et al., 2008; Lai and Lin, 2008; Eckles and Halek, 2010) find a relationship between the reserve error and the incentives related to executive compensation.

When considering the reasons why insurers manipulate the loss reserve, it is important to underline the potential effects of this practice, distinguishing under-reserving from over-reserving.

Insufficient reserves produce the immediate effect of improving the insurer's surplus (i.e., the difference between assets and liabilities), making it appear that the insurer's position is less risky. However, under-reserving also increases the gross income, and as a result, the amount of cash outflows for taxes and to remunerate shareholders increases as well. It is clear that when claims need to be settled, the company will draw from its surplus to meet its claim settlement obligations. If such a situation continues unchecked, and the surplus is depleted, the company faces insolvency. In addition, as reserves are a component of rate making, under-reserving can result in rates that are lower than they should be, and this may accelerate the company's decline.

Moreover, over-reserving exposes the firm to criticism because it understates an insurer's financial strength and may send the false signal that rate increases are necessary. In addition, as earnings are understated, the company pays less in taxes. This could result in penalties from the tax authorities. However, over-reserving also produces important advantages, allowing the insurer to retain cash flows and increase the levels of premiums.

In summary, proper reserving is important to accurately reflect an insurer's financial position. Although loss reserves are the insurer's largest liability and the survival of insurers may well depend on their ability to accurately estimate reserves and appropriately price premiums, most stakeholders do not properly check their accuracy. For these reasons, we believe that an insurer's governance structure is important to mitigate loss reserve manipulation and under-reserving, in particular.

In this paper we analyze the determinants of listed P&C insurers' reserve error, focusing in particular on whether the level of financial distress affects the loss reserve evaluation, and investigate the relationship between loss reserve manipulation and corporate governance structure. We focus on a sample of 54 U.S. listed P&C insurance companies, analyzing data collected from SEC filings and Datastream and taking into account a relatively long sample period (1995–2005). We process the panel data using fixed effects regression models to account for unobservable cross-sectional differences that affect reserve error.

We are confident that we are able to further the existing literature in several ways.

First, prior studies measure smoothing as the average return on assets (Roa) for the previous three years, but we believe that this variable is able to capture the insurer's risk in addition to the smoothing effect. In fact, it is likely that a company with a high historical profitability *ceteris paribus* appears less risky than one with a low historical profitability. In order to capture the smoothing effect alone, we measure the smoothing variable as the difference between the Roa for the current fiscal year and the average of the Roa for the previous three years. When the difference is positive, we expect that insurers will overestimate the loss reserve. When it is negative, we predict that they will underestimate the loss reserve.

Second, although there is extensive research on reserve error manipulation by P&C insurers, there is no persuasive effort that verifies how the level of financial distress affects the loss reserve manipulation. Several authors find that insurers in major financial distress are inclined to underestimate the loss reserve compared to other insurers, but, theoretically, it is possible a

"prudential hypothesis", too. In fact, if a weak insurer underestimates loss reserve, it can incur in the future in serious financial problems, as previous shown. Consequently and according to a long run view, it should be inclined to enhance loss reserve, to retain cash flows and make more robust its financial structure in the following years. Looking beyond the different theoretical interpretations, the major criticism of prior studies concerns the approach used to examine whether or not an insurer has solvency incentives. The literature on loss reserve manipulation initially measured financial distress with the failure of one or more Insurance Regulatory Information System (IRIS) ratios, and later by trying to replicate the Financial Analysis and Surveillance Tracking (FAST) system. We believe that this approach may lead to biased results because it is not able to approximate the more complex NAIC (National Association of Insurance Commissioners) warning system and because it is based on an arbitrary IRIS ratios selection process[1]. Therefore, we believe that an effective way to extend the literature is to introduce a system of risk measures extensively used in the financial literature. In particular, we use accounting-based measures of financial distress (leverage, Roa volatility, and z-score), which, unlike the approaches used in prior studies, have the advantage of being not based on arbitrary choices. Moreover, we check the robustness of our findings by also using market-based measures (stock price volatility, VaR, and BetaVaR). Given the assumption of market efficiency, this should give a good measure of firm risk because all the information about risk and return should be incorporated in the stock price;

Third, although there is a substantial literature investigating insurance loss reserve manipulation and the use of accounting discretion to affect the compensation of managers, there is little research linking loss reserve manipulation and governance structure. We analyze the way in which governance structure affects loss reserve manipulation practices by taking into account a large set of variables related to ownership structure and board and audit committee quality and activity, whereas previous studies focus solely on a few governance variables.

Our findings have some interesting implications and can be summarized as follows:

1. In concert with major prior studies, we find that the most important determinants of reserve error are income smoothing incentives and tax incentives. Moreover, when we consider the managers' self-interested with regard to incentives, we find that compensation schemes have a marginal impact on loss reserve manipulation. Particularly, we find that the higher the bonus, the lower the overestimation. Relative to other components of compensation (salary, stock awarded and options granted) we report results that are not statistically significant.

2. In contrast to previous studies, we reject the solvency incentives theory and find that weak insurers are more likely to overestimate the loss reserve than are other insurers. Therefore, our results suggest a "prudential hypothesis" that is consistent with an insurer's long run view: riskier insurance companies may have incentives to increase the loss reserve to retain cash flows and make their financial structure more robust in the following years.

3. Finally, we find that among insurers, those with small boards and more active audit committees are less likely to underestimate their loss reserves. Therefore, properly functioning corporate governance mechanisms can help an insurer's stakeholders accurately check the adequacy of the loss reserve.

The remainder of the paper is organized into the following sections. Section 2 presents recent literature about loss reserve manipulation and its relationship with corporate governance structure. Section 3 contains a description of the data, sample construction procedures and the methodological approach, while Section 4 describes the main results. Section 5 concludes the paper.

2. Related literature and hypotheses development

2.1. Traditional incentives and insurer risk-taking

The loss reserve is the most important accrual P&C companies see on their balance sheets. Because of the nature of the losses included in the reserve, the role of management in determining reported income may be more relevant for insurers than for other firms. Required disclosure of revisions to loss reserve estimates allows researchers to measure the degree of management discretion. Smith

(1980) is the first paper to document the bias in each year's original estimate, and it suggests that this bias is not random, but is caused by specific loss reserve management strategies. By developing these significant indications, Weiss (1985) demonstrates that loss reserve management is driven by the need to stabilize the reported financial results and to absorb economic shocks (changes in the interest rate and unanticipated inflation). As managers may believe that shareholders prefer a stable income, insurers may be more likely to smooth income and to accurately forecast inflation; when incurred losses and loss expenses are high, an underestimation of the reserve could neutralize the effect on underwriting results, and when inflation is greater than forecasted, the loss reserve would also be underestimated. Grace (1990) reports empirical findings that support Weiss's (1985) results, and at the same time, introduces the tax incentives hypothesis: a high level of reported income increases the probability that managers will act to minimize the tax burden until the ultimate claim costs are known. To derive the decision variable used by the insurers, she adds the reserve back into taxable income. In the short run, the overestimation of future costs implies a reduction in taxable income and of cash outflows in the form of taxes. In the long run, overestimation may alter an insurer's stock price and may trigger the intervention of market and/or insurance authorities.

After these pioneering efforts, researchers tested new forms of the incentives for earnings manipulation, such as solvency incentives, rate regulation and competition incentives, and executive compensation incentives.

One group of studies finds that insurers under financial distress are inclined to underestimate the loss reserve compared to other insurers (the solvency incentives hypothesis), but starting with the same results, the interpretations of this behavior are different. The first solvency-related hypothesis focuses on the incentives by weak insurers to avoid regulatory intervention (Petroni, 1992; Gaver and Paterson, 2004; Grace and Leverty, 2010). The second solvency-related hypothesis is that (Harrington and Danzon, 1994) insurers with bigger solvency problems, due risk-insensitive guaranty funds, have an incentive to under-report claim liabilities to increase firm growth (the

moral hazard hypothesis). Finally, Penalva (1998) suggests that more stable insurance companies may signal their quality through a larger reserve.

