# 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 events that can help us establish causality. 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, Property & Casualty (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.[1] 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 these investors 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 help characterize the way in which these investors manage their financial portfolios.

[1] 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), 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 financial 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 demands. This illiquidity will be more of a problem for firms who face a higher cost of external financing, which could lead more financially constrained institutions to prefer a more liquid portfolio.[2] In addition, liabilities can increase, leading the organization closer to insolvency. For example, a pension fund's liabilities and its probability of insolvency can increase if retirees' life expectancy increases. If an institution invests in risky assets whose value declines with high probability, the institution will be more likely to approach costly bankruptcy. For this reason, more constrained institutions could prefer a safer portfolio.[3] 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 is a cost coming from a firm's weak financial conditions. This possibility would also lead financial constraints to move institutions' portfolios toward safer and more liquid securities. Alternatively, worse financial conditions could lead institutions to shift toward riskier and more illiquid securities as institutions gamble for higher returns as famously suggested by Jensen and Meckling (1976).

We evaluate the portfolio decisions of a sample of 2,084 U.S. Property & Casualty (P&C) insurers and 842 U.S. life insurers between 2001 and 2015. Insurers are important institutional investors, holding $6.5 trillion of financial assets in 2017, including more than 25% of U.S. corporate bonds. Insurers report detailed security-level holdings, 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

[2] 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.

[3] 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).

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.

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. Because larger insurers' portfolios are riskier, they should have higher expected returns than smaller insurers' portfolios. In our sample, larger firms do earn higher returns on their portfolios. In addition, larger size is associated with a better financial strength rating and lower operating cash flow volatility. These cross-sectional correlations suggest 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.[4] 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, because we can control for regulatory treatments among corporate bonds. 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

[4] Section 2 discusses the regulatory treatment of insurers' financial security holdings in detail.

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 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. The instrument should reflect insurers' exposure to unexpected weather shocks.

Our results suggest that, following operating losses, P&C insurers reduce their holdings of riskier corporate bonds. This result also holds when 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 constraints, insurers appear to seek higher expected returns by taking on more risk and illiquidity in their financial portfolio. If absent concerns about financial constraints, 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 institutions' financial conditions are likely among the drivers of the "flight to quality" phenomenon, meaning that during market downturns, their demand for securities shifts more toward safer ones.[5] We find that insurers in weaker financial conditions have larger portfolio weights in safer assets, more so during the financial crisis. Erel et al. (2012) document that during market downturns, low-rated firms issue substantially fewer bonds, but high-rated firms issue more bonds than in good times. 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 idea that the risk-management incentives increase as firms' financial conditions worsen, 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 (e.g. He and Krishnamurthy (2012, 2013 and 2018)). It is often modeled that, when asset values decline, a reduction in the risk tolerance of (the managers of) the intermediary shifts its portfolio accordingly. Our evidence suggests that the phenomenon He and Krishnamurthy describe is widespread—when asset values decline and financial constraints tighten, institutional investors shift their portfolios toward safer securities. This

[5] See, for example, Caballero and Krishnamurthy (2008) and Vayanos (2004) for theoretical motivation of the flight to quality arguments.

study also relates to papers on investors' heterogeneous demand of financial assets, e.g. Koijen and Yogo (2019). We shed light on one of the factors that can affect institutional investors' demand of different assets, namely the institutions' financial conditions.

We also contribute to the literature on whether financial constraints increase risk-management or risk-shifting behavior in asset holdings. 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 the allocation within an asset class, which Rauh (2009) and Duchin et al (2017) are not able to do. Moreover, the tradeoffs between return and risk/liquidity across asset classes are different from the tradeoffs within asset classes. Our results at the individual bond level cannot be directly inferred from Rauh (2009) and Duchin et al (2017).[6] Becker and Ivashina (2015) document that insurers reduce their reaching-for-yield in their bond portfolios during the financial crisis, consistent with our finding that insurers reduce the risk of their portfolios when they are more constrained.[7]

[6] Different from the implications in Rauh (2009), 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. 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 (2000), Eisdorfer (2008), Rampini, Sufi and Viswanathan (2014), Landier, Sraer and Thesmar (2015), Acharya and Steffen (2015), and. Drechsler et al (2016).

[7] 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 (2016) study the commonality in insurers' portfolio and

# 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 (more precisely, 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 corporate bonds rated BBB and 7.38% for corporate bonds rated B.

# 3. Data

## 3.1 Insurers' Financial Data and Security 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. We transform insurers' A.M. Best ratings

their asset sales behavior. Kirti (2017) examines how insurers hit hard during the crisis adjust their portfolio holdings. 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. Greenwood and Vissing-Jorgensen (2018) document how pension and insurance assets affect the yield curve.

to integers starting from one, with larger numbers indicating worse ratings. Insurers with negative assets or net premium written lower than $10,000 are excluded. All financial variables, except ratings, 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 portfolios, we use P&C insurers' operating losses due to insurers' underwriting activities as shocks that worsen their financial constraints. We set underwriting losses, *Loss*, as the absolute value of net underwriting gain scaled by lagged assets if net underwriting gain is negative, and zero otherwise. *Loss* is either positive, indicating poor underwriting performance, or zero. The net underwriting gain, and thus also *Loss*, are net of reinsurance payments.

We also construct an instrumental variable for the reported P&C insurers' underwriting losses, following Ge (2019). Data on damages due to weather events are from Spatial Hazard Events and Losses Database for the United States (SHELDUS). The data offer monetary estimates of damages caused by every natural hazard event that has caused injury, death, or property/farm damages since 1960 in the U.S. We include all the events in the data, 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 *s*-quarter *q* level, then compute rolling historical averages (going back to 1960) of state *s*, adjusting for inflation. Since weather damages can vary by season, we construct historical averages for each quarter *q* using historical data from the same quarter of previous years. We then subtract the rolling state-quarter historical averages 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,

$\sum_s \left(Unusual\ Weather\ Damages_{s,q} * Lag\ Mkt\ Share_{i,\,s,\,q}\right)$, and scale by lagged assets, to obtain the instrumental variable.

We need to make some assumptions for the instrument to satisfy the exclusion restriction: 1) unusual weather damages should be uncorrelated with insurers' lagged market share; 2) unusual weather damages should be uncorrelated with omitted variables that affect insurers' investment decisions; 3) weather damages are stationary, in other words, unusual weather damages have an expectation of zero.[8]

Our data on insurers' holdings in financial securities are from SNL, which provides annual data on insurers' financial assets in broad categories based on 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 A.M. Best financial strength rating, respectively. We tabulate the averages of insurers' financial variables and portfolio weights of different security categories for each subsample. If the averages of the smallest and largest (or best- and worst-rated) subsamples 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.

