How Do Insurance Companies Manage Reserves? Evidence from Reserve Manipulation across Lines of Business and Accident Years

Abstract

We study the question of how insurance companies manipulate reserves. Specifically, we investigate how managerial incentives affect insurers' reserving practice across line of businesses (LOBs) and accident years (AYs). As the tax discount factor assigned by the tax authority varies across LOBs and AYs, insurers with stronger tax saving incentives will be inclined to manipulate reserves across both LOBs and AYs. As the RBC regime specifies different industry worst case factors across LOBs, insurers with stronger incentives to increase their RBC ratio will be inclined to manipulate reserves across LOBs. In terms of income smoothing incentives, only the overall level (and not the composition) of reserves is of consequence, thus we predict that there will be no similar systematic patterns in reserves manipulation by insurers based on income smoothing incentives. By using a Firm-LOB-Year sample, we find that both tax incentives and RBC incentives can not only affect the level of reserve errors (REs), but also the composition of REs. These results help us identify how managerial incentives impact insurers' reserving behavior.

Keywords: loss reserve, reserve error, managerial discretion, insurance.

JEL Classification: G22, M12, M41

1. Introduction

There is a large body of literature that examines reserve errors (REs) in the property and casualty (P&C) insurance industry. These studies have provided insights as to whether insurance companies manipulate loss reserves; why do they manipulate reserves; when do they manipulate reserves; the modification factors on reserves management; among other considerations.[1] However, there is a paucity of evidence on *how* insurance companies manipulate reserves. In this paper, we investigate insurers' reserving strategies, i.e., how P&C insurance companies manipulate loss reserves across lines of business (LOBs) and accident years (AYs).

Different managerial incentives imply different ways for insurers to manage reserves across LOBs and AYs. In terms of tax incentives, the U.S. tax authority (i.e., Internal Revenue Service (IRS)) assigns separate tax discount factors for loss reserves booked in different LOBs and AYs. The change in discounted loss reserves is used by the IRS to calculate incurred loss, which offsets the insurers' revenue. Given that loss reserves between two insurers are equal, the insurer with more reserves booked in LOBs and AYs that have a higher tax discount factor translates to a larger amount that can be deducted from the insurer's revenue. This helps to reduce the insurer's current tax liability and postpone these tax payments into future time periods. As a result, in order to meet tax objectives, we may observe reserves manipulation by insurers across both LOBs and AYs.

In terms of solvency incentives, the Risk based capital (RBC) regime assigns distinct industry worst case factor for each LOB in calculating reserving risk charge (R_4). The reserving risk charge accounts for approximately half of the industry's total RBC, making it a dominant item in the RBC requirements (Cummins, Harrington, and Klein 1995). Therefore, insurers have strong incentives to manipulate reserves so as to reduce reserving risk charge and improve their RBC ratio. The reserving risk charge for each LOB is calculated by multiplying the amount of loss reserves by the assigned RBC factor. Given that loss reserves between two insurers are equal, the insurer with more reserves booked in LOBs that have a higher RBC factor translates to a greater RBC charge and higher regulatory costs. Therefore, we expect insurers to manipulate reserves across LOBs to meet RBC goals.

In terms of income smoothing incentives, only the overall level of reserves is of consequence. The increase in loss reserves is an offset to insurance income, regardless of which LOB or AY the increased loss reserves is booked. Thus, we do not expect to observe systematic reserve

[1] The prior studies document that P&C insurers are actively managing their reserve estimate (e.g., Petroni 1992; Grace and Leverty 2012). The literature finds that tax incentives (e.g., Grace 1990; Gaver and Paterson 1999), solvency incentives (e.g., Petroni 1992; Gaver and Paterson 2004), income smoothing incentives (e.g., Weiss 1985; Beaver, McNichols, and Nelson 2003), rate regulation incentives (e.g., Nelson 2000; Grace and Leverty 2010) and executive compensation incentives (e.g., Browne, Ma, and Wang 2009; Eckles and Halek 2010; Eckles et al. 2011) can help explain why insurers manage reserves. Furthermore, Eckles and Halek (2010) provides evidence on the timing of reserves management where they find managers that either received capped bonuses or no bonuses tend to over-reserve for current year incurred losses. There is also a growing literature discussing the impacts of modification factor (e.g., corporate governance) on reserve management. These studies find that actuarial and auditor independence (e.g., Kelly, Kleffner, and Li 2012; Grace and Leverty 2013; Kamiya and Milidonis 2016), board structures (e.g., Eckles et al. 2011; Hsu, Huang, and Lai 2018) play important roles in reserves management.

manipulation patterns across LOBs or AYs.

We first investigate the effect of different managerial incentives on how insurance companies manipulate reserves across LOBs (i.e., not AYs). Specifically, we use a sample of Firm-LOB-Year observations from year 2000 to 2012. We find that insurers with a higher tax avoidance incentive (measured by tax shield) tend to overestimate in LOBs with a higher tax discount factor. This result is consistent with our tax saving hypothesis. Furthermore, these tax strategies will generate higher deferred tax liabilities and postpone the cash payment of taxes. To improve the identification of our tests and also provide evidence of cross-sectional variation in the relationship between tax saving incentives and reserve management arising from the tax discount factor, we examine whether the level of cash holdings attenuate such a relationship. Consistent with our expectations, we find that insurers with less cash and a higher tax shield overestimates more in LOBs with a greater tax discount factor. These results complete the findings of Edwards, Schwab, and Shevlin (2016) who document that financially constrained firms in general industries tend to increase internally generated funds via tax planning.

We also document that insurers with a lower RBC ratio tend to underestimate in LOBs with a higher RBC factor. This is consistent with our solvency hypothesis, as underestimation in LOBs with a higher RBC factor results in a lower reserving risk charge and aids the insurers in achieving a higher RBC ratio.

We then test the REs across AYs by constructing the RE measure using the unpaid loss reserve errors in AY0 (i.e., the most recent accident year) for each LOB. As we argue above, tax incentives will induce insurers to manipulate reserves across both LOBs and AYs; RBC incentives will induce insurers to only manipulate reserves across LOBs; and income smoothing incentives is of no consequence in reserves manipulation across both LOBs and AYs. The implication is that only tax incentives have an impact on how insurers manage reserves across AYs, and we document results consistent with this hypothesis.

It is important to study how insurance companies manipulate their reserves. First, combining managerial incentives documented in prior literature with specific reserve management strategies discussed in this study can help us test different hypotheses explaining the same managerial incentive. For example, there are different hypotheses attempting to connect underreserving and financial weakness, leading to the discussion on whether weak insurers aim to game the solvency system. First, the accounting literature argues that insurance companies game the IRIS system by underestimating reserves so that they can report less than three IRIS violations and be able to avoid regulatory attention (e.g., Petroni 1992; Gaver and Paterson 2004). Second is the moral hazard hypothesis. Insurers have incentives to underestimate loss reserves due to limited liability and the presence of risk-insensitive guaranty funds (Harrington and Danzon 1994). Third, as 8 of the 12 IRIS ratios are mechanically improved by underestimating the loss reserves, Grace and Leverty (2012) argue that "weak insurers under reserve because they are weak and not necessarily they are attempting to deceive the regulators". Therefore, it is difficult to test whether insurers aim to avoid regulatory attention by managing reserves under traditional settings. By carefully exploring the design of the RBC regime, a type of solvency regime, we complete the work by Grace and Leverty (2012) and provide evidence that weak insurers do attempt to avoid regulatory attention by gaming the RBC system, as insurers with a lower RBC ratio tend to underestimate in LOBs with a higher RBC factor.

Second, it enables us to better understand the channels through which various corporate governance mechanisms work. We investigate how the use of Big four audit firms are related to above tax-saving and RBC-improving strategies. We find these reserve management strategies are mainly concentrated in insurers using non-Big four auditors, implying that Big four audit firms are able to limit managers' use of both tax-saving and RBC-improving strategies.

Our research makes several contribution to the literature on reserve management. First, we have drawn a more detailed picture as to how insurers manipulate reserves. In contrast to prior literature, which uses the firm level RE measure, we use the LOB-level RE measure. By adding firm, LOB and year fixed effects, we can control for omitted variables which do not change over LOBs, years, or firms. This helps to mitigate the concern of whether we have chosen the appropriate control variables at the firm level in order to control for the non-discretionary errors in loss reserve estimation (Guay, Kothari, and Watts 1996).

Second, we add to the literature on how tax incentives affect insurers' reserving practice. Prior literature (e.g., Grace 1990; Gaver and Paterson 1999) primarily focuses on the effect of reserve management on statutory income with less attention paid to the different impacts on statutory income and taxable income. By identifying reserve management across LOBs as a type of nonconforming earnings management (Badertscher et al. 2009),[2] which in turn saves on cash payment of taxes (Edwards, Schwab, and Shevlin 2016), we attempt to link the insurers' level of cash holdings to their reserve management behavior. We find that the relationship between tax incentives and reserve management will be attenuated when insurers hold more cash.

Third, we add to the literature on how tax and regulation affect corporate decisions. Petroni and Shackelford (1999) find that P&C insurers structure their cross-state expansion to mitigate both state taxes and regulatory costs. Gaver and Paterson (1999) document that P&C insurers manipulate reserves to meet tax and regulatory objectives simultaneously. Grace and Leverty (2012) conduct a joint test and shows that tax and solvency incentives persist even after controlling for a wide range of managerial incentives as well as economic and institutional factors. Our paper shows that tax and regulatory concerns will not only affect the overall level of loss REs, but will also affect the composition of loss REs. This allows us to document stronger evidence of corporate decisions being influenced by tax and regulatory objectives, helps us to infer different managerial incentives from their reserving behavior, and also enables us to better understand the channels through which various corporate governance mechanisms work.

[2] Earnings management activities that have the same impact on book and taxable income are referred to as book-tax conforming earnings management, while earnings management that have different impact on current taxable income are referred to as nonconforming earnings management. (e.g., Phillips, Pincus, and Rego 2003; Phillips et al. 2004).

2. Institutional background and hypothesis development

2.1. Tax incentive and loss reserve discounting in federal income tax regime

For statutory financial reporting, calendar year incurred losses is given by the losses paid during the year plus the change in the full value loss reserves from the beginning to the end of the year. For the purpose of federal income tax, the incurred losses is given by the losses paid during the year plus the change in the *discounted* loss reserves from the beginning to the end of the year (Feldblum 2002).

The rationale for using the discounted value, instead of the full value, of loss reserves is related to the insurers' investment business. The expected investment income arising from the time lag between losses incurred and losses paid is an important consideration in the book profitability of the insurers' business, particularly so for long-tailed LOBs. After policy expiration, the investment income on the assets backing the loss reserves provide steady and positive net income. For tax accounting purposes, the expected investment income from assets backing the loss reserves offsets the expected amortization of the interest discount in the reserves. Therefore, only the change in discounted value of loss reserves can be considered in offsetting taxable income (Feldblum 2002).

There are two determinants of the tax discount factors: loss payment patterns and yield rates. These determinants imply that the tax discount factors will vary across LOBs and AYs, respectively. The tax discount factor differs by LOBs because of the variation in loss payment patterns across LOBs. Loss payment pattern determines how fast the loss is fully paid out. Therefore, the loss payment pattern will affect the discounting process of future loss payments. The faster the loss is fully paid out, the larger the tax discount factor. The payout pattern is determined using industry aggregate data and comparing paid losses to incurred losses across LOBs.

The tax discount factor differs by AYs because of the variation in yield rate across AYs. IRS, the tax authority, uses a sixty-month moving average of the Federal Midterm Rate, ending on the December 1st preceding the AY. In tax parlance, the yield rate is vintaged, this means that the discount rate is specified for the specific AY and will not change over future calendar years (Feldblum 2002). As a rule of thumb, the lower the yield rate, the larger the tax discount factor.