A second group of studies suggests that insurers are inclined to under-reserve in response to rate regulation and competition in the P&C industry. Nelson (2000) highlights that the stricter rate regulatory environments are, the more insurers underestimate the loss reserve to persuade regulators that they can charge lower rates. While the evidence suggests that regulation has often held rates below the economic cost of writing business (Cummins and Harrington, 1987; Grabowski, et al., 1989), Grace and Leverty (2009) theorize a different relationship between reserve error and rate regulation. In fact, stringent rate regulation that pushes rates below the economic cost of writing business may produce an incentive to overestimate the loss reserve to mitigate the effects of rate suppression.

While prior studies document that P&C companies are influenced by several (potentially conflicting) incentives that derive from their shareholders' expectations (smoothing incentives), from the tax environment (tax incentives) or from the regulatory framework (solvency and rate incentives), a recent body of literature focuses on the managers' compensation structure. According to Lai and Lin (2008), managers are inclined to over-reserve when their compensation is composed of a considerable amount of stock awarded and options granted. It is because the enhancement of the reserve should strengthen an insurer's capacity to absorb unexpected losses and improve the firm's value in the long run. Conversely, managers opt for under-reserving when they have the opportunity to sell a large number of shares and to exercise a large number of options. Eckles and Halek (2010) find that managers are inclined to over-reserve when they receive either capped bonuses or no bonus at all, while managers tend to under-reserve when they hold restricted stocks and can exercise stock options. Additionally, their findings do not show any relationship between the awarding of stock options, restricted stocks, or long-term incentive plans and reserve error.

Finally, recent studies systematize the existing literature, developing a general theory about loss reserve management and its causes (Grace and Leverty, 2006 and 2010). Their findings provide no

evidence in favor of the smoothing and solvency hypotheses, while they support the findings of tax incentive and rate regulation studies.

Although the research on reserve error manipulation by P&C insurers is extensive, in our opinion, there is no persuasive effort that attempts to verify how the level of financial distress affects the loss reserve manipulation. The main criticism against prior studies is that the approach used to measure an insurer's financial distress is too simplistic or arbitrary (see part 3.3 for further details). In order to solve this problem, our paper tests the prudential hypothesis with a system of risk measures having a strong scientific basis that is widely used in the financial literature, not only for insurance companies. Thus, the formal representation of the first hypothesis we address in this study is as follows:

H1*: Riskier insurers have a greater incentive to reduce the under-reserving*

2.2. Corporate governance structure and accruals manipulation

Other studies related to our research explore the effects of corporate governance characteristics (board and audit committee composition and performance and ownership structure) on accruals manipulation, and on loss reserve manipulation in particular.

Several recent papers have pointed out that well functioning board governance can provide a more effective monitoring function and discourage the CEO's earnings manipulation behavior. In particular, Klein (2002) finds that abnormal accruals are negatively associated with both audit committee independence and board independence for a sample of 687 large and publicly traded U.S. firms. Xie et al. (2003) select 282 firms from the S&P 500 Index and underscore that the opportunities for engaging in earnings management are fewer for those companies with boards composed of more independent outside directors and directors with corporate experience. Abbott et al. (2004) explain that financial mis-statements are less likely to occur in firms whose audit committees are independent and have at least one financial expert. Cornett et al. (2008), with a

sample composed of the firms included in the S&P 100 Index, find that the presence of institutional investors in the capital ownership and their representation on the board of directors and the presence of independent outside directors on the board reduce the use of discretionary accruals. These factors largely offset the impact of option compensation, which strongly encourages earnings management.

Following these preliminary studies, others look at the effects of corporate governance structures on earnings manipulation across markets (Park and Shin (2004) in Canada; Davidson et al. (2005) in Australia; Wright et al. (2006) in the U.K.; Piot and Janin (2007) in France; Osma and Noguer (2007) in Spain; Wang et al. (2008) in China) and across business sectors (Zhou and Chen (2004), Cornett et al. (2009), for banks; Lai and Lin (2008) for insurance companies).

In particular, Zhou and Chen (2004) and Cornett et al (2009) extend the analysis to the banking sector. Zhou and Chen (2004) find that banks with more active audit committees, audit committees with better governance expertise, and more active boards are associated with less income-increasing earnings management. Cornett et al (2009), instead, find that board independence is negatively related to earnings management, while pay-for-performance positively affects earnings management.

Focusing on the insurance literature, investigations related to corporate governance in general, and to the impact of corporate governance structures on management behavior in particular, are less numerous. More precisely, there are some papers that analyze the determinants of board composition (He and Sommer, 2010; Mayers and Smith, 2010), the relationship between board structure and managers' compensation（Myers and Smith, 2010), the interdependence between reserve error manipulation and the governance mechanism (also including compensation schemes and ownership structure) (Eckles et al, 2007; Lai and Lin, 2008).

Under the last line of studies, Eckles et al. (2007) show that managers who hold more stocks tend to understate the loss reserve. In addition, they examine the monitoring effect the corporate board structure has in mitigating managers' reserve manipulation practices, finding that managers are more likely to manipulate reserves in the presence of a weak board.

Lai and Lin (2008) highlight the fact that insurers with larger boards and greater degrees of board independence are less likely to suffer from conventional agency problems (cost) and show a lower reserve error. Conversely, the relationships between reserve error and the other governance variables, such as a CEOs duality, a CEO's option-based wealth, and the shareholding of directors' are not statistically significant.

Even though there is a substantial literature investigating insurance loss reserve manipulation and the use of accounting discretion to affect a managers' compensation, there is little research linking loss reserve manipulation and governance structure. In addition, the studies on the monitoring effects of a corporate governance structure in mitigating managers' reserve manipulation only take into account certain governance characteristics. We believe this represents a gap in the existing literature that needs to be filled. Hence, the formal representation of the second hypothesis of this study is as follows:

H2*: Insurers with proper corporate governance show a lower probability of underestimating the loss reserve*

H2 (A)*: a greater percentage of equity owned by the largest shareholder reduces under-reserving*

H2 (B)*: more shareholdings by the CEO reduce under-reserving*

H2 (C)*: a smaller board size reduces under-reserving*

H2 (D)*: more frequent board meetings reduce under-reserving*

H2 (E)*: a larger audit committee reduces under-reserving*

H2 (F)*: more frequent audit committee meetings reduce under-reserving*

3. Data and econometric methods

3.1. Sample and data

We use a panel data of 54 U.S. listed P&C insurers covering the period from 1995 through 2005. In order to be included in the sample, an insurance company must meet the following requirements:

1. the insurer operates in the P&C sector; as we need extensive disclosures about the gradual settlement of claims over time (so called run-off triangle), we exclude life and health insurance companies;

2. the P&C insurer is listed on stock exchange, as, compared with previous studies, we use stock price data to estimate risk measures and to effectively test the prudential hypothesis;

3. the P&C listed insurer is U.S., as the vast majority of non-U.S. listed insurers does not disclose the run-off triangle;

4. the U.S. listed P&C insurer is a publicly traded firm during the period 1995-2005, as before 1995 and after 2005 data for calculating reserve error are not available.

Our sample is smaller than those used in previous studies, but it covers around the 50 per cent of the overall U.S. P&C industry, if we consider the amount of net written premiums. For example, in 2005, the insurers in our sample have collected net written premiums for an amount of $217.6 billion, that represents the 50.1 percent of the overall industry net written premiums (A.M. Best and Deloitte Analysis, 2005). Data are consistent with the circumstance that the U.S. P&C insurance market is highly concentrated.

