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Abstract

When firms approach distress, whether they engage in asset substitution (risk shifting) or rebuild equity (risk management) may depend on their access to capital markets. The property-casualty insurance industry has two features that make it ideal for testing this hypothesis: (1) the main losses for insurers are exogenous events like hurricanes that provide a strong instrument for financial distress; and (2) many insurers are organized as mutual companies, which cannot issue stock. Consistent with the importance of capital constraints, stock companies issue new equity following a negative shock, while mutual companies increase the riskiness of their investment portfolios.

Keywords: Risk shifting, insurance, reinsurance, capital structure

JEL Codes: G22, G32

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1 Introduction

Since Jensen and Mecking (1976) and Myers (1977), the problems of asset substitution and debt overhang have been cornerstones of corporate finance theory. Under these hypotheses, the owners of levered firms have incentives to adopt higher levels of risk as they approach distress, reaping the upside rewards in good states of the world and transferring losses to liability-holders in bad states. The dominance of these incentives is not certain, however. Countervailing forces, such as the desire to preserve franchise value, avoid bankruptcy costs, or minimize external financing, may outweigh them (Smith and Stulz, 1985; Froot et al., 2003). Some previous authors have characterized this tension as a contest between “risk shifting” and “risk management” (e.g., Rauh, 2009). The relative importance of these two outcomes, and the factors that matter in the decision between them, remain open empirical questions.

We provide evidence on one potentially important aspect of firms’ choice between risk shifting versus risk management: their access to capital markets. A straightforward way for firms to “manage risk” after a negative shock is to raise new equity, but that option is costlier for some firms than for others. At the margin, firms that are capital constrained should thus find risk shifting more attractive relative to risk management. Our findings are consistent with this hypothesis.

Our data consist of a panel of about 900 property-and-casualty (P&C) insurance firms over the period 2004 - 2018. The P&C industry has two important features that make it uniquely suited for studying these questions. First, the main shocks to P&C insurers’ capital positions arise from hurricanes and other natural disasters that can be safely taken to be exogenous. This gives us a strong instrument for changes in owners’ equity value that may induce risk-shifting or risk-management behavior. Second, approximately one-third of the insurers in our sample are organized as mutual companies, which are owned by their policyholders and have limited ability to raise equity. This allows us to examine the effects of capital constraints on the risk-shifting / risk-management choice.

We first verify that, following a shock that erodes equity, insurance companies organized as mutuals have a harder time recovering to their initial levels of capital. Three years later, they have only made up about 20% of the capital lost in the shock, compared to 40% at stock companies. The lost capital exposes owners of the companies—particularly of mutual companies—to increased risk. The question then is whether the owners attempt to shift this risk to liability holders through asset substitution. At mutual companies, the owners themselves are also liability holders, in principle limiting the scope for such behavior. However, policy liabilities are super-senior in the capital structure, and non-policy debt constitutes a significant percentage of liabilities at mutual companies, Thus, there is ample opportunity for risk shifting.

We show that mutual companies increase the risk of their asset portfolios after their capital levels deteriorate, shifting a greater fraction of securities out of high-grade bonds and into junk bonds, equities, and "alternative investments" (a category that includes hedge funds and private equity), consistent with the risk-shifting hypothesis. In contrast, stock companies show no significant change in the riskiness of their portfolios after exogenous losses. We show that these results are not driven by differences in firm size or initial capital structures across the two types of firms.

We also examine a second dimension of insurer risk-taking—the use of reinsurance. Consistent with their desire to rebuild capital, we find that stock companies marginally increase their use of reinsurance to protect against future losses in the year after a negative shock. But mutual companies increase reinsurance by twice as much as stock companies and much more persistently. We argue that the seeming inconsistency of mutual companies' tendency to increase the risk of their assets while decreasing risk stemming from their liabilities results from their particular organizational structure. Catastrophic losses from insurance claims are likely to bankrupt the firm and lead to defaults on policy claims in the same states of the world—a doubly bad outcome for owner/policyholders. This outcome becomes more likely following an increase in leverage, and boosting reinsurance partially hedges against it. At the same time, losses on the asset portfolio are likely uncorrelated with insurance claims. Thus, the brunt of such losses, if they lead to bankruptcy, are likely to fall on non-policyholders.

Looked at another way, distressed mutual insurers finance an increased reliance on reinsurance by shifting into higher-yielding, riskier assets. Since non-policy debtholders bear the downside risk of these assets but receive only part of the upside benefits of the reinsurance, this behavior amounts to asset substitution on net. Note that, although mutual insurers' policy claims may end up being more protected in this scenario, the risk of equity claims, like that of debt claims, unambiguously rises. Consistent with this story, we find that risk-based-capital ratios—a broad measure of risk-taking activity—decline at mutual firms by about twice as much as at stock companies for a given-sized shock.

Given the wide attention it has received in corporate-finance theory, empirical work on asset substitution is surprisingly sparse. In part, this is because discriminating between risk shifting and risk management involves difficult problems of both identification and measurement. Firms may take on risk because they are distressed, or they may become distressed because they are inherently risky. Thus, to test for risk shifting, one needs a plausibly exogenous source of variation in leverage. Furthermore, "risk taking" is difficult to observe, since the projects undertaken by firms are often opaque *ex ante*, and *ex post* outcomes may not be highly correlated with the intentions of the owners and managers. The empirical work that does exist thus mostly focuses on particular industries where there is a plausible instrument for leverage and a relatively unambiguous measure of *ex ante* risk-taking. For example, Rauh (2009) finds that well-funded pension plans hold riskier portfolios than poorly funded plans; Landier et al. (2015) find that a large mortgage originator made riskier loans after its assets deteriorated in the financial crisis; Gilje (2016) finds that oil and gas firms reduce exploratory projects when they approach distress; and Kirti (2017) finds that life insurers that suffered the greatest losses during the crisis decreased their risk taking by more than those that had smaller losses.[1]

Our paper adds to this literature with new evidence of asset substitution from the P&C industry. This industry is exposed to exogenous variation in leverage through catastrophe risk, and it presents advantages over other industries in terms of measuring risk-taking since the assets of insurers consist almost entirely of financial securities, which are reported in great detail. Unlike previous studies, we are also able to test for differential effects across groups of firms with different ability to raise equity. Although many industries include non-public companies without access to public capital markets, such firms typically do not release financial statements, making it difficult to study their behavior. But insurance companies, regardless of their corporate structure, are required to file detailed quarterly reports with their regulators. Our results suggest a possible reason that the previous empirical literature has reached conflicting conclusions: the incidence of risk shifting may vary across industries and firms due to differences in corporate structure and capital constraints. In recent, related work Ge and Weisbach (forthcoming) also examine how P&C investment portfolios react to capital shocks, but they only look at firms in the aggregate and so miss these patterns.