[8] Denote the factors that affect insurers' portfolio decisions that are orthogonal to controls (included in the empirical analysis) $X$. To satisfy the exclusion restriction, the correlation between P&C Unusual Weather Exposure and $X$ needs to be zero. $Cov\left(P\&C\ Weather\ Exposure_{i,s,q}, X\right) = \sum_s E\left(Unusual\ Weather\ Damage_{s,q} \cdot Lag\ Mkt\ Share_{i,s,q} \cdot X\right) - E(X)\left[\sum_s E\left(Unusual\ Weather\ Damage_{s,q} \cdot Lag\ Mkt\ Share_{i,s,q}\right)\right] = \sum_s\left[E\left(UnusualWeatherDamage_{s,q} \cdot LagMktShare_{i,s,q}\right) \cdot E(X)\right] - E(X) \cdot \sum_s\left[E\left(UnusualWeatherDamage_{s,q}\right) \cdot E\left(LagMktShare_{i,s,q}\right)\right] = 0$
Assumptions 1 and 2 can generate the second-to-last equality. Assumption 3 can lead to the last equality.

Size appears to play an important role, beyond leverage and RBC ratios, in characterizing a firm's financial flexibility by the rating agency. 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, in the short term, 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)[9] 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 insurers. 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 and Trading at the Security Level

We obtain P&C insurers' CUSIP-level bond holding data from SNL between 2008 and 2015, which are based on insurers' annual filings, Schedule D, Part 1. We also obtain data on insurers' acquisition and disposal of bonds between 2008 and 2015, reported in Q1, Q2, Q3 and annual filings, Schedule D, Parts 3 and 4. We use the quarterly trading data to back out quarter-end holding information.[10] The data offer information of the bond, for example, coupon rate, maturity, and NAIC designation for the risk charge of

[9] "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).

[10] 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.

the bond at the time of reporting. The holding data offer the par, fair, and carry value of the holding. The trading data offer the actual cost and par value of a purchase or disposal.

From Mergent FISD, we obtain bond ratings and maturity dates. If the maturity date for the same bond is different between insurers' filings 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 that bond among all the P&C insurers' Schedule D filings. We use TRACE (Trade Reporting and Compliance Engine) to calculate bond liquidity measures following Dick-Nielsen, Feldhütter and Lando (2012) after cleaning the data following Dick-Nielsen (2009). We calculate the market value of each holding by multiplying the par value with the latest trading price of the bond in the prior quarter in TRACE.

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. There are 83,966 unique CUSIPs in total, among all the corporate bonds in P&C insurers' filings. Panel C of Table 2 offers summary statistics of CUSIP-level corporate bond holdings by P&C insurers.

# 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 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 8.04 percentage points (32% of the standard deviation), a decrease in treasury holdings of 7.37 percentage points (46% of the standard deviation), an increase in MBS holdings of 2.88 percentage points (22% of the standard deviation), and an increase in corporate bond holdings of 6.64 percentage points (38% of the standard deviation). For life insurers, a one standard deviation increase in *Log(Assets)* (2.91) is associated with a decrease in cash holdings of 12.80 percentage points (54%. of the standard deviation), a decrease in treasury holdings of 7.65 percentage points (44% of the standard deviation), an increase in MBS holdings of 5.38 percentage points (38% of the standard deviation), and an increase in corporate bond holdings of 14.35 percentage points (56% 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 (2% of the standard deviation), as well as a 0.50 percentage point decrease in the share of corporate bonds (3% of the standard deviation).

How do we interpret the result that as insurers become larger, they have a larger allocation to risky and illiquid assets? One interpretation is that larger insurers are less financially constrained and are less concerned about an increase in liquidity needs or the likelihood of insolvency. In Table A.3, we provide more evidence that larger sizes could be correlated with better financial conditions. Panel A shows that asset size explains a significant portion of the variation in ratings based on the R-squared and suggests that larger insurers have better financial strength ratings. Panel B indicates that larger insurers experience less

operating cash flow volatility.[11] The results in Table A.3 imply 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. Therefore, on average, we expect insurers to achieve higher realized returns when they are larger. We test this prediction by estimating the following equation:

$$Realized\ Return\ on\ Cash\ \&\ Invested\ Assets_{i,q} = \beta_1 * Log(Assets)_{i,q-1} + \beta_2 * Leverage_{i,q-1} + \beta_3 * RBC\ Ratio_{i,y-1} + \beta_4 * Insurer\ Rating_{i,q-1} + FE_i + FE_q + e_{i,q}, \quad (2)$$

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.

Table 4 presents estimates of Equation (2). 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 firm fixed effects and include the variation in asset size across insurers. The coefficient on assets is again positive and statistically significant. The estimate in Column (3) implies that a one standard deviation increase in

[11] The coefficients on *Log(Assets)* in Table 3 remain similar in both magnitude and statistical significance if we control for cash flow volatility.

*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 again suggest that larger insurers have higher portfolio returns. The estimated coefficients 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 17% of the standard deviation (0.5%). Overall, the results in Table 4 suggest that larger insurers achieve higher realized returns, consistent with the idea that they seek higher expected returns by taking on more risk and illiquidity in their 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:

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

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, and take the average across different rating agencies. For bonds in the NAIC 1 category, *Bond Worse-Rated* is 1 for bonds rated AAA, and increases to 7 for bonds rated A- (see Table A.2 in Appendix). For bonds in the NAIC 2 category, *Bond Worse-Rated* is 1 for bonds rated BBB+, 2 for BBB and 3 for BBB-. The minimum of *Bond Worse-Rated* is set to 1 so that bonds in NAIC 1 and 2 categories have some common support for this variable.

Panel A of Table 5 contains the results. 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 percentage of the insurer *i*'s cash and invested assets. We use the market value of the bond holdings instead of book value in the numerator because of the concern that insurers endogenously choose their own calculation of the book value (Sen and Sharma 2019). 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 percentage of the total market value of all the corporate bonds insurer *i* holds. Columns (1) and (3) only include corporate bonds in NAIC 1 category, which are the highest quality bonds. Such bonds make up 57% of the corporate bonds held by

P&C insurers (equally weighting the bonds). Columns (2) and (4) further add NAIC 2 category bonds. These two categories make up 90% of P&C insurers' corporate bond holdings (equally weighting the bonds).

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 smaller size is associated with insurers holding more bonds in the safer NAIC 1 category relative to the riskier NAIC 2 category. In Column (2) the coefficients imply that a one standard deviation decrease in insurers' assets is associated with a 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 ratios, 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 in the main specification and use the imputed round-trip costs in the robustness test. 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 Column (1), we add *Bond Duration* in quarter *q-1* as one of the characteristics of bonds, which reduces the sample size by 36%. 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 bonds' 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 insurer fixed effects and adding insurers' lagged financial variables as controls. The results described above all hold in each specification.