Data for our study are collected from the following:

1. form 10-K, containing information about loss development, a consolidated balance sheet, consolidated statements of income, and consolidated statements of cash flow;

2. form DEF 14A, containing definitive proxy statements about executive compensation, corporate governance, and ownership structure;

3. Datastream, which provides information about stock price.

3.2. Reserve error

The SEC requires publicly traded insurance companies to disclose information about their loss reserve for each of the previous ten years, the annual revision of those reserves and cumulative paid losses. This is the source of information that the existing literature in this field refers to in order to measure the loss reserve misestimation through the reserve error, and it identifies two primary methods for calculating it. According to Weiss (1985), reserve error is the difference between the originally reported reserve and the cumulative developed losses paid at a future point in time (see Eq. (1)), whereas Kazenski et al. (1992) calculate it as the difference between the originally reported reserve and the re-estimated reserve in a given later period (see Eq. (2)).

$$Error\_W_{i,t}^{j} = \mathrm{Re}\,serve_{i,t} - Cumulative_{i,t+j} \qquad (1)$$

$$Error\_K_{i,t}^{j} = \mathrm{Re}\,serve_{i,t} - \mathrm{Re}\,estimation_{i,t+j} \qquad (2)$$

where i denotes an insurer ($i = 1, 2, \ldots, 54$), t denotes a time period ($t = 1995, 1996, \ldots, 2005$), and j denotes a development time horizon ($j = 5$). *Reserve* is the originally reported loss reserve, *Cumulative* is the sum of paid losses after a given later period, *Reestimation* is the value of reserve reestimated after a given later period. *Error* is scaled by total assets to reduce problems of heteroskedasticity. Five years time horizon is consistent with prior papers that have considered this development horizon able of capturing statistically significant reserve errors (Smith, 1980; Kazenski et al., 1992).

3.3. Measures of insurer risk: "traditional" approaches versus "innovative" approaches

Pioneering researchers attempting to estimate an insurer's financial weakness have focused on the IRIS system, which is, as underlined in the introduction, a set of financial ratios used by NAIC to determine whether an insurer should be subjected to more careful solvency scrutiny. Petroni (1992) and Beaver et al. (2003) identify a condition of financial distress in P&C insurance when a

company has one or more IRIS ratios (except those that involve reserves) outside the NAIC "usual range", whereas Neale et al. (2003) identify such a situation when four or more IRIS ratios are outside the NAIC range. Defining financial weakness based upon the IRIS ratios is potentially ambiguous because financial situations outside the range are not disclosed. Bratton (1994) proves the poor predictive power of this system because almost half of the troubled insurers in his sample have three or fewer IRIS ratios outside the "usual range" one year prior to insolvency. The difficulties faced by researchers in simulating the IRIS system arise from a variety of factors: the IRIS system is a preliminary screen, well-known by insurers, reviewed annually on the basis of the economic conditions (and consequently not stationary), and revised when the authorities deem it necessary, and not according to a predefined algorithm. Lastly, the final judgment is subject to the discretion of the authorities. In 1993, the NAIC instituted a more sophisticated solvency early warning system, the FAST, which is triggered when the IRIS system signals a troubled situation. The FAST tool supports a "ratios analysis" along with a "trend analysis" of specific items on the balance sheet. Therefore, recent studies (Grace and Laverty, 2010), in an effort to test the solvency incentives hypothesis, develop a method to evaluate an insurer's financial weakness similar to the FAST system, but as the FAST's algorithm is not disclosed, their approach may be arbitrary and, therefore, lead to misleading findings.

In summary, the analysis of the existing literature shows a need to test the solvency incentives hypothesis using risk measures that are less arbitrary and have a more scientific basis. In this regard, important indications arise from an emerging segment of the financial literature studying bank risk taking (Boyd and De Nicolò, 2005; Caprio et al., 2007; Laeven and Levine, 2009; Altunbas et al., 2010). Consequently, following this segment of studies and in an attempt to measure an insurers' financial weakness, we select a set of accounting-based and market-based risk measures.

In particular, among the accounting-based risk measures, we use the following:

- *leverage*, measured as the ratio between equity and total assets because it is a simple and effective measure of risk, as suggested by Carson and Hoyt (1995) and Grace et al. (1998). Moreover, it can be considered a good measure of the risk induced by the capital structure;

- *Roa volatility*, calculated as standard deviation of the return on assets for three years prior because it is used by potential shareholders and bondholders to estimate a firm's risk (Froot et al., 1993). It can be considered an effective measure of risk derived from the uncertainty of income flows;

- *z-score*, the sum of return on assets (Roa) and capital-asset ratio (Car), scaled to the standard deviation of asset returns (σ(Roa)) because it is widely used in the literature as a proxy for a firm's risk (Caprio et al., 2007; Laeven and Levine, 2009). It measures the "distance" from insolvency considering both the firm's capital structure and the return variability of assets (a higher *z-score* indicates that the insurer is more stable).

Among the market-based measures we use the following:

- *stock price volatility*, calculated as the annualized standard deviation of a firm's daily stock returns because, according to market efficiency theory, the overall variability in an insurer stock's returns reflects the risks inherent in the insurer's assets and liabilities. Both supervisors and insurance managers regularly monitor this measure of total risk (Ren and Schmidt, 2006; Pathan, 2009);

- *VaR*, measured as the maximum likely loss over a given time period at a given confidence level because it is the most frequently used downside risk measure (Ren and Schmidt, 2006). In this study, we use the empirical distribution of daily returns during the past twelve months and a confidence level of ninety-five per cent;

- *BetaVaR*, the ratio between the *VaR* of firm's stock and the *VaR* of the market index (in this study we use the *S&P 500 Index*) because it is able to capture systemic risk.

3.4. Measures of the explanatory variables

As the literature identifies the tax and smoothing incentives as the sources of the two main explanatory variables of reserve error, we first insert these two regressors in our model. As in Grace (1990), we measure the tax indicator (*Tax*) as the sum of net income and the estimated reserve, as a percentage of total assets. As an insurer's underwriting income is linked to the estimated reserve, the formula of the tax indicator used in the literature adds the estimated reserve to have a measure of income level before the insurer has made any decisions about the reserve. It is hypothesized that high levels of income, and hence high tax liabilities, lead insurers to overestimate their reserves. The smoothing indicator (*Smooth*) is defined, unlike in the previous literature (see for example Grace, 1990), as the difference between the Roa for the current fiscal year and the average Roa for the previous three years. Because managers may believe that the company's shareholders prefer a stable earnings trend, they may have a strong incentive to underestimate the reserve when they report earnings lower than the historical profitability. Conversely, they may have the tendency to overestimate the reserve when the earnings are higher than the average of the previous three years.

Second, the literature indicates that each component of executive compensation affects the management's behavior differently. In order to measure a managers' use of accounting practices to pursue self-interest, we analyze the CEO's compensation, focusing on three different components[2]:

- the change in salary (*Salary_change*). The change in salary is defined as the ratio between a forthcoming change in salary ($salary_{year\ t+1}$ - $salary_{year\ t}$) and total compensation. Managers who expect an increase in salary from year *t* to year *t+1* have an incentive to underestimate loss reserve reported in year *t* (Eckles and Halek, 2010);

- the bonus as percentage of total compensation (*Bonus*). According to the literature, the bonus can be classified as a way to align the interests of managers to the interests of shareholders, but at the same time, it can encourage a manager to take a short-run view. Therefore, a higher *Bonus* should represent an incentive to underestimate the loss reserve (Lai and Lin, 2008);

- the sum of the values of stock and stock options awarded, as percentage of total compensation (Stock&*Option_granted*). The literature classifies this component as a long-term incentive and

suggests that it may represent an incentive to promote overestimation: to improve a firm's future profitability and increase both the probability to exercise the stock options granted and the opportunity to sell stocks awarded, managers may arrive at a high estimate of the loss reserve (Lai and Lin, 2008).

Third, the literature suggests that a more effective governance structure may affect loss reserve manipulation. Particularly, as an underestimation causing reserve deficiencies, is likely to weaken an insurer's future balance sheets and limit its future growth; we expect that insurers with a more effective corporate governance structure are less inclined to under-reserve.

