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The role of financial conditions in portfolio choices: The case of insurers ☆

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ABSTRACT

Many institutional investors depend on the returns they generate to fund their operations and liabilities. How do these investors' financial conditions affect the management of their portfolios? We address this issue using the insurance industry because insurers are large investors for which detailed portfolio data are available, and can face financial shocks from exogenous weather events which help us establish causality. Among corporate bonds, for which we can control for regulatory treatment, results suggest that when Property & Casualty (P&C) insurers become more constrained due to operating losses, they shift towards safer bonds. The effect of losses on allocations is likely to be causal because it holds when instrumenting for losses with weather shocks. The change in allocations following losses is larger for smaller or worse-rated 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 conditions in institutional investors' portfolio decisions.

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 the investor's risk aversion. 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.

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Since these organizations do not necessarily have "preferences" like individual investors, how would one characterize the way they view the tradeoff between risk and return? What drives their portfolio choices? How should we characterize these institutional investors' portfolio optimization problem?

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 can materially inflence the price of risk in the economy, and their appetite for different securities can affect different firms' cost of capital differently. These investors differ from professionally managed portfolios such as mutual funds and hedge funds because they rely at least partially 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.

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 that 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] Agents managing these portfolios could also 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 2,926 U.S. insurers between 2001 and 2015. Insurers are important institutional investors, holding $6.5 trillion in 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, such as hurricanes, which can meaningfully worsen insurers' financial conditions by increasing their demand for cash and their probability of insolvency. These exogenous shocks presumably occur independently of insurers' financial investments, and help us identify the causal effects of insurers' financial conditions on their portfolios.

We first present some stylized facts about how 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 and government debt, but more mortgage-backed securities (MBS) and corporate bonds. This pattern is consistent with the idea that larger insurers have less exposure to risks from operations due to the diversification in their underwriting business. Lower exposure to operational risk means that larger insurers can take on more risk in their financial portfolios. Alternatively, larger insurers could be less financially constrained, leading them to hold riskier and less liquid financial portfolios.

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. (Section 2 discusses the regulatory treatment of insurers' financial security holdings in detail.) To evaluate whether insurers' financial conditions affect their choice between safer and riskier, as well as between more liquid and less liquid securities, we focus on insurers' holdings of corporate bonds, because we can control for regulatory treatments among corporate bonds.

As a more direct way of linking financial conditions with insurers' portfolios, we assume that insurers' operating losses represent negative shocks to their financial conditions and estimate the way that portfolios change following operating losses. To address the concern that insurers' operating losses and portfolio choices could both be related to their 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 is constructed to reflect insurers' exposure to unexpected weather shocks.

Our results suggest that following operating losses, P&C insurers reduce their holdings of riskier corporate bonds, holding constant the regulatory treatment of different bonds. This finding 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 safer and more liquid. The ef-

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

[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 et al. (1999). See Almeida et al. (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 et al. (1993).

fect of losses on the shift towards safer bonds in insurers' holdings lasts around seven quarters. In addition, we find that when firms are smaller or worse-rated and during the 2008 financial crisis, operating losses lead insurers to have larger increases in the allocation to safer bonds. Firms' financial conditions are likely to be affected more by unexpected losses if they are smaller or worse-rated, and during the 2008 financial crisis. Therefore, this result provides additional support for the view that when financial constraints are exacerbated, insurers shift their portfolios toward safer and more liquid securities.

Because insurers are regulated, the observed change in portfolios following losses could potentially occur because of regulatory pressure. In our estimates using insurers' corporate bond holdings, we essentially compare bonds with the same regulatory treatment in terms of risk-based capital charge. However, regulators, through other rules and actions, could effectively force insurers to shift towards safer portfolios following operating losses. Inconsistent with this idea, we find that insurers closer to the regulatory lower bound for the capital ratio do not tend to shift towards safer bonds more after losses than insurers further away from the lower bound. Given that insurers closer to the regulatory lower bound are more likely to receive regulators' scrutiny, this result suggests that insurers' shift towards safer bonds is unlikely merely driven by regulators' intervention.

We also find that even when insurers' capital ratios are below the regulatory lower bound, they still purchase bonds rated below A-. Thus, insurers unlikely face restrictions on their investment in bonds rated A- or better. Our results still hold when we restrict to bonds rated A- or better, where insurers are unlikely to face regulatory restrictions. We also conduct robustness tests restricting our analysis to insurers that purchase bonds rated worse than A-, and we study their investment in bonds rated A- or better in the same quarter. Regulators are unlikely to restrict insurers' choices among bonds rated A- or better when insurers are allowed to purchase bonds rated worse than A-. Our results on how losses affect insurers' corporate bond portfolios hold. Overall, the evidence suggests that insurers' shift toward safer bonds following losses occurs at least partially because of voluntary choices, and is not just a consequence of regulatory pressure.

In addition to our findings about the way in which financial conditions affect portfolio allocations, this paper has three other important implications. First, we provide insights on insurers' attitudes toward risk, and their desired portfolio if they were not financially constrained. We find evidence consistent with the idea that insurers in better financial conditions have larger portfolio weights on riskier and more illiquid securities. 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 seeking higher expected returns is the objective of these investors absent concerns about financial constraints, one cost of insurers' financial constraints is that insurers need to forgo 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.[4] 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 toward safer assets. If similar shifts in demand for securities occur when aggregate downturns worsen insurers' financial constraints, 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 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 et al. (1993), and Almeida et al. (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, because we find that insurers shift towards safer financial investments in response to a negative financial shock. However, insurers are regulated entities. Even though our results suggest that insurers' tendency to shift their portfolios toward safer securities following shocks is at least partially due to their voluntary choice, it is entirely possible that other firms and institutional investors behave differently.

This paper is closely related to the literature on intermediary asset pricing (e.g., He and Krishnamurthy (2012, 2013, and 2018)). In these models, when asset values decline, a reduction in the risk tolerance of the managers of the intermediary leads them to alter the intermediary's portfolio. 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 study also relates to papers on investors' heterogeneous demand for financial assets such as Koijen and Yogo (2019). We shed light on one of the factors that can affect institutional investors' demand for 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 de-

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

fined 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 large portfolios 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, because 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. Moreover, the tradeoffs between return and risk/liquidity across asset classes studied by Rauh (2009) and Duchin et al. (2017) are different from the tradeoffs within asset classes that we focus on.[5]

One other related paper is Becker and Ivashina (2015), which documents that insurers reduce their reaching-for-yield in their bond portfolios during the 2008 financial crisis. This finding is consistent with our result that insurers reduce the risk of their portfolios when they are more constrained. Other papers also study insurers' investment in financial assets, some of which focus on how regulation affects insurers' holdings, and some others focus on the effect of insurers' holdings (or transactions) on the underlying assets.[6] Our paper is distinct in studying the causal effect of insurers' financial conditions on the riskiness of bonds they hold using plausibly exogenous shocks to insurers' financial health.

