# Asymmetry in Earnings Management Surrounding Targeted Ratings*

Evan M. Eastman[a] Florida State University
David L. Eckles[b] University of Georgia
Martin Halek[c] University of Calgary

June 2, 2017

**Abstract**

This study investigates asymmetric incentives in firms managing earnings in an attempt to achieve a target financial strength rating. We find empirical evidence that firms with an actual rating below their target rating use income-increasing earnings management. However, we find no evidence that firms above their target rating manage earnings. Our findings are robust to a variety of alternative definitions of target rating. We additionally find evidence that this earnings management can be mitigated through external monitoring. These findings indicate that firms have incentives to reach a target rating if they are rated below their target, but not above their target.

*Keywords*: Accounting Discretion; Ratings Agencies; Accruals; Earnings Management; Audit Quality; Insurance; Reserve Management

*JEL classification*: G22, G24, M41

---

*The authors would like to thank Thomas Berry-Stölzle, Patty Born, Mark Browne, Jim Carson, J. David Cummins, Anne Ehinger, Cameron Ellis, Jenny Gaver, Martin Grace, Helmut Gründl, Rob Hoyt, Ty Leverty, Andre Liebenberg, Andreas Milidonis, Lars Powell, Santhosh Ramalingegowda, Andreas Richter, Andrew Van Buskirk, Mary Weiss, and seminar participants at Georgia State University, LMU Munich, St. John's University, Florida State University, and Temple University for helpful comments. We would also like to thank Rob Hoyt and A.M. Best for assistance in obtaining the ratings data.

[a]College of Business, Department of Risk Management/Insurance, Real Estate, and Legal Studies, Florida State University, Tallahassee, FL, eeastman@business.fsu.edu.

[b]Terry College of Business, Department of Insurance, Legal Studies, and Real Estate, University of Georgia, Athens, GA, deckles@uga.edu.

[c]Contact author: Haskayne School of Business, Risk Management & Insurance, University of Calgary, Scurfield Hall 448, 2500 University Drive NW, Calgary, AB T2N 1N4, Canada, Tel.: 403.220.7262, Fax: 403.282.0095, martin.halek@haskayne.ucalgary.ca.

# Asymmetry in Earnings Management Surrounding Targeted Ratings

**Abstract**

This study investigates asymmetric incentives in firms managing earnings in an attempt to achieve a target financial strength rating. We find empirical evidence that firms with an actual rating below their target rating use income-increasing earnings management. However, we find no evidence that firms above their target rating manage earnings. Our findings are robust to a variety of alternative definitions of target rating. We additionally find evidence that this earnings management can be mitigated through external monitoring. These findings indicate that firms have incentives to reach a target rating if they are rated below their target, but not above their target.

*Keywords*: Accounting Discretion; Insurance; Reserve Management; Ratings Agencies; Accruals; Earnings Management; Audit Quality

*JEL classification*: G22, G24, M41

## 1. Introduction

Prior research has shown, perhaps not surprisingly, evidence of firms managing earnings to achieve a specific (target) rating. Notably, in a recent study Alissa, Bonsall, Koharki, and Penn (2013) find empirical evidence that firms manage earnings in *both* directions (i.e., upward and downward) in an effort to move a rating upward or downward towards a target rating. Intuitively it seems clear that firms will manage earnings upwards to improve a rating, however, Alissa et al. (2013) also note that there may be incentives for above-target-rating firms to *reduce* their rating. Relying on survey results presented in Graham and Harvey (2001), Alissa et al. (2013) point out that firms consider a rating to be "too high" as creating an unnecessary cost. This response is contrary to results in the target capital structure literature, where Kisgen (2006, 2009) finds evidence that firms reduce leverage following a ratings downgrade, but make no adjustment following an upgrade. In a similar vein, prior studies document asymmetric capital market responses to ratings changes, where there are negative market reactions to downgrades, but no observable reactions to upgrades (e.g., Holthausen and Leftwich 1986; Dichev and Piotroski 2001). Although there may exist differential incentives, Alissa et al. (2013) indeed find evidence of a symmetric effect with firms managing earnings in both directions ostensibly to improve or even reduce a rating. Using a unique setting as well as improving upon the methodology in Alissa et al. (2013), we are able to disentangle the effects and show a more intuitively appealing result where firms only manage earnings to improve their financial rating. Our study should be viewed as unifying the notion of firms managing earnings to obtain higher ratings (e.g., Alissa et al. 2013) yet forgoing earnings management in instances when a given rating is too "high" (as in the target capital structure literature, e.g., Kisgen (2006, 2009)).

Studies involving earnings management and specific targets (e.g., ratings, leverage, etc.) are inherently difficult. Studying earnings management, broadly, is itself not simple since observing the actual management of earnings is challenging. Though valiant attempts are made to derive a measure of earnings management, measurement error certainly exists. Similarly, since firms rarely (if ever) publicly announce a ratings goal, studying incentives around a "target" rating, that must be estimated, also introduces measurement error. Using an unique setting, our sample allows us to minimize the measurement error associated with these two important variable constructions. Further, the results presented account (econometrically) for what measurement error does remain.

In order to minimize the measurement error, we turn to the property and liability (P&L) insurance industry for examination. For a number of reasons, the P&L insurance industry is an excellent laboratory to investigate this specific issue. First, we minimize the measurement error around earnings measurement by using loss reserve errors as a measure of earnings management. Each year insurers accrue a liability for unpaid losses. Over time, they must disclose how these estimated losses develop as they reflect actual losses paid and changes in estimates. This allows for observability of the actual error made in the original accounting estimate. McNichols (2000) suggests that commonly used earnings management models based on model residuals (e.g., Jones 1991; Dechow, Sloan, and Sweeney 1995; Kothari, Leone, and Wasley 2005) can be unreliable and instead recommends focusing on specific accruals that are material to a firm.[1] Indeed, loss reserve errors have been frequently used as a measure of managerial discretion, being linked to various incentives, such as income smoothing (Weiss 1985; Beaver, McNichols, and Nelson 2003), financial weakness (Petroni 1992; Gaver and Paterson 2004), and regulation (Nelson 2000; Grace and Leverty 2010).

To mitigate measurement error around estimation of a "target rating," we note that a subset of insurers (commercial insurers) are dependent on a specific rating, "A-."[2] A

[1]Loss reserves are material as they are generally the largest liability on an insurer's balance sheet. Petroni (1992), for example, reports that the average firm in her sample has loss reserves that account for 44.3 percent of total liabilities. The average firm during our sample period (1992-2008) has loss reserves that account for 42.2 percent of total liabilities.

[2]Our study focuses on A.M. Best financial strength ratings, which we describe in more detail subsequently.

rating of at least "A-" is particularly important for commercial writers, as many commercial enterprises will not purchase insurance from insurers with a rating below "A-." Epermanis and Harrington (2006) and Halek and Eckles (2010) find empirical evidence that there are substantial costs associated with an insurer's failure to maintain a rating of at least "A-." Further, Alissa et al. (2013) note that investors are particularly aware of "investment grade" ratings, providing an incentive for firms to manage earnings around a specific rating.[3] Here, we have an identified subsample of firms (those insurers with a commercial focus) where this "investment grade" rationale specifically holds. For these firms, we argue an exogenous target rating of "A-" exists, which allows us to minimize error associated in estimating a "target rating."

An additional advantage of focusing on the insurance industry is that there exists an industry-specific financial strength rating. A.M. Best (Best) has offered financial strength ratings of insurers since its incorporation in 1899. These ratings represent Best's opinion on an insurer's ability to continue to pay claims to policyholders in the future. Indeed, financial strength ratings have been shown to be positively associated with insolvency risk (Pottier and Sommer 2002; Doherty, Kartasheva, and Phillips 2012). Unlike credit ratings (which are the focus of Alissa et al. (2013)), which can focus on an individual security, financial strength ratings consider the entire firm.[4] Since ratings serve as an insolvency measure, they are important to an insurer as many corporate insurance purchasers have minimum ratings requirements and personal-lines consumers are price sensitive with respect to ratings (e.g., Berger, Cummins, and Tennyson 1992). Accordingly, losing a high rating is associated with significant costs (Doherty and Phillips 2002). Capital markets also react negatively to

[3] Alissa et al. (2013) do consider a "investment grade cutoff," although a heterogenous set of firms will perceive differing advantages to achieving an investment grade rating. For commercial insurers, the advantages to achieving an "A-" are more consistent. Specifically, only firms with a high proportion of institutional debtholders will consider an investment grade rating particularly advantageous; whereas most (if not all) commercial insurers will consider an "A-" financial strength rating important.

[4] Credit ratings certainly reflect the strength of a firm, but will also reflect the idiosyncrasies of an individual security. Financial strength ratings remove this source of variability.

ratings downgrades (Halek and Eckles 2010; Wade, Liebenberg, and Blau 2015). For these reasons insurers will have incentives to achieve and maintain a high target rating.

Another advantage of using insurers stems from regulatory reporting requirements. Because most firms are required to report financial information to regulators, our sample is broader, consisting of different organizational forms. The insurance industry has a variety of ownership structures including public and private stock firms, as well as mutual companies. Therefore, our study is not restricted to only publicly traded firms. These differing organizational forms each have separate agency conflicts that may influence the incentives of managers to manipulate loss reserves (Mayers, Shivdasani, and Smith 1997; Cummins, Weiss, and Zi 1999; Burgstahler, Hail, and Leuz 2006).

We find evidence that firms manage earnings upward, through under-reserving (i.e., under-reporting losses), when they are below their target financial strength rating. We find no evidence of reserve management for firms that have an actual rating above their target financial strength rating. This result is robust to alternative definitions of target rating. More specifically, in addition to using an ordered probit model to estimate a target rating (as in Alissa et al. (2013)) we also focus on insurers writing predominantly commercial lines and measure their target as "A-."[5] We also use past ratings as a proxy for a target rating and adapt a model from the target leverage literature (e.g., Hovakimian, Opler, and Titman 2001; Flannery and Rangan 2006) to test our hypotheses that firms will manage reserves to attain a target rating. Additionally, the results of a falsification test provide further support for our empirical proxies for target ratings.

Alissa et al. (2013) is the most similar study to ours.[6] They find that firms use accruals-based and real activities earnings management in order to attempt to achieve a target S&P

[5]As noted above, Epermanis and Harrington (2006) and Halek and Eckles (2010) find evidence that maintaining a rating of "A-" is particularly important to insurers.

[6]Jung, Soderstrom, and Yang (2013) examine earnings *smoothing* incentives related to credit ratings. Demirtas and Cornaggia (2013) examine earnings management incentives around initial credit ratings.

credit rating. Our study extends and improves on Alissa et al. (2013) in several important ways. First, we explicitly examine the asymmetric effect of managerial incentives around ratings. That is, we examine whether incentives to manage earnings differ between above-target rating firms and below-target rating firms.[7] Our empirical finding that incentives do differ between these two groups is a significant contribution that is both consistent with literature examining how firms adjust leverage following ratings changes (Kisgen 2006, 2009) and intuitively appealing with regards to managerial incentives.[8] This finding is strikingly stable across all of our tests.

Second, we utilize a unique group of firms that allows us to minimize estimation error with regards to the measurement of earnings management and the measurement of a "target rating." Insurers have been used in prior studies to provide better measurement of earnings management (Petroni 1992; Gaver and Paterson 2004; Grace and Leverty 2010), but we also leverage another benefit of utilizing insurers by considering the existence of an industry-specific target rating to provide a better measure of a ratings target. In addition to this measure, we also consider alternative definitions of target ratings that are not considered by Alissa et al. (2013). For any remaining measurement error, we account for econometric issues created when there is a generated regressor present in our model. Finally, we also examine whether high quality external monitoring (i.e., Big 4 audit firms and Big 4 actuarial firms) can mitigate the ability of firms to manage earnings if they are below their target rating.

Our study contributes to the literature on earnings management, in general, and loss reserve management, in particular. Our study also contributes to the literature on ratings, providing further evidence that ratings are highly important to firms (Kisgen 2006, 2009). The findings in this paper both extend and complement the findings of Alissa et al. (2013)

[7]In footnote 20 of Alissa et al. (2013), the authors note that their results, of a symmetric response, are consistent when considering above- and below-target firms, though results are not presented.

[8]That is, it is easy to imagine why a manager may desire to undertake activities that increase a rating, but a bit harder to consider a manager undertaking activities to reduce a given rating.

and provide further support for the idea that firms manage earnings in response to deviations from expected ratings, albeit in an asymmetric fashion.

The rest of our paper proceeds as follows. In Section 2 we provide background on insurer loss reserve errors and financial strength ratings, as well as a brief summary of prior literature. In Section 3 we develop our testable hypotheses. In Section 4 we describe our research design. In Section 5 we describe our data and provide our empirical results. In Section 6 we end with a brief conclusion.

## 2. Background

### *Loss Reserves*

Insurer loss reserve errors are frequently used as a measure of managerial discretion in the accounting and insurance literature (e.g., Petroni 1992; Beaver et al. 2003; Grace and Leverty 2010). Loss reserves are typically the largest liability on a property-liability insurer's balance sheet. The loss reserve represents the estimated cost of settling claims. The general process for establishing the loss reserve involves a firm's actuaries presenting a recommended range of acceptable loss reserves, with management choosing the ultimate loss reserve amount. As claims occur over time and new information is gathered on existing claims, an insurer will revise their original and prior loss reserve estimates. These revisions are referred to as "development," and eventually indicate how much the initial estimate was off. An insurer underreserved if the original loss reserve was less than the developed reserve and overreserved if the original loss reserve was greater than the developed reserve. This information, as well as information on the settlement of claims, is reported by all P&L insurers to the National Association of Insurance Commissioners (NAIC) in annual statutory filings on Schedule P. While some of the reserving error is the result of inherent randomness (i.e., it is difficult to predict claims), there is also the potential for management to manage reserves in response to various incentives.

An excerpt from a Schedule P can be found in Table 1. These data are used to construct the loss reserve error for firm $i$ as follows:

$$Error_{i,t} = Incurred\ Losses_{i,t} - Incurred\ Losses_{i,t+n} \tag{1}$$

This error is calculated as the initial loss reserve estimate in year $t$ minus the total incurred losses in year $t+n$. The sum of the boxed values under column 6 in Table 1 are the incurred losses in year $t$ and the sum of the boxed values under column 11 are the incurred losses in year $t+n$. The error, also used in previous studies (e.g., Beaver et al. 2003; Gaver and Paterson 2004; Grace and Leverty 2010), will be positive if the initial loss reserve estimate is overestimated and negative if the initial loss reserve is understated. Consistent with the majority of prior literature (e.g., Petroni 1992; Beaver et al. 2003; Grace and Leverty 2010), we use a five year development horizon. To control for insurer size and to express the loss reserve error as a percentage, this difference is scaled by total assets.

McNichols (2000) notes several advantages in using loss reserve errors as a measure of earnings management compared to other accruals-based measures. For one, it is a material accrual, as the loss reserve is generally the largest liability on an insurer's balance sheet. Also, due to reporting requirements, the development of loss estimates over time is observable, allowing for the comparison of ultimate losses (or a proxy of ultimate losses) to the original accounting estimate. The discretionary manipulation of loss reserves has been frequently studied in the literature as a result of its strength as a measure of earnings management. Loss reserve errors have been linked to various incentives such as earnings smoothing (Weiss 1985; Grace 1990; Beaver et al. 2003), avoiding financial weakness (Petroni 1992; Gaver and Paterson 2004; Grace and Leverty 2012), and regulation (Nelson 2000; Grace and Leverty 2010). Studies have also examined the relation between external monitoring and insurer loss reserve errors (Petroni and Beasley 1996; Gaver and Paterson 2001, 2007) as well as capital market implications of insurer loss reserves (Beaver and McNichols 1998; Petroni, Ryan, and Wahlen 2000).

### *Financial Strength Ratings*

A.M. Best financial strength ratings reflect the agency's opinion on a firm's ability to meet its obligation to pay policyholders and to, therefore, remain solvent. Unlike debt ratings, financial strength ratings reflect the risk of the firm overall, as opposed to one security. Insurers have numerous incentives to maintain a high financial strength rating as they are of interest to regulators, consumers (corporate or individual), and agents.

Doherty and Phillips (2002) examine whether rating standards have changed over time, and find evidence that the increased stringency of A.M. Best is one potential explanation for the capital buildup of P&L insurers in the 1990s. Pottier and Sommer (2002) find empirical evidence that A.M. Best ratings are better predictors of insolvency compared to measures used by regulators (e.g., Risk-Based Capital (RBC) ratios). Epermanis and Harrington (2006) document that firms experience a decrease in premiums written following ratings downgrades. They find that this effect is stronger for firms that write primarily in commercial lines of insurance. Halek and Eckles (2010) examine market reactions to financial strength ratings changes. They document significant negative market reactions to ratings downgrades. Additionally, Halek and Eckles (2010) find evidence that reactions are significantly higher in magnitude for firms that experience the loss of a rating of "A-." Wade et al. (2015) find empirical evidence of abnormally high short selling for insurers prior to a ratings downgrade. This suggests that investors can anticipate ratings downgrades and profit from negative reactions.

## 3. Hypothesis Development

Since A.M. Best financial strength ratings represent the overall ability of a firm to meet policyholder obligations, they are important to firms. Negative consequences of a low financial strength rating, such as not being able to sell to certain corporate customers, lower prices, and negative stock market reactions, provide an incentive for below-target-rating firms to take action to achieve a higher rating. Additionally, Kisgen (2006, 2009) notes in his analysis of leverage and credit ratings, that there may be incentives for firms to attempt to obtain upgrades, but not necessarily downgrades.

Alissa et al. (2013), however, note there may also be incentives for above-target-rating firms to *reduce* their financial strength rating. Graham and Harvey (2001) survey CFOs and find that firms view a rating that is higher than expected as an unnecessary cost.[9] Alissa et al. (2013) conclude, following their empirical analysis, that firms above (below) their target rating tend to manage earnings downward (upward). However, their empirical strategy does not allow them to disentangle whether this result is driven by above-target firms or below-target firms (or both). We propose that the costs associated with being below a target rating are significantly greater than those imposed for being above a target rating. We, therefore, separately examine above-rating and below-rating firms in our analysis.

As firms are penalized by consumers and investors for having a low rating and they (potentially) incur unnecessary costs for being above target ratings, they have an incentive to manage reserves if they are not at their target rating.[10] Therefore, firms below their target rating could make income-increasing earnings management decisions (under-reserving) in an effort to achieve a higher financial strength rating. Further, firms above their target rating could make income-decreasing earnings management decisions (over-reserving) in an effort to achieve a lower financial strength rating. This is consistent with the empirical findings of Alissa et al. (2013) on a sample of non-financial firms using credit ratings. We additionally

[9]Graham and Harvey (2001) are concerned with credit ratings unlike our study which investigates financial strength ratings.

[10]While Best does not reveal its ratings formula, they do state some of the main variables they consider. Best specifically notes that "Operating Performance" is a key criteria, stating "Profitable insurance operations are essential for a company to operate as a going concern (A.M. Best 2014, p. 15)."

examine whether the empirical findings in Alissa et al. (2013) are driven by either above-target or below-target firms.

A firm is likely better able to estimate its own loss exposure, and thus its appropriate level of loss reserves, than A.M. Best due to information asymmetry that exists between a firm and A.M. Best. A firm's actuaries and managers have full access to information on the policies they have written. A.M. Best relies on their own model to estimate loss reserves, which may differ from the one used by each firm (A.M. Best 2014). Since changes in income are more observable than mistakes in reserving, firms can under- (over-)reserve to improve (reduce) performance in an effort to achieve a higher (lower) rating.