Therefore, we take into account a set of variables referring to three different dimensions of a corporate governance structure:

- the percentage of an insurer's equity owned by the largest shareholder (*Main_share*) and by the CEO (*CEO_share*). A high degree of ownership concentration forces managers to perform better in their work (La Porta et al., 1998), while a large CEO share should align the interests of managers and shareholders in the long run. Therefore, we expect a positive relationship with the reserve error for both variables.

- the size (*Dir_size*) and the number of meetings (*Dir_meet*) of the board of directors. The board of directors is the first line of defense against the opportunistic behavior of managers (CEO *in primis*) (Hermalin and Weisbach, 2003; Pathan, 2009), and the board size and the number of its meetings are the main characteristics used to measure the effectiveness of a board. The literature (Andres and Vallelado, 2008; Pathan, 2009) suggests that a board with a lot of directors assigns more people to supervise and advise on managers' decisions and, in this way, should be able to reduce the managers' opportunistic behavior. Conversely, a board with too many members may present considerable problems of organization, communication, and decision-making, as well as engage in what psychologists call "social loafing." Considering that our sample is composed of many large insurers, we should find that insurers with larger boards are inclined to under-reserve. In fact, the empirical evidence for non-financial firms suggests that the problems of oversized boards outweigh

their advantages (Yermack, 1996; Fernández et al., 1997; Eisenberg et al., 1998). Another key characteristic is the frequency of board meetings (Vafeas, 1999; Andres and Vallelado, 2008) because they provide board members with the opportunity to discuss how they wish to monitor managers, reserve estimations, and firm strategy. Hence, the more frequent the meetings, the closer the control the board has over managers, and the more relevant the advisory role. These factors lead to a reduction in the practice of underestimation.

- the size (*AC_size*) and the number of meetings (*AC_meet*) of the audit committee. The size of the audit committee can be interpreted as the willingness to improve the organizational status of the audit committee (Braiotta, 2000). Moreover, larger audit committees are more likely to be acknowledged as an authoritative body by the external and internal audit functions (Kalbers and Fogarty, 1993). However, as we saw with board size, a committee composed of too many members may experience low motivation and problems with coordination and organization. Therefore, it is difficult to predict if larger audit committees are able to effectively reduce reserve understatement. Meeting frequency may indirectly provide information about the audit committee's diligence (De Zoort et al., 2002; Menon and Williams, 1994), and therefore, we expect a positive relationship with reserve error.

Finally, we define a set of control variables to account for business mix, efficiency, and reinsurance. A first group of control variables measures differences in insurers business structure. One of these variables is longtail business (*Longtail*), which is defined as the percentage of net written premiums from longtail lines over the total net written premiums. Prior research finds that insurers underwriting long-tail lines of business have more discretion over their reserves (e.g., Petroni and Beasley, 1996; Beaver et al., 2003; Grace and Leverty, 2010). The second variable is the ratio between net written premiums and total assets (*Premiums_ta*) and measures the importance of underwriting activity for an insurer. The higher the *Premiums_ta* ratio, the greater the weight of claims settled will be, and therefore, the negative effect that the overestimation produces on insurers' current insurers balance sheets will be greater.

Our second type of control variable accounts for differences in efficiency. In particular, we use a combined ratio (*Combined*) that describes the level of efficiency in the extensive claim settlement process. As reported by Weiss (1985), when the underwriting process shows a low level of efficiency, the insurer has an incentive to overestimate the loss reserve in order to increase the level of premiums.

The last control variable is *Reinsurance*, which represents the percentage of gross written premiums ceded to reinsurers. The greater the reinsurance ratio, the greater the incentive to over-reserve should be.

3.5. Empirical models and estimation methods

3.5.1. Empirical models

The regressions Eq (3) and Eq (4) are formulated to empirically test Hypotheses ***H1*** and ***H2***, as discussed in Section 2.1 and in Section 2.2:

$$\begin{aligned} Error\_W_{i,t} = {} & \alpha + \beta_1 Tax_{i,t} + \beta_2 Smooth_{i,t} + \beta_3 Salary\_change_{i,t} + \beta_4 Bonus_{i,t} + \\ & + \beta_5 Stock\ \&\ Option\_granted_{i,t} + \beta_6 Risk_{i,t} + \beta_7 Longtail_{i,t} + \beta_8 \Pr emiums\_ta_{i,t} + \\ & + \beta_9 Combined_{i,t} + \beta_{10} \mathrm{Re} insurance_{i,t} + \sum_{t=1}^{1994-2005} \beta_t Year_t + \varepsilon_{i,t} \end{aligned} \tag{3}$$

$$\begin{aligned} Error\_W_{i,t} = {} & \alpha + \beta_1 Tax_{i,t} + \beta_2 Smooth_{i,t} + \beta_3 Salary\_change_{i,t} + \beta_4 Bonus_{i,t} + \\ & + \beta_5 Stock\ \&\ Option\_granted_{i,t} + \beta_6 Risk_{i,t} + \beta_7 Main\_share_{i,t} + \beta_8 CEO\_share_{i,t} + \\ & + \beta_9 Dir\_size_{i,t} + \beta_{10} Dir\_meet_{i,t} + \beta_{11} AC\_size_{i,t} + \beta_{12} AC\_meet_{i,t} + \beta_{13} Longtail_{i,t} + \\ & + \beta_{14} \Pr emiums\_ta_{i,t} + \beta_{15} Combined_{i,t} + \beta_{16} \mathrm{Re} insurance_{i,t} + \sum_{t=1}^{1994-2005} \beta_t Year_t + \varepsilon_{i,t} \end{aligned} \tag{4}$$

where i denotes an insurer ($i = 1, 2, \ldots, 54$), t denotes a time period ($t = 1995, 1996, \ldots, 2005$), *Risk* denotes one of the six risk measures, and $Error\_W^3$ denotes the difference between the originally reported reserve and the cumulative developed losses paid after five years. ε is the idiosyncratic error term that captures material errors and the effects of unpredictable events. The definition of the independent variables in the regressions is illustrated in Sections 3.2 and 3.3 and is also summarized in Table 1.

3.5.2. Estimation methods

The data set is a balanced panel of 54 listed insurance companies from 1995 to 2005 (594 firm-years). The firm characteristics are observed over 11 years for each of the 54 individuals in the sample, so the reserve error is scaled by the total assets, and the explanatory variables are indexed by both insurer and time. In the presence of unobserved insurer fixed-effects, panel 'Fixed-Effect' (FE) estimation is generally suggested (see Cameron and Trivedi, 2005, for details on FE estimation). Thanks to FE estimation, we control, on the one hand, for unobserved common time varying effects (i.e., the business cycle) and, on the other hand, for individual-specific effects (i.e., differences in business ability).

3.6. Descriptive statistics

Table 1 presents descriptive statistics for insurer-specific variables, reserve error measures, loss reserve manipulation incentives, and governance structure characteristics. With reference to insurer-specific variables in *Panel A*, the average value of total assets is almost $25 billion, and the average value of net written premiums is approximately $2.8 billion. These values reflect the presence of a significant number of large insurers in our sample. The smallest insurer in the sample has a book value of assets of around $25 million, while the largest has a book value of around $850 billion.

Looking at the percentages for *combined ratio* (on average less than 100 percent), our sample shows a good level of efficiency in the claim settlement process. The *longtail ratio*, which is a proxy for an insurer's business line mix, is 57 percent on average, with a median value of 67 percent. The two reserve error measures included in *Panel B* are different in terms of the averages (6.05 percent versus -1.15 percent) and in terms of variability (7.39 percent versus 6.62 percent). In particular, the mean *Error_W* is 6.05, which resembles the mean value (4.05) found by Grace and Leverty (2010). The error calculated according to Weiss's suggestions is positive on average and indicates the overestimation of loss reserves, while the error measure recommended by Kazenski et al. is negative and indicates the underestimation of loss reserves. *Panel C* reports descriptive statistics relative to each class of incentives. For the sake of brevity, we analyze only the findings relative to the risk measures.