Several empirical papers in both the insurance and banking literatures touch on related issues. Lamm-Tennant and Starks (1993) and Ho et al. (2013) find that overall risk-taking is lower, on average, at P&C insurers organized as mutuals than at those organized as stock companies, results that are similar to those found by Etsy (1997) in a comparison of mutual

[1] In the only study to consider a cross-section of firms across industries, Eisdorfer (2008) finds that distressed firms are more likely to invest in new projects when volatility is high, a result he interprets as implying that risk-shifting incentives outweigh real-options considerations among distressed firms. Becker and Stromberg (2012) present evidence consistent with reduced risk shifting in the wake of a 1991 court ruling that imposed fiduciary duties on firm managers in Delaware.

and stock companies in the savings-and-loan industry. Our data are consistent with these unconditional findings, but we show that, conditional on a negative shock, mutuals are more likely to increase risk than stock companies are. A number of papers—notably Shrieves and Dahl (1992) for banks and Cummins and Sommer (1996) for insurance companies—argue that capital and risk are likely positively related. This conclusion is broadly consistent with the interpretation of our results for stock companies as reflecting a desire to maintain the firm as a going concern. Duran and Lozano-Vivas (2014) present evidence in favor of risk-shifting in banking prior to the 2008 financial crisis, though not after, and argue that higher capital buffers may help to reduce such behavior. As with our results, their findings suggest a complex interplay between risk-taking incentives and capital.[2] Finally, our results on the relationship between reinsurance and leverage are consistent with the previous empirical findings of Garvin and Lamm-Tennant (2003) and Shiu (2010).

2 Data and Background

2.1 P&C Insurers in the Aggregate

Our data come from regulatory reports filed annually with each state's insurance commissioner by every U.S. P&C insurance operating company.[3]. Insurers file securities transactions data on a quarterly basis, but inconsistencies in the quarterly filings raise concerns about the validity of quarterly data. (For example, the fourth quarter consistently shows a substantially higher transaction volume than the other quarters.) To avoid potential

[2] Rampini et al. (2020) find that banks in areas with greater house-price declines during the financial crisis reduced their hedging of interest-rate risk, but they specifically argue that the reason was *not* risk shifting; rather, they claim that it had to do with the opportunity cost of collateral posted against derivatives positions.

[3] The data are provided by SNL Financial, LC. SNL Financial LC. contains copyrighted and trade secret material distributed under lisense from SNL.

bias, we use yearly data. Although some data exist as far back as 1996, investment allocations are available only since 2004. Therefore, the statistical analysis uses data from 2004 to 2018. In total, we observe 1,023 different companies, with about 840 companies on average in each year, giving us 12,544 observations.[4]

Table 1 presents some summary statistics, aggregating across our entire sample. On average, insurers in our sample held \$6.9 billion in assets, although this number is skewed by some very large insurers. (The median insurer held \$70 million in assets.) Premiums written—the amount of revenue received from providing insurance to policyholders—averages \$2.4 billion per year. Meanwhile, the average loss ratio in a given calendar year—calculated as insurance losses incurred, net of recoveries, as a fraction of premiums earned—was 51.3 percent.[5]

Insurer assets consist almost entirely of securities and other financial investments. The the largest category of assets is corporate bonds (about 40% of assets, on average in our sample), and the bulk of these bonds (about 99%) are investment-grade.[6] One reason for the high proportion of investment-grade bonds is that insurers face steep regulatory capital charges for holding high-yield bonds. Another way that insurers can take risk is by buying equities or investing in "alternative investments," a category that comprises hedge funds, private equity, direct lending, and real estate. Holdings of junk bonds, equities,

[4]Statutory reports are filed by insurers at the operating company level. Many insurance companies are part of larger groups, where a group is defined as a set of companies under the same ownership. We aggregate data to the group level for our analysis under the maintained hypothesis that investment decisions are made at the aggregate level. One limitation of our data is that we do not have investment data for non-U.S. operating companies within groups headquartered in the U.S.

[5]We estimate this ratio using premiums *earned* and losses *incurred* to appropriately reflect risk exposure in each calendar year. Premiums earned are the premiums associated with coverage provided during the calendar year, regardless of when the premiums are paid. The losses incurred are insured losses associated with events occurred during the calendar year, regardless of when the claims are paid to policyholders. The alternative would be using losses *paid* and premiums *written*, but these amounts can reflect claim payments associated with previous years' loss events or insurers' revenues associated with coverage to be provided in future years.

[6]Bonds are valued at their acquisition cost to eliminate the effect of price changes in the investment portfolio risk composition. "Investment grade" bonds are those classified by the National Association of Insurance Commissioners as NAIC-1 or -2, which correspond to private credit ratings of BBB or higher.

and alternative investments will be our main measure of risk taking.

PC insurers' primary liabilities are the policies they have written, which cover the full spectrum of household and business risks.[7] They typically also fund themselves using other types of liabilities, including long-term debt (bonds and bank loans), deposit-like contracts, and surplus notes. We refer to these types of liabilities collectively as "debt." For the insurers in our sample, debt constituted 27.8 percent of assets. The average liability as a fraction of assets, which is our measure of leverage, is 55.3 percent.

The average ratio of adjusted capital to required risk-based capital, referred to as the RBC ratio, is 9.84 to 1. Adjusted capital is the difference between the value of the assets and the value of liabilities as accounted for regulatory purposes, and required risk-based capital is the minimum capital required by the regulator for an insurer to operate without regulatory intervention given its risk exposure. When the RBC ratio falls below 2 the insurance company needs to submit a capital plan to be approved by the state insurance regulator. When the RBC ratio falls below 1, the regulator has the option of taking control of the insurer, and when the ratio is below 0.7, the regulator is required to place the insurer under control (source: Society of Actuaries). The formula used to calculate required capital is complex and reflects not only the asset mix of insurers but also other sources of risk, including underwriting and interest-rate risk. Below, we use it as a broad measure of insurer risk taking.

In many cases, insurance policies are covered by reinsurance, which is a contract that shares the risk in a given insurers' policies with other insurers. (See, e.g., Mayers and Smith, 1990; Froot and O'Connell, 2008). In practice, to cede risk insurers give a proportion of their premiums to the assuming insurer, and in exchange the assuming insurer commits to cover a proportion of the losses associated with these premiums. To

[7] Among the insurers in our sample, the largest policy category, by premiums written, is auto, followed by homeowners multi-peril.

the extent that an insurer's policies are reinsured, it does not face potential losses from claims, and policies that are reinsured do not count against capital for regulatory purposes. This means that reinsurance is a substitute for capital. However, the substitutability is not perfect because reinsurance does not protect against investment or operating losses—in this sense, it can be thought of as "low-quality" capital.[8] Premiums ceded in our sample represent 21 percent of premiums written or 16 percent of total assets, on average, although the use of reinsurance varies widely across insurers.[9]

2.2 Mutual vs. Stock Companies

Insurance companies in the United States are organized in one of two ways: as stock companies or as mutual companies. Stock companies are owned by shareholders, and the largest are publicly traded. In contrast, mutual companies are owned by their policyholders. Every entity that purchases an insurance contract through a mutual company becomes a partial owner of that company, entitled to dividends. About one-third of P&C insurance companies are organized as mutuals. Although they are smaller than stock companies on average, some large insurers, such as State Farm and Northwestern Mutual, are organized as mutual companies.