2. Relevant regulation

Regulators monitor insurers' financial health using a number of 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, the required capital. Financial securities in insurers' portfolios can add to the 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 that a particular security can affect insurers' RBC ratio can be approximated with the following formula:

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

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 is 0 for treasury securities, 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

We obtain financial data for 2,084 P&C and 842 U.S. life insurers between 1996 and 2015 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 issued between 2004 and 2013. A.M. Best is the leading rating agency for insurance companies, and issues such reports three times a year. These reports offer insurers' most recent ratings, which can be issued before 2004. We transform insurers' A.M. Best ratings to integers starting from 1, 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 conditions 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

[5] Cortés and Strahan (2017) and Schüwer et al. (2019) study how banks respond to natural disaster shocks both in their operations and their asset holdings. Mohan and Zhang (2014) and Andonov et al. (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 are small for most firms. However, some papers do find evidence for risk-shifting incentives, for example, Hovakimian and Kane (2000), Eisdorfer (2008), Rampini et al. (2014), Landier et al. (2015), Acharya and Steffen (2015), and Drechsler et al. (2016).

[6] Ambrose et al. (2008), Ellul et al. (2011), and Merrill et al (2014) study insurers' sales of downgraded assets. Becker et al. (2021) 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. Kirti (2017) examines how insurers hit hard during the crisis adjust their portfolio holdings. Chen et al. (2020) study how insurers' operating risk affect their portfolio choices. Sen (2020) studies how regulation affects life insurers' hedging incentives. Chodorow-Reich et al. (2021) argue that life insurers can insulate the value of financial assets from exposure to market movement by holding the assets for the long run. Girardi et al., 2021 and Nanda et al. (2019) study the commonality in insurers' portfolio and its effect. Ellul et al. (2018) find that the investment of insurers selling variable annuities can create systemic risk. Murray and Nikolova (2019) argue that insurers' portfolio choices, driven by regulation, affect prices of corporate bonds. Huang et al. (2020) and Chaderina et al. (2018) study the effect of insurers' holdings (and selling) of illiquid (liquid) bonds on the bond pricing. Greenwood and Vissing-Jorgensen (2018) document how pension and insurance assets affect the yield curve. Massa and Zhang (2020) study the effect of insurers' selling of bonds following Katrina on bond issuers' financing choices. Chen et al. (2019) study how insurers' financial health affect municipal bond liquidity risk they hold.

Table 1
RBC risk charge for different securities. This table presents the regulatory risk capital charge used in the calculation of the RBC ratio, associated with different categories of securities, for P&C and life insurers, respectively. See Becker, Opp, and Saidi (2021) for MBS.

Security Type	Credit Ratings	NAIC Corporate Bonds Category	Regulatory Risk Capital 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%[a]	0.4%[b]
Bonds Issued by U.S. Government Agencies (not backed by the U.S. government)[c]		NAIC 1	0.3%	0.4%
Corporate Bonds[d] & 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%[e]
Real Estate		NA	10%	5% ~ 23%[f]
Mortgage Loans		NA	5%	3% ~ 20%
Schedule BA (Private Equity, Hedge Funds, etc.)		NA	20%	30%[g]

[a] NAIC (2015a), P10.
[b] NAIC (2015b), P41.
[c] Examples are FNMA and FHLMC collateralized mortgage obligations; see NAIC (2015a) P8.
[d] See Becker and Ivashina (2015) and Becker, Opp, and Saidi (2021).
[e] 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%."
[f] NAIC (2015b), P19.
[g] NAIC (2015b), P23.

lagged assets if net underwriting gain is negative, and 0 otherwise. *Loss* is either positive, indicating poor underwriting performance, or 0. The net underwriting gain, and thus also *Loss*, is net of reinsurance payments. Our data on P&C insurers' losses end in 2016Q1.

We also construct an instrumental variable for the reported P&C insurers' underwriting losses, following Ge (2021). Data on damages due to weather events are from Spatial Hazard Events and Losses Database for the United States (SHELDUS). These 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, and so on.

To construct the instrument, we first sum the dollar value of weather damages to properties from SHELDUS at the state (s) by quarter (q) level, then compute rolling historical averages (going back to 1960) of state s, adjusting for inflation. Because 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 historical averages from the state-quarter-level weather damages, to obtain what we call *Unusual Weather Damages*. By subtracting historical averages, *Unusual Weather Damages* should reflect the surprise weather damages that happen to a state in a quarter.

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 preceding four 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, $\sum_s (Unusual\ Weather\ Damages_{s,q} * Lag\ Mkt\ Share_{i,s,q})$, and scale by lagged assets, to obtain the instrumental variable. See Ge (2021) for descriptive graphs and summary statistics on *Unusual Weather Damages* and the market shares across the states.

If we make the following assumptions, then the instrument can 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.[7]

[7] Denote the factors that affect insurers' portfolio decisions that are orthogonal to controls (included in the empirical analysis) X. To satisfy the

Table 2
Summary statistics. This table presents summary statistics. Panel A offers statistics on insurers' financial variables and their holdings in major categories. Panel B offers statistics on corporate bonds in P&C insurers' holdings at the CUSIP-insurer-quarter level. In Panel C, we sort insurers into tertiles based on lagged assets or insurer ratings, 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 averages of the most two extreme subsamples are displayed in bold.

Panel A: Insurers' Financials and Holdings in Major Categories

Variable	N	Mean	Std	25 Pctl	Median	75 Pctl
P&C Insurers						
Financial Variables						
Asset ($Billion)	28,866	0.44	1.31	0.02	0.06	0.24
Leverage (%)	28,866	72.29	71.61	45.17	61.64	72.87
RBC Ratio	27,069	14.88	25.56	4.80	7.78	13.46
Rating (Larger=Worse)	15,972	3.99	2.48	3 (A)	3 (A)	4 (A-)
Underwriting Loss (% of Lagged Assets), >=0	23,096	2.35	4.64	0.00	0.00	2.69
Underwriting Gain (% of Lagged Assets), >=0	23,096	2.50	4.34	0.00	0.27	3.26
Weather Exposure (% of Lagged Assets)	19,219	0.80	5.94	-0.48	-0.05	0.30
Holdings in % of Cash and Invested Assets						
Cash	28,866	19.91	25.24	3.82	9.63	24.63
Treasury	28,866	10.61	16.17	0.35	4.06	13.38
U.S. Gov Agency	28,866	6.04	11.77	0.00	0.44	6.46
Muni Bond	28,866	20.75	23.84	0.00	11.61	34.95
MBS	28,866	10.13	13.15	0.00	4.02	16.94
Corp Bond	28,866	18.02	17.58	0.00	14.75	29.52
Public Stock	28,866	5.43	10.62	0.00	0.00	6.43
All Other	28,866	8.97	13.36	0.00	3.22	12.38
Life Insurers						
Financial Variables						
Asset ($Billion)	13,110	4.68	16.19	0.02	0.12	1.29
Leverage (%)	13,110	65.69	30.59	45.10	78.63	91.10
RBC Ratio	12,711	66.77	246.81	6.37	9.82	20.58
Rating (Larger=Worse)	6,663	4.24	2.75	2 (A+)	4 (A-)	5 (B++)
Holdings in % of Cash and Invested Assets						
Cash	13,110	15.52	23.75	1.96	5.44	16.98
Treasury	13,110	9.21	17.45	0.15	1.82	8.92
U.S. Gov Agency	13,110	5.77	12.50	0.00	0.56	4.62
Muni Bond	13,110	5.70	11.38	0.00	0.62	5.46
MBS	13,110	13.12	14.22	0.01	9.63	21.00
Corp Bond	13,110	33.88	25.81	6.07	35.94	55.08
Public Stock	13,110	1.88	5.38	0.00	0.00	0.44
All Other	13,110	14.26	18.22	0.81	8.03	20.70