In particular, the figures presented show that insurers' leverage is 26.03 percent on average, while the mean of *Roa_volatility* is 1.81 percent. The mean of *z-score* is 134.52. *Z-score* varies quite significantly across insurers: its standard deviation is 48.73, and its range varies from a minimum value of -59.91 to a maximum value of 404.60. Among the market-based measures, *stock_volatility* has a mean of 0.97 percent: it varies from a low of 0.35 percent per annum to a high of 8.56 percent; it has a standard deviation of 0.61 percent and high values of skewness (576.61) and of kurtosis (6199.04). *VaR*, measured as the maximum likely loss over one year at the 95 percent confidence level, is 3.22 percent, with a maximum of 24.66 percent and a minimum of 2.91 percent. Our estimate of the relationship between a firm's stock and the market index displays a variation similar to *VaR*: *BetaVaR* is 2.07 on average and has a standard deviation of 1.21.

Finally, the corporate governance structure in *Panel D* shows that the median *Dir_size* is 10, with a minimum of 4 and a maximum of 23, and the median *AC_size* is 4 with a minimum of 1 and a maximum of 11. With regard to the level of activity, the boards meet on average 5 times as frequently as the audit committees. With reference to ownership structure, the primary shareholder

has 25.36 percent of the voting rights on average, while the CEO's participation average is just above the threshold of 5 percent of outstanding shares (the average is 6.48).

Table 2 presents the descriptive statistics of the *Error_W* by year. Data reveal the existence of a relationship between the business cycle and the reserve error. In particular, the trend of reserve error suggests that insurance companies are less likely to overestimate loss reserve in the peaks of the business cycle (2000-2001), and during the recession (2002), when it is difficult to meet expectations on earnings growth rates, and when the effects of the crisis begin to impact on the profitability of the company. This evidence appears consistent with the smoothing hypothesis.

In Table A.1 in Appendix we analyze the Pearson's pair-wise correlation matrix between variables after applying the FE estimation. The *Error_W* is highly correlated (0.59) with the tax shield, but the relationship is not statistically significant. Multicollinearity among the incentives should not be a concern, as the maximum value of correlation coefficient is -0.31 between the smoothing indicator (*Smooth*) and the insurer's risk measure (*Risk*). The governance variables show high values of correlation. For example, the correlation coefficient between the number of a board's meetings and the weight of the main shareholder is high (-0.46).

Table A.2 in Appendix gives the correlations between each pair of risk variables. As predicated by the literature, *z-score* is negatively correlated with all measures of risk, except for leverage. As described by the theory, *VaR* is highly correlated with stock price volatility and with *BetaVaR*[4].

4. Empirical results and sensitivity analysis

Table 3 presents the results of the fixed effects regression Eq. (3), where the dependent variable is *Error_W*. The table reports six columns because to test the solvency hypothesis, we used a set of risk measures that includes both accounting-based (*Leverage, Roa_volatility*, *Z-score*) and market-based measures (*Stock_price_volatility*, *VaR*, *BetaVaR*). The regression Eq. (3) is well-fitted,

showing an overall R^2 exceeding 40 percent when we used accounting-based risk measures and an overall R^2 of around 38 percent when we used market-based risk measures.

With regard to "traditional" loss reserve incentives, *Tax* exhibits significant coefficients with the sign conforming to that predicted in the theory (for example in *Column 1* the coefficient is 0.4419 and *t* is 10.60), confirming that a greater potential tax savings is associated with a higher incentive to over-reserve. In addition, the *Smooth* variable is positively and significantly related to reserve error (in *Column 1* the coefficient is 0.1087 and *t* is 1.84), suggesting that insurers manage the loss reserve in an attempt to stabilize earnings; they have a strong incentive to underestimate the loss reserve when they report earnings lower than the firm's historical profitability, while they are inclined to overestimate the loss reserve when the difference from historical profitability is positive. Therefore, our results are consistent with the findings of previous studies (Weiss, 1985; Grace, 1990; Browne et al, 2008; Grace and Leverty, 2010), although we used a different smoothing variable.

Regarding the effects that incentives based on compensation structure have on loss reserve manipulation, we report findings that are weak compared to "traditional" loss reserve incentives. The percentage of bonus value on total compensation (*Bonus*) seems to be an incentive to under-reserve (the coefficient is always negative, but is only significant in some cases; for example in *Column 4,* the *t* is -1.65). This evidence can be explained by considering that, if CEOs underestimate insurers' loss reserves, their bonus may increase in the short run. Moreover, the coefficient of the sum of the values of stock awarded and options granted scaled by total compensation (*Stock&Option_granted*) is not significant, in contrast to the prediction. In fact, the sign was expected to be positive, as executives' compensation would primary rely on the long run firm value if the *Stock&Option_granted* ratio is high (Lai and Lin, 2008; Eckles and Halek, 2010). Finally, the ratio between the forthcoming change (year *t* to year *t+1*) in salary and the total compensation *(Salary_Change)* does not exhibit a significant relationship with reserve error.

Considering the risk variables, of great interest to this study, we proceed first by analyzing the accounting-based (*Columns 1*, *2*, and *3*) and then market-based measures (*Columns 4*, *5*, and *6*). In the first regression (*Column 1*), to test the solvency hypothesis, we included *Leverage* in the model, the coefficient estimate of which is negative (-0.0883) and significant (*t*=-2.05). This means that insurers in major financial distress are more likely to overestimate the loss reserve. As robustness checks, we replace the *Leverage* variable with two other accounting-based measures, *Roa_volatility* (*Column 2*) and *z_score* (*Column 3*), and rerun the regression. The first variable gives a coefficient that is significant (*t* = 2.91) and in the predicted positive direction (its coefficient is 0.5256), while *z-score*, although showing a sign in line with the expectations (its coefficient is -0.0049), has a non-significant coefficient (*t* = -0.96). In order to ensure that the results are not biased by accounting adjustments, we replace accounting-based measures with market-based measures. *Stock_price_volatility* (*Column 4*) exhibits a positive (the coefficient is 0.9655) and significant (*t* = 2.14) relationship with reserve error. However, as the volatility does not account for the direction of the stock return's movement, we check the results by using *Var*, which is a good measure of downside risk, and *BetaVaR*, which takes into account systemic risk. As reported in *Column 5*, *Var* has a negative (-0.3766) and significant (*t*=-2.54) coefficient, while *BetaVaR* (*Column 6*) shows a positive (0.0092) and significant (*t*=2.95) coefficient. All market-based risk measures have the predicted sign.

It should be noted that when we replace one risk measure with another as a robustness check, our model maintains the same explanatory variables and the effects of insurers risk taking on reserve error remain substantially unchanged. Therefore, our results reject the traditional solvency incentives hypothesis and provide evidence in favor of the prudential hypothesis (as summarized in $\boldsymbol{H_1}$): riskier insurance companies may have an incentive to increase the loss reserve to retain cash flows and make their financial structure more robust in the following years. In addition, over-reserving may also have a positive effect on rate making; as reserves are a component of rate making, overestimated reserves can result in premiums that are higher than they should be.

The discrepancy between our results and those reported in the literature can be explained by three main factors. First, we use a set of risk measures different from those traditionally adopted in the literature on reserve error manipulation. As shown in the introduction, we consider these measures to be effective, having a robust scientific basis and not being confined to the literature on insurance companies. Second, we focus only on P&C listed insurance companies that should be subject to strict monitoring from the market. Finally, our measure of smoothing has been constructed to ensure that we do not capture the insurer's risk. As discussed in the introduction, we have raised this criticism regarding the smoothing variable traditionally used in literature.

