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THE ROLE OF FINANCIAL CONDITIONS IN PORTFOLIO CHOICES:  
THE CASE OF INSURERS

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## **ABSTRACT**

Many institutional investors depend on the returns they generate to fund their operations and liabilities. How do these investors' financial conditions affect the management of their portfolios? We address this issue using the insurance industry because insurers are large investors for which detailed portfolio data are available, and can face financial shocks from exogenous weather-related events. Results suggest that more constrained insurers have smaller portfolio weights on riskier and illiquid assets, and have lower realized returns. Among corporate bonds, for which we can control for regulatory treatment, results suggest that more constrained insurers have smaller portfolio weights on riskier corporate bonds. Following operating losses, P&C insurers decrease allocations to riskier corporate bonds. The effect of losses on allocations is likely to be causal since it holds when instrumenting for P&C losses with weather shocks. The change in allocations following losses is larger for more constrained insurers and during the financial crisis, suggesting that the shift toward safer securities is driven by concerns about financial flexibility. The results highlight the importance of financial flexibility to fund operations in institutional investors' portfolio decisions.

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## 1. Introduction

Modern portfolio theory began with Markowitz (1952), who proposed the then-novel idea that risk-averse investors will demand a premium to invest in risky assets and the risk of an investor's portfolio will depend on how risk-averse the investor is. This idea is naturally applied to portfolios of individual investors, who, according to empirical evidence, do in fact tend to be risk-averse. However, in contrast to the era in which Markowitz wrote his seminal work, the vast majority of financial assets today are owned or managed by institutional investors rather than individuals. The largest investors in the economy today, institutional investors such as pension funds, endowments, and insurance companies, are organizations that depend on their financial investments to fund their operations. Since these organizations do not necessarily have "preferences" like individual investors, it is not obvious how one would characterize the way they view the tradeoff between risk and return. How should we characterize these institutional investors' portfolio optimization problem? What drives their portfolio choices?

The answers to these questions are of fundamental importance to our understanding of financial markets. Endowments, foundations, pension funds, and insurance companies had U.S. assets of over \$22 trillion at the end of 2017.<sup>1</sup> Their portfolio choices could materially impact the price of risk in the economy, and their appetite for different securities can affect different firms' cost of capital differently. These investors differ from professionally managed portfolios such as mutual funds and hedge funds because they rely (at least in part) on the returns from their investments to fund their operations. Consequently, the issues raised in the corporate finance literature on risk and liquidity management are likely to apply to how these investors manage their financial portfolios.

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<sup>1</sup> At the end of 2017, insurers hold invested assets worth \$6.5 trillion and pension funds hold \$14.5 trillion. At the end of 2015, university endowments hold \$0.5 trillion, and foundations hold \$0.9 trillion. The sources for these figures are: National Association of Insurance Commissioners for insurers ([https://www.naic.org/capital\\_markets\\_archive/180816.pdf](https://www.naic.org/capital_markets_archive/180816.pdf)), Federal Reserve Statistical Release, Financial Accounts of the United States for pension funds (<https://www.federalreserve.gov/releases/z1/20180920/z1.pdf>, page 94), Department of Education for university endowments (<https://nces.ed.gov/fastfacts/display.asp?id=73>), and Foundation Center for foundations (<http://data.foundationcenter.org/>).

If an institutional investor relies on returns from its investments to fund operations, it will have to account for the possibility that the organization has a cash shortfall, and will need to sell some of its investments. If an institution's investments are highly illiquid, it will have a harder time meeting these increased liquidity needs. This illiquidity will be more of a problem for firms who face a higher cost of financing, so more financially constrained institutions could prefer a more liquid investment policy.<sup>2</sup> In addition, liabilities can increase, leading the organization closer to insolvency, even if the current cash requirements do not change. For example, a pension fund's liabilities and probability of insolvency can increase if the future life expectancy of retirees' increases. If an institution invests in risky assets whose value declines with a higher probability, the institution will be more likely to approach costly bankruptcy. Thus, more constrained institutions could prefer a safer portfolio.<sup>3</sup> It is also possible that agents managing these portfolios become more risk averse as the probability of losing their job due to institutions' insolvency increases, which we consider as one cost associated with financial constraints. Therefore, it is possible that financial constraints can move institutions toward safer and more liquid securities. Alternatively, financial constraints could lead institutions to risk shift toward riskier and more illiquid securities as institutions gamble for higher returns as famously suggested by Jensen and Meckling (1976).

We use a sample of 2,084 Property-Casualty (P&C) insurers and 842 life insurers in the U.S. between 2001 and 2015. Insurers are important institutional investors, holding approximately \$6.5 trillion of financial assets, including more than 25% of U.S. corporate bonds. Insurers report detailed security-level financial investments, so we can observe the risk and liquidity of these investments. In addition, P&C insurers can suffer from shocks due to unusual weather events, like hurricanes, which can meaningfully worsen insurers' financial conditions by increasing their demand for cash and their probability of insolvency. These exogenous shocks presumably occur independently of insurers' financial investment and help us identify the causal effects of insurers' financial conditions on their portfolios.

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<sup>2</sup> The idea that concerns about future financial constraints can affect liquidity management policies dates at least to Keynes (1936). The modern literature examining this idea began with Opler, Pinkowitz, Stulz, and Williamson (1999). See Almeida, Campello, Cunha, and Weisbach (2014) for a survey.

<sup>3</sup> The argument that the demand for risk management comes from the cost of accessing external financial markets was proposed by Froot, Scharfstein, and Stein (1993).

We first examine whether insurers' portfolios vary cross-sectionally with insurers' characteristics. Larger insurers have substantially different portfolios than smaller insurers. In particular, larger insurers have, as a fraction of their total portfolio, less cash (including short-term investments) and government debt, but more mortgage-backed securities (MBS) and corporate bonds. Larger insurers should have higher expected returns on their portfolios than smaller insurers, and in our sample, do in fact earn higher realized investment returns. In addition, larger size is associated with a better financial strength rating, lower operational cash flow volatility and less reinsurance usage. These cross-sectional correlations are suggestive of the view that larger insurers are less financially constrained, which is one potential reason why they invest in riskier, less liquid securities and earn higher average returns.

Securities differ from one another in a number of dimensions. Cash and government debt are safer, more liquid, and also receive more lenient regulatory treatment than MBS and corporate bonds.<sup>5</sup> To evaluate whether smaller insurers hold more cash and government debt because of the safety and liquidity or only because of favorable regulatory treatment of cash and government debt, we consider insurers' holdings of corporate bonds separately. Among corporate bonds, we can control for regulatory treatments. Our results suggest that, holding constant the regulatory treatment of different bonds, smaller or worse-rated insurers have a larger allocation to safer corporate bonds than larger or better-rated insurers, and more so during the financial crisis. These results suggest that financial securities' safety and liquidity, in addition to their regulatory treatments, affect insurers' allocations.

The relation between insurers' asset size and their portfolio choices does not necessarily mean that insurers' financial conditions causally affect their portfolio choices. It is possible that the two are related for other reasons. For example, insurers who are more risk-seeking in their financial portfolios receive, on average, higher realized returns, which could lead firms with riskier portfolios to have larger assets. As a more direct way of linking financial conditions with insurers' portfolios, we assume that insurers' operating losses represent negative shocks to their financial conditions and estimate the way that portfolios change following operating losses. To address the concern that insurers' operating losses and

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<sup>5</sup> Section 2 discusses the regulatory treatment of insurers' financial security holdings in detail.

portfolio choices could both be related to insurers' unobservable characteristics (e.g. management quality), we construct an instrumental variable for P&C insurers' losses with two sources of data: unusual weather damages at the state-quarter level and insurers' lagged market share in each state.

Our results suggest that, following operating losses, P&C insurers reduce their holdings of riskier corporate bonds. This result holds using OLS and also instrumenting for losses using weather data. We also find that, following operating losses, insurers are more likely to purchase bonds that are relatively liquid (controlling for bond-quarter fixed effects). Finally, we find that when firms are more financially constrained (smaller or worse-rated) or during the financial crisis, operating losses lead insurers to have larger increases in the allocation to safer bonds. More constrained firms are likely to be affected more by unexpected losses, so this result provides additional support for the view that insurers' financial constraints affect their portfolio choices. These results all suggest that when financial constraints are exacerbated, insurers shift their portfolios toward safer and more liquid securities.

In addition to our conclusions about the way in which financial constraints affect portfolio allocations, this paper has three other important implications. First, we shed light on insurers' attitudes toward risk, their desired portfolio if they were not financially constrained, as well as the shadow cost of financial constraints on insurers' financial investments. We find evidence consistent with the idea that larger insurers seem less financially constrained and have higher portfolio weights on riskier and more illiquid securities, and earn higher realized returns. Consequently, in the absence of concerns about financial flexibility, insurers appear to seek higher expected returns by taking on more risk and illiquidity in their financial portfolio. If absent financial management considerations, seeking higher expected returns is the objective of these investors, one cost of insurers' financial constraints is that insurers need to forego higher expected returns in exchange for lower risk and more liquidity in their financial portfolio.

Second, this paper also offers micro-level evidence that more constrained investors pursue a "flight to quality," meaning that during market downturns, their demand for securities shifts toward safer

ones.<sup>6</sup> During aggregate market downturns, it has been documented that issuances of low rated firms decline substantially, but high-rated firms actually issue more bonds in poor times than in good times (see Erel et al. (2012)). Our paper finds that for insurers, who hold more than one quarter of all the corporate bonds in the U.S., exogenous shocks to financial conditions lead them to shift their portfolios towards safer assets. If similar shifts in demand for securities occur when aggregate downturns worsen insurers' financial constraints, then the aggregate shift towards issuances of safer bonds during worse financial conditions can be partially explained by the shifting demand for safer bonds.

Third, this paper presents a clean test of theories about the way in which firms respond to negative shocks to their financial condition. The “risk-management” theories of Smith and Stulz (1985), Froot, Scharfstein and Stein (1993), and Almeida, Campello, and Weisbach (2011) imply that a weakening of a firm’s financial condition should lead to a reduction of the risk of the firm’s portfolio because of the increased cost of raising capital in the event of a financial shortfall. In contrast, the “risk-shifting” argument of Jensen and Meckling (1976) suggests that a weakening of a firm’s financial conditions should instead lead it to increase the riskiness of its portfolio. Our results support the risk-management hypothesis since we find that insurers shift towards safer financial investments in response to a negative financial shock.

Closely related to this paper is the literature on “intermediary asset pricing”, summarized in He and Krishnamurthy (2018). When asset values decline, a reduction in the risk tolerance of managers and the intermediary shifts its portfolio accordingly (see section 2.5 of He and Krishnamurthy (2018) for discussion). Our evidence suggests that the phenomenon He and Krishnamurthy (2018) describe is widespread -- when asset values decline and financial constraints tighten, asset managers shift their portfolios toward less risky securities. During financial downturns, demand for anything but the safest securities dries up, making it difficult for many firms to receive financing during these times.

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<sup>6</sup> See Caballero and Krishnamurthy (2008) and Vayanos (2004) for theoretical motivation of the flight to quality arguments.

We are not the first to distinguish empirically between the risk-management and risk-shifting hypotheses in the setting of financial investment. Rauh (2009) suggests that defined benefit pension plans hold a larger portion of safer assets such as government debt and cash when the plans are poorly funded or the firms have poor credit ratings. Duchin et al (2017) find that nonfinancial firms have larger portfolio weights in safer assets if they are more financially constrained. Our results are consistent with these two studies, using a different set of firms, insurers, who have a large, understudied portfolio and are important actors in the economy. We improve upon these two papers in two ways. First, we identify the causal effect of firms' financial conditions on their portfolio choices by using weather shocks to insurers' operations. Second, since we have CUSIP-level data on insurers' financial assets, we can better control for the securities' liquidity while studying how securities' riskiness affects insurers' allocation to them by examining within allocation within an asset class, which Rauh (2009) and Duchin et al (2017) are not able to do. Different from the implications in Rauh (2009) and Duchin et al (2017), Mohan and Zhang (2014) and Andonov, Bauer and Cremers (2017) find that public pension funds have higher portfolio weights on riskier assets if the funds have a severe underfunding problem.<sup>7</sup>

Another related paper is Becker and Ivashina (2015), which has implications on the relationship between insurers' financial conditions and their risk-shifting or risk-management behavior. They document that insurers with lower regulatory capital surplus acquire bonds with higher yields, compared to insurers with higher capital surplus. This result could be due to that insurers' regulatory capital surplus and their larger allocation towards riskier securities are both related to omitted variables, such as insurers' appetite for a riskier portfolio. Insurers with more tolerance for risk hold riskier assets which lower insurers' regulatory capital surplus through higher required capital. These insurers hold riskier corporate bonds probably because they have the financial flexibility to take on more risk in their portfolios. We use

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<sup>7</sup> While these studies examine financial investments in, some other papers examine firms' real investments. Andrade and Kaplan (1998) and Gilje (2016) do not find evidence for risk-shifting behavior. Calomiris and Wilson (2004) and Duchin and Sosyura (2014) suggest more constrained banks engage in less risky activities. Using numerical techniques, Parrino and Weisbach (1999) estimate the magnitude of the investment distortions due to stockholder-bondholder conflicts, which they conclude to be small for most firms. However, some papers do find evidence for risk-shifting incentives, for example, Hovakimian and Kane (2007), Eisdorfer (2008), Rampini, Sufi and Viswanathan (2014), Landier, Sraer and Thesmar (2015), Acharya and Steffen (2015), and Drechsler et al (2016).

unusual weather damages as exogenous shocks to insurers' financial conditions, our results suggest that more constrained insurers prefer safer corporate bonds more than the less constrained insurers.<sup>8</sup>

## 2. Relevant Regulation

Regulators monitor insurers' financial health using several different measures. An important one is the Risk-Based Capital Ratio (hereafter RBC Ratio). This ratio can be seen as the book value of equity (in the language of the regulation, total adjusted capital) divided by required capital. Regulators have complex formulas for calculating the denominator, required capital. Financial securities in insurers' portfolios can add to required capital. The addition to required capital can be simplified as a percentage of the book value of the security, which we denote as *Risk Charge*\**BV* of the security, where *BV* stands for the book value of the security. The way in which a particular security can affect insurers' RBC ratio can be simplified with the following formula:

$$RBC\ Ratio = \frac{Equity\ excluding\ the\ security + BV\ of\ the\ security}{Required\ capital\ excluding\ the\ security + Risk\ charge\ * BV\ of\ the\ security}$$

The *Risk Charge* for a particular security differs across securities. Table 1 summarizes these risk charges. Generally, the riskier a security is, the larger is the risk charge. For example, the risk charge for treasury securities is 0, 0.96% for BBB-rated corporate bonds and 7.38% for B-rated corporate bonds.