The statistical tests that follow concern whether insurance firms shift risk to liability holders after a shock to capital. There are two key differences between the capital structures of stock and mutual companies that may matter for risk-shifting behavior. The first is that, while the owners of both types of companies have incentives to shift risk to debtholders, only the owners of stock companies have an incentive to shift risk to policyholders. This is because the owners of mutual companies *are* the policyholders.

[8]Reinsurance is paid for up-front, so that reinsurers do not face potential defaults from their customers. Consequently, the use of reinsurance, by itself, should not lead to increased risk shifting.

[9]We only consider for reinsurance contracts with non-affiliates. We ignore reinsurance with affiliates because we assume that insurers manage risk at the holding level.

Risk-shifting incentives only exist at mutual companies to the extent that those companies have non-policy liabilities outstanding. The second difference is that stock companies are far better positioned to raise new equity than mutual companies are. Generally speaking, mutual companies are unable to issue equity, since they are owned by their policyholders. Leverage only improves at mutual companies through retained earnings—a process that can only occur slowly over time.

Among the stock companies, some are likely to have better access to capital markets than others. In particular, in our sample there are 118 stock companies that are publicly listed and 618 that are private. The private firms are still able to raise new equity through additional contributions from their owners, including in many cases infusions from private equity firms, which still gives them an advantage over mutual firms.[10]

Table 2 shows summary statistics conditional on ownership structure. Mutual insurers constitute about one-third of the population and are smaller on average. The median mutual company has $41 million in assets and writes $16 million in premiums per year, while the median stock insurer has $107 million in assets and writes $58 million in premiums per year. Mutual insurers hold 0.9 percent of their portfolios in non-investment grade bonds and 14.5 percent of their portfolios in stock and alternative investments, while stock insurers hold 1.5 percent of non-investment grade bonds and 11.6 percent of stock and alternative investments. Mutuals also tend to have a somewhat more conservative capital structure than stock insurers do. Specifically, in our sample, they have a 51 percent leverage ratio on average and operate with 12 times more capital than required to operate without regulatory intervention, while stock insurers have a 58 percent leverage ratio and operate with 9 times required capital.[11] However, the two types of firms have

[10]In the SNL data, were able to identify 76 stock issuances (excluding IPOs) among the publicly traded firms in our sample and 19 among the private firms, although it is likely that many equity injections at private firms go unreported.

[11]The safer structure of mutual balance sheets, on average, has been documented by Lamm-Tennant and Starks (1993) and Ho et al. (2013).

similar ratios of non-policy debt.

Mutuals and stock companies have similar loss ratios, but mutual companies reinsure a slightly larger fraction of these policies, ceding 21.7 percent of premiums versus 20.5 percent. However, since stock insurers write more policies as a fraction of their assets, the portion of their balance sheet that is reinsured is somewhat larger (16.8 percent versus 14.7 percent).

3 Methodology

We examine how insurers change their balance-sheet structure and risk taking when leverage increases. The challenge in the analysis is that insurers endogenously (and simultaneously) decide on their leverage level and asset allocation. Consequently, ordinary least squares would likely return a biased estimate of the degree of asset substitution in insurers' investment decisions. We address this concern by using an instrumental-variables approach, where the instrument is insurance-related losses, which are beyond the insurers' control and generally unpredictable. For example, when insurers face claims associated with a hurricane or flood, their leverage increases—first because they must set aside extra reserves in anticipation of payouts (raising liabilities), and then because they must actually make the payouts (reducing assets).

Specifically, our instrument for leverage in each year is the loss ratio (the ratio of insurance losses to premiums) for that year.[12] We run two-stage least-squares regressions, where, in the first stage, the leverage ratio is the dependent variable and the loss ratio is the exogenous variable. To be precise, in our baseline model the first-stage regression is

[12] As a robustness check to our main approach we ran an alternative estimation where we used catastrophic losses as the instrument, where catastrophic losses is equal to the loss ratio if the loss ratio falls above the 95th percentile assuming a normal distribution, and 0 otherwise. The results were not significantly different from our baseline.

$$Lev_{it} = \beta Loss_{it} + f_i^{(1)} + \delta_t^{(1)} + e_{it} \tag{1}$$

where Lev_{it} is the ratio of liabilities to assets of insurer i at time t, the $Loss_{it}$ is the ratio of net losses incurred to net premiums earned of insurer i in year t, $\delta_t^{(1)}$ is the first-stage year-t fixed effect, $f_i^{(1)}$ is the first-stage insurer-i fixed effect, and e_{it} is the error term. To avoid outliers caused by loss ratios with small denominators, in our baseline specification we winsorize the loss ratio at the 1 percent level. However, the results are robust to this choice.

To some extent, the effect of losses on leverage is mechanical, since losses must be paid out of assets and ultimately feed though to capital. Indeed, if no other changes to the balance sheet occur, one can show that $Lev_{it}p_{it} \leq \beta \leq p_{it}$ for any i, t, where p_{it} is the ratio of premiums to assets. On average in our sample, these bounds on the first-stage coefficient would be about 0.17 and 0.33. Variation within these bounds depends on the timing of payoffs. Losses on insurance policies are first recorded as a liability (leaving assets unchanged and therefore decreasing capital) and then subsequently paid out to claimants (decreasing assets and liabilities both). The effects on the capital ratio go in opposite directions, but on net necessarily leave it lower; how much lower it is at any point in time depends on how much of the recorded losses have not yet been paid. In addition, firms may make rapid changes to their balance-sheet composition as soon as losses are reported. Since our data are observed at the end of each year, while losses occur throughout the year, some of our coefficient estimates will reflect within-year rebalancing. In particular, if firms take steps to rebuild their capital ratios—for example, by selling assets—the coefficient could be below the lower bound stated above.

In our second stage, we regress various measures of risk-taking on the instrumented level of leverage. Again, we include insurer (group-level) fixed effects and yearly time fixed effects. Thus, our second-stage regressions take the form

$$y_{it+s} = \gamma \hat{Lev}_{it} + f_i^{(2)} + \delta_t^{(2)} + \eta_{it} \tag{2}$$

where y_{it+s} is the value of the dependent variable of insurer i at time $t+s$, $\hat{Lev}_{it}$ is the first-stage predicted value of insurer i's leverage in year t, $\delta_t^{(2)}$ is the second-stage year-t fixed effect, $f_i^{(2)}$ is the second-stage insurer-i fixed effect, and η_{it} is the error term. The coefficient of interest for each dependent variable is γ.

We use several different dependent variables in equation (2), to examine different dimensions of insurer responses to leverage shocks, including capital ratios, use of reinsurance, and investments in risky assets. In each case we track the response of the dependent variable over the year in which the shock occurs and three subsequent years ($s = [0, ..., 3]$).