Longtail does not affect the reserve error: its coefficient is never significant. However, *Premiums_ta* is always negative and significant: an increase in premiums necessarily implies a reduction in over-reserving. *Combined*, as predicted by the literature, has a large impact on reserve error (for example, in *Column 1* the coefficient is 0.06, and *t* is 2.72). The coefficient of *Reinsurance* is positive, but never significant.

Although the determinants of loss reserving on the part of management, i.e., a tax shield, income smoothing, executive compensation and insurer's risk, have been analyzed in several prior papers, they have been examined jointly with governance structure variables less frequently (Lai and Lin, 2008). Therefore, one goal of this study is to investigate the marginal effect of corporate governance structure on the loss reserve errors in the presence of other motives.

Table 4 reports the results of the fixed effects regression Eq. (4), obtained by adding six governance structure variables to the explanatory variables used in Eq. (3). The regression Eq. (4) shows an overall R^2 of around the 36 percent when we used accounting-based risk measures and an overall R^2 of around 32 percent when we used market-based risk measures. Moreover, it should be noted that controlling for governance variables does not change the relationships between incentives and reserve error highlighted in regression Eq. (3).

The results suggest that an insurer's ownership structure does not significantly affect loss reserve manipulation. In detail, *CEO_share* exhibits a sign contrary to predictions ($\boldsymbol{H_{2A}}$) and a high

statistical insignificance, while *Main_share* shows a positive sign according to predictions (***H2B)*** but a very low statistical significance (for example, in *Column 1* the *t* is 1.57).

With the regard to the effects of the board's monitoring, findings reveal that *Dir_size* is negatively and significantly related to the dependent variable (for example, in *Column 1* the coefficient is -0.1253 and *t* is -3.22). Given the potential negative effects of under-reserving, we infer that overly large boards are not able to effectively carry out their monitoring activity. If we consider that our sample is composed of many large insurers, and that studies on non-financial firms suggest that the problems of oversized boards outweigh their advantages (Yermack, 1996; Fernández et al., 1997; Eisenberg et al., 1998), we can state that this result is in line with expectations (***H2C***). Moreover, our findings reject hypothesis ***H2D***, as *Dir_meet* shows an insignificant relationship with reserve error.

Finally, variables related to the audit committee also reveal interesting indications. In fact, while the size of the audit committee (*AC_size*) is irrelevant for reserve error mitigation (this evidence is contrary to hypothesis ***H2E)***, the level of its activity (*AC_meet*) reduces under-reserving consistent with predictions (***H2F***). With reference to the last point, AC_meet always shows a positive and significant relationship with the dependent variable (for example, in *Column 1* the coefficient is 0.0354 and *t* is 2.80)[5].

5. Conclusions

This study analyzes the determinants of listed P&C insurers' reserve error, focusing in particular on whether the level of financial distress affects the evaluation of the loss reserve, and investigates the relationship between loss reserve manipulation and corporate governance structure. With regard to the determinants of reserve error, the literature provides several incentives to explain why insurers might overestimate or underestimate their loss reserves: tax incentives, smoothing incentives, solvency incentives, and executive compensation incentives. Moreover, the literature suggests that a well functioning governance structure is more likely to reduce the accrual errors resulting from the self-interest of managers.

Using a sample of 54 U. S. listed P&C insurance companies over the period 1995–2005, i.e. 594 insurer observations, this study reports some interesting results.

First, and consistent with the predictions, the results highlight the fact that insurers manipulate loss reserves mainly to reduce their tax burden and stabilize earnings. Concerning this point, we believe that we have extended the literature by using a more effective smoothing variable.

Second, we find weak evidence in support of executive compensation incentives, discovering that the higher the bonus, the greater the underestimation, while relative to other components of compensation (salary, stock awarded, and options granted), we report results that are not statistically significant.

Third, according to the prudential hypothesis, we find that riskier insurers are inclined to overestimate loss reserves, to reduce the cash outflows for fiscal reasons and for shareholders' remuneration and to make their financial structure in the following years more robust (the prudential hypothesis). These findings are robust to various risk measures (both accounting-based and market-based), and the prudential hypothesis seems to be consistent with an insurer's long run view. The discrepancy between our results and those reported in the literature can be primarily explained by the use of a set of risk measures different from those traditionally employed in the literature on reserve error manipulation, the focus on P&C listed insurance companies, and the use of a smoothing variable that has been constructed to be sure as not to capture the insurer's risk.

Finally, our results suggest that stronger boards (that remain relatively small) and more active audit committees are less inclined to underestimate the loss reserve. This evidence can be interpreted with the understanding that boards with too many members may present considerable problems of organization, communication, and decision-making, as well as engage in what psychologists call "social loafing," while meeting frequency may indirectly provide information about the audit committee's diligence.

Our findings provide interesting implications for the insurance companies' stakeholders, policymakers and supervisory authorities. The first implication concerns the evidence that the main

aim of reserve management for listed P&C insurers is to maximize shareholder wealth, while a manager's self-interested motives appear to be marginal. The second implication is that effective governance structures could encourage an improved estimation of the loss reserve. This is an important point, as most stakeholders do not perform adequate checks on the accuracy of loss reserve estimates; an inadequate reserve, on the one hand, produces the immediate effect of making the insurer appear less risky and, on the other hand, can create problems for long-term survival. In fact, as a result of continuous and unchecked under-reserving, the company will draw from its surplus to settle its claims, and when the surplus is depleted, the company faces insolvency. In addition, as reserves are a component of rate making, under-reserving can result in rates that are lower than they should be, and this may accelerate a company's decline.

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Appendix

Table A.1. Correlation matrix

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Error_W	1.0000																
2	Tax	0.5904	1.0000															
3	Smooth	0.1694	0.1364	1.0000														
4	Salary_change	**0.0470**	**0.0575**	**0.0134**	1.0000													
5	Bonus	0.1236	**0.0259**	0.2738	**-0.0090**	1.0000												
6	Option_stock	**0.0515**	**-0.0602**	**-0.0319**	**-0.0329**	-0.2427	1.0000											
7	Risk	**-0.0054**	**0.0496**	**0.0570**	**-0.0163**	**-0.1092**	-0.2315	1.0000										
8	Main_share	**-0.0770**	0.2278	**-0.0036**	**0.0047**	**-0.0677**	-0.3167	0.3139	1.0000									
9	CEO_share	-0.2351	**-0.0428**	**0.0278**	**-0.0998**	**-0.1078**	-0.3009	0.3218	0.2938	1.0000								
10	Dir_size	**0.0495**	**-0.1094**	**-0.0152**	**0.0011**	**0.0378**	0.3795	-0.3609	-0.4658	-0.3131	1.0000							
11	Dir_meet	**-0.0590**	-0.2043	**-0.0605**	**0.0452**	**0.0681**	0.2137	**-0.0917**	-0.1791	-0.2669	0.1608	1.0000						
12	AC_size	**0.0795**	-0.1526	**0.0002**	**-0.0744**	0.1835	0.3631	-0.1541	-0.3773	-0.2545	0.4081	0.1899	1.0000					
13	AC_meet	**0.0415**	-0.1429	**-0.0545**	**-0.0139**	0.1284	**0.0687**	**-0.0534**	-0.1432	-0.2045	0.1546	0.2869	0.2178	1.0000				
14	Longtail	0.2356	0.2309	**-0.1080**	**0.0503**	**0.1060**	**-0.0060**	**0.0452**	**0.0161**	**-0.0481**	**-0.0332**	**-0.0411**	**-0.0044**	**0.0671**	1.0000			
15	Combined	**-0.0258**	**0.0162**	-0.4965	**-0.0109**	-0.2704	**-0.0535**	**0.0569**	**0.0677**	**-0.0349**	**-0.0750**	**0.0389**	**-0.0220**	**0.0880**	0.3569	1.0000		
16	Reinsurance	-0.2398	-0.4349	**-0.0576**	**-0.0035**	**0.0586**	-0.1598	**-0.0821**	**-0.0685**	**0.0094**	**0.1026**	**0.0964**	**0.0470**	**0.1182**	**-0.0776**	**0.0272**	1.0000	
17	Premiums_ta	-0.1843	0.2693	0.1478	**-0.0185**	**0.0778**	**-0.1180**	0.1336	0.3672	0.2378	-0.2584	-0.1346	-0.2348	**-0.0126**	-0.2794	-0.1134	-0.3229	1.0000

The table shows Pearson pairs-wise correlation matrix. Bold texts indicate statistically significant at 1% level or better. *Risk* is *BetaVaR*. See Table 1 for other variable definitions.