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 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 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% (=0.0012/ 0.0035) 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% (=0.0016/ 0.0012)

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 potential 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 potential 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. 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 in Table 6, using data on the individual bonds held by each insurer in the specification below.

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

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 the 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). Insurers' *Financial* is from *q-2.*[12] 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 described in Section 3.

In Panel A of Table 6, 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 (4). 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 of the sample used in the regression (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

[12] Because our insurers' A.M. Best ratings data are from 2004 to 2013 and bond holding data are from 2008 to 2015, using *Financial (q-2)* increases the sample size compared to using *Financial (q-1)*, compared to estimation of Equation (3).

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 Column (1), we add *Bond Duration* in quarter *q-1* as one of the characteristics of bonds, which reduces the sample size by 38%. 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 bonds' 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. The estimates from this specification 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 net underwriting gain scaled by lagged assets if net underwriting gain is positive, and zero otherwise. The results suggest that insurers indeed shift towards riskier 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 stronger risk-shifting behavior in any situation, it would occur when they suffer large losses and are close to insolvency.

Therefore, we 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 losses are not larger than the cutoff, and equals the cutoff if losses are above the cutoff. *Loss>Cutoff* equals losses minus the cutoff if losses are above the cutoff, and zero otherwise. The cutoff is the median, the 75$^{th}$ percentile or the 95$^{th}$ 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 and 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 par value of bond *j* that insurer *i* sold in quarter *q*, as a fraction of the par value of bond *j* insurer *i* held at the end of quarter *q-2*. We choose the denominator to be from *q-2* instead of *q-1*, so that *Loss (q-1)* does not directly affected the denominator is if insurer *i* sells or buys bond *j* in *q-1* due to *Loss (q-1)*. We exclude transactions that are involuntary, for example, due to bond maturing and being called by the issuer. 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) replacing the dependent variable with 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*. The dependent variable is zero if insurer *i* does not purchase any of bond *j* in quarter *q*. We include all the corporate bonds that any P&C insurer bought in that quarter. We assume an insurer could conceivably buy any of these bonds. 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, 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 bonds (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 transaction 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 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 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. Panel A of Table 8 reports the estimates. 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 add the *NAIC 1 Dummy* to *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 when insures structure their portfolios, they take their financial conditions into consideration: financially more constrained insurers tend to hold a safer portfolio. As such, the results here 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 worse-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 C of Table 6 suggests that the shift towards safer bonds 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 following losses.

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), *Fin Constraint* is 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. 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*.

In Column (1), the coefficient on *Fin Constraint*Loss*Worse-Rated* is statistically significantly different from zero, suggesting that insurers, whose RBC ratio is below the regulatory lower bound of 2, respond more strongly to losses by shifting towards safer bonds. In Column (3), where the RBC ratio cutoff is 5, the coefficient on this interaction term is statistically significant at 10% and negative, but of much smaller magnitude than the one in Column (1). Potentially, insurers with RBC ratios below 2 largely contribute to the coefficient being statistically significant in Column (3).

The other six coefficients on *Fin Constraint*Loss*Worse-Rated* 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 all the columns among Columns (1)-(6), the negative and statistically significant coefficients on the interaction term between *Loss* and *Worse-Rated* suggest that, on average, insurers with RBC ratios higher than the corresponding cutoffs also shift towards safer bonds following losses. These results suggest that insurers' shift towards safer portfolios following losses is unlikely to be 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 assets totaling over $22 trillion in 2017 in the U.S. 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 insurance companies, and evaluates the extent to which variations in these investors' financial conditions due to their operations affect the management of their financial 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 have little control over 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, affect their portfolio allocation. We also evaluate how P&C insurers change their allocations among corporate bonds following operating losses, and how the degree of their financial constraints 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 safer 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 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 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 become stronger because of the costs of financial constraints.

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. 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 costs associated with financial frictions 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 different securities and adjust their portfolios based on the changing residual supply of available securities? How do macroeconomic conditions interact with changes 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%[15] | 0.4%[16] |
| Bonds Issued by U.S. Government Agencies (not backed by the U.S. government)[17] | | NAIC 1 | 0.3% | 0.4% |
| Corporate Bonds[18] & 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%[19] |
| Other Long-Term Assets | | NA | | |
| Real Estate | | NA | 10% | 5% ~ 23%[20] |
| Mortgage Loans | | NA | 5% | 3% ~ 20% |
| Schedule BA (Private Equity, Hedge Funds etc.) | | NA | 20% | 30%[21] |

[15] NAIC (2015a), P10.
[16] NAIC (2015b), P41.
[17] Examples are FNMA and FHLMC collateralized mortgage obligations, see NAIC (2015a) P8.
[18] See Becker and Ivashina (2015), and Becker and Opp (2014).
[19] 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%."
[20] NAIC (2015b), P19.
[21] NAIC (2015b), P23.

## Table 2: Summary Statistics

This table presents summary statistics. 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 averages of lagged financial variables and holdings in categories of each subsample. If the averages between the most two extreme subsamples are statistically different at the 5% level or lower, the numbers are displayed in bold. Panel C offers statistics on corporate bonds in P&C insurers' holdings at the CUSIP-insurer-quarterly level.