Appendix 1 provides the tax discount factors for AY 2007 and LOB "Other Liability-Occurrence" (OL-O). Using this example, the discounted loss reserves for AY 2007 and LOB OL-O in year 2011 is calculated as the unpaid loss reserves of AY 2007 in calendar year 2011 multiplied by 90.8722%. The firm level discounted loss reserves in calendar year 2011 is calculated as the sum of all discounted loss reserves across all LOBs and AYs in calendar year 2011 (note that the current year's reserves comprise of all prior accident years' reserves).

The discounted loss reserves are used to determine the taxable income. The change in the *discounted* loss reserves from the beginning of the year to the end of the year is used to offset taxable income. This implies that keeping all else constant, the higher the *discounted* value of loss reserves at the end of the year, the lower the taxable income.

This IRS discounting mechanism incentivizes insurers to manipulate reserves across LOBs and AYs.

Insurers with stronger incentives to reduce taxable income will overestimate reserves in LOBs with a higher tax discount factor. Likewise, insurers with stronger incentives to reduce taxable income will overestimate reserves in AYs with a lower yield rate (which corresponds to a higher tax discount factor). These strategies will increase the discounted value of loss reserves, which makes for a greater offset towards taxable income.[3]

In an extreme scenario, we assume that insurers first determine the total amount of overestimation in loss reserves, followed by an allocation of these overestimations into different LOBs and AYs. According to our argument, insurers with stronger tax saving incentives will allocate more of these overestimations into LOBs with a higher tax discount factor; and will allocate more of these overestimations into AYs with a lower yield rate. Both methods give rise to a higher discounted value of loss reserves and a correspondingly lower taxable income.

Hypothesis 1: Insurers with stronger tax saving incentives will overestimate more loss reserves in LOBs with a higher tax discount factor.

Hypothesis 2: Insurers with stronger tax saving incentives will overestimate more loss reserves in AYs with a lower yield rate.

As mentioned above, the difference between the full value and *discounted* value of loss reserves is a difference in the timing. This implies that the difference will reverse in subsequent accounting time periods. Assuming that the insurer have determined the overall level of REs, the reallocation of REs across LOBs can be regarded as a type of nonconforming earnings management (Badertscher et al. 2009). This is because the proposed strategy reduces the taxable income while keeping the statutory income constant, which leads to greater savings in terms of cash tax. Edwards, Schwab, and Shevlin (2016) find that financially constrained firms are more likely to engage in cash tax saving practices, and this relationship will be attenuated when firms hold more cash. As firms face higher expected detection costs associated with these tax saving strategies (Badertscher et al. 2009), we hypothesize that higher cash holdings will reduce the firm's incentive to employ cash tax saving strategies.

Hypothesis 3: The relationship between tax saving incentives and reserve management across LOBs will be weaker for insurers with higher cash holdings.

2.2. RBC incentive and industry worst case factor in RBC regime

In the U.S. insurance industry, the RBC system was adopted in 1994 for P&C insurers. It has since been regarded as one of the main capital adequacy monitoring tool used by the National Association of Insurance Commissioners (NAIC). According to the NAIC, RBC is a method for measuring the minimum amount of capital required for an insurer to support its overall business operations. Under the RBC system, capital adequacy is assessed by the RBC ratio which is given by the ratio of total adjusted capital (TAC) to the firm's overall RBC:

[3] Note that these strategies does not mean that insurers avoid paying taxes, it only means that insurers postpone tax payments into future time periods.

$$RBC\ ratio = \frac{Total\ adjusted\ capital\ (TAC)}{0.5 \times Risk - based\ capital\ (RBC)} \quad (1)$$

where TAC primarily consists of capital (termed as "surplus" in the insurance industry) and RBC is the required capital that reflects business and asset risks. Specifically, RBC is the aggregation of capital charges across different risk categories.

One of the most important components of the RBC is the reserving risk charge (i.e., R_4), accounting for approximately half of the total RBC risk charge (Cummins, Harrington, and Klein 1995). Although we need to account for the loss concentration adjustment and the loss-sensitive contract adjustment, the building block of calculating R_4 is the initial reserving risk charge across LOBs, which is calculated using the following equations (Feldblum 1996):

$$(R_4) = (Reserves_{Rep}) \times [(1 + Adj \times Ind\ WC\ Factor) \times Disc\ Factor - 1] \quad (2)$$

where,

$$Adj = \frac{(Industry\ average\ development) + (Company\ average\ development)}{2 * (Industry\ average\ development)}$$

R_4 is the reserving risk charge, $Reserves_{Rep}$ is the reported reserves, *Ind WC Factor* is the industry worst case factor. It is designed to measure the most extreme adverse reserve development in history. *Disc Factor* is the discount factor, Adj is the adjustment factor, *Industry average development* is the average of *Company average development*[4] within the industry.[5] The *Industry average development*, *Ind WC Factor* and *Disc Factor* are given by the NAIC annually.

As we can observe from equation (2), one of the key factors that determine the reserving risk charge for LOB *i* is its *industry worst case factor* (*Ind WC Factor*). We can see that the larger the *industry worst case factor*, the larger is the reserving risk charge. Applying this into equation (1), this gives rise to a higher RBC charge which lowers the RBC ratio.

There are at least three types of benefits in avoiding a low RBC ratio. First, an insurer with a low RBC ratio is subjected to regulatory action, which incurs significant regulatory costs.[6] Second, multiple rating agencies have internal financial strength models which are similar to the RBC regime.[7] Therefore, when manipulating reserves across LOBs according to the RBC system, insurers might also perform better on the internal models used by rating agencies which results in insurers being given a higher rating. Third, although NAIC prohibits P&C insurers from using RBC

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4 *Company average development* = (*Current incurred losses* - *Initial incurred losses*) / (*Initial incurred losses*)

5 Appendix 2 provides an example calculation of *Company average development* (or runoff measure).

6 There are four levels of regulatory actions depending on the insurer's RBC ratio. The company action level is 150% to 200%, regulatory capital level is 100% to 150%, the authorized control level is 70% to 100% and the mandatory control level is below 70%.

7 See the report, Review and Comparison of Rating Agency Capital Models, by Joseph R. Lebens and François Morin.

ratios for marketing purposes, the insurers' RBC ratio is publicly available. Thus, customers or business partners who are particular about financial strength, might be reluctant to do business with insurers that have a low RBC ratio. There are also related costs in manipulating reserves according to the RBC regime, such as the cost of being identified for engaging in financial fraud (Grace 1990).

Therefore, the variation in the *industry worst case factor* across different LOBs provides insurers with an avenue to manipulate reserves and improve on their RBC position. This means that in order to increase their RBC ratio, insurers may underestimate (overestimate) more reserves in LOBs with a higher (lower) *industry worst case factor*.

Hypothesis 4: Insurers with stronger incentives to increase their RBC ratio will underestimate (overestimate) more reserves in LOBs with a higher (lower) *industry worst case factor*.

2.3. Income smoothing incentive

According to the income smoothing hypothesis, insurers may smooth income by managing loss reserves to meet earnings expectations and to reduce income variability (i.e., firm's risk). This behavior primarily arises from agency problems (Weiss 1985; Grace 1990; Froot, Scharfstein, and Stein 1993; Beaver, McNichols, and Nelson 2003; Eckles and Halek 2010) and regulatory concerns (Grace 1990).

Prior literature uses average return on assets (ROA) across the previous 3 years (e.g., Grace 1990; Grace and Leverty 2012) to test whether a negative relationship between income smoothing and REs exists. Specifically, a negative relationship means that insurers with stronger income smoothing incentives are more likely to under reserve (over reserve) in the current year given that these insurers experienced higher (lower) profits in prior years.

The statutory financial statement is used in calculating the firm's profitability, where the change in the full value of loss reserves is used to offset against statutory income. This means that only the overall level of loss reserves matters as the composition of loss reserves have no impact on statutory income. Therefore, for the income smoothing hypothesis, we do not expect to document manipulation of reserves by insurers across either LOBs or AYs.

3. Variable construction

3.1. Reserve error measure

Grace and Leverty (2012) survey the literature and summarize two main methods used to calculate REs. They termed the first measure as Weiss Error (Weiss 1985), which is defined as the difference between total incurred losses and cumulated developed losses paid j years later. They termed the second measure as KFS Error (Kazenski, Feldhaus, and Schneider 1992), which is defined as the difference between total incurred losses and a revised estimate of incurred losses j years later.

We use the revised estimate of incurred losses 5 years later to construct our RE measure. We do not use losses paid because the LOBs in our study are relatively long-tailed (i.e., more than ten development years according to Schedule P), which means that using losses paid may not be an accurate proxy for the ultimate losses.

As our study is based on Firm-LOB-Year observations, we do not scale reserves development by admitted assets. This is because admitted assets is a firm-level measure and may give rise to improper scaling under our research setting.[8] Therefore, we scale the loss reserves development by the initial estimate of incurred losses, which is a LOB-level variable. In robustness tests, we also scale our REs measure by the LOBs' direct premium written or direct premium earned, and we continue to yield similar empirical results.

Formally, we define the loss RE measure for insurer *i* with line of business *j* at the end of year *t* as:

$$Reserve\ Error_{i,j,t} = \frac{Incurred\ losses_{i,j,t} - Incurred\ losses_{i,j,t+5}}{Incurred\ losses_{i,j,t}}$$

Our definition implies that we expect a positive RE if the original reported reserves are overestimated.

3.2. LOB-level variables

3.2.1. Tax discount factor

For each LOB and each AY, IRS provides a set of discount factors for future tax years. For example, Appendix 1 shows the set of discount factors for AY 2009 and LOB "Other Liability - Occurrence". As our analysis is at the Firm-LOB-Year level, we collapse the set of factors into a single factor following the method used in the RBC regime.[9] We average discount factors across different tax years, weighted by the industry level loss reserves, to yield a single factor. Thus, the tax discount factor is at the LOB-level, and varies from year to year. The data for the set of discount factors for each LOB and each AY is retrieved from the IRS. The industry level unpaid reserves is calculated using Part 2 and Part 3 of Schedule P for all insurers that reported to NAIC.

3.2.2. Industry worst case factor[10]

The industry worst case factors are given by NAIC annually (NAIC 2009). They are designed to measure the most extreme adverse reserve development in history. Therefore, they do not change that often. They are calculated based on the historical reserve development patterns documented in Part 2 and Part 3 of Schedule P for each main LOBs (Feldblum 1996).We use the factor provided

8 For example, if we scale LOBs' reserve errors using assets (i.e., a firm-level variable), the main LOB within a firm may persistently have extremely large or small REs; compared to other minor LOBs within the firm. This is because the main LOB tends to have a larger absolute amount of reserves.

9 See appendix 3, Page 1 of the following report: Update to P/C Risk-Based Capital Underwriting Factors Presented to National Association of Insurance Commissioners' P/C Risk-Based Capital Working Group. It is prepared by the American Academy of Actuaries' P/C Risk-Based Capital Committee.

10 Notice that subsequent LOB-level variables are chosen in accordance with equation (2).

by NAIC in 2009, which implies that we assume this variable is constant over the years in our paper.

3.2.3. Company average development (Runoff Measure)

We construct the Company average development measure (i.e. the runoff measure) by following Feldblum (1996). For each LOB, the Company average development measure is defined as the ratio of the sum of developed incurred losses across the nine AYs prior to the current year to the sum of incurred losses at the initial statement dates for the nine AYs prior to the current year.[11] As the LOB-level runoff measure is quite volatile, we winsorized the runoff measure at the 5% and 95% level to ensure that there are no extreme values. The data used to construct the runoff measure is extracted from Part 2 of Schedule P.

3.2.4. LOB real yield rate

The difference between the real investment gains and assumed investment gains in either the RBC or the tax regime may affect insurers' behavior in reserve management. Because the IRS uses a 60 month moving average of Federal Midterm Rate as the yield rate to discount loss reserves,[12] we therefore use the average investment yield over year t-4 to year t to proxy for the real investment yield for each LOB. The annual investment yield rate is calculated as the sum of investment gains attributed to capital and surplus and investment gains attributed to insurance transactions, scaled by the net premium earned (NPE) for each LOB. Only LOBs with positive NPE are included and we also winsorized the annual yield rate at the 5% and 95% level to make sure there are no extreme values. The data is extracted from the Insurance Expense Exhibit (IEE).

