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In-House Provision of Corporate Services: The Case of Property-Casualty Insurers and In-House Actuarial Loss Reserve Certification

企業內部服務提供：以美國產險業內部精算師準備金提存為例

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Abstract

The purpose of this research is to investigate the relationship between managerial discretion in U.S. Property-Casualty (P-C) accounting reports and the use of an in-house or Appointed Actuary to certify loss reserves; we use loss reserving errors as measures of managerial discretion. The results indicate that it is important to distinguish between healthy and weak insurers in the analysis because their incentives to earnings management are different. Also, using an in-house or Appointed Actuary to certify loss reserves is associated with more under-reserving than when an external actuary is used for both weak and healthy insurers, although the degree of under-reserving is greater for weak insurers. Finally, the enactment of the Sarbanes-Oxley Act (SOX) leads to more conservative financial reporting for weak publicly-traded P-C insurers using external actuaries but not for weak publicly-traded P-C insurers using in-house actuaries.

【Keywords】in-house actuary, Sarbanes-Oxley Act, property-casualty insurance

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摘 要

本文旨在研究美國產險公司會計報告中經理人的自由裁量權與使用公司內部或指定精算師進行損失準備金簽證之間的關係。我們以損失準備金誤差作為經理人自由裁量權的衡量指標。研究結果顯示，由於盈餘管理動機的不同，因此有必要在進行實證分析時，將樣本區分成財務體質健康或孱弱的保險公司。此外，無論是財務體質健康或孱弱的保險公司，其使用公司內部或指定精算師進行損失準備金簽證都存在較多低估準備金的情況，儘管對於財務體質孱弱的保險公司而言，低估程度更大。最後，沙賓法案（Sarbanes-Oxley Act; SOX）的頒布導致財務體質孱弱的上市保險公司在使用外部精算師時會出具更加審慎的財務報告，但對於使用內部精算師的財務體質孱弱上市保險公司，則並未產生影響。

【關鍵字】內部精算師、沙賓法案、產物保險

1. Introduction

This research investigates whether managerial incentives affect loss reserve estimation when in-house actuaries perform loss reserve certification for U.S. Property-Casualty (P-C) insurers compared to when external actuaries (such as auditors) are employed to certify reserves. Detecting managerial bias in firms' financial reports such as loss reserve estimation is possible when information on specific discretionary accruals is available. The P-C insurance industry allows for measuring how insurers manage their claim loss reserves, a very important discretionary accrual.

In addition, we also examine the impact of the Sarbanes-Oxley Act (SOX) on the reporting practices for loss reserves by insurers. The implementation of SOX appears to have had a general mitigating effect on earnings management behavior and errors in loss reserve reporting for publicly-traded stocks (Akhigbe and Martin, 2006; Iliev, 2010; Eckles, Halek, He, Sommer, and Zhang, 2011; Eastmen, Eckles, and Van Buskirk, 2021). Thus, lower loss reserve manipulation (or managerial bias) by insurers is expected after SOX, at least for publicly-traded stock insurers. But the mitigating effect of SOX on in-house actuaries' behavior compared to external (consulting) actuaries' behavior has not been investigated.

Loss reserves are the P-C insurer's estimate of total unpaid losses. That is, most insurance policies provide coverage for losses associated with events that "occur" in the coverage period. For liability lines in particular, it may take years before a claim associated with a covered loss is actually presented to the insurer that provides coverage. Thus, claims for latent injuries such as asbestosis may take years before they are reported to the insurance company. Even for more mundane types of insurance such as private passenger auto liability and homeowners' multiple peril, losses associated with a policy year may take years to be reported to the insurer and eventually reach payment status (Barth, Eastman, and Eckles, 2019). Loss reserves are the largest liability of a P-C insurer. Over the period 2011 to 2014, these reserves accounted for 56 percent of total liabilities, on average (A. M. Best Company, 2012a, 2013, 2014, 2015).[1] Because loss reserves can

1 This figure includes loss adjustment expense reserves.

only be estimated, the possibility of managerial discretion exists in the form of over- and under-reserving. P-C insurers are required to report revisions to loss reserves (so that loss reserving errors can be derived from the updated values of loss reserves), and these errors can be interpreted as direct measures of managerial bias.[2]

Another advantage of studying the P-C insurance industry is that it provides for a sample of firms doing homogeneous business (McNichols, 2000). Finally, this industry consists of firms with different organizational forms, including mutuals, privately-held stocks, and publicly-traded stocks. This variation in ownership forms allows for detection of managerial bias under varying incentives associated with the different organizational forms. The sample in this research incorporates all of these organizational forms and covers the period 1999 to 2010.

Besides, the accuracy of loss reserve estimates is not only important in measuring managerial bias; it also plays a critical role in gauging the solvency of P-C insurers. Therefore, since 1980, P-C insurers have been required by state regulators to have an "Appointed Actuary" certify the accuracy of an insurer's loss reserves (Williams, 2020).[3] The independence of the Appointed Actuary was discussed by the National Association of Commissioners (NAIC) as a potential requirement for loss reserve certification. However, the final rule adopted did not contain this requirement.[4] Thus, in-house actuaries can certify

2 More specifically, loss reserve errors include both discretionary and nondiscretionary errors. Nondiscretionary errors are errors due to inaccuracies in estimation of loss reserves without specific intent, e.g., due to business complexity. Ideally, we would focus on discretionary errors. However, it is not straightforward to calculate the discretionary errors. Following the most recent literature, we use reserve errors to capture the potential managerial bias. See, for example, Beaver and McNichols (1998), Beaver, McNichols, and Nelson (2003), Berry-Stölzle, Eastman, and Xu (2018), Gaver and Paterson (2000, 2004, 2007, 2014), Grace and Leverty (2010, 2012), Petroni (1992).

3 The model law related to the Appointed Actuary is, "Property and Casualty Actuarial Opinion Model Law." This model law does not contain any provision for the requirements to become an Appointed Actuary. Rather, the National Association of Insurance Commissioners (NAIC) left this consideration to be addressed by the main professional association of actuaries in the U.S., the American Academy of Actuaries (AAA). More information about the AAA can be found at www.actuary.org. Note that the NIAC updated the requirements in 2020.

4 However, any relationship between the insurer and the certifying loss reserve specialist must be disclosed.

loss reserves so long as they have met specific requirements.[5 6] Therefore, a question arises as to whether in-house actuaries provide unbiased estimates of loss reserves compared to external actuaries.

This paper is the first to study the relationship between the loss reserve error and the use of an in-house actuary using data on U.S. P-C insurers. Although our sample consists of publicly-traded stock, privately held stock, and mutual insurers, we pay special attention to publicly-traded insurers.[7] That is, in addition to determining the relationship between in-house actuaries and loss reserve errors, we expect that greater market scrutiny exists specifically for publicly-traded P-C stock insurers in the sample compared to other organizational forms, such that more accurate reserving exists for publicly-traded insurers using an in-house actuary (Becker, DeFond, Jiambalvo, and Subramanyam, 1998; Reynolds and Francis, 2000).

SOX also may have an impact on loss reserving behavior. One important purpose of SOX is to improve financial reporting by publicly-traded firms with respect to accuracy, transparency, and reliability (Data Governance Institute, 2012). For U.S. P-C insurers specifically, then, one would expect that SOX would have an impact for publicly-traded P-C insurers although whether the use of an in-house actuary mitigated this impact is undetermined.

Moreover, weak insurers are expected to understate their loss reserves to improve their reported financial condition, whereas healthy insurers do not have this incentive. But in most of the literature on loss reserve errors, a pooled sample of weak and healthy

5 According to the AAA, the Appointed Actuary, "is a qualified actuary who is appointed or retained to prepare the Statement of Actuarial Opinion ... either directly by or by the authority of the board of directors through an executive officer of the company" (The Committee on Property and Liability Financial Reporting of the American Academy of Actuaries, 2013). A "qualified actuary" must meet specific, strict qualification requirements (American Academy of Actuaries, 2008).

6 American Institute of Certified Public Accountants (1992) Statement of Position 92-8 requires an additional external review of the reserves if the reserves are certified by an employee of the insurer. The information is not publicly available about whether the auditor uses the services of an actuary from the audit firm itself, or engages an independent actuarial consulting firm for this purpose (Gaver and Paterson, 2001). Nevertheless, the mixture of the quality of external reviewers potentially biases against our main hypotheses.

7 In this study, mutuals and reciprocals are combined. Cheng, Cummins, and Lin (2017) suggest that modern reciprocals are virtually indistinguishable from mutuals.

insurers is used with a dummy variable to distinguish between weak and healthy firms (e.g., Beaver and McNichols, 1998; Nelson, 2000; Beaver et al., 2003). Petroni (1992) and Gaver and Paterson (2014) recognize that the incentives of weak insurers are likely to differ from those of healthy insurers. Thus, this research will investigate the appropriateness of conducting separate analysis on weak versus healthy firms.