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

| Variable | N | Mean | Std | 25 Pctl | Median | 75 Pctl |
|---|---|---|---|---|---|---|
| **P&C Insurers** | | | | | | |
| **Financial Variables** | | | | | | |
| Asset ($Billion) | 28866 | 0.44 | 1.31 | 0.02 | 0.06 | 0.24 |
| Leverage (%) | 28866 | 72.29 | 71.61 | 45.17 | 61.64 | 72.87 |
| RBC Ratio | 27069 | 14.88 | 25.56 | 4.80 | 7.78 | 13.46 |
| Rating (Larger=Worse) | 15972 | 3.99 | 2.48 | 3 (A) | 3 (A) | 4 (A-) |
| Underwriting Loss (% of Lagged Assets), >=0 | 23096 | 2.35 | 4.64 | 0.00 | 0.00 | 2.69 |
| Underwriting Gain (% of Lagged Assets), >=0 | 23096 | 2.50 | 4.34 | 0.00 | 0.27 | 3.26 |
| Weather Exposure (% of Lagged Assets) | 19219 | 0.80 | 5.94 | -0.48 | -0.05 | 0.30 |
| **Holdings in % of Cash and Invested Assets** | | | | | | |
| Cash | 28866 | 19.91 | 25.24 | 3.82 | 9.63 | 24.63 |
| Treasury | 28866 | 10.61 | 16.17 | 0.35 | 4.06 | 13.38 |
| U.S. Gov Agency | 28866 | 6.04 | 11.77 | 0.00 | 0.44 | 6.46 |
| Muni Bond | 28866 | 20.75 | 23.84 | 0.00 | 11.61 | 34.95 |
| MBS | 28866 | 10.13 | 13.15 | 0.00 | 4.02 | 16.94 |
| Corp Bond | 28866 | 18.02 | 17.58 | 0.00 | 14.75 | 29.52 |
| Public Stocks | 28866 | 5.43 | 10.62 | 0.00 | 0.00 | 6.43 |
| All Other | 28866 | 8.97 | 13.36 | 0.00 | 3.22 | 12.38 |
| **Life Insurers** | | | | | | |
| **Financial Variables** | | | | | | |
| Asset ($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++) |
| **Holdings in % of Cash and Invested Assets** | | | | | | |
| Cash | 13110 | 15.52 | 23.75 | 1.96 | 5.44 | 16.98 |
| Treasury | 13110 | 9.21 | 17.45 | 0.15 | 1.82 | 8.92 |
| U.S. Gov Agency | 13110 | 5.77 | 12.50 | 0.00 | 0.56 | 4.62 |
| Muni Bond | 13110 | 5.70 | 11.38 | 0.00 | 0.62 | 5.46 |
| MBS | 13110 | 13.12 | 14.22 | 0.01 | 9.63 | 21.00 |
| Corp Bond | 13110 | 33.88 | 25.81 | 6.07 | 35.94 | 55.08 |
| Public Stocks | 13110 | 1.88 | 5.38 | 0.00 | 0.00 | 0.44 |
| All Other | 13110 | 14.26 | 18.22 | 0.81 | 8.03 | 20.70 |

## Panel B: Insurers' Holdings in Different Subsamples

| | N (Firm-Year) | Financial Variables (y-1): Assets ($Billion) | Leverage (%) | RBC Ratio | Rating Larger=Worse | Holdings in % of Cash and Invested Assets (y): Cash | Treasury | U.S. Gov Agency | Muni Bond | MBS | Corp Bond | Public Stocks | All Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **P&C Insurers** | | | | | | | | | | | | | |
| **Sort by P&C Insurers' Assets (y-1)** | | | | | | | | | | | | | |
| Largest | 9806 | **1.23** | **73.75** | **9.8** | **3.08** | **9.36** | **8.12** | **4.28** | **26.2** | **12.77** | **21.74** | **6.13** | **11.06** |
| Middle | 9526 | **0.07** | **73.63** | **14.97** | **4.15** | **16.56** | **11.42** | **7.19** | **22.17** | **11.83** | **19.43** | **4.5** | **6.85** |
| Smallest | 9534 | **0.01** | **69.47** | **20.48** | **5.69** | **34.11** | **12.35** | **6.72** | **13.69** | **5.71** | **12.82** | **5.63** | **8.63** |
| **Sort by P&C Insurers' Rating (y-1)** | | | | | | | | | | | | | |
| 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 |
| **Life Insurers** | | | | | | | | | | | | | |
| **Sort by Life Insurers' Assets (y-1)** | | | | | | | | | | | | | |
| 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** |
| **Sort by Life Insurers' Rating (y-1)** | | | | | | | | | | | | | |
| 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-Quarter Level**

| Variable | N | Mean | Std | 25 Pctl | Median |
|---|---|---|---|---|---|
| Mrkt Value*100/Cash & Invested Assets | 1602118 | 0.31 | 0.44 | 0.05 | 0.16 |
| Mrkt Value*100/Mrkt Value of All Corp Bonds Held | 1602118 | 1.47 | 2.43 | 0.24 | 0.69 |
| Bond Rating | 1602118 | 7.18 | 2.89 | 5.50 | 7.00 |
| Years to Maturity | 1602118 | 5.73 | 5.11 | 2.58 | 4.58 |
| Coupon Rate | 1602118 | 5.20 | 1.78 | 4.25 | 5.35 |
| Downgraded Dummy | 1602118 | 0.08 | 0.26 | 0.00 | 0.00 |
| 0-Trading Day (%) | 1602118 | 28.49 | 29.20 | 1.64 | 17.46 |
| Imputed Round-trip Transct Cost*1000 | 1602118 | 5.49 | 3.72 | 2.86 | 4.52 |
| Dummy for NAIC Category = 1 | 1602118 | 0.54 | 0.50 | 0.00 | 1.00 |
| Dummy for NAIC Category = 2 | 1602118 | 0.36 | 0.48 | 0.00 | 0.00 |
| Dummy for NAIC Category = 3 | 1602118 | 0.05 | 0.23 | 0.00 | 0.00 |
| Dummy for NAIC Category = 4 | 1602118 | 0.04 | 0.20 | 0.00 | 0.00 |
| Dummy for NAIC Category = 5 | 1602118 | 0.01 | 0.09 | 0.00 | 0.00 |
| Dummy for NAIC Category = 6 | 1602118 | 0.00 | 0.04 | 0.00 | 0.00 |
| Offering Spread over Treasury | 705925 | 169.94 | 117.05 | 88.30 | 137.60 |

**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 insurer 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.

| | P&C Insurers | | | | | | Life Insurers | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dependent Var: Holding (y) (% of cash & invested assets) | 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*** | -3.76*** | -0.04 | 1.14* | 1.47*** | 3.39*** | -4.40*** | -2.63*** | -0.99** | 0.67 | 1.85*** | 4.93*** |
| | (-6.15) | (-6.42) | (-0.16) | (1.76) | (3.82) | (6.15) | (-5.60) | (-3.78) | (-2.43) | (1.09) | (3.14) | (6.46) |
| Leverage (y-1) | 0.57** | -0.09 | -0.02 | 0.12 | 0.03 | -0.69*** | 3.09 | -6.02* | 3.80 | 1.50 | 0.95 | 1.97 |
| | (2.57) | (-0.46) | (-0.37) | (0.53) | (0.24) | (-3.73) | (0.92) | (-1.87) | (1.63) | (0.57) | (0.33) | (0.54) |
| RBC Ratio (y-1) | 0.01 | 0.02** | -0.00 | -0.01 | -0.00 | -0.01 | 0.00 | 0.00 | -0.00 | -0.00 | -0.00* | -0.00 |
| | (1.05) | (2.31) | (-0.45) | (-0.40) | (-0.41) | (-0.46) | (0.66) | (0.99) | (-0.85) | (-0.89) | (-1.78) | (-0.19) |
| Insurer's Rating (y-1) | 0.34 | 0.05 | -0.03 | -0.94*** | 0.28** | 0.08 | 0.35 | 0.07 | 0.08 | -0.07 | -0.05 | -0.40* |
| (larger number = worse) | (1.64) | (0.36) | (-0.29) | (-4.83) | (2.21) | (0.50) | (1.45) | (0.34) | (0.97) | (-0.39) | (-0.30) | (-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.