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

Variable	N	Mean	Std	25 Pctl	Median	75 Pctl
Mrkt Value*100/Cash & Invested Assets	1,602,118	0.31	0.44	0.05	0.16	0.39
Mrkt Value*100/Mrkt Value of All Corp Bonds Held	1,602,118	1.47	2.43	0.24	0.69	1.64
Bond Rating	1,602,118	7.18	2.89	5.50	7.00	9.00
Years to Maturity	1,602,118	5.73	5.11	2.58	4.58	7.58
Coupon Rate	1,602,118	5.20	1.78	4.25	5.35	6.25
Downgraded Dummy	1,602,118	0.08	0.26	0.00	0.00	0.00
0-Trading Day (%)	1,602,118	28.49	29.20	1.64	17.46	50.82
Imputed Round-Trip Transct Cost*1000	1,602,118	5.49	3.72	2.86	4.52	7.05
Dummy for NAIC Category = 1	1,602,118	0.54	0.50	0.00	1.00	1.00
Dummy for NAIC Category = 2	1,602,118	0.36	0.48	0.00	0.00	1.00
Dummy for NAIC Category = 3	1,602,118	0.05	0.23	0.00	0.00	0.00
Dummy for NAIC Category = 4	1,602,118	0.04	0.20	0.00	0.00	0.00
Dummy for NAIC Category = 5	1,602,118	0.01	0.09	0.00	0.00	0.00
Dummy for NAIC Category = 6	1,602,118	0.00	0.04	0.00	0.00	0.00
Offering Spread over Treasury	705,925	169.94	117.05	88.30	137.60	214.91

(*continued on next page*)

Table 2
(*continued*)

Panel C: Insurers' Financials and Holdings in Categories across Subsamples of Insurers													
		Financial Variables (y-1)				Holdings in % of Cash and Invested Assets (y)							
	N (Firm-Year)	Assets ($Billion)	Leverage (%)	RBC Ratio	Rating Larger=Worse	Cash	Treasury	Gov Agency	Muni Bond	MBS	Corp Bond	Public Stock	Other
P&C Insurers													
Sort by P&C Insurers' Assets (y-1)													
Largest	9,806	**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	9,526	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	9,534	**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	8,352	**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	3,905	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	3,715	**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	4,450	**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	4,325	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	4,335	**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	3,069	**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	1,838	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	1,756	**0.63**	**66**	**30.17**	**7.52**	**15.32**	**9.89**	**7.69**	**7.51**	**13.64**	**32.12**	**1.8**	**11.64**

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Our data on insurers' holdings in financial securities are from insurers' reports to NAIC, which can be downloaded from SNL and provides annual data on insurers' financial assets in broad categories. 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 sample. 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 was \$1.85 trillion, totaling \$2.12 trillion, or 26% of all corporate bonds outstanding in the U.S.

3.2. Insurers' corporate bond holdings at the security level

We obtain P&C insurers' CUSIP-level bond holding data between 2008 and 2015, which are based on insurers' annual statutory 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.[8] We use quarterly trading data to back out quarter-end holding information. The data offer information on the bond, for example, coupon rate, maturity, and NAIC designation for the risk charge of 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 those reported on 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 Trade Reporting and Compliance Engine (TRACE) to calculate bond liquidity measures following Dick-Nielsen et al. (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.[9]

A P&C insurer holds an average of 74 corporate 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 and 83,966 unique CUSIPs in total, among all the corporate bonds in P&C insurers' filings. Panel B of Table 2 offers summary statistics of CUSIP-level corporate bond holdings by P&C insurers.

4. Insurers' size, ratings, and investments in broad categories

In Panel C of Table 2, we sort insurers into three subsamples based on their asset size or A.M. Best financial strength ratings, respectively. We tabulate the averages of insurers' financial variables and portfolio weights of different asset 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 averages of the two extreme subsamples 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, but still receive lower ratings from agencies. Size appears to play an important role, beyond leverage and RBC ratios, in characterizing a firm's financial flexibility by the rating agency. Presumably, an insurer has more difficulty growing larger in assets than lowering its leverage or increasing its RBC ratio. To lower its leverage, an insurer can simply limit sales of policies 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)[10] 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 smaller or worse-rated insurers prefer safer, more liquid portfolios than larger or better-rated insurers. In addition, because cash and government securities also have lower risk charges than MBS and corporate bonds, smaller or worse-rated 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.

How do we interpret the result that as insurers become larger, they tend to have larger allocations to risky and

exclusion restriction, the correlation between P&C Unusual Weather Exposure and X needs to be zero. $Cov(P\&C\ Weather\ Exposure_{i,s,q},\ X) = \sum_s E(Unusual\ Weather\ Damage_{s,q} \cdot Lag\ Mkt\ Share_{i,s,q} \cdot X) - E(X)[\sum_s E(Unusual\ Weather\ Damage_{s,q} \cdot Lag\ Mkt\ Share_{i,s,q})] = \sum_s [E(UnusualWeatherDamage_{s,q} \cdot LagMktShare_{i,s,q}) \cdot E(X)] - E(X) \cdot \sum_s [E(UnusualWeatherDamage_{s,q}) \cdot E(LagMktShare_{i,s,q})] = 0$ Assumptions 1 and 2 can generate the second-to-last equality. Assumption 3 can lead to the last equality.

[8] Although annual holding data of corporate bonds at the CUSIP-level are available through SNL beginning in 2004, quarterly trading data are not available until 2008 through SNL. Although we collect the acquisition and disposal data until 2016Q2, due to the availability of control variables, data in 2016 are only used in Table 7.

[9] We calculate the market value because of the concern that insurers endogenously choose their own calculation of the market value (Sen and Sharma 2020).