Only two prior papers consider the relationship between loss reserve accuracy and the use of an in-house actuary. Using a sample of Canadian insurers, Kelly, Kleffner, and Li (2012) do not find a significant relationship between the use of in-house actuaries and the absolute value of the loss reserve error. Our research differs from Kelly et al. (2012) with respect to the methodology used, the loss reserve error definition, and sample analyzed, largely due to the different institutional settings between Canada and the U.S.

Secondly, Kamiya and Milidonis (2018) analyze the loss reserve error for U.S. P-C insurers, but limit their sample to firms using in-house actuaries. A distinction between insurers using officer and non-officer in-house actuaries is made.[8] Therefore, their approach cannot be used to detect whether there is an *overall* effect on managerial bias from using in-house actuaries compared to external actuaries. On the other hand, this is exactly the purpose of the present paper, which is the first to analyze loss reserve accuracy of in-house versus external actuaries using U.S. P-C insurer data. Furthermore, neither Kelly et al. (2012) nor Kamiya and Milidonis (2018) explicitly contain hypotheses concerning the relationship between the enactment of SOX and the loss reserve error in the context of in-house actuaries.

This research proceeds by estimating regressions in which the loss reserve error is the dependent variable. The loss reserve error indicates the direction of the reserve error (under- or over-statement of losses). Under-reserving is relevant because it is an important cause of insolvencies.[9] Also, Eckles et al. (2011) indicates that managers can have an

8 It would be interesting to also include an officer-actuary variable in our analysis. However, this would entail an unreasonable amount of hand collection of data. Our sample period is 12 years, compared to three years for Kamiya and Milidonis (2018). Further, information on officer versus non-officer actuarial certification only became available in 2007, while our sample period starts in 1999.

9 Best's Insolvency Study indicates that inadequate pricing/deficient loss reserves is the single largest cause of insolvency for U.S. P-C insurers, accounting for 42 percent of all insolvencies (A. M. Best Company, 2012b). Milidonis and Stathopoulos (2014) indicate that financially weak firms are more

incentive to manipulate earnings (via over- or under-reserving of loss reserves) to gain larger compensation; this is against stockholders' interests.[10] Over-reserving leads to lower reported earnings and potentially lower stock prices.[11]

In this study, we define the loss reserve error in terms of the difference between the original report of total incurred losses in year t and an updated or developed estimate of the same incurred losses five years later. This definition is consistent with most of the extant literature (e.g., Petroni, 1992; Nelson, 2000; Gaver and Paterson, 2004, 2014).[12] The value for the loss reserve error is scaled by admitted assets. We make a distinction in the analysis for publicly-traded insurers using in-house actuaries to certify loss reserves in the pre- versus post-SOX periods. To identify any differences in the use of in-house and external actuaries with respect to SOX, we conduct an analysis of publicly-traded insurers using external actuaries to certify loss reserves in the pre- versus post-SOX periods as well.

Estimation is first conducted using feasible generalized least squares (FGLS) with AR (1) autocorrelation and fixed year effects on all available observations, which is consistent with prior literature (e.g., Grace and Leverty, 2010, 2012). We also conduct Chow tests to determine whether it is appropriate to pool weak and healthy insurers together. Then, we use Propensity Score Matching (PSM) to find pairs of insurers with matching characteristics (except for the use of an in-house actuary to certify loss reserves) The PSM sample is used as an alternative sample of insurers to analyze.

likely to be affected by managerial incentives.

10 That is, they indicate that restricted stock awards may induce managers to engage in earnings-decreasing behavior (or over-reserving). Also, structured bonus plans may lead to earnings decreasing or earnings increasing behavior (i.e., over-reserving or under-reserving). (See Eckles et al. (2011), p. 766, for example.)

11 Under-or over-reserving has an economic impact beyond consideration of managerial behavior. Over-reserving misstates the financial position of the insurer too and results in reduced, current taxes. Thus, over-reserving has implications for the imposition of taxes on insurers compared to other commercial and individual taxpayers. Over-reserving in rate-regulated lines of insurance such as workers compensation and automobile liability results in lower reported income for these lines and can be used as the basis for insurers seeking a (premium) rate increase.

12 Prior studies find that in the automobile liability market (one of the most important short-tail line of business in P-C insurance), 97-100% of the original claims are settled within five years after the loss was incurred (Smith, 1980).

By way of preview, Chow test results indicate that it is not appropriate to pool weak and healthy insurers together in one regression analysis, in contrast with many previous loss reserving studies (e.g., Gaver and Paterson, 2001, 2004; Grace and Leverty, 2010, 2012). Hence weak and healthy insurers are analyzed using separate regressions. Empirical results indicate that significant under-reserving occurs for insurers using in-house actuaries to certify reserves; the degree of under-reserving is significantly higher for weak than for healthy insurers. This result is a clear indication that the loss reserving behavior of weak versus healthy insurers is different, requiring a statistical analysis which can account for this systematic difference. In addition, the effect of SOX on weak publicly-traded P-C insurers using in-house actuaries is insignificant (in the PSM sample). Thus, contrary to many previous studies of the effect of SOX on financial reporting, this study reveals that SOX did not necessarily lead to more conservative financial reporting for weak insurers using in-house actuaries. But it did lead to more conservative reporting for weak insurers using external actuaries.[13]

This research contributes to the literature in several ways. Approximately 60% of total P-C insurer reserves in the U.S. are certified by in-house actuaries, but the degree of managerial bias associated with using in-house actuaries using U.S. P-C insurer data has not been investigated until this study.[14] This research is important, too, because it contributes to the financial literature on the role of managerial discretion in accounting reports. The use of in-house actuaries may increase managerial bias due to the influence/ pressure of insurer management on in-house actuaries in some cases. This research also provides evidence that the results and inferences from analysis of pooled loss reserve error

13 We acknowledge that one should also be concerned about the size of the reserve if the reliability of financial reporting is the focus of SOX (Marlo and Nyce, 2006). Because we are more interested in the difference in behavior of weak insurers versus healthy insurers in response to SOX, we do not report the results of the absolute value of loss reserve errors. In untabulated results, we find that the absolute value of loss reserving errors increased after SOX for healthy, publicly-traded stock insurers, and this is due to more over-reserving after SOX. Thus, SOX led to more conservative financial reporting for healthy U.S. publicly-traded P-C insurers. For weak publicly-traded P-C insurers, the absolute value of the loss reserve error decreased after SOX, indicating that SOX led to less under-reserving by weak publicly-traded P-C insurers. Results are reported in an earlier version of the paper, and they are available upon request from the authors.

14 This estimate was obtained from the NAIC database over the period 1999 to 2010.

data for weak and healthy insurers do not necessarily apply to weak and healthy insurers separately, so that separate analysis of the two groups should be conducted as a robustness test at a minimum.

Finally, this research contributes to the current literature investigating whether the use of in-house resources, such as in-house tax departments, is related to firm behavior. Klassen, Lisowsky, and Mescall (2016) find that firms that prepare their own tax filings (or use a non-auditor) take a more aggressive tax position than firms using their auditor to prepare taxes. Robinson, Sikes, and Weaver (2010) also find that, under certain conditions, in-house preparation of taxes leads to lower tax rates and higher reported earnings. By analogy, the use of an in-house versus an external actuary to certify loss reserves for Property-Liability insurers may lead to differences in loss reserve reporting biases.[15]

The remainder of this paper is organized as follows. The next section discusses the hypotheses. Section 3 contains the methodology. Section 4 discusses the data and the sample. The next section discusses the results, and the last section offers conclusions and suggestions for future research.

2. Hypotheses

The purpose of this section is to develop hypotheses concerning the direction of the loss reserve error for P-C insurers using an in-house Appointed Actuary or an external consultant actuary. Seemingly, an in-house actuary has more detailed, first-hand knowledge of the firm's operations; this could lead to more accurate loss reserve estimation than when an outside consultant is used. However, when an in-house actuary is used, the independence of the in-house actuary may be compromised. There is a large amount of empirical evidence on the impact of the external auditor's independence on managerial discretion (see e.g., Cheng et al., 2017; Becker et al., 1998; Francis, Maydew, and Sparks, 1999; Frankel, Johnson, and Nelson, 2002; Reynolds and Francis, 2000; Cheng, Weiss, and Lin, 2019), indicating that independence is an important consideration

15 Firm value maximization may, of course, be an important incentive for management. Other incentives, such as earnings manipulation to increase managerial compensation, may also exist. (See, e.g., Eckles et al. (2011)).

when evaluating the auditor-client relationship.[16] Similarly, the tax positions of firms can vary according to whether the auditor prepares tax filings for a firm (Klassen et al., 2016). By extension, the use of an in-house versus an external actuary should be important when evaluating the certification of loss reserves for P-C insurers.

Prior research indicates that weak firms are likely to be more under-reserved (less over-reserved) than healthy firms (Gaver and Paterson, 2004, 2014; Harrington and Danzon, 1994; Petroni, 1992). That is, weak firms may attempt to hide their financial position by under-reserving. Under-reserving reduces reported liabilities and leads to a higher reported level of surplus (i.e., capital). Greater management influence over in-house actuaries might lead to greater under-reserving for weak insurers when in-house actuaries are used compared to when external actuaries are used.