$Realized\ Return\ on\ Cash\ \&\ Invested\ Assets_{i,q} = \beta_1 * Log(Assets)_{i,q-1} + \beta_2 * Leverage_{i,q-1} + \beta_3 * RBC\ Ratio_{i,y-1} + \beta_4 * Insurer\ Rating_{i,q-1} + FE_i + FE_q + e_{i,q}$, 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 | 0.03*** | 0.04*** | 0.00 | 0.02*** | 0.03*** |
| | (1.53) | (5.18) | (13.00) | (0.34) | (3.85) | (10.11) |
| Leverage (q-1) | -0.04* | -0.07*** | 0.04** | 0.08 | 0.13*** | 0.51*** |
| | (-1.84) | (-5.15) | (2.07) | (1.55) | (4.29) | (17.13) |
| RBC Ratio (y-1) | -0.0002* | -0.0002*** | 0.0004*** | -0.00 | -0.00 | 0.00 |
| | (-1.87) | (-2.90) | (2.90) | (-0.59) | (-0.83) | (0.25) |
| Insurer's Rating (q-1) | -0.003** | | -0.008*** | 0.00 | | -0.01*** |
| (larger number = worse) | (-2.27) | | (-7.74) | (0.10) | | (-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 a percentage of *i*'s cash and invested assets in quarter *q* in both panels. Panel A presents results of the following regression. $Holding\ of\ Bond_{i,j,q} = Financial_{i,q-1} * (\beta_1 * Bond\ Rating_{j,q-1} + \beta_2 * Bond\ Illiquidity_{j,q-1} + \beta_3 * Bond\ Maturity_{j,q} + \beta_4 * Bond\ Coupon\ Rate_j + \beta_5 * Bond\ Downgrade\ Dummy_{j,q-1} + \lambda * NAIC\ Category\ FE_{j,t}) + FE_{i,q} + FE_{j,q} + e_{i,j,q}$, 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 at the end of quarter *q*. 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 at the end of quarter *q*.

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 at the end of quarter *q*. 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 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 in addition to all the variables in Panel A.

In both panels, Columns (1) and (3) only include bonds in NAIC 1 category. Columns (2) and (4) include bonds in NAIC 1 and 2 categories. 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 1 | NAIC Category 1 & 2 | NAIC Category 1 | NAIC Category 1 & 2 |
| | (1) | (2) | (3) | (4) |
| Log Assets (q-1)*Bond Worse-Rated(q-1) | 0.0038*** | 0.0038*** | 0.0146*** | 0.0135*** |
| | (21.56) | (24.70) | (17.55) | (18.84) |
| Log Assets (q-1)*Bond Coupon Rate | -0.0032*** | -0.0027*** | -0.0115*** | -0.0098*** |
| | (-18.34) | (-20.67) | (-14.42) | (-16.52) |
| Log Assets (q-1)*Bond Maturity (q) | -0.0018 | 0.0036*** | 0.0472 | 0.0216** |
| | (-0.45) | (2.63) | (1.20) | (2.35) |
| Log Assets (q-1)*Bond Illiquidity (q-1) | 0.0049*** | 0.0041*** | 0.0070* | 0.0087*** |
| | (5.84) | (6.62) | (1.78) | (2.97) |
| Log Assets (q-1)*Bond Downgraded Dummy (q-1) | 0.0036*** | 0.0023*** | 0.0182*** | 0.0131*** |
| | (4.12) | (3.46) | (4.18) | (4.04) |
| Log Assets (q-1)*Bond NAIC 1 Dummy (q-1) | | -0.0287*** | | -0.1033*** |
| | | (-38.67) | | (-29.70) |
| Insurer Rating (larger=worse) (q-1) | -0.0018*** | -0.0013*** | -0.0097*** | -0.0075*** |
| *Bond Worse-Rated(q-1) | (-7.68) | (-6.04) | (-8.65) | (-7.71) |
| Insurer Rating (q-1)*Bond Coupon Rate | -0.0006*** | -0.0005*** | -0.0016 | -0.0025*** |
| | (-2.68) | (-2.63) | (-1.52) | (-3.18) |
| Insurer Rating (q-1)*Bond Maturity (q) | -0.0202* | 0.0048 | -0.1192 | 0.0452 |
| | (-1.68) | (0.83) | (-1.18) | (1.34) |
| Insurer Rating (q-1)*Bond Illiquidity (q-1) | -0.0052*** | -0.0036*** | -0.0221*** | -0.0264*** |
| | (-4.79) | (-4.29) | (-4.53) | (-6.93) |
| Insurer Rating (q-1)*Bond Downgraded Dummy (q-1) | -0.0004 | -0.0001 | 0.0051 | 0.0057 |
| | (-0.35) | (-0.16) | (1.02) | (1.50) |
| Insurer Rating (q-1)*Bond NAIC 1 Dummy (q-1) | | 0.0075*** | | 0.0434*** |
| | | (7.13) | | (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 a percentage of *i*'s cash and invested assets in quarter *q*. Panel A estimates $Holding\ of\ Bond_{i,j,q} = \alpha * Loss_{i,q-1} * Bond\ Charateristics_{j,q-2} + \beta * Financial_{i,q-2} * Bond\ Charateristics_{j,q-2} + FE_{i,q} + FE_{j,q} + e_{i,j,q}$. *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 (4) are reported in Table A.4.

Panel B replaces insurers' operating *Loss* in Panel A with operating *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$^{th}$ percentile or the 95$^{th}$ 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**