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<sup>8</sup> Some other papers also study insurers' investment in financial assets. Ellul, Jotikasthira, and Lundblad (2011) and Merrill et al (2014) study insurers' fire sales of downgraded assets. Becker and Opp (2014) study how changes in regulation distort insurers' holdings of MBS. Ellul et al (2015) examine how different accounting rules affect insurers' asset holdings differently during the crisis. Getmansky et al (2017) study the commonality in insurers' portfolio and their asset sales behavior. Sen (2018) studies how regulation affects life insurers' hedging incentives. Chodorow-Reich, Ghent, and Haddad (2018) argue that life insurers can insulate the value of financial assets from exposure to market movement by holding the assets for the long run. Ellul et al (2018) find that the investment of insurers selling variable annuities can create systemic risk. Murray and Nikolova (2018) argue that insurers' portfolio choices, driven by regulation, affect prices of corporate bonds. Huang et al (2018) show that insurers' holdings of illiquid bonds affect the bond pricing.

### 3. Data

#### 3.1 Insurers' Financial Data and Holdings in Categories

Insurers' financial data between 1999 and 2015 are obtained from the National Association of Insurance Commissioners (NAIC) and SNL Financial. Insurers' financial strength ratings are from Best's Insurance Reports by A.M. Best between 2004 and 2013. A.M. Best is the leading rating agency for insurance companies, and issues such reports three times a year. Insurers with negative assets or net premium written lower than \$10,000 are excluded. All financial variables are winsorized at the 1st and 99th percentiles. Panel A of Table 2 offers summary statistics on insurers' financials.

To study the effect of insurers' financial constraints on their investment portfolio, we use P&C insurers' operating losses as shocks that worsen their financial constraints. We construct an instrumental variable for the reported P&C insurers' operating losses, following Ge (2019). Data on damages due to weather events are from Spatial Hazard Events and Losses Database for the United States (SHELDUS). SHELDUS' main data source is the National Centers for Environmental Information. We include all the event types covered in the dataset, including hurricanes, wildfires, tornadoes, etc.

To construct the instrument, we first sum the dollar value of weather damages to properties (from SHELDUS) at the state-quarter level, then compute rolling historical averages using data on state  $s$ , prior to quarter  $q$ , adjusting for inflation. Since weather damages vary systematically by season, we construct historical averages for each quarter  $q$  using historical data from the same quarter. We then subtract the state-quarter historical average from the state-quarter level weather damages, to obtain what we call *Unusual Weather Damages*.

Second, we construct each P&C insurer  $i$ 's lagged market share in state  $s$ , quarter  $q$ , as insurer  $i$ 's direct premiums written in state  $s$  over the four preceding quarters, divided by the sum of the direct premiums written by all the P&C insurers operating in state  $s$  over the same period. We multiply this lagged market share at the insurer-state-quarter level with *Unusual Weather Damages* at the state-quarter

level from the first step. We then sum the resulting products over all the states for each insurer, and scale by assets at the end of the previous year, to obtain the instrumental variable.

Some assumptions are needed for the instrument to satisfy the exclusion restriction: 1) the unusual weather damages should be uncorrelated with insurers' lagged market share; 2) the unusual weather damages should be uncorrelated with omitted variables that affect insurers' investment decisions; 3) the unusual weather damages should have an expectation of zero. Ge (2019) presents a formal proof with a different outcome variable.

Our data on insurers' holdings in financial securities are from SNL Financial. SNL provides annual data on insurers' financial assets in broad categories based on Summary Investment Schedule in insurers' regulatory filings since 2001. We collect data at the category level between 2001 and 2015. Panel A of Table 2 offers summary statistics on holdings in some major categories, whose average holding exceeds 5% in either the P&C or life insurer subsample. Besides cash, municipal and corporate bonds make up the largest portions of P&C insurers' portfolios, while corporate bonds, MBS and treasuries make up the largest portion of life insurers' portfolios. The value of the corporate bonds held by P&C insurers at the end of 2015 was \$269.24 billion, and that by life insurers \$1.85 trillion, totaling \$2.12 trillion, or 26% of all corporate bonds outstanding in the U.S.

In Panel B, we sort insurers into three subsamples based on their asset size and insurers' financial strength rating, respectively. We tabulate the averages of insurers' financial variables and portfolio weights of different security categories for each subsample. If the most two extreme subsamples' averages are statistically different at the 5% level, the numbers are displayed in bold.

Smaller asset size is associated with lower leverage, higher RBC ratios and worse insurer ratings. This observation suggests that smaller firms tend to manage their leverage and RBC ratio in a way that keeps them further away from economic and regulatory default, yet still receive lower ratings from agencies. Size appears to play an important role, beyond leverage and RBC ratios, in characterizing a firm's financial flexibility by ratings agencies. Presumably, it is harder for an insurer to grow larger in size than to lower its leverage or to increase its RBC ratio. To lower its leverage, an insurer can simply

limit sales of products that increase reserves (under liabilities) more than assets. To increase its RBC ratio, an insurer can limit such policy sales and invest heavily in treasury securities.

Smaller or worse-rated insurers have larger portfolio weights on cash (including short-term investments)<sup>9</sup> and government securities, and smaller weights on MBS and corporate bonds, relative to larger or better-rated insurers. The differences are substantial. For example, the average cash holding is 34% among the smallest one-third of P&C insurers and 9% among the largest. The average corporate bond holding is 13% among the smallest P&C insurers and 22% among the largest. These patterns suggest that more constrained insurers have safer, more liquid portfolios than less constrained issuers. In addition, since cash and government securities also have lower risk charges than MBS and corporate bonds, constrained insurers could be trying to achieve higher RBC ratios with higher portfolio weights on cash and government securities. The difference in portfolio weights between better-rated and worse-rated insurers is similar to but smaller in magnitude than the difference between larger and smaller insurers.

### 3.2. Insurers' Corporate Bond Holdings at the Security Level

We obtain CUSIP-firm-year-level bond holding data for P&C insurers from SNL between 2008 and 2015, which are based on insurers' annual Schedule D—Part 1 regulatory filings, Long-Term Bonds Owned December 31 of Current Year.<sup>10</sup> These data offer CUSIP-level or CUSIP-year-level information, for example, the maturity date, interest rate, and NAIC designation for risk charge of the security at the time of reporting. Insurers' statutory filing data also offer CUSIP-firm-year-level information on the book value of the holding, unrealized valuation change, and effective rate of interest, among other variables. From Mergent FISD, we obtain bond ratings and maturity dates. If the maturity date for the same bond is different between the insurers' data and Mergent, we use Mergent's. If the maturity date for a certain bond is missing in both a specific insurer's filing and Mergent, we use the most frequent maturity date for

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<sup>9</sup> "Cash" is from Summary Investment Schedule, Line 10, which includes cash, cash-equivalents (Schedule E Part 2) and short-term investments (Schedule DA Part 1 investments with one-year or less maturity at the time of acquisition including exempt money market funds and class one money market mutual funds).

<sup>10</sup> Although annual holding data of corporate bonds at the CUSIP-level are available through SNL since 2004, quarterly trading data are not available until 2008 through SNL. We use quarterly trading data to back out quarter-end holding information.

that bond that appeared in any P&C insurer's Schedule D filings. Panel C of Table 2 offers summary statistics of CUSIP-level corporate bond holdings by P&C insurers. A P&C insurer holds an average of 74 bonds each year, with a median of 32. There are on average 24,395 unique CUSIPs per year among all the corporate bonds P&C insurers hold (median = 23,274). There are 83,966 unique CUSIPs in total, among all the corporate bonds.

## 4. Insurers' Financial Conditions and Their Portfolios

### 4.1. Insurers' Financial Conditions and Investments in Broad Categories

To evaluate the way in which insurers' financial conditions affect their financial investment decisions, we first estimate the relation between insurers' lagged financial conditions and their allocations across broad categories. We use the following specification:

$$Holding\ of\ Category_{i,j,y} = \beta_1 * Log(Assets)_{i,y-1} + \beta_2 * Leverage_{i,y-1} + \beta_3 * RBC\ Ratio_{i,y-1} + \beta_4 * Insurer\ Rating_{i,y-1} + FE_i + FE_y + e_{i,j,y}, \quad (1)$$

where  $i$  indexes the insurer,  $j$  the category of securities (cash, treasury etc.), and  $y$  the year. The dependent variable is the holding of security type  $j$ , as a percentage of insurer's cash and invested assets. We estimate the equation using annual data, since insurers report holdings in broad categories annually but not quarterly. Each equation includes for firm and year fixed effects.

Table 3 presents the estimated equations. Among asset size, leverage, RBC Ratio and insurers' ratings, asset size is the only variable consistently associated with insurers' allocations across different kinds of assets. For both P&C and life insurers, larger insurers allocate a smaller share of the assets to cash and treasury, and a larger share to MBS and corporate bonds. For P&C insurers, a one standard deviation increase in  $Log(Assets)$  (1.96) is associated with a decrease in cash holdings of 8.06 percentage points (31.89% of the standard deviation), a decrease in treasury holdings of 7.37 percentage points (45.59% of the standard deviation), an increase in MBS holdings of 2.28 percentage points (21.80% of the standard deviation), and an increase in corporate bond holdings of 6.64 percentage points (37.70% of the

standard deviation). For life insurers, a one standard deviation increase in  $\text{Log}(\text{Assets})$  (2.91) is associated with a decrease in cash holdings of 12.80 percentage points (53.92% of the standard deviation), a decrease in treasury holdings of 7.65 percentage points (43.87% of the standard deviation), an increase in MBS holdings of 5.38 percentage points (37.86% of the standard deviation), and an increase in corporate bond holdings of 14.35 percentage points (55.58% of the standard deviation).

Some of the coefficients on other lagged financial variables are statistically significantly different from zero. However, the effects on portfolio allocation are much smaller than those of asset size. For example, for P&C insurers, higher leverage is associated with a larger allocation to cash and a smaller allocation to corporate bonds. The estimates imply that a one standard deviation increase in leverage is associated with an increase in the share of cash of 0.41 percentage points (1.62% of the standard deviation), as well as a 0.50 percentage point decrease in the share of corporate bonds (2.82% of the standard deviation).

How do we interpret the results that larger insurers have a larger allocation to risky and illiquid assets than smaller insurers? One interpretation is that larger insurers are less financially constrained and are less concerned about an increase in liquidity needs or probability of insolvency. In Table A.3, we provide more evidence that larger size could be correlated with lower levels of financial constraints. Panel A suggests that larger insurers have better ratings of financial strength, even after controlling for firm fixed effects. Panel B suggests that larger insurers experience less operational cash flow volatility. Panel C suggests that larger insurers use less reinsurance. The consistent message from Table A.3 is that insurers' asset size is positively related to their financial flexibility. Our results on allocations across categories are consistent with the notion that less constrained insurers have larger portfolio weights on riskier and more illiquid securities compared to more constrained insurers.

## 4.2. Insurers' Financial Conditions and Realized Portfolio Returns

Presumably, the reason why larger insurers allocate more of their portfolios to riskier and more illiquid securities is to receive higher expected returns. Therefore, given that larger insurers have riskier

and more illiquid portfolios than smaller insurers, insurers' expected returns should be positively correlated with their size. On average, therefore, we expect larger insurers to achieve higher realized returns. We test this prediction by estimating the following equation:

$$\begin{aligned} \text{Realized Return on Cash \& Invested Assets}_{i,q} = & \beta_1 * \text{Log}(Assets)_{i,q-1} + \beta_2 * \text{Leverage}_{i,q-1} + \\ & \beta_3 * \text{RBC Ratio}_{i,y-1} + \beta_4 * \text{Insurer Rating}_{i,q-1} + FE_i + FE_q + e_{i,q}, \end{aligned} \quad (2)$$

where  $i$  indexes insurers,  $q$  quarters, and  $y$  years. We estimate this equation at the quarterly level since insurers report their investment returns quarterly. However, *RBC Ratio* is only available at the annual frequency, so we use *RBC Ratio* on the right-hand side from the end of the previous year. We control for firm and year-quarter fixed effects.

We present estimates of Equation (2) in Table 4. In Column (1), we include all the variables in the specification and the coefficient on *Log(Assets)* is positive, but not statistically significant. In Column (2), we omit the variable *Insurers' Rating*, the number of observations increases by 85%, and the coefficient on *Log(Assets)* becomes statistically significant with a t-statistic of 5.18. In Column (3), we omit the firm fixed effects and include the variation in asset size across insurers. The coefficient on assets is again positive and statistically significant. The estimates imply that a one standard deviation increase in *Log(Assets)* leads to an 8 basis point increase in realized quarterly returns, which is 10% of the median quarterly return (0.8%) and 18% of the standard deviation (0.4%).

Columns (4)-(6) of Table 4 repeat the analysis for life insurers, with similar results. The estimates suggest that larger insurers have higher portfolio returns. The estimated coefficients reported in Column (6) imply that a one standard deviation increase in *Log(Assets)* leads to a 9 basis point increase in realized quarterly returns, which is 8% of the median quarterly return (1.2%) and 16% of the standard deviation (0.5%). Overall, the results in Table 4 suggest that larger insurers achieve higher realized portfolio returns, consistent with the idea that they seek higher expected returns by taking on more risk and illiquidity in their financial portfolios.

