Organizational Structure, Corporate Governance, Loss Reserve Error and Actuaries Switching in the U.S. Property Casualty Insurance Industry

Chia-Ling Ho*
Department of Insurance
Tamkang University
clho@mail.tku.edu.tw

* Corresponding author

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Abstract

This paper aims to examine the U.S. property casualty insurer's organizational structure, corporate governance and loss reserve error in relation to actuaries switching. The results show that stock insurers are more likely to switch their actuaries than mutual insurers. Insurers with high percentage of long-tail business are also more likely to switch their actuaries. Large and weak financial condition insurers are less likely to switch their actuaries. We find that insurers with under-estimated (over-estimated) reserve error in the previous year are not significantly to switch their actuaries. In terms of corporate governance variables, the evidence shows that insurers with large board size are more likely to switch their actuaries from internal actuary to Big 6 actuarial firms, whereas insurers with CEO/Chairperson duality are more likely to switch their actuaries from Big 6 actuarial firms to internal actuary. We next examine the impact of organizational structure, corporate governance and actuaries switching on reserve error. The evidence shows that insurers tend to have less reserve error after actuaries switching than before. Insurers with CEO/Chairperson duality and high percentage of insider directors on the board are positively related to reserve error post actuaries switching. In addition, stock insurers are more likely to have less reserve error after actuaries switching from internal actuary to Big 6 actuarial firms than stock insurers without actuaries switching. Insurers with CEO/Chairperson duality and large board size are positively and significantly related to reserve error when actuaries switching from Big 6 actuarial firms to internal actuary. We also find that insurers with actuaries switching from internal actuary to Big 6 actuaries are more likely to have less under-estimate reserve error than insurers without actuaries switching. Examination of the impact of the Sarbanes-Oxley Act (SOX) on reserve error indicates that insurers are more likely to switch actuaries after SOX. After SOX, insurers with actuaries switching are more likely to less under-estimated reserve error. The overall results show that organizational structure, corporate governance and some firm characteristics affect actuaries switching, while actuaries switching and corporate governance variables have impact on insurers' reserve error.

Keywords: Organizational Structure, Corporate Governance, Loss Reserve Error, Actuaries Switching, Internal actuary, Big 6 actuarial firms, Sarbanes-Oxley A

Organizational Structure, Corporate Governance, Loss Reserve Error and Actuaries Switching in the U.S. Property Casualty Insurance Industry

1. Introduction

The purpose of this paper is to examine the U.S. property casualty insurer's organizational structure, corporate governance and loss reserve estimating in relation to actuaries switching. Actuaries play an important role in alleviating contracting incentive conflicts and information asymmetry problems for insurers (Sherris, 1987). Actuaries should use their professional judgment to ensure that loss reserve formula correlates to actual conditions and accurately reflect the financial statements based on the requirements of stakeholders such as regulators and policyholders. Selecting actuaries to provide accurate loss reserve estimates and financial statements is critical to insurers because it has an impact on the solvency of insurers. Actuaries switching may serve as a signal to policyholders, regulators, and shareholders. Insurers with actuaries switching have economically and statistically meaningful issue may be influenced by insurer's organizational structure, corporate governance and the estimate of loss reserve.

The insurance industry is particularly interesting because insurers take different organizational forms and there are agency conflicts of stakeholders in the different organizational structures. The two most vital organizational structures in the insurance industry are mutual insurers and stock insurers. Mutual insurers are owned by policyholders and do not have shareholders, thereby avoiding insolvency of insurers for all policyholders. Dionne (2000) suggests that insurance exists because policyholders are risk-averse and relatively undiversified. Thus, the conflicts between shareholders and policyholders do not exist. On the contrary, stock insurers should be increase shareholder wealth at the expense of policyholders. There is a significant agency conflict between shareholders and policyholders.

Inappropriate corporate governance was found to have resulted in some large-scale financial scandals at Enron, Tyco International, Adelphia, Peregrin System and Worldcom. In order to restore confidence and protect stakeholders, corporate governance mechanism should be a vital issue for investors, policyholders and regulators. Passage of the Sarbanes–Oxley Act (SOX) of 2002 has led to some changes in board composition. Financial disclosures must accurately reflect insurers' operating performance, especially, avoiding inaccurate loss reserve error result in misstate financial restatement.

Under Sarbanes–Oxley Act (SOX) of 2002 requirements, insurers must attest to the accuracy of the information contained in the statement by having the insurer CEO and CFO sign all financial statements and comply with requirements for the use of independent external auditors to help avoid any potential conflict of interest (Appleton and Mulligan, 2012). Corporate boards make all-important decisions, including decisions on financial policy, selection of auditor, selection of actuaries and board governance itself. In particular, if directors on the board find that over-estimated reserve error or under-estimated reserve error on loss reserve estimation may probably switch to their original actuaries.

Passage of the SOX of 2002 has led to some changes in auditor, actuaries and board composition. We test whether insurers with good corporate governance mechanism result from effectiveness of regulation (e.g., SOX) should be able to remove ineffective actuaries. To examine the issue, we propose the signaling hypothesis which suggests that it is worthwhile for insurers to seek accuracy on their loss reserve through advising and monitoring with actuaries switching. Actuaries switching (such as switch to internal actuary or Big 6 actuaries) also serve as a signal to policyholders, regulators, and shareholders that the loss reserve estimation are more accurate and solvency indicators are more trust worthy.

The loss reserve is the largest liability on the property casualty insurer's balance sheet[1] (Figure 1). Under statutory accounting principles (SAP), the loss reserve is the property casualty insurance company's estimated liability for unpaid claims on all losses that occurred prior to the balance sheet date. Insurers follow what are known as SAP for reporting to state insurance commissioners[2]. Loss reserves management is an important issue in the insurance industry, because the accurate loss reserve estimates is required to designate statutory requirement. The lack of adequate loss reserve[3] (i.e., underestimation of loss reserve) is one of the major causes of insurers' insolvency and its impacts on stakeholders (e.g., shareholders, policyholders, regulators, and employees) have always been a major concern of the insurance industry. In addition, it will be a major disaster for policyholders if their insurers become insolvent resulting from inadequate loss reserve when they suffer losses.

Estimating loss reserves involves uncertainties in future losses, thus, insurance companies can more easily manipulate earning through overstatement or understatement of loss reserves (Grace, 1990). For example, insurers are more likely to delay income taxed paid through overstatement of loss reserve (i.e. over-estimated reserve). When an insurer considers over-estimated reserve or under-estimated reserve depends on different incentives for stakeholders. For example, policyholders or regulators or employees would

[1] For example, Petroni (1992), Gaver and Paterson (2004), Grace and Leverty (2012a), Grace and Leverty (2012b), Kelly, Kleffner and Li (2012).
[2] For example, Grace and Leverty (2012a), Grace and Leverty (2012b), Gaver, Paterson, and Pacini (2012).
[3] The bulk of studies on the management of the property casualty insurer's loss reserve error examine the different issues include: income smoothing (e.g., Smith, 1980; Weiss, 1985; Grace, 1990; Beaver, McNichols, and Nelson, 2003, Grace and Leverty, 2012a), financial weakness (e.g., Petroni, 1992, Harrington and Danzon, 1994; Gaver and Paterson, 2001; Pike, 2003; Gaver and Paterson, 2004; Grace and Leverty, 2012a), evade regulatory scrutiny (Petroni, 1992; Gaver and Paterson, 2004), tax incentives (e.g., Grace, 1990; Gaver and Paterson, 1999; Gaver and Paterson, 2000; Grace and Leverty, 2005; Grace and Leverty, 2012a), executive compensation (e.g., Eckles and Halek, 2010), audit committee characteristics (e.g., Hsu et al., 2013). A positive (negative) estimation loss reserve error implies the property casualty insurer's loss reserve overstatement (understatement).

want insurance companies to have over-estimated reserve than under-estimated reserve, because they worry about insolvency of insurers. When insurance companies are profitable, shareholders prefer insurance companies to have over-estimated reserve for insurers' tax saving. For managers, on the one hand, managers are more likely to under-reserve when they want to overstate earnings to satisfy with insurers earning goals (e.g., Morgenson, 2005) or to get over-compensation (Eckles and Halek, 2010). On the other hand, managers are more likely to over-estimated reserve when they want to understate earnings to reduce the present value of tax payments (e.g., Gaver and Paterson, 1999) or to present a credible signal of insurer financial strength (e.g., Pertoni, 1992). This implies that insurers with actuaries switching would like to less or more under reserve error or over reserve error based on different incentives.

As a mentioned above, actuaries switching may be influenced by managers or directors to manipulate reserves. In order to examine actuaries switching in determining their effectiveness of loss reserve accuracy, we separate the whole sample into two sub-samples: over-estimated reserve and under-estimate reserve. Actuaries may be switched resulting in inaccurate loss reserve, over-estimated reserve or under-estimated reserve is referred to as accuracy, understate or overstate. To examine the efficacy of insurers actuaries switching determined by organizational structure, corporate governance and loss reserve estimation (i.e., accuracy or under-estimated reserve error or over-estimated reserve error) and to accommodate the asymmetric monitoring incentives of actuaries in determining their effectiveness of loss reserve accuracy.

Our study stands out in several ways. First, we are the first to examine the impact of organizational structure, corporate governance and loss reserve error (e.g., accuracy, over-estimated reserve or under-estimated reserve) on actuaries switching in the U.S. property casualty insurance industry. The insurance industry is highly regulated with special financial report requirement. Second, we also examine the impact of organizational structure, corporate governance and loss reserve error on different actuaries switching' types (i.e., switching from Big 6 actuaries to internal actuary and switching from internal actuary to Big 6 actuaries). Third, we next to investigate the impact of actuaries switching, organizational structure and corporate governance variables on loss reserve error measures (e.g., under-estimated reserve). In particular, insurers with actuaries switching from internal actuary to Big 6 actuarial firms or Big 6 actuarial firms to internal actuary may result in more or less loss reserve error. Fourth, no research has been done on actuaries switching related to organizational structure, corporate governance and loss reserve error in the context of SOX. This paper provides the evidence whether the actuaries switching can enhance the accuracy of loss reserve and increase the financial reporting quality when considering insurers' organizational structure, corporate governance mechanisms and financial situation. To the best of our knowledge, our study is probably the first to examine the impact of interaction term of SOX on actuaries switching in the U.S. property casualty insurance industry. This study provides that policy implication of actuaries switching in relation to organizational structure, corporate governance mechanisms and loss reserve error in the U.S. property casualty insurance industry.

Our sample consists of 640 property casualty insurance companies for the years 2000 to 2007. The results show that stock insurers are more likely to switch their actuaries than mutual insurers. Insurers with high percentage of long-tail business are also more likely to switch their actuaries, while insures with large firm size and weak financial condition are less likely to switch their actuaries. We find that insurers with under-estimated (or over-estimated) reserve error in the previous year are not significantly to switch their actuaries. In terms of corporate governance variables, the evidence shows that insurers with large board size are more likely to switch their actuaries from internal actuary to Big 6 actuarial firms, whereas insurers with CEO/Chairperson duality are more likely to switch their actuaries from Big 6 actuarial firms to internal actuary.

We next examine the impact of organizational structure, corporate governance and actuaries switching on the loss reserve error. The evidence shows that insurers tend to have less reserve error after actuaries switching than before. Insurers with CEO/Chairperson duality and high percentage of insider directors on the board are positively and significantly related to reserve error post actuaries switching. In addition, stock insurers are more likely to have less reserve error after actuaries switching from internal actuary to Big 6 actuarial firms than stock insurers without actuaries switching. Insurers with CEO/Chairperson duality and large board size are positively and significantly related to reserve error when actuaries switching from Big 6 actuarial firms to internal actuary. We also find that insurers with actuaries switching form internal actuary to Big 6 actuaries are more likely to have less under-estimate reserve error than insurers without actuaries switching. Examination of the impact of the Sarbanes-Oxley Act (SOX) on reserve error indicates that insurers are more likely to switch actuaries after SOX. After SOX, insurers with actuaries switching are more likely to less under-estimated reserve error. The overall results show that organizational structure, corporate governance and some firm characteristics affect actuaries switching, while actuaries switching and corporate governance variables have impact on insurers' reserve error.

Actuaries Switching and the Signaling Hypothesis

Actuaries usually provide an insurer with a recommended pure premium setting, and propose on a range of actual loss reserve levels according to the probability distribution associated with specific losses and magnitude of claims which would be paid when losses occur. There are two types of actuaries: external actuaries and internal actuaries. External actuaries may face different incentives than internal actuaries in setting loss reserve (Kelly, Kleffner and Li, 2012). Unlike the annual statutory audit, for which the insurer must use an independent certified public accountant, the actuarial opinion may be provided by internal actuaries[4]. Gustavson and Joseph (1983) suggest that an internal actuary is familiar with his company and its operations, and then she is in the best position to offer an opinion of loss reserve. Insurer's managers may give pressure to their internal actuaries by setting loss reserve into complying with their wishes. For example, an insurer with financial weakness might be tempted to understate the loss reserve in order to present good performance in the financial statement. Gustavson and Joseph (1983) also argue that external actuaries rendering the opinion would have professional reputation at stake and there exists a strong incentive for loss reserve accuracy. Among external actuaries (Figure 2), Big 6 actuaries are less likely to be influenced by non-Big 6 actuaries because Big 6 actuaries need to protect their reputational capital when compared to the non-Big 6 actuaries. Thus, selecting actuaries to provide accurate reserve estimates of reserve is critical to insurers' solvency. For example, Ho and Lai (2014) discuss that organizational structure, corporate governance variables, and some firm characteristics (e.g., firm size and reinsurance decision) have impact on the selection of actuaries.