In both the first and the second stage we exclude insurers with an average RBC ratio across the sample of below 0 or above 5000 percent. We also exclude from the sample observations with negative losses, leverage below 0 or above 1, or losses three or more times larger than premiums. Results are robust to higher exclusion thresholds.[13]. In all cases, we cluster standard errors at the firm level.

4 Results

4.1 First stage

The first stage of the estimation (equation (1)) is presented in the first column of Table 3. (Columns (2) and (3) will be discussed later.) The loss ratio has a high predictive power

[13]Insurers with an RBC ratio above 50 are usually fronting companies that write premiums but cede all the associated risk to other insurers. Insurers with this business model do not see their balance sheet affected by insured losses and are therefore unsuited for our IV approach. Loss ratios above 3 are frequently associated with drastic reductions in premiums rather than large increases in losses.

for leverage, with an F statistic of 46.8. This is more than twice as large as the threshold recommended by Stock and Yogo (2005) to reduce the maximum weak instrument relative bias to less than 10 percent (given the characteristics of our setup). In economic terms, the coefficient estimate implies that an increase in the loss ratio of 1 percentage point raises the leverage ratio by 12 basis points. Note that this is a bit below the lower bound calculated above for the case when the rest of the balance sheet remains constant within the year. In other words, it appears that insurers rebalance somewhat in the immediate aftermath of shocks with a dampening effect on leverage.

4.2 Second stage: Baseline regressions

Tables 4 through 6 present our main results, from the second-stage regressions (2). We report results both for the pooled sample and for separate samples of stock and mutual companies. Note that we use the same (pooled) first stage for all three samples, though the results are robust to splitting the first stage as well.

4.2.1 The response of capital

Table 4 estimates equation (2) using the capital/assets ratio as the dependent variable. Since the capital ratio is equal to $1 - Lev_{it}$, the coefficient estimates are all equal to -1 by construction in the period of the shock. In the subsequent three years, as shown in the top panel, firms on average gradually rebuild their capital—by the end of the fourth year ($t+3$) they have recovered 33 percent. However, as can be seen in the middle and bottom panels, most of this difference is due to the behavior of stock companies. After two years, stock companies have recovered 18 percent of their capital, while mutual companies still have capital ratios that are essentially unchanged from the period of the shock. By the end of the year $t+3$, stock companies have recovered 40 percent of their lost capital, while mutual companies have only recovered 20 percent. These observations are consistent with our prior that mutual companies are less agile in their capital positions.

While mutual companies cannot readily issue new equity, they can gain some of the benefits of equity—including regulatory relief—through reinsurance. Table 5 provides evidence on this point. Here, the dependent variable is the amount of insurance premiums ceded in each year as a proportion of assets. Following the shock, both stock and mutual firms increase their use of reinsurance, but mutual companies do so by more. Indeed, for mutual companies, the increase by the year following the shock almost exactly matches the decrease in the capital ratio that is caused by the shock. The magnitude is economically significant—a one-standard-deviation increase in leverage raises mutual firms' reinsurance ratio by 140% of its average value. And, like the capital ratio, the coefficient remains little changed in years $t+1$ and $t+2$ and then decreases somewhat in magnitude in year $t+3$. Stock companies increase reinsurance after a shock too, but not by as much and not as persistently. The increase is only 64% of their average, and by year $t+2$ their use of reinsurance has essentially reverted to its pre-shock level.[14]

The picture that emerges from Tables 4 and 5 is that, when faced with a shock that increases their leverage, insurers generally take steps to rebuild their capital positions. Stock companies have an easier time doing this because they can issue new equity. Mutual firms only rebuild equity by retaining earnings, but they can and do substitute for equity using reinsurance while this rebuilding takes place. However, reinsurance is only a partial substitute for lost capital. It protects the firm against some insurance losses, but not against losses on the asset portfolio. Arguably, however, the owners/policyholders of mutual firms have more incentive to care about insurance losses than the owners of stock companies do, since bankruptcy of the firm is correlated with default on insurance claims

[14]These results are not simply due to insurers writing more policies after the shock; regressions using reinsurance as a fraction of premiums written, rather than assets, show similar patterns to Table 4.

in states of the world where they are likely to make such claims.

4.2.2 The response of risk

We have shown that, when hit with an exogenous shock that erodes capital, stock companies' preference is to raise new capital, consistent with a risk-management story. Meanwhile, mutual companies are constrained in how efficiently they are able to do this. Might such companies have a stronger incentive to shift risk to debtholders as a second-best alternative?

Table 6 presents evidence on this question, running our second-stage regressions (2) with the percentage of assets held in risky investments (junk bonds, equities, and alternative investments) as the dependent variable. When we pool all insurers together (top panel), the percentage of insurers' assets held in such investments is essentially unchanged following a shock to leverage. But the bottom panels of the table reveal a stark difference across firms of different organizational structure, with mutual companies increasing risky investments significantly, particularly subsequent to year t. When leverage increases by one percentage point, mutual companies increase risky investments by 0.34 percent of assets. This is an economically significant response, equal to 43% of the average value of risky investments. The allocation also rises even further over the following three years. In contrast, stock companies have no significant increase in risky investments during the year of the shock to leverage or any subsequent year. Indeed, their allocation to such assets falls slightly (by a statistically insignificant amount).

Table 7 shows the second-stage response of the risk-based capital ratio. Because RBC is in large part a function of leverage, it falls for both companies when a shock to leverage occurs. However, the decrease at mutual firms is approximately twice as large as that at stock companies. By construction, the change in actual capital held in the period of the shock is the same in both sub-samples. Therefore, the difference must be due to changes in the amount of capital that is required, which is a function of the firm's risk. In other words, even conditional on the capital erosion, mutual companies' risk increases significantly relative to that of stock companies when hit with a shock to leverage. Moreover, these differences persist for several years. This is consistent with the result using the risk of the asset portfolio, and indeed suggests that mutual companies do not fully offset the increase in the credit risk of their securities with reductions in risk-taking elsewhere on their balance sheets. In particular, while their increased use of reinsurance, shown above, reduces their required capital all else equal, the results in Table 7 indicate that changes in investment composition and potentially elsewhere in insurers' operations more than outweigh this benefit, at least from a regulatory perspective.

4.3 Discussion

Our results suggest that mutual insurers choose to increase the risk of their balance sheets as their equity erodes, consistent with risk shifting. The fact that stock companies, which are not capital constrained, do not increase risk points to the inability to access equity markets as a key factor driving the risk-shifting decision. Yet, in addition to increasing asset risk, mutual firms also engage in reinsurance after a shock to leverage, which would seem to indicate a risk-management motive. How can one reconcile these observations?