On the other hand, healthy insurers using in-house actuaries have no incentive to distort reserves once they have controlled for factors such as net income smoothing, taxes, rate regulation, line of business mix, etc. are controlled for. The independence of the Appointed Actuary is likely to be more of a factor in curbing managerial opportunism for weak insurers compared to healthy ones. In contrast, in-house actuaries working for healthy insurers may benefit from the close personal information they have on the insurers. In other words, the insider advantage associated with using an in-house Appointed Actuary might dominate over the managerial opportunism incentive for healthy insurers. Therefore, we predict that healthy insurers will be neither over- nor under-reserved, on average, when using an in-house actuary to certify loss reserves. The above discussions largely apply to nonpublic insurers (mutuals and private-held stocks) because they receive less direct market monitoring than publicly-traded insurers (Cheng et al., 2017; Cheng, Cummins, and Lin, 2021a, 2021b; Mayers and Smith, 1988). Hence, Hypotheses 1a and 1b state:

Hypothesis 1a: Weak P-C nonpublic insurers using in-house actuaries to certify loss reserves are under-reserved relative to P-C nonpublic insurers using external actuaries.

Hypothesis 1b: Healthy P-C nonpublic insurers using in-house actuaries to certify loss

16 These studies do not consider insurers. They are mainly concerned with audit quality and independence of the auditor.

reserves are neither under- nor over- reserved compared to P-C nonpublic insurers using external actuaries.

Further, publicly-traded firms should receive more scrutiny by capital markets than nonpublic insurers. Therefore, publicly-traded insurers using in-house actuaries may report more accurate reserves than nonpublicly-traded insurers using in-house actuaries because of the extra scrutiny afforded by the stock market. Thus, we expect that the effect of using in-house actuaries would be largely negated for publicly-traded firms. If this is the case, then weak publicly-traded P-C insurers using in-house actuaries should exhibit less under-reserving than nonpublic insurers using in-house actuaries:

Hypothesis 2: Weak publicly-traded P-C insurers using an in-house actuary are less under-reserved than weak nonpublic P-C insurers using an in-house actuary pre-SOX.

Third, the implementation of SOX may have had a bearing on loss reserving practices with regard to the usage of in-house actuaries to certify loss reserves. SOX applies only to publicly-traded firms. After SOX, managers are expected to have reduced any opportunistic behavior regarding financial reporting due to increasing legal liability and enhanced regulatory requirements. Increasing legal liability after SOX is expected to make the board of directors more vigilant in monitoring managers with respect to financial reporting as well. And research mostly supports this view; He, Miller, and Yang (2012) find that both public and large privately-held insurers increased board independence after SOX.[17]

We hypothesize that weak, publicly-traded insurers will be under-reserved before SOX; thus, they will have more "to make up" in loss reserves after SOX. Nonetheless,

17 Akhigbe and Martin (2006) argue that SOX's disclosure requirements could increase transparency in the financial services industry including insurance. Ashbaugh-Skaife, Collins, Kinney, and Lafond (2009) suggest that firms with internal control deficiencies reduced their information risk due to the mandatory SOX disclosure requirements. This leads to a lower cost of capital. Iliev (2010) suggests that SOX compliance leads to conservative reported earnings. Eckles et al. (2011) find limited evidence that SOX reduces managerial opportunism to manage loss reserves to maximize personal compensation. However, Ma and Pope (2020) use a difference-in-difference approach and find that SOX did not have an impact on the accuracy of loss reserves for publicly-traded insurers.

this applies mainly for weak, publicly-traded insurers using external actuaries. Similar to independent external auditors, external actuaries have more reputation risk and increased legal liability after SOX. We expect that weak, publicly-traded insurers using external actuaries became less under-reserved after SOX. This leads to the following hypothesis:

Hypothesis 3a: Weak publicly-traded P-C insurers using external actuaries became less under-reserved after SOX than weak publicly-traded P-C insurers pre-SOX.

In contrast, in-house actuaries working for weak, publicly-traded insurers may face pressure from firm management to conceal firm weakness even after SOX. Thus, we have no priors for the effect of SOX on weak, publicly-traded insurers using in-house actuaries to certify loss reserves.

Conversely, healthy insurers are expected to become more conservative in income reporting and reserve estimation post-SOX. Thus, we expect that healthy publicly traded insurers after SOX would bolster reserves. This would reduce the probability of adverse regulatory scrutiny after SOX and prevent lawsuits against the directors and officers that could be associated with under-reserving. This hypothesis applies to all healthy publicly-traded insurers.

Hypothesis 3b: Healthy publicly-traded P-C insurers became relatively over-reserved after SOX than healthy publicly-traded insurers pre-SOX, regardless of whether in-house actuaries or external actuaries are used.

3. Methodology

We regress our measures of the loss reserve error on a set of variables designed to test our hypotheses. Additional variables are included in the model to test hypotheses appearing in the prior literature concerning income smoothing, taxes, and rate regulation. Finally, we include control variables representing firm and economic characteristics in the model as well. The remainder of this section describes the model, the estimation strategy and variables more fully.

3.1 Regression Model

The following general model is estimated:

$$Y_{it} = \alpha + \beta_1(In - House\ Actuary) + \beta_2(In - House\ Actuary) \times (Publicly - traded\ Stock) + \beta_3(SOX\ dummy) \times (External\ Actuary) \times (Publicly - traded\ Stock) + \beta_4(SOX\ dummy) \times (In - House\ Actuary) \times (Publicly - traded\ Stock) + \gamma X_{it} + \delta Z_{it} + \lambda Year_t + \varepsilon_{it}, \quad (1)$$

where i represents firm i and t references time. As explained more fully below, the dependent variable, Y_{it}, is the scaled loss reserve error. The X_{it}, are variables used to test the hypotheses concerning loss reserve errors. Z_{it} is a vector of institutional and firm characteristics variables; and $Year_t$ indexes time periods.[18] The error term is ε_{it}. Estimation strategy is discussed further in section 3.3.

3.2 Specification of Regression Variables

We first discuss estimation of the dependent variable – i.e., the loss reserve error. Independent variables used in the regression model are then discussed in the following two subsections.

3.2.1 Specification of the Dependent Variable

The loss reserve error is defined as the difference between the estimate of total incurred losses for a company (which includes errors from prior accident years) as of a given calendar year t (LR_t) and the future revised estimate of the same losses in calendar year t+5 (LR_{t+5}). This definition follows Petroni (1992), and Gaver and Paterson (2004, 2014), among others. Table 1 provides a detailed explanation on how we calculate the loss reserve error using an example with actual firm data. The five-year loss reserve error is scaled by admitted assets, following Beaver et al. (2003), Cheng, Chow, Lin, and Ng (2022), Gaver and Paterson (2014), and Petroni (1992). The loss reserve error is positive (negative) if the original estimate of incurred losses is overestimated (underestimated).

18 Previous literature indicates that loss reserving errors are serially correlated (Beaver and McNichols, 1998; Grace and Leverty, 2010, 2012) and heteroscedastic (Grace and Leverty, 2010, 2012). FGLS rather than full fixed effects is commonly used when these problems exist (Grace and Leverty, 2012).

3.2.2 Specification of the Independent Variables for Hypothesis Testing

We specify an indicator variable (*In-House Actuary*), which is set equal to one if the Appointed Actuary is an employee; this variable is set equal to zero otherwise. According to Hypotheses 1a and 1b, we expect weak insurers to be under-reserved while healthy insurers to be neither over- nor under-reserved. Therefore, we expect that the coefficient for the *In-House Actuary* Indicator will be negative for weak insurers, while the coefficient for healthy insurers will be insignificant.

Second, an indicator variable denoting *Publicly-traded Stock* insurers is created. This variable takes the value of one if the insurer is a publicly-traded stock insurer, and zero otherwise.[19] An interaction variable defined as the interaction of the *In-House Actuary* indicator variable and the *Publicly-traded Stock* indicator variable is created as well. We expect that weak publicly-traded stock insurers using an in-house actuary are less under-reserved than weak nonpublic insurers using an in-house actuary under Hypothesis 2. Hence, in the regressions for weak insurers, the coefficient for the in-house actuary variable interacted with the indicator variable for a publicly-traded stock insurer should be positive if Hypothesis 2 holds.

To capture the effects of SOX, we create an indicator variable which is set equal to one in 2002 and afterwards, and it is set to zero otherwise.[20] Previous research indicates that the magnitude of earnings manipulation diminished after the enactment of SOX in 2002 (e.g., Khurana and Raman, 2004). Hence, we further construct an interaction variable, *In-House Actuary Indicator*×*Post SOX Indicator*×*Publicly-traded Stock Indicator*; the *Post SOX* indicator variable is also interacted with the *Publicly-traded Stock Indicator* variable and an *External Actua*ry Indicator variable to create a new variable: *External Actuary*×*Post SOX Indicator*×*Publicly-traded Stock Indicator*. The *External Actuary Indicator* is equal to one if the insurer uses an external actuary and is equal to zero otherwise.