We, therefore, propose the following hypothesis:

**H1**: *Firms that deviate from their target financial strength rating will manage their loss reserves.*

A finding supporting this hypothesis would be consistent with Alissa et al. (2013). We also expect that if the finding of Alissa et al. (2013) is driven by one group of firms, it will be those that are below their target rating as opposed to those that are above their target rating. The costs for being below a target are significantly higher than any costs that a firm may incur for being above their target. For example, Epermanis and Harrington (2006) finds that firms experiencing a ratings downgrade see a larger and statistically stronger decline in net premiums written compared to firms experiencing an upgrade. Similarly, Halek and Eckles (2010) find that there is an asymmetric response to ratings changes from the stock market, where downgrades experience a larger decline in stock price compared to ratings upgrades.

We, therefore, propose the following hypothesis:

**H2**: *Firms below their target financial strength rating will tend to underreserve while firms above their target rating manage reserves to a lesser extent.*

A finding in support of this hypothesis is partially consistent with the findings in Alissa et al. (2013). While Alissa et al. (2013) finds firms below their target rating manage earnings (as **H2** suggests), they also find evidence that this result persists for firms with a rating above a certain target (contrary to **H2**). Thus, finding support for **H2** would either provide a significant contribution by finding evidence of an asymmetric response to deviations from a target rating, consistent with findings in the target leverage literature (Kisgen 2006, 2009), or verify the symmetric incentives of Alissa et al. (2013).

Prior research has examined how external monitoring can influence insurer reserving practices (e.g., Petroni and Beasley 1996; Gaver and Paterson 2001, 2007; Gaver, Paterson, and Pacini 2012). When establishing loss reserves, firms are required to obtain an auditor to assess the accuracy of management's estimate. In addition to being examined by auditors, actuaries are also required to assess and submit an opinion regarding the adequacy of management's initial loss reserve estimate.[11] High quality monitoring by both audit firms and actuarial firms could result in a lessened ability for managers of insurance firms to manage reserves. Notably, Gaver and Paterson (2001) find evidence that high quality monitoring by both audit and actuarial firms results in more conservative loss reserve estimates.

In our present setting, we predict that high quality external monitoring will lessen the ability of firms to manage reserves if they deviate from their target rating. We particularly focus on firms with ratings *below* their target rating, since we expect the incentives will be strongest for these firms (see **H2**). We expect to observe high quality external monitoring (i.e., Big 4 audit firms and their affiliated Big 4 actuarial firms) resulting in a reduction of the ability of firms below their target rating to understate reserves.

We, therefore, propose the following hypothesis:

[11] Gaver and Paterson (2001) note that while some firms rely on internal actuaries, the majority of firms obtain a statement from external actuaries.

**H3**: *High quality external monitors (Big 4 audit firms and Big 4 actuaries) mitigate the ability of firms that deviate from their target ratings to manage earnings.*

We expect to empirically observe firms with high quality external monitoring and a rating below their target rating to either overreserve or at least for this effect to cancel out any under-reserving we observe for firms below their target rating when we do not control for external monitoring. A finding supporting this hypothesis would be consistent with Gaver and Paterson (2001).[12]

## 4. Research Design

In order to estimate a target financial strength rating, we use an ordered probit model. For non-insurers, Alissa et al. (2013) use an ordered probit to estimate Standard & Poor's long-term credit rating as a function of various firm characteristics such as size, profitability, operating risk, asset specialization, and future growth options, using the fitted values from this regression to create an expected rating. Numerous studies on insurers (e.g., Pottier and Sommer 1999; Doherty and Phillips 2002) use ordered probit models to estimate determinants of A.M. Best ratings for insurance firms. Applying the strategy of Alissa et al. (2013) and the variables identified by these insurance-specific studies, we adopt the following ordered probit model:

$$\begin{aligned} Rating_{i,t} = {} & \gamma_1 Size_{i,t} + \gamma_2 Product\ Diverse_{i,t} + \gamma_3 Longtail_{i,t} + \gamma_4 Reinsurance_{i,t} \\ & + \gamma_5 Geo\ Herf_{i,t} + \gamma_6 Growth_{i,t} + \gamma_7 ROA_{i,t} + \gamma_8 ROI_{i,t} + \gamma_9 Kenny\ Ratio_{i,t} \\ & + \gamma_{10} Earthquake_{i,t} + \gamma_{11} Surplus_{i,t} + \gamma_{12} Group_{i,t} + \gamma_{13} Hurricane_{i,t} + u_{i,t} \end{aligned} \tag{2}$$

where:

[12] Petroni and Beasley (1996) do not document a difference in reserve errors between firms with Big 8 auditors and those without. However, they do not control for the effect of having a "Big N" actuarial firm, which subsequent studies (e.g., Gaver and Paterson 2001) have shown to be an important consideration.

$i,t =$ Firm $i$ in year $t$;

$Rating_{i,t} =$ Firm $i$'s A.M. Best financial strength rating in year $t$, where 8 corresponds to the highest rating ("A++") and 1 corresponds to the lowest rating ("B-");

$Size_{i,t} =$ The natural log of firm $i$'s total assets in year $t$;

$Product\ Diverse_{i,t} =$ 1 minus a Herfindahl index based on firm $i$'s net premiums written across 24 lines of business in year $t$;[13]

$Longtail_{i,t} =$ The percentage of firm $i$'s net premiums written in long-tailed lines of business in year $t$;[14]

$Reinsurance_{i,t} =$ Firm $i$'s reinsurance premiums ceded divided by the sum of direct premiums written and reinsurance assumed in year $t$;

$Geo\ Herf_{i,t} =$ A geographic Herfindahl index based on direct premiums written in the fifty U.S. states and Washington D.C. in year $t$;

$Growth_{i,t} =$ The percent change in firm $i$'s net premiums written from year $t-1$ to year $t$;

$ROA_{i,t} =$ Firm $i$'s net income divided by total assets in year $t$;

[13]Using net premiums written data from the Underwriting and Investment Exhibit (Part 1B-Premiums Written) in the annual statutory filings, we make the following adjustments as described in Berry-Stölzle, Liebenberg, Ruhland, and Sommer (2012). Fire and Allied Lines is defined as the sum of "Fire" and "Allied Lines." Accident and Health is defined as the sum of "Group Accident and Health," "Credit Accident and Health," and "Other Accident and Health." Medical Malpractice is defined as the sum of "Medical Malpractice—Occurrence" and "Medical Malpractice—Claims Made." Products Liability is defined as the sum of "Products Liability—Occurrence" and "Products Liability—Claims Made." Auto is defined as the sum of "Private Passenger Auto Liability," "Commercial Auto Liability," and "Auto Physical Damage." Reinsurance is defined as the sum of "Nonproportional Assumed Property," "Nonproportional Assumed Liability," and "Nonproportional Assumed Financial Lines." After these combinations we are left with 24 lines of business from which we construct the Herfindahl Index: Accident and Health, Aircraft, Auto, Boiler and Machinery, Burglary and Theft, Commercial Multi Peril, Credit, Earthquake, Farmowners', Financial Guaranty, Fidelity, Fire and Allied lines, Homeowners, Inland Marine, International, Medical Malpractice, Mortgage Guaranty, Ocean Marine, Other, Other Liability, Products Liability, Reinsurance, Surety, and Workers' Compensation.

[14]We define the following lines as long-tailed lines of business: Farmowners', Homeowners, Commercial Multi Peril, Medical Malpractice, Workers' Compensation, Products Liability, Auto Liability, and Other Liability.

$ROI_{i,t}$ = Firm $i$'s net investment income divided by total assets in year $t$;

$Kenny\ Ratio_{i,t}$ = Firm $i$'s net premiums written divided by policyholder surplus in year $t$;

$Earthquake_{i,t}$ = The percentage of firm $i$'s net premiums written in earthquake insurance in year $t$;

$Surplus_{i,t}$ = The ratio of firm $i$'s policyholder surplus to total assets in year $t$;

$Group_{i,t}$ = A binary variable equal to 1 if firm $i$ is a member of a group and 0 otherwise;

$Hurricane_{i,t}$ = The percentage of firm $i$'s direct premiums written in hurricane-prone states in year $t$;[15] and

$u_{i,t}$ = The error term for firm $i$ in year $t$.

An alternative methodology includes a set of regulatory ratios, the Insurance Regulatory Information System (IRIS) ratios, as control variables in the ratings determinants model. However, prior research, such as Petroni (1992), Gaver and Paterson (1999, 2004), and Grace and Leverty (2012) examine whether insurers manipulate reserves in order to avoid violating four IRIS ratios, which would trigger regulatory intervention. Therefore, since reserve manipulation can affect the IRIS ratios, we must first calculate the "unmanipulated" IRIS ratios. Here, we remove the observed error in reserves, essentially assuming a reserve error of zero.[16] Using the following model, we again estimate ordered probit models for each

[15] These include the Gulf states—Texas, Louisiana, Mississippi, Alabama, and Florida—and the south Atlantic states—Georgia, South Carolina, and North Carolina (Cheng and Weiss 2012).

[16] See Gaver and Paterson (1999) for a description of calculating "unmanipulated" IRIS ratios.

year in our sample using "unmanipulated" IRIS ratios:[17]

$$Rating_{i,t} = \alpha_1 Size_{i,t} + \alpha_2 Mutual_{i,t} + \alpha_3^{'} X_{i,t}^{IRIS} + \eta_{i,t} \tag{3}$$

where $Rating_{i,t}$ is firm $i$'s A.M. Best financial strength rating in year $t$, where 8 corresponds to the highest rating ("A++") and 1 corresponds to the lowest rating ("B-") in year $t$. $Size_{i,t}$ is the natural log of firm $i$'s assets in year $t$. $Mutual_{i,t}$ is a binary variable equal to 1 if firm $i$ is organized as a mutual in year $t$ and 0 otherwise. $X_{i,t}^{IRIS}$ is a vector of firm $i$'s unmanipulated IRIS ratios in year $t$. $\eta$ is a random error term. We estimate a separate model for each year in our sample (1992-2008). We next use the estimated coefficients from these models to calculate a target rating using a firm's observed IRIS ratios (i.e., those including any reserve manipulation). We use this target as an alternative definition of a firm's target financial strength rating.

Consistent with Alissa et al. (2013), we use the results from these ordered probit models to construct a firm's target financial strength rating.[18] This target rating is the rating that has the highest fitted probability from equation (2) or equation (3). We then construct *Difference*, which is *Rating* minus the target rating. *Difference* is positive for firms with actual rating above expected rating (over-rated firms) and negative for firms with actual rating below expected rating (under-rated firms).

Table 2 provides the distribution of actual ratings compared to target ratings. These results are generally as expected, as most ratings are at their target. Fewer firms are predicted to have low ratings ("B+" or less) compared to the actual number of firms with these ratings.

[17] We use the following ratios in our estimation: gross premiums written to policyholders' surplus, net premiums written to policyholders' surplus, change in net premiums written, surplus aid to policyholders' surplus, two-year overall operating ratio, investment yield, gross change in policyholders' surplus, adjusted liabilities to liquid assets, gross agents' balances (in collection) to policyholders' surplus, one-year reserve development to policyholders' surplus, two-year reserve development to policyholders' surplus, and estimated current reserve deficiency to policyholders' surplus.

[18] Empirical results from our ordered probit models of equation (2) and equation (3) are presented in the appendix.

The largest deviation appears at "B++," where only 18 firm-years have "B++" as a target, while 1,589 firm-years have a rating of "B++." A possible explanation for this distribution is the importance for many firms of attaining a rating of at least "A-." We note that the number of firms targeting an "A-" rating (7,848) is substantially larger than the number of firms with "A-" rating (4,735). If it is important for firms to have an "A-" rating this could explain the low number of firms targeting a "B++" rating.[19]

Table 3 provides the average reserve error scaled by total assets by the intersection of actual and target rating. Positive values indicate over-reserving while negative values indicate under-reserving. Overall, there are no strong trends in this table. There are a few cases of firms below their target rating under-reserving, but these results are not consistent.

Table 4 examines whether *Difference* provides an adequate measure of target rating for a firm. We would expect to see a firm's actual rating move toward its target rating over time if this is a reasonable measure of target rating. As in Alissa et al. (2013), we estimate: $\Delta Difference_{i,t+k} = \theta_0 + \theta_1 Difference_{i,t} + \omega_{i,t}$. A negative estimated coefficient of $\theta_1$ indicates mean reversion and would provide evidence that ratings do trend towards the target rating. The results in Table 4 provide evidence that *Difference* mean reverts over $t+1$, $t+3$, and $t+5$.

This method of measuring deviation from a target rating captures a firm's target rating in that it is the rating a firm can expect to receive based on its observable firm characteristics. Since A.M. Best does not make its exact rating formula public, firms cannot take actions to directly influence their rating. According to A.M. Best, they also take into account qualitative factors when assessing their rating (A.M. Best 2014). Therefore, based on observable factors, this fitted value of a target rating proxies the financial strength rating a firm is tar-

[19] While it is possible that this is an artifact of using an ordered probit model to calculate a target rating (e.g., Cantor and Metz 2006), we emphasize again that there is good reason to believe firms—or at least a subset of firms—are targeting a rating of at least "A-" (Epermanis and Harrington 2006). Additionally, our subsequent tests provide similar results and would not be impacted by any concerns about using an ordered probit model to calculate our target ratings.

geting. In subsequent sections we employ different measures of target ratings as robustness checks. Notably, we take advantage of a subset of insurers—those writing predominantly in commercial lines of business—which have a particular target rating. While our research design is largely the same in these tests, measurement error associated with our target rating is substantially mitigated.

In order to test for whether firms engage in earnings management activities when their current financial strength rating differs from their target financial strength rating, we employ the following ordinary least squares (OLS) regression:

$$RE_{i,t} = \beta_0 + \beta_1 Difference_{i,t} + \beta_2^{'} X_{i,t} + \beta_3^{'} I_t + \epsilon_{i,t} \quad (4)$$

$$RE_{i,t} = \psi_0 + \psi_1 Above\ Target_{i,t} + \psi_2 Below\ Target_{i,t} + \psi_3^{'} X_{i,t} + \psi_4^{'} I_t + \epsilon_{i,t} \quad (5)$$

where $RE_{i,t}$ is reserve error in year $t$ for firm $i$ scaled by total assets. $Difference_{i,t}$ is the difference between $Rating_{i,t}$ and a firm's target financial strength rating. We also disaggregate *Difference* into two variables, *Above Target* and *Below Target* to examine the potential of an asymmetric effect in being either above or below a target rating. *Above Target* (*Below Target*) is equal to the number of notches above (below) a firm's actual rating is relative to their target rating, and zero otherwise.[20] **H1** predicts a positive coefficient estimate of *Difference* ($\beta_1 > 0$). **H2** predicts a negative estimated coefficient of *Below Target* ($\psi_2 < 0$) and a positive estimated coefficient of *Above Target* ($\psi_1 > 0$), and also predicts that the magnitude of the coefficient estimate of *Below Target* will be larger than *Above Target* ($|\psi_1| < |\psi_2|$). $X_{i,t}$ is a vector of firm-level control variables to account for discretionary and non-discretionary determinants of a firms' loss reserve error. $I_t$ is a vector of year fixed effects. $\epsilon_{i,t}$ is a random error term.

[20] In unreported results, we also perform empirical tests using binary variables to represent whether a firm is above or below their target rating. While this captures the asymmetric responses to deviations from target rating, information—notably information about the distance from a target rating—is lost in this specification. Regardless, the results are consistent when using either specification.

We include the following variables in vector $X_{i,t}$ in order to isolate the effect of deviations from a target financial strength rating on loss reserve errors. Long-tailed lines of business require more managerial discretion, which would provide managers more discretion over reserves (Petroni and Beasley 1996; Beaver et al. 2003; Grace and Leverty 2010). *Growth* controls for the incentive to underreserve in an attempt to take advantage of growth opportunities. Harrington and Danzon (1994) find that firms will use reinsurance to attempt to hide this under-reserving, so we also include *Reinsurance*. *Tax Shield* proxies for an insurer's taxable income, as an insurer can overreserve to delay its current tax liability (Grace 1990; Petroni 1992). We measure *Tax Shield* as an insurer's net income plus developed reserves, scaled by assets. We include *Size* as larger insurers are likely to have advantages in accurately calculating reserves as they, for example, likely employ more actuaries (Aiuppa and Trieschmann 1987). *Product Diverse* and *Geo Herf* control for firm complexity, which is likely to increase the difficulty in correctly estimating the initial loss reserve. Managers of firms organized as mutuals are likely to have less discretion compared to managers of stock firms, so we include a mutual binary variable (Mayers et al. 1997; Cummins et al. 1999).[21] Firms organized as groups may reserve differently compared to unaffiliated firms, so we include a group indicator variable (Shin and Stulz 1998). Firms may also have incentives to smooth earnings and could underreserve in order to attain a positive profit (Beaver et al. 2003). We control for this incentive with *Small Profit*. Finally, prior literature has found evidence that financially weak insurers tend to underreserve (Petroni 1992; Grace and Leverty 2012). Similar to Grace and Leverty (2010, 2012) we regress a binary variable equal to one if an insurer became insolvent on an insurer's IRIS ratios and then use predicted values from this model as our measure of *Insolvent*.

[21] The insurance industry has multiple types of organizational forms, but stocks and mutuals are the most prominent. In firms organized as mutuals, policyholders act as the firms owners, whereas in stock firms the owners are the shareholders.

## 5. Results

### *Data*

Our data on insurer financial strength ratings come from A.M. Best from 1992 to 2008.[22] Other insurer characteristics come from insurer's annual statutory filings with the NAIC from 1991 to 2013.[23] We include only property-liability insurers domiciled in the United States. Life and health insurers are excluded, as their managers have less discretion in reserving practices due to the existence of well-established actuarial tables (Petroni 1992). Additionally, the statutory filings for life and health insurers do not contain sufficient data to calculate five-year loss reserve errors.

Our final sample consists of firms who have been rated by A.M. Best and have statements from annual statutory filings with the NAIC from 1991 to 2013. Our analysis is based on affiliated and unaffiliated individual insurers.[24,25] We keep only stock and mutual firms in our sample.[26] We exclude observations that are missing any of the variables needed for the analysis. Values of *Reinsurance*, *Geo Herf*, *Product Diverse*, and *Longtail* that are outside their theoretically possible range (i.e., less than zero or greater than one) are set equal to the bounded value. We exclude firms who have an A.M. Best financial strength rating that

[22]We would like to thank A.M. Best for providing the ratings data in electronic form.

[23]The reserve error calculation requires five years of data. For example, the 2003 reserve error is calculated using data from 2007. Therefore, the most recent five years of available data (2009-2013) are excluded.

[24]Some insurers are organized as a group, where they operate under common ownership with other insurance firms. For example, as of 2011, the Allstate Insurance Group is comprised of numerous subsidiaries, such as Allstate Fire and Casualty Insurance Company, Encompass Insurance Company, and Esurance Insurances Services. The NAIC statements provide financial information consolidated at the group level and also for each subsidiary. Approximately 80 percent of our sample firms are organized as groups, which is consistent with prior studies (Grace and Leverty 2010, 2012)

[25]Grace and Leverty (2010, 2012) conduct their analysis at the affiliated and unaffiliated single insurer level, but report that their results are robust to conducting analysis at the group and unaffiliated insurer level.