Actuaries switching may serve as a signal to policyholders, regulators, and shareholders. We further classify external actuaries into two types: Big 6 actuaries[5] and non-Big 6 actuaries. In particular, we focus on an insurer which switches its appointed

[4] Best Review, January 2013.
http://www.thefreelibrary.com/Top+auditors+and+actuaries+for+2011%3a+methodology.-a0314650963
[5]Best's Review, January 2009, on page 65. The market share of Big 6 actuarial firms showed a slight increase to 81% of NPW (net premium written) in 2007.

actuary from internal actuary to Big 6 actuaries and an insurer which switches its appointed actuary from Big 6 actuaries to internal actuary.

We propose the signaling hypothesis as follows. Insurers can acquire actuarial services internally by hiring their own internal actuaries. Internal actuaries are more likely to follow the suggestions of manager to manipulate loss reserve estimates and solvency evaluations based on their job security. In addition, insurers can acquire external actuarial services for advice or consulting services in insurance pricing and reserve estimates. Compared with internal actuaries, Big 6 actuaries can provide more professional actuarial opinions or accurate loss reserve estimates. This implying that insurer with more reserve error is more likely to switch its appointed actuaries from internal actuary to Big 6 actuaries because Big 6 actuaries are more independent and more technical knowledge than internal actuaries who are employees of insurers. Big 6 actuaries may provide more accurate financial statements (loss reserve estimates) and solvency evaluation than non-Big 6 actuaries because Big 6 actuaries are concerned more about their brand reputation than non-Big 6 actuaries. Therefore, an insurer with overestimation (or underestimation) of loss reserve will be probability changed their actuaries. An insurer may switch to Big 6 actuaries whereas the firms with over-estimated reserve error or under-estimated reserve error. Grace and Leverty (2011) claim that the reputation of actuaries is positively correlated with accurate loss reserves. We believe Big 6 actuaries can provide more accurate loss reserve estimates than internal actuary. In addition, an insurer switches appointed actuary from Big 6 actuaries to internal actuary or from internal actuary to Big 6 actuaries may more likely to have less reserve error. We develop the following testable hypotheses in the next section.

2. Hypotheses Development

We develop hypotheses to examine organizational structure, corporate governance and loss reserve error in relation to actuaries switching.

Organizational structure and actuaries switching

The conflicts of interests between owners (stockholders) and policyholders are more severe for stock form than for mutual form (e.g., Mayers and Smith, 1981, 1988). The mutual form eliminates conflicts of interest between owners and policyholders because mutual insurers merge the owner and policyholder functions. A manager of a mutual insurer is less likely to manipulate financial statements (e.g., reserves, earnings and solvency evaluation) to exploit policyholders than a stock insurer because policyholders are owner of mutual insurers. In addition, a manager is under more pressure from stockholders than policyholders, thus, *the signaling hypothesis* also indicates that stock insurers are more likely to switch their actuaries than mutual insurers to signal that their reserves, financial statements and solvency evaluation are more accurate. Based on the mentioned above, stock insurers should be associated with actuaries switching. We thus suggest:

Hypothesis 1: The stock organizational structure results in more actuaries switching than mutual organizational structure in the property casualty insurance industry.

Corporate governance and actuaries switching

A single officer who holds both CEO and chairperson positions of the board (i.e., CEO and chairperson of the board are the same person) may be more powerful. CEOs/chairpersons are able to direct board meetings and may act in their self-interest. A powerful CEO/chairperson would therefore generally weaken the oversight power that boards hold. A manager may be more conservative and want to protect his or her job (Belkhir, 2006). Bebchuk et al. (2009) describe that a CEO playing a dominant role in a firm's decision-making may play it safe[6]. Pathan (2009) also shows that CEOs have more

[6]This paper investigates the negatively relation between the CEO compensation and the firm-specific

power to influence board decision because managers have un-diversifiable wealth including human capital and comparatively fixed salary. It is implying that an insurer with CEO/Chairperson duality may change its actuaries based on their benefit. Cheng (2008) contends that a CEO can influence and control board's decisions when the board size is large. Insurers with large board need to compromise and difficult to accept risky projects. It is implying that larger boards are likely to be associated with more actuaries switching behaviors. Laeven and Levine (2009) argue that, as managers have accumulated human capital and enjoy the private benefits of control. The agency theory of corporate finance describes that insider directors on the board may not maximize shareholder value for reasons of self-interest. It is expect that insurers with higher insider directors on the board are more likely to switch their actuaries. We propose hypothesis:

Hypothesis 2a: CEO/Chairperson duality is more likely to switch its actuary in the property casualty insurance industry.

Hypothesis 2b: Larger Board size is more likely to switch its actuary in the property casualty insurance industry.

Hypothesis 2c: Higher percentage of insider director on the board is more likely to switch its actuary in the property casualty insurance industry.

Loss reserve error and actuaries switching

Some studies discuss the relation between loss reserve error and Big 4 auditor firms[7] (e.g., Pertoni and Beasley, 1996) and Big N actuaries (e.g., Pike, 2003; Gaver and Paterson, 2001; Gaver and Paterson, 2004; Gaver and Paterson, 2007; Grace and Leverty, 2012a; Grace and Leverty, 2012b; Kelly, Kleffner and Si, 2012) in the property casualty insurance industry. For example, Gaver and Paterson (2001)[8] find that less

variability of stock returns over firm-specific volatility.

[7]Audit firm size is an indicator of audit quality because larger firms may have more independence from their clients and are therefore more likely to provide higher quality audits (DeAngelo, 1981). DeAngelo (1981) also suggest that Big 4 auditors impose a high level of fees based on their brand reputation capital. Pertoni and Beasley (1996) examine the relation between loss reserve and audit firm type. They find that the size of an auditor firm has no systematic differences in loss reserve accuracy or bias between clients of Big 8 auditor and non-Big 8 auditor firms. However, they also argue that Big 8 auditor is significantly more conservative in their loss reserve when they estimate loss errors variable is used relative to total assets.

[8]Gaver and Paterson (2001) extend the study of Pertoni and Beasley (1996) by expanding the set of external monitor quality to include between auditor and actuaries.

under-reserving error[9] by financially struggling insurers is essentially eliminated when the auditor and actuaries are both from Big 6 auditor firms, but insurers with actuaries that are not-Big 6 actuaries have less impact on under-estimated reserve but the auditor is not. Using loss reserve error as a proxy, Grace and Leverty (2012b) indicate that larger actuaries (i.e., Big 4 actuaries) reduce the extent of insurer's managerial discretion decisions such as reducing the impact of rate regulation, smoothing earnings, and for tax purposes[10]. They also find that larger actuaries are significantly related to less under-reserving in the under-reserving sample. Grace and Leverty (2011) find the reputation of actuaries is positively correlated with accurate loss reserves, but they find little evidence to claim that the high reputation auditors are associated with the accuracy of loss reserve estimates. Kelly, Kleffner and Si (2012) show that there is no difference in loss reserve accuracy between internal actuary role (i.e., in-house) and external actuaries in Canada property casualty insurance industry[11]. The empirical evidence to date is inconclusive.

For property casualty insurer companies, loss reserve can be difficult to estimate and the amounts ultimately paid may be far less than or greater than, amounts previously estimated[12]. Actuaries usually play an integral role in the loss reserve estimation process. Actuaries should use their professional judgment to ensure that loss reserve formula. Therefore, we believe an insurer with more reserve error includes overestimation (or underestimation) of loss reserve will be probability changed their actuaries. This leads to the following hypothesis:

Hypothesis 3: An insurer with more reserve error is more likely to switch its actuary than an insurer with accurate loss reserve estimation in the property

[9] Gaver and Paterson (2001) show that the loss reserve error is positive if the manager initially under-reserved.
[10] However, Grace and Leverty (2012b) do not find evidence that larger auditors reduce managerial discretion. This result is similar to finding of Pertoni and Beasley (1996).
[11] Authors don't consider the relation between Big 4 actuary and non-Big 4 actuary.
[12] 2013 American academy of Actuaries: property and casualty practice note.

casualty insurance industry.

Organizational structure and loss reserve error

Mayers and Smith (1981, 1988) and Dionne et al. (2007) suggest agency problems related to organizational structure. Conflicts of interest between owners (shareholders) and managers (agents) seem to be controlled better under a stock insurers than mutual insurers, because stock insurers have better mechanisms to control the agency costs of managers. The mutual insurers can eliminate conflicts of interest between owners and policyholders because mutual insurers merge the owner and policyholder functions. Mutual insurers would be associated with lower "costs of expanding and contracting assets" because of efficiencies of controlling agency costs (Fama and Jensen, 1983a, 1983b). It is implying that stock insurers are likely to be associated with less reserve error behaviors based on signaling hypothesis. We thus suggest:

Hypothesis 4: The stock organizational structure are more like to less loss reserve error than mutual organizational structure in the property casualty insurance industry.

Corporate governance and loss reserve error

Corporate governance mechanism provides an external monitoring mechanisms in detecting or mitigating inappropriate reserve management. It is expect that insurers with CEO/Chairperson duality is more likely to increase conservatism in reserve estimations result in reducing reserve error. Cheng (2008) suggests that there are more coordination and communication problems with large board size. As a board grows, it is more difficult for members to reach a consensus to manipulate reserve error. Hsu et al., (2014) find that insurers with large audit committee size are more conservative in loss reserve estimations. It is implying that insurers with large board size is more likely to less reserve error. Grace and Leverty (2012b) suggest that the managers of insurers subject to stringent rate regulation resulting in over-estimate loss reserves than other insurers. They also find that a majority of the response occurs from under-reserving insurers' under-reserving less because of stringent rate regulation. This is implied that insurers with high percentage of insider directors on the board would like to less reserve error. For example, manager would like to less loss reserve error to achieve firm's solvency goals. We propose hypothesis:

Hypothesis 5a: The CEO/Chairperson duality is more likely to less loss reserve error in the property casualty insurance industry.

Hypothesis 5b: Large Board size is more likely to less loss reserve error in the property casualty insurance industry.

Hypothesis 5c: Higher percentage of insiders on a board is more likely to less loss reserve error in the property casualty insurance industry.

Actuaries switching and loss reserve error

Actuaries switching also serve as a signal to policyholders, regulators, and shareholders that the loss reserve estimation are more likely to accurate. For example, Grace and Leverty (2012b) find that insurers with non-Big 4 actuaries that switch to Big 4 actuaries report less over-estimated reserve error and less under-estimated reserve error. This result indicates that large actuaries are more independent to limit managerial discretion. This implying that insurers with actuaries switching are required to possess extensive technical knowledge or practice in evaluating loss reserve. In addition, insurers would like to switch their actuaries when managers have incentives to overstate reported earnings through loss reserve error to achieve earning goals. We believe an insurer with newly appointed actuary is more likely to have less reserve error than an insurer without actuaries switching based on shareholder incentives. This leads to the following hypothesis:

Hypothesis 6: An insurer with actuary switching is more likely to have less reserve error than an insurer without actuaries switching in the property casualty insurance industry.

The Sarbanes-Oxley Act and actuaries switching

The Sarbanes-Oxley Act (2000) requires directors on the board to be responsible for the financial statements of the insurance companies. It has been shown that boards of directors have become much more cautious about their roles since the implementation of the law. This implies that insurers are more likely to switch their actuaries after SOX Act. We believe that insurers with actuaries switching are more likely to reduce reserve error would take more conservative relative to insurers without actuaries switching. After SOX, insurers may have more likely to less under-estimate reserve error to protect insurer's solvency. This leads to the following hypothesis:

Hypothesis 7a: An insurer is more likely to switch their actuaries after enactment of the Sarbanes-Oxley Act than before SOX.

Hypothesis 7b: An insurer which switches its actuaries after enactment of the Sarbanes-Oxley Act is less reserve error estimation than before SOX.

3. Data and Methodology

Data

There were 640 insurance companies in 2000, representing over 83% of the total assets of all property casualty insurers, 137 mutual insurers and 503 stock insurers. Our sample consists of U.S. property casualty insurance companies with net admitted assets of more than US$100 million[13]. We use hand-collected detailed information on insurers board's composition including name of actuarial firms (or name of actuary), name of auditor firms (e.g., KPMG), CEO, Chairperson, board size, CEO/Chairperson duality, firm age (i.e., number of years since the firm was established) and percentage of insider directors on the board from A.M. Best's Insurance Report (Property Casualty). Organizational structure (i.e., mutual and stock insurers) and other financial data will be obtained from the National Association of Insurance Commissioners (NAIC). We calculate loss reserve error using five-year periods data from Schedule P of the NAIC Annual Statement for the period 1999 to 2013. Because the loss reserve error is measured relative to a five-year resolution period, the loss reserve error sample years are 2000 to

[13] There are 791 initial insurance companies' net admitted assets more than US$100 million in 2000. When we use balance panel data and drop unreasonable data (e.g., negative net admitted assets or negative net written premiums), the final sample includes 640 insurers.