[10] "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).

illiquid assets? One possibility is that larger insurers are more diversified in their operations and are exposed to less risk through their operations. Alternatively, larger insurers could be less financially constrained and less concerned about an increase in liquidity needs or the likelihood of insolvency. Panel A of Table A.3 indicates that larger insurers do have lower operating income volatility. This result is consistent with the notion that larger insurers are exposed to less operating risk.

Panel B documents that asset size explains a substantial portion of the variation in ratings (based on the R-squared), and suggests that larger insurers have better financial-strength ratings. The rating agency could potentially assign better ratings to larger insurers because of their smaller operating risk. Having a better rating could also mean better financial health and fewer financial frictions. A number of papers in the corporate finance and banking literature argue that size is highly correlated with firms' financial constraints.[11] Because larger insurers enjoy better ratings, demand for their products or profitability is higher.[12] Therefore, larger insurers can enjoy more market power, which enables them to obtain more policy premiums and retained earnings, which reduces financing frictions. The results in Table A.3 are consistent with both interpretations of insurers' size: it can reflect that size is negatively related to risk exposure, and also that a larger size can be associated with lower financial constraints.

Presumably, the reason that 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 in Table A.4 in the Appendix. The estimate in column (1) implies that for life insurers, 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%). The estimate in column (2) implies that for P&C insurers, a one standard deviation increase in *Log Assets* leads to an 8-basis-point increase in realized quarterly returns, which is 10% of the median quarterly return (0.8%).

Larger insurers' higher realized returns could reflect returns on the risk and illiquidity that larger insurers' portfolios are exposed to, or due to chance/luck during our short sample period. It could also be the case that larger insurers have more skills in their investment. To understand the cause of larger insurers' higher realized returns, we examine P&C insurers' corporate bond portfolios, for which there are widely accepted measures for risk and illiquidity. In columns (3) and (4), we present estimates of equations in which the dependent variable is the value-weighted average corporate bond realized returns. Column (3) suggests that larger insurers indeed earn higher realized returns on their corporate bond portfolios. A one-standard-deviation increase in insurers' size corresponds to an increase of 0.4 percentage point in insurers' realized returns. In column (4), we include value-weighted averages of corporate bond ratings and two illiquidity measures. The coefficient on insurers' size becomes 20% smaller than that in column (3), but remains statistically significant. This result suggests that during our sample period, larger insurers' higher realized returns on their corporate bond portfolio cannot be fully explained by the risk and illiquidity captured in our measures.

If larger insurers' higher realized returns in their corporate bond portfolios can be explained by other risks they take in their corporate bond investments, then the yields on their corporate bond portfolio should also be higher after controlling for the risk and illiquidity in their portfolios. In columns (5) and (6), we replace the dependent variable with the value-weighted average annual yield of each insurer's corporate bond portfolio at the end of each quarter. Column (5) suggests that larger insurers' corporate bond investments have higher yields: a one-standard-deviation increase in insurers' assets corresponds to a 0.17-percentage-point increase in the expected annual yields of their corporate bond portfolio, which is 5% of the median (3.3%).

In column (6), we add value-weighted averages of the bond ratings and illiquidity. The estimated coefficient on insurers' asset size becomes statistically insignificant, while bond ratings and illiquidity measures all have positive and statistically significant estimated coefficients. The result in column (6) suggests that most of the additional priced risks larger insurers take in their corporate bond portfolios, compared to smaller insurers, are credit and illiquidity risks. Column (6) suggests that larger insurers are unlikely to have earned higher realized returns, as shown in column (4), by taking on priced risks beyond credit and illiquidity risk. Larger insurers could have earned higher realized returns either due to chance or luck during our short sample period, or due to their "skills." One of the "skills" could be getting better prices in their trades as argued by O'Hara et al. (2018). Another "skill" could be larger insurers' better ability to predict bond default.

5. The impact of insurers' operating losses on their investments in corporate bonds

5.1. Insurers' operating losses and investments in corporate bonds

The summary statistics in Panel C of Table 2 suggest that larger insurers invest larger fractions of their portfolios in cash and government securities than smaller 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? These portfolio choices could occur because of risk and liquidity management incentives related to insurers' size. However, these choices could also occur because of regulation, because different asset classes have

[11] See, for example, Almeida et al. (2004), Hadlock and Pierce (2010), Campello et al. (2010), and Kashyap and Stein (2000).

[12] For discussion and evidence on this point, see Epermanis and Harrington (2006) for P&C insurance and Koijen and Yogo (2015) for life insurance.

different regulatory treatments in terms of risk charges (see Table 1). Distinguishing between these explanations is complicated by the fact that asset classes differ systematically in their risk, liquidity, and regulatory treatment. However, since securities in an asset class or a given subgroup within it are treated the same by regulators, the importance of investors' financial conditions can be evaluated by examining choices *within* a given asset class. We next 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.

As we discussed earlier, there are at least two explanations for the pattern that larger insurers invest in riskier assets. One possible explanation is that larger insurers have smaller exposure to risks from their underwriting activities due to their more diversified operations. Alternatively, larger insurers could have more financial flexibility and are therefore less concerned about the riskiness and illiquidity of securities when constructing their portfolios.

To evaluate whether insurers' financial conditions affect their portfolio choices, we use insurers' operating losses as shocks to their financial strength. Such shocks are especially important in the P&C business, in which 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.

For the reasons above, we next estimate the extent to which P&C insurers' operating losses can cause insurers to change their corporate bond holdings, using data on the individual bonds held by each insurer in this specification:

$$\begin{aligned} Holding\ of\ Bond_{i,j,q} &= \alpha * Loss_{i,q-1} * Bond\ Characteristics_{j,q-1} \\ &+ \beta * Financial_{i,q-2} * Bond\ Characteristics_{j,q-1} + FE_{i,q} \\ &+ FE_{j,q} + e_{i,j,q}, \end{aligned} \tag{1}$$

where *Holding of Bond* is the market value of any particular bond *j* that the insurer *i* holds in quarter *q* scaled by the insurers' cash and invested assets or scaled by the market value of all the corporate bonds held by the insurer. *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 Worse-Rated*, illiquidity, coupon rate, maturity, an indicator for bonds downgraded in *q-1*, and an indicator for bonds in the NAIC 1 category. 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-, so that bonds in NAIC 1 and 2 categories have some common support for this variable. To measure bond illiquidity, we use the number of days without trading as a fraction of the total number of trading days in the main specification and use the imputed round-trip costs in a robustness test.

Insurers' *Financial* includes *Log Assets, Insurer Rating*, and *Leverage*, all from *q-2*, as well as *RBC Ratio* from the prior year as it is only available annually. To address the possibility 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. We control for bond CUSIP-year-quarter fixed effects, so we are essentially comparing an insurer's holding of a bond with other insurers' holding of the same bond in the same quarter. We also include insurance firm-year-quarter fixed effects to control for the average pattern in an insurer's bond holding in a certain quarter.