### 4.3. Insurers' Financial Conditions and Their Corporate Bond Portfolio

Section 4.1 suggests that more financially constrained insurers invest larger fractions of their portfolios in cash and government securities than less constrained insurers. Cash and government securities are safe and liquid, and are subject to more lenient regulatory treatment through lower risk charges. What makes cash and government securities more attractive to smaller insurers than to larger ones? It is possible that these portfolio choices occur because of risk and liquidity management incentives or managers' increased risk aversion as insurers' financial conditions worsen. However, it is also possible that these choices occur because of regulation since different asset classes have different regulatory treatments in terms of risk charges (see Table 1). Regardless of the specific reason, high levels of financial constraints restrict insurers' ability to bear risk, illiquidity or regulation in exchange for higher expected returns. We are interested in whether smaller insurers hold more cash and government debt simply due to regulation, or at least partially due to the safety and liquidity of cash and government debt.

Distinguishing between these explanations is complicated by the fact that asset classes differ systematically in their risk, their liquidity and their regulatory treatment. However, since securities in a given asset class (or in a given subgroup within an asset class) are treated the same by regulators, it is possible to evaluate the importance of financial constraints by examining choices *within* a given asset class. We focus on corporate bonds since they constitute one of the largest categories in insurers' portfolios and have substantial variation in their riskiness and liquidity. In addition, there are commonly accepted measures of corporate bonds' risk and liquidity.

We estimate the way in which P&C insurers' holdings of individual corporate bonds vary with insurers' financial conditions and the bonds' characteristics. We use P&C insurers' CUSIP-level corporate bond holding data to estimate the following specification:

$$\begin{aligned}
 Holding of Bond_{i,j,q} = & Financial_{i,q-1} * (\beta_1 * Bond Worse - Rated_{j,q-1} + \beta_2 * \\
 & Bond Illiquidity_{j,q-1} + \beta_3 * Bond Maturity_{j,q} + \beta_4 * Bond Coupon Rate_j + \beta_5 * \\
 & Bond Downgrade Dummy_{j,q-1} + \lambda * Bond NAIC 1 Dummy_{j,q-1}) + FE_{i,q} + FE_{j,q} + e_{i,j,q}
 \end{aligned} \tag{3}$$

where  $i$  indexes insurers,  $j$  indexes bonds and  $q$  indexes year-quarters. *Financial* includes a vector of insurers' financial variables, *Log(Assets)*, *Insurer Rating*, *Leverage* and *RBC Ratio*. We also control for insurer-year-quarter and bond CUSIP-year-quarter fixed effects. For a specified insurer, we only consider bonds the insurer actually holds. We use lagged *Bond Worse-Rated* as our measure of the bond's risk. We transform different rating agencies' latest bond ratings to numeric values (see Table A.2 in Appendix), and take the average across different rating agencies. For bonds in the NAIC 1 category, *Bond Worse-Rated* is bonds' rating. For bonds in the NAIC 2 category, we subtract seven from the average rating, so that the bonds in NAIC 1 and 2 categories have some common support for the variable *Bond Worse-Rated*.

We first estimate the equation using the corporate bonds in the NAIC 1 category in terms of risk charge. Such bonds make up 57% of the corporate bonds held by P&C insurers (equally weighting the bonds). In addition, we also estimate the equation using corporate bonds in both NAIC 1 and 2 categories, which together consist on average 89% of all the corporate bonds held by P&C insurers (equally weighting the bonds).

Panel A of Table 5 contains estimates of this specification. In Columns (1) and (2), the dependent variable is the market value of bond  $j$  in P&C insurer  $i$ 's portfolio at the end of quarter  $q$ , expressed as a fraction of the insurer  $i$ 's cash and invested assets. In Columns (3) and (4), the dependent variable is the market value of bond  $j$  in P&C insurer  $i$ 's portfolio at the end of quarter  $q$ , expressed as a fraction of the total market value of all the corporate bonds insurer  $i$  holds. Columns (1) and (3) only include corporate bonds in NAIC category 1, which are the highest quality bonds. Columns (2) and (4) further add NAIC category 2 bonds to include all corporate bonds in the insurers' portfolios.

The positive and statistically significant coefficients on the interaction term between *Log(Assets)* and *Bond Worse-Rated* suggest that P&C insurers with larger assets have a larger portfolio weight on riskier bonds. To illustrate the magnitude of this difference, suppose there are two bonds: Bond 1 is rated A- and Bond 2 AAA, the difference being six notches. Column (1) suggests that a decrease in insurers' assets by one standard deviation is associated with 0.04 percentage point decrease in the holding of Bond 1 relative to Bond 2, which is 35% of the median (0.12%) and 13% of the standard deviation (0.33%).

The negative and statistically significant coefficients on the interaction term between *Insurer Rating* and *Bond Worse-Rated* suggest that worse-rated insurers have a smaller portfolio weight on riskier bonds. Again, if Bond 1 is rated A- and Bond 2 rated AAA, Column (1) implies that a deterioration in an insurers' rating of 2.5 notches (one standard deviation), is associated with a 0.03 percentage point decrease in the holding of bond 1 relative to bond 2, which is 22% of the median and 8% of the standard deviation. These results are consistent with the idea that more constrained insurers prefer safer securities more than less constrained insurers.

In Columns (2) and (4), the interaction term between *Log Assets* and *Bond NAIC 1 Dummy* has a negative and statistically significant coefficient, suggesting that smaller insurers hold more of bonds in the safer NAIC 1 category relative to the riskier NAIC 2 category. Column (4) suggests that a decrease in insurers' assets by one standard deviation is associated with 0.05 percentage point increase in the holding of bonds in NAIC 1 relative to NAIC 2 category, which is 44% of the median and 16% of the standard deviation. The interaction term between *Insurer Rating* and *Bond NAIC 1 Dummy* has a positive and statistically significant coefficient, suggesting that worse-rated insurers hold more of bonds in the safer NAIC 1 category relative to the riskier NAIC 2 category. Column (4) implies that a deterioration in an insurers' rating of 2.5 notches (one standard deviation), is associated with a 0.1 percentage point increase in the holding of bonds in NAIC 1 relative to NAIC 2 category, which is 89% of the median and 32% of the standard deviation. These results could be explained by smaller and worse-rated insurers' incentives to achieve higher RBC ratio, since bonds in the NAIC 1 category have a lower risk charge compared to those in the NAIC 2 category. However, these results are also consistent with our conclusion from the within-NAIC category observation: smaller and worse-rated insurers have a stronger preference for safer corporate bonds, compared to other insurers.

Do insurers with different financial conditions have different preferences for bond liquidity? To measure bond illiquidity, we use the number of days without trading as a percentage of the total number of trading days. The positive, statistically significant coefficients on the interaction term between *Log(Assets)* and *Bond Illiquidity* suggest that P&C insurers with larger assets have larger portfolio

weights on more illiquid bonds. The negative, statistically significant coefficients on the interaction term between *Insurer Rating* and *Bond Illiquidity* suggest that P&C insurers with larger assets have larger portfolio weights on more illiquid bonds. To illustrate the magnitude, consider two corporate bonds, where Bond 1 is more illiquid than Bond 2 by 0.3 (one standard deviation within NAIC 1 category). Column (1) suggests a deterioration in insurers' rating by one standard deviation, is associated with a 0.004 percentage point decrease in the holding of Bond 1 relative to Bond 2, which is 3% of the median and 1% of the standard deviation. The effect of a decrease in insurer assets by one standard deviation is of a similar small magnitude. However, it could be the case that when large and better-rated insurers hold a certain bond, they hold a large portion of the bond outstanding and do not trade the bond often, thus causing the bond to appear more illiquid.

In Panel A of Table A.5 in the Appendix, we present several robustness checks by altering Column (2). In each column, we add *Bond Duration* in quarter  $q-1$  as one of the characteristics of bonds, which reduces the sample size by 44%. In Column (2), we omit *Bond Coupon Rate* and *Bond Maturity*. In Column (3), we use *Imputed Round Trip Costs* as a proxy for bond illiquidity. In Column (4), we use bond's yield to maturity from the previous quarter as the measure for bond risk. In Column (5), we repeat the original specification, replacing the insurer-year-quarter fixed effects with firm fixed effects and adding firms lagged financial variables as controls. The results described above all hold in each specification. Interestingly, larger insurers have a smaller allocation towards bonds with high duration, although the magnitude is small.

The magnitude of the effect of insurers' financial variables on their holdings across bonds with different risk and liquidity levels is relatively small. These results nonetheless provide evidence that the large difference in holdings across categories between small and large (or worse-rated and better-rated) insurers is at least partially due to the safety and liquidity of cash and government securities relative to MBS and corporate bonds. It does not appear to be entirely driven by the more lenient regulatory treatment of cash and government securities.

#### 4.4. The financial crisis, Insurers' Financial Conditions, and Corporate Bond Holdings

The previous section finds that, all other things equal, smaller and lower-rated insurers tend to prefer safer corporate bonds. If this result occurs because the smaller and worse-rated insurers are usually more financially constrained, one would expect that during the 2008 financial crisis, when the external financing frictions are more severe, smaller and worse-rated insurers' preference for safer bonds would be larger than in other time periods. Panel B of Table 5 tests this idea by modifying the specifications in Columns (1) and (2) of Panel A. Columns (1) and (2) of Panel B add interaction terms between the *Crisis Dummy*, *Log Assets*, and all the bond characteristics, where *Crisis Dummy* equals one for 2008 and 2009 and zero otherwise. The interaction term *Crisis Dummy*\**Log Assets*\**Bond Worse-Rated*, as well as the term *Log Assets*\**Bond Worse-Rated* has a positive and statistically significant coefficient in each column. The estimates suggest that during the periods outside of the crisis, smaller insurers have a higher allocation to safer bonds relative to larger insurers, and such effect is 33% larger during the financial crisis. Additionally, results also suggest that smaller insurers' preference for bonds in the safer NAIC 1 category (relative to larger insurers) is stronger during the financial crisis.

Columns (3) and (4) of Panel B add the interaction terms between the *Crisis Dummy*, *Insurer Rating*, and all the bond characteristics. The interaction term *Crisis Dummy*\* *Insurer Rating* \**Bond Worse-Rated*, as well as the term *Insurer Rating* \**Bond Worse-Rated* has a negative and statistically significant coefficient in each column. The estimates suggest that during the period outside of the crisis, worse-rated insurers have a higher allocation to safer bonds relative to better-rated insurers, and this effect is 133% larger during the financial crisis. In addition, the results also indicate that worse rated insurers' preference for bonds in the safer NAIC 1 category is stronger during the financial crisis.

## 5. The Impact of Insurers' Losses on Their Portfolio Choices

### 5.1. Insurers' Operating Losses and Investments in Corporate Bonds

We have documented that larger insurers tend to take more risky investments than smaller insurers and subsequently earn higher average returns. One possible explanation is that larger insurers have more financial flexibility and therefore are less concerned about meeting potential cash flow requirements. A concern with the causal interpretation of the results presented to this point is that insurers' financial conditions can be jointly determined with their investment preferences. Insurers seeking more risk in their portfolios can earn higher returns on average and thus can grow more quickly and become larger. To address this concern, we use insurers' operating losses as shocks to their financial strength. Such shocks are especially important in the P&C business, where a weather-related disaster can lead to a large number of claims in a region where a particular insurer has a substantial market presence. Such unusual weather events are exogenous shocks that can substantially affect an insurer's financial condition.

We estimate the extent to which operating losses can cause insurers to change their corporate bond holdings, using data on the individual bonds held by each insurer in the following specification:

$$Holding\ of\ Bond_{i,j,q} = \alpha * Loss_{i,q-1} * Bond\ Characteristics_{j,q-2} + \beta * Financial_{i,q-2} * Bond\ Characteristics_{j,q-2} + FE_{i,q} + FE_{j,q} + e_{i,j,q}, \quad (4)$$

where *Holding of Bond* is the market value of any particular bond that the insurer holds scaled by the insurers' cash and invested assets in Columns (1)-(2) and scaled by market value of all the corporate bonds held by the insurer in Columns (3)-(4). *Loss* is the operating losses due to insurers' underwriting activities (net of reinsurance payments) from *q-1* scaled by insurers' assets from *q-2*. *Bond Characteristics* is a vector of bond characteristics, including bond rating, illiquidity, and all variables included in Equation (4). To address the concern that operating losses and insurers' financial portfolios can be both related to insurers' unobservable characteristics (e.g. management quality), we instrument for operating losses using the weather-based instrument from Ge (2019) described in Section 3.

Panel A of Table 6 presents the results. Columns (1)-(4) are estimated using only bonds in the NAIC 1 category. Columns (1) and (3) present estimates using OLS and Columns (2) and (4) include the second-stage results when instrumenting for operating losses using the weather-based instrument. (Table A.4 presents the first-stage results corresponding to Column (2).) In each column, the coefficient on the interaction term between *Loss* and *Bond Worse-Rated* is negative and statistically significantly different from zero, suggesting that following operating losses, P&C insurers reduce their holdings of riskier corporate bonds. The coefficient on losses in the instrumental variable specifications presented in the even numbered columns is statistically significant and slightly larger than the corresponding coefficient in the OLS specification. This finding suggests that the relation between an insurer's losses and changes to its portfolio is causal, and does not occur because of a spurious correlation between the two variables.

To illustrate the magnitude of the estimated effect, consider two hypothetical corporate bonds, where Bond 1 is rated A- and Bond 2 is rated AAA. The instrumental variable estimates in Column (2) imply that following one standard deviation of losses (4.6% of lagged assets), insurers' holdings of bond 1 will decrease by 0.05 percentage points relative to bond 2, which is 39% of the median holding (0.12%) and 14% of the standard deviation (0.33%). The results in Columns (3)-(4) are similar to those in Columns (1)-(2), although the coefficients are larger since the dependent variable is scaled by a smaller number (insurers' total corporate bond holding), and hence has a larger value.

Columns (5)-(8) repeat the specifications presented in Columns (1)-(4) but include all the bonds in NAIC 1 and 2 categories. The results using the larger sample of bonds are similar to those on the sample of NAIC 1 category. The coefficients on the interaction term between *Loss* and *Bond Worse-Rated* are negative and statistically significant in all columns, suggesting that following (exogenous) losses, P&C insurers respond by shifting their portfolios toward safer securities, consistent with Columns (1)-(4).