[26]This restriction results in the exclusion of Reciprocals, Lloyd's organizations, and Risk Retention Groups.

is lower than a "B-", as these firms are severely vulnerable to insolvency.[27] All continuous variables are winsorized at the one percent level.

Table 5 provides summary statistics for our sample. From 1992 to 2008, the sample consists of 18,680 firm-year observations which represents 1,909 unique firms. Using assets as a scaling factor, the average magnitude of *RE* is 0.0110. The median reserve error is positive, indicating that the majority of firms overreserved in our sample, which is consistent with prior studies on reserve errors (e.g., Beaver et al. 2003; Gaver and Paterson 2004; Grace and Leverty 2010). Specifically, 61.9 percent of the firm-years in our sample had a firm over-reserving. The average firm in the sample has an A.M. Best financial strength rating between "A-" and "A" (*Rating*=5.4781). The median rating is an "A" (*Rating*=6). The average value of *Difference* is -0.2170 which indicates that the average firm is below their expected financial strength rating.

***Main Results***

Table 6 provides the results from our OLS model examining whether deviation from a target financial strength rating is a significant determinant of insurer loss reserve errors. The dependent variable is loss reserve error scaled by total assets (*RE*). Standard errors are presented beneath each coefficient estimate in parentheses. Standard errors are bootstrapped and account for firm-level clustering. A potential issue with the analysis in Alissa et al. (2013) is that they do not account for the presence of an estimated independent variable in their estimation. Since we follow their methodology, *Difference* contains an estimate (from our ordered probit models) of each firm's target rating. We perform 1,000 bootstrap replications to deal with any issues related to *Difference* being a generated regressor (Pagan 1984).[28]

[27] This is consistent with Alissa et al. (2013), who find that their results do not change based on restricting their sample to firms with an S&P rating greater than "B-."

[28] In untabulated results, we also perform feasible generalized least squares estimation of our model. Prior studies, such as Grace and Leverty (2012) use this methodology in estimating the determinants of reserve errors. Our results are statistically consistent with the results presented in the paper.

Column (1) of Table 6 provides a baseline model that does not include any variables controlling for deviations from a target financial strength rating. The results in column (2) include *Difference* as an independent variable. The estimated coefficient of *Difference* is positive and statistically significant at the one percent level. This is consistent with our hypothesis and provides evidence that firms above (below) their target financial strength rating tend to over- (under-)reserve. This is also consistent with the results in Alissa et al. (2013). However, as with Alissa et al. (2013), this construction of *Difference* does not allow us to disentangle asymmetric incentives to manage reserves whether a firm is above or below their target rating. As noted above, we, therefore, create two new variables, *Above Target* and *Below Target*, to be equal to the number of notches above or below a firm's actual rating relative to their target rating (*Above Target* (*Below Target*) is set to zero if the firm is below (above) their target).[29] The results from this model are presented in column (3) of Table 6. These results are consistent with an asymmetric response to being above and below a target rating. Specifically, the estimated coefficient of *Above Target* is not statistically significant, providing empirical evidence that firms with a rating above their target do not appear to manage reserves. However, the estimated coefficient of *Below Target* is negative and statistically significant at the one percent level. This provides empirical support for our hypothesis that firms with a rating below their target tend to underreserve (income-increasing discretionary accruals). Taken together, these results also suggest that firms have more incentive to manage reserves when their actual rating is below their target rating, but not when their actual rating is above their target rating.

The results in columns (2) and (3) of Table 6 use a full set of control variables to calculate our *Difference*, and also, therefore, our *Above Target* and *Below Target* variables. In columns

[29]We also perform the empirical tests using binary variables to represent whether a firm is above or below their target rating. The current method captures both the asymmetric response as well as the distance from a target rating. The results are consistent when using a binary variable to only capture the asymmetric response.

(4) and (5) of Table 6 we use the alternative approach to estimating target ratings using a firm's IRIS ratios. These results are consistent with those in columns (2) and (3). The estimated coefficient of *Difference* is significant and positive, which is consistent with our hypothesis. Again, however, when we allow for an asymmetric response to being above a target rating or below a target rating, we only find evidence of reserve management for firms below their target rating. Specifically, the estimated coefficient of *Above Target* is not statistically significant, but the estimated coefficient of *Below Target* is significant at the five percent level and is negative, indicating an association with underreserving.

Overall, the results in columns (2), (3), (4), and (5) of Table 6 provide empirical support for our hypothesis that firms manage reserves to achieve a target financial strength rating. In addition, we find evidence that this result is driven by firms whose actual ratings are below their estimated target ratings. These firms tend to underreserve, whereas firms whose actual ratings are above their target ratings do not tend to manage reserves.

***Natural Experiment: Commercial Insurers***

A particular advantage of focusing on the P&L insurance industry is that we have a subset of firms for whom we can identify an (essentially) exogenously determined target rating. Specifically, P&L insurers who write predominantly commercial lines have particularly strong incentives to target a rating of at least "A-." Prior research, such as Epermanis and Harrington (2006) and Halek and Eckles (2010), find evidence that a rating of "A-" is particularly important for commercial insurers. Measurement error associated with our prior definition of a target rating (and the definition used by Alissa et al. (2013)) is substantially reduced in these current tests, as we no longer rely on estimating a target rating.[30]

In order to test whether insurers particularly target a rating of "A-," we again employ the two ordinary least squares (OLS) regression models introduced in Section 4. We estimate

[30] Again, Alissa et al. (2013) do consider an investment grade cut-off. However, the incentive for firms to meet this investment grade requirement will vary by firm. Our subsample of commercial insurers will face a much more consistent incentive to meet the "A-" rating requirement.

equations (4) and (5) and define the target rating as "A-" for all firms. Hence, the *Above Target* (*Below Target*) variable becomes *Above A-* (*Below A-*). In the second model, we decompose *Difference* into firms that are above and below their target rating, in this case "A-." *Above A-* is equal to *Difference* if *Difference* is positive, and zero otherwise. *Below A-* is equal to negative one times *Difference* if *Difference* is negative, and zero otherwise. This allows us to capture an asymmetric resposne to being above or below a rating of "A-." In this case we focus on firms operating in commercial lines, since a rating of "A-" is particularly important for these firms. Accordingly, we estimate this model for firms writing at least a certain amount of commercial lines.[31] Specifically, we estimate both equations ((4) and (5) with a target of "A-") separately for firms writing more than 60, 70, 80, and 90 percent of net premiums written in commercial lines. We also estimate models for firms writing exclusively in commercial lines of business. As in our main model, we expect to observe a positive estimated coefficient for *Difference*. In addition, we expect to observe a positive coefficient estimate on *Above A-* and a negative coefficient estimate on *Below A-*. We also expect the magnitude of the coefficient estimate for *Below A-* to be larger than the coefficient estimate for *Above A-*.

Table 7 provides OLS estimates of the determinants of reserve errors for firms writing more than 60, 70, 80, and 90 percent of their annual net written premiums in commercial lines (we also estimate the model for insurers who write 100 percent of premiums in commercial lines). The dependent variable is reserve error scaled by total assets (*RE*). Columns (1), (3), (5), (7), and (9) are models where *Difference* is the variable of interest. We predict a positive and significant relationship between *Difference* and *RE*. In columns (2), (4), and (6), the variables of interest are *Below A-*, where we predict a negative sign, and *Above A-*, where

[31] Consistent with Cummins and Xie (2013) we define the following lines as commercial: fire, allied lines, commercial multi peril, mortgage guaranty, ocean marine, inland marine, financial guaranty, medical malpractice, group accident and health, credit accident and health, workers' compensation, other liability, products liability, commercial auto liability, aircraft, fidelity, surety, burglary and theft, boiler and machinery, credit, international, and reinsurance.

we predict a positive sign. However, if there is an asymmetric response to being above or below a target rating, we would fail to find significance for the estimated coefficient of *Above A-*. Columns (1) and (2) are for firms writing more than 60 percent of net premiums written in commercial lines, columns (2) and (3) are for firms writing more than 70 percent of net premiums written in commercial lines, columns (5) and (6) are for firms writing more than 80 percent of net premiums written in commercial lines, columns (7) and (8) are for firms writing more than 90 percent of net premiums written in commercial lines, and columns (9) and (10) are for firms writing 100 percent of net premiums written in commercial lines. Standard errors are presented beneath each coefficient estimate and are clustered at the firm level.[32] All regressions include year fixed-effects.

Overall, the results in Table 7 are consistent across the five subsets of commercial-lines focused firms. In columns (1), (3), and (5), the estimated coefficient of *Difference* is significant and positive. This is consistent with firms with ratings above "A-" over-reserving and firms with ratings below "A-" under-reserving. However, the estimated coefficients for *Difference* for the subsets of the most commercial-focused firms are not statistically different from zero (columns (7) and (9)).

Additionally, we again find an asymmetric response once we include variables that separate above- and below-target firms with only below-target firms showing any evidence of reserve management. Specifically, the results in columns (2), (4), (6), (8), and (10) provide empirical evidence that firms below their target rating of "A-" tend to underreserve. The estimated coefficient of *Below A-* is negative and significant at the one percent level in all five models. We also note that the estimated coefficient increases in magnitude as firms write proportionally more commerical lines. However, we do not find statistical significance on *Above A-* in any of the models where it is included. Here, using an "exogenously"

[32]Even though *Difference* is not estimated in these models, we still bootstrap the standard errors since *Insolvent* is an estimated regressor.

given rating target, we find qualitatively similar results from before with an estimated rating target.

Finally, we repeat this analysis for a subset of firms with more than 60, 70, 80, and 90 percent of premiums written in non-commercial lines (including firms with 100 percent of premiums in non-commercial lines). If the above analysis was simply a reflection of the importance of "A-" to all insurers, or even a systematic prevalence of under-reserving at lower ratings levels, we would expect to find the same results. If, however, "A-" represents a unique, specific target for commercial insurers, we would find no results on the non-commercial insurers. In general, Table 8 shows *no* significant earnings management for non-commercial insurers below the "A-" ratings threshold.[33,34] The lack of significance on the *Below A-* variable for these non-commercial insurers provides evidence that 1) "A-" is an appropriate exogenous ratings target for commercial insurers and 2) there is no systematic under-reserving by lower rated firms.

***Additional Tests***

One potential issue with the analysis in Alissa et al. (2013) and our prior analysis is the question of whether we are accurately capturing a firm's true target financial strength rating. We now consider two alternative measures, in addition to our natural experiment, of a firm's target financial strength rating.

*Past Ratings as Target Ratings*

Another potential way to measure a firm's target financial strength rating is to examine a firm's past rating. If a firm's target is relatively consistent over time and a firm generally is at its target rating, this measure should capture a firm's target rating and any deviation from it in the current period. Accordingly, we calculate three alternative targets using a

[33]There is some limited evidence of earnings management (downward) for non-commercial insurers above the "A-" threshold in two (of five) specifications.

[34]We also continue to show a significant coefficient on *Difference*, suggesting potential interpretation concerns when not considering the asymmetric incentives.

firm's past rating. Specifically, we use a firm's prior year rating (*Rating* in $t-1$) as well as the firm's rolling average financial strength rating over the past two, three, four, and five years. For each of these measures of target, we construct *Difference* as before, where it is a firm's *Rating* minus its target rating. We then re-estimate equation (4), again controlling for discretionary and non-discretionary determinants of a firm's loss reserve error. We also estimate models including variables representing if a firm is above or below its target rating instead of *Difference* to examine whether the incentive to manage reserves is stronger for above-target or below-target rating firms. *Above Target* is defined as *Difference* if a firm's actual rating is above their target rating, and zero otherwise. *Below Target* is defined as negative one times *Difference* if a firm's actual rating is below their target rating, and zero otherwise.

Table 9 provides results for our OLS estimation of the determinants of insurer reserve error. The variable of interest in columns (1), (3), (5), (7), and (9) is *Difference* while the variables of interest in columns (2), (4), (6), (8), and (10) are *Above Target* and *Below Target*. Columns (1) and (2) use a firm's rating in year $t-1$ as a measure of target, columns (3) and (4) use a firm's average rating over the past two years as a target rating, columns (5) and (6) use a firm's average rating over the past three years as a target rating, columns (7) and (8) use a firm's average rating over the past four years, and columns (9) and (10) use a firm's average rating over the past five years. All models include year fixed effects. Firm-level clustered standard errors are presented beneath each coefficient estimate. Standard errors are caluclated from 1,000 bootstrap replications to account for the presence of an estimated regressor, *Insolvent*.

In all five models including *Difference* (columns (1), (3), (5), (7), and (9)) the estimated coefficient of *Difference* is positive and statistically significant. This empirical result is consistent with both our hypothesis as well as our previous empirical results. In our models allowing for an asymmetric response to above-target firms and below-target firms, we find evidence that below-target firms tend to understate reserves, while we find almost no evidence of reserve management for above-target firms. Specifically, we find a negative and statistically significant estimated coefficient on all five models including *Below Target* (columns (2), (4), (6), (8), and (10)). We find significance in only one instance (column (2)) for the estimated coefficient of *Above Target*, and in the single case where it is significant, it is significant at only the ten percent level.

Taken together, these results are, again, consistent with firms below their target having strong incentives to manage reserves to achieve their target rating, but firms above their target having little incentive to achieve a lower rating. The combined result using past ratings to measure a firm's target rating are consistent with our prior results and with those of Alissa et al. (2013) (using the ordered probit model to estimate a target rating). As before, extending Alissa et al. (2013), our results suggest, however, that firms are mainly incentivized to manage reserves when they are below a target, but not above a target.

*Alternative Target Rating Estimation*

Prior empirical work in corporate finance has examined the speed with which firms adjust to their target capital structure (Hovakimian et al. 2001; Flannery and Rangan 2006). Hence, an alternative to measuring target rating is to apply the methods of studies which examine the adjustment towards target capital structures. However, instead of a target leverage, a target rating is utilized. The limitation is that leverage is a continuous variable, while rating is discrete. The methodology of calculating target leverage generally relies on using a lagged dependent variable (leverage normally, but financial strength rating in our case). Unfortunately, there is no well-established econometric method to include a lagged dependent variable in an ordered probit model, which is how studies would normally estimate a ratings-determinants model (Doherty and Phillips 2002). We, therefore, run the model treating

*Rating* as though it were continuous. While this has clear limitations, taken with our prior evidence, this can provide additional support for our hypotheses.

In adopting the Flannery and Rangan (2006) model, we first model a firm's target financial strength rating as a function of various firm characteristics related to firm insolvency risk:

$$Rating^*_{i,t} = \beta X_{i,t-1} \tag{6}$$

where $Rating^*$ is a firm's target financial strength rating and $X$ is a vector of firm characteristics related to a firm's financial strength rating. We use the same variables in this model as we used previously in the ordered probit estimation (see Section 4).

In the absence of any frictions, we would expect a firm to always be at its target rating. However, in the presence of frictions, there is the potential for a firm to deviate. In this case, we would expect a firm to make adjustments to move towards its target rating. Again, taking from the Flannery and Rangan (2006) model, the partial adjustment model is as follows:

$$Rating_{i,t} - Rating_{i,t-1} = \lambda \left( Rating^*_{i,t} - Rating_{t-1} \right) + \delta_{i,t} \tag{7}$$

where each year a firm closes a certain proportion of the gap between it's actual rating (*Rating*) and its target rating ($Rating^*$). This proportion of the gap is $\lambda$ in equation (7). We substitute equation (6) into equation (7), which provides the following model:

$$Rating_{i,t} = \lambda \beta X_{i,t-1} + (1 - \lambda)\, Rating_{i,t-1} + \delta_{i,t} \tag{8}$$

We now empirically estimate this model, where *Rating* is a function of a firm's past rating (at $t-1$) and a vector of firm-specific characteristics. We can specifically estimate the value of the speed of adjustment, $\lambda$. Next, we rearrange equation (7) to yield an empirical estimate of a target rating as follows:

$$Rating^*_{i,t} = \frac{1}{\lambda}\left[Rating_{i,t} - Rating_{i,t-1} - \delta_{i,t}\right] + Rating_{i,t-1} \quad (9)$$

We then calculate *Difference* as before, where *Difference* is defined as *Rating* minus *Rating*$^*$ from equation (9). We estimate equation (4) with this alternative definition of target rating. We also, as in our prior analysis, provide results for a model including variables—*Above Target* and *Below Target*—that allow for an asymmetric response to being above or below a target rating. As in prior sections, *Above Target* is defined as *Difference* if a firm's actual rating is above their target rating, and zero otherwise and *Below Target* is defined as negative one times *Difference* if a firm's actual rating is below their target rating, and zero otherwise. As noted, this methodology produces a continuous target rating variable, *Rating*$^*$. With this construction, firms will only be at their target rating if *Rating*$^*$ is *exactly* equal to *Rating*. We, therefore, round values of *Rating*$^*$ to create a discrete target rating variable.[35]

Table 10 provides OLS estimates of models estimating the determinants of loss reserve errors scaled by total assets. Column (1) includes *Difference* as the variable of interest, while column (2) includes variables for firms above their target rating (*Above Target*) and for firms below their target rating (*Below Target*). Standard errors are included in parentheses beneath each coefficient estimate. Standard errors account for firm-level clustering. Standard errors are bootstrapped to account for the presence of estimated regressors (Pagan 1984). Both models include year fixed-effects.

The results in column (1) of Table 10 are consistent with firms above their target rating over-reserving and firms below their target rating under-reserving. However, in our second model, which allows us to identify whether this is driven by above- or below-target firms, we find evidence that firms below their target rating underreserve, as seen in the negative

[35] For example, target rating is defined as being equal to 4 for values of *Rating*$^*$ between 3.5 and 4.5.

estimated coefficient of *Below Target*, while we fail to find evidence of reserve management for firms above their target rating. These results are consistent with our prior results.

*Falsification Test*

To further examine the relation between reserve management and deviations from target ratings, we perform a falsification test. It is possible that our defined target ratings are not accurately measuring a firm's true target rating. One way to attempt to rule out this possibility—beyond our previously stated rationale for why each of our chosen targets is a good measure—is to assign targets randomly and see if our findings hold. If our findings no longer hold when targets are random, this provides credibility for our measure of target ratings.

Accordingly, we randomly assign a value of *Difference* between -6 and 5 (as observed in our data) to each firm on our sample. We then back out a firm's target rating from this assignment of *Difference*, and truncate for impossible values (e.g., if a firm has a target that is higher than the highest possible rating). We then estimate equation (5), and examine the sign and significance of the coefficient estimates for *Above Target* and *Below Target*. We perform this procedure 250 times and count how often the coefficient estimate of *Above Target* (*Below Target*) was statistically significant and positive (negative).

Out of our 250 repetitions, the estimated coefficient of *Above Target* was positive and significant at the five (one) percent level in 5.2 (1.2) percent of our repetitions. The estimated coefficient of *Below Target* was negative and significant at the five (one) percent level in 8.0 (2.4) percent of our repetitions. Overall, these results suggest that randomly assigning target ratings does not produce the results we observe when we select theoretically consistent targets. The results of these falsification tests are consistent with our hypotheses suggesting that firms asymmetrically manage reserves in response to targeted ratings.