3.2.5. Payment speed measure

We calculate the payment speed for each LOB and for each firm.[13] We first determine the payment patterns using a similar method used by the IRS (Feldblum 2002), but differs in three aspects. First, the payout pattern is determined by comparing paid losses to incurred losses across AYs and LOBs, using the firm's own loss experience, instead of the industry level data. Second, we capped the payment period to 10 years, whereas IRS have some adjustments for time period extensions. Third, we use the flat 5% yield rate to discount future loss payments, instead of the past 60 month moving average of the Federal Midterm Rate. The reported paid losses or unpaid losses are negative in some AYs for some observations. We drop Firm-LOB-Year observations that have more than 3 such cases out of 10 AYs. We then defined the payment speed measure as the negative of the payment duration. The data used to construct the payment speed measure is extracted from Part 1 of Schedule P.

3.2.6. The initial incurred losses variable

Because we scale the REs by the initial incurred losses, the result may be due to a relationship with the denominator and not the numerator. In response, we include the logarithm of the initial incurred losses as a control variable. The data to construct the initial incurred losses is extracted from Part 2

[11] See Appendix 2 for an example.
[12] Please refer to the Internal Revenue Bulletin.
[13] See Appendix 2 for an example.

of Schedule P.

3.3. Firm-level variables

3.3.1. Tax shield

The literature uses the tax shield (i.e., an approximation for the level of taxable income) to measure the firm's tax saving incentives (Grace 1990). Specifically, a higher tax shield ratio implies a stronger incentive for insurers to save on taxes. The tax shield ratio is defined as:

$$TaxShield = \frac{Net\ Income + (Losses\ \&\ loss\ adjustment\ expense\ reserves)}{Total\ Asset}$$

3.3.2. RBC ratio

The RBC ratio is used to measure the insurers' incentives in improving their solvency. As a lower RBC ratio is associated with a higher regulatory costs, we expect firms with a lower RBC ratio to have stronger incentives to improve their RBC position. We measure adequacy of the RBC by taking the nature logarithm of the insurer's RBC ratio (Ellul et al. 2015; Ellul, Jotikasthira, and Lundblad 2011).

3.3.3. Income smoothing incentives

Following prior literature (e.g., Grace 1990; Grace and Leverty 2013), we use average return on assets (ROA) across the previous 3 years to measure insurers' income smoothing incentives.

3.3.4. Rate regulation measure

We construct a rate regulation index that captures the level of regulation faced by each LOB of each insurer (Grace 1990; Grace and Leverty 2012, 2013). Using data from the NAIC's Compendium of State Laws on Insurance Topics, we calculate the following variable:

$$PreReg = \frac{\sum_{i,s,t,l} PW_{istl} \times STR_{stl}}{\sum_{i,s,t,l} PW_{istl}}$$

where PW_{istl} represents the total premiums written by each insurer i, in state s, for each LOB l, in year t. STR_{stl} is an indicator variable that takes the value of one if stringent regulation is adopted in state s, for each LOB l, in year t, and zero otherwise. This means that the regulation variable *PreReg* is the share of business written by each insurer that is subjected to a stringent regulatory regime.

3.3.5. Other firm-level control variables

Following prior literature (Grace and Leverty 2012; Kamiya and Milidonis 2016), we control for the set of nondiscretionary variables that reflect the firm's organizational structure and business characteristics. In terms of organizational structure, we prepare two variables, *Mutual* and *Group*. *Mutual* is an indicator variable that takes the value of one if the firm is a mutual insurer, and zero otherwise. *Group* is an indicator variable that takes the value of one if the insurer is an affiliated firm of an insurance group, and zero otherwise. The size of the insurer is defined to be the natural logarithm of the total admitted assets (*LnAsset*). The economic condition of an insurer is evaluated by the premium growth rate (*NPWGrowth*). In order to control for the effect of ceded businesses, we further include *Reinsurance*, given by the proportion of gross premiums written ceded to reinsurers.

We also control for business characteristics with three variables. First, loss developments for long-tailed LOBs have a high volatility which in turn influences the insurer's loss reserving decisions. Thus, we include the proportion of businesses written in long-tailed lines (*Long-tail*) as one of our control variables.[14] Next, to measure the business concentration of each firm, we construct the LOB Herfindahl-Hirschman Index (*Lob Herfindahl*), which is defined as the sum of squared ratio of the direct premium written in each LOB to the total premium written in all LOBs. Specifically, a value of 1 implies that the insurer focuses on a single LOB. Finally, we control for the geographic concentration of the insurer's business by constructing the geographic Herfindahl-Hirschman Index (*Geo Herfindahl*), which is defined as the sum of squared ratio of the direct premium written in each state to the total premium written in all states.[15] Specifically, a value of 1 implies that the insurer only writes business in a single state.

4. Data and Sample

4.1. Sample construction

Our sample space begins with all affiliated and unaffiliated single P&C insurers that file annual reports to the NAIC. We extract data from Schedule P and relevant information from the NAIC Annual Statements from 1996 to 2017. As the construction of the RE variable in the current year requires the associated loss development over the five subsequent years, our sample excludes observations in the most recent five years and this yields a time series sample that runs from 1996 to 2012. Furthermore, as the LOB yield measure in the current year is given by the average investment return over the most recent five years, our sample excludes observations in the first four years and this yields a final time series sample that runs from 2000 to 2012.

At the LOB-level, we drop LOB-year observations with negative initial incurred losses estimation. We also drop LOB-year observations with negative revised incurred losses or cumulated paid losses five years later. We also exclude LOB-year observations with non-positive net premiums written from our sample. As the RE variable at the LOB-level is more volatile than that at the firm-level, we trim the bottom and top one percent of the RE measure. At the firm-level, we only include

[14] *Long-tail* is calculated by taking the ratio of aggregated non-negative direct premiums written in long-tailed LOBs to the aggregated non-negative direct premiums written in all LOBs. Long-tailed LOBs include farm owners' multiple perils, homeowners' multiple perils, commercial multiple peril (non-liability portion and liability portion), medical malpractice (occurrence and claims-made), workers' compensation, product liability (occurrence and claims-made), automobile liability and "other" liability.

[15] Both the *Lob Herfindahl* and *Geo Herfindahl* variables are calculated based on non-negative direct premiums written.

insurers with positive admitted assets and positive direct premiums written. Furthermore, as our focus is on reserves management across LOBs, we drop firm-year observations with only a single LOB. Finally, we winsorized all continuous variables at the 1% and 99% level.

4.2. The classification of LOBs

The LOBs in our regression model is based on Schedule P. However, we find that the classification of LOBs is not always consistent with IRS, RBC and Insurance Expense Exhibit (IEE), where we extract tax information, industry worst case factor, and investment yield information, respectively. Therefore, we convert the LOBs from IRS, RBC and IEE to the classification used in Schedule P.

First, as Schedule P's classification is more refined than that of IRS and RBC,[16] we apply the same set of tax discount factors and industry worst case factors from IRS and RBC, respectively, to all their corresponding Schedule P's LOBs. Second, there is a many to many (m: n) mapping from IEE LOBs to Schedule P LOBs. For LOBs that can be mapped one to many (1: m) from IEE to Schedule P, we use the same adjustment as we did for RBC and IRS LOBs. For LOBs that can be mapped many to one (m: 1) from IEE to Schedule P, we aggregate the data in IEE LOBs under the same Schedule P LOB to calculate the investment yield, and apply that to the Schedule P LOB.

4.3. Summary statistics

Our final sample consists of 13 LOBs based on Schedule P and these 13 LOBs report 10 years of loss development in Schedule P. Our sample includes 45,197 Firm-LOB-Year observations, and 1,216 unique insurers from 2000 to 2012. Panel A of Table 1 shows the distribution of our observations across Schedule P LOBs. The LOB with the highest frequency is *Other liability-Occurrence* with 7,550 observations, followed by *Homeowner, Farmowner* with 6,278 observations.

Panel B of Table 1 reports the descriptive statistics of our sample. In terms of LOB-level variables, the average (median) reserve error (*RE)* is 0.014 (0.016), which implies an overestimation of reserves by the average (median) LOB. The tax discount factor (*TaxDisct*), which is used by IRS to calculate discounted loss reserves, has an average (median) of 89.623% (90.619%). The industry worst case factor (*WorstCase*) (i.e., RBC risk factor), which is provided by NAIC, has an average (median) of 0.349 (0.310). The runoff factor (*Runoff*) (i.e., firm average development factor), which is used to adjust the industry worst case factor according to each insurers' loss experience, has an average (median) of 0.98 (0.979). The payment speed (*PaySpeed*), which is the negative of Macaulay Duration of loss payment, has a mean (median) value of -1.63 (-1.34). This means that considering the time value, the average (median) unpaid loss reserves will be paid off fully after 1.63 years (1.34 years). The investment yield (*Yield*) for the LOBs is calculated as the investment gain scaled by net premiums written using data from IEE and has an average (median) of 0.211 (0.135). The average (median) of initial incurred losses estimate (*Initial IL*) for LOBs is $199,278 ($26,619) thousands.

[16] I.e., A 1:m mapping from IRS and RBC to Schedule P LOBs.

For the hypothesized incentives' measures, tax shield (*Taxshield*) has a mean (median) value of 0.365 (0.368). The average (median) RBC ratio in our sample is 9.08 (7.45). The three year average ROA (*Smth*) has a mean (median) value of 0.026 (0.026). The average (median) ratio of premiums written under stringent rate regulations (*PreReg*) is 0.426 (0.397).

In terms of firm-level control variables, the average (median) observation in our sample cedes about 42.5% (39.4%) of their gross premiums written to the reinsurers (*Reinsurance*). The average (median) net premiums growth (*NPWGrowth*) is 5.60% (3.40%). On average, mutual firms (*Mutual*) own about 25.3% LOBs observations in our sample while 83.5% of LOBs in our sample belongs to an affiliated insurer of an insurance group (*Group*). The average firm in our sample has an asset value (*Admit Assets*) of $1.867 billion. The average LOB Herfindahl-Hirschman index (*Lob Herfindahl*) is 0.324 while the average Geographic Herfindahl-Hirschman index (*Geo Herfindahl*) is 0.410. Furthermore, the average observation write 75% of direct premiums in long-tailed LOBs (*Longtail*).

Finally, for the first accident year-LOB variables, the average reserve error in AY0 (*REAY0*) in the sample is 0.058, which is higher than the calendar year average RE. This is reasonable as the calendar year reserves consist of all historical AYs, and that the RE is decreasing in the loss development period. In addition, the average initial estimate of incurred losses in AY0 (*Initial IL AY0*) is $33,423 thousands.

5. Empirical methodology and results

5.1. Tax incentives and REs across LOBs

5.1.1. Baseline model

In order to test hypothesis 1, we employ the following Firm-LOB-Year regression model for LOB *j* of insurer *i* in year *t*:

$$\begin{aligned} RE_{ijt} = \alpha_0 &+ \beta_1 TaxDisct_{ijt} * Taxshield_{it} + (\beta_2 WorstCase_j) + \beta_3 TaxDisct_{ijt} + \beta_4 Runoff_{ijt} \\ &+ \beta_5 PaySpeed_{ijt} + \beta_6 Yield_{ijt} \\ &+ \beta_7 \text{Ln}(Initial\ IL)_{ijt} + \theta_1 Taxshield_{it} + \theta_2 Ln(RBC\ Ratio)_{it} + \theta_3 Smth_{it} \\ &+ \theta_4 PreReg_{it} + \gamma_x X_{it} + Firm\ FE + (LOB\ FE) + Year\ FE + \varepsilon_{ijt} \end{aligned} \tag{3}$$

Our dependent variable is the signed RE measure which is used to measure insurers' reserves management across LOBs. Our explanatory variables include both LOB-level and firm-level variables. The LOB-level variables are based on the IRS tax regime (*TaxDisct*, *PaySpeed*) and Equation (2) where we included variables used in the RBC calculation (*WorstCase*, *Runoff*, *Yield*). We also control for the initial loss estimate (*Ln (Initial IL)*) to ensure that our results are not driven by the denominator. The firm-level variables consist of the incentive measures (*Ln (RBC Ratio)*, *Taxshield*, *Smth*, *PreReg*) used in prior literature, and a set of firm-level control variables X_{it} as described in section 3.3.5. Appendix 3 provides detailed descriptions of all the variables.