The interaction terms between *Loss* and *Bond NAIC 1 Dummy* in the specifications presented in Columns (5)-(8) have positive and statistically significant coefficients. These coefficients suggest that after insurers suffer losses, they tend to weight their portfolio more heavily toward bonds in the safer NAIC 1 category and more lightly from bonds in the riskier NAIC 2 category. The estimates in Column

(6) imply that following one standard deviation of losses (4.6% of lagged assets), an average insurer's holdings of bonds in the NAIC 1 category will increase by 0.03 percentage points relative to bonds in the NAIC 2 category, which is 29% of the median (0.12%) and 10% of the standard deviation (0.33%).

In Panel B of Table A.5 in the Appendix, we present several robustness checks and present variants of the specification used in Column (5) of Table 6, Panel A. In each column of Table A.5, we add *Bond Duration* in quarter  $q-1$  as one of the characteristics of bonds, which reduces the sample size by 44%. In Column (2), we omit *Bond Coupon Rate* and *Bond Maturity*. In Column (3), we use *Imputed Round Trip Costs* as a proxy for bond illiquidity. The results described above all hold. Following losses, insurers' shift in corporate bond portfolios does not appear to be a function of the bonds' duration. In Column (4), we use bond's yield to maturity from the previous quarter as the measure for bond risk. The coefficient on the interaction term between *P&C Loss* and bond yield is not statistically significantly different from zero. One potential explanation of this finding is that insurers use a bond's rating as their measure for bond riskiness as they try to shift away from risk following operating losses. In Column (5), we repeat the original specification, replacing the insurer-year-quarter fixed effects with firm fixed effects and adding firms' lagged financial variables as controls. Results are similar to those in Panel A of Table 6.

If operating losses reflect negative shocks that worsen insurers' financial conditions and insurers change their portfolio allocation as a result, we expect insurers to shift towards riskier bonds after experiencing operating gains. In Panel B of Table 6, we replace *Loss* in Panel A with *Gain*, which equals operating income scaled by assets if operating income is positive, and zero otherwise. The results suggest that insurers indeed shift towards safer bonds after experiencing positive operating income.

## 5.2. Extremely Large Losses and Insurers' Investments in Corporate Bonds

We have documented that as their financial conditions worsen, insurers' portfolios tend to become less risky. An important issue in interpreting these results is the extent to which they are driven by extremely large losses. Theoretically, if insurers exhibit risk-shifting behavior in any situation, it would occur when they suffer large losses and are close to insolvency.

We therefore evaluate whether the tendency toward safer securities when conditions worsen applies in the case of extremely large losses. Panel C of Table 6 estimates a spline specification by splitting the *Loss* variable into two variables: *Loss>Cutoff* and *Loss<=Cutoff*. *Loss<=Cutoff* equals loss if loss is not larger than the cutoff, and equals the cutoff if loss is above the cutoff. *Loss>Cutoff* equals loss minus the cutoff if loss is above the cutoff, and zero otherwise. The cutoff is the median, the 75<sup>th</sup> percentile or the 95<sup>th</sup> percentile of the positive losses of each quarter in different columns. The negative and statistically significant coefficient on *Loss<=Cutoff*\**Bond Worse-Rated* suggest that the results in Panel A are not driven by extreme losses. In addition, with large losses, insurers' portfolios do not become riskier, implying that even in the circumstances that are likely to be most conducive to risk shifting, insurers nonetheless appear to decrease risk in response to losses.

### 5.3. Do Insurers' Losses Affect Which Bonds They Sell or Which Bonds They Buy?

Table 7 examines the way in which insurers adjust their portfolio following losses in more detail, by considering the sales and purchases of bonds separately. In Columns (1) and (2), we estimate the specification described in Equation (4), replacing the dependent variable with the market value of bond *j* that insurer *i* sold in quarter *q*, as a fraction of the market value of bond *j* insurer *i* held at the end of quarter *q-2*. The estimated coefficients on the interaction term between *Loss* and *Bond Worse-Rated* are positive, suggesting that insurers sell more of riskier bonds relative to safer bonds following losses. However, these estimated coefficients are not statistically significantly different from zero.

In Columns (3) and (4), we report estimates of Equation (4) in which the dependent variable is the amount spent by insurer *i* for buying bond *j* in quarter *q*, scaled by insurer *i*'s cash and invested assets at the end of quarter *q-2*. We include all the corporate bonds that an insurer could conceivably buy — any corporate bond that any P&C insurer bought in that quarter. The coefficients on the interaction term between *Loss* and *Bond Worse-Rated* are negative and statistically significantly different from zero, suggesting that following operating losses, insurers' preference for safer bonds relative to riskier bonds become stronger. In addition, the coefficients on the interaction term between *Loss* and *Bond Illiquidity*

are negative and statistically significant, suggesting that, following operating losses, insurers' preference for more liquid bonds relative to less liquid bonds becomes stronger. Columns (3)-(4) also suggest that smaller insurers buy more bonds that are safer, more liquid bonds, and in the NAIC 1 category, compared to larger insurers. In addition, worse-rated insurers tend to buy more liquid bonds compared to those purchased by better-rated insurers. To illustrate the magnitude, Column (3) suggests that when losses increase by one standard deviation, insurers decrease their purchase of A- relative to AAA bond by 68% of the mean. When assets increase by one standard deviation, insurers decrease the purchase of illiquid relative to liquid bond (liquidity difference being one standard deviation) by 45% of the mean.

The results in Table 7 are consistent with the idea that when more constrained, insurers shift their portfolio towards safer and more liquid assets. However, the effect is much larger for purchases than for sales. Rather than paying the transactions costs selling bonds in their portfolios, insurers appear to change their portfolios following losses by replacing bonds that mature with less risky ones.

#### 5.4. Financial Constraints, Losses and Investments in Corporate Bonds

The results in Section 5.1 indicate that after operating losses, P&C insurers shift their corporate bond portfolios towards safer bonds. We have argued that this shift likely occurs because the operating losses tighten insurers' financial constraints. This explanation predicts that more constrained insurers should shift their portfolios to safe bonds in larger magnitude following losses compared to less constrained insurers, since the effect of losses is likely to be stronger for firms that are already constrained. We also predict that during the 2008 financial crisis, when financing frictions are more severe, the effect of operating losses on insurers' allocation across bonds is more pronounced than during periods outside of the crisis. To test these hypotheses, we estimate the following specification:

$$Holding\ of\ Bond_{i,j,q} = \gamma * Fin\ Constraint_{q-2} * Loss_{i,q-1} * Bond\ Characteristics_{j,q-2} + \alpha * Loss_{i,q-1} * Bond\ Characteristics_{j,q-2} + \beta * Financial_{i,q-2} * Bond\ Characteristics_{j,q-2} + FE_{i,q} + FE_{j,q} + e_{i,j,q}. \quad (5)$$

The dependent variable is the market value of bond  $j$  in P&C insurer  $i$ 's portfolio at the end of quarter  $q$ , as a fraction of the total market value of all the corporate bonds insurer  $i$  holds.

*Fin Constraint* is defined in three different ways. Panel A of Table 8 reports estimates of this equation. In Columns (1) and (2), *Fin Constraint* is *Insurer Small Dummy*, which equals one if the insurer is smaller than the median in quarter  $q-2$ . In Columns (3) and (4), *Fin Constraint* is *Insurer Worse Rated Dummy*, which equals one if the insurer's rating is worse than the median in quarter  $q-2$ . In Columns (5) and (6), *Fin Constraint* is the *Crisis Dummy*. *Bond Characteristics* is a vector of bond characteristics, including bond rating, illiquidity, and all other variables controlled for in Table 5. Columns (1), (3) and (5) only use bonds in the NAIC 1 category, while Columns (2), (4) and (6) use bonds in both NAIC 1 and 2 categories, and include the *NAIC 1 Dummy* among the *Bond Characteristics*.

The estimated coefficients on the interaction terms of *Fin Constraint*, *Loss* and *Bond Worse-Rated* are all negative and statistically significantly different from zero. This result suggests that more constrained insurers decrease their holdings of riskier bonds more than less constrained insurers following losses. To illustrate the magnitude of these estimates, compare two bonds: Bond 1 is rated A- and Bond 2 is rated AAA. The estimated coefficients in Column (1) imply that, following one standard deviation of losses (4.6% of lagged assets), smaller insurers' holdings of Bond 1 will decrease by 0.03 percentage points (21% of the median holding) relative to Bond 2, compared to the holdings of larger insurers.

These results suggest that when more financially constrained, insurers make larger shifts in their portfolios following losses than less constrained insurers. This result provides additional support for the view that a consideration in structuring insurers' portfolios is to provide funds in the event of a cash flow shortfall. As such, they highlight the role of financial constraints in the portfolio choice of insurers.

## 5.5. Regulation, Losses and Investments in Corporate Bonds

An important issue is the extent to which the shift towards safer portfolio in response to losses is purely driven by regulation. It is possible that smaller or lower-rated insurers are more likely to approach the regulatory RBC ratio lower bound following losses than larger or better-rated insurers. The spline specification in Panel B of Table 6 suggests that the shift towards safer portfolios following losses is not driven by the most extreme losses, which are more likely to push insurers below the regulatory lower

bound. We next examine whether insurers below or near the regulatory lower bound are more likely to shift towards safer portfolios.

In Panel B of Table 8, we estimate Equation (5) using alternative definitions of *Fin Constraint* as a function of insurers' RBC ratios from the prior year. In Columns (1)-(2), we define *Fin Constraint* equal to 1 if insurers' RBC ratio in the prior year is below 2, in Columns (3)-(4), equal to 1 if the RBC ratio is below 5, and in Columns (5)-(6) equal to 1 if the RBC ratio is below the median in our sample for that year. In Columns (7)-(8), *Fin Constraint* equals the continuous RBC ratio from the prior year. A larger RBC ratio indicates that the insurer is further away from regulatory lower bound.

Two of the eight coefficients on the interaction term, *Fin Constraint*\**Loss*\**Worse-Rated*, are statistically significantly different from zero. These two coefficients, in Columns (1) and (3), are negative, suggesting that insurers below the regulatory lower bound or near it respond more strongly to losses by shifting towards safer bonds. The other six coefficients are not statistically different from zero, suggesting that insurers close to the regulatory lower bound and those further away from it do not respond differently to operating losses. In Columns (5)-(6), the negative and statistically significant coefficients on the interaction term between *Loss* and *Worse-Rated* suggest that insurers with RBC ratio higher than the median also shift towards safer bonds following losses. These results suggest that insurers' shift towards safer portfolios following losses is unlikely only driven by regulation.

## 6. Summary and Discussion

Endowments, foundations, pension funds, and insurance companies are among the most important investors in the economy, with U.S. assets totaling over \$22 trillion in 2017. These investors are different from professionally managed portfolios such as mutual funds and hedge funds because they rely (at least in part) on the returns generated from their investments to fund their operations. While there has been substantial research on some of these investors' activities such as their activism programs, there has been surprisingly little work on the more basic question of how these investors determine which securities to include in their portfolios. This paper studies the investment decisions of a large sample of

insurance companies and evaluates the extent to which financial management practices because of risks coming from the operational side of the firms affect the management of their portfolios.

We consider a sample of 2,084 P&C and 842 life insurance companies from the U.S. between 2001 and 2015. Insurance companies are important institutional investors that do not control the timing and the size of claims they must pay. P&C insurers in particular can face large costs when weather-related or other disasters unexpectedly strike. We study how insurers' financial constraints, measured by their lagged financial variables, affects their portfolio allocation. We also evaluate how insurers change their allocations among corporate bonds following operating losses, and how the extent to which they are financially constrained affects the magnitude of the changes.

Our results suggest that more financially constrained insurers have larger portfolio weights on cash and government securities, and smaller weights on MBS and corporate bonds, compared with less constrained insurers. These riskier portfolios should lead more financially constrained insurers to have lower expected returns than less constrained insurers. In our sample, more constrained insurers do have lower realized returns on their investments, probably for this reason.

One issue that is important to address is that of regulation. Insurers' portfolios are regulated in that each asset has a certain "risk capital charge," and the resulting RBC ratio affects whether regulators deem insurers as insolvent. It is possible to control econometrically for the regulatory effects of security choices within an asset class. We choose corporate bonds because they account for the largest share of insurers' portfolios and we can measure their risks, which has significant variation among corporate bonds. For this reason, we repeat our analysis on the corporate bond portfolios that our insurers hold. We find that in their choices of corporate bond investments, more constrained insurers tend to invest in safer bonds than less constrained insurers. This pattern is stronger during the 2008 financial crisis, when financial constraints were exacerbated for most firms. These findings support the view that insurers' financial constraints affect the portfolio choices of insurers independently of any regulation.

We also estimate the way in which operating losses affect insurers' portfolios. Our results suggest that following operating losses, P&C insurers reduce their holdings in riskier corporate bonds. This

finding also holds when we instrument for insurers' losses with weather damages, which can substantially affect insurers' claims. This result shows that exogenous shocks to insurers' financial strength lead insurers to lower the risk of their portfolios. Insurers with more financial flexibility can afford to take more portfolio risk, and hence receive higher expected returns.

Finally, we consider the role of financial constraints in how insurers change their portfolios following losses. Presumably, the effect of a negative shock on insurers' financial flexibility will be larger for firms that are more constrained than for firms that are less constrained. Therefore, we expect financially more constrained firms to adjust their portfolios more than less constrained firms in response to operating losses. Empirically, following losses, more constrained insurers decrease holdings of riskier corporate bonds by more than less constrained insurers. In addition, we also find that during the 2008 financial crisis, insurers make a larger shift to a safer corporate bond portfolio following losses, compared to periods outside of the crisis. These results suggest that insurers have stronger risk-management incentives when they become more financially constrained. As argued by Froot, Scharfstein, and Stein (1993), risk management incentives appear to occur because of the costs of accessing financial markets.

Institutional investors who are not delegated money managers are some of the most important investors in the economy. However, we know surprisingly little about the way in which they make their investment choices. Theory is not clear on the source of these investors' preferences and the extent to which institutional investors behave as if they are a risk-averse agent. By studying insurance companies' portfolio strategies, we hope to understand the decisions of these important investors, and also on the considerations affecting portfolio decisions of institutional investors more broadly.