One answer is that, because reinsurance is paid upfront, its use reduces the amount of capital the firm has to invest in risky assets. Consequently, all else equal, the use of reinsurance reduces the expected returns to shareholders, even as it raises the expected returns for policyholders by providing protection against disaster risk. Thus, when policyholders and shareholders are the same people, the effect on their unconditional expected returns largely cancels. However, the *volatility* of returns is unambiguously reduced for both policyholders and owners: if the firm remains solvent, reinsurance smooths payouts of claims, reducing uncertainty from the owners' perspective; if the firm becomes insolvent, reinsurance makes claims more likely to be paid, reducing uncertainty from the policyholders' perspective. Thus, risk-averse owner/policyholders will generally find reinsurance attractive. Moreover, the effect on volatility, all else equal, is greater when the firm is more levered; thus, the incentive to use reinsurance should rise when a negative shock to leverage occurs, as we find.[15]

One can also state this argument in the reverse. Conditional on using renisurance, mutual companies generally have a greater incentive to shift risk to debtholders when their leverage exogenously increases. With higher leverage, a high-risk, high-reinsurance strategy leads both to greater expected returns (through the usual asset-substitution mechanism) and lower uncertainty about returns (because reinsurance dampens policy and equity volatility by more in highly levered states). Thus, the incentives to move toward such a strategy are greater when a mutual company finds itself capital-constrained.

5 Subsample analysis

This section further explores our main results by splitting the sample in two ways. First, we split the sample by size of the firm. Second, we split according to the composition of liabilities.

5.1 Sample split by size

As was clear from the summary statistics, there is wide heterogeneity in firm size in the insurance industry, and size is correlated with a number of the variables of interest for us, including ownership structure. To ensure that our results do not reflect differences across

[15] We note that the effect is ambiguous for stock companies, because expected returns and volatility for equityholders are both increasing in the use of reinsurance.

large and small firms, Table 8 presents our main regression results when the sample is split into large and small firms. This split is made at the full-sample median asset size of $70 million$.

Table 8a shows that, in the aggregate, small and large firms recover capital at roughly the same rate following a shock. The large mutual companies recover more slowly than the aggregate, while the large stock companies recover faster. Small mutual and stock companies recover at about the same rate. Table 8b shows that, across both large and small firms, mutual companies engage in more reinsurance following the leverage shock than stock companies do; this difference is particularly pronounced at the smaller firms. Table 8c shows that, as in the baseline results, mutual companies increase the riskiness of their asset portfolios in all years after the shock, while stock companies do not, for both large and small firms. Indeed, there is some evidence that small stock companies reduce their asset risk, consistent with a "risk management" motive. Finally, Table 8d shows that, as in the baseline results, mutual companies' RBC ratios fall by more than those of stock companies, even conditional on the change in leverage, indicating that they are taking on more overall risk (as measured by regulatory standards). This difference is particularly pronounced for larger firms.

5.2 Results by initial liability composition

In this section, we check the robustness of our results to the liability composition of firms before the insurance losses occur, since one might expect the incentives to engage in asset substitution to also depend on the proportion of stakeholders subject to wealth loss "expropriation" in the event of asset substitution. In particular, we estimate

$$
\begin{aligned}
y_{it+s} =& \gamma \hat{Lev}_{it} + \gamma_{HP} \widehat{Lev_{it} HP_{it}} + \gamma_{HD} \widehat{Lev_{it} HD_{it}} + \gamma_{HS} \widehat{Lev_{it} HS_{it}} + \zeta_{HP} HP_{it} + \zeta_{HD} HD_{it} \\
&+ f_i^{(2)} + \delta_t^{(2)} + \eta_{it}
\end{aligned} \tag{3}
$$

where HP_{it} is a dummy variable indicating whether firm i is in a "high policies" group and HD_{it} is a dummy variable indicating whether firm i is in a "high debt" group, and HS_{it} is a dummy variable indicating whether firm i is in a "high surplus notes" group. In each case, the variable takes a value of 1 if the ratio of the liability class to assets was above the median as of the end of the year prior to the shock. Note that in the first-stage regression, we instrument the interactive terms and include the dummies as independent variables. The first-stage regression results are shown in columns (2) and (3) of Table 3. For robustness, we run the first stage with and without independent interaction terms between the liability dummies and the loss ratio.

Table 9a shows the results for capital; table 9b shows the results for reinsurance; table 9c shows the results for risky assets; and table 9d shows the results for the RBC ratio. In all cases our main baseline results go through when controlling for the possible nonlinearities in debt structures. In particular, in these alternative specifications, mutual companies still take longer to recover from a loss, engage in more reinsurance in the meantime, and shift toward more risk as indicated by both their investment mix and RBC ratios. The statistical significance of the risky-asset and RBC regressions for mutuals is weaker than in our baseline model. However, the differences between stock and mutual companies are still strongly significant. Moreover, the results highlight that our aggregate mutual results in Tables 6 and 7 are driven mostly by firms with high levels of surplus notes. Since these are non-policy debtholders, this result is consistent with our risk-shifting interpretation.

Otherwise, within firm type there is not much difference in results across different liability structures. There is some evidence that both types of firms shift more toward reinsurance following a shock when they initially have higher levels of debt and less when they initially have more surplus notes. In addition, stock companies are actually likely to *decrease* investment risk when they start out with low levels of leverage—particularly low levels of policies relative to assets.

6 Conclusion

We have used exogenous variation in insurers' leverage, stemming from losses associated with payouts of insurance claims, to study risk-shifting behavior. We find significant differences between the responses of firms organized as mutual companies and those organized as stock companies. Following a negative shock to capital stock companies recapitalize their firms relatively quickly and have muted responses in terms of risk-taking measures. Mutual companies, which cannot easily raise new equity, show more pronounced changes in risk taking, raising the proportion of stock and alternative investments, but decreasing liability risk through relying more on reinsurance.

These results suggest that risk shifting and risk-management considerations can depend in subtle ways on organizational structure. For mutual firms, which are owned by their policyholders and cannot easily issue new shares, an increase in risky bond holdings raises expected returns by exploiting debtholders, as in the standard asset-substitution model. But the owners/policyholders of such firms simultaneously take steps to reduce volatility through insurance payouts by engaging more in reinsurance. Taken together, our results suggest that whether risk-management or risk-shifting incentives dominate depends on the organizational structure of the firm and the extent of its access to capital markets.

Table 1. Summary statistics for full sample

	mean	sd	p5	p50	p95
net admitted assets billion $	6.904	42.197	0.003	0.070	16.033
direct premiums written billion $	2.350	13.954	0.001	0.036	6.351
adjusted capital	2.636	17.825	0.001	0.029	6.556
proportion non-investment grade	0.012	0.042	0.000	0.000	0.067
prop. of stock and alt. inv.	0.126	0.186	0.000	0.055	0.522
debt ratio	0.278	0.145	0.057	0.264	0.549
surplus notes / assets	0.014	0.048	0.000	0.000	0.087
leverage	0.553	0.181	0.215	0.572	0.819
capital / assets	0.447	0.181	0.180	0.428	0.785
loss ratio	0.513	0.232	0.117	0.529	0.810
rbc ratio	9.826	8.803	2.406	7.795	23.813
prop. of prem. ceded to non-affiliates	0.209	0.207	0.000	0.149	0.666
premiums ceded / assets	0.160	0.290	0.000	0.060	0.703
Mutual dummy	0.351	0.477	0.000	0.000	1.000
Observations	12544				