We include both year- and firm-fixed effects in our models. Specifically, firm-fixed effects serve to control for time-invariant differences in RE practices across firms. However, a potential concern is that the differences we document across LOBs is attributed to specific LOB characteristic. Therefore, we introduce LOB-fixed effects to control for the unobservable factors that are specific to individual LOBs (e.g., some lines have relatively long development period, or are more likely to be subjected to legal changes). In addition, as our research setting is based on Firm-LOB-Year regressions, it is important to double cluster the standard errors by firm and LOB to account for the correlation of the error terms for observations that share the same LOB or are from the same firm (Petersen 2009).

We are primarily interested in β_1 (i.e., the coefficient of the interaction term) as it captures how insurers with different tax saving incentives will manage reserves in response to the tax discount factor. Based on hypothesis 1, where insurers with stronger tax saving incentives are more likely to overestimate loss reserves in LOBs with a higher tax discount factor, we expect β_1 to be positive.[17]

Column 1 and 2 of Table 2 reports the results of how insurers' tax saving incentives affect their reserve management across different LOBs. In column 1, we include firm- and year-fixed effects. In column 2, we further control for the LOB-fixed effects. We observe that in column 1, the coefficient of the interaction term *TaxDisct**Taxshield* is significantly positive. This implies that insurers with a higher tax shield (i.e., a stronger tax saving incentive) tends to overestimate more loss reserves in LOBs with larger tax discount factors. The results continue to hold even after controlling for the unobservable LOB-specific factors in column 2.

Furthermore, our results are economically significant. From column 1, given that the insurer's tax shield is at the first quartile of the distribution, and that LOB A has a tax discount factor which is 4.41% higher than that of LOB B (i.e., a one standard deviation difference in *TaxDisct*), LOB A will have a RE that is 0.004 lower than that of LOB B.[18] If the insurer's tax shield increases to the third quartile of the distribution, LOB A will have a RE that is 0.016 higher than that of LOB B.[19] The change in the difference of RE translates to approximately 142.9% of the average value of RE in our sample.[20]

In terms of the LOB-level control variables, we find that the coefficient of *WorstCase* is significantly negative, which implies that LOBs with a higher RBC risk factor are associated with an underestimation in REs. Likewise, the coefficient of *PaySpeed* is significantly negative, which implies that LOBs with a faster payment speed is associated with an underestimation in REs. In terms of the firm-level control variables, we find that the coefficient of *Geo Herfindahl* and *Longtail* is significantly positive and significantly negative, respectively. This means that more

[17] Furthermore, as discussed in section 2.1, a higher tax discount factor implies a faster payment speed of the LOB which is associated with a lower *absolute* RE. Therefore, we do not have any prior expectation on β_3.

[18] -0.004=(-0.0067)*4.41+0.0219*4.41*0.263. -0.0067 is the coefficient of *TaxDisct* in column 1. 4.41 is one standard deviation of *TaxDisct*. 0.0219 is the coefficient of *TaxDisct**Taxshield*. 0.263 is the 25th percentile of *Taxshield* in our sample.

[19] 0.016=(-0.0067)* 4.41+0.0219*4.41*0.47, where 0.47 is the 75th percentile of *Taxshield* in our sample.

[20] 142.9%=100%*(0.016-(-0.004))/0.014, where 0.014 is the average value of RE in our sample.

geographically-concentrated LOBs and longer-tailed LOBs are associated with an overestimation and underestimation in REs, respectively.

5.1.2. Cash holdings and tax saving incentives

As discussed in hypothesis 3, managing reserves across different LOBs based on the tax discount factor is a type of nonconforming earnings management which can result in greater book-tax differences (Badertscher et al. 2009). Therefore, this behavior helps the firm to postpone tax payments and build up their contemporaneous cash holdings. In response, we use this behavior to improve on the identification of our tests. Specifically, we provide additional evidence by examining whether cross-sectional variation in cash holdings attenuate the relationship between tax saving incentives and reserve management across different LOBs. Edwards, Schwab, and Shevlin (2016) find that financially constrained firms increase internally generated funds via tax planning strategies, and that this relationship is attenuated when firms hold higher level of cash.

We augment regression model (3) with the triple interaction term *CashHoldings *TaxDisct*Taxshield*. Following Edwards, Schwab, and Shevlin (2016), the level of cash holdings is given by the ratio of cash and cash equivalents to total assets. The results are presented in columns 3 and 4 of Table 2. We document that the coefficient of the triple interaction term becomes significantly negative after we control for LOB-specific factors by including LOB-fixed effects in column 4. The result implies that the positive relationship between tax saving incentives and reserve management arising from the variation in tax discount factors across different LOBs is weakened when insurers have a higher level of cash holdings. This lends credence to our argument that tax incentives drive insurers to manage reserves across different LOBs.

5.2. RBC incentives and REs across LOBs

In order to test hypothesis 4, we employ the following Firm-LOB-Year regression model for LOB *j* of insurer *i* in year *t*:

$$\begin{aligned} RE_{ijt} = \alpha_0 &+ \beta_1 WorstCase_j * Ln(RBC\ Ratio)_{it} + (\beta_2 WorstCase_j) + \beta_3 TaxDisct_{ijt} \\ &+ \beta_4 Runoff_{ijt} + \beta_5 PaySpeed_{ijt} + \beta_6 Yield_{ijt} \\ &+ \beta_7 \mathrm{Ln}(Initial\ IL)_{ijt} + \theta_1 Taxshield_{it} + \theta_2 Ln(RBC\ Ratio)_{it} + \theta_3 Smth_{it} \\ &+ \theta_4 PreReg_{it} + \gamma_x X_{it} + Firm\ FE + (LOB\ FE) + Year\ FE + \varepsilon_{ijt} \end{aligned} \quad (4)$$

The model is similar to that of regression model (3), but the interaction term is now given by *WorstCase*Ln (RBC Ratio)*. We are primarily interested in β_1 (i.e., the coefficient of the interaction term) as it captures how insurers with different RBC increasing incentives will manage reserves in response to the RBC risk factor. Based on hypothesis 4, where insurers with stronger incentives to increase their RBC ratio are more likely to underestimate (overestimate) loss reserves in LOBs with a higher (lower) industry worst case factor, we expect β_1 to be positive. Furthermore, as the underlying rationale of the RBC is that more risky LOBs (i.e., the risk of underestimating reserves) should be assigned a higher RBC risk factor, we expect β_2 to be negative when we include firm-fixed effects.[21]

Table 3 reports the results of how insurers' RBC increasing incentives affect their reserve management across different LOBs. In column 1, we include firm- and year-fixed effects. In column 2, we further control for the LOB-fixed effects. We observe that in column 1, the coefficient of the interaction term *WorstCase*Ln (RBC Ratio)* is significantly positive. This implies that insurers with a lower RBC ratio (i.e., a stronger incentive to increase their RBC ratio) tends to underestimate more loss reserves in LOBs with larger RBC risk factors. The results continue to hold even after controlling for the unobservable LOB-specific factors in column 2.

Furthermore, our results are economically significant. From column 1, given that the insurer's RBC ratio is at the third quartile of the distribution, and that LOB A has an industry worst case factor which is 0.135 higher than that of LOB B (i.e., a one standard deviation difference in *WorstCase*), LOB A will have a RE that is 0.025 lower than that of LOB B.[22] If the insurer's RBC ratio decreases to the first quartile of the distribution, LOB B will have a RE that is 0.038 lower than that of LOB A.[23] The change in the difference of RE translates to approximately 100% of the average value of RE in our sample.[24]

To further test whether insurers are indeed managing reserves to avoid regulatory attention, we study whether insurers with a RBC ratio that is nearer to the regulatory threshold are more active in managing their loss reserves across different LOBs. Specifically, we replace the RBC measure *LN (RBC ratio)* in regression model (4) with a dummy variable *RBC Bottom 5%,* which takes the value of one if the observation's RBC ratio fall within the bottom five percent of the RBC ratio distribution, and zero otherwise.[25]

The results are presented in columns 3 and 4 of Table 3. In column 3, we include firm- and year-fixed effects. In column 4, we further control for the LOB-fixed effects. We document that the coefficient of the interaction term is significantly negative in both columns. The results imply that insurers with a RBC ratio that is nearer to the regulatory threshold are more active in managing their loss reserves, where these insurers underestimate more loss reserves in LOBs with a higher RBC risk factor. Our findings are consistent with the evidence documented by Hoyt and McCullough (2010). They propose that insurers are manipulating reserves to meet RBC requirements, as they find that insurers with a RBC ratio that falls below 2 report a lower IBNR reserves after 1994 when the RBC regime is introduced.

Our results are related to the discussion on whether weak insurers are gaming the solvency system. The accounting literature argues that insurance companies game the IRIS system by underestimating

[21] Notice that if we include LOB-fixed effects, the variable *WorstCase* would be omitted as it will be absorbed by the LOB-fixed effects.

[22] 0.025=(-0.5087)*0.135+0.1371*2.36*0.135. -0.5087 is the coefficient of *WorstCase* in column 1. 0.135 is one standard deviation of *WorstCase*. 0.1371 is the coefficient of *WorstCase*Ln (RBC Ratio)*. 2.36 is the 75th percentile of *Ln (RBC Ratio)* in our sample.

[23] 0.038=(-0.5087)*0.135+0.1371*1.65*0.135, where 2.36 is the 25th percentile of *Ln (RBC Ratio)* in our sample.

[24] 100%=100%*(0.038-0.025)/0.014, where 0.014 is the average value of RE in our sample.

[25] The threshold for the bottom 5% of the RBC ratio distribution in our sample is 3.086. Recall that the company action level RBC ratio is 2. We have zero observations with a RBC ratio that falls below 2.

reserves so that they can report less than three IRIS violations and be able to avoid regulatory attention (e.g., Petroni 1992; Gaver and Paterson 2004). Harrington and Danzon (1994) propose that this behavior may be related to the moral hazard issue. Weak insurers have incentives to underestimate loss reserves due to limited liability and the presence of risk-insensitive guaranty funds. However, as 8 of the 12 IRIS ratios are mechanically improved by underestimating the loss reserves, Grace and Leverty (2012) document that "weak insurers under reserve because they are weak and not necessarily they are attempting to deceive the regulators."

We carefully explore the design of the RBC regime (i.e., a type of solvency regime) coupled with the Firm-LOB-Year sample. We document that weak insurers indeed manage reserves across LOBs in a systematic way to increase their low RBC ratio. Our results complete the work by Grace and Leverty (2012) and show that weak insurers do attempt to avoid regulatory attention by gaming the RBC system. As rightfully pointed out by Grace and Leverty (2012), this behavior by insurers is relatively difficult to detect using the traditional firm-level setting.

5.3. Tax incentives and REs across AYs

We argue in section 2.1 that insurers with stronger tax saving incentives are more likely to manipulate loss reserves across both LOBs and AYs. Thus far, our results provide robust evidence for reserves management across LOBs. In this section, we provide evidence of reserves manipulation across AYs.

We continue to use the Firm-LOB-Year sample, but we make three modifications to regression model (3). First, we replace the dependent variable with the REs in AY0 (*REAY0*), which is the most recent AY on the reporting date (The calendar year loss reserves are composed of loss reserves across all historical accident years). The most recent AY (AY0) on the reporting date is the reporting year.[26] Second, we interact the different managerial incentive measures with the calendar year dummies. Third, we replace the control variable natural logarithm of the initial incurred losses estimate (*Ln (Initial IL)*) with the natural logarithm of the initial incurred losses in AY0 (*Ln (Initial IL AY0)*) to control for the denominator effect.