Our results suggest that more constrained insurance companies prefer safer portfolio choices, plausibly because the increased cost of financial distress exacerbates the downside risk of any investment. The amount of risk they are willing to take is a function of their financial constraints. The desire to maintain financial flexibility appears to lead insurers to forego higher expected returns to obtain less risk and greater liquidity in their portfolios.

This study raises a number of questions. Given that there are capital raising costs that limit the ability of insurers to take more risky investments, can we identify the factors leading to these costs and can we quantify their magnitudes directly? Do other institutional investors take advantage of insurers' demand for safe securities and adjust their portfolios based on the changing residual supply of available securities? How do macroeconomic conditions interact with the change in insurers' investment demands? In particular, does the quality of bonds demanded by insurers vary inversely with the business cycle, leading to the observed increase in the quality of bonds issued during downturns? Finally, and perhaps most importantly, to what extent are insurers typical of other institutional investors, and how general is the finding that access to capital markets is an important factor in institutional portfolio decisions? These and other related questions would be excellent topics for future research.

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**Table 1: RBC Risk Charge for Different Securities**

This table presents the regulatory risk capital charge used in calculation of RBC ratio, associated with different categories of securities, for P&C and life insurers, respectively. See Becker and Opp (2014) for MBS.

Security Type	Credit Ratings	NAIC Corporate Bonds Category	Risk Charge	
			P&C	Life
U.S. Treasury Debt and Government Debt (guaranteed and backed by the full faith and credit of the U.S. government)		NA	0	0
Cash		NA	0.3% <sup>13</sup>	0.4% <sup>14</sup>
Bonds Issued by U.S. Government Agencies (not backed by the U.S. government) <sup>15</sup>		NAIC 1	0.3%	0.4%
Corporate Bonds <sup>16</sup> & Municipal Bonds	AAA, AA, A	NAIC 1	0.3%	0.4%
	BBB	NAIC 2	0.96%	1.3%
	BB	NAIC 3	3.39%	4.6%
	B	NAIC 4	7.38%	10%
	CCC	NAIC 5	16.96%	23%
	CC or below	NAIC 6	19.50%	30%
Unaffiliated Common Stock		NA	15%	22.5% ~ 45% <sup>17</sup>
Other Long-Term Assets		NA		
Real Estate		NA	10%	5% ~ 23% <sup>18</sup>
Mortgage Loans		NA	5%	3% ~ 20%
Schedule BA (Private Equity, Hedge Funds ect.)		NA	20%	30% <sup>19</sup>

<sup>13</sup> NAIC (2015a), P10.

<sup>14</sup> NAIC (2015b), P41.

<sup>15</sup> Examples are FNMA and FHLMC collateralized mortgage obligations, see NAIC (2015a) P8.

<sup>16</sup> See Becker and Ivashina (2015), and Becker and Opp (2014).

<sup>17</sup> NAIC (2015b), P16: “30% adjusted in the case of publicly traded stock by the weighted average beta for the portfolio of common stock, subject to a minimum factor of 22.5% and a maximum factor of 45%.”

<sup>18</sup> NAIC (2015b), P19.

<sup>19</sup> NAIC (2015b), P23.

**Table 2: Summary Statistics**

This table presents summary statistics of the data. Panel A offers statistics on insurers' financial variables and their holdings in major categories. In Panel B we sort insurers into tertiles based on lagged assets or insurer rating, and report the average of lagged financial variables and holdings in categories in each subsample. If the averages between the most two extreme subsamples are statistically different at the 5% level, the numbers are marked as bold. Panel C offers statistics on corporate bonds in P&C insurers' holdings at the CUSIP-insurer-year level.

**Panel A: Insurers' Financials and Holdings in Major Categories**

Variable	N	Mean	Std	25 Pctl	Median	75 Pctl	Total \$Billion	2015
<b>P&amp;C Insurers</b>								
<b>Financial Variables</b>								
Asset (\$Billion)	28780	0.47	1.48	0.02	0.06	0.24		
Leverage (%)	28780	72.33	71.76	45.16	61.61	72.85		
RBC Ratio	26989	14.88	25.56	4.80	7.78	13.47		
Rating (Larger=Worse)	15972	3.99	2.48	3 (A)	3 (A)	4 (A-)		
Public	28780	0.39	0.49	0.00	0.00	1.00		
Standalone	28780	0.36	0.48	0.00	0.00	1.00		
Underwriting Loss (% of Lagged Assets), >=0	23022	2.35	4.64	0.00	0.00	2.69		
Underwriting Loss (% of Lagged Assets)	23022	-0.16	7.22	-3.27	-0.27	2.69		
<b>Holdings in % of Cash and Invested Assets</b>								
Cash	28780	19.93	25.26	3.82	9.64	24.64		71.77
Treasury	28780	10.60	16.17	0.35	4.05	13.38		54.12
U.S. Gov Agency	28780	6.07	11.94	0.00	0.44	6.45		12.16
Muni Bond	28780	20.74	23.83	0.00	11.59	34.94		252.81
MBS	28780	10.14	13.22	0.00	4.02	16.92		105.91
Corp Bond	28780	18.03	17.63	0.00	14.75	29.51		269.24
Public Stocks	28780	5.43	10.65	0.00	0.00	6.44		147.14
Other	28780	8.41	13.29	0.00	2.47	11.15		317.32
<b>Life Insurers</b>								
<b>Financial Variables</b>								
Asset (\$Billion)	13110	4.68	16.19	0.02	0.12	1.29		
Leverage (%)	13110	65.69	30.59	45.10	78.63	91.10		
RBC Ratio	12711	66.77	246.81	6.37	9.82	20.58		
Rating (Larger=Worse)	6663	4.24	2.75	2 (A+)	4 (A-)	5 (B++)		
Public	13110	0.40	0.49	0.00	0.00	1.00		
Standalone	13110	0.21	0.41	0.00	0.00	0.00		
<b>Holdings in % of Cash and Invested Assets</b>								
Cash	13110	15.52	23.75	1.96	5.44	16.98		103.36
Treasury	13110	9.21	17.45	0.15	1.82	8.92		137.55
U.S. Gov Agency	13110	5.77	12.50	0.00	0.56	4.62		48.94
Muni Bond	13110	5.70	11.38	0.00	0.62	5.46		151.00
MBS	13110	13.12	14.22	0.01	9.63	21.00		435.07
Corp Bond	13110	33.88	25.81	6.07	35.94	55.08		1853.40
Public Stocks	13110	1.88	5.38	0.00	0.00	0.44		29.56
Other	13110	14.26	18.22	0.81	8.03	20.70		1016.30

### Panel B: Insurers' Holdings in Different Subsamples

	N (Firm-Year)	Financial Variables (y-1)					Holdings in % of Cash and Invested Assets (y)							
		Assets (\$Billion)	Leverage (%)	RBC Ratio	Rating Larger=Worse		Cash	Treasury	U.S. Gov Agency	Muni Bond	MBS	Corp Bond	Public Stocks	
<b>P&amp;C Insurers</b>														
<b>Sort by P&amp;C Insurers' Assets (y-1)</b>														
Largest	9776	1.3	73.73	9.83	3.08		9.36	8.12	4.28	26.2	12.77	21.74	6.13	11.06
Middle	9498	0.07	73.68	14.95	4.15		16.57	11.41	7.24	22.2	11.87	19.43	4.51	6.14
Smallest	9506	0.01	69.52	20.48	5.69		34.15	12.35	6.75	13.67	5.72	12.82	5.64	7.94
<b>Sort by P&amp;C Insurers' Rating (y-1)</b>														
Best	8352	1.04	73.68	16.67	2.54		10.76	11.16	4.59	27.86	11.57	18.56	5.83	9.01
Middle	3905	0.24	72.42	15.25	4.01		14.00	9.35	6.94	23.25	12.13	20.25	5.97	7.74
Worst	3715	0.13	71.75	11.7	7.22		20.15	10.31	8.05	17.74	10.75	19.08	4.76	8.58
<b>Life Insurers</b>														
<b>Sort by Life Insurers' Assets (y-1)</b>														
Largest	4450	13.61	87.07	10.21	2.93		4.16	3.07	2.70	3.95	16.04	49.62	0.94	19.48
Middle	4325	0.18	69.36	24.96	4.63		10.39	7.64	6.46	7.41	15.72	36.14	2.15	13.27
Smallest	4335	0.01	40.08	175.7	7.33		32.29	17.08	8.23	5.79	7.52	15.48	2.57	9.89
<b>Sort by Life Insurers' Rating (y-1)</b>														
Best	3069	15.17	81.43	17.45	2.32		5.78	4.33	2.39	4.35	15.09	49.72	1.14	17.12
Middle	1838	1.58	71.64	21.56	4.33		9.30	7.18	6.61	8.07	16.31	39.8	1.13	11.44
Worst	1756	0.63	66	30.17	7.52		15.32	9.89	7.69	7.51	13.64	32.12	1.8	11.64

**Panel C: Summary Statistics of P&C Insurers' Corporate Bond Holdings, CUSIP-Insurer-Year Level**

<b>Variable</b>	<b>N</b>	<b>Mean</b>	<b>Std</b>	<b>25 Pctl</b>	<b>Median</b>	<b>75 Pctl</b>
Book Value/Asset (%)	565426	0.24	0.33	0.04	0.12	0.30
Effective Rate of Interest	563007	4.70	1.96	3.39	4.80	5.78
Bond Rating (Annual Avg)	564255	7.15	2.87	5.25	6.75	8.89
Holding of the Insurers' Other Bonds (%)	565426	0.05	0.13	0.00	0.00	0.01
Years to Maturity	565426	5.85	5.32	3.00	5.00	8.00
Coupon Rate	565426	5.23	1.82	4.13	5.38	6.38
Downgraded Dummy	565426	0.17	0.38	0.00	0.00	0.00
0-Trading Day (%)	565426	34.25	30.19	4.83	27.78	58.97
Imputed Round-trip Transct Cost	565426	0.01	0.00	0.00	0.00	0.01
Bond Unrealized Gain	565426	0.00	0.00	0.00	0.00	0.00
Dummy for NAIC Category = 1	565426	0.57	0.49	0.00	1.00	1.00
Dummy for NAIC Category = 2	565426	0.32	0.47	0.00	0.00	1.00
Dummy for NAIC Category = 3	565426	0.06	0.23	0.00	0.00	0.00
Dummy for NAIC Category = 4	565426	0.04	0.19	0.00	0.00	0.00
Dummy for NAIC Category = 5	565426	0.01	0.09	0.00	0.00	0.00
Dummy for NAIC Category = 6	565426	0.00	0.00	0.00	0.00	0.00
Offering Spread over Treasury	241157	156.54	108.22	83.30	127.30	190.30
Years since Issue	308355	4.13	3.00	2.00	3.00	6.00

**Table 3: Insurers' Financial Conditions and Holdings in Broad Categories**

The dependent variable is insurers' holdings of different broad categories of securities in percentage of assets. The independent variables are insurers' lagged financial variables. This table presents results estimating the relationship between insurers' asset allocation to each category of securities and insurers' lagged financial variables, see the equation below. Standard errors are corrected for clustering at the firm level. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels. See Table A.1 for variable definitions.

$Holding \ of \ Category_{i,j,y} = \beta_1 * Log(Assets)_{i,y-1} + \beta_2 * Leverage_{i,y-1} + \beta_3 * RBC \ Ratio_{i,y-1} + \beta_4 * Insurer \ Rating_{i,y-1} + FE_i + FE_y + e_{i,j,y}$ , where  $i$  indexes the insurer,  $j$  the category of securities (cash, treasury etc.), and  $y$  the year.

Dependent Var: Holding (y) of (% of cash & invested assets)	P&C Insurers						Life Insurers					
	Cash	Treasury	Gov Agency	Muni Bond	MBS	Corp Bond	Cash	Treasury	Gov Agency	Muni Bond	MBS	Corp Bond
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log(Assets) (y-1)	-4.10*** (-6.15)	-3.76*** (-6.42)	-0.04 (-0.16)	1.14* (1.76)	1.47*** (3.82)	3.39*** (6.15)	-4.40*** (-5.60)	-2.63*** (-3.78)	-0.99** (-2.43)	0.67 (1.09)	1.85*** (3.14)	4.93*** (6.46)
Leverage (y-1)	0.57** (2.57)	-0.09 (-0.46)	-0.02 (-0.37)	0.12 (0.53)	0.03 (0.24)	-0.69*** (-3.73)	3.09 (0.92)	-6.02* (-1.87)	3.80 (1.63)	1.50 (0.57)	0.95 (0.33)	1.97 (0.54)
RBC Ratio (y-1)	0.01 (1.05)	0.02** (2.31)	-0.00 (-0.45)	-0.01 (-0.40)	-0.00 (-0.41)	-0.01 (-0.46)	0.00 (0.66)	0.00 (0.99)	-0.00 (-0.85)	-0.00 (-0.89)	-0.00* (-1.78)	-0.00 (-0.19)
Insurer's Rating (y-1) (larger number = worse)	0.34 (1.64)	0.05 (0.36)	-0.03 (-0.29)	-0.94*** (-4.83)	0.28** (2.21)	0.08 (0.50)	0.35 (1.45)	0.07 (0.34)	0.08 (0.97)	-0.07 (-0.39)	-0.05 (-0.30)	-0.40* (-1.67)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster SE by Firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	15625	15625	15625	15625	15625	15625	6615	6615	6615	6615	6615	6615

**Table 4: Insurers' Financial Conditions and Realized Returns on Financial Investment**

The dependent variable is insurers' investment income (dividends and interests) plus realized and unrealized capital gains in quarter  $q$  scaled by insurers' cash and invested assets at the end of quarter  $q-1$ . The independent variables are insurers' lagged financial variables. This table presents results estimating the relationship between insurers' realized returns and their lagged financial variables, see the equation below. Standard errors are corrected for clustering at the year-quarter level. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels. See Table A.1 for variable definitions.

*Realized Return on Cash & Invested Assets* <sub>$i,q$</sub>  =  $\beta_1 * \text{Log}(\text{Assets})_{i,q-1} + \beta_2 * \text{Leverage}_{i,q-1} + \beta_3 * \text{RBC Ratio}_{i,y-1} + \beta_4 * \text{Insurer Rating}_{i,q-1} + \text{FE}_i + \text{FE}_q + e_{i,q}$ , where  $i$  indexes the insurer,  $q$  the year-quarter, and  $y$  the year.