| | NAIC Category = 1 | | | | NAIC Category = 1 & 2 | | | |
|---|---|---|---|---|---|---|---|---|
| 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) | | 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) | |
| | OLS | IV | OLS | IV | OLS | IV | OLS | IV |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Loss (q-1)*Bond Worse-Rated(q-1) | -0.1312*** | -0.1681*** | -0.4435*** | -0.7473** | -0.1088*** | -0.1515*** | -0.3361*** | -0.6131** |
| | (-7.37) | (-2.61) | (-6.06) | (-1.99) | (-7.32) | (-2.70) | (-5.44) | (-2.21) |
| Loss (q-1)*Bond Coupon Rate | 0.0130 | -0.0332 | 0.1244** | 0.7857** | -0.0118 | -0.0171 | -0.0090 | 0.3714 |
| | (0.91) | (-0.41) | (2.02) | (2.11) | (-1.13) | (-0.28) | (-0.20) | (1.43) |
| Loss (q-1)*Bond Maturity (q) | 0.0000 | 0.0019 | 0.0002 | 0.0329 | -0.1511 | 0.9292 | -0.5343 | 13.8909 |
| | (0.76) | (0.47) | (0.66) | (0.46) | (-0.83) | (0.83) | (-0.65) | (0.79) |
| Loss (q-1)*Bond Illiquidity (q-1) | 0.0089 | 0.3566 | 0.3828 | 1.2039 | -0.0074 | 0.1854 | 0.2841 | 0.7119 |
| | (0.13) | (1.07) | (1.26) | (0.77) | (-0.14) | (0.73) | (1.27) | (0.72) |
| Loss (q-1)*Bond Downgraded Dummy (q-1) | -0.1254* | -0.3914 | -0.5531* | -1.1858 | -0.1192** | -0.0841 | -0.4472* | 0.1961 |
| | (-1.71) | (-0.98) | (-1.70) | (-0.55) | (-2.13) | (-0.27) | (-1.81) | (0.12) |
| Loss (q-1)*Bond NAIC 1 Dummy (q-1) | | | | | 0.4935*** | 0.7454** | 1.3595*** | 3.3970** |
| | | | | | (6.76) | (2.56) | (4.46) | (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 & 2 | 1 | 1 & 2 |
| | (1) | (2) | (3) | (4) |
| Gain (q-1)*Bond Worse-Rated (q-1) | 0.1532*** | 0.1286*** | 0.4161** | 0.3331** |
| | (4.58) | (4.33) | (2.50) | (2.26) |
| Gain (q-1)*Bond Coupon Rate | -0.2253*** | -0.2005*** | -1.1602*** | -0.8740*** |
| | (-6.61) | (-7.93) | (-6.89) | (-7.16) |
| Gain (q-1)*Bond Maturity (q) | -0.4734 | -0.4886** | -0.9952 | -1.5950 |
| | (-0.82) | (-2.08) | (-0.33) | (-0.83) |
| Gain (q-1)*Bond Illiquidity (q-1) | -0.2034 | -0.2681** | -1.5187** | -0.4847 |
| | (-1.37) | (-2.49) | (-2.16) | (-0.96) |
| Gain (q-1)*Bond Downgraded Dummy (q-1) | 0.3661*** | 0.2536** | 1.5159** | 1.3706** |
| | (2.65) | (2.31) | (2.00) | (2.40) |
| Gain (q-1)*Bond NAIC 1 Dummy (q-1) | | -0.6268*** | | -1.5116** |
| | | (-4.49) | | (-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 | 849175 | 1419495 |

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

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

**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.

| | Sell | | Buy | |
|---|---|---|---|---|
| Dependent Variable: | Par Value Sold (i,j,q) *100 / Par Value of the Bond Held (i,j,q-2) | | Actual Costs (i,j,q) *10E5 / Cash & Invested Assets (i,q-2) | |
| NAIC Category | 1 | 1 & 2 | 1 | 1 & 2 |
| | (1) | (2) | (3) | (4) |
| Loss (q-1)*Bond Worse-Rated (q-1) | 0.0020 | 0.0023 | -2.4386** | -1.8262** |
| | (1.14) | (1.40) | (-2.48) | (-2.34) |
| Loss (q-1)*Bond Coupon Rate | 0.0026 | 0.0011 | -0.1543 | -0.3370 |
| | (1.28) | (0.69) | (-0.30) | (-0.97) |
| Loss (q-1)*Bond Maturity (q) | 0.0015 | -0.5878 | 2.3106** | -4.5742 |
| | (0.00) | (-1.15) | (2.21) | (-1.17) |
| Loss (q-1)*Bond Illiquidity (q-1) | 0.0001 | 0.0001 | -0.0866** | -0.0898*** |
| | (0.69) | (0.89) | (-2.52) | (-3.96) |
| Loss (q-1)*Bond Downgraded Dummy (q-1) | 0.0107 | -0.0053 | 6.4897 | 6.2845* |
| | (1.20) | (-0.72) | (1.47) | (1.92) |
| Loss (q-1)*Bond NAIC 1 Dummy (q-1) | | -0.0082 | | 9.3325*** |
| | | (-0.99) | | (2.71) |
| Log Assets (q-2)*Bond Worse-Rated (q-1) | -0.0087 | -0.0056 | 0.0093* | 0.0139*** |
| | (-0.72) | (-0.53) | (1.84) | (3.49) |
| Log Assets (q-2)*Bond Coupon Rate | -0.0655*** | -0.0613*** | -0.0010 | -0.0009 |
| | (-4.98) | (-5.92) | (-0.32) | (-0.41) |
| Log Assets (q-2)*Bond Maturity (q) | 11.6512*** | 12.7424*** | 0.0454** | 0.0381*** |
| | (2.77) | (3.93) | (2.57) | (2.66) |
| Log Assets (q-2)*Bond Illiquidity (q-1) | -0.0009* | -0.0009** | 0.0031*** | 0.0024*** |
| | (-1.70) | (-2.00) | (15.15) | (18.96) |
| Log Assets (q-2)*Bond Downgraded Dummy (q-1) | 0.1270* | 0.0682 | 0.0147 | 0.0062 |
| | (1.79) | (1.22) | (0.60) | (0.37) |
| Log Assets (q-2)*Bond NAIC 1 Dummy (q-1) | | 0.0766 | | -0.1614*** |
| | | (1.41) | | (-9.09) |
| Insurer Rating (larger=worse) (q-2) | 0.0287* | 0.0273** | 0.0016 | 0.0016 |
| *Bond Worse-Rated (q-1) | (1.94) | (1.97) | (0.30) | (0.38) |
| Insurer Rating (q-2)*Bond Coupon Rate | 0.0297* | 0.0092 | -0.0030 | 0.0028 |
| | (1.71) | (0.68) | (-0.83) | (1.16) |
| Insurer Rating (q-2)*Bond Maturity (q) | 23.6296*** | 20.1346*** | -0.0249* | 0.0422 |
| | (3.98) | (4.05) | (-1.89) | (1.00) |
| Insurer Rating (q-2)*Bond Illiquidity (q-1) | -0.0015** | -0.0025*** | -0.0016*** | -0.0014*** |
| | (-2.02) | (-3.76) | (-8.15) | (-10.38) |
| Insurer Rating (q-2)*Bond Downgraded Dummy (q-1) | 0.0913 | 0.0389 | -0.0174 | 0.0131 |
| | (0.76) | (0.42) | (-0.86) | (0.82) |
| Insurer Rating (q-2)*Bond NAIC 1 Dummy (q-1) | | -0.1599** | | -0.0100 |
| | | (-2.11) | | (-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. $Holding\ of\ Bond_{i,j,q} = \gamma * Fin\ Constraint_{q-2} * Loss_{i,q-1} * Bond\ Charateristics_{j,q-2} + \alpha * Loss_{i,q-1} * Bond\ Charateristics_{j,q-2} + \beta * Financial_{i,q-2} * Bond\ Charateristics_{j,q-2} + FE_{i,q} + FE_{j,q} + e_{i,j,q}$. 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**