***External Monitoring***

We next examine whether external monitoring can mitigate the behavior of firms below their target ratings. We have provided empirical evidence in this paper that firms below their target rating tend to understate their reserves. Extant studies in the area of loss reserve management have examined the interaction between external monitors (i.e., auditors) and reserve management (e.g., Petroni and Beasley 1996; Gaver and Paterson 2001, 2007). We propose that high quality external auditing can detect and prevent management of the loss reserve in an attempt to achieve a target financial strength rating. In examining insurer loss reserves, we consider not only the audit firm, but also the external actuaries responsible for the "Statement of Actuarial Opinion" which speaks to the adequacy of the loss reserve. Gaver and Paterson (2001) find evidence that high quality auditing and also a high quality external actuary is necessary to prevent biased loss reserves. We therefore examine whether the combination of "high quality" auditing and actuaries results in a reduced ability of firms below their target rating to underreserve.

For this empirical analysis, the identify of the external auditor and the external actuarial firm responsible for auditing each firm's statutory filing is needed. This information is reported in the statutory filings each year, but is only available in the data provided from the NAIC from 2005 to 2008.[36] Therefore, we perform our analysis on the sub-sample of firms with available information on the audit firm and actuarial firm from 2005 to 2008.

Consistent with Gaver and Paterson (2001), we construct a binary variable (*Big 4*) that is equal to one if a firm's financial statements were examined by both a Big 4 auditor and a Big 4 actuary and zero otherwise.[37] We include this variable in equation 4 and

[36]Specifically, this data is available in the annual statutory filings on the "General Interrogatories" page. The identity of the audit firm is data item "9 What is the name and address of the independent certified public accountant or accounting firm retained to conduct the annual audit?" The identity of the actuarial firm is data item "10 What is the name, address and affiliation (officer/employee of the reporting entity or actuary/consultant associated with an actuarial consulting firm) of the individual providing the statement of actuarial opinion/certification?"

[37]As in Gaver and Paterson (2001), a Big 4 actuarial firm is one that is affiliated with a Big 4 auditor.

also interact it with *Below Target* to examine whether it mitigates under-reserving.[38] We predict that if high quality external monitoring is effective in mitigating reserve management, the estimated coefficient on the interaction term *Big 4*Below Target* will be positive. We perform Wald tests to examine whether the overall effect of *Below Target* + *Big 4*Below Target* is statistically different from zero. A non-significant test statistic of the Wald test is consistent with high quality external monitoring reducing the ability of firms to manage reserves if they are below their target rating. In addition to testing this for our main model, we also examine whether external monitoring reduces reserve management using our test of commercial lines insurers.

The results of our main model are presented in Table 11. We present results from OLS models with standard errors presented beneath each coefficient estimate. We perform 1,000 bootstrap replications to account for the presence of an estimated regressor in these models. The dependent variable is the five-year reserve error scaled by total assets. All regressions include year fixed effects.

The results in column (1) of Table 11 are a re-estimation of equation 4. Since we are now examining a reduced sample due to the limited availability of data needed to construct our *Big 4* variable, we establish that our main result of a negative and significant estimated coefficient on *Below Target* holds during the sample period from 2005 to 2008. The results on column (2) of Table 11 include *Big 4*. The estimated coefficient on *Big 4* is not statistically different from zero. However, the negative and significant coefficient of *Below Target* remains.

The main result of interest in Table 11 is in column (3). Here, the estimated coefficient on the interaction term *Big 4*Below Target* is positive, but not significant. The *p*-value for the Wald test (presented at the bottom of Table 11) that the sum of the estimated coefficients of *Below Target* and *Big 4*Below Target* are not statistically different from zero fails to reject

[38]Since we find no evidence of above-target rating firms managing reserves, we do not interact *Big 4* with *Above Target*.

the null hypothesis ($p$-value = 0.6656). This provides empirical evidence that is consistent with high quality external monitoring mitigating the ability of firms to manage reserves if they are below their target financial strength rating.

Table 12 provides results for our commercial lines test of reserve management for commercial lines insurers including the *Big 4* indicator variable. Since a rating of "A-" is an exogenous rating we can take to be a target for firms writing predominantly in commercial lines, this provides a clean test of reserve management to achieve a target rating. As in the "*Commercial Insurers*" section, we examine insurers writing more than 60, 70, 80, and 90 percent of net premiums in commercial lines, as well as firms writing entirely in commercial lines. In columns (1), (3), (5), (7), and (9) we estimate models excluding *Big 4* to establish that our main results of a negative and significant estimated coefficient of *Below A-* hold on our reduced sample from 2005 to 2008 (which is when the data necessary to calculate *Big 4* is available). The results in columns (2), (4), (6), (8), and (10) of Table 12 include *Big 4* and the interaction term *Big 4*Below A-*. We perform a Wald test of whether the estimated coefficient of *Below A-* plus the estimated coefficient of *Big 4*Below A-* is statistically different from zero. Failure to reject the null provides empirical support for our hypothesis that high quality auditing reduces the ability of firms to manage earnings if they are below their target financial strength rating.

The results in columns (1), (3), (5), (7), and (9) indicate that that firms below a rating of "A-" tend to underreserve. The estimated coefficient of *Below A-* is negative and significant (at the one percent level) in all five models, indicating that our result holds for this subsample. In columns (2), (4), (6), (8), and (10) of Table 12, we include *Big 4* and the interaction term *Big 4*Below A-*. *Big 4* is significant in columns (2), (4), (6), and (10), and in this case it is negative, which is not consistent with higher quality monitoring resulting in more conservative financial reporting (as found in Gaver and Paterson (2001)). However, we find that the estimated coefficient of *Big 4*Below A-* is positive in all five models, though it is not statistically different from zero in three of the five models. The Wald tests that the sum of the estimated coefficients of *Below A-* and *Big 4*Below A-* are equal to zero are presented at the bottom of the table. In all five cases, the $p$-values indicate that the test fails to reject the null ($p$-values $> 0.10$ in all three cases). This result provides some empirical support for our hypothesis that firms below their target rating ("A-" in this case) do not tend to underreserve if they have both a Big 4 auditor and a Big 4 actuary. This is consistent with stronger external monitoring reducing the ability of firms to manage reserves.

## 6. Conclusion

Recent studies examine the relation between earnings management and ratings (Alissa et al. 2013; Demirtas and Cornaggia 2013; Jung et al. 2013). We extend the literature by examining the relation between earnings management—measured by insurer loss reserve errors—and financial strength ratings for a sample of property and liability insurance firms. We are specifically interested in the asymmetric incentives to manage earnings depending on whether a firm is above or below their target rating.

The P&L insurance industry is well-suited for this analysis for at least four reasons. First, measurement error in our earnings management proxy—insurer loss reserve errors—is significantly reduced compared to other common measures of earnings management. Second, we take advantage of a natural experiment by examining a subgroup of firms—firms operating predominantly in commercial lines—where we have an exogenously determined target rating. Third, P&L insurers are subject to external monitoring from actuaries in addition to auditors, allowing us to examine the role of external monitoring in mitigating earnings management. Fourth, we make use of insurer financial strength ratings as opposed to corporate debt ratings. These ratings serve to assess the financial strength of an entire enterprise as opposed to a single security.

Our primary contribution to the literature is to document that there is an asymmetric earnings management response depending on whether firms are above or below their target rating. Our empirical tests provide evidence that firms are only incentivized to manage earnings if they are below their target rating, but not if they are above. This is consistent with, but a substantial contribution beyond, the work of Alissa et al. (2013). Our main result is consistent across many robustness tests including in our natural experiment on commercial lines insurers.

We contribute to several streams of literature. First, we contribute to the literature examining earnings management incentives surrounding ratings (Alissa et al. 2013; Demirtas and Cornaggia 2013; Jung et al. 2013). We also specifically contribute to the literature examining insurer incentives to manage loss reserves (Petroni 1992; Beaver et al. 2003; Gaver and Paterson 2004; Grace and Leverty 2010). Our results provide evidence that in addition to previously hypothesized incentives to manage loss reserves, financial strength ratings are another determinant of insurer loss reserve errors. Finally, we contribute to the literature examining how external monitoring can influence insurer reserving (Petroni and Beasley 1996; Gaver and Paterson 2001, 2007). Our study provides evidence that external monitoring of Big 4 audit and actuarial firms can mitigate reserve manipulation related to deviations from a target financial strength rating.

## References


Aiuppa, T. A., and J. S. Trieschmann. 1987. An empirical analysis of the magnitude and accuracy of incurred-but-not-reported reserves. *Journal of Risk and Insurance* 54 (1): 100–118.

Alissa, W., S. B. Bonsall, IV, K. Koharki, and M. W. Penn. 2013. Firms' use of accounting discretion to influence their credit ratings. *Journal of Accounting and Economics* 55 (2): 129–147.

A.M. Best. 2014 Best's credit rating methodology: Global life and non-life insurance edition. Oldwick, N.J.

Beaver, W. H., and M. F. McNichols. 1998. The characteristics and valuation of loss reserves of property casualty insurers. *Review of Accounting Studies* 3 (1-2): 73–95.

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

Berger, L. A., J. D. Cummins, and S. Tennyson. 1992. Reinsurance and the liability insurance crisis. *Journal of Risk and Uncertainty* 5 (3): 253–272.

Berry-Stölzle, T. R., A. P. Liebenberg, J. S. Ruhland, and D. W. Sommer. 2012. Determinants of corporate diversification: Evidence from the property–liability insurance industry. *Journal of Risk and Insurance* 79 (2): 381–413.

Burgstahler, D. C., L. Hail, and C. Leuz. 2006. The importance of reporting incentives: Earnings management in european private and public firms. *The Accounting Review* 81 (5): 983–1016.

Cantor, R., and A. Metz. 2006 Moody's credit rating prediction model. Moody's Special Comment.

Cheng, J., and M. A. Weiss. 2012. The role of RBC, hurricane exposure, bond portfolio duration, and macroeconomic and industry-wide factors in property–liability insolvency prediction. *Journal of Risk and Insurance* 79 (3): 723–750.

Cummins, J. D., M. A. Weiss, and H. Zi. 1999. Organizational form and efficiency: The coexistence of stock and mutual property-liability insurers. *Management Science* 45 (9): 1254–1269.

Cummins, J. D., and X. Xie. 2013. Efficiency, productivity, and scale economies in the u.s. property–liability insurance industry. *Journal of Productivity Analysis* 39 (2): 141–164.

Dechow, P. M., R. G. Sloan, and A. P. Sweeney. 1995. Detecting earnings management. *The Accounting Review* 70 (2): 193–225.

Demirtas, K. O., and K. R. Cornaggia. 2013. Initial credit ratings and earnings management. *Review of Financial Economics* 22 (4): 135–145.

Dichev, I. D., and J. D. Piotroski. 2001. The long-run stock returns following bond ratings changes. *Journal of Finance* 56 (1): 173–203.

Doherty, N. A., A. V. Kartasheva, and R. D. Phillips. 2012. Information effect of entry into credit ratings market: The case of insurers' ratings. *Journal of Financial Economics* 106 (2): 723–750.

Doherty, N. A., and R. D. Phillips. 2002. Keeping up with the joneses: Changing rating standards and the buildup of capital by u.s. property-liability insurers. *Journal of Financial Services Research* 21 (1-2): 55–78.

Epermanis, K., and S. E. Harrington. 2006. Market discipline in property/casualty insurance: Evidence from premium growth surrounding changes in financial strength ratings. *Journal of Money, Credit & Banking* 38 (6): 1515–1544.

Flannery, M. J., and K. P. Rangan. 2006. Partial adjustment toward target capital structures. *Journal of Financial Economics* 79 (3): 469–506.

Gaver, J. J., and J. S. Paterson. 1999. Managing insurance company financial statements to meet regulatory and tax reporting goals. *Contemporary Accounting Research* 16 (2): 207–241.

Gaver, J. J., and J. S. Paterson. 2001. The association between external monitoring and earnings management in the property-casualty insurance industry. *Journal of Accounting Research* 39 (2): 269–282.

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

Gaver, J. J., and J. S. Paterson. 2007. The influence of large clients on office-level auditor oversight: Evidence from the property-casualty insurance industry. *Journal of Accounting and Economics* 43 (2): 299–320.

Gaver, J. J., J. S. Paterson, and C. J. Pacini. 2012. The influence of auditor state-level legal liability on conservative financial reporting in the property-casualty insurance industry. *Auditing: A Journal of Practice & Theory* 31 (3): 95–124.

Grace, E. V. 1990. Property-liability insurer reserve errors: A theoretical and empirical analysis. *Journal of Risk and Insurance* 57 (1): 28–46.

Grace, M. F., and J. T. Leverty. 2010. Political cost incentives for managing the property-liability insurer loss reserve. *Journal of Accounting Research* 48 (1): 21–49.

Grace, M. F., and J. T. Leverty. 2012. Property-liability insurer reserve error: Motive, manipulation, or mistake. *Journal of Risk and Insurance* 79 (2): 351–380.

Graham, J. R., and C. R. Harvey. 2001. The theory and practice of corporate finance: Evidence from the field. *Journal of Financial Economics* 60 (2): 187–243.

Halek, M., and D. L. Eckles. 2010. Effects of analysts' ratings on insurer stock returns: Evidence of asymmetric responses. *Journal of Risk and Insurance* 77 (4): 801–827.

Harrington, S. E., and P. M. Danzon. 1994. Price cutting in liability insurance markets. *Journal of Business* 67 (4): 511–38.

Holthausen, R. W., and R. W. Leftwich. 1986. The effect of bond rating changes on common stock prices. *Journal of Financial Economics* 17 (1): 57–89.

Hovakimian, A., T. Opler, and S. Titman. 2001. The debt-equity choice. *Journal of Financial and Quantitative Analysis* 36 (1): 1–24.

Jones, J. J. 1991. Earnings management during import relief investigations. *Journal of Accounting Research* 29 (2): 193–228.

Jung, B., N. Soderstrom, and Y. S. Yang. 2013. Earnings smoothing activities of firms to manage credit ratings. *Contemporary Accounting Research* 30 (2): 645–676.

Kisgen, D. J. 2006. Credit ratings and capital structure. *Journal of Finance* 61 (3): 1035–1072.

Kisgen, D. J. 2009. Do firms target credit ratings or leverage levels?. *Journal of Financial and Quantitative Analysis* 44 (6): 1323–1344.

Kothari, S. P., A. J. Leone, and C. E. Wasley. 2005. Performance matched discretionary accrual measures. *Journal of Accounting and Economics* 39 (1): 163–197.

Mayers, D., A. Shivdasani, and C. W. Smith, Jr. 1997. Board composition and corporate control: Evidence from the insurance industry. *Journal of Business* 70 (1): 33–62.

McNichols, M. F. 2000. Research design issues in earnings management studies. *Journal of Accounting and Public Policy* 19 (4-5): 313–345.

Nelson, K. K. 2000. Rate regulation, competition, and loss reserve discounting by property-casualty insurers. *The Accounting Review* 75 (1): 115–138.

Pagan, A. 1984. Econometric issues in the analysis of regressions with generated regressors. *International Economic Review* 25 (1): 221–247.

Petroni, K., and M. Beasley. 1996. Errors in accounting estimates and their relation to audit firm type. *Journal of Accounting Research* 34 (1): 151–171.

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

Petroni, K. R., S. G. Ryan, and J. M. Wahlen. 2000. Discretionary and non-discretionary revisions of loss reserves by property-casualty insurers: Differential implications for future profitability, risk and market value. *Review of Accounting Studies* 5 (2): 95–125.

Pottier, S. W., and D. W. Sommer. 1999. Property-liability insurer financial strength ratings: Differences across rating agencies. *Journal of Risk and Insurance* 66 (4): 621–642.

Pottier, S. W., and D. W. Sommer. 2002. The effectiveness of public and private sector summary risk measures in predicting insurer insolvencies. *Journal of Financial Services Research* 21 (1-2): 101–116.

Shin, H.-H., and R. M. Stulz. 1998. Are internal capital markets efficient?. *Quarterly Journal of Economics* 113 (2): 531–552.

Wade, C., A. Liebenberg, and B. M. Blau. 2015. Information and insurer financial strength ratings: Do short sellers anticipate ratings changes?. *Journal of Risk and Insurance* 83 (2): 475–500.

Weiss, M. 1985. A multivariate analysis of loss reserving estimates in property-liability insurers. *Journal of Risk and Insurance* 52 (2): 199–221.

## Table 1: Excerpt from Schedule P—Part 2

| | *Excerpt from the 2011 Annual Statement of ACE American Ins Co.* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *NAIC Property-Liability Annual Statement: Schedule P—Part 2—Summary* | | | | | | | | | |
| | *Incurred Net Losses and Defense and Cost Containment Expenses Reported at Year End ($000 omitted)* | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Accident Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
| Prior | 5,078,038 | 5,071,351 | 5,797,589 | 6,254,020 | 6,226,103 | 6,196,693 | 6,272,376 | 6,319,513 | 6,380,162 | 6,556,014 |
| 2002 | 1,500,643 | 1,577,357 | 1,781,499 | 1,694,376 | 1,764,741 | 1,730,440 | 1,693,571 | 1,701,902 | 1,710,655 | 1,698,728 |
| 2003 | | 2,287,425 | 2,070,036 | 2,193,082 | 2,128,955 | 2,009,994 | 2,005,987 | 1,950,893 | 1,965,579 | 1,922,897 |
| 2004 | | | 2,888,365 | 2,592,836 | 2,603,694 | 2,278,069 | 2,235,793 | 2,246,927 | 2,187,825 | 2,172,853 |
| 2005 | | | | 3,435,994 | 3,284,263 | 2,962,984 | 2,845,413 | 2,812,629 | 2,784,845 | 2,774,656 |
| 2006 | | | | | 3,062,746 | 2,886,813 | 2,880,132 | 2,813,843 | 2,753,745 | 2,601,211 |
| 2007 | | | | | | 3,285,381 | 3,003,720 | 2,927,313 | 2,893,535 | 2,896,689 |
| 2008 | | | | | | | 3,516,789 | 3,555,336 | 3,548,912 | 3,519,332 |
| 2009 | | | | | | | | 2,782,336 | 2,690,015 | 2,637,746 |
| 2010 | | | | | | | | | 2,942,142 | 2,952,660 |
| 2011 | | | | | | | | | | 3,452,200 |

Note: This table is an excerpt from the National Association of Insurance Commissioner's annual statutory filing. Schedule P—Part 2 data are used to construct loss reserve errors. Loss reserve errors are defined as $Error_{i,t} = Incurred\ Losses_{i,t} - Incurred\ Losses_{i,t+n}$. We use 5-year errors, so $n = 5$. For the firm-year represented in the above table, we sum the top 6 values in column 6, (which equal 19,070,502) and subtract from that the sum of values in column 11 (17,726,359). The loss reserve error equals 1,344,143. Here, the firm overreserved by approximately $1.3 billion. In general, a negative number indicates underreserving, while a positive value indicates overreserving.

Table 2: Distribution of Actual Ratings compared to Target Ratings

| | Target Rating | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Actual Rating | A++ | A+ | A | A- | B++ | B+ | B | B- | Total Actual |
| A++ | 213 | 446 | 496 | 111 | 0 | 0 | 0 | 0 | 1,266 |
| A+ | 147 | 966 | 1,704 | 674 | 1 | 0 | 1 | 0 | 3,493 |
| A | 74 | 848 | 2,702 | 1,750 | 0 | 7 | 1 | 0 | 5,382 |
| A- | 16 | 374 | 1,758 | 2,549 | 1 | 32 | 1 | 4 | 4,735 |
| B++ | 3 | 38 | 339 | 1,135 | 6 | 49 | 9 | 10 | 1,589 |
| B+ | 1 | 26 | 165 | 917 | 6 | 134 | 17 | 20 | 1,286 |
| B | 0 | 3 | 65 | 502 | 3 | 49 | 7 | 12 | 641 |
| B- | 0 | 1 | 14 | 210 | 1 | 34 | 7 | 21 | 288 |
| Total Expected | 454 | 2,702 | 7,243 | 7,848 | 18 | 305 | 43 | 67 | 18,860 |

Note: This table shows the distribution of actual financial strength ratings by target financial strength ratings. Target ratings are calculated based on estimation of equation (2). Expected ratings are the rating level with the highest fitted probability from equation (2). Actual ratings are presented by row and expected ratings are presented by column.