Table 3 presents estimates of Eq. (1). Columns (1)-(4) are estimated using only bonds in the NAIC 1 category. Such bonds make up 57% of the corporate bonds held by P&C insurers (equally weighting the bonds). 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.5 presents the first-stage results corresponding to column (4). Columns (5)-(8) repeat the specifications presented in columns (1)-(4) but include all the bonds in NAIC 1 and 2 categories. These two categories make up 90% of P&C insurers' corporate bond holdings.

In each column of Table 3, the coefficient on the interaction term between *Loss* and *Bond Worse-Rated* is negative and statistically significantly different from 0, suggesting that following operating losses, P&C insurers reduce their holdings of riskier corporate bonds. The corresponding coefficient in the instrumental variable specifications presented in the even-numbered columns is statistically significant and of similar magnitude as the corresponding coefficient in the OLS specification. This finding suggests that the relationship between an insurer's losses and changes to its portfolio is causal, and does not occur because of a spurious correlation between the two.

To illustrate the magnitude of the estimated effect, consider two hypothetical corporate bonds: one is rated A- and the other is rated AAA, the difference being six notches. The instrumental variable estimates in column (2) imply that following one standard deviation of losses (4.6% of lagged assets), insurers' holdings of the A- rated bond will decrease by 0.05 percentage points relative to the bond rated AAA, which is 39% of the median holding of the sample used in the regression (0.12%) and 14% of the standard deviation (0.33%).[13]

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

[13] The coefficient estimates in columns (3), (4), (7), and (8) are larger because the dependent variable is scaled by a smaller number (insurers' total corporate bond holdings), and hence has a larger value.

Table 3

P&C insurers' operating losses and their corporate bond holdings at CUSIP level. 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 columns (1), (2), (5), and (6), or as a percentage of the total market value of all the corporate bonds insurer *i* holds in quarter *q* in the other columns. We estimate the following specification: $Holding\ of\ Bond_{i,j,q} = \alpha * Loss_{i,q-1} * Bond\ Char_{j,q-1} + \beta * Financial_{i,q-2} * Bond\ Char_{j,q-1} + FE_{i,q} + FE_{j,q} + e_{i,j,q}$. *Bond Char* includes *Bond Worse-Rated*, coupon rate, maturity, illiquidity, an indicator for whether the bond was downgraded in *q-1*, and an indicator for bonds in the NAIC 1 category. *Financial* is a vector including insurers' log assets, insurers' ratings, leverage, and the RBC ratio, all of which are from quarter *q-2*, except the RBC ratio. The RBC ratio is only available annually, so we use the RBC ratio from the year prior. Odd columns present OLS results, and even columns present the second-stage results of the instrumental variable regressions. The first-stage results corresponding to column (4) are reported in Table A.5. In each column, we control for bond CUSIP-Year-Quarter and insurance Firm-Year-Quarter fixed effects. Sample starts in 2008 and ends in 2014Q2 (due to the availability of insurers' ratings). Standard errors are corrected for clustering at the bond CUSIP-year-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Table A.1 for variable definitions.

	Bond Holdings, NAIC Category = 1				Bond Holdings, 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 (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
Loss (q-1)*Bond Worse-Rated (q-1)	-0.1312***	-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)
Log Assets (q-2) *Bond Worse-Rated (q-1)	0.0034***	0.0034***	0.0128***	0.0124***	0.0035***	0.0034***	0.0121***	0.0118***
	(20.97)	(20.38)	(16.54)	(13.97)	(24.03)	(23.56)	(17.68)	(17.23)
Log Assets (q-2) *Bond Coupon Rate	-0.0031***	-0.0030***	-0.0109***	-0.0099***	-0.0026***	-0.0025***	-0.0093***	-0.0090***
	(-18.84)	(-17.04)	(-14.69)	(-7.65)	(-20.71)	(-19.78)	(-16.43)	(-15.45)
Log Assets (q-2) *Bond Maturity (q)	0.0045	-0.0265	0.0811***	-0.4542	0.0042***	0.0039***	0.0254***	0.0220**
	(1.39)	(-0.33)	(2.62)	(-0.32)	(3.03)	(2.77)	(2.89)	(2.19)
Log Assets (q-2) *Bond Illiquidity (q-1)	0.0047***	0.0048***	0.0070*	0.0082*	0.0041***	0.0041***	0.0095***	0.0094***
	(5.99)	(5.87)	(1.92)	(1.68)	(6.92)	(6.80)	(3.44)	(3.39)
Log Assets (q-2) *Bond Downgraded Dummy (q-1)	0.0038***	0.0037***	0.0193***	0.0190***	0.0024***	0.0024***	0.0133***	0.0139***
	(4.48)	(4.33)	(4.67)	(4.48)	(3.73)	(3.76)	(4.28)	(4.34)
Log Assets (q-2) *Bond NAIC 1 Dummy (q-1)					-0.0270***	-0.0267***	-0.0966***	-0.0947***
					(-38.53)	(-37.57)	(-29.16)	(-28.27)
Insurer Rating (larger=worse) (q-2)*Bond Worse-Rated (q-1)	-0.0015***	-0.0015***	-0.0086***	-0.0082***	-0.0011***	-0.0010***	-0.0068***	-0.0065***
	(-6.84)	(-6.20)	(-8.16)	(-6.99)	(-5.37)	(-4.83)	(-7.28)	(-6.36)

(*continued on next page*)

Table 3 (*continued*)