| Dependent Variable: | Mrkt Value (i,j,q) *100 / Cash & Invested Assets (i,q) | | | | | |
|---|---|---|---|---|---|---|
| Financial Constraint Dummy | Insurer Small Dummy (q-2) | | Insurer Worse Rated Dummy (q-2) | | Crisis (2008-2009) Dummy | |
| NAIC Category: | 1 | 1 & 2 | 1 | 1 & 2 | 1 | 1 & 2 |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Financial Constraint Dummy | -0.0932*** | -0.0790*** | -0.0972*** | -0.1216*** | -0.0886** | -0.0906** |
| *Loss (q-1)*Bond Worse-Rated(q-1) | (-2.70) | (-2.84) | (-3.06) | (-4.79) | (-1.98) | (-2.29) |
| Loss (q-1)*Bond Worse-Rated(q-1) | -0.0717*** | -0.0601*** | -0.0742*** | -0.0264 | -0.1088*** | -0.0882*** |
| | (-2.65) | (-2.90) | (-3.05) | (-1.44) | (-5.63) | (-5.60) |
| Financial Constraint Dummy | -0.0100*** | -0.0101*** | -0.0037*** | -0.0032*** | | |
| *Bond Worse-Rated(q-1) | (-18.41) | (-21.22) | (-6.51) | (-6.51) | | |
| Financial Constraint Dummy | | 0.4855*** | | 0.7386*** | | 0.4178** |
| *Loss (q-1)*Bond NAIC 1 Dummy (q-1) | | (3.60) | | (5.88) | | (2.27) |
| Loss (q-1)*Bond NAIC 1 Dummy (q-1) | | 0.2288** | | 0.0098 | | 0.3987*** |
| | | (2.34) | | (0.11) | | (5.03) |
| Financial Constraint Dummy | | 0.0781*** | | 0.0192*** | | |
| *Bond NAIC 1 Dummy (q-1) | | (33.20) | | (8.19) | | |
| 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**

| Dependent Variable: | Mrkt Value (i,j,q) *100 / Cash & Invested Assets (i,q) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Financial Constraint Dummy | RBC (y-1) < 2 | | RBC (y-1) < 5 | | RBC (y-1) < Median(y-1) | | RBC (y-1) | |
| NAIC Category: | 1 | 1 & 2 | 1 | 1 & 2 | 1 | 1 & 2 | 1 | 1 & 2 |
| | (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 |
| Insurer 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 | See Table A.2. |
| 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: How Financial Conditions Correlate with Ratings and Cash Flow Volatility**

In Panel A, the dependent variable is insurers' rating in year *y*. The table estimates how insurers' ratings are related to their lagged financial variables. Columns (1)-(3) use P&C insurers, (4)-(6) life insurers. All columns include year fixed effects. Columns (3) and (5) also include firm fixed effects. In Panel B, the dependent variable is insurers' five-year operating cash flow volatility from year *y-4* to year *y*, and the independent are from year *y-5*. Standard errors are corrected for clustering at the insurer 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*** | -0.36*** | | -0.68*** | -0.30*** |
| | | (-9.37) | (-3.87) | | (-15.62) | (-2.88) |
| Leverage (y-1) | 0.56 | 1.19*** | 0.33** | -1.04* | 0.69* | 0.76** |
| | (1.50) | (3.23) | (2.28) | (-1.89) | (1.84) | (2.26) |
| RBC Ratio (y-1) | -0.005** | -0.004** | -0.002** | 0.002 | 0.002 | 0.001** |
| | (-2.56) | (-2.53) | (-2.12) | (1.59) | (1.42) | (2.47) |
| Direct Premium Written (y-1) | -0.01 | -0.17*** | -0.01 | 0.38*** | 0.24*** | 0.09*** |
| | (-0.30) | (-3.92) | (-0.61) | (6.58) | (5.17) | (2.65) |
| Net Income (y-1) | -5.48*** | -4.17*** | -0.80* | -3.43*** | -2.54*** | -0.07 |
| | (-3.96) | (-3.68) | (-1.72) | (-4.47) | (-3.84) | (-0.24) |
| Current Liquidity (y-1) | 0.00*** | 0.00 | 0.00 | 0.00** | -0.00 | -0.00 |
| | (3.16) | (0.51) | (0.08) | (2.21) | (-1.57) | (-0.74) |
| Unrealized Capital Gain (y-1) | -2.69*** | -1.30* | -0.42 | -0.82** | -0.06 | 0.55*** |
| | (-2.75) | (-1.77) | (-1.49) | (-2.06) | (-0.10) | (3.18) |
| Asset Grth (y-1) | 0.24* | 0.51*** | 0.14** | -0.43* | 0.14 | 0.15 |
| | (1.73) | (3.29) | (2.36) | (-1.78) | (1.23) | (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 (y-4 to y) | | | |
|---|---|---|---|---|
| | P&C Insurers | | Life Insurers | |
| | (1) | (2) | (4) | (5) |
| Log(Assets) (y-5) | -0.5274*** | -0.1468*** | -0.4815*** | -0.1200 |
| | (-12.98) | (-2.58) | (-7.15) | (-0.85) |
| Leverage (y-5) | 0.3513*** | 0.0813*** | -3.9794*** | 0.4183 |
| | (3.30) | (2.67) | (-4.41) | (0.95) |
| RBC Ratio (y-5) | -0.0132*** | -0.0034*** | -0.0018** | -0.0005* |
| | (-4.94) | (-3.19) | (-2.44) | (-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 |