Specifically, in order to test hypothesis 2, we employ the following Firm-LOB-Year regression model for LOB *j* of insurer *i* in year *t*:

$$
\begin{aligned}
REAY0_{ijt} = \alpha_0 &+ \sum_{t=2001}^{2012} \beta_{t1}\, Taxshield_{it} * year_t + \sum_{t=2001}^{2012} \beta_{t2}\, Ln\ (RBC\ Ratio)_{it} * year_t \\
&+ \sum_{t=2001}^{2012} \beta_{t3}\, Smth_{it} * year_t + \beta_4 TaxDisct_{ijt} + \beta_5 Runoff_{ijt} \\
&+ \beta_6 PaySpeed_{ijt} + \beta_7 Yield_{ijt} \\
&+ \beta_8 Ln(Initial\ IL\ AY0)_{ijt} + \theta_1 Taxshield_{it} + \theta_2 Ln(RBC\ Ratio)_{it} \\
&+ \theta_3 PreReg_{it} + \theta_4 Smth_{it} + \gamma_x X_{it} + LOB\ FE + Firm\ FE + Year\ FE + \varepsilon_{ijt}
\end{aligned}
$$

[26] For example, if the reporting date is 12.31.2015, the AY0 is given as 2015. See Appendix 2 for more details.

(5)

As we employ the most recent accident year (AY0), this means that the calendar year is the same as the AY. Furthermore, we argued in section 2 that only tax incentives will drive insurers to manipulate reserves across AYs while RBC incentives and income smoothing incentives will not. Therefore, we expect β_{t1} to be significantly different from zero and do not expect β_{t2} and β_{t3} to be significantly different from zero.

The sample size is smaller than our earlier regression models for two reasons. First, in order to avoid the effect of extreme values, we trim our sample at the top and bottom 1% of the distribution of the new dependent variable (*REAY0*). Second, observations with negative initial incurred losses in AY0 is dropped (*Initial IL AY0*) as this is the denominator of *REAY0*. This implies that observations may have positive combined initial incurred losses across all historical AYs but not necessarily have positive initial incurred losses in AY0. In addition, recall that our sample runs from 2000 to 2012 and that we include year-fixed effects. This implies that the interaction terms span from 2001 to 2012.

The results are presented in Table 4 and we continue to document evidence that is consistent with our hypothesis. Specifically, on the one hand, we observe that most of the coefficients for the interaction terms between tax incentives (*Taxshield*) and calendar year dummies are significant at the 1% level. On the other hand, we document that almost none of the coefficients for the interaction terms between calendar year dummies and RBC incentives (*Ln (RBC Ratio)*) or income smoothing incentives (*Smth*) are significant.

Hypothesis 2 also suggests that insurers will overestimate more loss reserves in AYs with a lower yield rate which implies a negative relationship between yield rate and the β_{t1} coefficient estimated from regression model (5). Figure 1 presents the time-series plot of the β_{t1} coefficients and the time-series plot of the yield rate provided by the IRS.[27] We observe that there is an initial decrease in the yield rate from 2001 to 2006, followed by a relatively stable yield rate from 2006 to 2010, and continued to decrease again from 2010 to 2012. We also observe that there is an initial increasing trend in β_{t1} from 2001 to 2005, followed by a decreasing trend from 2005 to 2010, and continued to increase again after 2011. Taken together, figure 1, to some extent, provides additional evidence that lends support to hypothesis 2.

6. Additional evidence based on the classification of LOB

As mentioned in section 4.2, the classification of LOBs between Schedule P and that in IRS, RBC and IEE is not always consistent. In this section, we exploit this inconsistency as an identification tool that allows us to document additional evidence of reserves management by insurers across different LOBs. We are able to identify specific LOBs that can be subdivided into LOBs that have the same *TaxDisct* (*WorstCase*) and different *WorstCase* (*TaxDisct*). This allows us to isolate the

[27] As discussed in section 2.1, the yield rate provided by the IRS is the sixty-month moving average of Federal Midterm Rate, ending on the December 1st preceding the AY.

effect of tax saving incentives and RBC increasing incentives which serves as a robustness test for hypothesis 1 and hypothesis 4, respectively.

6.1. 1:M mapping from IRS LOBs to RBC LOBs

In this section, we provide robust evidence for hypothesis 4 by focusing on LOBs that have the same *TaxDisct* but different *WorstCase*. Specifically, the LOB "Multiple Peril Lines" is defined as a single LOB by the IRS but is subdivided into three LOBs by the RBC regime. These three LOBs are "Homeowners/ Farmowners", "Commercial Multiple Peril", and "Special Liability". This implies that these three subdivided LOBs have the same *TaxDisct* but different *WorstCase*.

In our analysis, we first sort insurers into quintiles based on their *RBC ratio* for each year of observation. We then calculate the simple average of the REs across all insurers within the same quintile for each of the three LOBs.

Our results are reported in Panel A of Table 5. We document that insurers with the lowest RBC ratio (i.e., insurers in the first quintile of the RBC Ratio distribution) tend to underestimate more loss reserves in the LOB "Commercial Multiple Peril", which is also the LOB with the highest *WorstCase*, relative to other insurers with a higher RBC ratio. Specifically, insurers in the first and second quintile of the RBC Ratio distribution underestimated loss reserves in the LOB "Commercial Multiple Peril" by 0.0103 and 0.0058, respectively. This lends credence to our hypothesis that insurers with stronger incentives to increase their RBC ratio (i.e., insurers in the bottom quintiles of the RBC distribution), tend to underestimate more loss reserves in LOBs that have a higher *WorstCase*.

6.2. 1:M mapping from RBC LOBs to IRS LOBs

In this section, we provide robust evidence for hypothesis 1 by focusing on LOBs that have the same *WorstCase* but different *TaxDisct*. Specifically, the LOB "Other liability" is defined as a single LOB by the RBC regime but is subdivided into two LOBs by the IRS. These two LOBs are "Other liability-Occurrence" (OL-O) and "Other liability-Claims Made" (OL-CM). This implies that these two subdivided LOBs have the same *WorstCase* but different *TaxDisct*.

In our analysis, we first sort insurers into quintiles based on their *Taxshield* for each year of observation. Furthermore, as *TaxDisct* is a time-varying variable, we further subdivide the sample into two groups. Specifically, the first (second) group consists of observations whose *TaxDisct* for LOB OL-O (OL-CM) is greater than that of OL-CM (OL-O). We then calculate the simple average of the REs across all insurers within the same quintile for each of the two LOBs in their respective groups.

Our results are reported in Panel B1 of Table 5, where the upper and lower section presents results for the first and second group, respectively. In the upper section, where the *TaxDisct* for LOB OL-O is greater than that of OL-CM, we document that insurers with the highest *Taxshield* (i.e., insurers in the top quintile of the *Taxshield* distribution) tend to underestimate relatively less loss reserves in the LOB OL-O than the LOB OL-CM. Specifically, insurers in the top quintile of the *Taxshield* distribution underestimated loss reserves in the LOB OL-O by 0.0041, which is smaller than the 0.0071 underestimation in the LOB OL-CM. Furthermore, in the lower section, where the *TaxDisct* for LOB OL-O is now smaller than that of OL-CM, we document that insurers with the highest *Taxshield* (i.e., insurers in the top quintile of the *Taxshield* distribution) changed their behavior by overestimating relatively more loss reserves in the LOB OL-CM than the LOB OL-O. Specifically, insurers in the top quintile of the *Taxshield* distribution overestimated loss reserves in the LOB OL-CM by 0.0488, which is greater than the 0.0125 overestimation in the LOB OL-O. These results provide interesting evidence of how insurers selectively overestimate more, or underestimate less, in LOBs that have a higher *TaxDisct*.

In addition, apart from the LOB "Other liability", the LOB "Products liability" is also defined as a single LOB by the RBC regime but is subdivided into two LOBs by the IRS. These two LOBs are "Products liability-Occurrence" (PL-O) and "Products liability-Claims Made" (PL-CM). Therefore, we conduct a similar analysis and the results are presented in Panel B2 of Table 5. In the upper section, we expect insurers in the top quintile of the *Taxshield* distribution to overestimate more, or underestimate less, in the LOB PL-O than that in LOB PL-CM, but we do not document consistent results. It may be caused by the fact that the LOB PL-CM is intrinsically more likely to be overestimated than PL-O. Thus we use the analysis method similar to the Difference in Difference (DID).

In the upper section of Panel B2, the difference of average REs between PL-CM and PL-O is 0.1173 (=0.092-(-0.0249)) for insurers at the bottom quintile of the *Taxshield* distribution, whereas it is 0.1624 (=0.0725-(-0.0899)) for insurers at the top quintile of the *Taxshield* distribution.

In the lower section where the *TaxDisct* for the LOB PL-CM is now larger than that of PL-O, the difference of average REs between PL-CM and PL-O is 0.0449 for insurers at the bottom quintile of the *Taxshield* distribution, whereas it is 0.3526 for insurers at the top quintile. We can observe that the gap of REs between PL-CM and PL-O becomes larger (0.3526>0.1634) for insurers at the top quintile of the *Taxshield* distribution, while the gap become smaller (0.0449<0.1173) for insurers at the bottom quintile. It implies that insurers with higher tax-saving incentives relatively increase the overestimation in LOB PL-CM than the LOB PL-O.

Taken together, our results lend credence to hypothesis 1 where insurers with stronger tax saving incentives (i.e., insurers in the top quintile of the *Taxshield* distribution), tend to overestimate more, or underestimate less, loss reserves in LOBs that have a higher *TaxDisct*.

7. Auditor types and reserve manipulation

There is a growing literature discussing the impacts of corporate governance on reserve management. These studies find that actuarial and auditor independence (e.g., Kelly, Kleffner, and Li 2012; Grace and Leverty 2013; Kamiya and Milidonis 2016), board structures (Hsu, Huang, and Lai 2018) play important roles in reserve management. However, we know less about through which channel these internal and external monitoring mechanisms work. Do they monitor either RBC-improving or tax-saving reserve management, or both? In this section, we investigate the impact of auditor types (i.e., Big four[28] and Non-Big four) on insurers' reserving practice.

In terms of mangers' RBC ratio-improving strategies, if the Big four auditors are able to limit managerial discretion, we should find that RBC improving strategies will be less used in insurers with Big four auditors.

In terms of mangers' tax-saving strategies, it is not straightforward. On the one hand, Big four auditors can monitor the accuracy of reserves and limit mangers' ability in doing tax-saving type reserve manipulation. On the other hand, auditors may also provide tax consulting services. Big four auditors can combine their financial and tax expertise and thus may help their tax clients improve their tax strategies (McGuire, Omer, and Wang 2012).

We collect the information of insurers' audit firms from their NAIC annual statements. The auditor information is available from 2005 to 2012. We partition our main sample into two subsamples based on whether the auditors are Big four auditors or not. We run the same regressions in both subsample. Results are presented in Table 6.

In terms of insurers' RBC-improving strategies, comparing the results from column 1 with column 2, we can observe that the coefficient of the interaction term *WorstCase*Ln (RBC Ratio)* is only significant in the subsample where the auditors are non-Big four. It implies that the use of Big four auditors are associated with less server RBC-improving reserve manipulation.

We also test insurers' tax-saving strategies across these two subsamples. Results are presented in columns 3 and 4 of Table 6. We can observe that the coefficient of the interaction term *Taxdisct*TaxShield* is significant at 10% level for the subsample of insurers with non-Big four auditors (column 3), while it is not significant for insurers with Big four insurers (column 4). Our results suggest that monitoring effect is stronger than the tax consulting effect in how Big four auditors affect insurers' tax-saving reserve manipulation.

Collectively, the results imply that the Big four auditors have strong ability to reduce managerial discretion in reserve manipulation by limiting insurers' use of both tax-saving and RBC-improving strategies.

8. Conclusion

Our paper studies the question of how insurers manipulate reserves. Specifically, we investigate how managerial incentives affect insurers' reserving practice across LOBs and AYs. As the tax discount factor assigned by the tax authority varies across LOBs and AYs, insurers with stronger tax saving incentives will be more likely to manipulate reserves across both LOBs and AYs. The RBC regime specifies different industry worst case factors across LOBs, thus insurers that are

[28] The big four audit firms are Ernst & Young (EY), Deloitte & Touche, KPMG, and PricewaterhouseCoopers (PwC).

concerned with their low RBC ratio will manipulate reserves along this dimension. In terms of income smoothing incentives, only the overall level (and not the composition) of reserves is of consequence, thus we predict that there will be no similar systematic patterns in reserves manipulation by insurers based on income smoothing incentives.