Table 3: Reserve Errors by Intersection of Actual and Target Ratings

| | Target Rating | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Actual Rating | A++ | A+ | A | A- | B++ | B+ | B | B- |
| A++ | -0.0203 | -0.0252 | -0.0314 | -0.0001 | 0.0026 | -0.0855 | -0.0402 | |
| A+ | 0.0244 | 0.0143 | 0.0012 | -0.0031 | 0.0332 | -0.0022 | -0.0038 | 0.2109 |
| A | 0.0125 | 0.0046 | 0.0100 | 0.0117 | 0.0085 | -0.0188 | -0.0122 | -0.0195 |
| A- | 0.0239 | 0.0079 | 0.0242 | 0.0243 | 0.0161 | 0.0135 | 0.0219 | -0.0123 |
| B++ | | -0.0946 | | 0.0813 | 0.0379 | 0.0574 | 0.0114 | 0.0016 |
| B+ | | | 0.0256 | 0.0016 | -0.0022 | 0.0197 | 0.0333 | -0.0075 |
| B | | | 0.0102 | 0.0307 | 0.0000 | 0.0562 | -0.1482 | -0.0076 |
| B- | | | | -0.0064 | 0.0629 | 0.0057 | | -0.0643 |

Note: This table shows the average loss reserve error by the intersection of actual and target rating. Positive values indicate over-reserving while negative values indicate under-reserving.

Table 4: Reversion to Target Ratings

| Dependent Variable: $\Delta Difference_{t+k}$ | | | |
|---|---|---|---|
| | t+1 | t+3 | t+5 |
| *Difference* | -0.1731*** | -0.3507*** | -0.4763*** |
| | (0.0056) | (0.0101) | (0.0133) |
| Intercept | -0.0190*** | -0.0312*** | -0.0599*** |
| | (0.0056) | (0.0118) | (0.0168) |
| $R^2$ | 9.46% | 19.96% | 27.73% |
| Observations | 16,093 | 12,927 | 10,178 |

Note: This table reports results from ordinary least squares regressions.The dependent variable is $\Delta Difference_{t+k}$. *Difference* is *Rating* minus a firm's target rating. *t*-statistics are presented in parentheses beneath each coefficient estimate. ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

Table 5: Descriptive Statistics

| Variable | Mean | Std. | Min | Percentiles 10$^{th}$ | 25$^{th}$ | 50$^{th}$ | 75$^{th}$ | 90$^{th}$ | Max |
|---|---|---|---|---|---|---|---|---|---|
| *RE* | 0.0110 | 0.0904 | -0.4560 | -0.0753 | -0.0148 | 0.0121 | 0.0489 | 0.0972 | 0.3407 |
| *Rating* | 5.4781 | 1.5276 | 1.0000 | 3.0000 | 5.0000 | 6.0000 | 7.0000 | 7.0000 | 8.0000 |
| *Difference* | -0.2170 | 1.3101 | -6.0000 | -2.0000 | -1.0000 | 0.0000 | 1.0000 | 1.0000 | 5.0000 |
| *Size* | 18.4088 | 1.7389 | 13.4680 | 16.2661 | 17.1387 | 18.2846 | 19.5631 | 20.7887 | 22.8629 |
| *Reinsurance* | 0.3813 | 0.2864 | 0.0000 | 0.0388 | 0.1309 | 0.3233 | 0.5992 | 0.8226 | 1.0000 |
| *Tax Shield* | 0.0292 | 0.0441 | -0.1721 | -0.0167 | 0.0102 | 0.0298 | 0.0499 | 0.0740 | 0.2226 |
| *Geo Herf* | 0.5232 | 0.3744 | 0.0441 | 0.0703 | 0.1441 | 0.4598 | 1.0000 | 1.0000 | 1.0000 |
| *Mutual* | 0.2448 | 0.4300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 1.0000 | 1.0000 |
| *Product Diverse* | 0.4688 | 0.3068 | 0.0000 | 0.0000 | 0.1518 | 0.5656 | 0.7162 | 0.8013 | 1.0000 |
| *Longtail* | 0.6745 | 0.2793 | 0.0000 | 0.1013 | 0.6160 | 0.7347 | 0.8517 | 0.9913 | 1.0000 |
| *Group* | 0.7675 | 0.4225 | 0.0000 | 0.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| *Growth* | 0.1864 | 1.0045 | -2.0068 | -0.1889 | -0.0391 | 0.0518 | 0.1664 | 0.4237 | 10.2893 |
| *Small Profit* | 0.0336 | 0.1801 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 1.0000 |
| *Small Loss* | 0.0100 | 0.0996 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 1.0000 |
| *Profit* | 0.7551 | 0.4300 | 0.0000 | 0.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| *Insolvent* | 0.0131 | 0.0163 | 0.0000 | 0.0000 | 0.0007 | 0.0093 | 0.0207 | 0.0308 | 0.7058 |
| *ROA* | 0.0278 | 0.0447 | -0.2254 | -0.0180 | 0.0089 | 0.0286 | 0.0488 | 0.0728 | 0.2204 |
| *ROI* | 0.0447 | 0.0207 | -0.0123 | 0.0216 | 0.0317 | 0.0432 | 0.0558 | 0.0681 | 0.1294 |
| *Hurricane* | 0.2225 | 0.3166 | 0.0000 | 0.0000 | 0.0000 | 0.0712 | 0.2962 | 0.8952 | 1.0000 |
| *Kenny Ratio* | 1.1023 | 0.7383 | 0.0000 | 0.2164 | 0.5339 | 1.0021 | 1.5485 | 2.0982 | 4.3884 |
| *Earthquake* | 0.0018 | 0.0064 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0004 | 0.0040 | 0.0512 |
| *Surplus-to-Assets* | 0.4275 | 0.1830 | 0.0387 | 0.2361 | 0.2936 | 0.3815 | 0.5219 | 0.7082 | 0.9999 |

Note: This table reports descriptive statistics for the years 1992 to 2008. The full sample is 18,680 firm-years, consisting of 1,909 unique firms. *RE* is the five-year loss reserve error scaled by total assets. *Rating* is a firm's A.M. Best financial strength rating, where 8 corresponds to the highest rating ("A++") and 1 corresponds to the lowest rating ("B-"). *Difference* is the difference between *Rating* and a firm's target rating. *Size* is the natural log of total assets. *Reinsurance* is reinsurance ceded divided by direct premiums plus reinsurance assumed. *Tax Shield* is a firm's net income plus developed reserves divided by total assets. *Geo Herf* is the geographic Herfindahl index. *Mutual* is a binary variable equal to 1 if a firm is a mutual and 0 otherwise. *Product Diverse* is 1 minus the line of business Herfindahl index. *Longtail* is the proportion of premiums written in longtailed lines. *Group* is a binary variable equal to 1 for a group and 0 otherwise. *Growth* is the one year change in net premiums written. *Small Profit* is a binary variable equal to 1 if a firm has earnings in the bottom 5 percent of the earnings distribution. *Small Loss* is a binary variable equal to 1 if a firm has earnings in the top 5 percent of the negative earnings distribution. *Profit* is a binary variable equal to 1 if a firm has earnings in the top 90 percent of the positive earnings distribution. *Insolvent* is an estimated probability of insolvency based on IRIS ratios. *ROA* is a firm's net income scaled by total assets. *ROI* is a firm's net investment income divided by total assets. *Hurricane* is the percentage of a firm's direct premiums written in hurricane-prone states. *Kenny Ratio* is net premiums written divided by policyholder surplus. *Earthquake* is the percentage of net premiums written in earthquake insurance. *Surplus-to-Assets* is policyholder surplus divided by total assets.

## Table 6: Main Regression Results

Dependent Variable: Reserve Error

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| *Difference* | | 0.0041*** | | 0.0019* | |
| | | (0.0010) | | (0.0010) | |
| *Above Target* | | | -0.0009 | | -0.0009 |
| | | | (0.0016) | | (0.0017) |
| *Below Target* | | | -0.0070*** | | -0.0036** |
| | | | (0.0017) | | (0.0016) |
| *Size* | -0.0021** | -0.0022** | -0.0024** | -0.0021** | -0.0022** |
| | (0.0010) | (0.0009) | (0.0010) | (0.0010) | (0.0010) |
| *Reinsurance* | -0.0353*** | -0.0356*** | -0.0355*** | -0.0360*** | -0.0359*** |
| | (0.0045) | (0.0045) | (0.0046) | (0.0045) | (0.0045) |
| *Tax Shield* | 0.1723*** | 0.1789*** | 0.1787*** | 0.1684*** | 0.1682*** |
| | (0.0307) | (0.0299) | (0.0301) | (0.0301) | (0.0301) |
| *Geo Herf* | 0.0073* | 0.0076* | 0.0082* | 0.0076* | 0.0079* |
| | (0.0044) | (0.0044) | (0.0045) | (0.0043) | (0.0043) |
| *Mutual* | 0.0081** | 0.0081** | 0.0078** | 0.0078** | 0.0076** |
| | (0.0037) | (0.0036) | (0.0036) | (0.0038) | (0.0038) |
| *Product Diverse* | -0.0005 | -0.0008 | -0.0017 | -0.0008 | -0.0013 |
| | (0.0053) | (0.0053) | (0.0052) | (0.0054) | (0.0052) |
| *Longtail* | 0.0188*** | 0.0191*** | 0.0196*** | 0.0192*** | 0.0196*** |
| | (0.0060) | (0.0061) | (0.0057) | (0.0059) | (0.0058) |
| *Group* | 0.0008 | 0.0004 | 0.0011 | 0.0000 | 0.0004 |
| | (0.0046) | (0.0044) | (0.0047) | (0.0046) | (0.0046) |
| *Growth* | -0.0001 | -0.0002 | -0.0002 | -0.0003 | -0.0003 |
| | (0.0007) | (0.0007) | (0.0007) | (0.0007) | (0.0007) |
| *Small Profit* | -0.0080** | -0.0077* | -0.0076** | -0.0078* | -0.0078** |
| | (0.0038) | (0.0039) | (0.0039) | (0.0041) | (0.0037) |
| *Small Loss* | -0.0058 | -0.0063 | -0.0067 | -0.0060 | -0.0063 |
| | (0.0059) | (0.0061) | (0.0061) | (0.0059) | (0.0063) |
| *Profit* | 0.0086*** | 0.0075*** | 0.0071** | 0.0083*** | 0.0081*** |
| | (0.0028) | (0.0028) | (0.0029) | (0.0029) | (0.0029) |
| *Insolvent* | -0.0522 | -0.0436 | -0.0298 | -0.0498 | -0.0440 |
| | (0.1369) | (0.1258) | (0.1299) | (0.1301) | (0.1314) |
| Intercept | 0.0384** | 0.0418** | 0.0481** | 0.0398** | 0.0434** |
| | (0.0191) | (0.0188) | (0.0196) | (0.0198) | (0.0195) |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 8.22% | 8.56% | 8.70% | 8.29% | 8.33% |
| Wald $\chi^2$ | 707.42 | 736.57 | 717.18 | 728.36 | 670.92 |
| Observations | 18,680 | 18,680 | 18,680 | 18,680 | 18,680 |

Note: This table reports coefficient estimates from OLS estimation. The dependent variable, *RE* is a firm's loss reserve error scaled by total assets. *Difference* is a firm's financial strength rating (*Rating*) minus a firm's target rating. *Above Target* is equal to *Difference* if *Difference* is positive and 0 otherwise. *Below Target* is equal to -1 times *Difference* if *Difference* is negative and 0 otherwise. *Size* is the natural log of total assets. *Reinsurance* is reinsurance ceded divided by direct premiums plus reinsurance assumed. *Tax Shield* is a firm's net income plus developed reserves divided by total assets. *Geo Herf* is the geographic Herfindahl index. *Mutual* is a binary variable equal to 1 if a firm is a mutual and 0 otherwise. *Product Diverse* is 1 minus the line of business Herfindahl index. *Longtail* is the proportion of premiums written in longtailed lines. *Group* is a binary variable equal to 1 for a group and 0 otherwise. *Growth* is the one year change in net premiums written. *Small Profit* is a binary variable equal to 1 if a firm has earnings in the bottom 5 percent of the earnings distribution. *Small Loss* is a binary variable equal to 1 if a firm has earnings in the top 5 percent of the negative earnings distribution. *Profit* is a binary variable equal to 1 if a firm has earnings in the top 90 percent of the positive earnings distribution. *Insolvent* is an estimated probability of insolvency based on IRIS ratios. Standard errors are presented beneath each coefficient estimate. Bootstrapped standard errors are from 1,000 replications and account for firm-level clustering. ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

# Table 7: Commercial Lines Regression Results

Dependent Variable: Reserve Error

| | >60% | | >70% | | >80% | | >90% | | =100% | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| *Difference* | 0.0037*** | | 0.0037** | | 0.0042** | | 0.0034 | | 0.0042 | |
| | (0.0014) | | (0.0016) | | (0.0021) | | (0.0024) | | (0.0029) | |
| *Above A-* | | -0.0010 | | -0.0017 | | -0.0027 | | -0.0053* | | -0.0063 |
| | | (0.0018) | | (0.0022) | | (0.0027) | | (0.0032) | | (0.0048) |
| *Below A-* | | -0.0091*** | | -0.0101*** | | -0.0124*** | | -0.0126*** | | -0.0127*** |
| | | (0.0026) | | (0.0031) | | (0.0036) | | (0.0040) | | (0.0043) |
| *Size* | -0.0046*** | -0.0043*** | -0.0054*** | -0.0051*** | -0.0064*** | -0.0060*** | -0.0060*** | -0.0055*** | -0.0020 | -0.0018 |
| | (0.0014) | (0.0014) | (0.0015) | (0.0016) | (0.0019) | (0.0017) | (0.0021) | (0.0021) | (0.0029) | (0.0027) |
| *Reinsurance* | -0.0373*** | -0.0362*** | -0.0388*** | -0.0377*** | -0.0396*** | -0.0384*** | -0.0413*** | -0.0393*** | -0.0355** | -0.0324** |
| | (0.0060) | (0.0056) | (0.0068) | (0.0068) | (0.0080) | (0.0076) | (0.0091) | (0.0089) | (0.0147) | (0.0145) |
| *Tax Shield* | 0.1485*** | 0.1465*** | 0.1510*** | 0.1490*** | 0.1515*** | 0.1490*** | 0.1413*** | 0.1392*** | 0.1280* | 0.1309* |
| | (0.0376) | (0.0382) | (0.0434) | (0.0423) | (0.0476) | (0.0477) | (0.0520) | (0.0515) | (0.0751) | (0.0788) |
| *Geo Herf* | 0.0028 | 0.0034 | 0.0021 | 0.0028 | 0.0009 | 0.0017 | 0.0005 | 0.0015 | 0.0086 | 0.0091 |
| | (0.0053) | (0.0052) | (0.0057) | (0.0062) | (0.0069) | (0.0068) | (0.0078) | (0.0077) | (0.0108) | (0.0101) |
| *Mutual* | 0.0132*** | 0.0128*** | 0.0177*** | 0.0169*** | 0.0223*** | 0.0212*** | 0.0263*** | 0.0254*** | 0.0213** | 0.0211** |
| | (0.0051) | (0.0047) | (0.0062) | (0.0059) | (0.0078) | (0.0075) | (0.0089) | (0.0087) | (0.0103) | (0.0103) |
| *Product Diverse* | -0.0010 | -0.0025 | 0.0042 | 0.0029 | 0.0125 | 0.0112 | 0.0143* | 0.0130 | 0.0482*** | 0.0472*** |
| | (0.0058) | (0.0054) | (0.0067) | (0.0067) | (0.0077) | (0.0076) | (0.0081) | (0.0081) | (0.0102) | (0.0096) |
| *Longtail* | 0.0260*** | 0.0258*** | 0.0266*** | 0.0264*** | 0.0277*** | 0.0273*** | 0.0319*** | 0.0310*** | 0.0393*** | 0.0369*** |
| | (0.0062) | (0.0062) | (0.0066) | (0.0065) | (0.0067) | (0.0067) | (0.0069) | (0.0070) | (0.0089) | (0.0089) |
| *Group* | -0.0081 | -0.0075 | -0.0098 | -0.0094 | -0.0104 | -0.0099 | -0.0109 | -0.0100 | -0.0185** | -0.0171** |
| | (0.0056) | (0.0054) | (0.0064) | (0.0065) | (0.0070) | (0.0067) | (0.0075) | (0.0075) | (0.0088) | (0.0087) |
| *Growth* | 0.0003 | 0.0002 | 0.0007 | 0.0006 | 0.0011 | 0.0010 | 0.0008 | 0.0007 | -0.0017 | -0.0019 |
| | (0.0008) | (0.0008) | (0.0010) | (0.0010) | (0.0010) | (0.0011) | (0.0012) | (0.0012) | (0.0017) | (0.0017) |
| *Small Profit* | -0.0020 | -0.0023 | -0.0022 | -0.0026 | -0.0021 | -0.0026 | 0.0003 | -0.0008 | -0.0045 | -0.0062 |
| | (0.0047) | (0.0048) | (0.0056) | (0.0059) | (0.0070) | (0.0070) | (0.0079) | (0.0080) | (0.0127) | (0.0127) |
| *Small Loss* | -0.0113 | -0.0124 | -0.0144 | -0.0156 | -0.0231* | -0.0244* | -0.0316 | -0.0330* | -0.0326 | -0.0337 |
| | (0.0085) | (0.0085) | (0.0110) | (0.0108) | (0.0140) | (0.0142) | (0.0192) | (0.0186) | (0.0278) | (0.0269) |
| *Profit* | 0.0139*** | 0.0140*** | 0.0163*** | 0.0164*** | 0.0203*** | 0.0204*** | 0.0238*** | 0.0237*** | 0.0318*** | 0.0306*** |
| | (0.0037) | (0.0036) | (0.0044) | (0.0042) | (0.0048) | (0.0048) | (0.0056) | (0.0054) | (0.0081) | (0.0083) |
| *Insolvent* | -0.1044 | -0.0903 | -0.0894 | -0.0772 | -0.0975 | -0.0850 | -0.1476 | -0.1368 | -0.2539 | -0.2312 |
| | (0.1540) | (0.1456) | (0.1591) | (0.1535) | (0.1753) | (0.1736) | (0.2133) | (0.2034) | (0.2978) | (0.2871) |
| Constant | 0.0738*** | 0.0742*** | 0.0882*** | 0.0893*** | 0.1075*** | 0.1097*** | 0.1048** | 0.1062** | 0.0271 | 0.0347 |
| | (0.0286) | (0.0269) | (0.0306) | (0.0330) | (0.0380) | (0.0351) | (0.0428) | (0.0421) | (0.0546) | (0.0522) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Wald $\chi^2$ | 650.20 | 685.08 | 605.47 | 613.40 | 433.04 | 431.04 | 320.01 | 372.04 | 184.32 | 204.12 |
| $R^2$ | 10.20% | 10.44% | 10.70% | 11.00% | 10.80% | 11.23% | 10.89% | 11.44% | 12.97% | 13.52% |
| Observations | 14,674 | 14,674 | 12,039 | 12,039 | 9,644 | 9,644 | 7,694 | 7,694 | 3,923 | 3,923 |