We expect that after SOX, weak, publicly-traded stock insurers using external actuaries became less under-reserved under Hypothesis 3a. Therefore, we expect a

19 We discuss other organizational form variables later as they do not relate to any hypotheses.

20 Most studies concerned with the impact of SOX use 2002 as the start of SOX (e.g., Causholli, Chambers, and Payne, 2014; Iliev, 2010; Knechel and Sharma, 2012; Linck, Netter, and Yang, 2009).

Table 1 NAIC P-C Statement Schedule P- Part 2: Calculation of Loss Reserve Error

NAIC P-C Statement Schedule P- Part 2 – Summary										
Incurred Losses and Allocated Expenses Reported at Year End ($000 Omitted)										
1	2	3	4	5	6	7	8	9	10	11
Accident year										
1. Prior	3,285,875	3,410,600	3,524,213	3,637,263	*3,587,121*	3,623,562	3,685,809	3,714,597	3,739,139	*3,746,374*
2. 2002	5,972,319	5,928,093	5,976,433	5,980,533	*5,956,761*	5,944,897	5,938,278	5,932,815	5,924,491	*5,933,300*
3. 2003		6,341,971	6,172,137	6,162,098	*6,115,388*	6,101,180	6,097,493	6,090,287	6,090,476	*6,085,835*
4. 2004			6,473,471	6,413,553	*6,339,425*	6,341,557	6,309,336	6,284,525	6,269,843	*6,263,201*
5. 2005				6,943,086	*6,791,488*	6,794,457	6,798,872	6,770,778	6,758,415	*6,745,659*
6. 2006					***7,073,917***	7,017,149	7,020,017	6,984,007	6,944,226	***6,919,259***
7. 2007						7,465,502	7,507,457	7,404,207	7,339,228	7,297,571
8. 2008							8,456,304	8,518,540	8,419,513	8,342,704
9. 2009								8,005,030	7,766,655	7,682,848
10. 2010									7,701,817	7,588,385
11. 2011										8,539,439

Note: This table is excerpted from the 2011 Annual Statement of Nationwide Mutual Insurance Company (NAIC Code 23787) Schedule P: Part 2-Summary for 2011. The table reports losses estimated in the year incurred as well as subsequent adjustments in the estimate as claims are settled over time. Incurred losses are losses that are expected to be paid as a result of providing insurance coverage, including the losses that are known to the insurer plus those that are incurred but not reported (IBNR). In particular, it shows incurred losses by the year in which the losses were incurred (rows 1 to 11), known as the accident year, and incurred losses by the years in which they are estimated (columns 2 to 11), known as the calendar year. For example, in calendar year 2006, Nationwide estimated that $7,073.917 million in losses were incurred during the accident year 2006. This estimate of 2006 accident year loss was revised downward to $6,919.259 million by calendar year 2011. An accident year reserve error is calculated as the difference between losses incurred in a given accident year and a revised estimate of losses incurred five years in the future. To get the revised estimate five years in the future for 2006, annual statement data from 2011 are used. Initial over- (under-) reserving yields a positive (negative) reserve error since the revised estimate of total losses incurred five years in the future is less (greater) than the initial estimate. For Nationwide in 2006, the accident year reserve error is $154.658 million (=$7,073.917 million-$6,919.259 million, indicated in bold and italic type). The reserve error that we estimate in this study is the error in the reserve at a given calendar year end. It is calculated as the sum of the accident year reserve errors for a given calendar year. Prior studies define this reserve error as the difference between total losses incurred in a given calendar year and a revised estimate of total losses incurred five calendar years in the future (Beaver et al., 2003; Gaver and Peaterson, 2004). The estimate of total incurred losses for a given calendar year is the sum of the losses in the column of that year. For Nationwide, at the end of 2006, estimated losses for all years up to and including 2006 totaled $35,864.100 million (the sum of the italicized values in column 6-2006). By the end of 2011, the estimated losses for the same loss period were reduced to $35,693.628 million (the sum of the italicized values in column 11-2011). Therefore, Nationwide's reserve error for 2006 is $170.472 million (=$35,864.100 million - $35,693.628 million), indicating that Nationwide over-reserved by $170.472 million in 2006.

positive coefficient for the interaction of the SOX indicator variable, the publicly-traded stock indicator and the external actuary indicator for weak insurers. However, the sign of coefficient for the interaction of the in-house actuary indicator, the publicly-traded stock indicator and the SOX indicator variable for weak insurers remains an empirical issue.

On the other hand, we hypothesize that healthy publicly-traded insurers to have bolstered reserves after SOX whether an in-house actuary is used or not. Thus, significantly positive coefficients are expected for *In-House Actuary*×*Post SOX*×*Publicly-traded*

Stock Indicator and for *External ActuaryPost SOX×Publicly-traded Stock Indicator* for healthy insurers, under Hypothesis 3b.

3.2.3 Specification of Other Independent Variables

We include independent variables to test the three principal hypotheses that exist in the literature concerning reserve errors.[21] These hypotheses relate to (1) taxes (Grace and Leverty, 2012; Nelson, 2000; Petroni, 1992), (2) income smoothing (Beaver et al., 2003; Grace and Leverty, 2012), and (3) rate regulation (Grace and Leverty, 2010; Nelson, 2000). We also include other independent variables reflecting firm characteristics and economic variables as described below. In order to streamline the following discussions, we make no further distinction in the expectations for weak versus healthy insurers.

Overestimates of incurred losses understate total net income of the insurer and reduce its current income tax liability. So everything else held equal, the tax hypothesis is that firms will shelter income by overstating losses to reduce current taxes. Nelson (2000) and Petroni (1992), among others, use an indicator variable to capture this effect. The indicator variable is defined as one if the firm has a high tax rate (i.e., it pays positive income tax in the current year) and is set to zero otherwise. We expect this variable to have a positive coefficient in the regressions if insurers overstate losses to reduce current taxes.

Loss reserving errors also have been shown to be related to income smoothing. In years with high unbiased income, insurers are expected to over-reserve more (under-reserve less).[22] Conversely, in years with low unbiased income, insurers would be expected to under-reserve more (over-reserve less). We include a variable to capture effects of net income smoothing in the model, which is defined as the difference between unbiased net income in year *t* and reported net income in year *t*-1 divided by the absolute value of reported net income in year *t*-1 (Gaver and Paterson, 2014). That is, unbiased net income in the current year reflects net income without the loss reserving error; it is an estimate of actual net income. We expect this variable to be positively related to the loss reserve error.

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21 The literature also contains hypotheses about weak insurers. We take this into account by estimating separate regressions for weak versus healthy insurers.

22 Unbiased net income is net income gross of the reserve error. This variable is used in prior research (e.g., Gaver and Paterson, 2014).

Two competing hypotheses exist in prior literature as to how rate regulation is related to loss reserve errors (i.e., Nelson, 2000; Grace and Leverty, 2010). Nelson (2000) posits that under-reserving takes place in rate-regulated lines because insurers are interested in convincing regulators that they can charge low rates. This gives an insurer an incentive to under-reserve in rate regulated lines. Grace and Leverty (2010), on the other hand, hypothesize that rate regulation results in rate suppression; that is, they hypothesize that insurers have an incentive to over-reserve in an attempt to convince regulators that the regulated price is too low. Therefore, we cannot predict a priori the sign of the coefficient.

The amount of premiums subject to rate regulation relative to total premiums written is used to measure the rate regulation variable, and this is the same definition used in both Nelson (2000) and Grace and Leverty (2010, 2012):

$$Rate\ Regulation_{it} = \left(\sum_{s,l} DirectPrem.Written_{istl} \times StringentReg.Law_{stl}\right) / \sum_{s,l} DirectPrem.Written_{istl}, \quad (2)$$

where i indicates firm i, s indicates state s, l indicates line l, and t indicates year t. Following Harrington (2002), a state is considered to have a stringent rate regulatory law if it had (1) state-made rates, (2) a prior approval law, or (3) a file and use law requiring the insurer to file for prior approval if the insurer wanted to charge a rate that deviated from that filed by a rate advisory organization. States that had file and use, use or file, filing only, or flex rating (with a large rating band) are not considered to be stringently regulated.[23] Direct premiums written are used to measure this variable because they do not include reinsurance; reinsurance transactions are not rate-regulated.

The remaining variables are control variables for firm size, proportion of business in personal lines, proportion of business in commercial long-tail lines, diversification of premiums by line of business and geographic area, group membership, and organizational form. Insurer size is estimated as the logarithm of net premiums written (Petroni, 1992; Kelly et al., 2012). Previous research indicates that loss reserving errors are more likely

23 The classification for each state was available from Harrington (2002) and Grace and Phillips (2008) until 2005. After 2005, we tracked down rating changes by comparing the 2005 results from the results available using NAIC's Compendium of State Laws and Regulations on Insurance Topics for 2011.

to occur in long-tail lines so we use the proportion of business in long-tail commercial business lines as a control variable (Beaver et al., 2003).[24] And we use the fraction of business in personal lines as another control variable. Compared to commercial long-tail lines, personal lines are simpler and have a shorter-tail (Mayers and Smith, 1988). (The omitted variable is the proportion of business in commercial, short-tail lines.) We have no priors on the expected signs for the coefficients of these variables.