By using a Firm-LOB-Year sample, we find results consistent with our hypotheses. We finally document that these reserve management strategies are mainly concentrated in insurers using non-Big four auditors, implying that Big four audit firms are able to reduce managerial discretion in reserve management by limiting insurers' use of both tax-saving and RBC-improving strategies. In conclusion, our paper highlights the importance of the analysis of specific strategies insurers used in their reserve manipulation, as it helps to infer managerial incentives documented in prior literature.

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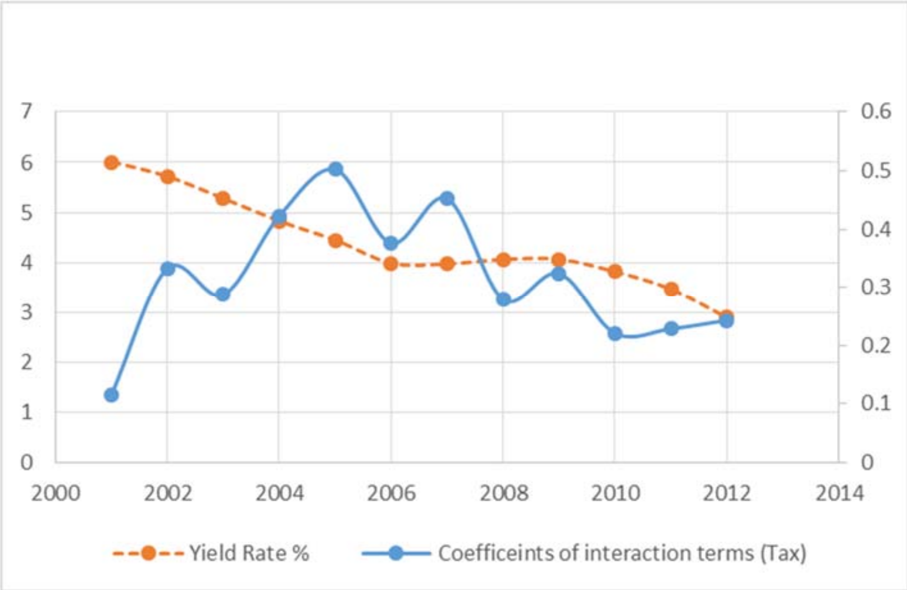
Figure 1.

Figure 1 presents the time-series plot of the coefficients for the interaction terms between *Taxshield* and calendar year dummies. The scale of the y-axis on the right reflects the value of these coefficients. This figure also presents the time-series plot of the yield rate provided by the IRS. The scale of the y-axis on the left reflects the value of these yield rates.



Appendix 1. Tax discount factor provided by the IRS

The table below shows an example of the tax discount factor for AY 2007 and the LOB "Other Liability -- Occurrence" (OL-O).

AY 2007: Other Liability -- Occurrence	
Tax Year	Discount Factors (%)
2007	87.3760
2008	88.3943
2009	90.6775
2010	91.4222
2011	90.8722
2012	90.9863
2013	90.4663
2014	93.1478
2015	95.8515
2016	97.6241

Appendix 2. Construction of variables

We demonstrate how to construct some of our LOB variables using Part 1 and Part 2 of Schedule P.

Table A2.1 is the Part 1 and Part 2 of Schedule P for the Metropolitan P&C Insurance Company's 2014 Annual Statement (NAIC code: 26298).

Schedule P- Part 1- Homeowners/Farmowners			
	(1) Col 11	(2) Col 24	(3)
Yeas in which Losses were Incurred	Total Net Paid	Total Net losses and expenses Unpaid	Total Losses Incurred =Col11+Col 24
Prior	1,025	2,543	3,568
2005	454,141	545	454,686
2006	427,190	657	427,847
2007	434,503	1,987	436,490
2008	611,630	4,583	616,213
2009	526,542	5,644	532,186
2010	607,940	8,876	616,816
2011	866,255	15,805	882,060
2012	723,151	23,022	746,173
2013	645,886	48,677	694,563
2014	613,094	140,568	753,662

Schedule P- Part 2- Homeowners/Farmowners										
	Incurred Net Losses and Defense and Cost Containment Expenses Reported at Year End ($000)									
Yeas in which losses were incurred	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Prior	98,835	88,677	81,349	75,791	72,561	73,106	71,039	69,972	68,943	69,979
2005	435,692	432,201	427,420	403,256	395,400	394,728	394,728	390,907	389,574	389,556
2006		392,958	391,548	378,329	375,924	373,322	370,219	369,839	370,982	370,430
2007			404,421	400,512	390,272	389,761	384,912	383,986	384,717	384,573
2008				577,867	585,882	556,555	549,557	548,143	549,188	548,780
2009					468,274	486,330	476,129	474,573	471,733	469,807
2010						530,394	548,946	549,039	547,059	546,488
2011							827,074	813,773	793,611	791,761
2012								662,871	667,989	660,781
2013									610,387	613,866
2014										662,795

Table A2.2 is the table used to illustrate how to calculate Payment Speed (*PaySpeed*).

(1)	(2) Paid losses	(3) Losses Unpaid	(4) Incurred	(5) Cumulate paid/incurred (2)/(4)	(6) Incremental	(7) Time to pay (t_i)	(8) Discounted Unpaid (PV_i)	(9) Discsounted Total (V)	(10) $t_i * Pv_i / V$
AY+10				100.00%	0.12%	9.5	0.075%	98.86%	0.725%
2005	454,141	545	454,686	99.88%	0.03%	8.5	0.022%		0.191%
2006	427,190	657	427,847	99.85%	0.30%	7.5	0.209%		1.587%
2007	434,503	1,987	436,490	99.54%	0.29%	6.5	0.210%		1.381%
2008	611,630	4,583	616,213	99.26%	0.32%	5.5	0.242%		1.348%
2009	526,542	5,644	532,186	98.94%	0.38%	4.5	0.304%		1.383%
2010	607,940	8,876	616,816	98.56%	0.35%	3.5	0.297%		1.053%
2011	866,255	15,805	882,060	98.21%	1.29%	2.5	1.145%		2.895%
2012	723,151	23,022	746,173	96.91%	3.92%	1.5	3.646%		5.532%
2013	645,886	48,677	694,563	92.99%	11.64%	0.5	11.362%		5.747%
2014	613,094	140,568	753,662	81.35%	81.35%	0	81.349%		0.000%
								MacD	0.218

The table below summarizes the variable construction for some of our LOB variables.

Variable	Description of the variable construction
Reserve Error (*RE*)	The reserve error (*RE*) is calculated using Part 2 of Schedule P. It is equals to the difference between the initial incurred losses and the revised estimate of incurred losses 5 years later, scaled by the initial incurred losses. To calculate the *RE* in 2009, the initial estimate of the incurred losses is the sum of the losses in the column of 2009. It is calculated as 75,791 + 403,256 + … + 577,867 = 2,288,313. The revised estimate of the loss reserves for AY 2009 five years later is found in Part 2, Schedule P of calendar year 2014. It is calculated as 69,979 + 389,556 + … + 469,807 = 2,233,125. Therefore, the reserve error in year 2009 is calculated as (2,288,313 - 2,233,125) / 2,288,313 = 0.0241.
Reserve Error for AY0 (*REAY0*)	The reserve error AY0 (*REAY0*) in year 2009 is calculated using Part 2 of Schedule P. It is called AY0 because in year 2009, accident 2009 is the most recent accident year. The revised estimate of the loss reserves for AY 2009 five years later is found in Part 2, Schedule P of calendar year 2014. Therefore, the reserve error for AY0 in year 2009 is calculated as (468,274 - 469,807) / 468,274 = -0.00327. The initial incurred losses of AY0 (*Initial IL AY0*) is 468,274.
Runoff measure (*Runoff*)	The Runoff Measure or Company Average Development (*Runoff*) is calculated using Part 2 of Schedule P. It is defined as the ratio of the sum of the developed incurred losses for the nine accident years prior to the current year (i.e., current incurred losses) to the sum of incurred losses at the initial statement dates for the nine accident years prior to the current year (i.e., initial incurred losses). In this example, the current incurred losses are the sum of values in the last column of Part 2, excluding the first row (i.e., prior year), (389,556 + 370,430 + 384,572 + … + 662,795) = 5,438,837. The initial incurred losses are the sum of incurred loss estimate in the diagonal of Part 2, Schedule P, excluding the first row, (435,692 + 392,958 + 404,421 + … + 610,387 + 662,795) = 5,572,733. Therefore, the *Runoff* factor for year 2014 equals 5,438,837 / 5,572,733 = 0.976.
Payment Speed (*PaySpeed*)	Payment Speed is calculated using Part 1 of Schedule P. The loss pattern is determined in a similar way as employed by the IRS but differs in three aspects. First, the payout pattern is determined by comparing paid losses to incurred losses across AYs and LOBs, using the firm's own loss experience, instead of the industry level data. Second, we capped the payment period to 10 years, whereas IRS have some adjustments for time period extensions. Third, we use the flat 5% yield rate to discount future loss payments, instead of the past 60 month moving average of the Federal Midterm Rate. Using Part 1 of Schedule P, we determined the payment pattern (see Columns 1-5). Columns 1-4 are from Part 1 (see Table A2.1). We then use the definition of Macaulay duration to solve for the payment duration (*MacD*). The accumulated loss payment pattern is shown in column 5, which is equals to the paid losses in column 2 divided by the losses incurred in column 4. We calculate the incremental

	percentage paid in column 6. These entries are the first difference of the series in column 5. Column 7 presents the time from now to the *i*th payment. Column 8 shows the present value of the *i*th cash payment (PV_i), the annual yield rate for discounting is 5%. Column 9 calculates the present value (V) of all future cash payments, it is the sum of column 8. The payment duration ($MacD$) is calculated as $MacD = \sum_{i=1}^{n} \frac{t_i * PV_i}{V}$. In our example, the payment duration in 2014 is equals to the sum of column 10 and is 0.218. The payment speed is the negative of payment duration, i.e., -0.218. As some of the companies do not have data for all 10 accident years as shown in Part 1 of Schedule P for some LOBs (i.e., some entries in column 2 or 3 in Table A2.2 is missing), or even show zero or negative value for some AYs (i.e., some entries in columns 2 or 3 in Table A2.2 is non-positive). If there are at least three such cases out of the 10 AYs, we drop this observation. We also drop observations with calculated payment duration ($MacD$) that is larger than 10 or smaller than 0.

Appendix 3.

Variables	Definition
LOB-level variables	
RE	Reserve Error. It equals to the difference between initial incurred losses and a revised estimate of incurred losses 5 years later, scaled by the initial incurred losses.
TaxDisct	Tax discount factor. For each AY and LOB, IRS gives a set of discount factors along the future tax years. We average the discount factors across different tax years, weighted by the industry level loss reserves, to yield a single factor for each AY and LOB.
WorstCase	Industry worst case factor, or RBC risk factor. The worst case factors are given by NAIC each year. They are designed to measure the most extreme adverse reserves development in history.
Runoff	The run off measure or the company development factor. It is defined as the ratio of the sum of developed incurred losses for the nine AYs prior to the current year to the sum of incurred losses at the initial statement dates for the nine AYs prior to the current year. See Appendix 2 for an example.
PaySpeed	The negative of payment duration (*MacD*). *MacD* is the Macaulay duration of loss payments according to its loss payment pattern. See Appendix 2 for an example.
Yield	The average investment yield over year *t*-4 to year *t* for each LOB and year. The annual investment yield rate is calculated as the sum of investment gains attributed to capital and surplus and investment gains attributed to insurance transactions, scaled by the net premium earned (NPE) for each LOB. The data is extracted from Insurance Expense Exhibit (IEE).
Initial IL ($000)	The initial incurred losses. The denominator of the reserve error measure (*RE*).
REAY0	Reserve Error in AY0, the most current AY on the reporting date. See Appendix 2 for an example.
Ln (Initial IL) AY0	The natural logarithm of initial incurred losses in AY0. It is the denominator of *REAY0*.