2008. For example, loss reserve error for 2008 is calculated using data from 2008 through 2013. In addition, since the variables of actuaries switching, premium growth and loss reserve error consider the previous year and the next year, the final sample years for our analysis is period 2000 to 2007. There are 5,120 observations for balance panel data in this study. To examine the effectiveness of SOX, we separate the full sample into two sub-samples, one prior to its implementation (2000-2002) and one following (2003-2007). We also use another two subsamples that attempt to capture lag effects for the period before SOX. The first period is prior to the implementation of SOX plus a two-year lag (2000 - 2004), and the second period is following the implementation of SOX plus a two-year lag (2005 - 2007). We chose a two-year lag period to allow the time for the implementation of SOX to become effective in the insurance industry. BEST's Review (2006) also states that SOX went into effect in 2004 for the insurance industry.[14]

Methodology

We first investigate whether organizational structure, corporate governance and loss reserve error (i.e. accuracy or over-estimated reserve error or under-estimated reserve error) in the previous year may result in actuaries switching and then we also examine the impact of actuaries switching, organizational structure and corporate governance on loss reserve error. We also consider endogeneity issue to investigate the relation between loss reserve error and actuaries switching in the U.S. property casualty insurance industry as follows.

We first discuss the endogeneity issue regarding the organizational structure, corporate governance, loss reserve error and actuaries switching. For example, insurers with over-estimated reserve (or under-estimated reserve) may switch their actuaries. In

[14] Insurance is the only industry that markets and sells products before their final costs are known. Under SOX, which went into effect in 2004, insurers not only have to show that their past financial statements are accurate, but also have to prove that future predictions are reasonable.

the first stage, a potential endogenous variable in question is regressed against all the exogenous variables and instrumental variables. It is also possible that a newly appointed actuary change the loss reserve error. We will then use the Durbin-Wu-Hausman (DWH) test (a two-stage least squares method) to address the potential endogeneity issue of actuaries switching variables. Some instrumental variables are obtained from Kelly, Kleffner and Si (2012) and Grace and Leverty (2012b). The instrumental variables in the first-stage regressions of actuaries switching include organizational structure (mutual or stock), group, business line Herfindahl Index, geography Herfindahl Index and ROA (return on assets). In addition, it should be noted that we include relative size and firm age as instrumental variables for the endogeneity variable. In the second stage, the residual of the endogenous variable in question is added to the original regression model. If a coefficient of residual of actuaries switching is statistically significant, then the variable is considered as endogenous. We use the predicted value of the variable instead the original value in the regression model. As our sample is in the form of panel data, we need to determine whether to use a fixed effects or random effects model, which is determined by the results Hausman test.

The logistic regression model used to examine the relation among organizational structure, corporate governance, loss reserve error and actuaries switching. The dependent variable is actuaries switching and the independent variable including lag year of organizational structure, corporate governance, loss reserve error, and control variables in the regression. The empirical model is:

$$
\begin{aligned}
Log\left[P_{it}/(1-P_{it})\right] &= \alpha_0 + \alpha_1 Stock_{it-1} + \alpha_2 Duality_{it-1} + \alpha_3 Boardsize_{it-1} + \alpha_4 Insider\_director_{it-1} + \\
&\alpha_5 Reserve\_error_{it-1} + \alpha_6 Big4auditors_{it-1} + \alpha_7 LN(auditfee)_{it-1} + \alpha_8 LN(NA)_{it-1} + \alpha_9 BusinesslineHerfindahl_{it-1} \\
&+ \alpha_{10} GeographicHerfindahl_{it-1} + \alpha_{11} Longtail_{it-1} + \alpha_{12} Reinsurance_{it-1} + \alpha_{13} Tax\_shield_{it-1} + \alpha_{14} Tax\_indicator_{it-1} \\
&+ \alpha_{15} Length_{it-1} + \alpha_{16} Malpractice_{it-1} + \alpha_{17} Premgrowth_{it-1} + \alpha_{18} Weak_{it-1} + \alpha_{19} Group_{it-1} + \alpha_{20} Public_{it-1} + u_{it-1}
\end{aligned}
$$

Dependent Variable

P_i is the probability that the actuaries switching (1 = for year t if the actuaries reported in year t is different from that reported in year t-1; 0 = otherwise). Another variable is that an insurer which switches its appointed actuary from internal actuary to Big 6 actuaries will be considered: $Swtich\_\text{int}\_Big6actuary_{it}$ is a binary variable; 1 = if a newly appointed actuary is Big 6 actuarial firms replace internal actuary in fiscal year t, 0 = otherwise. We use the other definition of actuaries switching that an insurer which switches its appointed actuary from Big 6 actuaries to internal actuary: $Swtich\_Big6actuary\_in_{it}$ is a binary variable; 1 = if a newly appointed actuary is internal actuary replace Big 6 actuaries in fiscal year t, 0 = otherwise.

Independent Variable

The independent variables include organizational structure, corporate governance and reserve error variables. $Stock$ is organizational structure variable, which is a binary variable: 1 = stock organizational structure, 0 = otherwise (e.g., He and Sommer, 2010; Mayers and Smith, 2010; Gaver and Leverty, 2012b). Corporate governance variables include: $Duality$, the same entity functioning as CEO and Chairperson of the board, is a binary variable; 1 = CEO and chairperson of the board are the same person, 0 = otherwise. $Boardsize$ (board size), which is defined as the total number of directors on the board (Cheng, 2008; Pathan, 2009; Ho et al., 2013). $Insider\_directors$, defined as the percentage of inside directors on the board (Ho et al., 2013).

$\text{Re}serve\_error$ is defined as previous one year of loss reserve error scaled by total admitted assets. There are three variables: accuracy, over-estimated reserve error and under-estimated reserve error in the regression, respectively. Accuracy is defined as an insurer' reserve error is equal to zero. $Under\_abkfsa$ ($Under\_abwa$)

Under-estimated reserve error is defined as 1= if an insurer' loss reserve error is negative, 0 = otherwise. $Over\_abkfsa$ ($Over\_abwa$) Over-estimated reserve error is defined as 1= if an insurer' loss reserve error is positive, 0 = otherwise.

There are two measures of insurance policy loss reserve error are discussed in the prior studies. Some studies compare the originally reported loss reserve to a future revised estimate (e.g., Kazenski, Feldhaus, and Schneider, 1992; Pertoni, 1992; Beaver, McNichols, and Nelson, 2003; Grace and Leverty, 2012a; Grace and Leverty, 2012b), whereas some studies compare loss reserve to future claims paid (e.g., Weiss, 1985; Grace, 1990; Grace and Leverty, 2012a; Grace and Leverty, 2012b).

To calculate the reserve error variable by two measures (Grace and Leverty, 2012b). The first loss reserve error follows Kazenski, Feldhaus, and Schneider (1992) who define it as the difference between total incurred losses from *i* as of a given year *t* and a revised estimate of incurred losses in year *t+5* (e.g., Pertoni, 1992; Beaver, McNichols, and Nelson, 2003; Eckles and Halek,2010; Grace and Leverty, 2012a). This error is positive if the initial reported reserve is over-estimated.

$$KFS\_Error_{it} = Incurred\_Losses_{i,t} - Incurred\_Losses_{i,t+5}$$

The second reserve error follows the study of Weiss (1985) who is the difference between total incurred loss for firm *i* as of a given year *t* and cumulative developed losses paid in a future year *t+5* (e.g., Grace, 1990; Browne, Ma and Wang, 2008, Grace and Leverty, 2012a). This error is positive if the initial reported reserve is over-estimated relative to what is eventually paid on these losses.

$$Weiss\_Error_{it} = Incurred\_Losses_{i,t} - Developed\_Losses\_Paid_{i,t+5}$$

Control variables

The control variables include firm size, auditor, audit fees, net admitted assets, lines of business Herfindahl index, geographic Herfindahl index, percentage of net written premiums in the long-tail lines, the reinsurance ratio, tax shield, tax rate, length, the percentage of net premiums written for malpractice insurance, the premium growth and financial condition. Audit quality is proxied by the auditor variables. $Big4auditor$ is a binary variable: 1 = the four largest accounting companies in the U.S. (PricewaterhouseCoopers LLP, Ernst & Young, Deloitte and KPMG), 0 = otherwise (Ho, Lai and Lee, 2013). $LN(Auditfee)_{it}$ is the natural logarithm of audit fees (Vafeas and Waegelein, 2007). $LN(NA)_{it}$ is a proxy for the firm size, which is natural logarithm of net admitted assets (He and Sommer, 2011; Ho, Lai and Lee, 2013). $Bu\sin essLineHerfindahlIndex$ (lines of business Herfindahl index) is defined as $\sum(PW_i / TPW)^2$ where PW_i is the value of net written premiums in line i and TPW is the insurer's total net written premiums. This measures the line concentration and indicates the levels of risk taking (Hill et al. 1992; Ho, Lai and Lee, 2013). $GeographicHerfindahlIndex$ is a measure of geographic concentration (e.g., Cole and McCullough, 2006; Ho, Lai and Lee, 2013). The Geographic Herfindahl index is defined as $\sum(PW_i / TPW)^2$ where PW_i is the value of net written premiums in state i, and TPW is the insurer's total net written premiums. $Longtail$ (Percentage of long-tail lines) is the premiums of long-tail lines divided by total net written premiums. The percentage of lines of business is from Schedule P of the NAIC annual statement. Prior studies suggest that the percentage of long-tail business lines have more discretion over-estimated reserve (e.g., Petroni and Beasley, 1996; Beaver et al., 2003). $\mathrm{Re}\,insurance$ (reinsurance ratio) is measured as the ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed (e.g., Harrington and Dazon, 1994). $Tax\_indictor$ (Tax indictor) is $Boardsize$ a binary variable: 1 = if an insurer has a high tax rate (insurer either paid taxes or received a refund of prior taxes[15]); 0 =otherwise (e.g., Grace 1990; Petroni, 1992; Grace and Leverty, 2012a). Tax_shield (Tax shield) is sum of net income plus estimated reserve (for 5 years) divide by total assets (e.g., Grace 1990; Grace and Leverty, 2012a). $Length$ (length) measured as claim loss reserve as a percentage of total liabilities (e.g., Petroni and Beasley, 1996). $Malpractice$ (Malpractice), measured as malpractice premiums as a percentage of total net written premiums (e.g., Petroni and Beasley, 1996). $\Pr emgrowth$ (premium growth) is measured as the one-year percent increase in net premiums written (Grace and Leverty, 2012b). $Weak$ (Financial weakness) is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise (e.g., Petroni, 1992; Beaver et al., 2003; Gaver and Paterson, 2004; Gaver and Paterson, 2007). Unusual IRIS ratios are defined as insurers with exceeding certain bounds specified by the National Association of Insurance Commissioners[16]. $Group$ is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise (e.g., Grace and Leverty, 2012a). $Public$ (Public) is a binary variable:1= the public-traded stock insurers, 0 = otherwise (e.g., Grace and Leverty, 2012a). u is an error term.

We then use the regression analysis to investigate the impact of actuaries switching, organizational structure and corporate governance on loss reserve error. The empirical model is stated below.

$$\begin{aligned}
&\operatorname{Re}serve_error_{it} = \alpha_0 + \alpha_1 Switch_{it} + \alpha_2 Stock_{it} + \alpha_3 Duality_{it} + \alpha_4 Boardsize_{it} + \\
&\alpha_5 Insider_director_{it} + \alpha_6 Big4auditors_{it} + \alpha_7 LN(auditfee)_{it} + \alpha_8 LN(NA)_{it} + \alpha_9 Bu\sin esslineHerfindahl_{it} + \\
&\alpha_{10} GeographicHerfindahl_{it} + \alpha_{11} Longtail_{it} + \alpha_{12} \operatorname{Re}insurance_{it} + \alpha_{13} Tax_shield_{it} + \alpha_{14} Tax_indicator_{it} + \\
&\alpha_{15} Length_{it} + \alpha_{16} Malpractice_{it} + \alpha_{17} \Pr emgrowth_{it} + \alpha_{18} Weak_{it} + \alpha_{19} Group_{it} + \alpha_{20} Public + u_{it}
\end{aligned}$$

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[15] Please see Petroni (1992).

[16] National Association of Insurance Commissioners (NAIC) provides the details about the calculation of Insurance Regulatory Information System (IRIS) Ratios for each individual insurers (2012 Edition).

Dependent variable

$\mathrm{Re}\,serve\_error_{it}$ is defined as the difference between $\mathrm{Re}\,serve\_error_{it+1}$ and $\mathrm{Re}\,serve\_error_{it-1}$ (i.e. reserve error in the next year minus one year lag of reserve error) scaled by total assets. To investigate the difference of reserve error will increasing or decreasing, we separate two sub-samples: over-estimated reserve error and under-estimated reserve error. Under-estimated reserve error is defined as the loss reserve estimation error is negative, whereas over-estimated reserve error is defined as the loss reserve estimation error is positive. To calculate the reserve error variable by two measures is as same as the previous regression.

Independent variable

The key of independent variable is $Switch$. $Switch$ is a binary variable:1 = if the actuary reported in year t is different from that reported in year t-1; 0 = otherwise. Two switching types are same as above regression will be discussed. The variable is that an insurer which switches its appointed actuary from internal actuary to Big 6 actuary or from Big 6 actuary to internal actuary. $Swtich\_\mathrm{int}\_Big6actuary_{it}$ is a binary variable; 1 = if a newly appointed actuary is Big 6 actuarial firms replace internal actuary in fiscal year t, 0 = otherwise. $Swtich\_Big6actuary\_in_{it}$ is a binary variable; 1 = if a newly appointed actuary is Big 6 actuaries replace internal actuary in fiscal year t, 0 = otherwise. The rest of independent variables include organizational structure, corporate governance variables, and all control variables are same as those variables of the first logit regression.

4. Summary Statistics and Empirical Results

This section presents summary statistics and then empirical results.