We measure diversification by line of business and by geographic area using Herfindahl indexes of premiums earned by line and state, respectively.[25] Grace and Leverty (2012) find these variables to be positively related to the loss reserve error, implying that over-reserving is positively related to higher concentration by line and by state of business. We also include reinsurance usage and growth in the regression model. Reinsurance usage is measured as the percentage of gross premiums written ceded to reinsurers, while growth is measured as the percentage increase in net premiums written from the previous to the current year. Grace and Leverty (2012) find that reinsurance usage and growth are negatively related to the loss reserve error. Group affiliation is associated with intragroup reinsurance, which may increase the complexity of the insurer.[26] Finally, we include an indicator variable in the regressions that is set equal to one for privately-held stock insurers and equal to zero otherwise. We include this variable and the indicator for publicly-traded stock insurers in the regression models. The omitted organizational form is mutuals.

24 The term "long-tail" refers to lines of insurance for which there is a long lag between premiums and claim payments. The fraction of net premiums written for commercial long-tail business lines is the proportion of net premiums written in long-tail lines (workers' compensation, other liability, and commercial automobile liability) to total net premiums written. The fraction of net premiums written from personal lines is the proportion of net premiums written in personal lines (farmowners multiple peril, homeowners multiple peril, automobile private passenger physical damage and private passenger automobile liability) to total net premiums written.

25 The product or business line Herfindahl index is measured as the sum of the squared percentage of direct premiums earned in each of the lines written by the P-C insurer; the geographic Herfindahl index is measured using the sum of the squared percentage of direct business written in each of the 50 states and the District of Columbia by the insurer.

26 We have no priors on the sign and significance of the Herfindahl variables and the group affiliation variable. These are merely control variables.

3.3 Estimation Strategy

First, we estimate equation (1) for the full sample using feasible generalized least squares (FGLS) with a panel-specific AR (1) autocorrelation structure.[27] We include year dummies in the model to control for exogenous economic factors related to reserving decisions that change over time and have not otherwise been controlled for in the model.[28]

Chow tests are conducted to determine whether it is appropriate to pool weak and healthy insurers in the same regression. Accordingly, equation (1) also is estimated for the subsamples of weak versus healthy insurers. We define weak insurers as insurers that have failed four of the Insurance Regulatory Information System (IRIS) ratio tests (e.g., see Gaver and Paterson, 2004; Petroni, 1992)[29] and classify all other insurers as "healthy."

4. Data and Sample Selection

In this section we discuss the sources for the data used in our analyses and sample selection criteria, which includes the Propensity Score Matching process.

27 The Breusch-Pagan Lagrangean multiplier tests suggest that fixed/random effects models are preferred to a pooled cross-sectional model with no unit or time effects. Hausman tests indicate that fixed effects are preferred to random effects models. However, full fixed effects models assume the error term is normally distributed and homogeneous. Modified Wald tests reject the null hypothesis that there is no existence of group-wise heteroscedasticity ($p < 0.0001$). Wooldridge (2010) tests indicate serious autocorrelation exists in our panel data. Beaver and McNichols (1998) report positive serial correlation in reserve errors indicating multi-period reserve management. Grace and Leverty (2012) also report heteroscedasticity and serial correlation in their sample. Therefore, the assumptions for fixed effects are not met for our data. FGLS estimation with autocorrelation controls for serial correlation and group wise heteroscedasticity is commonly used to deal with these problems (Grace and Leverty, 2012). We have to drop some firms from the FGLS estimation because they are present for only one year of the sample period. This reduced the sample by 112 observations.

28 Exogenous economic factors include unexpected inflation and changes in court attitudes and jury verdicts which are out of management control (Petroni, 1992). Gaver, Paterson, and Pacini (2012) document that the P-C insurance industry as a whole over-reserved from 1993 to 1997, under-reserved from 1998 to 2002, and returned to over-reserving from 2003 to 2004. Reserve errors for our sample by year are -0.0108, -0.0298, -0.0346, -0.0261, -0.0034, 0.0162, 0.0296, 0.0346, 0.0348, 0.0322, 0.0305, and 0.0286 from 1999 to 2010, respectively.

29 The IRIS system consists of twelve financial ratio tests. Insurers with four test results outside of the NAIC prescribed boundaries are scrutinized more rigorously than other insurers. The degree of scrutiny; however, varies by state. For an excellent discussion of these ratio tests, see Gaver and Paterson (2004).

4.1 Data

The main data sources for this research are Best's Insurance Reports -- Property/Casualty Edition,[30] the NAIC annual statement database, and proxy statements of the publicly-traded insurers. Observations are at the company level rather than the group level, which are consistent with most prior research. We obtain information of actuaries from Best's Insurance Reports -- Property/Casualty Edition (in various years) and cross-check with information in the insurer's annual statement. Data from the same source as for the actuary information is used to find organizational form and ownership structure as well.[31] We determine the loss reserve errors from Schedule P, Part 2 of the insurers' annual statements. As for data to determine whether a state has stringent rate regulation, we acquire from Harrington (2002), Grace and Phillips (2008), and the NAIC's Compendium of State Laws and Regulations on Insurance Topics for 2011 (National Association of Insurance Commissioners, 2011). We obtain all other remaining variables from the NAIC annual statement database.

4.2 Sample Selection

The original sample of this study consists of all P-C insurers with loss reserving data for our sample period 1999 to 2010. Then we eliminate firms that have extreme errors in their loss reserves (i.e., observations with an original loss reserve estimate that differs from the revised estimate by greater than 50% in absolute value) from the sample. In addition, we exclude firms that cede all premiums to reinsurers and/or write greater than 25% of their premiums in workers compensation, accident and health, surety, credit, and/or reinsurance as well. (See Petroni, 1992.) This screening process for our data parallels that of Gaver and Paterson (2014), Grace and Leverty (2010, 2012), and Petroni (1992), among others. [32]

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30 Best's Insurance Reports -- Property/Casualty Edition is published annually by the A. M. Best Company (A. M. Best Company, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011).

31 If these sources did not reveal the ultimate owner of an insurer, we further checked the insurer's website and news sources on the internet.

32 The initial number of observations from 1999 to 2010 is 16,877. Missing data regarding whether an in-house actuary is used or not reduces the sample to 16,091. The requirements that insurers be

After the screening process, we obtain an unbalanced final sample of 7,455 observations. The sample has 354 unique publicly-traded stock insurance companies, 225 unique privately-held stock insurance companies and 383 unique mutual insurers. The sample period is from 1999 to 2010. The sample period stops in 2010 because 5 future years of data are needed to estimate the loss reserve error.

Table 2 indicates the proportion of the sample using in-house actuaries to certify loss reserves. The proportion of insurers in the sample using in-house actuaries to certify loss reserves is 28% for our sample and remains stable throughout our sample period.[33] This ratio is 52% for publicly-traded stocks, compared to 17% for mutuals and 9% for privately-held stocks.

Besides, it is possible that insurers systematically choose an in-house actuary. For example, managers who are more inclined to manage earnings reporting through loss reserve estimation (i.e., weak insurers) might tend to select an in-house actuary because (s)he might be easier to influence. Thus, the results might be influenced by selection bias. Therefore, we conduct Durbin-Wu-Hausman tests for endogeneity surrounding the choice of using an in-house actuary.[34]

Following Lawrence, Minutti-Meza, and Zhang (2011), we use a PSM to control for differences in insurer characteristics for insurers using an in-house actuary for reserve certification and for those using an external actuary (Lennox, Francis, and Wang, 2012). PSM is a statistical tool attempting to estimate the effect of a treatment by controlling for the variables that predict obtaining the treatment. That is, PSM matches pairs of firm-years that have similar firm characteristics but differ in the choice of using an in-house actuary.

mutuals, publicly-traded stocks or privately-held stocks and that they be domiciled in the U.S. result in a sample size of 11,918. Deletion of observations with extreme errors in their loss reserves then reduces the sample to 11,741. Dropping observations for insurers that cede all premiums and/or write greater than 25% of their premium in workers compensation, accident & health, surety, credit, and/or reinsurance further reduces the sample size to 8001. We continuously reduce the sample size to 7,567 observations with the requirement that the sample firms have data for all of the control variables. Finally, dropping firms that are present for only one year in the FGLS estimation leads to a final sample of 7,455 observations.

33 The 28% is based on the number of insurers that use in-house actuaries. This is not the same as the total dollar amount of reserves associated with in-house actuaries in the U.S., which earlier was stated as 60% on average.