Dependent Var: Realized Return on Cash & Invested Assets (q)						
	P&C			Life		
	(1)	(2)	(3)	(4)	(5)	(6)
Log(Assets) (q-1)	0.01 (1.53)	0.03*** (5.18)	0.04*** (13.00)	0.00 (0.34)	0.02*** (3.85)	0.03*** (10.11)
Leverage (q-1)	-0.04* (-1.84)	-0.07*** (-5.15)	0.04** (2.07)	0.08 (1.55)	0.13*** (4.29)	0.51*** (17.13)
RBC Ratio (y-1)	-0.0002* (-1.87)	-0.0002*** (-2.90)	0.0004*** (2.90)	-0.00 (-0.59)	-0.00 (-0.83)	0.00 (0.25)
Insurer's Rating (q-1) (larger number = worse)	-0.003** (-2.27)		-0.008*** (-7.74)	0.00 (0.10)		-0.01*** (-8.73)
Firm FE	Yes	Yes		Yes	Yes	
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster SE by Year-Quarter	Yes	Yes	Yes	Yes	Yes	Yes
N	57298	105919	57310	24219	48956	24225

**Table 5: Financial Conditions and Corporate Bond Holdings at CUSIP Level, P&C Insurers**

The dependent variable is P&C insurer  $i$ 's holdings of a specific corporate bond  $j$ , as percentage of  $i$ 's cash and invested assets in quarter  $q$  in both panels. Panel A presents results estimating the following equation.  $Holding\ of\ Bond_{i,j,q} = Financial_{i,q-1} * (\beta_1 * Bond\ Rating_{j,q-1} + \beta_2 * Bond\ Illiquidity_{j,q-1} + \beta_3 * Bond\ Maturity_{j,q} + \beta_4 * Bond\ Coupon\ Rate_j + \beta_5 * Bond\ Downgrade\ Dummy_{j,q-1} + \lambda * NAIC\ Category\ FE_{j,t}) + FE_{i,q} + FE_{j,q} + e_{i,j,q}$ , where  $i$  indexes the insurer,  $j$  the bond and  $q$  the year-quarter. Controls include interaction terms between insurers' leverage and bond characteristics, as well as interactions between insurers' RBC ratio and bond characteristics. In Columns (1) and (2), the dependent variable is the market value of bond  $j$  in P&C insurer  $i$ 's portfolio at the end of quarter  $q$ , as a percentage of the insurer  $i$ 's cash and invested assets. In Columns (3) and (4), the dependent variable is the market value of bond  $j$  in P&C insurer  $i$ 's portfolio at the end of quarter  $q$ , as a percentage of the total market value of all the corporate bonds insurer  $i$  holds.

Panel B adds extra interaction terms to Columns (1) and (2) in Panel A, the dependent variable is the market value of bond  $j$  in P&C insurer  $i$ 's portfolio at the end of quarter  $q$ , as a percentage of the insurer  $i$ 's cash and invested assets. Columns (1) and (2) of Panel B add the interaction terms between the *Crisis Dummy*, *Log Assets*, and all the bond characteristics, where *Crisis Dummy* equals one for 2008 and 2009 (the sample at the bond level starts in 2008) and zero otherwise. Columns (3) and (4) of Panel B add the interaction terms between the *Crisis Dummy*, *Insurer Rating*, and all the bond characteristics on top of all the variables in Columns (1) and (2) in Panel A.

In both panels, Columns (1) and (3) only include corporate bonds in NAIC category 1, those with the best ratings. Columns (2) and (4) include all corporate bonds in insurers' portfolios. Standard errors are corrected for clustering at the CUSIP-year-quarter level. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels. See Table A.1 for variable definitions.

### Panel A: Financial Conditions and Corporate Bond Holdings at CUSIP Level

Dependent Variable:	Mrkt Value(i,j,q)*100/Cash & Invested Assets(i,q)		Mrkt Value(i,j,q)*100/Mrkt Value of All Corp Bonds Held(i,q)	
	NAIC Category	NAIC Category	NAIC	NAIC Category
	1 (1)	1 & 2 (2)	Category 1 (3)	1 & 2 (4)
Log Assets (q-1)*Bond Worse-Rated(q-1)	0.0038*** (21.56)	0.0038*** (24.70)	0.0146*** (17.55)	0.0135*** (18.84)
Log Assets (q-1)*Bond Coupon Rate	-0.0032*** (-18.34)	-0.0027*** (-20.67)	-0.0115*** (-14.42)	-0.0098*** (-16.52)
Log Assets (q-1)*Bond Maturity (q)	-0.0018 (-0.45)	0.0036*** (2.63)	0.0472 (1.20)	0.0216** (2.35)
Log Assets (q-1)*Bond Illiquidity (q-1)	0.0049*** (5.84)	0.0041*** (6.62)	0.0070* (1.78)	0.0087*** (2.97)
Log Assets (q-1)*Bond Downgraded Dummy (q-1)	0.0036*** (4.12)	0.0023*** (3.46)	0.0182*** (4.18)	0.0131*** (4.04)
Log Assets (q-1)*Bond NAIC 1 Dummy (q-1)		-0.0287*** (-38.67)		-0.1033*** (-29.70)
Insurer Rating (larger=worse) (q-1)	-0.0018*** *Bond Worse-Rated(q-1) (-7.68)	-0.0013*** (-6.04)	-0.0097*** (-8.65)	-0.0075*** (-7.71)
Insurer Rating (q-1)*Bond Coupon Rate	-0.0006*** (-2.68)	-0.0005*** (-2.63)	-0.0016 (-1.52)	-0.0025*** (-3.18)
Insurer Rating (q-1)*Bond Maturity (q)	-0.0202* (-1.68)	0.0048 (0.83)	-0.1192 (-1.18)	0.0452 (1.34)
Insurer Rating (q-1)*Bond Illiquidity (q-1)	-0.0052*** (-4.79)	-0.0036*** (-4.29)	-0.0221*** (-4.53)	-0.0264*** (-6.93)
Insurer Rating (q-1)*Bond Downgraded Dummy (q-1)	-0.0004 (-0.35)	-0.0001 (-0.16)	0.0051 (1.02)	0.0057 (1.50)
Insurer Rating (q-1)*Bond NAIC 1 Dummy (q-1)		0.0075*** (7.13)		0.0434*** (9.20)
Controls	Yes	Yes	Yes	Yes
CUSIP-Year-Quarter FE	Yes	Yes	Yes	Yes
Firm-Year-Quarter FE	Yes	Yes	Yes	Yes
Cluster SE by CUSIP-Year-Quarter	Yes	Yes	Yes	Yes
N	821940	1364711	823157	1366650

### Panel B: Crisis, Financial Conditions and Corporate Bond Holdings at CUSIP Level

Dependent Variable:	Mrkt Value (i,j,q) *100 / Cash & Invested Assets (i,q)			
NAIC Category:	1	1 & 2	1	1 & 2
	(1)	(2)	(3)	(4)
Crisis ('08-'09) Dummy*	0.0012***	0.0014***		
Log Assets (q-1)*Bond Worse-Rated(q-1)	(3.60)	(5.13)		
Log Assets (q-1)*Bond Worse-Rated (q-1)	0.0035***	0.0033***		
	(17.46)	(19.83)		
Crisis ('08-'09) Dummy*			-0.0016***	-0.0020***
Insurer Rating (larger=worse) (q-1) *Bond Worse-Rated (q-1)			(-3.63)	(-5.15)
Insurer Rating (q-1)*Bond Worse-Rated (q-1)			-0.0012***	-0.0004
			(-3.90)	(-1.63)
Controls	Yes	Yes	Yes	Yes
CUSIP-Year-Quarter FE	Yes	Yes	Yes	Yes
Firm-Year-Quarter FE	Yes	Yes	Yes	Yes
Cluster SE by CUSIP-Year-Quarter	Yes	Yes	Yes	Yes
N	821940	1364711	821940	1364711

**Table 6: Losses (Gains) and Corporate Bond Holdings at CUSIP Level, P&C Insurers**

In both panels, the dependent variable is P&C insurer  $i$ 's holdings of a specific corporate bond  $j$ , as percentage of  $i$ 's cash and invested assets in quarter  $q$ . Panel A estimates  $Holding\ of\ Bond_{i,j,q} = \alpha * Loss_{i,q-1} * Bond\ Characteristics_{j,q-2} + \beta * Financial_{i,q-2} * Bond\ Characteristics_{j,q-2} + FE_{i,q} + FE_{j,q} + e_{i,j,q}$ . Controls include all the independent variables used for estimation for Table 5 (including those not shown). Odd columns present OLS results, and even columns the second-stage results of the instrumental variable regressions. The first-stage results corresponding to Column (2) are reported in Table A.4.

Panel B replaces *Loss* in Panel A with *Gain* and only presents the OLS results.

Panel C estimates a spline specification by splitting the *Loss* variable into two variables: *Loss>Cutoff* and *Loss<=Cutoff*. *Loss<=Cutoff* equals loss if loss is not larger than the cutoff, and equals the cutoff if loss is above the cutoff. *Loss>Cutoff* equals loss minus the cutoff if loss is above the cutoff, and zero otherwise. The cutoff is the median, the 75<sup>th</sup> percentile or the 95<sup>th</sup> percentile of the positive losses of each quarter.

In all the panels, standard errors are corrected for clustering at the CUSIP-year-quarter level. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels. See Table A.1 for variable definitions.

### Panel A: Losses and Corporate Bond Holdings

Dependent Variable:	NAIC Category = 1				NAIC Category = 1 & 2			
	Mrkt Value (i,j,q) *100 / Cash & Invested		Mrkt Value (i,j,q) *100 / Mrkt Value of All		Mrkt Value (i,j,q) *100 / Cash & Invested		Mrkt Value (i,j,q) *100 / Mrkt Value of All	
	Assets (i,q)		Corp Bonds Held (i,q)		Assets (i,q)		Corp Bonds Held (i,q)	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
Loss (q-1)*Bond Worse-Rated(q-1)	-0.1312*** (-7.37)	-0.1681*** (-2.61)	-0.4435*** (-6.06)	-0.7473** (-1.99)	-0.1088*** (-7.32)	-0.1515*** (-2.70)	-0.3361*** (-5.44)	-0.6131** (-2.21)
Loss (q-1)*Bond Coupon Rate	0.0130 (0.91)	-0.0332 (-0.41)	0.1244** (2.02)	0.7857** (2.11)	-0.0118 (-1.13)	-0.0171 (-0.28)	-0.0090 (-0.20)	0.3714 (1.43)
Loss (q-1)*Bond Maturity (q)	0.0000 (0.76)	0.0019 (0.47)	0.0002 (0.66)	0.0329 (0.46)	-0.1511 (-0.83)	0.9292 (0.83)	-0.5343 (-0.65)	13.8909 (0.79)
Loss (q-1)*Bond Illiquidity (q-1)	0.0089 (0.13)	0.3566 (1.07)	0.3828 (1.26)	1.2039 (0.77)	-0.0074 (-0.14)	0.1854 (0.73)	0.2841 (1.27)	0.7119 (0.72)
Loss (q-1)*Bond Downgraded Dummy (q-1)	-0.1254* (-1.71)	-0.3914 (-0.98)	-0.5531* (-1.70)	-1.1858 (-0.55)	-0.1192** (-2.13)	-0.0841 (-0.27)	-0.4472* (-1.81)	0.1961 (0.12)
Loss (q-1)*Bond NAIC 1 Dummy (q-1)					0.4935*** (6.76)	0.7454** (2.56)	1.3595*** (4.46)	3.3970** (2.47)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CUSIP-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster SE by CUSIP-Year-Quarter	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	848671	848218	849175	848722	1418688	1417926	1419495	1418733
Cragg-Donald Wald F statistic		145.787		144.568		1290.103		1323.616

### Panel B: Gains and Corporate Bond Holdings

Dependent Variable:	Mrkt Value (i,j,q) *100 / Cash & Invested Assets (i,q)		Mrkt Value (i,j,q) *100 / Mrkt Value of All Corp Bonds Held (i,q)	
	NAIC Category: 1 (1)	1 & 2 (2)	1 (3)	1 & 2 (4)
Gain (q-1)*Bond Worse-Rated(q-1)	0.1532*** (4.58)	0.1286*** (4.33)	0.4161** (2.50)	0.3331** (2.26)
Gain (q-1)*Bond Coupon Rate	-0.2253*** (-6.61)	-0.2005*** (-7.93)	-1.1602*** (-6.89)	-0.8740*** (-7.16)
Gain (q-1)*Bond Maturity (q)	-0.4734 (-0.82)	-0.4886** (-2.08)	-0.9952 (-0.33)	-1.5950 (-0.83)
Gain (q-1)*Bond Illiquidity (q-1)	-0.2034 (-1.37)	-0.2681** (-2.49)	-1.5187** (-2.16)	-0.4847 (-0.96)
Gain (q-1)*Bond Downgraded Dummy (q-1)	0.3661*** (2.65)	0.2536** (2.31)	1.5159** (2.00)	1.3706** (2.40)
Gain (q-1)*Bond NAIC 1 Dummy (q-1)		-0.6268*** (-4.49)		-1.5116** (-2.23)
Controls	Yes	Yes	Yes	Yes
CUSIP-Year-Quarter FE	Yes	Yes	Yes	Yes
Firm-Year-Quarter FE	Yes	Yes	Yes	Yes
Cluster SE by CUSIP-Year-Quarter	Yes	Yes	Yes	Yes
N	848671	1418688	793977	1418688

### Panel C: Losses and Corporate Bond Holdings, Spline Specification

NAIC Category	Dependent Variable: Mrkt Value (i,j,q) *100 / Cash & Invested Assets (i,q)			1 & 2		
	1			1 & 2		
	Median (1)	75 Pctl (2)	95 Pctl (3)	Median (4)	75 Pctl (5)	95 Pctl (6)
Loss (q-1)>Cutoff*Bond Worse-Rated(q-1)	-0.1873*** (-3.76)	-0.1564** (-2.54)	-0.0925 (-0.75)	-0.1038** (-2.33)	-0.0642 (-1.16)	0.1120 (0.98)
Loss (q-1)<=Cutoff*Bond Worse-Rated(q-1)	-0.5511*** (-3.67)	-0.4109*** (-4.85)	-0.2971*** (-6.13)	-0.6012*** (-4.76)	-0.4055*** (-5.60)	-0.2801*** (-6.66)
Loss (q-1)>Cutoff*Bond NAIC 1 Dummy (q-1)				0.2553 (1.17)	-0.0138 (-0.05)	-1.6020*** (-2.76)
Loss (q-1)<=Cutoff*Bond NAIC 1 Dummy (q-1)				3.8381*** (6.51)	2.4188*** (7.16)	1.6317*** (8.23)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
CUSIP-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster SE by CUSIP-Year-Quarter	Yes	Yes	Yes	Yes	Yes	Yes
N	848671	848672	848674	1418688	1418689	1418690

**Table 7: Losses and Corporate Bond Disposals & Purchases at CUSIP Level, P&C Insurers**

In Columns (1) and (2), the dependent variable is the market value of bond  $j$  insurer  $i$  sold in quarter  $q$ , as a percentage of the market value of bond  $j$  insurer  $i$  held at the end of quarter  $q-2$ . In Columns (3) and (4), the dependent variable with insurer  $i$ 's actual costs for buying bond  $j$  in quarter  $q$ , scaled by insurer  $i$ 's cash and invested assets at the end of quarter  $q-2$ . We include all the corporate bonds that an insurer can theoretically buy—any corporate bond any insurer bought in quarter  $q$ . Controls include all the independent variables used for estimation for Table 5 (including those not shown). Standard errors are corrected for clustering at the CUSIP-year-quarter level. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels. See Table A.1 for variable definitions.