Table 2. Summary statistics by ownership type

	(1) Mutual Companies			(2) Stock Companies		
	mean	sd	p50	mean	sd	p50
net admitted assets billion $	0.450	1.965	0.041	10.393	52.026	0.107
direct premiums written billion $	0.152	0.472	0.016	3.539	17.200	0.058
adjusted capital	0.231	1.200	0.020	3.936	21.998	0.040
prop. of stock and alt. inv.	0.145	0.188	0.084	0.116	0.185	0.036
prop. of prem. ceded to non-affiliates	0.217	0.183	0.167	0.205	0.219	0.129
debt ratio	0.266	0.122	0.260	0.284	0.156	0.266
surplus notes / assets	0.013	0.049	0.000	0.014	0.048	0.000
leverage	0.506	0.178	0.516	0.578	0.177	0.603
capital / assets	0.494	0.178	0.484	0.422	0.177	0.397
loss ratio	0.510	0.201	0.521	0.515	0.248	0.534
proportion non-investment grade	0.008	0.030	0.000	0.015	0.047	0.000
premiums ceded / assets	0.147	0.256	0.071	0.168	0.307	0.051
rbc ratio	11.790	8.831	9.874	8.797	8.612	6.863
Observations	4402			8142		

Table 3. First-Stage Regression
Dependent variable: leverage ratio

	(1)	(2)	(3)
1 % winsorized loss ratio	0.119***	0.120***	0.134***
	(0.005)	(0.004)	(0.007)
HD (high-debt dummy)		0.087***	0.092***
		(0.002)	(0.005)
HP (high policy liab. dummy)		0.076***	0.081***
		(0.003)	(0.005)
HS (high surplus notes dummy)		0.052***	0.068***
		(0.003)	(0.006)
losa ratio X HD			-0.009
			(0.008)
losa ratio X HP			-0.008
			(0.008)
loas ratio X HS			-0.031***
			(0.010)
Constant	0.494***	0.393***	0.386***
	(0.005)	(0.005)	(0.006)
Observations	13,579	12,544	12,544
R-squared	0.079	0.269	0.270
Number of groups	1,023	969	969
Firm FE	YES	YES	YES
Year FE	YES	YES	YES
r2	0.0811	0.467	0.471
F-test	46.75	169.8	152.1

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 4. Second stage

Dependent variable: capital/assets

	all			
	year-end	one year	two years	three years
leverage	-1.000***	-0.985***	-0.882***	-0.672***
	(0.000)	(0.048)	(0.070)	(0.076)
Observations	12,544	11,605	10,710	9,885
Number of groups	969	922	856	815
RMSE	0.000	0.0623	0.081	0.093
	mutual			
	year-end	one year	two years	three years
leverage	-1.000***	-1.087***	-0.993***	-0.804***
	(0.000)	(0.069)	(0.090)	(0.113)
Observations	4,402	4,126	3,861	3,607
Number of groups	280	271	261	255
RMSE	0.000	0.051	0.064	0.072
	stock			
	year-end	one year	two years	three years
leverage	-1.000***	-0.937***	-0.824***	-0.604***
	(0.000)	(0.063)	(0.097)	(0.101)
Observations	8,142	7,479	6,849	6,278
Number of groups	689	651	595	560
RMSE	0.000	0.068	0.088	0.103

Robust standard errors in parentheses; clustering at firm level;

*** p<0.01, ** p<0.05, * p<0.1.

Firm and year fixed effects included in all regressions.

Table 5. Second stage

Dependent variable: Premiums ceded to reinsurers/assets

	all			
	year-end	one year	two years	three years
leverage	0.610***	0.567***	0.464***	0.236*
	(0.138)	(0.177)	(0.170)	(0.136)
Observations	12,468	11,535	10,641	9,825
Number of groups	968	921	856	815
RMSE	0.151	0.144	0.142	0.136

	mutual			
	year-end	one year	two years	three years
leverage	0.953***	1.163***	1.047***	0.413*
	(0.239)	(0.406)	(0.330)	(0.236)
Observations	4,394	4,116	3,852	3,598
Number of groups	279	270	261	255
RMSE	0.130	0.135	0.132	0.121

	stock			
	year-end	one year	two years	three years
leverage	0.466***	0.288*	0.163	0.141
	(0.166)	(0.164)	(0.182)	(0.169)
Observations	8,074	7,419	6,789	6,227
Number of groups	689	651	595	560
RMSE	0.162	0.151	0.149	0.144

Robust standard errors in parentheses; clustering at firm level;
*** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Firm and year fixed effects included in all regressions.

Table 6. Second Stage

Dependent variable: Risky assets/total assets

	year-end	one year	two years	three years
leverage	0.098	0.120	0.080	0.068
	(0.084)	(0.086)	(0.088)	(0.096)
Observations	12,544	11,605	10,710	9,885
Number of groups	969	922	856	815
RMSE	0.114	0.118	0.121	0.123
		mutual		
	year-end	one year	two years	three years
leverage	0.336*	0.353**	0.380**	0.478***
	(0.190)	(0.148)	(0.154)	(0.170)
Observations	4,402	4,126	3,861	3,607
Number of groups	280	271	261	255
RMSE	0.111	0.118	0.122	0.126
		stock		
	year-end	one year	two years	three years
leverage	-0.010	0.002	-0.078	-0.142
	(0.081)	(0.100)	(0.101)	(0.108)
Observations	8,142	7,479	6,849	6,278
Number of groups	689	651	595	560
RMSE	0.115	0.118	0.121	0.122

Robust standard errors in parentheses; clustering at firm level;
*** p<0.01, ** p<0.05, * p<0.1.
Firm and year fixed effects included in all regressions.

Table 7. Second stage

Dependent variable: Risk-based capital ratio

	all			
	year-end	one year	two years	three years
leverage	-27.482***	-33.634***	-34.541***	-28.006***
	(5.850)	(5.234)	(4.895)	(4.949)
Observations	12,138	11,245	10,388	9,599
Number of groups	964	915	846	805
RMSE	4.972	5.107	5.353	5.178
	mutual			
	year-end	one year	two years	three years
leverage	-40.292***	-47.079***	-52.622***	-42.531***
	(6.188)	(6.930)	(8.874)	(6.569)
Observations	4,171	3,910	3,661	3,421
Number of groups	277	266	254	248
RMSE	4.653	4.823	5.573	4.928
	stock			
	year-end	one year	two years	three years
leverage	-22.499***	-27.740***	-25.586***	-20.355***
	(8.213)	(7.207)	(5.976)	(6.829)
Observations	7,967	7,335	6,727	6,178
Number of groups	687	649	592	557
RMSE	5.114	5.205	5.240	5.301

Robust standard errors in parentheses; clustering at firm level;

*** p<0.01, ** p<0.05, * p<0.1.

Firm and year fixed effects included in all regressions.