Summary statistics

The summary statistics for all variables are presented in Table 1. Mean switch is about 5 percent. Mean switching external actuary is 1.7 percent, while 3.7 percent of switching Big 6 actuary. Mean reserve error of Kazenski, Feldhaus, and Schneider (1992) (Weiss, 1985) is under-estimated by 0.6 percent (over-estimated by 0.87 percent) of total net admitted assets with a minimum of -1.292 (-0.763) and a maximum of 1.043 (1.596). The mean of reserve error of Kazenski, Feldhaus, and Schneider (1992) is similar to Grace and Leverty (2012b)[17]. The absolute value of reserve error of Kazenski, Feldhaus, and Schneider (1992) (Weiss, 1985) has a mean of 0.1 (0.062) of total net admitted assets. The mean of under-estimated reserve error of Kazenski, Feldhaus, and Schneider (1992) (Weiss, 1985) is 41.2 (12.4) percent, while 53.9 (82.8) percent of over-estimated reserve error. Our sample consists of 78.5 percent of stock insurers and 21.5 percent of mutual insurers. Within stock insurers, only about 19.5 percent of them are public held. Mean of board size is 9.11 with a minimum of 2 and a maximum of 39. The mean of board size is similar to findings of the literature (e.g., Ho et al., 2013; Ashbaugh-Skaife et al., 2006). According to Lipton and Lorsch (1992) suggest that boards of eight or nine members are the most effective. The mean of percentage of insider directors on the boards represent on average 44 percent of directors. The average of Big 4 auditor is 91.7 percent, implying most of insurers are more likely to select Big 4 auditor firms.

[Insert Table 1 here]

Table 2 presents the Pearson correlation coefficients of all variables. We find some variables are highly correlated. For example, the percentage of insider director on the board is negatively and significantly related to board size (-0.457 at the one percent level). In addition, percentage of the insider director on the board is highly related to mutual insurers (0.392 at the one percent level). Therefore, we use variance-inflation factors (VIFs) to test for multicollinearity among independent variables in the regression design (See Neter et al., 1985). The VIFs of all independent variables in the regressions

[17] Grace and Leverty (2012b) find that mean of reserve error is under-estimated by1.3 percent of total assets.

are lower than 2.

[Insert Table 2 here]

Empirical results

Table 3 shows the results of logit regression of organizational structure, corporate governance, loss reserve error on actuaries switching. All Tables[18] report that the results of loss reserve error are measured as Kazenski, Feldhaus, and Schneider (1992). The loss reserve error is positive if the originally report loss reserve is over-estimated reserve. We use under-estimated reserve and over-estimated reserve when comparing accurate loss reserve estimation. Actuaries switching is significantly and positively related to stock insurers, implying a stock insurer is associated with higher probability of actuaries switching. We find stock insurers are more likely to switch their actuaries than mutual insurers to signal to stakeholders about their accuracy of financial statements, financial conditions, soundness of risk management, and investment strategies. This result is consistent with *the signaling hypothesis*. Our results support Hypothesis 1.

For corporate governance mechanism, we find the coefficients of all variables are insignificant. Our results cannot support Hypotheses 2a to 2c. We find firm size is positively correlated with actuaries switching. Large Insurers are less likely to switch their actuaries. Insurers with high percentage of long tail business are more likely to switch their actuaries, but insurers with high tax rate, high percentage of length, or financial weak are less likely to switch their actuaries.

We find the insurers with loss reserve error (i.e., under-estimated reserve and over-estimated reserve) in the previous year are not significantly related to actuaries switching in the Table 3 when comparing accurate loss reserve estimation. In other words, insurers with more loss reserve error do not have impact on actuaries switching than

[18] All results of loss reserve error are not tabulated when using estimation of Weiss (1985).

insurers with accurate loss reserve estimation. Our results cannot support Hypothesis 3.

[Insert Table 3 here]

Tables 4 and 5 present the results of regression of organizational structure, corporate governance, loss reserve error on actuaries switching when insurers switch to Big 6 actuaries or switch to internal actuary. The evidence shows that stock insurers are more likely to switch actuaries from internal actuary to Big 6 actuaries or from internal actuary to Big 6 actuaries than mutual insurers in Table 4. This result is also consistent with *the signaling hypothesis*. Our results are consistent with Hypothesis 1.

Insurers with large board size are more likely to switch their actuaries from internal actuary to Big 6 actuaries in Table 4. We find that insures with CEO/chairperson duality is more likely to switch their actuaries from Big 6 to internal actuary in Table 5. Our results are consistent with Hypotheses 2a and 2b.

We also find the insurers with more loss reserve error in the previous year are not significantly related to actuaries switching, while insurers are more likely to switch their actuaries to Big 6 actuaries or internal actuary. In other words, insurers with more loss reserve error do not have impact on actuaries switching than insurers with accurate loss reserve estimation. Our results cannot support Hypothesis 3.

For the control variables, insurers with high tax shield, high tax rate, high percentage of length, high growth of premium, weak financial condition, and group are less likely to switch their actuaries from internal actuary to Big 6 actuaries in Table 4. Table 5 shows that insurers with high shield are more likely switch to internal actuary.

[Insert Tables 4-5 here]

Tables 6 to 8 show the results of regression of actuaries switching, organizational structure and corporate governance on loss reserve error. The loss reserve error is defined as the difference between Reserve error_kfsa(t+1) and Reserve error_kfsa(t-1) scaled by total assets. Table 6 presents that loss reserve error is significantly and positively related to actuaries switching, indicating that insurers with actuaries switching tend to have less reserve error than insurers without actuaries switching. Our results are consistent with Hypothesis 6.

In particular, Table 7 shows that insurers with actuaries switching from internal actuary to Big 6 actuaries are more likely to less reserve error than insurers without actuaries switching, whereas insurers with actuaries switching from Big 6 actuaries to internal actuary are not changed reserve error in Table 8. Insurers with CEO/chairperson duality and high percentage of insider on the board are more likely to have less reserve error than insurers without actuaries switching in Tables 6 to 8. Our results are consistent with Hypotheses 5a and 5c.

For the control variables, insurers with high reinsurance ratio, high tax shield, high tax rate, high percentage of length, low malpractice, low premium growth, weak financial condition, group and public insurers are more likely to less their reserve error in Tables 6 to 8. Those results are similar to prior studies. For example, Grace and Leverty (2012a) find that the tax shield is positively and significantly related to the magnitude of the KFS error.

[Insert Tables 6 to 8 here]

Tables 9 and 10 present that all results include interaction terms between actuaries switching (i.e. from Big 6 actuaries to internal actuary and from internal actuary to Big 6 actuaries), organizational structure and corporate governance variables on reserve error. The evidence shows that stock insurers with actuaries switching from internal actuary to Big 6 actuaries are more likely to reduce reserve error, while insurers with high percentage of insider on the board more likely to increase reserve error after actuaries switching from internal actuary to Big 6 actuaries than before actuaries switching in Table 9. Table 10 shows that insurers with CEO/chairperson duality and large board size are more likely to less reserve error when actuaries switching from Big 6 actuaries to internal actuary than before actuaries switching. Other results of control variables are similar to Tables 6 to 8.

[Insert Tables 9 to 10 here]

Insurers with under-estimated reserve or over-estimated reserve are referred to as reserves error estimation under-starters (or over-starters) in Tables 11 to Table 14 (or Table 15). When we focus on under-estimated (or over-estimated) loss reserve issues, we drop the all accuracy reserve error sample in our sample. We find that insurers with actuaries switching tend to have less under-estimated reserve error than insurers without actuaries switching in Tables 11 to 14. In particular, the coefficient of actuaries switch from internal actuary to Big 6 actuaries (0.043) in Table 13 is higher than the coefficient of actuaries switch from Big 6 actuaries to internal actuary (0.032) in Table 14. Table 15 notes the result of regression of actuaries switching, organizational structure and corporate governance variables on over-estimated reserve error. The evidence shows that there is no significant between actuaries switching and over-estimated reserve error. In other words, an insurer with actuary switching does not have impact on over-estimate reserve error.

To sum up, insurers with actuaries switching tend to less under-estimate reserve error than insurers without actuaries switching. It is implied that a new appointed actuary is likely to mitigate under-estimated reserve. In other words, a newly appointed actuary is likely to have a more conservative reserve behavior after actuary switching.

We find that insurers with CEO/chairperson duality, large board size, high percentage of insider on the board tend to have less under-estimate reserve error after actuaries switching than insurers without actuaries switching. It is implied that insurers with CEO/chairperson duality, large board size, high percentage of insider on the board post actuaries switching are likely to have a more conservative reserve behavior.

The evidence shows that insurers with high percentage of reinsurance ratio, high tax shield, high tax rate, high percentage of length, low growth of premium, weak financial condition, and group are more likely to less under-estimate reserve error. In particular, insurers with weak financial condition is more likely to less under-estimate reserve error. The result is consistent with findings of prior studies. Some studies find that financial weak insurers under-estimated reserve to a greater extent than financial health insurers (e.g., Pertoni, 1992; Harrington and Danzon, 1994; Penalva, 1998; Pertoni, Ryan and Wahlen, 2000; Gaver and Paterson, 2004). Pike (2003) find that financial weak insurers with between Big 6 actuaries and Big 6 auditors are associated with reducing loss reserve error. However, Gaver and Paterson (2012b) do not find that financial weak insurers under-estimated reserve to a greater extent than other insurers. Other results of control variables are similar to Tables 6 to 10.

[Insert Tables 11 to 15 here]

To investigate the effect of SOX, we examine the impact of SOX with two-year lag[19] on actuaries switching. Table 16 include SOX variable, but do not include interaction terms of SOX Act among organizational structure, corporate governance variables and loss reserve error, while Table 17 do include the interaction terms.

The evidence shows that SOX is significantly and positively related to actuaries switching in Table 16, indicating that insurers are more likely to switch their actuaries after SOX Act than before SOX Act. Our results are consistent with Hypothesis 7a.

Large insurers, high percentage of long tail, low tax rate and low percentage of length are more likely to switch their actuaries. Table 17 presents that all interaction terms of SOX Act is not significantly related to actuaries switching with one exception. The coefficient of interaction terms between SOX and percentage of insider directors on

[19] The results of SOX are not tabulated when separating two periods before and after 2002.

the board is significantly and negatively related to actuaries switching. It is implied that insurers with low percentage of insider on the board are more likely to switch their actuaries after SOX Act than before SOX Act. Other control variables are similar to the previous results in Tables 6 to 10.

[Insert Tables 16-17 here]

We examine the impact of actuaries switching, organizational structure, and corporate governance on loss reserve error when considering SOX Act with two-year lag. Tables 18 and 19 include SOX variable, but do not include interaction terms among SOX Act, actuaries switching and corporate governance variables, while Table 19 do include the interaction terms. Table 18 shows that SOX Act is significantly and positively related to reserve error, implying that insurers tend to have less reserve error after SOX Act than before SOX Act.

Table 19 shows that an insurer with actuaries switching is not significantly related to reserve error behavior after SOX Act than before SOX Act. In other words, insurers with actuaries switching do not change their reserve error behavior compared to without actuaries switching after the enactment of the Sarbanes-Oxley Act. The reason is that new actuary resulting from actuary switching face the same new regulatory environment, SOX.

In addition, we find that the coefficient of the interaction term between the percentage of insider directors on the board and SOX Act is significant. It is implied that an insurer with high percentage of insider directors on the board is associated with decreasing reserve error post the SOX Act. The evidence is consistent with the spirit of SOX, indicating that insurers with high percentage of insiders are more likely to have conservative reserve behavior after enactment of the SOX Act. This result is consistent with Hypothesis 7b. The results of the control variables are very similar to those in the previous Tables.

[Insert Tables 18-19 here]

5. **Conclusion**

This study examines actuaries switching and loss reserve in the U.S. property-liability insurance industry from 2000 through 2007. The first purpose is to examine whether organizational structure, corporate governance and loss reserve error in the previous year will cause the insurers to switch their actuaries. The second purpose in this paper is to examine the impact of actuaries switching, organizational structure and corporate governance on loss reserve error behavior. Finally, we examine the interaction effect of enactment among SOX Act, organizational structure, corporate governance, loss reserve error and actuaries switching.

The results show that stock insurers are more likely to switch their actuaries than mutual insurers. Insurers with high percentage of long-tail business are also more likely to switch their actuaries. Large and weak financial condition insurers are less likely to switch their actuaries. We find that insurers with under-estimated (over-estimated) reserve error in the previous year are not significantly to switch their actuaries. In terms of corporate governance variables, the evidence shows that insurers with large board size are more likely to switch their actuaries from internal actuary to Big 6 actuarial firms, whereas insurers with CEO/Chairperson duality are more likely to switch their actuaries from Big 6 actuarial firms to internal actuary.

We next examine the impact of organizational structure, corporate governance and actuaries switching on reserve error. The evidence shows that insurers tend to have less reserve error after actuaries switching than before. Insurers with CEO/Chairperson duality and high percentage of insider directors on the board are positively and significantly related to reserve error post actuaries switching. In addition, stock insurers are more likely to have less reserve error after actuaries switching from internal actuary to Big 6 actuarial firms than stock insurers without actuaries switching. Insurers with CEO/Chairperson duality and large board size are positively and significantly related to reserve error when actuaries switching from Big 6 actuarial firms to internal actuary. We also find that insures with actuaries switching form internal actuary to Big 6 actuaries are more likely to have less under-estimate reserve error than insurers without actuaries switching. Examination of the impact of the Sarbanes-Oxley Act (SOX) on reserve error indicates that insurers are more likely to switch actuaries after SOX. After SOX, insurers with actuaries switching are more likely to less under-estimated reserve error.