Firm-level variables	
TaxShield	The sum of net income and unpaid loss and loss adjustment expense reserves divided by assets.
Ln (RBC Ratio)	The natural logarithm of the RBC Ratio.
RBC Bottom 5%	Equals to one for observations whose RBC ratios fall within the bottom 5 percent of the RBC ratio distribution, and zero otherwise.
Smth	Previous 3 years' average return on assets (i.e., from year *t*-1 to *t*-3).
PreReg	The percentage of business written that are subjected to stringent rate regulation
CashHoldings	The ratio of insurer's cash and cash equivalents to assets.
Reinsurance	Premiums written ceded to reinsurers scaled by gross premiums written
NPWGrowth	Growth rate in net premiums written.
Mutual	Equals to one if the reporting insurer is a mutual insurer, and zero otherwise

Group	Equals to one if the reporting insurer belongs to a group, and zero otherwise
LnAsset	Natural logarithm of reporting insurer's assets ($000)
Lob Herfindahl	The sum of square ratio of direct (non-negative) premiums written in LOBs to total premiums written. Specifically, a value of 1 implies that the insurer focuses on a single LOB. It is based on all non-consolidated NAIC LOBs on the "Underwriting & Investment" page.
Geo Herfindahl	The sum of square ratio of direct (non-negative) premiums written in each state to total premiums written in all states. Specifically, a value of 1 implies that the insurer only writes business in a single state.
Longtail	The share of direct premiums written in long-tail LOBs. Long-lines LOBs include farm owners' multiple perils, homeowners' multiple perils, commercial multiple peril (non-liability portion and liability portion), medical malpractice (occurrence and claims-made), workers' compensation, product liability (occurrence and claims-made), automobile liability and "other" liability.

Table 1. Summary statistics

Table 1 presents the summary statistics of our Firm-LOB-Year sample. Panel A shows the distribution of our observations across Schedule P LOBs. Panel B presents pooled descriptive statistics on dependent and independent variables used in our regression models. Appendix 3 provides detailed descriptions of all the variables.

Panel A		
ScheduleP Lines	N	Percent
Homeowner, Farmowner	6,278	13.89
Pvt Pass Auto Liab	5,663	12.53
Comm'l Auto Liab	5,952	13.17
Workers' Comp	4,087	9.04
Comm'l Multi Prl	6,026	13.33
Med Prof Liab (Occ)	908	2.01
Med Prof Liab (Claims)	1,030	2.28
Special Liab	1,797	3.98
Oth Liab (Occ)	7,550	16.7
Oth Liab (Claims)	2,792	6.18
International	14	0.03
Product Liab (Occ)	2,513	5.56
Product Liab (Claims)	587	1.3
Total	45,197	100

Panel B								
Variable	N	Mean	S.D.	Min	P25	P50	P75	Max
RE	45197	0.014	0.159	-0.620	-0.032	0.016	0.071	0.479
TaxDisct (%)	45197	89.623	4.412	71.878	87.526	90.619	92.741	96.194
WorstCase	45197	0.349	0.135	0.199	0.206	0.310	0.478	0.627
Runoff	45197	0.980	0.206	0.333	0.904	0.979	1.042	1.629
PaySpeed	45197	-1.631	1.216	-9.552	-2.298	-1.344	-0.730	-0.001
Yield	45197	0.211	0.231	0.026	0.086	0.135	0.231	1.425
Initial IL ($000)	45197	199,278	542,246	84	5,934	26,619	116,397	3,695,627
TaxShield	45197	0.365	0.138	0.067	0.263	0.368	0.470	0.666
RBC Ratio	45197	9.080	6.534	2.017	5.206	7.450	10.658	46.324
Smth	45197	0.026	0.028	-0.061	0.011	0.026	0.041	0.110
PreReg	45197	0.426	0.311	0	0.183	0.397	0.599	1.123
Reinsurance	45197	0.425	0.279	0.002	0.176	0.394	0.662	0.982
NPWGrowth	45197	0.056	0.253	-0.929	-0.026	0.034	0.117	1.403
Mutual	45197	0.253	0.435	0	0	0	1	1
Group	45197	0.835	0.371	0	1	1	1	1
Admit Assets ($000)	45197	1,867,198	5,023,383	6,945	95,755	290,063	1,049,741	31,200,000
Lob Herfindahl	45197	0.324	0.188	0.110	0.192	0.265	0.395	0.960
Geo Herfindahl	45197	0.410	0.358	0.039	0.085	0.276	0.736	1.000
Longtail	45197	0.750	0.177	0.109	0.666	0.765	0.874	1.000
REAY0	44643	0.058	0.340	-1.458	-0.045	0.055	0.196	0.983
Initial IL AY0 ($000)	44643	33,423	89,173	6	966	4,602	20,197	599,680

Table 2. Tax incentives and reserves management across LOBs

Table 2 reports how the variation in the IRS tax discount factors (*TaxDisct*) affect insurers' reserves management behavior across different LOBs. The sample consists of 45,197 Firm-LOB-Year observations from year 2000 to 2012. The dependent variable is the reserve error measure (*RE*), which is equals to the difference between initial incurred losses and a revised estimate of incurred losses five years later, scaled by the initial incurred losses. A positive (negative) value of the *RE* implies an overestimation (underestimation) of the loss reserves. In columns 1 and 2, we study the effects of IRS tax discount factors (*TaxDisct*). In columns 3 to 4, we add the triple interaction term *CashHoldings*TaxDisct*Taxshield*. All continuous variables are winsorized at the 1st and 99th percentiles. Robust standard errors are double clustered by firm and LOB and are reported in parentheses. The superscripts ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

VARIABLES	(1) RE	(2) RE	(3) RE	(4) RE
CashHoldings*TaxDisct*Taxshield			-0.0638	-0.0866**
			(0.0515)	(0.0387)
TaxDisct*Taxshield	0.0219**	0.0246***	0.0236**	0.0267***
	(0.0091)	(0.0064)	(0.0097)	(0.0069)
CashHoldings*TaxDisc			0.0198	0.0243*
			(0.0163)	(0.0132)
CashHoldings*Taxshield			5.4838	7.5539**
			(4.5555)	(3.3847)
WorstCase	-0.2396**		-0.2404**	
	(0.1083)		(0.1084)	
TaxDisct	-0.0067*	-0.0052**	-0.0073*	-0.0059**
	(0.0035)	(0.0023)	(0.0035)	(0.0022)
Runoff	-0.0519***	-0.0517***	-0.0520***	-0.0519***
	(0.0122)	(0.0111)	(0.0121)	(0.0110)
PaySpeed	-0.0301***	-0.0412***	-0.0301***	-0.0412***
	(0.0055)	(0.0038)	(0.0056)	(0.0038)
Yield	-0.0482***	-0.0257	-0.0477***	-0.0247
	(0.0141)	(0.0225)	(0.0139)	(0.0224)
Ln (Initial IL)	-0.0055*	-0.0048**	-0.0055*	-0.0049**
	(0.0030)	(0.0020)	(0.0030)	(0.0021)
TaxShield	-1.8117**	-2.0547***	-1.9515**	-2.2403***
	(0.8051)	(0.5555)	(0.8551)	(0.6019)
Ln(RBC Ratio)	0.0031	0.0005	0.0030	0.0004
	(0.0045)	(0.0048)	(0.0045)	(0.0047)
Smth	-0.0472	-0.0675	-0.0441	-0.0638
	(0.0675)	(0.0647)	(0.0672)	(0.0647)
PreReg	-0.0096	-0.0053	-0.0097	-0.0049
	(0.0133)	(0.0120)	(0.0130)	(0.0117)
Reinsurance	-0.0092	-0.0080	-0.0093	-0.0084
	(0.0096)	(0.0095)	(0.0096)	(0.0095)
NPWGrowth	-0.0047	-0.0053	-0.0050	-0.0056
	(0.0037)	(0.0034)	(0.0038)	(0.0035)
Mutual	0.0177	0.0178*	0.0182	0.0182*
	(0.0100)	(0.0098)	(0.0102)	(0.0100)

Group	0.0084	0.0095	0.0079	0.0089
	(0.0112)	(0.0109)	(0.0110)	(0.0107)
LnAsset	0.0138	0.0126	0.0136	0.0124
	(0.0087)	(0.0084)	(0.0087)	(0.0084)
Lob Herfindahl	0.0215	0.0173	0.0222	0.0179
	(0.0234)	(0.0235)	(0.0229)	(0.0229)
Geo Herfindahl	0.0496***	0.0472***	0.0502***	0.0476***
	(0.0153)	(0.0145)	(0.0151)	(0.0141)
Longtail	-0.0306*	-0.0236	-0.0299*	-0.0228
	(0.0169)	(0.0149)	(0.0168)	(0.0148)
CashHoldings			-1.7114	-2.1127*
			(1.4543)	(1.1669)
Constant	0.5270	0.2930*	0.5806*	0.3581**
	(0.3131)	(0.1571)	(0.3045)	(0.1467)
Observations	45,197	45,197	45,197	45,197
R-squared	0.2719	0.3090	0.2723	0.3097
Firm FE	Yes	Yes	Yes	Yes
LOB FE	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes
SE cluster	Firm&LOB	Firm&LOB	Firm&LOB	Firm&LOB

Table 3. RBC incentives and reserves management across LOBs

Table 3 reports how the variation in RBC risk factors (*WorstCase*) affect insurers' reserves management behavior across different LOBs. The sample consists of 45,197 Firm-LOB-Year observations from year 2000 to 2012. The dependent variable is the reserve error measure (*RE*), which is equals to the difference between initial incurred losses and a revised estimate of incurred losses five years later, scaled by the initial incurred losses. A positive (negative) value of the *RE* implies an overestimation (underestimation) of the loss reserves. The RBC measure is the natural logarithm of the RBC Ratio (*LN (RBC Ratio)*) in columns 1 and 2, and is a dummy variable (*RBC Bottom 5%*) in column 3 and 4. *RBC Bottom 5%* is equals to one for observations whose RBC ratios fall within the bottom 5 percent of the RBC ratio distribution, and zero otherwise. All continuous variables are winsorized at the 1st and 99th percentiles. Robust standard errors are double clustered by firm and LOB and are reported in parentheses. The superscripts ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

VARIABLES	(1) RE	(2) RE	(3) RE	(4) RE
RBC Measure	Ln (RBC Ratio)		RBC Bottom 5%	
WorstCase*RBC Measure	0.1371***	0.1197***	-0.1359***	-0.1379***
	(0.0406)	(0.0358)	(0.0309)	(0.0349)
WorstCase	-0.5087***		-0.2248*	
	(0.1430)		(0.1064)	
TaxDisct	0.0018	0.0048**	0.0022	0.0052**
	(0.0022)	(0.0020)	(0.0022)	(0.0023)
Runoff	-0.0527***	-0.0525***	-0.0530***	-0.0527***
	(0.0122)	(0.0111)	(0.0121)	(0.0112)
PaySpeed	-0.0302***	-0.0402***	-0.0301***	-0.0398***
	(0.0051)	(0.0038)	(0.0052)	(0.0037)
Yield	-0.0572***	-0.0359	-0.0578***	-0.0356
	(0.0146)	(0.0229)	(0.0146)	(0.0224)
Ln (Initial IL)	-0.0058*	-0.0054**	-0.0063**	-0.0060**
	(0.0027)	(0.0021)	(0.0029)	(0.0023)
TaxShield	0.1467***	0.1404***	0.1387***	0.1367***
	(0.0320)	(0.0328)	(0.0330)	(0.0337)
RBC Measure	-0.0425**	-0.0389**	0.0490**	0.0508***
	(0.0164)	(0.0141)	(0.0174)	(0.0165)
Smth	0.0121	-0.0027	0.0223	0.0001
	(0.0802)	(0.0740)	(0.0834)	(0.0762)
PreReg	-0.0092	-0.0047	-0.0090	-0.0044
	(0.0134)	(0.0122)	(0.0132)	(0.0120)
Reinsurance	-0.0090	-0.0082	-0.0101	-0.0093
	(0.0099)	(0.0098)	(0.0099)	(0.0097)
NPWGrowth	-0.0056	-0.0062*	-0.0060	-0.0064*
	(0.0037)	(0.0034)	(0.0039)	(0.0035)
Mutual	0.0219*	0.0227*	0.0216*	0.0224*
	(0.0110)	(0.0110)	(0.0112)	(0.0112)