Table 8a. Second stage, split by size

Dependent variable: Capital ratio

	year-end	one year	two years	three years	year-end	one year	two years	three years
				all				
leverage	-1.000***	-0.947***	-0.939***	-0.678***	-1.000***	-1.027***	-0.779***	-0.646***
	(0.000)	(0.068)	(0.102)	(0.111)	(0.000)	(0.066)	(0.098)	(0.108)
Observations	6,264	5,699	5,175	4,703	6,280	5,906	5,535	5,182
Number of groups	651	610	552	517	431	414	398	387
size	small	small	small	small	big	big	big	big
RMSE	0.000	0.076	0.101	0.119	0.000	0.045	0.055	0.060
				mutual				
leverage	-1.000***	-1.057***	-0.904***	-0.637***	-1.000***	-1.123***	-1.096***	-1.008***
	(0.000)	(0.105)	(0.130)	(0.166)	(0.000)	(0.077)	(0.114)	(0.131)
Observations	2,196	2,047	1,903	1,766	2,206	2,079	1,958	1,841
Number of groups	160	155	148	145	149	143	139	135
size	small	small	small	small	big	big	big	big
RMSE	0.000	0.060	0.074	0.082	0.000	0.039	0.052	0.061
				stock				
leverage	-1.000***	-0.898***	-0.960***	-0.695***	-1.000***	-0.985***	-0.623***	-0.471***
	(0.000)	(0.089)	(0.142)	(0.148)	(0.000)	(0.088)	(0.142)	(0.158)
Observations	4,068	3,652	3,272	2,937	4,074	3,827	3,577	3,341
Number of groups	491	455	404	372	282	271	259	252
size	small	small	small	small	big	big	big	big
RMSE	0.000	0.085	0.114	0.137	0.000	0.047	0.058	0.061

Robust standard errors in parentheses; clustering at firm level; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Firm and year fixed effects included in all regressions.

Table 8b. Second stage, split by size

Dependent variable: Premiums ceded/assets

	year-end	one year	two years	three years	year-end	one year	two years	three years
				all				
leverage	0.880***	0.783***	0.693**	0.384*	0.203*	0.254**	0.219*	0.104
	(0.207)	(0.279)	(0.277)	(0.214)	(0.109)	(0.121)	(0.117)	(0.118)
Observations	6,220	5,661	5,133	4,668	6,248	5,874	5,508	5,157
Number of groups	650	609	552	517	430	414	397	387
size	small	small	small	small	big	big	big	big
RMSE	0.193	0.182	0.180	0.173	0.098	0.096	0.096	0.093
				mutual				
leverage	1.403***	1.711***	1.573***	0.494	0.190**	0.323***	0.287***	0.275***
	(0.354)	(0.629)	(0.528)	(0.408)	(0.076)	(0.086)	(0.099)	(0.090)
Observations	2,193	2,042	1,898	1,760	2,201	2,074	1,954	1,838
Number of groups	160	154	148	145	148	143	138	135
size	small	small	small	small	big	big	big	big
RMSE	0.175	0.183	0.178	0.160	0.063	0.063	0.065	0.065
				stock				
leverage	0.640***	0.322	0.196	0.303	0.199	0.204	0.168	-0.009
	(0.241)	(0.237)	(0.287)	(0.248)	(0.154)	(0.169)	(0.164)	(0.166)
Observations	4,027	3,619	3,235	2,908	4,047	3,800	3,554	3,319
Number of groups	490	455	404	372	282	271	259	252
size	small	small	small	small	big	big	big	big
RMSE	0.201	0.182	0.182	0.179	0.112	0.110	0.109	0.105

Robust standard errors in parentheses; clustering at firm level; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Firm and year fixed effects included in all regressions.

Table 8c. Second stage, split by size

Dependent variable: Risky assets/total assets

	year-end	one year	two years	three years	year-end	one year	two years	three years
				all				
leverage	0.086	0.126	0.017	-0.057	0.129	0.096	0.156	0.220*
	(0.114)	(0.115)	(0.124)	(0.148)	(0.124)	(0.129)	(0.137)	(0.127)
Observations	6,264	5,699	5,175	4,703	6,280	5,906	5,535	5,182
Number of groups	651	610	552	517	431	414	398	387
size	small	small	small	small	big	big	big	big
RMSE	0.141	0.146	0.149	0.154	0.075	0.082	0.085	0.085
				mutual				
leverage	0.285	0.343*	0.379*	0.527**	0.545**	0.438*	0.407	0.395*
	(0.268)	(0.197)	(0.211)	(0.253)	(0.257)	(0.255)	(0.262)	(0.215)
Observations	2,196	2,047	1,903	1,766	2,206	2,079	1,958	1,841
Number of groups	160	155	148	145	149	143	139	135
size	small	small	small	small	big	big	big	big
RMSE	0.137	0.145	0.149	0.156	0.076	0.082	0.085	0.087
				stock				
leverage	0.000	0.018	-0.176	-0.364**	-0.063	-0.068	0.034	0.134
	(0.108)	(0.138)	(0.151)	(0.171)	(0.115)	(0.128)	(0.139)	(0.143)
Observations	4,068	3,652	3,272	2,937	4,074	3,827	3,577	3,341
Number of groups	491	455	404	372	282	271	259	252
size	small	small	small	small	big	big	big	big
RMSE	0.144	0.147	0.151	0.158	0.077	0.082	0.086	0.084

Robust standard errors in parentheses; clustering at firm level; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Firm and year fixed effects included in all regressions.

Table 8d. Second stage, split by size

Dependent variable: RBC ratio

	year-end	one year	two years	three years	year-end	one year	two years	three years
				all				
leverage	-33.026***	-33.989***	-31.148***	-21.436***	-15.755	-28.845***	-35.559***	-34.160***
	(4.741)	(5.601)	(7.226)	(7.782)	(14.420)	(10.732)	(6.299)	(5.308)
Observations	5,909	5,385	4,896	4,456	6,229	5,860	5,492	5,143
Number of groups	646	603	542	507	431	414	398	387
size	small	small	small	small	big	big	big	big
RMSE	6.179	6.282	6.477	6.094	3.458	3.567	3.861	3.958
				mutual				
leverage	-37.941***	-38.093***	-44.696***	-33.071***	-45.124***	-56.908***	-58.562***	-50.556***
	(9.357)	(9.945)	(13.494)	(9.414)	(6.485)	(8.223)	(9.474)	(7.646)
Observations	1,966	1,832	1,703	1,580	2,205	2,078	1,958	1,841
Number of groups	157	150	141	138	149	143	139	135
size	small	small	small	small	big	big	big	big
RMSE	5.896	5.859	6.661	5.374	2.998	3.559	4.047	4.199
				stock				
leverage	-32.346***	-32.579***	-24.416***	-15.021	-2.402	-15.616	-24.094***	-25.665***
	(5.547)	(6.909)	(8.809)	(10.932)	(21.754)	(16.241)	(7.960)	(6.971)
Observations	3,943	3,553	3,193	2,876	4,024	3,782	3,534	3,302
Number of groups	489	453	401	369	282	271	259	252
size	small	small	small	small	big	big	big	big
RMSE	6.324	6.487	6.391	6.470	3.718	3.631	3.799	3.841

Robust standard errors in parentheses; clustering at firm level; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Firm and year fixed effects included in all regressions.