The overall results show that organizational structure, corporate governance and some firm characteristics affect actuaries switching, while actuaries switching and corporate governance variables have impact on insurers' reserve error.

Table 1 Descriptive Statistics

Variables	N	Mean	Std. Dev.	Min	Max
Switch	5,120	0.050	0.218	0.000	1.000
Switch_int_Big 6 actuary	5,120	0.014	0.117	0.000	1.000
Switch_Big 6 actuary_int	5,120	0.010	0.101	0.000	1.000
Reserve error_kfsa	5,120	-0.006	0.107	-1.292	1.043
Reserve error_wa	5,120	0.087	0.122	-0.763	1.596
Reserve error_abkfsa	5,120	0.100	0.111	0.000	1.596
Reserve error_abwa	5,120	0.062	0.087	0.000	1.292
Diff_Reserve error_kfsa	5,120	0.010	0.095	-1.148	1.877
Diff_Reserve error_wa	5,120	0.014	0.296	-2.004	15.014
Under_abkfsa	5,120	0.038	0.086	0.000	1.292
Over_abkfsa	5,120	0.025	0.055	0.000	1.043
Under_kfsa	5,120	0.412	0.492	0.000	1.000
Over_kfsa	5,120	0.539	0.498	0.000	1.000
Under_wa	5,120	0.124	0.329	0.000	1.000
Over_wa	5,120	0.828	0.377	0.000	1.000
Stock	5,120	0.785	0.411	0.000	1.000
Duality	5,120	0.566	0.496	0.000	1.000
Boardsize	5,120	9.112	3.833	2.000	39.000
Insider directors	5,120	0.440	0.294	0.000	1.000
Big 4 auditors	5,120	0.917	0.275	0.000	1.000
LN(auditfee)	5,120	4.842	5.671	0.000	16.764
LN(NA)	5,120	20.140	1.316	15.502	25.376
Business Line Herfindahl Index	5,120	0.372	0.287	0.000	1.000
Geographic Herfindahl Index	5,120	0.386	0.359	0.032	1.000
Longtail	5,120	0.707	0.253	0.000	1.000
Reinsurance	5,120	0.381	0.298	0.000	1.000
Tax Shield	5,120	0.041	0.067	-1.292	1.413
Tax Indicator	5,120	0.755	0.430	0.000	1.000
Length	5,120	0.539	0.242	0.000	3.527
Malpractice	5,120	0.121	0.228	0.000	1.000
Premgrowth	5,120	0.055	0.514	-4.868	5.973
Weak	5,120	0.125	0.331	0.000	1.000
Group	5,120	0.899	0.301	0.000	1.000
Public	5,120	0.195	0.396	0.000	1.000

Notes: Switch is a binary variable: 1 = if the actuary reported in year t is different from that reported in year t-1; 0 = otherwise. Switch_int_Big 6 actuary is a binary variable: 1 = if a newly appointed actuary is Big 6 actuarial firms replace internal actuary in fiscal year t; 0 = otherwise. Switch_Big 6 actuary_int is a binary variable: 1 = if a newly appointed actuary is internal actuary replace Big 6 actuaries in fiscal year t; 0 = otherwise. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. Reserve error_wa is the reserve error estimation comparing the originally reported loss reserve to future claims paid five years in the future (e.g. Weiss, 1985) scaled by total admitted assets. Reserve error_abkfsa (Reserve error_abwa) is absolute value of Reserve error_kfsa (Reserve error_wa). Diff_ Reserve error_kfsa (Diff_ Reserve error_wa) is defined as the difference between Reserve error_kfsa$_{t+1}$ (Reserve error_wa$_{t+1}$) minus Reserve error_kfsa$_{t-1}$ (Reserve error_wa$_{t-1}$) scaled by total assets. Under_abkfsa$_{(t-1)}$ is the absolute value of Reserve error_kfsa in year t-1= if the negative Reserve error_kfsa in year t-1 indicate that the insurers under-reserved, 0 = otherwise. Over_abkfsa$_{(t-1)}$ is the absolute value of Reserve error_kfsa in year t-1= if the positive Reserve error_kfsa in year t-1 indicate that the insurers over-reserved, 0 = otherwise. Under_kfsa (Under_wa) is a binary variable:1 = if the negative Reserve error_kfsa (Reserve error_wa) indicate that the insurers under-reserved, 0 = otherwise. Over_kfsa (Over_wa) is a binary variable:1 = if the positive Reserve error_kfsa (Reserve error_wa) indicate that the insurers over-reserved, 0 = otherwise. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise.

Table 2 Correlation Coefficients of Variables

Variables	stock	Duality	Boardsize	Insider directors	Big 4 auditors	LN(auditfee)	LN(NA)	Business Line Herfindahl Index	Geographic Herfindahl Index	Longtail	Reinsurance	Tax Shield	Tax Indicator	Business Line Herfindahl Index	Length	Malpractice	Premgrowth	Weak	Group
stock	1																		
Duality	0.097	1.000																	
	0.000																		
Boardsize	-0.264	-0.113	1.000																
	0.000	0.000																	
Insider directors	0.392	0.206	-0.457	1.000															
	0.000	0.000	0.000																
Big 4 auditors	0.270	0.019	-0.059	0.176	1.000														
	0.000	0.169	0.000	0.000															
LN(auditfee)	-0.094	-0.035	0.022	-0.091	-0.024	1.000													
	0.000	0.014	0.119	0.000	0.092														
LN(NA)	0.059	0.050	0.128	0.065	0.166	0.093	1.000												
	0.000	0.000	0.000	0.000	0.000	0.000													
Business Line Herfindahl Index	-0.058	-0.082	0.009	-0.141	-0.127	-0.202	-0.078	1.000											
	0.000	0.000	0.520	0.000	0.000	0.000	0.000												
Geographic Herfindahl Index	-0.219	-0.131	0.157	-0.223	-0.178	-0.193	-0.203	0.236	1.000										
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000											
Longtail	-0.163	-0.092	0.020	-0.049	-0.069	0.267	-0.028	-0.145	0.149	1.000									
	0.000	0.000	0.153	0.001	0.000	0.000	0.053	0.000	0.000										
Reinsurance	0.216	0.099	-0.092	0.174	0.127	0.069	-0.180	-0.315	-0.278	0.054	1.000								
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000									
Tax Shield	0.037	0.046	-0.064	0.058	0.009	-0.076	0.011	0.033	-0.059	-0.161	-0.025	1.000							
	0.009	0.002	0.000	0.000	0.542	0.000	0.466	0.023	0.000	0.000	0.080								
Tax Indicator	-0.057	-0.018	-0.009	-0.033	-0.064	-0.007	0.061	0.068	0.034	-0.005	-0.172	0.253	1.000						
	0.000	0.204	0.546	0.017	0.000	0.610	0.000	0.000	0.017	0.702	0.000	0.000							
Length	-0.019	-0.036	0.026	0.002	-0.038	0.169	0.120	0.005	0.070	0.437	-0.194	-0.126	0.034	1.000					
	0.166	0.010	0.061	0.890	0.007	0.000	0.000	0.750	0.000	0.000	0.000	0.000	0.014						
Malpractice	-0.103	-0.038	-0.072	-0.070	-0.111	0.360	-0.032	0.247	0.093	0.367	-0.037	-0.069	-0.004	0.306	1.000				
	0.000	0.007	0.000	0.000	0.000	0.000	0.024	0.000	0.000	0.000	0.009	0.000	0.793	0.000					
Premgrowth	-0.017	-0.058	0.033	-0.036	0.000	0.041	0.074	0.005	-0.017	0.027	-0.175	-0.066	0.168	-0.005	0.014	1.000			
	0.226	0.000	0.021	0.012	0.978	0.004	0.000	0.744	0.237	0.063	0.000	0.000	0.000	0.743	0.313				
Weak	0.072	0.023	0.037	-0.012	0.006	0.005	-0.010	0.045	-0.003	-0.006	0.084	-0.211	-0.249	0.052	0.012	0.002	1.000		
	0.000	0.098	0.008	0.399	0.669	0.722	0.488	0.001	0.838	0.694	0.000	0.000	0.000	0.000	0.385	0.868			
Group	0.211	0.069	-0.134	0.191	0.220	0.052	0.157	-0.256	-0.235	-0.142	0.188	0.048	-0.053	-0.094	-0.123	-0.023	-0.015	1.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.100	0.277		
Public	0.207	0.055	-0.171	0.115	0.081	0.022	-0.112	-0.005	-0.121	-0.007	0.140	0.046	0.034	-0.035	0.018	0.021	0.016	0.109	1.000
	0.000	0.000	0.000	0.000	0.000	0.119	0.000	0.736	0.000	0.602	0.000	0.001	0.015	0.012	0.217	0.144	0.268	0.000	

Table 3 Logit Regression Results of Organizational Structure, Corporate Governance and Loss Reserve Error on Actuary Switching

Variables	Estimate	Std. Error	z	P value
Stock	0.475	0.222	2.140	0.032 **
Duality	0.007	0.154	0.050	0.963
Boardsize	0.032	0.023	1.400	0.161
Insider directors	-0.236	0.319	-0.740	0.458
Under_abkfsa(t-1)	0.042	1.034	0.040	0.967
Over_abkfsa(t-1)	-0.122	1.683	-0.070	0.942
Big 4 auditors	-0.325	0.271	-1.200	0.230
LN(auditfee)	0.013	0.016	0.810	0.419
LN(NA)	-0.134	0.067	-1.990	0.046 **
Business Line Herfindahl Index	0.160	0.348	0.460	0.645
Geographic Herfindahl Index	-0.317	0.249	-1.270	0.204
Longtail	0.963	0.400	2.410	0.016 **
Reinsurance	-0.183	0.319	-0.570	0.566
Tax Shield	-1.312	0.980	-1.340	0.181
Tax Indicator	-0.518	0.173	-2.990	0.003 ***
Length	-1.310	0.468	-2.800	0.005 ***
Malpractice	0.019	0.418	0.050	0.964
Premgrowth	-0.135	0.158	-0.860	0.392
Weak	-0.463	0.255	-1.820	0.069 *
Group	-0.036	0.265	-0.130	0.893
Public	0.093	0.196	0.470	0.635
Intercept	-0.150	1.415	-0.110	0.915
Number of observations	5,120			
Wald Chi-square Statistics	37.36			
Probability > chi-square	0.015			
Log likelihood	-886.855			

Notes: The table shows the regression results of organizational structure, corporate governance and loss reserve error on actuary switching. Dependent variable: Switch is a binary variable: 1 = if the actuary reported in year t is different from that reported in year t-1; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Under_abkfsa$_{(t-1)}$ is the absolute value of Reserve error_kfsa in year t-1= if the negative Reserve error_kfsa in year t-1 indicate that the insurers under-reserved, 0 = otherwise. Over_abkfsa$_{(t-1)}$ is the absolute value of Reserve error_kfsa in year t-1= if the positive Reserve error_kfsa in year t-1 indicate that the insurers over-reserved, 0 = otherwise. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 4 Logit Regression Results of Organizational Structure, Corporate Governance and Loss Reserve Error on Actuary Switching from Internal Actuary to Big 6 Actuarial firms

Variables	Estimate	Std. Error	z	P value
Stock	0.923	0.428	2.160	0.031 **
Duality	0.019	0.276	0.070	0.945
Boardsize	0.066	0.037	1.800	0.072 *
Insider directors	0.352	0.551	0.640	0.524
Under_abkfsa(t-1)	-0.375	2.078	-0.180	0.857
Over_abkfsa(t-1)	-0.305	3.133	-0.100	0.923
Big 4 auditors	0.365	0.638	0.570	0.567
LN(auditfee)	0.024	0.028	0.850	0.394
LN(NA)	-0.050	0.109	-0.460	0.648
Business Line Herfindahl Index	-0.406	0.633	-0.640	0.521
Geographic Herfindahl Index	-0.136	0.424	-0.320	0.748
Longtail	1.089	0.725	1.500	0.133
Reinsurance	0.306	0.560	0.550	0.585
Tax Shield	-2.849	1.255	-2.270	0.023 **
Tax Indicator	-1.025	0.288	-3.560	0.000 ***
Length	-2.114	0.814	-2.600	0.009 ***
Malpractice	0.231	0.798	0.290	0.772
Premgrowth	-0.615	0.235	-2.620	0.009 ***
Weak	-1.250	0.544	-2.300	0.022 **
Group	-0.949	0.421	-2.250	0.024 **
Public	-0.414	0.385	-1.070	0.283
Intercept	-3.097	2.338	-1.320	0.185
Number of observations	5,120			
Wald Chi-square Statistics	58.33			
Probability > chi-square	0.000			
Log likelihood	-293.442			

Notes: The table shows the regression results of organizational structure, corporate governance and loss reserve error on actuary switching. Dependent variable: Switch is a binary variable: 1 = if the actuaries switching from internal actuary to Big 6 actuaries firms; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Under_abkfsa($_{t-1}$) is the absolute value of Reserve error_kfsa in year t-1= if the negative Reserve error_kfsa in year t-1 indicate that the insurers under-reserved, 0 = otherwise. Over_abkfsa($_{t-1}$) is the absolute value of Reserve error_kfsa in year t-1= if the positive Reserve error_kfsa in year t-1 indicate that the insurers over-reserved, 0 = otherwise. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 5 Logit Regression Results of Organizational Structure, Corporate Governance and Loss Reserve Error on Actuary Switching from Big 6 Actuarial firms to Internal Actuary