Dependent Variable:	Sell		Buy		
	Par Value Sold (i,j,q)		Actual Costs (i,j,q)		
	*100 / Par Value of the Bond Held (i,j,q-2)		*10E5 / Cash & Invested Assets (i,q)		
	NAIC Category	1	1 & 2	1	
		(1)	(2)	(3)	
Loss (q-1)*Bond Worse-Rated(q-1)		0.0020 (1.14)	0.0023 (1.40)	-2.4386** (-2.48)	-1.8262** (-2.34)
Loss (q-1)*Bond Coupon Rate		0.0026 (1.28)	0.0011 (0.69)	-0.1543 (-0.30)	-0.3370 (-0.97)
Loss (q-1)*Bond Maturity (q)		0.0015 (0.00)	-0.5878 (-1.15)	2.3106** (2.21)	-4.5742 (-1.17)
Loss (q-1)*Bond Illiquidity (q-1)		0.0001 (0.69)	0.0001 (0.89)	-0.0866** (-2.52)	-0.0898*** (-3.96)
Loss (q-1)*Bond Downgraded Dummy (q-1)		0.0107 (1.20)	-0.0053 (-0.72)	6.4897 (1.47)	6.2845* (1.92)
Loss (q-1)*Bond NAIC 1 Dummy (q-1)			-0.0082 (-0.99)		9.3325*** (2.71)
Log Assets (q-2)*Bond Worse-Rated(q-1)		-0.0087 (-0.72)	-0.0056 (-0.53)	0.0093* (1.84)	0.0139*** (3.49)
Log Assets (q-2)*Bond Coupon Rate		-0.0655*** (-4.98)	-0.0613*** (-5.92)	-0.0010 (-0.32)	-0.0009 (-0.41)
Log Assets (q-2)*Bond Maturity (q)		11.6512*** (2.77)	12.7424*** (3.93)	0.0454** (2.57)	0.0381*** (2.66)
Log Assets (q-2)*Bond Illiquidity (q-1)		-0.0009* (-1.70)	-0.0009** (-2.00)	0.0031*** (15.15)	0.0024*** (18.96)
Log Assets (q-2)*Bond Downgraded Dummy (q-1)		0.1270* (1.79)	0.0682 (1.22)	0.0147 (0.60)	0.0062 (0.37)
Log Assets (q-2)*Bond NAIC 1 Dummy (q-1)			0.0766 (1.41)		-0.1614*** (-9.09)
Insurer Rating (larger=worse) (q-2)		0.0287* (1.94)	0.0273** (1.97)	0.0016 (0.30)	0.0016 (0.38)
*Bond Worse-Rated(q-1)					
Insurer Rating (q-2)*Bond Coupon Rate		0.0297* (1.71)	0.0092 (0.68)	-0.0030 (-0.83)	0.0028 (1.16)
Insurer Rating (q-2)*Bond Maturity (q)		23.6296*** (3.98)	20.1346*** (4.05)	-0.0249* (-1.89)	0.0422 (1.00)
Insurer Rating (q-2)*Bond Illiquidity (q-1)		-0.0015** (-2.02)	-0.0025*** (-3.76)	-0.0016*** (-8.15)	-0.0014*** (-10.38)
Insurer Rating (q-2)*Bond Downgraded Dummy (q-1)		0.0913 (0.76)	0.0389 (0.42)	-0.0174 (-0.86)	0.0131 (0.82)
Insurer Rating (q-2)*Bond NAIC 1 Dummy (q-1)			-0.1599** (-2.11)		-0.0100 (-0.55)
Controls		Yes	Yes	Yes	Yes
CUSIP-Year-Quarter FE		Yes	Yes	Yes	Yes
Firm-Year-Quarter FE		Yes	Yes	Yes	Yes
Cluster SE by CUSIP-Year-Quarter		Yes	Yes	Yes	Yes
N		819578	1366253	17457838	34467944

**Table 8: Financial Constraints, Losses and Corporate Bond Holdings at CUSIP Level, P&C Insurers**

The dependent variable is the market value of bond  $j$  in P&C insurer  $i$ 's portfolio at the end of quarter  $q$ , as a percentage of the total market value of all the corporate bonds insurer  $i$  holds. This table presents results estimating the following equation.  $Holding\ of\ Bond_{i,j,q} = \gamma * Fin\ Constraint_{q-2} * Loss_{i,q-1} * Bond\ Characteristics_{j,q-2} + \alpha * Loss_{i,q-1} * Bond\ Characteristics_{j,q-2} + \beta * Financial_{i,q-2} * Bond\ Characteristics_{j,q-2} + FE_{i,q} + FE_{j,q} + e_{i,j,q}$ .  $Fin\ Constraint$  is one of three variables. In Panel A, in Columns (1) and (2),  $Fin\ Constraint$  is *Insurer Small Dummy*, which equals one if the insurer is smaller than the median in quarter  $q-2$ ; in Columns (3) and (4),  $Fin\ Constraint$  is *Insurer Worse Rated Dummy*, which equals one if the insurer's rating is worse than the median in quarter  $q-2$ ; in Columns (3) and (4),  $Fin\ Constraint$  is the *Crisis Dummy*. In Panel B,  $Fin\ Constraint$  is a dummy variable that equals one if RBC ratio at the end of year  $y-1$  is lower than 2 in (1)-(2), lower than 5 in (3)-(4), lower than the median in year  $y-1$  in (5)-(6) and the continuous variable RBC ratio at the end of  $y-1$  in (7)-(8). In both panels,  $Bond\ Characteristics$  is a vector of bond characteristics, including bond rating, illiquidity, and all other variables controlled for in Table 5. Controls include all the independent variables used for estimation for Table 5 (including those not shown), except the interaction term between insurer size and bond characteristics in Panel A (1)-(2), between insurer rating and bond characteristics in Panel A (3)-(4), and insurer RBC ratio and bond characteristics in Panel B. Odd-numbered columns only use bonds in the NAIC 1 category and even-numbered columns use bonds in both NAIC 1 and 2 categories, and include *NAIC 1 Dummy* among the  $Bond\ Characteristics$ . Standard errors are corrected for clustering at the CUSIP-year-quarter level. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels. See Table A.1 for variable definitions.

**Panel A: Insurer Size, Rating and the financial crisis as Measures of Financial Constraints**

Financial Constraint Dummy	Dependent Variable:		Mrkt Value (i,j,q) *100 / Cash & Invested Assets (i,q)			
	Insurer Small Dummy (q-2)		Insurer Worse Rated Dummy (q-2)		Crisis (2008-2009) Dummy	
	NAIC Category:	1 (1)	1 & 2 (2)	1 (3)	1 & 2 (4)	1 (5)
Financial Constraint Dummy		-0.0932*** (-2.70)	-0.0790*** (-2.84)	-0.0972*** (-3.06)	-0.1216*** (-4.79)	-0.0886** (-1.98)
*Loss (q-1)*Bond Worse-Rated(q-1)		-0.0717*** (-2.65)	-0.0601*** (-2.90)	-0.0742*** (-3.05)	-0.0264 (-1.44)	-0.1088*** (-5.63)
Loss (q-1)*Bond Worse-Rated(q-1)		-0.0717*** (-2.65)	-0.0601*** (-2.90)	-0.0742*** (-3.05)	-0.0264 (-1.44)	-0.1088*** (-5.63)
Financial Constraint Dummy		-0.0100*** (-18.41)	-0.0101*** (-21.22)	-0.0037*** (-6.51)	-0.0032*** (-6.51)	
*Bond Worse-Rated(q-1)						
Financial Constraint Dummy			0.4855*** (3.60)		0.7386*** (5.88)	0.4178** (2.27)
*Loss (q-1)*Bond NAIC 1 Dummy (q-1)						
Loss (q-1)*Bond NAIC 1 Dummy (q-1)			0.2288** (2.34)		0.0098 (0.11)	0.3987*** (5.03)
Financial Constraint Dummy			0.0781*** (33.20)		0.0192*** (8.19)	
*Bond NAIC 1 Dummy (q-1)						
Controls	Yes	Yes	Yes	Yes	Yes	Yes
CUSIP-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster SE by CUSIP-Year-Quarter	Yes	Yes	Yes	Yes	Yes	Yes
N	848671	1418688	848671	1418688	848671	1418688

### Panel B: Insurer RBC Ratio as Measures of Financial Constraints

Financial Constraint Dummy	Mrkt Value (i,j,q) *100 / Cash & Invested Assets (i,q)							
	RBC (y-1) < 2		RBC (y-1) < 5		RBC (y-1) < Median(y-1)		RBC (y-1)	
	1	1 & 2	1	1 & 2	1	1 & 2	1	1 & 2
NAIC Category:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Financial Constraint	-0.6263**	-0.2172	-0.1066*	-0.0491	-0.0128	-0.0406	0.0021	-0.0009
*Loss (q-1)*Bond Worse-Rated(q-1)	(-2.04)	(-0.82)	(-1.66)	(-0.88)	(-0.24)	(-0.89)	(0.86)	(-0.44)
Loss (q-1)*Bond Worse-Rated(q-1)	-0.2144***	-0.1980***	-0.1947***	-0.1840***	-0.2215***	-0.1737***	-0.2549***	-0.1868***
	(-7.60)	(-8.05)	(-6.23)	(-6.76)	(-5.90)	(-5.40)	(-6.82)	(-5.94)
Financial Constraint Dummy	0.0099	0.0096	-0.0042***	-0.0040***	0.0005	0.0001	-0.0003***	-0.0001***
*Bond Worse-Rated(q-1)	(1.20)	(1.35)	(-6.18)	(-7.06)	(0.80)	(0.18)	(-8.36)	(-6.24)
Financial Constraint Dummy		1.2236		0.3423		0.3882*		-0.0088
*Loss (q-1)*Bond NAIC 1 Dummy (q-1)		(0.98)		(1.26)		(1.75)		(-0.97)
Loss (q-1)*Bond NAIC 1 Dummy (q-1)		0.9901***		0.8854***		0.7795***		1.0804***
		(8.31)		(6.70)		(5.06)		(7.17)
Financial Constraint Dummy		-0.1282***		0.0161***		-0.0057**		0.0011***
*Bond NAIC 1 Dummy (q-1)		(-3.53)		(6.08)		(-2.42)		(10.01)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CUSIP-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster SE by CUSIP-Year-Quarter	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	848671	1418688	848671	1418688	848671	1418688	848671	1418688

# Appendix

**Table A.1: Variable Definitions**

## **Firm-Level Financial Variables**

Assets	Net admitted assets
Leverage	Total liabilities/net admitted assets
RBC Ratio	See Section 2
Insurers' Rating	Rating from A.M. Best, converted to a numeric value, larger means worse rating. 1 for A.M. Best rating of A++, 2 for A+, 3 for A, 4 for A-, 5 for B++, 6 for B+, 7 for B, 8 for B-, 9 for C++, 10 for C+, 11 for C, 12 for C-, and missing for ratings below or missing.
Net Income	Net income scaled by assets.
Direct Premium Written	Direct premium written scaled by assets.
Current Liquidity	A.M. Best's measure of insurers' liquidity, which "measures the proportion of liabilities (excluding AVR, conditional reserves and separate account liabilities) covered by cash and unaffiliated holdings, excluding mortgages and real estate".
Asset Grth	The admitted assets of the life insurer in year (t - 1) minus that in year (t - 2), scaled by the latter, in percentage.
Loss	Set to zero if net underwriting gain is positive. Equal to the negative of net underwriting gain, scaled by lagged assets, if net underwriting gain is negative. Net underwriting gain is available on Statement of Income in the statutory filings, Line 8 Column 1 in 2014 filing. To break it down, P&C Losses = (losses incurred + loss expenses incurred + other underwriting expenses incurred + aggregate write-ins for underwriting deductions)-(premiums earned + net income of protected cells), and set to 0 if the first bracket is smaller than the second bracket. Life insurers unaffiliated with P&C insurers, when included in regressions, are assigned P&C Losses equal to zero. Losses incurred = losses paid less salvage from direct business and reinsurance assumed - reinsurance recovered + net losses unpaid current year - net losses unpaid prior year.
Gain	Net underwriting gain if it is positive, zero otherwise.
P&C Weather Exposure	Instrument variable for P&C Loss, see Section 3 for the construction of the variable
Cash	From Summary Investment Schedule, Line 10, which includes cash, cash-equivalents (Schedule E Part 2) and short-term investments (Schedule DA Part 1 investments with one-year or less maturity at the time of acquisition including exempt money market funds and class one money market mutual funds).