Dependent Variable:	Bond Holdings, NAIC Category = 1				Bond Holdings, NAIC Category = 1 & 2			
	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 (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
Insurer Rating (q-2)	-0.0006***	-0.0005**	-0.0020**	-0.0022	-0.0004**	-0.0003*	-0.0023***	-0.0027***
*Bond Coupon Rate	(-2.87)	(-2.04)	(-2.00)	(-1.46)	(-2.17)	(-1.81)	(-3.03)	(-3.28)
Insurer Rating (q-2)	-0.0010	-0.1409	-0.0287	-2.4553	0.0061	0.0043	0.0506	0.0270
*Bond Maturity (q)	(-0.14)	(-0.47)	(-0.44)	(-0.47)	(1.01)	(0.66)	(1.51)	(0.61)
Insurer Rating (q-2)	-0.0050***	-0.0054***	-0.0224***	-0.0219***	-0.0036***	-0.0039***	-0.0254***	-0.0263***
*Bond Illiquidity (q-1)	(-4.85)	(-4.73)	(-4.97)	(-3.16)	(-4.50)	(-4.56)	(-7.10)	(-6.85)
Insurer Rating (q-2)	0.0005	0.0009	0.0088*	0.0091	0.0003	0.0003	0.0076**	0.0069
*Bond Downgraded Dummy (q-1)	(0.47)	(0.72)	(1.85)	(1.54)	(0.42)	(0.37)	(2.07)	(1.59)
Insurer Rating (q-2)					0.0065***	0.0064***	0.0398***	0.0378***
*Bond NAIC 1 Dummy (q-1)					(6.50)	(5.89)	(8.72)	(7.58)
Leverage (q-2)	-0.0002***	-0.0002***	-0.0000	0.0000	-0.0001***	-0.0001***	0.0001	0.0001
*Bond Worse-Rated (q-1)	(-8.08)	(-7.83)	(-0.02)	(0.08)	(-6.76)	(-6.50)	(0.72)	(0.89)
Leverage (q-2)	0.0002***	0.0002***	0.0008***	0.0007***	0.0002***	0.0002***	0.0007***	0.0007***
*Bond Coupon Rate	(11.27)	(10.62)	(7.78)	(5.83)	(13.66)	(13.21)	(9.95)	(9.58)
Leverage (q-2)	-0.0030*	0.0131	-0.0217*	0.2569	-0.0009***	-0.0010***	-0.0059***	-0.0067***
*Bond Maturity (q)	(-1.73)	(0.38)	(-1.82)	(0.44)	(-4.48)	(-3.92)	(-3.79)	(-2.81)
Leverage (q-2)	0.0001	0.0001	0.0006	0.0001	0.0002**	0.0002**	0.0004	0.0005
*Bond Illiquidity (q-1)	(0.74)	(0.55)	(1.13)	(0.12)	(2.25)	(2.45)	(1.22)	(1.30)
Leverage (q-2)	-0.0000	-0.0000	-0.0011**	-0.0010*	0.0000	0.0000	-0.0006	-0.0006
*Bond Downgraded Dummy (q-1)	(-0.47)	(-0.36)	(-2.20)	(-1.77)	(0.35)	(0.32)	(-1.58)	(-1.61)
Leverage (q-2)					0.0007***	0.0007***	-0.0004	-0.0005
*Bond NAIC 1 Dummy (q-1)					(7.76)	(7.41)	(-0.90)	(-1.12)
RBC Ratio (y-1)	-0.0001***	-0.0001***	-0.0007***	-0.0007***	-0.0001***	-0.0001***	-0.0005***	-0.0005***
*Bond Worse-Rated (q-1)	(-7.39)	(-7.40)	(-6.29)	(-5.92)	(-6.20)	(-6.19)	(-5.64)	(-5.65)
RBC Ratio (y-1)	0.0001***	0.0001***	0.0006***	0.0007***	0.0001***	0.0001***	0.0006***	0.0006***
*Bond Coupon Rate	(6.39)	(5.32)	(6.08)	(2.74)	(7.56)	(7.48)	(7.38)	(7.39)
RBC Ratio (y-1)	-0.0067	-0.0300	-0.0413	-0.4460	0.0000	0.0000	-0.0002	-0.0002
*Bond Maturity (q)	(-1.50)	(-0.67)	(-1.37)	(-0.57)	(0.18)	(0.23)	(-0.58)	(-0.33)
RBC Ratio (y-1)	0.0003***	0.0003***	0.0015***	0.0017**	0.0002**	0.0002**	0.0008**	0.0008**
*Bond Illiquidity (q-1)	(2.93)	(2.93)	(3.14)	(2.28)	(2.41)	(2.45)	(2.28)	(2.27)
RBC Ratio (y-1)	-0.0000	-0.0000	-0.0000	-0.0000	-0.0001*	-0.0001*	-0.0006	-0.0006
*Bond Downgraded Dummy (q-1)	(-0.49)	(-0.49)	(-0.06)	(-0.09)	(-1.71)	(-1.68)	(-1.53)	(-1.49)
RBC Ratio (y-1)					0.0007***	0.0007***	0.0033***	0.0033***
*Bond NAIC 1 Dummy (q-1)					(9.13)	(9.11)	(7.06)	(7.08)
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	848,671	848,218	849,175	848,722	1,418,688	1,417,926	1,419,495	1,418,733
Cragg-Donald Wald F statistic		145.787		144.568		1290.103		1323.616