Variables	Estimate	Std. Error	z	P value
Stock	0.484	0.498	0.970	0.332
Duality	0.833	0.371	2.240	0.025 **
Boardsize	0.029	0.052	0.570	0.571
Insider directors	-0.591	0.616	-0.960	0.338
Under_abkfsa(t-1)	0.492	2.064	0.240	0.812
Over_abkfsa(t-1)	-1.682	4.660	-0.360	0.718
Big 4 auditors	0.126	0.771	0.160	0.870
LN(auditfee)	-0.023	0.032	-0.730	0.462
LN(NA)	-0.007	0.129	-0.060	0.956
Business Line Herfindahl Index	-1.099	0.899	-1.220	0.221
Geographic Herfindahl Index	-0.500	0.562	-0.890	0.374
Longtail	0.695	0.890	0.780	0.435
Reinsurance	0.712	0.649	1.100	0.273
Tax Shield	3.079	1.774	1.740	0.083 *
Tax Indicator	0.531	0.476	1.120	0.264
Length	-0.946	1.000	-0.950	0.344
Malpractice	-0.641	1.352	-0.470	0.635
Premgrowth	-0.341	0.358	-0.950	0.340
Weak	0.008	0.540	0.020	0.988
Group	1.072	1.052	1.020	0.308
Public	-0.433	0.418	-1.040	0.300
Intercept	-6.682	3.020	-2.210	0.027 **
Number of observations	5,120			
Wald Chi-square Statistics	25.660			
Probability > chi-square	0.220			
Log likelihood	-229.610			

Notes: The table shows the regression results of organizational structure, corporate governance and loss reserve error on actuary switching. Dependent variable: Switch is a binary variable: 1 = if the actuaries switching from Big 6 actuaries firms to internal actuary; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Under_abkfsa$_{(t-1)}$ is the absolute value of Reserve error_kfsa in year t-1= if the negative Reserve error_kfsa in year t-1 indicate that the insurers under-reserved, 0 = otherwise. Over_abkfsa$_{(t-1)}$ is the absolute value of Reserve error_kfsa in year t-1= if the positive Reserve error_kfsa in year t-1 indicate that the insurers over-reserved, 0 = otherwise. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 6 Regression Results of Actuary Switching, Organizational Structure and Corporate Governance on Loss Reserve Error

Variables	Estimate	Std. Error	z	P value
Switch	0.012	0.006	1.890	0.059 *
Stock	0.000	0.004	0.110	0.915
Duality	0.006	0.003	2.050	0.041 **
Boardsize	0.000	0.000	1.010	0.314
Insider directors	0.016	0.006	2.600	0.009 ***
Big 4 auditors	-0.007	0.006	-1.230	0.218
LN(auditfee)	0.000	0.000	0.270	0.785
LN(NA)	0.004	0.001	3.090	0.002 ***
Business Line Herfindahl Index	0.012	0.006	1.790	0.073 *
Geographic Herfindahl Index	0.000	0.005	-0.030	0.978
Longtail	0.008	0.008	1.010	0.312
Reinsurance	0.022	0.006	3.620	0.000 ***
Tax Shield	0.068	0.024	2.810	0.005 ***
Tax Indicator	0.027	0.004	6.690	0.000 ***
Length	0.066	0.008	7.830	0.000 ***
Malpractice	-0.024	0.008	-2.940	0.003 ***
Premgrowth	-0.018	0.003	-5.480	0.000 ***
Weak	0.010	0.005	1.970	0.049 **
Group	0.010	0.005	1.890	0.059 *
Public	0.007	0.004	1.980	0.047 **
Intercept	-0.161	0.027	-6.030	0.000 ***
Number of observations	5,120			
Wald Chi-square Statistics	242.050			
Probability > chi-square	0.000			
R-square	0.057			

Notes: The table shows the regression results of actuary switching,organizational structure and corporate governance on reserve error. Dependent variable: Loss reserve error is defined as Diff_ Reserve error_kfsa: the difference between Reserve error_kfsa(t+1) and Reserve error_kfsa(t-1) scaled by total assets. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Switch is a binary variable: 1 = if the actuary reported in year t is different from that reported in year t-1; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 7 Regression Results of Actuary Switching from Internal Actuary to Big 6 Actuarial Firms, Organizational Structure and Corporate Governance on Loss Reserve Error

Variables	Estimate	Std. Error	z	P value
Switch int_Big 6 actuary	0.024	0.012	2.030	0.042 **
Stock	0.000	0.004	0.100	0.924
Duality	0.006	0.003	2.050	0.041 **
Boardsize	0.000	0.000	0.990	0.321
Insider directors	0.016	0.006	2.560	0.010 ***
Big 4 auditors	-0.007	0.006	-1.290	0.199
LN(auditfee)	0.000	0.000	0.260	0.791
LN(NA)	0.004	0.001	3.040	0.002 ***
Business Line Herfindahl Index	0.012	0.006	1.820	0.068 *
Geographic Herfindahl Index	0.000	0.005	-0.060	0.948
Longtail	0.008	0.008	1.040	0.299
Reinsurance	0.022	0.006	3.580	0.000 ***
Tax Shield	0.069	0.024	2.850	0.004 ***
Tax Indicator	0.027	0.004	6.710	0.000 ***
Length	0.066	0.008	7.850	0.000 ***
Malpractice	-0.024	0.008	-2.950	0.003 ***
Premgrowth	-0.017	0.003	-5.410	0.000 ***
Weak	0.010	0.005	2.000	0.046 **
Group	0.010	0.005	1.960	0.051 *
Public	0.008	0.004	2.030	0.042 **
Intercept	-0.160	0.027	-5.990	0.000 ***
Number of observations	5,120			
Wald Chi-square Statistics	242.640			
Probability > chi-square	0.000			
R-square	0.057			

Notes: The table shows the regression results of actuary switching from internal actuary to Big 6 actuarial firms,organizational structure and corporate governance on reserve error. Dependent variable: Loss reserve error is defined as Diff_ Reserve error_kfsa: the difference between Reserve error_kfsa(t+1) and Reserve error_kfsa(t-1) scaled by total assets. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Switch is a binary variable: 1 = if the actuary switching from internal actuary to Big 6 actuarial firms; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 8 Regression Results of Actuary Switching from Big 6 Actuarial Firms to Internal Actuary, Organizational Structure and Corporate Governance on Loss Reserve Error

Variables	Estimate	Std. Error	z	P value
Switch Big 6 actuary_int	0.015	0.014	1.060	0.287
Stock	0.001	0.004	0.170	0.868
Duality	0.006	0.003	2.010	0.045 **
Boardsize	0.000	0.000	1.040	0.298
Insider directors	0.016	0.006	2.590	0.010 ***
Big 4 auditors	-0.007	0.006	-1.270	0.205
LN(auditfee)	0.000	0.000	0.300	0.765
LN(NA)	0.004	0.001	3.010	0.003 ***
Business Line Herfindahl Index	0.012	0.006	1.820	0.068 *
Geographic Herfindahl Index	0.000	0.005	-0.070	0.947
Longtail	0.008	0.008	1.060	0.289
Reinsurance	0.022	0.006	3.580	0.000 ***
Tax Shield	0.066	0.024	2.730	0.006 ***
Tax Indicator	0.026	0.004	6.590	0.000 ***
Length	0.066	0.008	7.780	0.000 ***
Malpractice	-0.024	0.008	-2.940	0.003 ***
Premgrowth	-0.018	0.003	-5.480	0.000 ***
Weak	0.009	0.005	1.910	0.056 *
Group	0.010	0.005	1.860	0.063 *
Public	0.008	0.004	2.010	0.045 **
Intercept	-0.158	0.027	-5.930	0.000 ***
Number of observations	5,120			
Wald Chi-square Statistics	239.470			
Probability > chi-square	0.000			
R-square	0.057			

Notes: The table shows the regression results of actuary switching from Big 6 actuarial firms to internal actuary,organizational structure and corporate governance on reserve error. Dependent variable: Loss reserve error is defined as Diff_ Reserve error_kfsa: the difference between Reserve error_kfsa(t+1) and Reserve error_kfsa(t-1) scaled by total assets. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Switch is a binary variable: 1 = if the actuary switching from Big 6 actuary to internal actuary; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 9 Regression Results of Actuary Switching from Internal Actuary to Big 6 Actuarial Firms, Organizational Structure and Corporate Governance with Interaction Terms on Loss Reserve Error

Variables	Estimate	Std. Error	z	P value
Switch int_Big 6 actuary	0.007	0.047	0.140	0.887
Stock	-0.001	0.004	-0.130	0.896
Switch int_Big 6 actuary× Stock	0.062	0.028	2.230	0.026 **
Duality	0.006	0.003	1.830	0.067 *
Switch int_Big 6 actuary× Duality	0.029	0.021	1.370	0.170
Boardsize	0.000	0.000	1.040	0.296
Switch int_Big 6 actuary× Boardsize	0.000	0.003	-0.070	0.941
Insider directors	0.018	0.006	2.920	0.003 ***
Switch int_Big 6 actuary× Insider directors	-0.124	0.044	-2.860	0.004 ***
Big 4 auditors	-0.007	0.006	-1.330	0.183
LN(auditfee)	0.000	0.000	0.320	0.747
LN(NA)	0.004	0.001	3.040	0.002 ***
Business Line Herfindahl Index	0.012	0.006	1.820	0.069 *
Geographic Herfindahl Index	0.000	0.005	0.020	0.985
Longtail	0.008	0.008	0.990	0.321
Reinsurance	0.022	0.006	3.560	0.000 ***
Tax Shield	0.074	0.024	3.030	0.002 ***
Tax Indicator	0.027	0.004	6.680	0.000 ***
Length	0.067	0.008	7.930	0.000 ***
Malpractice	-0.025	0.008	-3.030	0.002 ***
Premgrowth	-0.018	0.003	-5.470	0.000 ***
Weak	0.010	0.005	2.000	0.046 **
Group	0.011	0.005	2.010	0.045 **
Public	0.008	0.004	2.070	0.038 **
Intercept	-0.160	0.027	-6.000	0.000 ***
Number of observations	5,120			
Wald Chi-square Statistics	242.640			
Probability > chi-square	0.000			
R-square	0.057			

Notes: The table shows the regression results of actuary switching from internal actuary to Big 6 actuarial firms,organizational structure and corporate governance on reserve error with interaction terms. Dependent variable: Loss reserve error is defined as Diff_ Reserve error_kfsa: the difference between Reserve error_kfsa(t+1) and Reserve error_kfsa(t-1) scaled by total assets. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Switch is a binary variable: 1 = if the actuary switching from internal actuary to Big 6 actuarial firms; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 10 Regression Results of Actuary Switching from Big 6 Actuarial Firms to Internal Actuary, Organizational Structure and Corporate Governance with Interaction Terms on Loss Reserve Error

Variables	Estimate	Std. Error	z	P value
Switch Big 6 actuary_int	-0.170	0.065	-2.630	0.008 ***
Stock	0.001	0.004	0.120	0.901
Switch Big 6 actuary_int× Stock	0.013	0.042	0.310	0.757
Duality	0.006	0.003	1.850	0.064 *
Switch Big 6 actuary_int× Duality	0.051	0.028	1.850	0.065 *
Boardsize	0.000	0.000	0.790	0.431
Switch Big 6 actuary_int× Boardsize	0.012	0.004	2.810	0.005 ***
Insider directors	0.015	0.006	2.450	0.014 **
Switch Big 6 actuary_int× Insider directors	0.069	0.061	1.120	0.261
Big 4 auditors	-0.007	0.006	-1.250	0.210
LN(auditfee)	0.000	0.000	0.290	0.769
LN(NA)	0.004	0.001	3.010	0.003 ***
Business Line Herfindahl Index	0.012	0.006	1.870	0.062 *
Geographic Herfindahl Index	0.000	0.005	-0.090	0.926
Longtail	0.008	0.008	1.100	0.270
Reinsurance	0.022	0.006	3.520	0.000 ***
Tax Shield	0.067	0.024	2.750	0.006 ***
Tax Indicator	0.026	0.004	6.640	0.000 ***
Length	0.066	0.008	7.780	0.000 ***
Malpractice	-0.024	0.008	-2.950	0.003 ***
Premgrowth	-0.018	0.003	-5.510	0.000 ***
Weak	0.009	0.005	1.900	0.057 *
Group	0.010	0.005	1.860	0.063 *
Public	0.008	0.004	2.010	0.044 **
Intercept	-0.157	0.027	-5.870	0.000 ***
Number of observations	5,120			
Wald Chi-square Statistics	251.520			
Probability > chi-square	0.000			
R-square	0.059			

Notes: The table shows the regression results of actuary switching from Big 6 actuarial firms to internal actuary,organizational structure and corporate governance on reserve error with Interaction Terms. Dependent variable: Loss reserve error is defined as Diff_ Reserve error_kfsa: the difference between Reserve error_kfsa(t+1) and Reserve error_kfsa(t-1) scaled by total assets. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Switch is a binary variable: 1 = if the actuary switching from Big 6 actuary to internal actuary; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 11 Regression Results of Actuary Switching, Organizational Structure and Corporate Governance on Loss Reserve Error for Under-Estimated Reserve Error sample