Table A.2. Correlation matrix among risk measures

	Variables	1	2	3	4	5	6
1	Leverage	1.000					
2	Roa_volatility	**0.0863**	1.000				
3	Z_score	0.2926	-0.7347	1.000			
4	Stock price volatility	**-0.0772**	0.3140	-0.2606	1.000		
5	VaR_95	**0.0619**	-0.3032	0.2556	-0.9555	1.000	
6	Beta_VaR_95	**0.0016**	0.3518	-0.2691	0.6467	-0.7314	1.000

The table shows Pearson pairs-wise correlation matrix. Bold texts indicate statistically significant at 1% level or better. See Table 1 for variable definitions.

Table 1. Descriptive statistics of the sample companies

Variables:	Mean	Standard deviation	Minimun	Median	Maximum	Skewness	Kurtosis	Observation
Panel A: Insurer-specific variables:								
TA (billion)	24.7	80.2	0.025	2.41	853	6.4829	54.1502	543
P (billion)	2.79	5.50	0.005	0.74	41.9	3.4196	17.2081	540
Longtail	0.5748	0.3772	0	0.6719	1	-0.3763	1.6194	592
Combined	95.1902	26.049	0	100	172.6	-2.5263	10.5304	592
Reinsurance (billion)	2.01	4.73	0.0004	0.235	29.9	3.2892	14.1399	474
Panel B: Reserve error measures:								
Error_W	0.0605	0.0739	-0.2779	0.0493	0.3297	-0.0059	4.7759	529
Error_KFS	-0.0115	0.0662	-0.2960	-0.0013	0.1876	-1.0621	5.6264	529
Panel C: Loss reserve manipulation incentives								
Tax	0.2983	0.1441	0.0089	0.2911	0.8882	0.4114	3.2401	540
Smooth	0.0090	0.0453	-0.2166	0.0086	0.1799	-0.4432	5.8385	482
Salary_change	0.0191	0.1698	-0.5973	0.0069	3.0950	13.9914	254.4932	428
Bonus	0.1927	0.1726	0	0.1635	0.7652	0.6844	2.6585	478
Stock&Option_granted	0.2985	0.2814	0	0.2614	1	0.4322	1.9071	479
Leverage	0.2603	0.1198	0.0269	0.2463	0.6880	0.5923	3.1515	543
Roa_volatility	0.0181	0.0178	0.0000	0.00120	0.1451	2.4068	11.9323	410
Z_score	1.3452	0.4873	-0.5991	1.3192	4.0460	0.5719	6.5240	409
Stock_price_volatility	0.0097	0.0061	0.0035	0.0085	0.0856	5.7661	61.9904	425
VaR	-0.0322	0.0193	-0.2466	-0.0291	-0.0108	-4.5461	41.2995	425
Beta_VaR	2.0771	1.2117	0.6867	1.7445	9.5180	2.9899	14.4011	425

Panel D: Governance structure variables:								
Main_share	0.2536	0.1965	0	0.166	0.8090	0.8958	2.5882	482
CEO_share	0.0648	0.1180	0	0.0156	0.7806	2.6638	10.1848	482
Dir_size	10.5394	3.1005	4	10	23	0.7473	3.6493	482
Dir_meet	5.5167	2.2954	1	5	21	1.9152	10.5015	480
AC_size	3.9315	1.3393	1	4	11	1.1283	5.0727	482
AC_meet	5.3382	3.3667	1	4	26	1.5443	7.1572	482

This table presents the distribution of variables by showing mean, standard deviation, minimum, median, skewness, kurtosis and the number of observations. *TA* is the total asset at fiscal year-end (billions of dollar). *P* is the total written premiums at fiscal year-end (billions of dollar). *Longtail* is the weight of premiums written in longtail business as percentage of total premiums written. *Premiums_ta* is the percentage of the total premiums written scaled by total assets. *Combined* is the sum of loss ratio and expense ratio calculated on GAAP basis. *Reinsurance* represents gross written premiums ceded to reinsurers. *Error_W* is the difference between the originally reported reserve and the cumulative developed losses paid after five years. *Error_K* is the difference between the originally reported reserve and re-estimation reserve after five years. *Tax* is the ratio between the sum of net income and the estimated reserve and total asset. *Smooth* is the difference between the Roa for the current fiscal year and the previous three year's average Roa. *Salary_change* is the ratio between the forthcoming change in salary and the total compensation. *Bonus* is the amount of bonus as percentage of total compensation. *Stock&Option_granted* is the sum of stock awarded value and option granted value as percentage of total compensation. *Leverage* is the book value of equity as percentage of total asset. *Roa_volatility* is the standard deviation of return on asset. *Z_score* is the logarithm of the sum of return on asset and capital-asset ratio related to the standard deviation of asset returns. *Stock_price_volatility* is the annualized standard deviation of the daily stock returns. *VaR* is the value at risk at 95%; it holds negative sing to show that is a loss value. *Beta_VaR* is the ratio between *VaR* of insurer's stock and *VaR* of the market index over the same time period (one year) at the same confidence level (95%). *Main_share* is the fraction of the insurer's voting rights, if any, owned by its controlling shareholder. *CEO_share* is the number of shares of the CEO as percentage of total shares outstanding. *Dir_size* is the number of directors in the insurer's board. *Dir_meet* is the number of meetings held by the board of directors. *AC_size* is the number of directors in the insurer's audit committee. *AC_meet* is the number of meetings held by the audit committee.

Table 2. Descriptive statistics of *Error_W* by year

Year	Mean	Std. Dev.	First quartile	Median	Third quartile	*p*-value mean
1995	0.0920	0.0754	0.0285	0.1001	0.1454	0.0000
1996	0.0925	0.0859	0.0241	0.0747	0.1494	0.0000
1997	0.0795	0.0787	0.0171	0.0666	0.1299	0.0000
1998	0.0643	0.0735	0.0119	0.0485	0.0989	0.0000
1999	0.0438	0.0717	0.0055	0.0347	0.0956	0.0001
2000	0.0269	0.0672	-0.0060	0.0175	0.0578	0.0048
2001	0.0278	0.0654	0.0053	0.0219	0.0567	0.0032
2002	0.0369	0.0597	0.0098	0.0391	0.0671	0.0000
2003	0.0595	0.0625	0.0228	0.0599	0.1059	0.0000
2004	0.0782	0.0693	0.0333	0.0868	0.1221	0.0000
2005	0.0897	0.0690	0.0412	0.0935	0.1354	0.0000
1995-2005	0.0605	0.0739	0.0129	0.0493	0.1056	0.0000

Table 3. Results from Fixed Effects Regression (*Eq. (3)*).