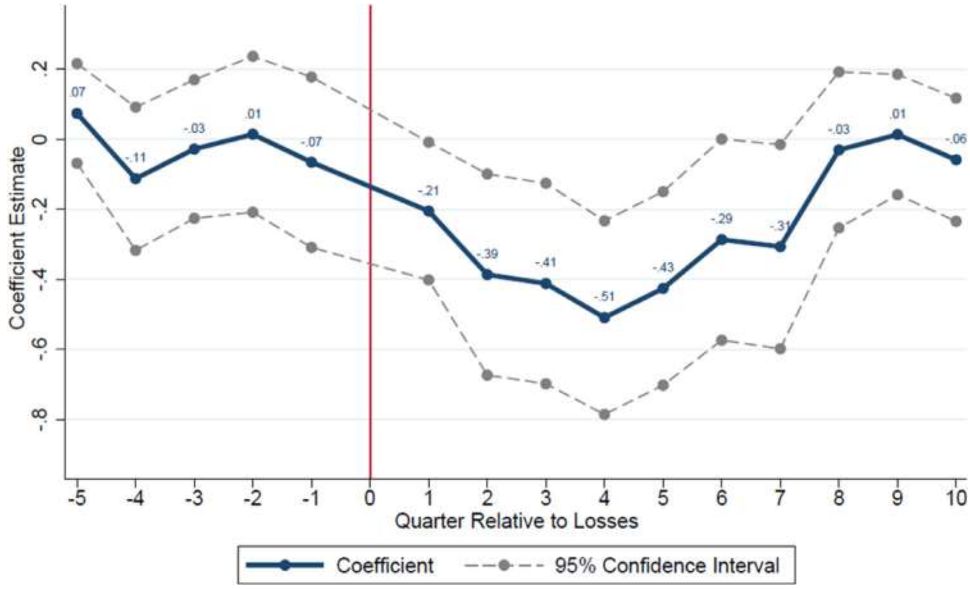

Fig. 1. Effect of losses on insurers' holdings of riskier vs. safer bonds, lead-lag plot. This figure plots the estimates of coefficients, α_n, and their corresponding 95% confidence interval from estimating the following specification: $Holding\ of\ Bond_{i,j,q} = \sum_{n=-5}^{10} \alpha_n * Loss_{i,q-n} * Bond\ Worse-Rated_{j,q-1} + \sum_{n=-5}^{10} \beta_n * Loss_{i,q-n} * Other\ Bond\ Char_{j,q-1} + \gamma * Financial_{i,q-11} * All\ Bond\ Char_{j,q-1} + FE_{i,q} + FE_{j,q} + e_{i,j,q}$, where n does not equal 0. When n is between 1 and 10, the losses precede insurers' holdings, and the estimated coefficient, α_n, reflects how losses in quarter q affect insurers' holdings of riskier versus safer bonds in $q+n$. These coefficients are plotted to the right of the vertical line in the figure. For example, the estimate of α_1 is the first point to the right of the vertical line, representing how insurers' losses in q affect holdings of riskier versus safer bonds in *q+1*. When n is between -5 and -1, the estimated coefficient, α_n, reflects how losses in quarter q are related to insurers' holdings of riskier versus safer bonds before q. These coefficients are plotted to the left of the vertical line in the figure. The dependent variable is P&C insurer *i*'s holdings of a specific corporate bond *j*, as a percentage of the total market value of all the corporate bonds insurer *i* holds. *Other Bond Char* is a vector of bond characteristics, including coupon rate, maturity, illiquidity, and whether the bond was downgraded in *q-1*. *All Bond Char* includes these variables and *Bond Worse-Rated*. We only use bonds in the NAIC 1 category. *Financial* is a vector of insurers' financial variables, including insurers' log assets, insurers' ratings, leverage, and RBC ratio, all of which are from quarter *q-11*, except the RBC ratio. The RBC ratio is only available annually, so we use the RBC ratio from four years prior to the holding quarter. The sample size is 953,743, and spans from 2008 to 2014. Standard errors are corrected for clustering at the bond CUSIP-year-quarter level. The solid line connects the estimates of α_n. The dashed lines plot the 95% confidence interval.

(6) implies 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 and 10% of the standard deviation. These results are consistent with the findings reported above: following losses, insurers shift their portfolios toward safer securities.

5.1.1. Duration of the effect

To see how long the effect of insurers' losses on their corporate bond portfolio lasts, we use a lead-lag plot. The plot can also illustrate whether there is a "pre-trend": whether insurers change their corporate bond portfolios prior to the losses. Fig. 1 plots the estimates of coefficients, α_n, and their corresponding 95% confidence interval from the regression below.

$$HoldingofBond_{i,j,q} = \sum_{n=-5}^{10} \alpha_n * Loss_{i,q-n} * BondWorse -Rated_{j,q-1} + \sum_{n=-5}^{10} \beta_n * Loss_{i,q-n} * OtherBondChar_{j,q-1} +\gamma * Financial_{i,q-11} * AllBondChar_{j,q-1} + FE_{i,q} + FE_{j,q} + e_{i,j,q}, \quad (2)$$

where n does not equal 0. When n is between 1 and 10, the $Loss_{q-n}$ precedes insurers' holdings in q, and the estimated coefficient, α_n, reflects how losses in quarter q affect insurers' holdings of riskier versus safer bonds in $q+n$. These coefficients are plotted to the right of the vertical line in Fig. 1. For example, the estimate of α_1 is the first point to the right of the vertical line, representing how insurers' losses in q affect holdings of riskier versus safer bonds in *q+1*. The magnitude of the effect of the losses in q on insurers' holdings increases from *q+1* to *q+4* before decreasing to statistically indistinguishable from 0 in *q+8*. Thus, the effect of insurers' losses on their corporate bond portfolios persists for around seven quarters.

When n is between -5 and -1, the estimated coefficient, α_n, reflects how losses in quarter q are related to insurers' holdings of riskier versus safer bonds before q. These coefficients are plotted to the left of the vertical line in Fig. 1. As the figure shows, none of these coefficients are statistically significantly different from 0, suggesting that insurers' losses are not related to their past holdings of riskier versus safer bonds. This result serves as additional reassurance that insurers' operating losses are plausibly shocks that induced a shift in insurers' portfolios.

5.1.2. Robustness

In Panel A of Table A.6 in the Appendix, we present several robustness checks with variants of the specification used in column (5) of Table 3. In column (1), we add *Bond Duration* in quarter *q-1* as one of the characteristics of bonds. In column (2), we omit *Bond Coupon Rate* and

Bond Maturity, and include *Bond Duration*. In column (3), we use *Imputed Round Trip Costs* as a proxy for bond illiquidity. The results described above hold in each of these specifications. 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 0. One potential explanation of this finding is that as insurers try to decrease the riskiness of their portfolios following operating losses, they use a bond's rating as their measure for bond riskiness, rather than calculating the yields by obtaining the latest trading prices.[14] In column (5), we repeat the original specification, replacing the insurance firm-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 Table 3. Table IA.1 in the Internet Appendix repeats Table 3, using bond characteristics from quarter *q-2* in Panel A, and those from quarter *q* in Panel B. The results highlighted here remain similar.

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 A.6, we repeat Table 3, replacing *Loss* with *Gain*, which equals net underwriting gain scaled by lagged assets if net underwriting gain is positive, and 0 otherwise. The results suggest that insurers indeed shift towards riskier bonds after experiencing operating gains.

5.1.3. Control variables

Turning back to Table 3, the coefficients on some of the control variables are worth noting. 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 again there are two bonds, one rated A- and the other is rated AAA. Column (1) suggests that a one standard deviation smaller asset size is associated with a 0.044-percentage-point decrease in the holding of the A-rated bond relative to the AAA rated bond, which is 37% 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. Column (1) implies that a one-standard-deviation worse insurer rating (2.5 notches) is associated with a 0.022-percentage-point decrease in the holding of the bond rated A- relative to the bond rated AAA, which is 18% of the median and 7% of the standard deviation. These results are consistent with the idea that smaller or worse-rated insurers prefer safer securities more than other insurers.

The interaction terms between *Log Assets* and *Bond NAIC 1 Dummy* have negative and statistically significant coefficients, suggesting insurers' smaller size is associated with holding more bonds in the safer NAIC 1 category than in the riskier NAIC 2 category. In column (5), the coefficients imply that a one-standard-deviation decrease in insurers' assets is associated with a 0.06-percentage-point increase in the holding of bonds in the NAIC 1 relative to the NAIC 2 category, which is 50% of the median and 18% of the standard deviation.

The interaction terms between *Insurer Rating* and *Bond NAIC 1 Dummy* have positive and statistically significant coefficients, suggesting that worse-rated insurers hold more of bonds in the safer NAIC 1 category than in the riskier NAIC 2 category. Column (5) implies that a one-standard-deviation worse insurer rating is associated with a 0.016-percentage-point increase in the holding of bonds in the NAIC 1 relative to the NAIC 2 category, which is 17% of the median and 6% 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 than 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 than other insurers.

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 better ratings have larger portfolio weights on more illiquid bonds. The economic magnitudes are small. However, when large and better-rated insurers hold a certain bond, they could hold a large portion of the bond outstanding and not trade the bond often, thus causing the bond to appear more illiquid.

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 can at least be 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.

The estimated coefficients on *RBC Ratio***Bond Worse-Rated* are all negative, suggesting that insurers with higher RBC ratios hold less of worse-rated bonds. Based on column (2), if an insurer's RBC ratio is higher by one standard deviation (25.6), its holdings of a bond rated A- is lower by 0.015 percentage points relative to a bond rated AAA, which is 13% of the median holding and 5% of the standard deviation. This effect is smaller than that of a one-standard-deviation increase in insurers' losses, which is 39% of the median holding and 14% of the standard deviation.