Note: This table reports results from OLS regressions. The dependent variable (*RE*) is loss reserve error scaled by total assets. *Difference* is a firm's actual financial strength rating (*Rating*) minus a firm's target rating ("A-"). *Above A-* is equal to *Difference* if *Difference* is positive and 0 otherwise. *Below A-* is equal to -1 times *Difference* if *Difference* is negative and 0 otherwise. *Size* is the natural log of total assets. *Reinsurance* is reinsurance ceded divided by direct premiums plus reinsurance assumed. *Tax Shield* is a firm's net income plus developed reserves divided by total assets. *Geo Herf* is the geographic Herfindahl index. *Mutual* is a binary variable equal to 1 if a firm is a mutual and 0 otherwise. *Product Diverse* is 1 minus the line of business Herfindahl index. *Longtail* is the proportion of premiums written in longtailed lines. *Group* is a binary variable equal to 1 for a group and 0 otherwise. *Growth* is the one year change in net premiums written. *Small Profit* is a binary variable equal to 1 if a firm has earnings in the bottom 5 percent of the earnings distribution. *Small Loss* is a binary variable equal to 1 if a firm has earnings in the top 5 percent of the negative earnings distribution. *Profit* is a binary variable equal to 1 if a firm has earnings in the top 90 percent of the positive earnings distribution. *Insolvent* is an estimated probability of insolvency based on IRIS ratios. All regressions include year indicators. Standard errors are presented beneath each coefficient estimate in parentheses. Bootstrapped standard errors are from 1,000 replications and account for firm-level clustering. ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

# Table 8: Non-Commercial Lines Regression Results

Dependent Variable: Reserve Error

| | >60% | | >70% | | >80% | | >90% | | =100% | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| *Difference* | 0.0050*** | | 0.0066*** | | 0.0057** | | 0.0056** | | -0.0038 | |
| | (3.2323) | | (3.3200) | | (2.5491) | | (2.2070) | | (-0.7141) | |
| *Above A-* | | 0.0064** | | 0.0075** | | 0.0057 | | 0.0068 | | 0.0171 |
| | | (2.1917) | | (2.1870) | | (1.5456) | | (1.5654) | | (1.4363) |
| *Below A-* | | -0.0038 | | -0.0058 | | -0.0057 | | -0.0046 | | 0.0163 |
| | | (-1.2657) | | (-1.6056) | | (-1.5067) | | (-0.9515) | | (1.3343) |
| *Size* | -0.0009 | -0.0011 | 0.0004 | 0.0003 | 0.0001 | 0.0001 | 0.0003 | 0.0002 | -0.0025 | -0.0039 |
| | (-0.5146) | (-0.5673) | (0.1663) | (0.1206) | (0.0264) | (0.0294) | (0.0960) | (0.0635) | (-0.3709) | (-0.5785) |
| *Reinsurance* | -0.0208*** | -0.0211*** | -0.0169** | -0.0172** | -0.0165* | -0.0165* | -0.0107 | -0.0110 | 0.0076 | -0.0030 |
| | (-2.8700) | (-2.8143) | (-1.9880) | (-2.0162) | (-1.6901) | (-1.7131) | (-0.9164) | (-0.9773) | (0.3872) | (-0.1612) |
| *Tax Shield* | 0.0818* | 0.0820* | 0.0691 | 0.0693 | 0.0304 | 0.0304 | 0.0299 | 0.0302 | 0.1015 | 0.1304 |
| | (1.9301) | (1.9281) | (1.4816) | (1.4574) | (0.5961) | (0.5786) | (0.5206) | (0.5091) | (0.5824) | (0.7032) |
| *Geo Herf* | 0.0022 | 0.0021 | 0.0033 | 0.0031 | -0.0012 | -0.0012 | 0.0049 | 0.0048 | 0.0037 | 0.0118 |
| | (0.2963) | (0.2839) | (0.3857) | (0.3594) | (-0.1265) | (-0.1269) | (0.4537) | (0.4498) | (0.1466) | (0.4671) |
| *Mutual* | -0.0079 | -0.0078 | -0.0104 | -0.0103 | -0.0074 | -0.0074 | -0.0138 | -0.0139 | -0.1102* | -0.1127* |
| | (-1.2366) | (-1.2564) | (-1.3697) | (-1.3440) | (-0.8248) | (-0.7937) | (-0.9811) | (-0.9386) | (-1.8757) | (-1.9573) |
| *Product Diverse* | -0.0188** | -0.0187** | -0.0220** | -0.0219** | -0.0158 | -0.0158 | -0.0150 | -0.0148 | 0.2198* | 0.2789** |
| | (-2.2158) | (-2.1412) | (-2.2306) | (-2.2007) | (-1.5586) | (-1.5715) | (-1.2818) | (-1.2618) | (1.8440) | (2.0087) |
| *Longtail* | 0.0112 | 0.0114 | 0.0162 | 0.0163 | 0.0107 | 0.0107 | 0.0170 | 0.0168 | 0.0518** | 0.0503** |
| | (0.8684) | (0.8995) | (1.1444) | (1.1153) | (0.6654) | (0.6829) | (0.9066) | (0.9555) | (2.1833) | (2.0618) |
| *Group* | 0.0052 | 0.0050 | 0.0057 | 0.0055 | 0.0112 | 0.0112 | 0.0128 | 0.0127 | 0.0304 | 0.0258 |
| | (0.8407) | (0.8190) | (0.7561) | (0.7192) | (1.3603) | (1.3842) | (1.2500) | (1.2534) | (1.2787) | (1.1133) |
| *Growth* | -0.0000 | 0.0000 | 0.0007 | 0.0008 | 0.0008 | 0.0008 | 0.0014 | 0.0014 | -0.0005 | -0.0002 |
| | (-0.0068) | (0.0300) | (0.6495) | (0.6775) | (0.7310) | (0.7213) | (1.1187) | (1.1059) | (-0.1428) | (-0.0733) |
| *Small Profit* | -0.0266*** | -0.0266*** | -0.0317** | -0.0317** | -0.0229* | -0.0229* | -0.0154 | -0.0151 | 0.0068 | 0.0123 |
| | (-3.2658) | (-3.1556) | (-2.4132) | (-2.3657) | (-1.6788) | (-1.7543) | (-0.9320) | (-0.9834) | (0.2813) | (0.4905) |
| *Small Loss* | -0.0610* | -0.0611** | -0.0872** | -0.0873** | -0.0924 | -0.0924 | -0.1178* | -0.1182 | -0.0039 | -0.0149 |
| | (-1.9147) | (-2.0123) | (-2.1992) | (-2.0542) | (-1.6169) | (-1.6194) | (-1.6793) | (-1.5922) | (-0.1748) | (-0.6247) |
| *Profit* | -0.0048 | -0.0048 | -0.0051 | -0.0052 | -0.0036 | -0.0036 | -0.0002 | -0.0003 | -0.0162 | -0.0157 |
| | (-0.9446) | (-0.9957) | (-0.7933) | (-0.8318) | (-0.4834) | (-0.4905) | (-0.0266) | (-0.0287) | (-0.6760) | (-0.6304) |
| *Insolvent* | -0.3256* | -0.3276* | -0.3757** | -0.3770** | -0.3575* | -0.3574* | -0.3114 | -0.3127 | -0.2799 | -0.3244 |
| | (-1.7536) | (-1.7509) | (-2.0296) | (-2.0274) | (-1.7224) | (-1.6858) | (-1.3518) | (-1.3424) | (-0.6058) | (-0.7122) |
| Intercept | 0.0587 | 0.0592 | 0.0344 | 0.0350 | 0.0472 | 0.0472 | 0.0297 | 0.0299 | 0.0454 | 0.0458 |
| | (1.4456) | (1.4452) | (0.7369) | (0.7487) | (0.8404) | (0.8742) | (0.4627) | (0.4586) | (0.3479) | (0.3463) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Wald $\chi^2$ | 115.92 | 110.52 | 105.74 | 124.64 | 121.85 | 114.19 | 91.41 | 91.74 | | |
| $R^2$ | 5.49% | 5.51% | 6.79% | 6.80% | 7.24% | 7.24% | 7.92% | 7.93% | 22.72% | 21.09% |
| Observations | 3,323 | 3,323 | 2,444 | 2,444 | 1,890 | 1,890 | 1,507 | 1,507 | 286 | 286 |

Note: This table reports results from OLS regressions. The dependent variable (*RE*) is loss reserve error scaled by total assets. *Difference* is a firm's actual financial strength rating (*Rating*) minus a firm's target rating ("A-"). *Above A-* is equal to *Difference* if *Difference* is positive and 0 otherwise. *Below A-* is equal to -1 times *Difference* if *Difference* is negative and 0 otherwise. *Size* is the natural log of total assets. *Reinsurance* is reinsurance ceded divided by direct premiums plus reinsurance assumed. *Tax Shield* is a firm's net income plus developed reserves divided by total assets. *Geo Herf* is the geographic Herfindahl index. *Mutual* is a binary variable equal to 1 if a firm is a mutual and 0 otherwise. *Product Diverse* is 1 minus the line of business Herfindahl index. *Longtail* is the proportion of premiums written in longtailed lines. *Group* is a binary variable equal to 1 for a group and 0 otherwise. *Growth* is the one year change in net premiums written. *Small Profit* is a binary variable equal to 1 if a firm has earnings in the bottom 5 percent of the earnings distribution. *Small Loss* is a binary variable equal to 1 if a firm has earnings in the top 5 percent of the negative earnings distribution. *Profit* is a binary variable equal to 1 if a firm has earnings in the top 90 percent of the positive earnings distribution. *Insolvent* is an estimated probability of insolvency based on IRIS ratios. All regressions include year indicators. Standard errors are presented beneath each coefficient estimate in parentheses. Bootstrapped standard errors are from 1,000 replications and account for firm-level clustering (we do not cluster the results in columns (9) and (10) due to sample-size restrictions). ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

# Table 9: Past Rating as Target Results

Dependent Variable: Reserve Error

| | Last Year | | Last 2 Years | | Last 3 Years | | Last 4 Years | | Last 5 Years | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| *Difference* | 0.0045*** | | 0.0047*** | | 0.0049*** | | 0.0037** | | 0.0036* | |
| | (0.0014) | | (0.0016) | | (0.0018) | | (0.0018) | | (0.0019) | |
| *Above Target* | | 0.0038* | | 0.0039 | | 0.0036 | | 0.0016 | | -0.0008 |
| | | (0.0021) | | (0.0024) | | (0.0026) | | (0.0028) | | (0.0030) |
| *Below Target* | | -0.0052** | | -0.0055** | | -0.0063** | | -0.0059** | | -0.0084*** |
| | | (0.0022) | | (0.0025) | | (0.0026) | | (0.0029) | | (0.0031) |
| *Size* | -0.0020** | -0.0020** | -0.0015 | -0.0016 | -0.0014 | -0.0014 | -0.0010 | -0.0011 | -0.0005 | -0.0006 |
| | (0.0009) | (0.0009) | (0.0010) | (0.0010) | (0.0010) | (0.0011) | (0.0011) | (0.0011) | (0.0012) | (0.0013) |
| *Reinsurance* | -0.0321*** | -0.0321*** | -0.0303*** | -0.0303*** | -0.0285*** | -0.0285*** | -0.0276*** | -0.0275*** | -0.0252*** | -0.0249*** |
| | (0.0045) | (0.0045) | (0.0049) | (0.0047) | (0.0053) | (0.0054) | (0.0061) | (0.0062) | (0.0068) | (0.0066) |
| *Tax Shield* | 0.1563*** | 0.1563*** | 0.1402*** | 0.1402*** | 0.1366*** | 0.1366*** | 0.1497*** | 0.1492*** | 0.1412** | 0.1398** |
| | (0.0335) | (0.0343) | (0.0380) | (0.0377) | (0.0444) | (0.0438) | (0.0511) | (0.0487) | (0.0585) | (0.0591) |
| *Geo Herf* | 0.0022 | 0.0022 | 0.0031 | 0.0032 | 0.0051 | 0.0052 | 0.0063 | 0.0064 | 0.0070 | 0.0071 |
| | (0.0043) | (0.0042) | (0.0043) | (0.0045) | (0.0048) | (0.0050) | (0.0052) | (0.0054) | (0.0057) | (0.0058) |
| *Mutual* | 0.0066* | 0.0066* | 0.0049 | 0.0048 | 0.0021 | 0.0021 | 0.0017 | 0.0016 | 0.0008 | 0.0007 |
| | (0.0035) | (0.0036) | (0.0035) | (0.0036) | (0.0040) | (0.0038) | (0.0041) | (0.0043) | (0.0043) | (0.0042) |
| *Product Diverse* | -0.0034 | -0.0035 | -0.0005 | -0.0006 | 0.0023 | 0.0022 | 0.0054 | 0.0053 | 0.0089 | 0.0087 |
| | (0.0054) | (0.0053) | (0.0057) | (0.0059) | (0.0063) | (0.0063) | (0.0069) | (0.0070) | (0.0080) | (0.0078) |
| *Longtail* | 0.0235*** | 0.0235*** | 0.0238*** | 0.0239*** | 0.0236*** | 0.0237*** | 0.0243*** | 0.0245*** | 0.0254*** | 0.0258*** |
| | (0.0062) | (0.0061) | (0.0061) | (0.0063) | (0.0071) | (0.0069) | (0.0078) | (0.0076) | (0.0086) | (0.0087) |
| *Group* | 0.0010 | 0.0011 | 0.0011 | 0.0011 | 0.0012 | 0.0012 | 0.0011 | 0.0012 | 0.0002 | 0.0004 |
| | (0.0046) | (0.0043) | (0.0046) | (0.0048) | (0.0052) | (0.0050) | (0.0056) | (0.0053) | (0.0058) | (0.0058) |
| *Growth* | 0.0011 | 0.0011 | 0.0014* | 0.0014* | 0.0014 | 0.0014 | 0.0020* | 0.0020* | 0.0023* | 0.0023* |
| | (0.0007) | (0.0007) | (0.0007) | (0.0007) | (0.0010) | (0.0010) | (0.0011) | (0.0011) | (0.0012) | (0.0012) |
| *Small Profit* | -0.0074* | -0.0075* | -0.0073 | -0.0073* | -0.0088* | -0.0089* | -0.0097* | -0.0098* | -0.0051 | -0.0054 |
| | (0.0043) | (0.0042) | (0.0045) | (0.0044) | (0.0052) | (0.0051) | (0.0059) | (0.0056) | (0.0059) | (0.0060) |
| *Small Loss* | -0.0121 | -0.0122 | -0.0095 | -0.0096 | -0.0063 | -0.0065 | -0.0071 | -0.0073 | -0.0086 | -0.0091 |
| | (0.0082) | (0.0084) | (0.0079) | (0.0079) | (0.0082) | (0.0084) | (0.0088) | (0.0087) | (0.0096) | (0.0097) |
| *Profit* | 0.0078*** | 0.0077*** | 0.0096*** | 0.0095*** | 0.0074** | 0.0073** | 0.0055 | 0.0053 | 0.0052 | 0.0049 |
| | (0.0030) | (0.0030) | (0.0031) | (0.0031) | (0.0035) | (0.0034) | (0.0038) | (0.0037) | (0.0043) | (0.0043) |
| *Insolvent* | -0.1237 | -0.1224 | -0.0674 | -0.0657 | -0.3381** | -0.3356** | -0.4143** | -0.4092** | -0.4443** | -0.4330** |
| | (0.1564) | (0.1582) | (0.1601) | (0.1661) | (0.1688) | (0.1661) | (0.1797) | (0.1693) | (0.1747) | (0.1768) |
| Intercept | 0.0346* | 0.0348* | 0.0212 | 0.0215 | 0.0411** | 0.0345 | 0.0317 | 0.0335 | 0.0189 | 0.0218 |
| | (0.0206) | (0.0205) | (0.0210) | (0.0207) | (0.0206) | (0.0217) | (0.0225) | (0.0229) | (0.0255) | (0.0257) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Wald $\chi^2$ | 562.12 | 584.37 | 427.60 | 445.54 | 324.54 | 360.79 | 237.64 | 264.15 | 229.74 | 232.98 |
| $R^2$ | 7.21% | 7.21% | 6.57% | 6.57% | 6.58% | 6.59% | 6.79% | 6.80% | 7.34% | 7.42% |
| Observations | 17,855 | 17,855 | 15,343 | 15,343 | 12,581 | 12,581 | 10,265 | 10,265 | 8,257 | 8,257 |

Note: This table reports results from OLS regressions. The dependent variable is loss reserve error scaled by total assets. *Difference* is the difference between *Rating* and a firm's target rating. *Above Target* is equal to *Difference* if *Difference* is positive and 0 otherwise. *Below Target* is equal to -1 times *Difference* if *Difference* is negative and 0 otherwise. Each column uses a different lag of *Rating* as a measure of target rating. *Size* is the natural log of total assets. *Reinsurance* is reinsurance ceded divided by direct premiums plus reinsurance assumed. *Tax Shield* is a firm's net income plus developed reserves divided by total assets. *Geo Herf* is the geographic Herfindahl index. *Mutual* is a binary variable equal to 1 if a firm is a mutual and 0 otherwise. *Product Diverse* is 1 minus the line of business Herfindahl index. *Longtail* is the proportion of premiums written in longtailed lines. *Group* is a binary variable equal to 1 for a group and 0 otherwise. *Growth* is the one year change in net premiums written. *Small Profit* is a binary variable equal to 1 if a firm has earnings in the bottom 5 percent of the earnings distribution. *Small Loss* is a binary variable equal to 1 if a firm has earnings in the top 5 percent of the negative earnings distribution. *Profit* is a binary variable equal to 1 if a firm has earnings in the top 90 percent of the positive earnings distribution. *Insolvent* is an estimated probability of insolvency based on IRIS ratios. All regressions include year indicators. Standard errors are presented beneath each coefficient estimate in parentheses. Bootstrapped standard errors are from 1,000 replications and account for firm-level clustering. ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

## Table 10: Target Rating Model Results

| Dependent Variable: Reserve Error | (1) | (2) |
|---|---|---|
| *Difference* | 0.0020*** | |
| | (0.0007) | |
| *Above Target* | | 0.0005 |
| | | (0.0015) |
| *Below Target* | | -0.0026*** |
| | | (0.0009) |
| *Size* | -0.0021** | -0.0021** |
| | (0.0010) | (0.0010) |
| *Reinsurance* | -0.0368*** | -0.0363*** |
| | (0.0048) | (0.0047) |
| *Tax Shield* | 0.1659*** | 0.1660*** |
| | (0.0298) | (0.0302) |
| *Geo Herf* | 0.0056 | 0.0059 |
| | (0.0045) | (0.0047) |
| *Mutual* | 0.0053 | 0.0052 |
| | (0.0037) | (0.0037) |
| *Product Diverse* | -0.0004 | -0.0008 |
| | (0.0055) | (0.0054) |
| *Longtail* | 0.0218*** | 0.0218*** |
| | (0.0064) | (0.0064) |
| *Group* | 0.0012 | 0.0013 |
| | (0.0048) | (0.0048) |
| *Growth* | 0.0003 | 0.0003 |
| | (0.0008) | (0.0008) |
| *Small Profit* | -0.0077* | -0.0077* |
| | (0.0041) | (0.0044) |
| *Small Loss* | -0.0135 | -0.0136 |
| | (0.0087) | (0.0085) |
| *Profit* | 0.0064** | 0.0063** |
| | (0.0027) | (0.0028) |
| *Insolvent* | -0.1111 | -0.1098 |
| | (0.1611) | (0.1644) |
| Intercept | 0.0485** | 0.0499** |
| | (0.0209) | (0.0217) |
| Year FE | Yes | Yes |
| $R^2$ | 7.87% | 7.88% |
| Wald $\chi^2$ | 587.76 | 570.26 |
| Observations | 16,066 | 16,066 |