Variable:	(Column 1)		(Column 2)		(Column 3)		(Column 4)		(Column 5)		(Column 6)	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Intercept	-0.0502	-1.44	-0.1401	-4.64***	-0.1070	-3.33***	-0.1194	-3.72***	-0.1227	-3.83***	-0.0941	-3.01***
Tax	0.4419	10.60***	0.5206	10.50***	0.5667	11.34***	0.4304	10.03***	0.4291	10.08***	0.4293	10.19***
Smooth	0.1087	1.84*	0.0834	1.37	0.0856	1.41	0.1511	2.36**	0.1533	2.42**	0.1407	2.21**
Salary_change	-0.0041	-0.41	-0.0037	-0.40	-0.0035	-0.38	0.0039	0.11	0.0070	0.19	0.0101	0.28
Bonus	-0.0191	-1.10	-0.0030	-0.17	-0.0040	-0.22	-0.0284	-1.65*	-0.0179	-1.66*	-0.0267	-1.49
Option&Stock_granted	0.0033	0.31	0.0032	0.31	0.0033	0.32	-0.0143	-1.15	-0.0136	-1.09	-0.0121	-0.97
Leverage	-0.0883	-2.05**	-	-	-	-	-	-	-	-	-	-
Roa_volatility	-	-	0.5256	2.91***	-	-	-	-	-	-	-	-
Z_Score	-	-	-	-	-0.0049	-0.96	-	-	-	-	-	-
Stock_price_volatility	-	-	-	-	-	-	0.9655	2.14**	-	-	-	-
VaR	-	-	-	-	-	-	-	-	-0.3766	-2.54**	-	-
Beta_VaR	-	-	-	-	-	-	-	-	-	-	0.0092	2.95***
Longtail	0.0190	1.28	-0.0076	-0.45	-0.0099	-0.59	0.0156	1.03	0.0137	0.91	0.0121	0.81
Combined	0.0006	2.72***	0.0006	3.12***	0.0005	2.52**	0.0007	3.59***	0.0007	3.62***	0.0007	3.66***
Reinsurance	0.0088	1.11	0.0166	2.02**	0.0209	2.55**	0.0065	0.64	0.0068	0.67	0.0059	0.59
Premiums_ta	-0.2164	-3.96***	-0.2286	-4.02***	-0.2206	-3.88***	-0.2779	-4.33***	-0.2757	-4.37***	-0.2661	-4.23***

(*continued*)

Table 3. (*Continued*).

Independent Variable	(Column 1)		(Column 2)		(Column 3)		(Column 4)		(Column 5)		(Column 6)	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Year dummies	Included		Included		Included		Included		Included			
Model fits:												
Within R^2	0.5720		0.5683		0.5729		0.5951		0.5981		0.6019	
Between R^2	0.4518		0.4409		0.4400		0.3084		0.3028		0.2887	
Overall R^2	0.4422		0.4228		0.4152		0.3873		0.3877		0.3838	
F-statistics	20.57		18.58		18.86		19.43		19.68		19.99	

Year dummies are time dummies. See Table 1 for other variable definitions. *F-statistic* tests whether all the coefficients in the model are different than zero. Superscripts *, **, *** indicate statistical significance at 10%, 5% and 1% levels, respectively.

Table 4. Results from Fixed Effects Regression (*Eq. (4)*).

Variable:	(Column 1)		(Column 2)		(Column 3)		(Column 4)		(Column 5)		(Column 6)	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Intercept	0.0309	0.58	-0.0236	-0.45	-0.0248	-0.47	-0.0169	-0.31	-0.0180	-0.34	0.0155	0.29
Tax	0.4258	10.09***	0.5076	10.17***	0.5486	10.90***	0.4268	10.06***	0.4241	10.06***	0.4261	10.21***
Smooth	0.1228	2.07***	0.0860	1.38	0.0837	1.35	0.1821	2.85***	0.1838	2.90***	0.1744	2.75***
Salary_change	0.0036	0.36	0.0015	0.15	0.0016	0.17	0.0089	0.25	0.0118	0.33	0.0143	0.40
Bonus	-0.0211	-1.22	-0.0042	-0.23	-0.0053	-0.29	-0.0326	-1.81*	-0.0319	-1.78*	-0.0309	-1.74*
Option&Stock_granted	0.0111	1.02	0.0105	0.99	0.0107	1.01	-0.0028	-0.22	-0.0019	-0.15	-0.0011	-0.09
Leverage	-0.0820	-1.88**	-	-	-	-	-	-	-	-	-	-
Roa_volatility	-	-	0.4513	2.47**	-	-	-	-	-	-	-	-
Z_Score	-	-	-	-	-0.0023	-0.44	-	-	-	-	-	-
Stock_price_volatility	-	-	-	-	-	-	0.7693	1.74*	-	-	-	-
VaR	-	-	-	-	-	-	-	-	-0.3253	-2.24**	-	-
Beta_VaR	-	-	-	-	-	-	-	-	-	-	0.0079	2.57**
Longtail	0.0138	0.91	-0.0058	-0.33	-0.0065	-0.37	0.0092	0.61	0.0075	0.49	0.0059	0.39
Combined	0.0005	2.52***	0.0006	2.86***	0.0005	2.24**	0.0007	3.39***	0.0007	3.43***	0.0007	3.48***
Reinsurance	0.0069	0.88	0.0143	1.70*	0.0179	2.15**	0.0045	0.45	0.0049	0.49	0.0044	0.43
Premiums_ta	-0.1790	-3.30***	-0.1942	-3.37***	-0.1839	-3.20***	-0.2342	-3.71***	-0.2293	-3.69***	-0.2222	-3.58***

(*continued*)

Table 4. (*Continued*).

Independent Variable	(Column 1)		(Column 2)		(Column 3)		(Column 4)		(Column 5)		(Column 6)	
	Coef.	t- stat	Coef.	t-stat	Coef.	t- stat	Coef.	t- stat	Coef.	t- stat	Coef.	t- stat
Main_share	0.0532	1.33	0.0359	0.86	0.0497	1.21	0.0661	1.39	0.0639	1.35	0.0608	1.29
CEO_share	-0.0283	-0.81	-0.0044	-0.12	-0.0045	-0.13	-0.0355	-0.96	-0.0370	-1.00	-0.0343	-0.93
Dir_size	-0.1229	-3.10***	-0.0977	-2.33**	-0.0967	-2.32**	-0.1582	-3.72***	-0.1598	-3.78***	-0.1569	-3.72***
Dir_meet	-0.0011	-0.07	-0.0066	-0.39	-0.0086	-0.52	0.0080	0.45	0.0086	0.49	0.0106	0.60
AC _size	0.0109	0.44	-0.0136	-0.50	-0.0129	-0.48	0.0185	0.75	0.0173	0.71	0.0195	0.80
AC_meet	0.0361	2.79***	0.0289	2.15**	0.0307	2.28**	0.0434	3.15***	0.0428	3.12***	0.0419	3.06***
Year dummies	Included		Included		Included		Included		Included		Included	
Model fits:												
Within R^2	0.5855		0.5874		0.5938		0.6328		0.6359		0.6383	
Between R^2	0.3684		0.3660		0.3559		0.2147		0.2048		0.1921	
Overall R^2	0.3896		0.3680		0.3543		0.3251		0.3223		0.3173	
F-statistics	15.83		14.48		14.81		16.58		16.81		16.98	

Year dummies are time dummies. See Table 1 for other variable definitions. *F-statistic* tests whether all the coefficients in the model are different than zero. Superscripts *, **, *** indicate statistical significance at 10%, 5% and 1% levels, respectively.

[1] IRIS is a set of financial ratios that has been used by NAIC as a method of determining whether an insurer should be subjected to some higher degree of solvency scrutiny. The FAST system, introduced in 1993, is a more sophisticated solvency early warning system that is triggered when the IRIS system signals a troubled situation. We will discuss NAIC's early warning systems in section 3.3.

[2] We do not include the long-term incentive plans because in only a few cases did the insurance managers in our sample receive this type of remuneration.

[3] We use *Error_W* as a dependent variable because it is able to optimize the explanatory power of our models. When we replaced *Error_W* with *Error_K* in unreported tables, the results were consistent with those illustrated in Section 4, but the models show a lower explanatory power.

[4] To facilitate the interpretation of this result, it is necessary to point out that the *VaR* is expressed as negative value.

[5] In an unreported table, we estimated the unobservable effects with a random effects (RE) regression. Hence, we reran regressions Eq. (3) and Eq. (4). The use of RE regression does not change the relationships between the dependent variable and the set of explanatory variables. The Hausman's test indicates that an FE regression is preferred to an RE regression.