Table 9a. Second stage, with interactive liability dummies

Dependent variable: Capital ratio

mutual				
	year-end	one year	two years	three years
leverage	-1.000***	-1.051***	-0.995***	-0.813***
	(0.000)	(0.094)	(0.141)	(0.181)
leverage X debt ratio above median	0.000	0.138	0.087	-0.068
	(0.000)	(0.149)	(0.206)	(0.237)
leverage X policyholder liab. ratio above median	-0.000	-0.172**	-0.062	0.056
	(0.000)	(0.079)	(0.110)	(0.142)
leverage X surplus notes ratio above median	-0.001	-0.220	-0.097	0.125
	(0.001)	(0.286)	(0.374)	(0.558)
Observations	4,402	4,126	3,861	3,607
Number of groups	280	271	261	255
RMSE	0.000	0.053	0.065	0.073

stock				
	year-end	one year	two years	three years
leverage	-1.000***	-0.894***	-0.864***	-0.600***
	(0.000)	(0.090)	(0.133)	(0.132)
leverage X debt ratio above median	-0.000	0.013	0.033	0.087
	(0.000)	(0.070)	(0.096)	(0.097)
leverage X policyholder liab. ratio above median	-0.000	-0.044	0.052	-0.047
	(0.000)	(0.070)	(0.110)	(0.107)
leverage X surplus notes ratio above median	0.000	-0.094	-0.048	-0.043
	(0.000)	(0.089)	(0.157)	(0.199)
Observations	8,142	7,479	6,849	6,278
Number of groups	689	651	595	560
RMSE	0.000	0.068	0.089	0.103

Robust standard errors in parentheses; clustering at firm level; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Firm and year fixed effects included in all regressions.

Table 9b. Second stage, with interactive liability dummies
Dependent variable: Premiums ceded/assets

mutual				
	year-end	one year	two years	three years
leverage	0.850***	0.736*	0.763**	0.185
	(0.297)	(0.379)	(0.320)	(0.227)
leverage X debt ratio above median	0.431	0.835	0.612	0.562
	(0.431)	(0.636)	(0.540)	(0.454)
leverage X policyholder liab. ratio above median	-0.121	0.208	0.146	-0.016
	(0.289)	(0.492)	(0.426)	(0.213)
leverage X surplus notes ratio above median	-0.526	-0.846	-0.778	-0.381
	(0.739)	(0.990)	(0.820)	(0.744)
Observations	4,394	4,116	3,852	3,598
Number of groups	279	270	261	255
RMSE	0.132	0.139	0.135	0.126

stock				
	year-end	one year	two years	three years
leverage	0.463**	0.221	0.030	-0.061
	(0.199)	(0.212)	(0.249)	(0.229)
leverage X debt ratio above median	0.060	0.254	0.211	0.140
	(0.164)	(0.164)	(0.195)	(0.180)
leverage X policyholder liab. ratio above median	-0.050	0.021	0.170	0.235
	(0.193)	(0.194)	(0.209)	(0.187)
leverage X surplus notes ratio above median	0.061	-0.277	-0.351	-0.071
	(0.368)	(0.315)	(0.338)	(0.270)
Observations	8,074	7,419	6,789	6,227
Number of groups	689	651	595	560
RMSE	0.162	0.152	0.151	0.145

Robust standard errors in parentheses; clustering at firm level; *** p<0.01, ** p<0.05, * p<0.1.
Firm and year fixed effects included in all regressions.

Table 9c. Second stage, with interactive liability dummies
Dependent variable: Risky assets/total assets

mutual				
	year-end	one year	two years	three years
leverage	0.359	0.400	0.621**	0.501
	(0.331)	(0.262)	(0.293)	(0.305)
leverage X debt ratio above median	0.028	-0.140	-0.524	-0.134
	(0.417)	(0.334)	(0.354)	(0.358)
leverage X policyholder liab. ratio above median	-0.055	-0.005	0.016	0.104
	(0.190)	(0.161)	(0.192)	(0.195)
leverage X surplus notes ratio above median	-0.119	0.237	0.124	-0.039
	(0.580)	(0.560)	(0.661)	(0.836)
Observations	4,402	4,126	3,861	3,607
Number of groups	280	271	261	255
RMSE	0.111	0.119	0.125	0.127

stock				
	year-end	one year	two years	three years
leverage	-0.171	-0.148	-0.358*	-0.427**
	(0.146)	(0.161)	(0.183)	(0.192)
leverage X debt ratio above median	-0.079	-0.075	0.149	0.190
	(0.105)	(0.116)	(0.129)	(0.140)
leverage X policyholder liab. ratio above median	0.227*	0.226*	0.327**	0.316*
	(0.122)	(0.137)	(0.157)	(0.164)
leverage X surplus notes ratio above median	0.188	0.133	-0.038	-0.035
	(0.126)	(0.134)	(0.165)	(0.188)
Observations	8,142	7,479	6,849	6,278
Number of groups	689	651	595	560
RMSE	0.117	0.119	0.123	0.125

Robust standard errors in parentheses; clustering at firm level; *** p<0.01, ** p<0.05, * p<0.1.
Firm and year fixed effects included in all regressions.

Table 9d. Second stage, with interactive liability dummies

Dependent variable: RBC ratio

mutual				
	year-end	one year	two years	three years
leverage	-57.947***	-56.496***	-51.602***	-45.874***
	(12.284)	(14.307)	(16.905)	(14.407)
leverage X debt ratio above median	45.365**	35.955*	27.695	23.560
	(19.458)	(21.054)	(28.434)	(24.679)
leverage X policyholder liab. ratio above median	3.901	-3.753	-12.779	-6.675
	(7.691)	(9.265)	(14.061)	(10.706)
leverage X surplus notes ratio above median	-35.111	-46.298	-57.030	-31.711
	(30.916)	(36.680)	(41.921)	(31.663)
Observations	4,171	3,910	3,661	3,421
Number of groups	277	266	254	248
RMSE	5.275	5.324	6.210	5.113

stock				
	year-end	one year	two years	three years
leverage	-36.611***	-29.268**	-25.490**	-15.373
	(7.686)	(11.377)	(10.856)	(11.835)
leverage X debt ratio above median	12.698	6.591	2.650	-5.801
	(10.992)	(8.689)	(6.916)	(7.046)
leverage X policyholder liab. ratio above median	12.232	-3.522	-5.182	-7.187
	(9.382)	(10.461)	(9.778)	(8.117)
leverage X surplus notes ratio above median	0.192	4.573	10.768	9.789
	(9.097)	(8.174)	(9.625)	(8.103)
Observations	7,967	7,335	6,727	6,178
Number of groups	687	649	592	557
RMSE	5.141	5.183	5.201	5.275

Robust standard errors in parentheses; clustering at firm level; *** p<0.01, ** p<0.05, * p<0.1.

Firm and year fixed effects included in all regressions.

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