Variables	Estimate	Std. Error	z	P value
Switch	0.029	0.010	2.930	0.003 ***
Stock	-0.007	0.007	-0.990	0.324
Duality	0.014	0.005	2.760	0.006 ***
Boardsize	0.001	0.001	1.880	0.060 **
Insider directors	0.019	0.010	1.880	0.060 **
Big 4 auditors	0.003	0.010	0.320	0.749
LN(auditfee)	0.000	0.000	0.180	0.857
LN(NA)	0.007	0.002	3.670	0.000 ***
Business Line Herfindahl Index	0.019	0.012	1.610	0.108
Geographic Herfindahl Index	0.000	0.008	-0.010	0.990
Longtail	-0.003	0.013	-0.250	0.806
Reinsurance	0.034	0.010	3.450	0.001 ***
Tax Shield	0.077	0.041	1.870	0.061 *
Tax Indicator	0.030	0.006	5.150	0.000 ***
Length	0.055	0.013	4.140	0.000 ***
Malpractice	-0.016	0.014	-1.150	0.252
Premgrowth	-0.026	0.005	-5.340	0.000 ***
Weak	0.016	0.007	2.320	0.020 **
Group	0.019	0.010	1.930	0.053 *
Public	0.002	0.006	0.400	0.692
Intercept	-0.272	0.042	-6.410	0.000 ***
Number of observations	2,308			
Wald Chi-square Statistics	146.710			
Probability > chi-square	0.000			
R-square	0.076			

Notes: The table shows the regression results of actuary switching,organizational structure and corporate governance on loss reserve error for under-estimated reserve error sample. Dependent variable: Loss reserve error is defined as Diff_ Reserve error_kfsa: the difference between Reserve error_kfsa(t+1) and Reserve error_kfsa(t-1) scaled by total assets. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Switch is a binary variable: 1 = if the actuary reported in year t is different from that reported in year t-1; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = $\Sigma(PWi/TPW)^2$, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=$\Sigma(PWi/TPW)^2$ where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 12 Regression Results of Actuary Switching, Organizational Structure and Corporate Governance on Loss Reserve Error for Under-Estimated Reserve Error Sample When Comparing Insurers without Actuary Switching

Variables	Estimate	Std. Error	z	P value
Switch	0.039	0.012	3.240	0.001 ***
Stock	-0.006	0.007	-0.870	0.385
Duality	0.014	0.005	2.740	0.006 ***
Boardsize	0.001	0.001	1.400	0.162 **
Insider directors	0.017	0.010	1.670	0.096 **
Big 4 auditors	0.005	0.010	0.520	0.604
LN(auditfee)	0.000	0.000	0.360	0.720
LN(NA)	0.007	0.002	3.820	0.000 ***
Business Line Herfindahl Index	0.020	0.012	1.740	0.082
Geographic Herfindahl Index	-0.001	0.008	-0.080	0.934
Longtail	-0.007	0.013	-0.530	0.595
Reinsurance	0.034	0.010	3.420	0.001 ***
Tax Shield	0.038	0.039	0.980	0.328 *
Tax Indicator	0.030	0.006	5.150	0.000 ***
Length	0.066	0.013	4.910	0.000 ***
Malpractice	-0.021	0.014	-1.550	0.121
Premgrowth	-0.028	0.005	-5.550	0.000 ***
Weak	0.014	0.007	1.950	0.052 **
Group	0.014	0.010	1.410	0.160 *
Public	0.000	0.006	0.060	0.948
Intercept	-0.271	0.042	-6.400	0.000 ***
Number of observations	2,268			
Wald Chi-square Statistics	149.040			
Probability > chi-square	0.000			
R-square	0.079			

Notes: The table shows the regression results of actuary switching,organizational structure and corporate governance on loss reserve error for under-estimated reserve error sample. Dependent variable: Loss reserve error is defined as Diff_ Reserve error_kfsa: the difference between Reserve error_kfsa(t+1) and Reserve error_kfsa(t-1) scaled by total assets. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Switch is a binary variable: 1 = if the actuary reported in year t is different from that reported in year t-1; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 13 Regression Results of Actuary Switching from Internal Actuary to Big 6 Actuarial Firms, Organizational Structure and Corporate Governance on Loss Reserve Error for Under-Estimated Reserve Error Sample When Comparing Insurers without Actuary Switching

Variables	Estimate	Std. Error	z	P value
Switch	0.043	0.013	3.240	0.001 ***
Stock	-0.007	0.007	-0.950	0.340
Duality	0.014	0.005	2.710	0.007 ***
Boardsize	0.001	0.001	1.330	0.183
Insider directors	0.017	0.010	1.650	0.100 *
Big 4 auditors	0.004	0.010	0.420	0.673
LN(auditfee)	0.000	0.000	0.300	0.761
LN(NA)	0.007	0.002	3.810	0.000 ***
Business Line Herfindahl Index	0.019	0.012	1.680	0.093 *
Geographic Herfindahl Index	0.000	0.008	-0.030	0.979
Longtail	-0.007	0.013	-0.520	0.604
Reinsurance	0.033	0.010	3.350	0.001 ***
Tax Shield	0.039	0.039	1.000	0.319
Tax Indicator	0.030	0.006	5.210	0.000 ***
Length	0.065	0.013	4.880	0.000 ***
Malpractice	-0.021	0.014	-1.550	0.121
Premgrowth	-0.027	0.005	-5.470	0.000 ***
Weak	0.014	0.007	1.980	0.047 **
Group	0.014	0.010	1.440	0.150
Public	0.000	0.006	0.050	0.960
Intercept	-0.268	0.042	-6.340	0.000 ***
Number of observations	2,268			
Wald Chi-square Statistics	149.0			
Probability > chi-square	0.000			
R-square	0.079			

Notes: The table shows the regression results of actuary switching from internal actuary to Big 6 actuarial firms,organizational structure and corporate governance on loss reserve error for under-estimated reserve error sample. Dependent variable: Loss reserve error is defined as Diff_ Reserve error_kfsa: the difference between Reserve error_kfsa(t+1) and Reserve error_kfsa(t-1) scaled by total assets. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Switch is a binary variable: 1 = if the actuary switching from internal actuary to Big 6 actuarial firms; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 14 Regression Results of Actuary Switching from Big 6 Actuarial Firms to Internal Actuary, Organizational Structure and Corporate Governance on Loss Reserve Error for Under-Estimated Reserve Error Sample When Comparing Insurers without Actuary Switching

Variables	Estimate	Std. Error	z	P value
Switch	0.032	0.016	2.050	0.040 **
Stock	-0.008	0.007	-1.050	0.296
Duality	0.013	0.005	2.500	0.012 **
Boardsize	0.001	0.001	1.640	0.100 *
Insider directors	0.023	0.010	2.190	0.028 **
Big 4 auditors	0.005	0.010	0.490	0.624
LN(auditfee)	0.000	0.000	0.500	0.614
LN(NA)	0.008	0.002	3.870	0.000 ***
Business Line Herfindahl Index	0.017	0.012	1.480	0.139
Geographic Herfindahl Index	0.002	0.008	0.290	0.772
Longtail	-0.008	0.013	-0.620	0.538
Reinsurance	0.028	0.010	2.840	0.005 ***
Tax Shield	0.074	0.044	1.670	0.095 *
Tax Indicator	0.032	0.006	5.370	0.000 ***
Length	0.064	0.014	4.700	0.000 ***
Malpractice	-0.020	0.014	-1.420	0.156
Premgrowth	-0.031	0.005	-5.990	0.000 ***
Weak	0.015	0.007	2.220	0.027 **
Group	0.016	0.010	1.560	0.120
Public	0.000	0.006	0.020	0.981
Intercept	-0.278	0.043	-6.510	0.000 ***
Number of observations	2,233			
Wald Chi-square Statistics	156.110			
Probability > chi-square	0.000			
R-square	0.083			

Notes: The table shows the regression results of actuary switching from Big 6 actuary to internal actuary,organizational structure and corporate governance on loss reserve error for under-estimated reserve error sample. Dependent variable: Loss reserve error is defined as Diff_ Reserve error_kfsa: the difference between Reserve error_kfsa(t+1) and Reserve error_kfsa(t-1) scaled by total assets. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Switch is a binary variable: 1 = if the actuary switching from Big 6 actuary to internal actuary; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = $\Sigma(PWi/TPW)$ ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=$\Sigma(PWi/TPW)$ ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 15 Regression Results of Actuary Switching, Organizational Structure and Corporate Governance on Loss Reserve Error for Over-Estimated Reserve Error sample

Variables	Estimate	Std. Error	z	P value
Switch	-0.003	0.008	-0.430	0.668
Stock	0.013	0.006	2.210	0.027 **
Duality	0.002	0.004	0.530	0.599
Boardsize	0.000	0.001	0.590	0.556
Insider directors	0.016	0.008	1.970	0.048 **
Big 4 auditors	-0.015	0.007	-2.250	0.024 **
LN(auditfee)	0.000	0.000	-0.300	0.767
LN(NA)	0.001	0.002	0.310	0.759
Business Line Herfindahl Index	-0.014	0.009	-1.530	0.126
Geographic Herfindahl Index	-0.007	0.007	-1.070	0.284
Longtail	0.006	0.010	0.610	0.545
Reinsurance	0.016	0.009	1.840	0.065 *
Tax Shield	0.027	0.033	0.820	0.410
Tax Indicator	0.006	0.006	1.030	0.302
Length	0.092	0.013	7.320	0.000 ***
Malpractice	-0.005	0.012	-0.390	0.693
Premgrowth	-0.006	0.004	-1.420	0.155
Weak	0.014	0.007	1.960	0.050 **
Group	0.007	0.007	0.940	0.348
Public	0.008	0.006	1.420	0.157
Intercept	-0.050	0.040	-1.250	0.210
Number of observations	2,577			
Wald Chi-square Statistics	141.67			
Probability > chi-square	0.000			
R-square	0.085			

Notes: The table shows the regression results of actuary switching,organizational structure and corporate governance on loss reserve error for over-estimated reserve error sample. Dependent variable: Loss reserve error is defined as Diff_ Reserve error_kfsa: the difference between Reserve error_kfsa(t+1) and Reserve error_kfsa(t-1) scaled by total assets. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Switch is a binary variable: 1 = if the actuary reported in year t is different from that reported in year t-1; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 16 Logit Regression Results of Organizational Structure, Corporate Governance and Loss Reserve Error on Actuary Switching after SOX Act with two-year lag

Variables	Estimate	Std. Error	z	P value
SOX	0.457	0.155	2.960	0.003 ***
Stock	0.458	0.221	2.070	0.039 **
Duality	0.005	0.154	0.030	0.976
Boardsize	0.031	0.023	1.390	0.165
Insider directors	-0.257	0.319	-0.810	0.420
Under_abkfsa(t-1)	0.625	1.004	0.620	0.534
Over_abkfsa(t-1)	-0.782	1.759	-0.440	0.657
Big 4 auditors	-0.233	0.272	-0.860	0.392
LN(auditfee)	0.014	0.016	0.890	0.373
LN(NA)	-0.169	0.069	-2.460	0.014 **
Business Line Herfindahl Index	0.167	0.347	0.480	0.630
Geographic Herfindahl Index	-0.318	0.248	-1.280	0.200
Longtail	0.905	0.398	2.270	0.023 **
Reinsurance	-0.250	0.320	-0.780	0.434
Tax Shield	-1.363	0.939	-1.450	0.146
Tax Indicator	-0.620	0.177	-3.500	0.000 ***
Length	-1.293	0.467	-2.770	0.006 ***
Malpractice	0.026	0.418	0.060	0.951
Premgrowth	-0.086	0.154	-0.560	0.578
Weak	-0.418	0.257	-1.630	0.104
Group	-0.039	0.264	-0.150	0.884
Public	0.079	0.196	0.400	0.686
Intercept	0.383	1.428	0.270	0.788
Number of observations	5,120			
Wald Chi-square Statistics	45.770			
Probability > chi-square	0.002			
Log likelihood	-882.441			

Notes: The table shows the regression results of organizational structure, corporate governance and loss reserve error on actuary switching after the SOX Act. SOX is a binary variable, 1 = if year is 2004 to 2007, 0 = otherwise. Switch is a binary variable: 1 = if the actuary reported in year t is different from that reported in year t-1; 0 = otherwise. Under_abkfsa(t-1) is the absolute value of Reserve error_kfsa in year t-1= if the negative Reserve error_kfsa in year t-1 indicate that the insurers under-reserved, 0 = otherwise. Over_abkfsa(t-1) is the absolute value of Reserve error_kfsa in year t-1= if the positive Reserve error_kfsa in year t-1 indicate that the insurers over-reserved, 0 = otherwise. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 17 Logit Regression Results of Organizational Structure, Corporate Governance and Loss Reserve Error on Actuary Switching when Considering Interaction Terms of SOX Act with two-year lag

Variables	Estimate	Std. Error	z	P value
SOX	1.420	0.636	2.230	0.026 **
Stock	0.400	0.314	1.270	0.204
SOX×Stock	0.113	0.382	0.300	0.767
Duality	0.080	0.224	0.360	0.720
SOX×Duality	-0.139	0.292	-0.480	0.634
Boardsize	0.048	0.033	1.460	0.145
SOX×Boardsize	-0.031	0.041	-0.750	0.452
Insider directors	0.717	0.439	1.630	0.102
SOX×Insider directors	-1.877	0.600	-3.130	0.002 ***
Under_abkfsa$_{(t-1)}$	-0.248	1.262	-0.200	0.844
SOX×Under_abkfsa$_{(t-1)}$	2.475	2.138	1.160	0.247
Over_abkfsa$_{(t-1)}$	-0.159	3.070	-0.050	0.959
SOX×Over_abkfsa$_{(t-1)}$	-0.201	3.540	-0.060	0.955
Big 4 auditors	-0.222	0.274	-0.810	0.418
LN(auditfee)	0.014	0.016	0.870	0.383
LN(NA)	-0.167	0.069	-2.410	0.016 **
Business Line Herfindahl Index	0.172	0.347	0.500	0.619
Geographic Herfindahl Index	-0.328	0.249	-1.320	0.187
Longtail	0.886	0.399	2.220	0.027 **
Reinsurance	-0.195	0.320	-0.610	0.543
Tax Shield	-1.430	0.971	-1.470	0.141
Tax Indicator	-0.607	0.178	-3.410	0.001 ***
Length	-1.272	0.470	-2.700	0.007 ***
Malpractice	0.032	0.419	0.080	0.939
Premgrowth	-0.080	0.153	-0.520	0.602
Weak	-0.421	0.258	-1.630	0.103
Group	-0.018	0.267	-0.070	0.948
Public	0.086	0.197	0.440	0.662
Intercept	-0.235	1.476	-0.160	0.874
Number of observations	5,120			
Wald Chi-square Statistics	57.68			
Probability > chi-square	0.000			
Log likelihood =	-876.046			