Note: This table reports results from OLS regressions. The dependent variable (*RE*) is loss reserve error scaled by total assets. *Difference* is the difference between *Rating* and a firm's target rating. *Above Target* is equal to *Difference* if *Difference* is positive and 0 otherwise. *Below Target* is equal to -1 times *Difference* if *Difference* is negative and 0 otherwise. Standard errors are presented in parentheses beneath each coefficient estimate. Standard errors are from 1,000 bootstrap replications. ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

## Table 11: Main Model with External Monitoring

Dependent Variable: Reserve Error

| | (1) | (2) | (3) |
|---|---|---|---|
| *Above Target* | -0.0015 | -0.0015 | -0.0013 |
| | (0.0024) | (0.0025) | (0.0024) |
| *Below Target* | -0.0063** | -0.0063** | -0.0090*** |
| | (0.0027) | (0.0027) | (0.0033) |
| *Big 4* | | -0.0035 | -0.0013 |
| | | (0.0038) | (0.0040) |
| *Big 4*Below Target* | | | 0.0074 |
| | | | (0.0045) |
| *Size* | -0.0017 | -0.0017 | -0.0021* |
| | (0.0011) | (0.0011) | (0.0011) |
| *Reinsurance* | -0.0243*** | -0.0245*** | -0.0254*** |
| | (0.0059) | (0.0055) | (0.0057) |
| *Tax Shield* | 0.1901*** | 0.1883*** | 0.1937*** |
| | (0.0440) | (0.0457) | (0.0458) |
| *Geo Herf* | 0.0005 | 0.0003 | 0.0006 |
| | (0.0055) | (0.0053) | (0.0054) |
| *Mutual* | -0.0062 | -0.0061 | -0.0062 |
| | (0.0040) | (0.0040) | (0.0040) |
| *Product Diverse* | 0.0168** | 0.0167*** | 0.0170** |
| | (0.0065) | (0.0064) | (0.0067) |
| *Longtail* | 0.0391*** | 0.0391*** | 0.0391*** |
| | (0.0073) | (0.0072) | (0.0073) |
| *Group* | -0.0048 | -0.0045 | -0.0056 |
| | (0.0050) | (0.0051) | (0.0049) |
| *Growth* | -0.0008 | -0.0008 | -0.0009 |
| | (0.0014) | (0.0015) | (0.0014) |
| *Small Profit* | -0.0101 | -0.0101 | -0.0101 |
| | (0.0071) | (0.0066) | (0.0070) |
| *Small Loss* | -0.0121 | -0.0123 | -0.0117 |
| | (0.0124) | (0.0122) | (0.0119) |
| *Profit* | 0.0030 | 0.0030 | 0.0029 |
| | (0.0043) | (0.0043) | (0.0043) |
| *Insolvent* | 0.0059 | 0.0039 | -0.0146 |
| | (0.1458) | (0.1445) | (0.1466) |
| Intercept | 0.0348 | 0.0344 | 0.0428* |
| | (0.0228) | (0.0227) | (0.0233) |
| Year FE | Yes | Yes | Yes |
| *Below Target+Big 4*Below Target* = 0 | | | 0.6656 |
| $R^2$ | 6.00% | 6.04% | 6.26% |
| Wald $\chi^2$ | 134.51 | 139.92 | 131.41 |
| Observations | 4,239 | 4,239 | 4,239 |

Note: This table reports results from OLS regressions. The dependent variable (*RE*) is loss reserve error scaled by total assets. *Difference* is the difference between *Rating* and a firm's target rating. *Above Target* is equal to *Difference* if *Difference* is positive and 0 otherwise. *Below Target* is equal to -1 times *Difference* if *Difference* is negative and 0 otherwise. *Big 4* is a binary variable equal to 1 if a firm had both a Big 4 auditor and a Big 4 actuary and 0 otherwise. Standard errors are presented in parentheses beneath each coefficient estimate. Standard errors are from 1,000 bootstrap replications. ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

# Table 12: Commercial Lines Results with External Monitoring

Dependent Variable: Reserve Error

| | >60% | | >70% | | >80% | | >90% | | =100% | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| *Above A-* | 0.0025 | 0.0029 | 0.0036 | 0.0040 | 0.0033 | 0.0040 | 0.0014 | 0.0023 | -0.0009 | -0.0006 |
| | (0.0023) | (0.0024) | (0.0027) | (0.0028) | (0.0032) | (0.0032) | (0.0042) | (0.0042) | (0.0065) | (0.0068) |
| *Below A-* | -0.0122*** | -0.0148*** | -0.0143*** | -0.0183*** | -0.0177*** | -0.0248*** | -0.0196*** | -0.0271*** | -0.0221*** | -0.0281*** |
| | (0.0037) | (0.0041) | (0.0046) | (0.0045) | (0.0055) | (0.0055) | (0.0056) | (0.0057) | (0.0076) | (0.0086) |
| *Big 4* | | -0.0080* | | -0.0095* | | -0.0104* | | -0.0068 | | -0.0262** |
| | | (0.0044) | | (0.0052) | | (0.0064) | | (0.0075) | | (0.0131) |
| *Big 4*Below A-* | | 0.0079 | | 0.0114 | | 0.0178* | | 0.0191* | | 0.0162 |
| | | (0.0075) | | (0.0096) | | (0.0100) | | (0.0109) | | (0.0155) |
| *Size* | -0.0030** | -0.0032** | -0.0037** | -0.0040** | -0.0041** | -0.0048** | -0.0038* | -0.0045** | -0.0031 | -0.0030 |
| | (0.0014) | (0.0015) | (0.0017) | (0.0016) | (0.0020) | (0.0019) | (0.0022) | (0.0022) | (0.0035) | (0.0036) |
| *Reinsurance* | -0.0302*** | -0.0310*** | -0.0322*** | -0.0327*** | -0.0369*** | -0.0375*** | -0.0367*** | -0.0366*** | -0.0287 | -0.0300* |
| | (0.0070) | (0.0070) | (0.0079) | (0.0077) | (0.0090) | (0.0089) | (0.0099) | (0.0101) | (0.0175) | (0.0169) |
| *Tax Shield* | 0.0552 | 0.0512 | 0.0587 | 0.0568 | 0.0448 | 0.0433 | 0.0214 | 0.0242 | 0.0982 | 0.1020 |
| | (0.0935) | (0.0912) | (0.1035) | (0.1023) | (0.1068) | (0.1111) | (0.1213) | (0.1217) | (0.1680) | (0.1741) |
| *Geo Herf* | 0.0024 | 0.0016 | 0.0025 | 0.0012 | 0.0061 | 0.0040 | 0.0053 | 0.0030 | 0.0166 | 0.0141 |
| | (0.0064) | (0.0060) | (0.0072) | (0.0070) | (0.0081) | (0.0080) | (0.0093) | (0.0091) | (0.0136) | (0.0134) |
| *Mutual* | 0.0011 | 0.0010 | 0.0030 | 0.0027 | 0.0073 | 0.0071 | 0.0079 | 0.0082 | 0.0086 | 0.0072 |
| | (0.0054) | (0.0055) | (0.0068) | (0.0065) | (0.0080) | (0.0079) | (0.0090) | (0.0090) | (0.0116) | (0.0119) |
| *Product Diverse* | 0.0115* | 0.0116* | 0.0117 | 0.0114 | 0.0167* | 0.0164* | 0.0233** | 0.0226** | 0.0723*** | 0.0692*** |
| | (0.0065) | (0.0063) | (0.0080) | (0.0082) | (0.0092) | (0.0093) | (0.0099) | (0.0097) | (0.0137) | (0.0130) |
| *Longtail* | 0.0402*** | 0.0396*** | 0.0406*** | 0.0398*** | 0.0415*** | 0.0406*** | 0.0426*** | 0.0417*** | 0.0462*** | 0.0436*** |
| | (0.0078) | (0.0074) | (0.0076) | (0.0079) | (0.0082) | (0.0082) | (0.0084) | (0.0084) | (0.0108) | (0.0108) |
| *Group* | -0.0081 | -0.0092 | -0.0103 | -0.0117* | -0.0120 | -0.0145* | -0.0111 | -0.0143* | -0.0136 | -0.0152 |
| | (0.0067) | (0.0063) | (0.0072) | (0.0069) | (0.0078) | (0.0083) | (0.0090) | (0.0085) | (0.0118) | (0.0113) |
| *Growth* | 0.0003 | 0.0003 | 0.0006 | 0.0005 | 0.0012 | 0.0011 | 0.0012 | 0.0011 | 0.0009 | 0.0006 |
| | (0.0015) | (0.0016) | (0.0016) | (0.0015) | (0.0017) | (0.0017) | (0.0019) | (0.0020) | (0.0028) | (0.0028) |
| *Small Profit* | -0.0057 | -0.0033 | -0.0040 | -0.0014 | -0.0037 | 0.0003 | 0.0068 | 0.0099 | 0.0212 | 0.0247 |
| | (0.0096) | (0.0099) | (0.0109) | (0.0104) | (0.0110) | (0.0109) | (0.0126) | (0.0125) | (0.0245) | (0.0226) |
| *Small Loss* | -0.0102 | -0.0107 | -0.0127 | -0.0135 | -0.0152 | -0.0160 | -0.0033 | -0.0050 | 0.0419** | 0.0367** |
| | (0.0141) | (0.0131) | (0.0162) | (0.0148) | (0.0185) | (0.0184) | (0.0258) | (0.0245) | (0.0202) | (0.0182) |
| *Profit* | 0.0133* | 0.0139* | 0.0141* | 0.0144* | 0.0171* | 0.0175* | 0.0257** | 0.0250** | 0.0341** | 0.0329** |
| | (0.0072) | (0.0071) | (0.0082) | (0.0086) | (0.0093) | (0.0092) | (0.0107) | (0.0106) | (0.0159) | (0.0164) |
| *Insolvent* | -0.0409 | -0.0596 | -0.0345 | -0.0588 | -0.0239 | -0.0551 | -0.0682 | -0.0960 | 0.0623 | 0.0346 |
| | (0.2210) | (0.2147) | (0.2922) | (0.2532) | (0.2577) | (0.2469) | (0.2785) | (0.2571) | (0.4697) | (0.4801) |
| Intercept | 0.0592* | 0.0652** | 0.0746** | 0.0839** | 0.0797* | 0.0969** | 0.0671 | 0.0854* | 0.0247 | 0.0322 |
| | (0.0303) | (0.0325) | (0.0351) | (0.0333) | (0.0420) | (0.0394) | (0.0455) | (0.0450) | (0.0683) | (0.0693) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *Below A-*+*Big 4*Below A-* = 0 | | 0.3077 | | 0.4284 | | 0.4511 | | 0.4184 | | 0.3787 |
| Wald $\chi^2$ | 87.00 | 102.93 | 97.31 | 95.01 | 97.50 | 97.24 | 89.36 | 96.17 | 105.72 | 124.94 |
| $R^2$ | 6.11% | 6.40% | 6.55% | 6.98% | 7.75% | 8.49% | 8.93% | 9.65% | 16.88% | 17.98% |
| Observations | 3,478 | 3,478 | 2,873 | 2,873 | 2,343 | 2,343 | 1,858 | 1,858 | 968 | 968 |

Note: This table reports results from OLS regressions. The dependent variable (*RE*) is loss reserve error scaled by total assets. *Difference* is a firm's actual financial strength rating (*Rating*) minus a firm's target rating ("A-"). *Above A-* is equal to *Difference* if *Difference* is positive and 0 otherwise. *Below A-* is equal to -1 times *Difference* if *Difference* is negative and 0 otherwise. *Big 4* is a binary variable equal to 1 if a firm had both a Big 4 auditor and a Big 4 actuary and 0 otherwise. *Size* is the natural log of total assets. *Reinsurance* is reinsurance ceded divided by direct premiums plus reinsurance assumed. *Tax Shield* is a firm's net income plus developed reserves divided by total assets. *Geo Herf* is the geographic Herfindahl index. *Mutual* is a binary variable equal to 1 if a firm is a mutual and 0 otherwise. *Product Diverse* is 1 minus the line of business Herfindahl index. *Longtail* is the proportion of premiums written in longtailed lines. *Group* is a binary variable equal to 1 for a group and 0 otherwise. *Growth* is the one year change in net premiums written. *Small Profit* is a binary variable equal to 1 if a firm has earnings in the bottom 5 percent of the earnings distribution. *Small Loss* is a binary variable equal to 1 if a firm has earnings in the top 5 percent of the negative earnings distribution. *Profit* is a binary variable equal to 1 if a firm has earnings in the top 90 percent of the positive earnings distribution. *Insolvent* is an estimated probability of insolvency based on IRIS ratios. All regressions include year indicators. Standard errors are presented beneath each coefficient estimate in parentheses. Bootstrapped standard errors are from 1,000 replications and account for firm-level clustering. ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

## Appendix A: Ordered Probit Models

The following tables present results from estimation of cross-sectional ordered probit models. Table A1 and Table A2 present results from estimation of equation (2) for each year of our sample. Table A3 and Table A4 present results from estimation of equation (3) for each year in our sample. The estimated coefficients from these models are used to create a target rating variable for each firm-year in our sample.

## Table A1: Ordered Probit Regression Results: 1992-1999

| Dependent Variable: *Rating* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
| *Size* | 0.3148*** | 0.2950*** | 0.3415*** | 0.3405*** | 0.3266*** | 0.3264*** | 0.3500*** | 0.4097*** |
| | (0.0280) | (0.0286) | (0.0299) | (0.0282) | (0.0296) | (0.0271) | (0.0277) | (0.0303) |
| *Hurricane* | -0.0818 | -0.0951 | -0.0955 | -0.0873 | -0.2042* | -0.3050*** | -0.1679 | -0.1998 |
| | (0.1153) | (0.1110) | (0.1093) | (0.1090) | (0.1138) | (0.1155) | (0.1090) | (0.1216) |
| *Product Diverse* | 0.0195 | 0.1839 | 0.0861 | 0.1797 | 0.2986** | 0.3251*** | 0.3383*** | 0.2878** |
| | (0.1341) | (0.1304) | (0.1268) | (0.1158) | (0.1207) | (0.1162) | (0.1121) | (0.1168) |
| *Longtail* | -0.0913 | 0.0432 | 0.0306 | 0.0300 | 0.1023 | 0.0843 | -0.0537 | 0.1223 |
| | (0.1284) | (0.1231) | (0.1189) | (0.1149) | (0.1199) | (0.1178) | (0.1150) | (0.1245) |
| *Reinsurance* | 0.3423** | 0.3733*** | 0.6738*** | 0.5233*** | 0.4776*** | 0.6226*** | 0.8135*** | 1.0679*** |
| | (0.1355) | (0.1354) | (0.1405) | (0.1353) | (0.1377) | (0.1404) | (0.1340) | (0.1444) |
| *Growth* | 0.1046* | 0.0025 | 0.1725** | 0.2129*** | 0.0654 | 0.1109** | 0.1405* | 0.1299** |
| | (0.0619) | (0.0447) | (0.0691) | (0.0793) | (0.0559) | (0.0559) | (0.0733) | (0.0524) |
| *Geo Herf* | 0.0127 | -0.1007 | -0.1295 | -0.2181** | -0.1486 | -0.2231** | -0.2475** | -0.1992* |
| | (0.1051) | (0.1020) | (0.1003) | (0.0995) | (0.1025) | (0.1075) | (0.1056) | (0.1101) |
| *ROA* | 0.6090 | 4.5245*** | 3.4179*** | 4.4644*** | 3.6797*** | 3.9349*** | 2.6021*** | 3.5464*** |
| | (0.7831) | (0.8443) | (0.8232) | (0.8892) | (0.9036) | (0.9011) | (0.7983) | (0.9066) |
| *ROI* | -1.1722 | -5.1663*** | 4.7474** | -2.4201 | -3.7648* | -1.9143 | -2.0223 | -4.4718* |
| | (1.7128) | (1.6974) | (2.1482) | (2.1381) | (2.1672) | (2.1163) | (1.8059) | (2.3352) |
| *Kenny Ratio* | -0.2165*** | -0.1059 | -0.1156* | -0.2085*** | -0.0544 | -0.1364* | -0.1460** | -0.0501 |
| | (0.0632) | (0.0657) | (0.0645) | (0.0636) | (0.0664) | (0.0704) | (0.0742) | (0.0793) |
| *Earthquake* | 2.8072 | 1.7007 | 5.3864 | -1.6208 | -1.2017 | 3.7460 | 2.3382 | -6.4742** |
| | (4.0796) | (5.4041) | (4.0222) | (3.4265) | (3.1870) | (3.7413) | (4.2441) | (3.0605) |
| *Surplus* | 1.8773*** | 1.8482*** | 2.0315*** | 1.8122*** | 2.0384*** | 1.4574*** | 0.9835*** | 1.8459*** |
| | (0.2910) | (0.2994) | (0.3046) | (0.2838) | (0.3112) | (0.2897) | (0.2770) | (0.3162) |
| *Group* | 0.2454*** | 0.2887*** | 0.2610*** | 0.3384*** | 0.3562*** | 0.3271*** | 0.3382*** | 0.4184*** |
| | (0.0882) | (0.0857) | (0.0854) | (0.0799) | (0.0817) | (0.0830) | (0.0810) | (0.0876) |
| Observations | 1,173 | 1,240 | 1,246 | 1,277 | 1,187 | 1,131 | 1,126 | 1,104 |
| Wald $\chi^2$ | 363.89 | 367.01 | 470.24 | 535.67 | 469.31 | 490.53 | 518.99 | 717.09 |
| Model $p$-value | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Pseudo-$R^2$ | 0.0902 | 0.0927 | 0.1181 | 0.1151 | 0.1099 | 0.1191 | 0.1164 | 0.1467 |

Note: This table presents results from cross-section estimates of an ordered probit model for years 1992-1999. The dependent variable, *Rating* is a firm's A.M. Best financial strength rating, where 8 corresponds to the highest rating ("A++") and 1 corresponds to the lowest rating ("B-"). *Size* is the natural log of a firm's assets. *Product Diverse* is 1 minus a line-of-business Herfindahl index. *Longtail* is the percentage of premiums written in long-tailed lines. *Reinsurance* is reinsurance ceded divided by the sum of reinsurance assumed and direct premiums written. *Geo Diverse* is a Herfindahl index of direct premiums written in the 50 U.S. states and Washington D.C. *Growth* is the change in net premiums written from year $t-1$ to year $t$. *ROA* is a firm's net income divided by total assets in year $t$. *ROI* is a firm's net investment income divided by total assets in year $t$. *Kenny Ratio* is net premiums written divided by policyholder surplus. *Earthquake* is the percentage of net premiums written in earthquake insurance. *Surplus* is policyholder surplus divided by total assets. *Group* is a binary variable equal to 1 if a firm is a member of a group and 0 otherwise. *Hurricane* is the percentage of direct premiums written in hurricane-prone states. Constants and threshold parameters are omitted. Robust standard errors are in parentheses beneath each coefficient estimate. ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