Group	0.0031	0.0038	0.0034	0.0040
	(0.0101)	(0.0097)	(0.0101)	(0.0098)
LnAsset	0.0120	0.0110	0.0127	0.0119
	(0.0085)	(0.0082)	(0.0083)	(0.0080)
Lob Herfindahl	0.0291	0.0259	0.0300	0.0264
	(0.0222)	(0.0227)	(0.0223)	(0.0229)
Geo Herfindahl	0.0492**	0.0466**	0.0490***	0.0459***
	(0.0161)	(0.0153)	(0.0157)	(0.0149)
Longtail	-0.0343*	-0.0279*	-0.0345*	-0.0279*
	(0.0170)	(0.0149)	(0.0172)	(0.0150)
Constant	-0.1197	-0.5734**	-0.2396	-0.6104**
	(0.2274)	(0.1918)	(0.2422)	(0.2104)
Observations	45,197	45,197	45,197	45,197
R-squared	0.2700	0.3052	0.2670	0.3031
Firm FE	Yes	Yes	Yes	Yes
LOB FE	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes
SE cluster	Firm&LOB	Firm&LOB	Firm&LOB	Firm&LOB

Table 4. Reserve management across AYs

Table 4 reports how the variation in tax saving incentives, RBC increasing incentives, and income smoothing incentives affect insurers' reserves management behavior across different AYs. The sample consists of 44,643 Firm-LOB-Year observations from year 2000 to 2012. The dependent variable is the reserve error measure for the current accident year (*REAY0*), which equals to the difference between initial incurred losses and a revised estimate of incurred losses five years later, for the most current accident year (i.e., the current reporting year), scaled by the initial incurred losses of AY0. All continuous variables are winsorized at the 1st and 99th percentiles. Robust standard errors are double clustered by firm and LOB and are reported in parentheses. The superscripts ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

VARIABLES		REAY0			
TaxShield*2001	0.1156	Ln (RBC Ratio)*2001	-0.0067	Smth*2001	0.2607
	(0.1289)		(0.0190)		(0.3845)
TaxShield*2002	0.3324***	Ln (RBC Ratio)*2002	0.0098	Smth*2002	0.8776
	(0.0848)		(0.0355)		(0.5778)
TaxShield*2003	0.2871**	Ln (RBC Ratio)*2003	-0.0392	Smth*2003	0.3840
	(0.1107)		(0.0346)		(0.6682)
TaxShield*2004	0.4225***	Ln (RBC Ratio)*2004	-0.0548*	Smth*2004	0.8264
	(0.0961)		(0.0283)		(0.5267)
TaxShield*2005	0.5023***	Ln (RBC Ratio)*2005	-0.0226	Smth*2005	0.2959
	(0.1169)		(0.0228)		(0.5128)
TaxShield*2006	0.3760***	Ln (RBC Ratio)*2006	-0.0136	Smth*2006	-0.1610
	(0.1056)		(0.0272)		(0.4492)
TaxShield*2007	0.4527***	Ln (RBC Ratio)*2007	-0.0075	Smth*2007	0.4372
	(0.1109)		(0.0282)		(0.4419)
TaxShield*2008	0.2790**	Ln (RBC Ratio)*2008	0.0008	Smth*2008	0.3757
	(0.0985)		(0.0201)		(0.6709)
TaxShield*2009	0.3238***	Ln (RBC Ratio)*2009	-0.0053	Smth*2009	0.3415
	(0.0935)		(0.0293)		(0.5983)
TaxShield*2010	0.2206**	Ln (RBC Ratio)*2010	-0.0009	Smth*2010	-0.0970
	(0.0918)		(0.0226)		(0.6206)
TaxShield*2011	0.2284	Ln (RBC Ratio)*2011	-0.0131	Smth*2011	0.3325
	(0.1305)		(0.0230)		(0.5111)
TaxShield*2012	0.2431**	Ln (RBC Ratio)*2012	-0.0119	Smth*2012	0.1823
	(0.1060)		(0.0298)		(0.4306)
Other Controls	Yes				
Observations	44,643				
R-squared	0.1998				
Firm FE	Yes				
LOB FE	Yes				
Year FE	Yes				
SE cluster	Firm&LOB				

Table 5. Evidence based on the different classification of LOBs

The LOB "Multiple Peril Lines" is defined as a single LOB by the IRS but is subdivided into three LOBs by the RBC regime. These three LOBs are "Homeowners/ Farmowners", "Commercial Multiple Peril", and "Special Liability". This implies that these three subdivided LOBs have the same *TaxDisct* but different *WorstCase*. We sort insurers into quintiles based on their *RBC ratio* for each year of observation and insurers in *RBC Ratio* Group 5 have the highest *RBC ratio*. We then calculate the simple average of the REs across all insurers within the same quintile for each of the three LOBs. Panel A presents the results.

The LOB "Other liability" is defined as a single LOB by the RBC regime but is subdivided into two LOBs by the IRS. These two LOBs are "Other liability-Occurrence" (OL-O) and "Other liability-Claims Made" (OL-CM). This implies that these two subdivided LOBs have the same *WorstCase* but different *TaxDisct*. We sort insurers into quintiles based on their *Taxshield* for each year of observation and insurers in *Taxshield* Group 5 have the highest *Taxshield*. Furthermore, as *TaxDisct* is a time-varying variable, we further subdivide the sample into two groups. Specifically, the first (second) group consists of observations whose *TaxDisct* for LOB OL-O (OL-CM) is greater than that of OL-CM (OL-O). We then calculate the simple average of the REs across all insurers within the same quintile for each of the two LOBs in their respective groups. Panel B1 presents the results where the upper and lower section presents results for the first and second group, respectively.

The LOB "Products liability" is also defined as a single LOB by the RBC regime but is subdivided into two LOBs by the IRS. These two LOBs are "Products liability-Occurrence" (PL-O) and "Products liability-Claims Made" (PL-CM). Therefore, we conduct a similar analysis as in Panel B1 and the results are presented in Panel B2.

Panel A	Homeowners/ Farmowners	Commercial Multiple Peril	Special Liability
WorstCase Factor	0.201	0.465	0.257
		Average REs	
RBC Ratio Group			
1	0.0188	-0.0103	0.0599
2	0.0086	-0.0058	0.0362
3	0.0114	0.0094	0.0347
4	0.0117	0.0151	0.0347
5	0.0232	0.0192	0.0401

Panel B1

	Other Liability - Claims-Made (OL-CM)	Other Liability-Occurrence (OL-O)
	Tax Discount Factor: OL-CM<OL-O	
	Average REs	
Taxshield Group		
1	0.0881	0.0326
2	0.1065	0.0400
3	-0.0115	0.0180
4	0.0231	-0.0088
5	-0.0071	-0.0041
	Tax Discount Factor: OL-CM>OL-O	
	Average REs	
Taxshield Group		
1	0.0702	0.0273
2	0.0511	0.0643
3	0.0395	0.0257
4	0.0492	0.0021
5	0.0488	0.0125

Panel B2

	Products Liability — Claims-Made (PL-CM)	Products Liability- Occurrence (PL-O)
	Tax Discount Factor: PL-CM<PL-O	
	Average REs	
Taxshield Group		
1	0.0920	-0.0249
2	0.0786	-0.0242
3	0.0770	-0.0705
4	0.0742	-0.1212
5	0.0725	-0.0899
	Tax Discount Factor: PL-CM>PL-O	
	Average REs	
Taxshield Group		
1	-0.0017	-0.0466
2	0.1004	-0.0919
3	0.1289	-0.1167
4	0.1255	-0.2331
5	0.0953	-0.2573

Table 6. Subsample results: auditor types and reserve management

Table 6 reports how auditor types are related to insurer's LOB level reserve management. The sample is from year 2005 to 2012. The dependent variable is the reserve error measure (*RE*), which is equals to the difference between initial incurred losses and a revised estimate of incurred losses five years later, scaled by the initial incurred losses. Columns 1 and 3 are for insurers using non-Big 4 auditors and columns are for insurers using Big 4 auditors. All continuous variables are winsorized at the 1st and 99th percentiles. Robust standard errors are double clustered by firm and LOB and are reported in parentheses. The superscripts ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

	(1)	(2)	(3)	(4)
VARIABLES	RE	RE	RE	RE
Interaction term	WorstCase* Ln (RBC Ratio)		TaxDisct*Taxshield	
	Non-Big 4	Big 4	Non-Big 4	Big 4
Interaction term	0.1406**	0.0747	0.0206*	0.0099
	(0.0589)	(0.0590)	(0.0103)	(0.0094)
TaxDisct	0.0017	-0.0009	-0.0066	-0.0053*
	(0.0020)	(0.0017)	(0.0048)	(0.0029)
Runoff	-0.0404**	-0.0412**	-0.0401**	-0.0418**
	(0.0137)	(0.0173)	(0.0136)	(0.0171)
PaySpeed	-0.0655***	-0.0315***	-0.0652***	-0.0318***
	(0.0075)	(0.0072)	(0.0072)	(0.0072)
Yield	-0.0753	0.0176	-0.0792*	0.0207
	(0.0449)	(0.0265)	(0.0440)	(0.0263)
TaxShield	0.1661***	0.0697	-1.7341*	-0.8345
	(0.0415)	(0.0429)	(0.9422)	(0.8652)
Ln(RBC Ratio)	-0.0664**	-0.0193	-0.0206**	0.0063
	(0.0260)	(0.0217)	(0.0073)	(0.0073)
Smth	0.0191	-0.1387	-0.0156	-0.1621
	(0.1144)	(0.0967)	(0.1113)	(0.1009)
Reinsurance	-0.0657**	-0.0184	-0.0666**	-0.0191
	(0.0283)	(0.0121)	(0.0279)	(0.0122)
NPWGrowth	-0.0080	-0.0064	-0.0071	-0.0059
	(0.0069)	(0.0046)	(0.0061)	(0.0045)
PreReg	0.0096	0.0083	0.0046	0.0077
	(0.0307)	(0.0165)	(0.0319)	(0.0162)
Mutual	-0.0058	0.0048	-0.0038	0.0058
	(0.0196)	(0.0107)	(0.0205)	(0.0104)
Group	-0.0090	-0.0012	-0.0077	-0.0002
	(0.0086)	(0.0116)	(0.0077)	(0.0120)
LnAsset	-0.0245	-0.0102	-0.0246	-0.0100
	(0.0300)	(0.0098)	(0.0291)	(0.0099)
Lob Herfindahl	0.0068	-0.0118	0.0034	-0.0114
	(0.0230)	(0.0151)	(0.0222)	(0.0147)
Geo Herfindahl	0.0749**	0.0167	0.0766**	0.0177
	(0.0307)	(0.0178)	(0.0306)	(0.0183)

Longtail	-0.0265	-0.0240	-0.0274	-0.0220
	(0.0599)	(0.0178)	(0.0593)	(0.0182)
Ln (Initial IL)	-0.0037	-0.0031	-0.0040	-0.0032
	(0.0040)	(0.0026)	(0.0039)	(0.0028)
Constant	0.1512	0.2529	0.9210	0.6455**
	(0.4379)	(0.2159)	(0.5657)	(0.2836)
Observations	6,772	20,761	6,772	20,761
R-squared	0.3868	0.3235	0.3853	0.3230
Firm FE	Yes	Yes	Yes	Yes
LOB FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
SE cluster	Firm&LOB	Firm&LOB	Firm&LOB	Firm&LOB