Notes: The table shows the regression results of organizational structure, corporate governance and loss reserve error on actuary switching after the SOX Act. The SOX dummy variable and interaction term just as in models. SOX is a binary variable, 1 = if year is 2004 to 2007, 0 = otherwise. Switch is a binary variable: 1 = if the actuary reported in year t is different from that reported in year t-1; 0 = otherwise. Under_abkfsa(t-1) is the absolute value of Reserve error_kfsa in year t-1= if the negative Reserve error_kfsa in year t-1 indicate that the insurers under-reserved, 0 = otherwise. Over_abkfsa(t-1) is the absolute value of Reserve error_kfsa in year t-1= if the positive Reserve error_kfsa in year t-1 indicate that the insurers over-reserved, 0 = otherwise. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 18 Regression Results of Actuary Switching, Organizational Structure and Corporate Governance on Loss Reserve Error after SOX Act with two-year lag

Variables	Estimate	Std. Error	z	P value
SOX	0.056	0.003	18.740	0.000 ***
Switch	0.010	0.006	1.680	0.092 *
Stock	0.000	0.004	0.110	0.911
Duality	0.006	0.003	2.030	0.042
Boardsize	0.001	0.000	1.340	0.179
Insider directors	0.015	0.006	2.500	0.012 **
Big 4 auditors	0.001	0.005	0.210	0.834
LN(auditfee)	0.000	0.000	0.370	0.708
LN(NA)	0.001	0.001	0.560	0.578
Business Line Herfindahl Index	0.006	0.006	1.020	0.306
Geographic Herfindahl Index	-0.002	0.004	-0.390	0.696
Longtail	0.000	0.007	0.060	0.950
Reinsurance	0.016	0.006	2.750	0.006 ***
Tax Shield	0.022	0.023	0.940	0.348
Tax Indicator	0.014	0.004	3.520	0.000 ***
Length	0.062	0.008	7.680	0.000 ***
Malpractice	-0.018	0.008	-2.350	0.019 **
Premgrowth	-0.011	0.003	-3.550	0.000 ***
Weak	0.020	0.005	4.250	0.000 ***
Group	0.010	0.005	1.920	0.055 *
Public	0.007	0.004	1.890	0.059 *
Intercept	-0.113	0.026	-4.400	0.000 ***
Number of observations	5,120			
Wald Chi-square Statistics	614.600			
Probability > chi-square	0.000			
R-square	0.133			

Notes: The table shows the regression results of under-estimated reserve error on actuary switching after the SOX Act. Dependent variable: Loss reserve error is defined as Diff_ Reserve error_kfsa: the difference between Reserve error_kfsa(t+1) and Reserve error_kfsa(t-1) scaled by total assets. Reserve error is the Reserve error_kfsa$_{(t+1)}$ minus Reserve error_kfsa$_{(t-1)}$. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. SOX is a binary variable, 1 = if year is 2004 to 2007, 0 = otherwise. Switch is a binary variable: 1 = if the actuary reported in year t is different from that reported in year t-1; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table 19 Regression Results of Actuary Switching, Organizational Structure and Corporate Governance on Loss Reserve Error when Considering the Interaction Terms of the SOX Act with two-year lag

Variables	Estimate	Std. Error	z	P value
SOX	0.037	0.012	3.060	0.002 ***
Switch	0.014	0.009	1.540	0.123
SOX×Switch	-0.005	0.012	-0.420	0.675
Stock	-0.003	0.006	-0.550	0.580
SOX×Stock	0.007	0.007	0.910	0.363
Duality	0.009	0.004	2.120	0.034 **
SOX×Duality	-0.006	0.006	-1.030	0.302
Boardsize	0.000	0.001	0.690	0.493
SOX×Boardsize	0.000	0.001	0.350	0.724
Insider directors	-0.005	0.009	-0.580	0.559
SOX×Insider directors	0.034	0.011	2.960	0.003 ***
Big 4 auditors	0.001	0.005	0.150	0.879
LN(auditfee)	0.000	0.000	0.480	0.628
LN(NA)	0.001	0.001	0.490	0.622
Business Line Herfindahl Index	0.006	0.006	0.960	0.337
Geographic Herfindahl Index	-0.002	0.004	-0.380	0.700
Longtail	0.001	0.007	0.120	0.904
Reinsurance	0.015	0.006	2.600	0.009 ***
Tax Shield	0.023	0.023	0.960	0.335
Tax Indicator	0.014	0.004	3.610	0.000 ***
Length	0.061	0.008	7.580	0.000 ***
Malpractice	-0.019	0.008	-2.430	0.015 **
Premgrowth	-0.011	0.003	-3.560	0.000 ***
Weak	0.020	0.005	4.330	0.000 ***
Group	0.010	0.005	1.920	0.055 *
Public	0.007	0.004	1.860	0.062 *
Intercept	-0.101	0.027	-3.810	0.000 ***
Number of observations	5,120			
Wald Chi-square Statistics	468.64			
Probability > chi-square	0.000			
R-square	0.103			

Notes: The table shows the regression results of loss reserve error on actuary switching after the SOX Act. The SOX dummy variable and interaction term just as in models. Dependent variable: Loss reserve error is defined as Diff_ Reserve error_kfsa: the difference between Reserve error_kfsa(t+1) and Reserve error_kfsa(t-1) scaled by total assets. Reserve error_kfsa is the reserve error estimation comparing the originally reported loss reserve to a revised estimate five years in the future (e.g. Kazenski, Feldhaus, and Schneider, 1992) scaled by total admitted assets. The loss reserve error is defined as the reserve estimation error disclosed in year t+5 associated with the reserve reports in year t scaled by total admitted assets in year t. SOX is a binary variable, 1 = if year is 2004 to 2007, 0 = otherwise. Switch is a binary variable: 1 = if the actuary reported in year t is different from that reported in year t-1; 0 = otherwise. Stock is a dummy variable for the stock organizational structure (Stock = 1 for mutual, 0 for mutual). Duality is a binary variable, 1 = CEO and chairperson of the board is the same person, 0 = otherwise. Boardsize is total number of directors on the board. Insider directors is the percentage of insider members on the board. Big 4 auditors is a binary variable: 1=four largest companies in the U.S. (PricewaterhouseCoopers, Ernst & Young, Deloitte and KPMG), 0 = otherwise. LN(NA) is natural logarithm of net admitted assets. LN(Auditfee) is the natural logarithm of audit fees. Business Line Herfindahl Index = Σ(PWi/TPW) ^2, where PWi is the value of net written premiums in line i and TPW is the insurer's total net written premiums. Geographic Herfindahl Index=Σ(PWi/TPW) ^2 where PWi is the value of written premiums in state i, and TPW is the insurer's total written premiums. Longtail is the percentage of long-tail lines divided by total net written premiums. Reinsurance is ratio of reinsurance ceded divided by the sum of direct premiums written plus reinsurance assumed. Tax indictor is a binary variable: 1 = if an insurer has a high tax rate; 0 =otherwise. Tax shield is sum of net income plus estimated reserve (for 5 years) divide by total assets. Length is measured as claim loss reserve as a percentage of total liabilities. Malpractice measured as malpractice premiums as a percentage of total net written premiums. Premgrowth is measured as the one-year percent increase in net premiums written. Weak is an indicator variable; 1 = if the insurer has four or more unusual IRIS (Insurance Regulatory Information System) ratios, 0 = otherwise. Group is an indicator variable, 1 = if the firm is a member of a group, 0 = otherwise. Public is a binary variable:1= the public-traded stock insurers, 0 = otherwise. ***, **, and * represent statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

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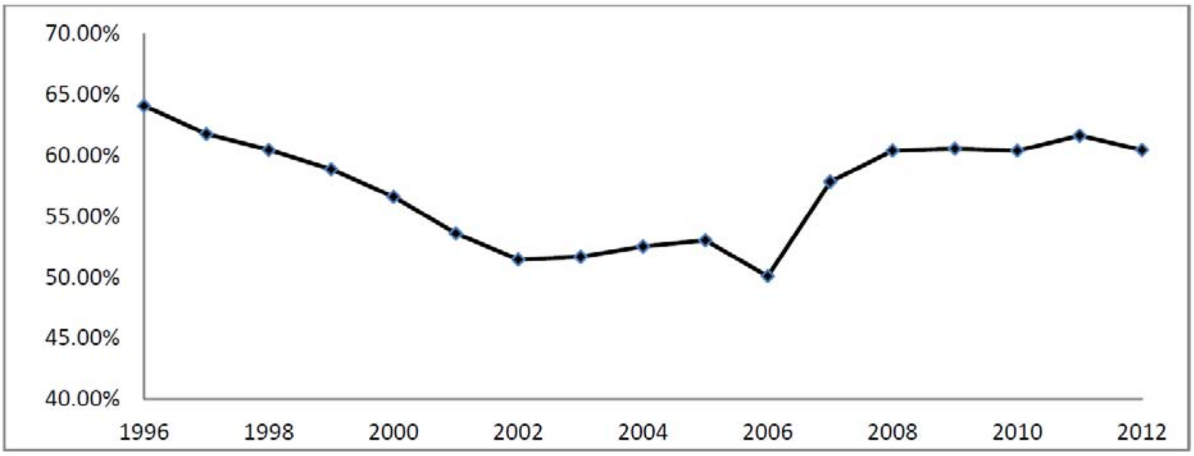
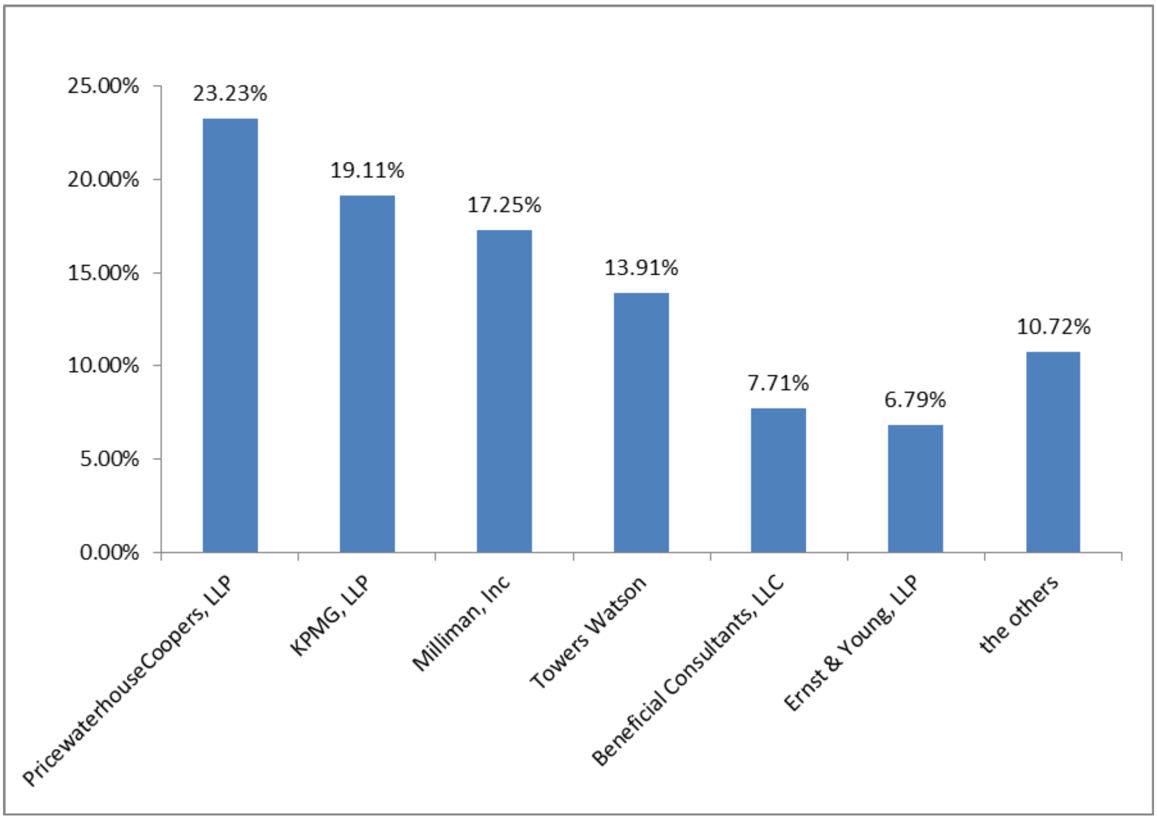
Figure 1 Loss Reserve to Liability Ratio of Property Casualty Insurance Industry from 1996 to 2012



Data Source: NAIC annual statement database

Figure 2 Actuarial Firms in the U.S. Property Casualty Insurance Industry on 2011



Data Source: BEST Review 2013