## Table A2: Ordered Probit Regression Results: 2000-2008

| | Dependent Variable: *Rating* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| *Size* | 0.4134*** | 0.4468*** | 0.3923*** | 0.3583*** | 0.3730*** | 0.3851*** | 0.3683*** | 0.3646*** | 0.3758*** |
| | (0.0291) | (0.0298) | (0.0279) | (0.0281) | (0.0279) | (0.0304) | (0.0293) | (0.0271) | (0.0256) |
| *Hurricane* | -0.1380 | -0.0808 | -0.1336 | -0.0875 | 0.0691 | -0.0365 | -0.1037 | -0.2358** | -0.3080*** |
| | (0.1046) | (0.1075) | (0.1015) | (0.0995) | (0.1013) | (0.1034) | (0.1067) | (0.1080) | (0.1072) |
| *Product Diverse* | 0.1383 | 0.3391*** | 0.1567 | 0.4006*** | 0.2469** | 0.0904 | 0.1492 | 0.2297** | 0.2430** |
| | (0.1090) | (0.1116) | (0.1099) | (0.1066) | (0.1177) | (0.1161) | (0.1106) | (0.1141) | (0.1082) |
| *Longtail* | -0.0154 | -0.0531 | -0.1392 | -0.2481** | -0.0596 | -0.0331 | -0.1346 | -0.2123* | -0.0772 |
| | (0.1125) | (0.1124) | (0.1113) | (0.1134) | (0.1215) | (0.1194) | (0.1223) | (0.1277) | (0.1277) |
| *Reinsurance* | 0.7979*** | 0.5279*** | 0.4589*** | 0.3313*** | 0.5595*** | 0.8916*** | 0.8045*** | 0.6437*** | 0.8708*** |
| | (0.1397) | (0.1383) | (0.1292) | (0.1266) | (0.1375) | (0.1446) | (0.1391) | (0.1355) | (0.1234) |
| *Growth* | 0.1200* | 0.0083 | 0.1566*** | 0.1908** | 0.1134** | -0.0529 | -0.0769 | -0.0030 | -0.0035 |
| | (0.0637) | (0.0523) | (0.0417) | (0.0779) | (0.0450) | (0.0696) | (0.0630) | (0.0602) | (0.0269) |
| *Geo Herf* | -0.1625 | -0.0224 | 0.0846 | 0.0396 | -0.1136 | -0.1521 | -0.2115** | -0.2045* | -0.1002 |
| | (0.1082) | (0.1039) | (0.1021) | (0.1035) | (0.1035) | (0.1054) | (0.1042) | (0.1068) | (0.1026) |
| *ROA* | 3.8348*** | 2.0846** | 3.2730*** | 3.6092*** | 5.0442*** | 3.4309*** | 4.7123*** | 1.9895** | 3.7343*** |
| | (0.8198) | (0.8548) | (0.8366) | (0.9490) | (0.8706) | (0.9978) | (1.0103) | (0.9448) | (0.7656) |
| *ROI* | -5.7571*** | 0.0556 | -2.7779 | -2.9301 | 0.0999 | 1.5788 | -8.1043*** | -0.6468 | -3.9028** |
| | (1.9437) | (2.0256) | (1.7508) | (2.0175) | (2.3672) | (3.0043) | (2.6945) | (2.6797) | (1.8931) |
| *Kenny Ratio* | -0.0833 | -0.1329* | -0.1763*** | -0.0884 | -0.0350 | -0.0306 | -0.1229 | -0.2221** | -0.0300 |
| | (0.0712) | (0.0723) | (0.0673) | (0.0667) | (0.0755) | (0.0861) | (0.0953) | (0.0999) | (0.0743) |
| *Earthquake* | 4.6685 | 6.3356 | -4.8563 | -5.8567** | -3.2972 | -0.3391 | 1.6755 | 2.0349 | -4.6043 |
| | (4.1863) | (4.4331) | (3.0033) | (2.6723) | (3.0965) | (4.4533) | (4.0110) | (4.2694) | (3.5528) |
| *Surplus-to-Assets* | 1.3379*** | 1.7545*** | 1.2780*** | 1.5099*** | 1.9744*** | 1.9203*** | 1.7828*** | 1.5963*** | 1.7879*** |
| | (0.2848) | (0.2945) | (0.3014) | (0.2739) | (0.3169) | (0.3392) | (0.3384) | (0.3249) | (0.2742) |
| *Group* | 0.5241*** | 0.4416*** | 0.4740*** | 0.4403*** | 0.3526*** | 0.3350*** | 0.3785*** | 0.4365*** | 0.4314*** |
| | (0.0820) | (0.0797) | (0.0759) | (0.0753) | (0.0777) | (0.0822) | (0.0786) | (0.0783) | (0.0759) |
| Observations | 1,220 | 1,220 | 1,201 | 1,140 | 1,182 | 1,167 | 1,208 | 1,172 | 1,224 |
| Wald $\chi^2$ | 588.96 | 565.42 | 539.44 | 504.45 | 539.64 | 650.69 | 610.24 | 649.41 | 608.88 |
| Model $p$-value | $<0.0001$ | $<0.0001$ | $<0.0001$ | $<0.0001$ | $<0.0001$ | $<0.0001$ | $<0.0001$ | $<0.0001$ | $<0.0001$ |
| Pseudo-$R^2$ | 0.1239 | 0.1167 | 0.1203 | 0.1195 | 0.1259 | 0.1406 | 0.1362 | 0.1407 | 0.1321 |

Note: This table presents results from cross-section estimates of an ordered probit model for years 2000-2008. The dependent variable, *Rating* is a firm's A.M. Best financial strength rating, where 8 corresponds to the highest rating ("A++") and 1 corresponds to the lowest rating ("B-"). *Size* is the natural log of a firm's assets. *Product Diverse* is 1 minus a line-of-business Herfindahl index. *Longtail* is the percentage of premiums written in long-tailed lines. *Reinsurance* is reinsurance ceded divided by the sum of reinsurance assumed and direct premiums written. *Geo Diverse* is a Herfindahl index of direct premiums written in the 50 U.S. states and Washington D.C. *Growth* is the change in net premiums written from year $t-1$ to year $t$. *ROA* is a firm's net income divided by total assets in year $t$. *ROI* is a firm's net investment income divided by total assets in year $t$. *Kenny Ratio* is net premiums written divided by policyholder surplus. *Earthquake* is the percentage of net premiums written in earthquake insurance. *Surplus* is policyholder surplus divided by total assets. *Group* is a binary variable equal to 1 if a firm is a member of a group and 0 otherwise. *Hurricane* is the percentage of direct premiums written in hurricane-prone states. Constants and threshold parameters are omitted. Robust standard errors are in parentheses beneath each coefficient estimate. ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

## Table A3: Ordered Probit Regression Results-IRIS Ratios: 1992-1999

| | Dependent Variable: *Rating* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
| *Size* | 0.2756*** | 0.3620*** | 0.3933*** | 0.4104*** | 0.3864*** | 0.4134*** | 0.4067*** | 0.3657*** |
| | (0.0213) | (0.0222) | (0.0225) | (0.0226) | (0.0221) | (0.0229) | (0.0221) | (0.0210) |
| *Mutual* | 0.1448* | 0.0313 | 0.0007 | -0.1138 | -0.1227* | -0.1767** | -0.2995*** | -0.3617*** |
| | (0.0760) | (0.0725) | (0.0721) | (0.0704) | (0.0724) | (0.0758) | (0.0777) | (0.0767) |
| *GPW-to-Surplus* | 0.0004*** | 0.0005*** | 0.0007*** | 0.0006*** | 0.0009*** | 0.0010*** | 0.0013*** | 0.0014*** |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| *NPW-to-Surplus* | -0.0048*** | -0.0031*** | -0.0034*** | -0.0030*** | -0.0036*** | -0.0040*** | -0.0046*** | -0.0048*** |
| | (0.0005) | (0.0005) | (0.0005) | (0.0005) | (0.0005) | (0.0006) | (0.0006) | (0.0005) |
| $\Delta NPW$ | -0.0000 | -0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | -0.0000 | 0.0000 |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| *Surplus Aid* | -0.0288*** | -0.0200*** | -0.0236*** | -0.0314*** | -0.0259*** | -0.0276*** | -0.0396*** | -0.0389*** |
| | (0.0063) | (0.0062) | (0.0061) | (0.0061) | (0.0064) | (0.0068) | (0.0068) | (0.0063) |
| *Operating Ratio* | -0.0003 | -0.0001 | -0.0005 | -0.0007** | -0.0008** | -0.0001 | 0.0005* | -0.0001 |
| | (0.0004) | (0.0004) | (0.0003) | (0.0003) | (0.0003) | (0.0002) | (0.0003) | (0.0002) |
| *Investment Yield* | -0.0042 | -0.0096 | 0.0177 | -0.0216 | -0.0274** | -0.0189 | -0.0095 | -0.0196 |
| | (0.0192) | (0.0210) | (0.0218) | (0.0136) | (0.0127) | (0.0249) | (0.0243) | (0.0141) |
| $\Delta$*Surplus* | -0.0044*** | -0.0053*** | 0.0003 | -0.0024* | -0.0024* | -0.0035*** | -0.0049*** | 0.0034** |
| | (0.0014) | (0.0014) | (0.0014) | (0.0014) | (0.0014) | (0.0014) | (0.0015) | (0.0014) |
| *Liabilities-to-Surplus* | -0.0034*** | -0.0148*** | -0.0138*** | -0.0158*** | -0.0106*** | -0.0144*** | -0.0060*** | -0.0030*** |
| | (0.0010) | (0.0017) | (0.0016) | (0.0018) | (0.0014) | (0.0017) | (0.0011) | (0.0010) |
| *Gross Agents' Balances* | 0.0021 | 0.0072*** | 0.0016 | 0.0034 | 0.0014 | 0.0108*** | -0.0002 | -0.0015 |
| | (0.0023) | (0.0024) | (0.0024) | (0.0026) | (0.0028) | (0.0029) | (0.0031) | (0.0034) |
| *One-Year Development* | 3.8193 | -0.4317 | 1.2104 | -0.0858 | 0.2203 | -2.5998 | 0.6171 | 4.2423 |
| | (2.4902) | (3.5742) | (3.4347) | (1.5931) | (0.9763) | (1.8382) | (2.3774) | (3.0871) |
| *Two-Year Development* | -2.3193 | -1.1548 | -0.0141 | 0.3147 | -0.3207*** | 1.6394 | 0.1906 | -3.1358* |
| | (1.4838) | (2.3372) | (2.1141) | (1.6838) | (0.1233) | (1.2317) | (0.3629) | (1.7302) |
| *Reserve Deficiency* | 0.0025** | 0.0002 | 0.0011 | 0.0032*** | 0.0012 | 0.0030** | 0.0009 | 0.0035** |
| | (0.0012) | (0.0012) | (0.0012) | (0.0012) | (0.0014) | (0.0014) | (0.0014) | (0.0015) |
| Observations | 1,140 | 1,238 | 1,268 | 1,279 | 1,203 | 1,127 | 1,096 | 1,122 |
| Wald $\chi^2$ | 309.71 | 402.23 | 485.13 | 565.32 | 472.83 | 502.99 | 486.76 | 513.05 |
| Model $p$-value | $<0.0001$ | $<0.0001$ | $<0.0001$ | $<0.0001$ | $<0.0001$ | $<0.0001$ | $<0.0001$ | $<0.0001$ |
| Pseudo-$R^2$ | 0.0804 | 0.0938 | 0.1084 | 0.1214 | 0.1091 | 0.1248 | 0.1230 | 0.1263 |

Note: This table presents results from cross-section estimates of an ordered probit model for years 1992-1999. The dependent variable, *Rating* is a firm's A.M. Best financial strength rating, where 8 corresponds to the highest rating ("A++") and 1 corresponds to the lowest rating ("B-"). *Size* is the natural log of a firm's assets. *Mutual* is a binary variable equal to 1 if a firm is a mutual and 0 otherwise. *GPW-to-Surplus* is gross premiums written divided by surplus. *NPW-to-Surplus* is net premiums written divided by surplus. $\Delta NPW$ is the change in net premiums written. *Surplus Aid* is surplus aid divided by surplus. *Operating Ratio* is the two-year overall operating ratio. *Investment Yield* is net investment income over cash and invested assets. $\Delta$*Surplus* is the gross change in surplus. *Liabilities-to-Surplus* is adjusted liabilities divided by liquid assets. *Gross Agents' Balances* is gross agents' balances (in collection) divided by surplus. *One-Year Development* is one-year reserve development divided by surplus. *Two-Year Development* is two-year reserve development divided by surplus. *Reserve Deficiency* is the estimated current reserve deficiency divided by surplus. Constants and threshold parameters are omitted. Robust standard errors are in parentheses beneath each coefficient estimate. ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

## Table A4: Ordered Probit Regression Results-IRIS Ratios: 2000-2008

Dependent Variable: *Rating*

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|
| *Size* | 0.4177*** | 0.4453*** | 0.4127*** | 0.3996*** | 0.3836*** | 0.3962*** | 0.3987*** | 0.4355*** | 0.3914*** |
| | (0.0227) | (0.0235) | (0.0222) | (0.0226) | (0.0222) | (0.0225) | (0.0217) | (0.0249) | (0.0217) |
| *Mutual* | -0.3743*** | -0.1271 | -0.0904 | -0.0881 | -0.0469 | 0.0262 | -0.0006 | 0.1125 | 0.0503 |
| | (0.0762) | (0.0775) | (0.0748) | (0.0745) | (0.0749) | (0.0765) | (0.0780) | (0.0854) | (0.0780) |
| *GPW-to-Surplus* | 0.0013*** | 0.0007*** | 0.0007*** | 0.0006*** | 0.0008*** | 0.0011*** | 0.0010*** | 0.0009*** | 0.0009*** |
| | (0.0002) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0002) | (0.0001) |
| *NPW-to-Surplus* | -0.0050*** | -0.0052*** | -0.0043*** | -0.0043*** | -0.0045*** | -0.0050*** | -0.0049*** | -0.0061*** | -0.0047*** |
| | (0.0005) | (0.0005) | (0.0004) | (0.0005) | (0.0005) | (0.0005) | (0.0006) | (0.0007) | (0.0005) |
| $\Delta NPW$ | 0.0000 | 0.0000 | 0.0001*** | 0.0000 | -0.0000 | 0.0000 | -0.0000 | -0.0001 | -0.0000 |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0002) | (0.0000) |
| *Surplus Aid* | -0.0394*** | -0.0499*** | -0.0470*** | -0.0523*** | -0.0443*** | -0.0356*** | -0.0395*** | -0.0372*** | -0.0518*** |
| | (0.0058) | (0.0061) | (0.0055) | (0.0061) | (0.0061) | (0.0071) | (0.0078) | (0.0088) | (0.0084) |
| *Operating Ratio* | -0.0004 | 0.0002 | -0.0004* | -0.0003 | -0.0006** | 0.0004 | -0.0008*** | -0.0001 | -0.0001 |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0003) | (0.0002) | (0.0003) | (0.0002) |
| *Investment Yield* | -0.0105 | 0.0019 | -0.0001 | 0.0262 | 0.0151 | 0.0188 | -0.0221 | 0.0491* | 0.0008 |
| | (0.0193) | (0.0236) | (0.0139) | (0.0189) | (0.0181) | (0.0181) | (0.0226) | (0.0262) | (0.0188) |
| $\Delta$*Surplus* | 0.0003 | 0.0013 | 0.0012 | -0.0009 | -0.0003 | -0.0055*** | -0.0012 | -0.0036* | -0.0011 |
| | (0.0015) | (0.0015) | (0.0013) | (0.0012) | (0.0014) | (0.0013) | (0.0015) | (0.0019) | (0.0016) |
| *Liabilities-to-Surplus* | -0.0002** | -0.0003*** | -0.0003*** | -0.0004*** | -0.0003*** | -0.0004*** | -0.0004*** | -0.0005*** | -0.0005*** |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| *Gross Agents' Balances* | -0.0033 | 0.0031 | -0.0014 | 0.0039* | 0.0021 | 0.0013 | -0.0020 | 0.0016 | -0.0010 |
| | (0.0027) | (0.0023) | (0.0020) | (0.0022) | (0.0021) | (0.0022) | (0.0021) | (0.0029) | (0.0025) |
| *One-Year Development* | 3.3577 | 1.2969* | -2.9657 | 2.1966 | 3.7605* | 8.4604*** | -0.0015 | 1.6090 | -0.6492 |
| | (4.2628) | (0.6756) | (3.0374) | (2.5852) | (1.9309) | (1.9558) | (0.0010) | (5.5644) | (3.3333) |
| *Two-Year Development* | -5.8396** | -0.3184 | -2.1512 | -3.7678*** | -6.5294*** | -8.7191*** | -0.5236** | -6.2977** | 0.0692 |
| | (2.8140) | (0.3461) | (2.3663) | (1.4007) | (1.8718) | (1.9306) | (0.2488) | (3.0440) | (3.1221) |
| *Reserve Deficiency* | -0.0006 | -0.0004 | 0.0010 | 0.0016 | 0.0037*** | 0.0041*** | 0.0051*** | -0.0020 | 0.0032* |
| | (0.0014) | (0.0012) | (0.0012) | (0.0013) | (0.0014) | (0.0014) | (0.0016) | (0.0021) | (0.0017) |
| Observations | 1,195 | 1,139 | 1,264 | 1,243 | 1,248 | 1,219 | 1,227 | 908 | 1,249 |
| Wald $\chi^2$ | 598.68 | 571.64 | 585.69 | 520.39 | 487.99 | 470.93 | 466.72 | 436.85 | 448.60 |
| Model $p$-value | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Pseudo-$R^2$ | 0.1394 | 0.1393 | 0.1305 | 0.1174 | 0.1098 | 0.1099 | 0.1108 | 0.1407 | 0.1075 |

Note: This table presents results from cross-section estimates of an ordered probit model for years 2000-2008. The dependent variable, *Rating* is a firm's A.M. Best financial strength rating, where 8 corresponds to the highest rating ("A++") and 1 corresponds to the lowest rating ("B-"). *Size* is the natural log of a firm's assets. *Mutual* is a binary variable equal to 1 if a firm is a mutual and 0 otherwise. *GPW-to-Surplus* is gross premiums written divided by surplus. *NPW-to-Surplus* is net premiums written divided by surplus. $\Delta NPW$ is the change in net premiums written. *Surplus Aid* is surplus aid divided by surplus. *Operating Ratio* is the two-year overall operating ratio. *Investment Yield* is net investment income over cash and invested assets. $\Delta$*Surplus* is the gross change in surplus. *Liabilities-to-Surplus* is adjusted liabilities divided by liquid assets. *Gross Agents' Balances* is gross agents' balances (in collection) divided by surplus. *One-Year Development* is one-year reserve development divided by surplus. *Two-Year Development* is two-year reserve development divided by surplus. *Reserve Deficiency* is the estimated current reserve deficiency divided by surplus. Constants and threshold parameters are omitted. Robust standard errors are in parentheses beneath each coefficient estimate. ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.