## CUSIP-Level Bond Variables

Bond Rating	We first convert bond ratings to numeric values (see Table A.2) and take the average of the ratings across rating agencies
Bond Worse-Rated	For bonds in the NAIC 1 category, Bond Worse-Rated is bonds' average rating. For bonds in the NAIC 2 category, we subtract seven from the average rating.
Bond Maturity	Number of years until the bond matures divided by 1000
Coupon Rate	Reported by the insurers in the regulatory filings
Downgraded Dummy	Dummy variable that equals one if the bond has been downgraded in a time period by any rating agency
Bond Illiquidity	We use 0-Trading Day (%) to proxy for bond illiquidity, which is the percentage of days when no trading for this bond happened relative to the number of trading days
Dummy for NAIC Category = i	Dummy variable that equals one if the bond belongs to NAIC category i

**Table A.2: Conversion from Bond Rating to Numeric Value**

This table shows how we convert rating agencies rating to the variable *Worse-Rated*.

NAIC Category	Bond Rating	Worse-Rated
1	AAA	1
	AA+	2
	AA	3
	AA-	4
	A+	5
	A	6
	A-	7
2	BBB+	1
	BBB	2
	BBB-	3

**Table A.3: Insurers' Financial Conditions, Rating, Cash Flow Volatility and Reinsurance Usage**

In Panel A, the dependent variable is insurers' rating in year  $y$ . This table estimates how insurers' ratings are related to their lagged financial variables, see equation below. Columns (1)-(3) use P&C insurers, (4)-(6) life insurers. Columns (1), (2), (4) and (5) include year fixed effects, (3) and (5) also firm fixed effects. In Panel B, the dependent variable is insurers' five-year operating cash flow volatility. In Panel C, we only use P&C insurers, the dependent variable is insurers' reinsurance usage. Standard errors are corrected for clustering at the firm level. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels. See Table A.1 for variable definitions.

**Panel A: Insurers' Financial Conditions and Insurers' Financial Strength Rating**

Dependent Variable:	Insurers' Rating (y) (Larger Number = Worse Rating)					
	P&C Insurer			Life Insurer		
	(1)	(2)	(3)	(4)	(5)	(6)
log(Assets) (y-1)		-0.52*** (-9.37)	-0.36*** (-3.87)		-0.68*** (-15.62)	-0.30*** (-2.88)
Leverage (y-1)	0.56 (1.50)	1.19*** (3.23)	0.33** (2.28)	-1.04* (-1.89)	0.69* (1.84)	0.76** (2.26)
RBC Ratio (y-1)	-0.005** (-2.56)	-0.004** (-2.53)	-0.002** (-2.12)	0.002 (1.59)	0.002 (1.42)	0.001** (2.47)
Direct Premium Written (y-1)	-0.01 (-0.30)	-0.17*** (-3.92)	-0.01 (-0.61)	0.38*** (6.58)	0.24*** (5.17)	0.09*** (2.65)
Net Income (y-1)	-5.48*** (-3.96)	-4.17*** (-3.68)	-0.80* (-1.72)	-3.43*** (-4.47)	-2.54*** (-3.84)	-0.07 (-0.24)
Current Liquidity (y-1)	0.00*** (3.16)	0.00 (0.51)	0.00 (0.08)	0.00** (2.21)	-0.00 (-1.57)	-0.00 (-0.74)
Unrealized Capital Gain (y-1)	-2.69*** (-2.75)	-1.30* (-1.77)	-0.42 (-1.49)	-0.82** (-2.06)	-0.06 (-0.10)	0.55*** (3.18)
Asset Grth (y-1)	0.24* (1.73)	0.51*** (3.29)	0.14** (2.36)	-0.43* (-1.78)	0.14 (1.23)	0.15 (1.42)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE			Yes			Yes
Cluster SE by Firm	Yes	Yes	Yes	Yes	Yes	Yes
N (Firm-Year)	11665	11665	11531	7864	7864	7756
Adj R2	0.047	0.172	0.879	0.162	0.344	0.915

### Panel B: Insurers' Financial Conditions and Operating Cash Flow Volatility

Dependent Var:	Oprt Income Vol (t-4 to t)			
	P&C Insurers		Life Insurers	
	(1)	(2)	(4)	(5)
Log(Assets) (t-5)	-0.5274*** (-12.98)	-0.1468*** (-2.58)	-0.4815*** (-7.15)	-0.1200 (-0.85)
Leverage (t-5)	0.3513*** (3.30)	0.0813*** (2.67)	-3.9794*** (-4.41)	0.4183 (0.95)
RBC Ratio (t-5)	-0.0132*** (-4.94)	-0.0034*** (-3.19)	-0.0018** (-2.44)	-0.0005* (-1.78)
Firm FE		Yes		Yes
Year FE	Yes	Yes	Yes	Yes
Cluster SE by Firm	Yes	Yes	Yes	Yes
N	21333	21333	12989	12989

### Panel C: Insurers' Financial Conditions and Reinsurance Usage, P&C Insurers

Dependent Var:	Reinsurance Usage (t)	
	P&C Insurers	
Log(Assets) (t-1)	-0.0192*** (-2.87)	
Leverage (t-1)	0.0218*** (5.84)	
RBC Ratio (t-1)	0.0007*** (4.66)	
Firm FE	Yes	
Year FE	Yes	
Cluster SE by Firm	Yes	
N	34320	

**Table A.4: Losses and Corporate Bond Holdings at CUSIP Level, P&C Insurers, Instrumental Variable Approach, First Stage**

This table presents the first-stage results estimating Equation (4), using the instrumental variable approach, corresponding to Column (2) in Table 6. Standard errors are corrected for clustering at the CUSIP-year-quarter level. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels. See Table A.1 for variable definitions.

Dependent Variable:	Loss (q-1)*Bond Rating (larger=worse) (q-1)	Loss (q-1)*Bond Coupon Rate	Loss (q-1)*Bond Months to Maturity (q)	Loss (q-1)*Bond Illiquidity (q-1)	Loss (q-1)*Bond Downgraded Dummy (q-1)
	(1)	(2)	(3)	(4)	(5)
Weather Exposure (q-1)*Bond Rating (larger=worse) (q-1)	0.5563*** (24.91)	0.0117 (1.23)	-1.1704 (-1.64)	0.0019 (0.84)	-0.0021 (-1.54)
Weather Exposure (q-1)*Bond Coupon Rate	-0.0018 (-0.17)	0.4468*** (32.16)	0.9749 (0.45)	0.0005 (0.24)	0.0003 (0.24)
Weather Exposure (q-1)*Bond Months to Maturity (q)	-0.0000 (-0.84)	0.0000 (0.31)	0.4695 (0.54)	-0.0000* (-1.75)	-0.0000 (-0.22)
Weather Exposure (q-1)*Bond Illiquidity (q-1)	0.0717 (1.40)	0.0545 (1.18)	1.6083 (0.21)	0.5761*** (33.46)	-0.0097* (-1.88)
Weather Exposure (q-1)*Bond Downgraded Dummy (q-1)	-0.1370* (-1.88)	-0.0213 (-0.37)	1.5895 (0.33)	-0.0273** (-2.05)	0.5790*** (11.72)
Controls	Yes	Yes	Yes	Yes	Yes
CUSIP-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Firm-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Cluster SE by CUSIP-Year-Quarter	Yes	Yes	Yes	Yes	Yes
N	848722	848722	848722	848722	848722

**Table A.5: Robustness Checks for Bond-Level Results, P&C Insurers**

This table presents robustness checks results at the corporate bond-level for P&C insurers. Panel A presents robustness checks on how insurers' financial variables are correlated with their allocation across bonds by altering Column (2) in Panel A, Table 5. Panel B presents robustness checks on how insurers' losses are correlated with their allocation across bonds by altering Column (5) in Panel A, Table 6. In each panel, in each column, we add *Bond Duration* as one of the characteristics of bonds. In Column (2), we omit *Bond Coupon Rate* and *Bond Maturity*. In Column (3), we use Imputed Round Trip Costs as a proxy for bond illiquidity. Standard errors are corrected for clustering at the CUSIP-year-quarter level. In Column (4), we use bond's yield to maturity from the previous quarter as the measure for bond risk. In Column (5), we repeat the original specification, replacing the insurer-year-quarter fixed effects with firm fixed effects and adding firms lagged financial variables as controls. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels. See Table A.1 for variable definitions.

## Panel A: Financial Conditions and Corporate Bond Holdings at CUSIP Level

Dependent Variable: NAIC Category:	Mrkt Value(i,j,q)*100/Cash & Invested Assets(i,q)				
			1&2		Replace Firm-YrQtrr FE w/ Firm FE
	Including Bond Duration	Illiquidity = Imputed Round Trip Costs	Bond Yield as Risk Measure		
	(1)	(2)	(3)	(4)	(5)
Log Assets (q-1)*Bond Worse-Rated(q-1)	0.0042*** (18.09)	0.0034*** (14.36)	0.0044*** (18.94)		0.0044*** (25.33)
Log Assets (q-1)*Bond Yield (q-1)				0.0011*** (7.80)	
Log Assets (q-1)*Bond Duration (q-1)	-0.0004*** (-5.51)	-0.0005*** (-6.99)	-0.0004*** (-5.62)	-0.0005*** (-7.18)	
Log Assets (q-1)*Bond Coupon Rate	-0.0048*** (-23.19)		-0.0048*** (-23.16)	-0.0043*** (-20.87)	-0.0038*** (-28.10)
Log Assets (q-1)*Bond Maturity (q)	0.0372*** (2.70)		0.0403*** (2.63)	0.0370*** (2.67)	0.0021 (0.88)
Log Assets (q-1)*Bond Illiquidity (q-1)	0.0050*** (4.72)	0.0064*** (6.03)	0.2674*** (2.66)	0.0079*** (7.59)	0.0036*** (5.28)
Log Assets (q-1)*Bond Downgraded Dummy (q-1)	0.0020* (1.85)	0.0016 (1.45)	0.0010 (0.89)	0.0003 (0.29)	0.0015** (2.04)
Log Assets (q-1)*Bond NAIC 1 Dummy (q-1)	-0.0331*** (-27.61)	-0.0270*** (-23.12)	-0.0340*** (-29.17)	-0.0149*** (-23.99)	-0.0336*** (-40.41)
Insurer Rating (larger=worse) (q-1)	-0.0023*** *Bond Worse-Rated(q-1)	-0.0027*** (-6.58)	-0.0024*** (-7.76)		-0.0013*** (-5.40)
Insurer Rating (larger=worse) (q-1)				-0.0002 (-1.15)	
Insurer Rating (q-1)*Bond Duration (q-1)	0.0004*** (4.57)	0.0004*** (3.72)	0.0004*** (4.15)	0.0004*** (4.30)	
Insurer Rating (q-1)*Bond Coupon Rate	-0.0025*** (-9.37)		-0.0024*** (-9.15)	-0.0030*** (-10.71)	-0.0006*** (-3.47)
Insurer Rating (q-1)*Bond Maturity (q)	0.0218* (1.90)		0.0240* (1.94)	0.0233** (2.00)	0.0021 (0.28)
Insurer Rating (q-1)*Bond Illiquidity (q-1)	-0.0030** (-2.36)	-0.0020 (-1.61)	0.0482 (0.40)	-0.0051*** (-4.03)	-0.0043*** (-4.52)
Insurer Rating (q-1)*Bond Downgraded Dummy (q-1)	-0.0001 (-0.05)	-0.0003 (-0.23)	0.0002 (0.14)	0.0003 (0.27)	-0.0001 (-0.10)
Insurer Rating (q-1)*Bond NAIC 1 Dummy (q-1)	0.0093*** (5.49)	0.0123*** (7.25)	0.0099*** (5.97)	-0.0001 (-0.12)	0.0065*** (5.39)
Controls	Yes	Yes	Yes	Yes	Yes
CUSIP-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Firm-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Cluster SE by CUSIP-Year-Quarter	Yes	Yes	Yes	Yes	Yes
N	868140	868233	863661	869316	1365905

### Panel B: Losses and Corporate Bond Holdings at CUSIP Level

NAIC Category:	Dependent Variable: Mrkt Value(i,j,q)*100/Cash & Invested Assets(i,q)				
	1&2		Illiquidity = Including Bond Duration Imputed Round Trip Costs	Bond Yield as Risk Measure	Replace Firm- YrQtr FE w/ Firm FE
	(1)	(2)			(5)
Loss (q-1)*Bond Worse-Rated(q-1)	-0.1455*** (-6.06)	-0.1534*** (-6.24)	-0.1447*** (-6.10)		-0.1319*** (-3.13)
Loss (q-1)*Bond Yield (q-1)				0.0064 (0.50)	
Loss (q-1)*Bond Duration (q-1)	0.0053 (0.84)	0.0029 (0.46)	0.0032 (0.50)	0.0018 (0.27)	
Loss (q-1)*Bond Coupon Rate	-0.0457*** (-2.63)		-0.0471*** (-2.69)	-0.0716*** (-3.97)	-0.0727*** (-2.64)
Loss (q-1)*Bond Maturity (q)	-0.7055 (-1.28)		-0.9774* (-1.74)	-0.8629* (-1.68)	-0.3428 (-0.84)
Loss (q-1)*Bond Illiquidity (q-1)	0.0305 (0.38)	0.0464 (0.57)	8.5013 (0.86)	-0.1075 (-1.36)	-0.2323* (-1.80)
Loss (q-1)*Bond Downgraded Dummy (q-1)	-0.1456 (-1.30)	-0.1486 (-1.33)	-0.1603 (-1.44)	-0.1506 (-1.35)	-0.0760 (-0.47)
Loss (q-1)*Bond NAIC 1 Dummy (q-1)	0.6522*** (5.52)	0.7108*** (5.89)	0.6457*** (5.59)	0.0308 (0.58)	0.6538*** (3.34)
Controls	Yes	Yes	Yes	Yes	Yes
CUSIP-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Firm-Year-Quarter FE	Yes	Yes	Yes	Yes	
Firm FE					Yes
Cluster SE by CUSIP-Year-Quarter	Yes	Yes	Yes	Yes	Yes
N	868140	868233	863661	869316	1342243