**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 (4) in Panel A of 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*** | 0.0117 | -1.1704 | 0.0019 | -0.0021 |
| | (24.91) | (1.23) | (-1.64) | (0.84) | (-1.54) |
| Weather Exposure (q-1)*Bond Coupon Rate | -0.0018 | 0.4468*** | 0.9749 | 0.0005 | 0.0003 |
| | (-0.17) | (32.16) | (0.45) | (0.24) | (0.24) |
| Weather Exposure (q-1)*Bond Months to Maturity (q) | -0.0000 | 0.0000 | 0.4695 | -0.0000* | -0.0000 |
| | (-0.84) | (0.31) | (0.54) | (-1.75) | (-0.22) |
| Weather Exposure (q-1)*Bond Illiquidity (q-1) | 0.0717 | 0.0545 | 1.6083 | 0.5761*** | -0.0097* |
| | (1.40) | (1.18) | (0.21) | (33.46) | (-1.88) |
| Weather Exposure (q-1)*Bond Downgraded Dummy (q-1) | -0.1370* | -0.0213 | 1.5895 | -0.0273** | 0.5790*** |
| | (-1.88) | (-0.37) | (0.33) | (-2.05) | (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 CUSIP-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 Columns (1)-(4), 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 bonds' 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: | Mrkt Value(i,j,q)*100/Cash & Invested Assets(i,q) | | | | |
|---|---|---|---|---|---|
| NAIC Category: | 1&2 | | | | |
| | Including Bond Duration | | Illiquidity = Imputed Round Trip Costs | Bond Yield as Risk Measure | Replace Firm-YrQrtr FE w/ Firm FE |
| | (1) | (2) | (3) | (4) | (5) |
| Log Assets (q-1)*Bond Worse-Rated (q-1) | 0.0042*** | 0.0034*** | 0.0044*** | | 0.0044*** |
| | (18.09) | (14.36) | (18.94) | | (25.33) |
| Log Assets (q-1)*Bond Yield (q-1) | | | | 0.0011*** | |
| | | | | (7.80) | |
| Log Assets (q-1)*Bond Duration (q-1) | -0.0004*** | -0.0005*** | -0.0004*** | -0.0005*** | |
| | (-5.51) | (-6.99) | (-5.62) | (-7.18) | |
| Log Assets (q-1)*Bond Coupon Rate | -0.0048*** | | -0.0048*** | -0.0043*** | -0.0038*** |
| | (-23.19) | | (-23.16) | (-20.87) | (-28.10) |
| Log Assets (q-1)*Bond Maturity (q) | 0.0372*** | | 0.0403*** | 0.0370*** | 0.0021 |
| | (2.70) | | (2.63) | (2.67) | (0.88) |
| Log Assets (q-1)*Bond Illiquidity (q-1) | 0.0050*** | 0.0064*** | 0.2674*** | 0.0079*** | 0.0036*** |
| | (4.72) | (6.03) | (2.66) | (7.59) | (5.28) |
| Log Assets (q-1)*Bond Downgraded Dummy (q-1) | 0.0020* | 0.0016 | 0.0010 | 0.0003 | 0.0015** |
| | (1.85) | (1.45) | (0.89) | (0.29) | (2.04) |
| Log Assets (q-1)*Bond NAIC 1 Dummy (q-1) | -0.0331*** | -0.0270*** | -0.0340*** | -0.0149*** | -0.0336*** |
| | (-27.61) | (-23.12) | (-29.17) | (-23.99) | (-40.41) |
| Insurer Rating (larger=worse) (q-1) | -0.0023*** | -0.0027*** | -0.0024*** | | -0.0013*** |
| *Bond Worse-Rated(q-1) | (-6.58) | (-7.76) | (-6.95) | | (-5.40) |
| Insurer Rating (larger=worse) (q-1) | | | | -0.0002 | |
| *Bond Yield (q-1) | | | | (-1.15) | |
| Insurer Rating (q-1)*Bond Duration (q-1) | 0.0004*** | 0.0004*** | 0.0004*** | 0.0004*** | |
| | (4.57) | (3.72) | (4.15) | (4.30) | |
| Insurer Rating (q-1)*Bond Coupon Rate | -0.0025*** | | -0.0024*** | -0.0030*** | -0.0006*** |
| | (-9.37) | | (-9.15) | (-10.71) | (-3.47) |
| Insurer Rating (q-1)*Bond Maturity (q) | 0.0218* | | 0.0240* | 0.0233** | 0.0021 |
| | (1.90) | | (1.94) | (2.00) | (0.28) |
| Insurer Rating (q-1)*Bond Illiquidity (q-1) | -0.0030** | -0.0020 | 0.0482 | -0.0051*** | -0.0043*** |
| | (-2.36) | (-1.61) | (0.40) | (-4.03) | (-4.52) |
| Insurer Rating (q-1)*Bond Downgraded Dummy (q-1) | -0.0001 | -0.0003 | 0.0002 | 0.0003 | -0.0001 |
| | (-0.05) | (-0.23) | (0.14) | (0.27) | (-0.10) |
| Insurer Rating (q-1)*Bond NAIC 1 Dummy (q-1) | 0.0093*** | 0.0123*** | 0.0099*** | -0.0001 | 0.0065*** |
| | (5.49) | (7.25) | (5.97) | (-0.12) | (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 | |
| Firm FE | | | | | 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**

| Dependent Variable: | Mrkt Value(i,j,q)*100/Cash & Invested Assets(i,q) | | | | |
|---|---|---|---|---|---|
| NAIC Category: | 1&2 | | | | |
| | Including Bond Duration | | Illiquidity = Imputed Round Trip Costs | Bond Yield as Risk Measure | Replace Firm-YrQrtr FE w/ Firm FE |
| | (1) | (2) | (3) | (4) | (5) |
| Loss (q-1)*Bond Worse-Rated(q-1) | -0.1455*** | -0.1534*** | -0.1447*** | | -0.1319*** |
| | (-6.06) | (-6.24) | (-6.10) | | (-3.13) |
| Loss (q-1)*Bond Yield (q-1) | | | | 0.0064 | |
| | | | | (0.50) | |
| Loss (q-1)*Bond Duration (q-1) | 0.0053 | 0.0029 | 0.0032 | 0.0018 | |
| | (0.84) | (0.46) | (0.50) | (0.27) | |
| Loss (q-1)*Bond Coupon Rate | -0.0457*** | | -0.0471*** | -0.0716*** | -0.0727*** |
| | (-2.63) | | (-2.69) | (-3.97) | (-2.64) |
| Loss (q-1)*Bond Maturity (q) | -0.7055 | | -0.9774* | -0.8629* | -0.3428 |
| | (-1.28) | | (-1.74) | (-1.68) | (-0.84) |
| Loss (q-1)*Bond Illiquidity (q-1) | 0.0305 | 0.0464 | 8.5013 | -0.1075 | -0.2323* |
| | (0.38) | (0.57) | (0.86) | (-1.36) | (-1.80) |
| Loss (q-1)*Bond Downgraded Dummy (q-1) | -0.1456 | -0.1486 | -0.1603 | -0.1506 | -0.0760 |
| | (-1.30) | (-1.33) | (-1.44) | (-1.35) | (-0.47) |
| Loss (q-1)*Bond NAIC 1 Dummy (q-1) | 0.6522*** | 0.7108*** | 0.6457*** | 0.0308 | 0.6538*** |
| | (5.52) | (5.89) | (5.59) | (0.58) | (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 |