34 The results of these tests are reported on later in the paper.

Table 2 In-House Actuary Usage by Year and Organizational Form

Variable	**Obs.**	**Mean**	**Std. Dev.**
Panel A			
In-House for full sample	7455	0.276	0.447
In-House if Mutual	3335	0.169	0.374
In-House if Publicly-traded Stock	2591	0.523	0.500
In-House if Privately-held Stock	1529	0.094	0.291
Panel B			
In-House in 1999	482	0.286	0.453
In-House in 2000	515	0.299	0.458
In-House in 2001	600	0.255	0.436
In-House in 2002	648	0.286	0.452
In-House in 2003	661	0.284	0.451
In-House in 2004	650	0.285	0.452
In-House in 2005	642	0.266	0.442
In-House in 2006	669	0.291	0.455
In-House in 2007	676	0.303	0.460
In-House in 2008	674	0.273	0.446
In-House in 2009	644	0.252	0.434
In-House in 2010	594	0.237	0.426
In-House before SOX (1999-2002)	2245	0.281	0.449
In-House after SOX (2003-2010)	5210	0.275	0.446
In-House before SOX (1999-2002) if Mutual	1020	0.185	0.389
In-House after SOX (2003-2010) if Mutual	2315	0.161	0.368
In-House before SOX (1999-2002) if Publicly-traded Stock	779	0.520	0.500
In-House after SOX (2003-2010) if Publicly-traded Stock	1812	0.525	0.500
In-House before SOX (1999-2002) if Privately-held Stock	446	0.081	0.273
In-House after SOX (2003-2010) if Privately-held Stock	1083	0.099	0.299

Note: This table reports summary statistics (mean and standard deviation) for the years 1999 to 2010 for the *In-House (Actuary)* variable. *In-House* is an indicator variable equal to one if the insurer employs an in-house actuary to certify loss reserves, and zero otherwise.

More specifically, we obtain our matched pairs of observations in three steps. First, we separate the full sample into three subsamples: mutuals, publicly-traded stocks, and privately-held stocks. We estimate a logistic PSM for in-house actuary choice to yield the probability of an insurer employing an in-house actuary in each of the three subsamples.

All of the variables (except the in-house indicator and the interaction terms with the in-house indicators) are used in the propensity score estimation. In the second step, for each insurer employing an in-house actuary, we identify an insurer with the closest five digits of the propensity score that has not used an in-house actuary.[35] This approach enables us to form matched pairs with the smallest propensity score differences (i.e., most similar along a set of firm characteristics) but the greatest difference in the in-house actuary choice among the three subsamples. Third, we combine insurers using in-house actuaries and their matched observations for all three subsamples. Eventually, we are able to identify 1,411 observations employing in-house actuaries and 1,411 matched observations. With the PSM sample, we estimate equation (1) to control for any potential remaining differences in insurer characteristics between the treatment and control groups.[36]

5. Results and Discussion

This section discusses the results of the regression models. But first, the results of the Chow tests are presented, and descriptive statistics are discussed.

5.1 Results of Chow Tests for Weak versus Healthy Insurers

As indicated previously, weak firms may behave differently than healthy ones (e.g., Gaver and Paterson, 2014; Petroni, 1992). If this were the case, then making inferences from a regression that includes both weak and healthy insurers in the sample could be misleading. If weak firms systematically behave differently from healthy ones, the results

35 If the selected insurer employs an actuary from an external independent firm, we find a match. If not, we next try to match on four digits of the propensity score. This process continues down to a one-digit match on propensity score for those that remain unmatched. Some observations could not be matched.

36 A simple univariate t-test (Wilcoxon rank-sum test) of the differences in means (medians) suggests that there are no significant differences in most variables between matched pairs except that insurers employing in-house actuaries have a larger size (larger premiums written) than those that do not at the 5% significance level. Insurers employing in-house actuaries have less reinsurance usage and lower values for the net income smoothing variable than those that do not at the 5% significance level. Also, insurers employing in-house actuaries have a higher mean (but lower median) for the line of business Herfindahl index, and the difference is significant at the 5% level.

from running regressions on a sample of weak and healthy insurers should be statistically different than running separate regressions on weak insurers and healthy insurers. Thus, we conduct a Chow test to determine if it is appropriate to include both weak and healthy insurers in the same sample (Chow, 1960). The Chow test results reject the validity of pooling weak and healthy insurers in the same regression sample.[37] Therefore, emphasis in the results is given to regressions in which weak and healthy insurers are separated.[38]

5.2 Descriptive Statistics

Descriptive statistics are presented in Table 3. Panel A shows the means and standard deviations for the full sample of insurers and the PSM sample. The table indicates that the mean reserve error (scaled by total admitted assets) is very small and positive for the full sample, i.e., 0.014. It is 0.013 for the PSM sample.

The results in Table 3, Panel B contain the means for the full and PSM samples of weak firms and healthy firms. The mean loss reserve errors for weak firms are less than zero in the full and PSM samples, while they are positive for healthy firms in the full and PSM samples. Weak and healthy firms are more likely to be mutual or publicly-traded stock insurers rather than privately-held insurers.

Panel C of Table 3 contains average annual values for the loss reserve error for the sample period. On average, the loss reserve error is negative for weak firms in the full and PSM samples, signifying that weak firms are under-reserved for the entire time period whether one considers the full or PSM sample. Conversely, healthy firms are consistently over-reserved for the entire period, which are signified by their positive values in the full and PSM samples. The weak and healthy firms' loss reserve errors are statistically different from each other at the 1% statistical level or better.

5.3 Regression Results and Discussion

Table 4 contains regression results in which the scaled loss reserve error is used as

37 The chi-squared statistic for the full (PSM) sample is 4,262.96 (5,402.06); therefore, the null hypothesis that the weak and healthy insurer samples can be pooled is rejected at better than the 1% level.

38 Pooled sample results in which weak and healthy insurer observations are combined are reported also for comparison purposes.

Table 3 Descriptive Statistics

Panel A. Means and Standard Deviations for Full and PSM samples

	Full sample		PSM sample	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Reserve Error	0.014	0.077	0.013	0.069
In-House Actuary Indicator	0.276	0.447	0.514	0.500
Mutual Indicator	0.447	0.497	0.349	0.477
Publicly-traded Stock Indicator	0.348	0.476	0.575	0.494
Privately-held Stock Indicator	0.205	0.404	0.076	0.265
Post SOX Indicator	0.699	0.459	0.690	0.462
Tax Indicator	0.596	0.491	0.624	0.484
Net Income Smoothing	0.830	4.342	0.857	4.285
Rate Regulation	0.383	0.362	0.374	0.331
Weak Firm Indicator	0.207	0.405	0.203	0.402
Firm Size (in Net Premiums Written)	17.495	1.899	18.089	2.012
Herfindahl Index by Lines of Business	0.478	0.267	0.422	0.236
Herfindahl Index of Premiums by State	0.583	0.376	0.502	0.384
Proportion of Premiums from Personal Lines	0.511	0.388	0.569	0.380
Prop. of Premiums from Commercial Long Tail Lines	0.160	0.244	0.174	0.231
Reinsurance Usage	0.325	0.274	0.337	0.276
Growth in Net Premiums Written	0.079	0.286	0.087	0.301
Group Affiliation Indicator	0.678	0.467	0.894	0.308

Panel B. Comparisons between Means of Weak and Healthy Insurers

	Full sample		PSM sample	
Variable	**Weak firms (1546 obs.)**	**Healthy firms (5909 obs.)**	**Weak firms (573 obs.)**	**Healthy firms (2249 obs.)**
Reserve Error	-0.073***	0.037	-0.066***	0.033
In-House Actuary Indicator	0.321***	0.265	0.553*	0.505
Mutual Indicator	0.309***	0.483	0.204***	0.386
Publicly-traded Stock Indicator	0.427***	0.327	0.696***	0.544
Privately-held Stock Indicator	0.264***	0.190	0.100**	0.070
Post SOX Indicator	0.466***	0.760	0.433***	0.756
Tax Indicator	0.448***	0.635	0.496***	0.657
Net Income Smoothing	-3.091***	1.856	-2.830***	1.797
Rate Regulation	0.425***	0.372	0.397**	0.369
Firm Size (in Net Premiums Written)	17.420**	17.515	17.970**	18.120
Herfindahl Index by Lines of Business	0.489	0.476	0.433	0.419
Herfindahl Index of Premiums by State	0.570	0.587	0.478	0.508
Proportion of Premiums from Personal Lines	0.498	0.515	0.521***	0.582
Prop. of Premiums from Commercial Long Tail Lines	0.183***	0.154	0.208***	0.165
Reinsurance Usage	0.426***	0.299	0.418***	0.316
Growth in Net Premiums Written	0.167***	0.056	0.183***	0.062
Group Affiliation Indicator	0.697**	0.673	0.904	0.892

Panel C. Mean Reserve Error by Year				
	Full sample		**PSM sample**	
Variable	**Weak firms**	**Healthy firms**	**Weak firms**	**Healthy firms**
Reserve Error in 1999	-0.076***	0.033	-0.066***	0.033
Reserve Error in 2000	-0.086***	0.030	-0.076***	0.028
Reserve Error in 2001	-0.076***	0.027	-0.086***	0.020
Reserve Error in 2002	-0.070***	0.026	-0.071***	0.023
Reserve Error in 2003	-0.064***	0.030	-0.049***	0.030
Reserve Error in 2004	-0.083***	0.036	-0.055***	0.034
Reserve Error in 2005	-0.068***	0.039	-0.045***	0.034
Reserve Error in 2006	-0.057***	0.041	-0.039***	0.036
Reserve Error in 2007	-0.056***	0.041	-0.038***	0.038
Reserve Error in 2008	-0.070***	0.043	-0.048***	0.036
Reserve Error in 2009	-0.077***	0.044	-0.082***	0.037
Reserve Error in 2010	-0.065***	0.042	-0.071***	0.036

Note: This table reports summary statistics for the years 1999 to 2010. There are 7,455 (2,822) observations for the full (PSM) sample. *Reserve error* is the difference between the loss reserve in the original reporting period and a revised estimate five years in the future scaled by total admitted assets. Positive reserve errors indicate that the firm initially over-reserved (managed earnings downward), while negative reserve errors indicate under-reserving (managed earnings upward). *In-House (Actuary)* is an indicator variable equal to one if the insurer employs an in-house actuary to certify loss reserves, and zero otherwise. *Mutual Indicator* is an indicator variable equal to one if the firm is a mutual or a reciprocal firm, and zero otherwise. *Privately-held stock* is an indicator variable equal to one for a stock firm that is not publicly traded, and zero otherwise. *Publicly-traded Stock* is a stock firm indicator variable equal to one for a stock firm that is publicly traded, and zero otherwise. *Tax* is an indicator variable equal to one if the insurer has a high tax rate, and zero otherwise. *Net Income Smoothing* is the difference in unbiased net income in year *t* and reported net income in year *t*-1 divided by the absolute value of reported net income in year *t-1*. *Weak Firm Indicator* is an indicator variable equal to one for insurers that have four or more unusual IRIS ratios, and is zero otherwise. *Rate Regulation* is the percentage of premiums written in a state with stringent rate regulation. *Firm size* is the logarithm of net premiums written. *Herfindahl indexes by line and states of business* are Herfindahl indexes of premiums written by product line and by state, respectively. *Prop. of NPW from commercial long tail lines* (Workers' Compensation, Other Liability, and Commercial Automobile Liability) is the proportion of Net Premiums Written (NPW) in commercial long tail lines to total NPW. *Prop. of NPW from Personal Lines* is the proportion of NPW in personal lines (Farmowners Multiple Peril, Homeowners Multiple Peril, Personal Automobile Physical Damage and Personal Automobile Liability) to total NPW. *Reinsurance Usage* is the percentage of gross premiums written ceded to reinsurers. *Growth in Net Premiums Written* is the one year percentage change in net premiums written. *Group Affiliation* is an indicator variable equal to one for insurers that are associated with a group, and zero otherwise. All continuous variables are winsorized at the 1 and 99 percentiles to remove the excess effects of outliers. Panel B presents comparisons between Healthy and Weak firms using *t*-tests for means and Wilcoxon rank sum tests for medians. The Weak Firm subsample has 1,546 (573) observations while the Healthy firm subsample has 5,909 (2,249) observations for the full (PSM) sample. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 4 Weak and Healthy Subsample Regression Results

Variable	Full sample			PSM sample		
Independent Variables	(1) Full Sample	(2) Weak Sample	(3) Healthy Sample	(4) PSM Sample	(5) Weak Sample	(6) Healthy Sample
Intercept	0.049***	0.005	0.007**	0.025***	-0.081***	0.039***
	(0.005)	(0.006)	(0.003)	(0.004)	(0.017)	(0.003)
In-House Actuary Indicator (=1 if In-House Actuary used)	0.000	-0.017***	-0.003***	-0.005***	-0.030***	-0.003***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.004)	(0.001)
In-House Actuary×Publicly-traded Stock Indicator	-0.000	0.007**	-0.002	0.004***	0.035***	-0.001
	(0.002)	(0.003)	(0.001)	(0.002)	(0.004)	(0.001)
External Actuary×Post SOX Indicator×Publicly-traded Stock Indicator	0.011***	0.032***	0.011***	0.015***	0.013***	0.016***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.005)	(0.001)
In-House×Post SOX Indicator×Publicly-traded Stock Indicator	0.013***	0.031***	0.015***	0.023***	-0.002	0.023***
	(0.001)	(0.003)	(0.001)	(0.001)	(0.004)	(0.001)
Tax Indicator	0.003***	0.006***	0.002***	0.004***	0.007***	0.006***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.002)	(0.000)
Net Income Smoothing	0.001***	0.002***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Rate Regulation	-0.007***	0.002	0.000	-0.008***	-0.005**	-0.004***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.003)	(0.001)
Weak firm indicator	-0.056***			-0.066***		
	(0.001)			(0.001)		
Firm Size (in Net Premiums Written)	-0.002***	-0.004***	0.001***	-0.001***	-0.002***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Herfindahl Index by Lines of Business	0.012***	-0.027***	0.032***	0.027***	0.001	0.031***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.006)	(0.001)
Herfindahl Index of Premiums by State	0.000	-0.020***	0.005***	-0.006***	-0.009***	-0.006***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.003)	(0.001)
Proportion of Premiums from Personal Lines	0.004***	0.036***	-0.011***	0.010***	0.077***	-0.006***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.005)	(0.001)
Prop. of Premiums from Commercial Long Tail Lines	0.020***	-0.056***	0.025***	0.026***	0.002	0.038***
	(0.002)	(0.003)	(0.001)	(0.002)	(0.009)	(0.001)
Reinsurance Usage	-0.005***	0.030***	-0.010***	0.000	0.034***	-0.013***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.004)	(0.001)
Growth in Net Premiums Written	0.009***	0.023***	-0.002***	0.003***	0.009***	-0.003***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)	(0.000)

Table 4 Weak and Healthy Subsample Regression Results

Variable	**Full sample**			**PSM sample**		
Independent Variables	(1) Full Sample	(2) Weak Sample	(3) Healthy Sample	(4) PSM Sample	(5) Weak Sample	(6) Healthy Sample
Group Affiliation Indicator (=1 if member of group)	-0.001	0.019***	-0.001*	0.008***	0.026***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)
Publicly-traded Stock Indicator (=1 Publicly-traded)	-0.008***	-0.033***	-0.011***	-0.022***	-0.040***	-0.019***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)
Privately-held Stock Indicator (=1 Privately-held)	-0.001	-0.043***	0.002***	-0.014***	-0.065***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.005)	(0.001)
Wald chi-squared	38469.34	71006.30	347036.83	203614.07	35358.95	427781.86
Number of Observations	7455	1399	5872	2822	455	2199

Note: This table reports results on the relationship between an *In-House Actuary Indicator*, organizational form variables, and SOX variables with loss reserve error for the sample period 1999-2010. Columns 1 to 3 report results using the full sample, while columns 4 to 6 report results using the Propensity Score Matching (PSM) sample. Feasible generalized least squares (FGLS) with a panel specific AR (1) autocorrelation structure is used in all models. The dependent variable is the value of the reserve error scaled by total admitted assets. All other variables are defined in Table 3. Year dummies are added in all models. Robust standard errors are reported in parentheses below each coefficient. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

the dependent variable. Recall that over-reserving is associated with a positive coefficient, while under-reserving is associated with a negative coefficient. Column 1 contains results using the full sample of (weak and healthy) insurers, while Columns 2 and 3 contain full sample results for weak versus healthy insurers separately. Column 4 contains results for the full (weak plus healthy) PSM sample, while columns 5 and 6 contain the results for the separate PSM samples of weak and healthy insurers.

The coefficients for the *In-House Actuary Indicator* variable are negative and significant in Table 4 for weak insurers in the full and PSM samples in columns 2 and 5 respectively. These results support Hypothesis 1a; weak nonpublic insurers using in-house actuaries are more under-reserved (less over-reserved) than nonpublic insurers using external actuaries. Note that the coefficient of intercept captures the effect of nonpublic insurers using external actuaries. The coefficients for the in-house actuary variable are also negative and significant for healthy nonpublic insurers in columns 3 and 6 of Table 4. These results do not support Hypothesis 1b, which predicts that the coefficient for the in-house actuary variable would be insignificant for healthy nonpublic insurers. Thus, there is very strong evidence (after controlling for firm characteristics and other incentive conflicts) that both weak and healthy nonpublic insurers that use in-house actuaries to certify loss reserves are under-reserve more (or over-reserve less) than nonpublic insurers using external actuaries.[39] However, the degree of under-reserving is economically very small for healthy nonpublic insurers.

According to Hypothesis 2, weak publicly-traded insurers using in-house actuaries should be less under-reserved (or more over-reserved) than weak nonpublicly-traded insurers using in-house actuaries pre-SOX. The coefficient for *In-House Actuary Indicator*×*Publicly-traded Stock Indicator* is positive for weak insurers in Table 4 column 5. The coefficient is 0.035, and it is significant at the 1 percent level. This result is consistent with Hypothesis 2: weak publicly-traded insurers using an in-house actuary are less under-reserved than weak nonpublic insurers using an in-house actuary pre-SOX. Interestingly, weak publicly-traded insurers using an in-house actuary overall tend to over-reserve than their peers using an external actuary (0.035-0.030 = 0.005, although not statistically significant at the conventional level). This suggests that monitoring from capital market seems to be able to constrain the incentives of under-reserving for financially weak insurers with an in-house actuary to some extent.

The coefficient for the *External Actuary*×*Post SOX Indicator*×*Publicly-traded Stock Indicator* is positive and significant in Table 4 column 5 (i.e., 0.013), signifying that weak publicly-traded P-C insurers using external actuaries became less under-reserved after SOX than weak publicly-traded insurers pre-SOX.[40] These results for weak insurers

39 Further, Wald tests indicate that the coefficients for weak insurers in the full and PSM samples are significantly larger (in absolute value) than for healthy insurers. For example, in columns 5 and 6, the coefficient for the *In-House Actuary Indicator* is larger in absolute value for weak (-0.030) compared to healthy insurers (-0.003). The chi-squared value for the test of equality of coefficients for the *In-House Actuary Indicator* variable between the weak sample and the healthy sample is 2.76 for the full sample, and this result is significant at the 10% level. The chi-squared value for the test of equality of coefficients for the *In-House Actuary Indicator* variable between the weak sample and the healthy sample is 4.29, and it is significant at the 5% level for the PSM sample.

40 We also estimate regressions in which the *post-SOX* indicator is interacted with a *nonpublicly-traded* indicator variable, where the *nonpublicly-traded* indicator is equal to one if the insurer is a mutual or privately-held, and it is set to zero otherwise. Interestingly, the results in the PSM samples indicate that the coefficient of the *nonpublicly-traded* indicator and the *post-SOX* indicator is negative and

support Hypothesis 3a. Hypothesis 3a is not supported for weak publicly-traded P-C insurers using in-house actuaries in the PSM sample in column 5; that is, the coefficient for the *In-House Actuary×Post SOX Indicator×Publicly-traded Stock Indicator* variable for weak insurers (-0.002) is insignificant in column (5).

The coefficients for *External Actuary×Post SOX Indicator×Publicly-traded Stock Indicator* (i.e., 0.016) and for *In-House Actuary×Post SOX Indicator×Publicly-traded Stock Indicator* (i.e., 0.023) for healthy insurers are both positive and significant at the 1 percent level in column 6. Thus, Hypothesis 3b is supported for healthy insurers regardless of whether in-house actuaries or external actuaries are used by healthy insurers. That is, healthy publicly-traded P-C insurers became more over-reserved (or less under-reserved) after SOX.

With respect to the remaining variables relating to incentive conflicts and loss reserve errors noted in previous literature, the coefficients for the *tax* indicator variable are positive and significant across all regression specifications in Table 4 as expected. Thus, insurers paying high federal income taxes are more over-reserved (less under-reserved). This result is consistent with prior literature. Also, as expected, the *net income smoothing* variable is positive and significant across all equations. In the PSM samples in columns 4, 5, and 6, the coefficient of the *rate regulation* variable is negative and significant, which is consistent with Nelson (2000). Hence, the PSM sample results overall are consistent with findings in prior literature regarding the reasons leading to loss reserving errors.

Otherwise, the remaining results in Table 4 indicate that under-reserving (less over-reserving) is associated with firm size; that is, the coefficients for the *firm size* variable in columns 5 and 6 are negative and significant. The same is true for the *publicly-traded stock* indicator and *privately-held stock* indicator variables. (The omitted indicator variable is for mutual insurers.) Thus, relative to mutuals, publicly-traded and privately-held insurers are more under-reserved (less over-reserved). Mutuals may have a tendency to be more conservative in reserving because they have limited ability to raise new capital. Therefore,

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significant for healthy insurers, while it is insignificant for weak insurers in the PSM sample. Thus, SOX apparently affected more than publicly-traded insurers. While we do not know the reason for the results, perhaps it is due to over-reserving *pre-SOX* for healthy nonpublicly-traded insurers. That is, these results would make sense if healthy nonpublicly-traded insurers reduce the amount of over-reserving after SOX to obtain more accurate reserve estimates.

it is important that they make ample provision for loss reserves.

The coefficients for the *group affiliation* variables in columns 5 and 6 are positive (i.e., 0.026 and 0.002, respectively) and significant at the 1 percent level. Thus, insurers that are members of a group tend to be more over-reserved (less under-reserved) than for single, stand-alone insurers. Otherwise, the coefficients of the remaining variables are mixed with respect to signs and significances in the weak and healthy insurer samples. The latter differences are not unexpected, if it is not appropriate to pool healthy and weak insurers together in the same regression sample.

5.4 Synthesis of Results

The variables to test the hypotheses are indicator variables, and netting of the coefficients of these variables allows us to estimate overall effects for publicly-traded stock insurers that use in-house actuaries. That is, for publicly-traded stock insurers the overall effect of SOX and the use of an in-house actuary to certify reserves can be found by netting together the coefficients for the in-house actuary variable and all of its interaction terms. The net effect for weak publicly-traded insurers associated with the *in-house actuary* variable and its interaction terms is 0.005 (i.e., -0.030 + 0.035 + 0 from column 5 in Table 4). Thus, when all effects are considered, weak, publicly-traded stock insurers using an in-house actuary after SOX are over-reserved (or less under-reserved); the corresponding monetary amount is $3.2 million ($631 million in mean total admitted assets multiplied by 0.005) or 0.5% of total admitted assets at the mean. The amount $3.2 million represents 0.9% of loss reserves and 1.2% of equity.

For healthy insurers, the effect of netting the coefficients is 0.020 (i.e., -0.003 + 0 + 0.023). Thus, when all effects are considered, healthy publicly-traded stock insurers using in-house actuaries are over-reserved (less under-reserved) by 2.0% of total admitted assets or $19.5 million ($976.6 million in mean admitted assets multiplied by 0.020) at the mean of the sample. As a percent of loss reserves, $19.5 million represents 4.1%, and this amount represents 3.0% of equity. For nonpublicly-traded stock insurers (i.e., mutual insurers and privately-held stock insurers), the estimated effect of using in-house actuaries is merely the coefficient for the *In-House Actuary Indicator*, which is -0.030 for weak insurers and -0.003 for healthy insurers in columns 5 and 6, respectively. That is, both weak and healthy insurers are under-reserved (or less over-reserved), with healthy insurers much less under-reserved (or more over-reserved).

6. Conclusion

This research investigates managerial bias associated with the use of in-house actuaries as the Appointed Actuary for certifying loss reserves in the U.S. P-C insurance industry. In addition, we examine the impact of SOX on the reporting practices of publicly-traded stock insurers associated with usage of in-house actuaries versus external independent actuaries in this industry. We assess managerial bias by examining errors in an important accrual item for P-C insurers: loss reserves.

Statistical analysis indicates that it is inappropriate to pool weak and healthy insurer observations in the same sample, whether a PSM sample of insurers is used or not. Chow tests unequivocally indicate that the two insurer samples are statistically different. Therefore, we carry out separate analyses for weak and healthy insurers.

The most notable result is that in-house actuarial loss reserve certification is associated with more under-reserving (less over-reserving) than when external actuaries are used. However, after SOX, over-reserving (less under-reserving) is associated with healthy publicly-traded stock insurers compared to pre-SOX, whether in-house or external actuaries are used. Thus, SOX appears to have led to more conservative reserve reporting for healthy publicly-traded stock insurers. Over-reserving after SOX is associated with weak publicly-traded stock insurers using external actuaries, and there is no effect on loss reserve errors associated with the use of in-house actuaries in this case.

Other results from this research support the presence of managerial incentive biases with respect to tax, net income smoothing, and rate regulation. The latter results are consistent with prior research. Relative to mutuals, publicly-traded stock insurers and closely-held stock insurers are under-reserved (less over-reserved).

This research is important for other reasons as well. It documents that the behavior of weak versus healthy insurers are different, at least with respect to loss reserving. This research also shows that organizational form makes a difference in loss reserve estimation. This study contributes to the growing literature on firm behavior with respect to the use of in-house resources versus external sources for services. In-house actuarial certification of loss reserves can be added to tax preparation as an example of a type of service that can be provided in-house that has an impact on firm financial reporting.

Finally, this research is important because P-C insurance is important (Chan, Peng, and Tsai, 2021; Chen and Gu, 2019; Yeh and Lin, 2018). A significant deficiency in loss reserves is associated with insurer insolvency, making loss reserving practices important to all of a firm's stakeholders including regulators. Over-reserving is important also, as it affects tax revenues contributed by P-C insurers, misstates income to the insurer's owners and can affect premium rates for some lines of business. For example, over-reserving in some instances has been shown not to be in stockholders' interests.

Areas of future research could relate the incentive compensation structure of in-house Appointed Actuaries to loss reserving error patterns. Case studies where deficient loss reserves lead to insolvency might provide clearer insight on exactly how managerial discretion is used prior to insolvency. It would be interesting, also to distinguish between an officer in-house actuary and a non-officer in-house actuary in our regression model to determine the relative impact of an external actuary on loss reserving accuracy vis à vis an officer in-house actuary.

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