[14] Another potential reason is the correlation between bond yields and the *NAIC 1 Dummy*.

The positive coefficient estimates on *RBC Ratio*Bond NAIC 1 Dummy* suggest that insurers with higher RBC ratios hold more bonds with the NAIC 1 designation. Column (6) implies that, if an insurer's RBC ratio is higher by one standard deviation, insurers' holdings of bonds in the NAIC 1 category will increase by 0.018 percentage points relative to bonds in the NAIC 2 category, which is 15% of the median and 5% of the standard deviation. This effect is again smaller than that of a one standard deviation increase in insurers' losses, which is 29% of the median and 10% of the standard deviation. These two results related to insurers' RBC ratios could be due to insurers' desire to maintain a high RBC ratio being correlated with their desire to hold a safer portfolio. Another possibility is that insurers that prefer a higher RBC ratio achieve it by investing more in bonds with NAIC 1 designation.

5.2. Heterogeneity in the effect of losses on 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 insurers' portfolios should have a larger shift to safe bonds following losses if the effect of losses matters more for them. We hypothesize that the effect of losses should be more important for insurers that are smaller or have worse ratings. The reason is that these insurers are likely exposed to more risk in their future operation or are more financially constrained prior to the losses. A negative shock today can cause these insurers' financial conditions to worsen by more, relative to other insurers. 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. To test these hypotheses, we estimate the following specification in Panel A of Table 4:

$$
\begin{aligned}
&Holding\ of\ Bond_{i,j,q} = \gamma * Dummy * Loss_{i,q-1} * Bond\ Char_{j,q-1}\\
&+\alpha * Loss_{i,q-1} * Bond\ Char_{j,q-1} \ + \beta * Financial_{i,q-2} * Bond\ Char_{j,q-1}\\
&+\lambda * Dummy * Bond\ Char_{j,q-1} \ + FE_{i,q} + FE_{j,q} + e_{i,j,q}. \qquad (3)
\end{aligned}
$$

In columns (1) and (2), *Dummy* is *Insurer Small Dummy*, which equals 1 if the insurer is smaller than the median in quarter *q-2*. In columns (3) and (4), *Dummy* is *Insurer Worse-Rated Dummy*, which equals 1 if the insurer's rating is worse than the median in quarter *q-2*. In columns (5) and (6), *Dummy* is *Crisis Dummy*, which equals 1 for 2008 and 2009 and 0 otherwise. *Bond Char* is a vector of bond characteristics included in Table 3. *Financial* is a vector of insurers' financial variables included in Table 3.

The estimated coefficients on the triple interaction terms between *Dummy, Loss*, and *Bond Worse-Rated* are all negative and statistically significantly different from 0. This result suggests that during 2008-2009, insurers decreased their holdings of riskier bonds by more following losses if the insurers are smaller or worse-rated. To illustrate the magnitude of these estimates, again compare a bond rated A- and another rated AAA. The estimated coefficient in column (1) implies that, following one standard deviation of losses, smaller insurers' holdings of the bond rated A- will decrease by 0.03 percentage point (21% of the median holding) relative to the bond rated AAA, compared with the holdings of larger insurers.

Instead of using triple interactions in the regressions, we also estimate Eq. (1), repeating columns (1) and (5) of Table 3, using subsamples that are likely to be more versus less affected by losses. In the top half of Panel C of Table 4, we report the coefficients on the variable that we care most about, *Loss*Bond Worse-Rated*, estimated using different subsamples. The estimates are always negative in each of the subsamples, and more negative for smaller (worse-rated) insurers than larger (better-rated) insurers. The estimates are also more negative during the crisis than outside of the crisis. These results confirm those in Panel A and suggest that insurers' losses have a larger effect on insurers' financial portfolios if the insurers' financial conditions are more likely to be worsened by losses.

Overall, the results described in this section provide additional support for the view that when insurers structure their portfolios, they consider their financial conditions: insurers shift to a safer portfolio when they become more financially constrained. As such, the results here highlight the role of financial constraints in the portfolio choice of insurers.

5.3. Regulation, losses, and investments in corporate bonds

To what extent is the shift towards a safer portfolio after losses driven purely by regulation? If regulation drives our results, then insurers with low RBC ratios and that are therefore more likely to attract regulators' attention should see a larger effect of losses on their corporate bond holdings. We next examine whether insurers below or near the regulatory lower bound for RBC ratios are more likely to shift towards safer portfolios following losses.

In Panel B of Table 4, we estimate Eq. (3) replacing *Dummy* with *RBC-Related Measure* based on insurers' RBC ratio in the prior year: a dummy variable equal to 1 if insurers' RBC ratio in the prior year is below 2 (a lower bound that triggers regulatory intervention) in columns (1)-(2), below 5 in (3)-(4), and below the median in (5)-(6). In columns (7)-(8), this RBC-ratio-related measure equals the continuous RBC ratio from the prior year. A larger RBC ratio indicates that the insurer is further away from the 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.

In 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 do shift towards safer bonds following losses. In column (1), the coefficient on *RBC-Related Measure*Loss*Worse-Rated* is statistically significantly different from 0, suggesting that insurers whose RBC ratio is below the regulatory lower bound of two, respond more strongly to losses by shifting towards

Table 4

Heterogeneous effect of losses on insurers' corporate bond holdings. 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 insurer *i*'s cash and invested assets in quarter *q*. Panel A presents results estimating the following equation: $Holding\ of\ Bond_{i,j,q} = \gamma * Dummy * Loss_{i,q-1} * Bond\ Char_{j,q-1} + \alpha * Loss_{i,q-1} * Bond\ Char_{j,q-1} + \beta * Financial_{i,q-2} * Bond\ Char_{j,q-1} + \lambda * Dummy * Bond\ Char_{j,q-1} + FE_{i,q} + FE_{j,q} + e_{i,j,q}$. In columns (1) and (2), *Dummy* is *Insurer Small Dummy*, which equals 1 if the insurer is smaller than the median in quarter *q-2*. In columns (3) and (4), *Dummy* is *Insurer Worse Rated Dummy*, which equals 1 if the insurer's rating is worse than the median in quarter *q-2*. In columns (5) and (6), *Dummy* is *Crisis Dummy*, which equals 1 for 2008 and 2009, and 0 otherwise. *Bond Char* is a vector of bond characteristics included in Table 3. *Financial* is a vector of insurers' financial variables included in Table 3. In Panel B, we replace the *Dummy* variable in the equation above with *RBC-Related Measure*. This measure is a dummy variable that equals 1 if the RBC ratio at the end of year *y-1* is lower than 2 in (1)-(2), lower than 5 in (3)-(4), and lower than the median in year *y-1* in (5)-(6). *RBC-Related Measure* is the continuous variable RBC ratio at the end of *y-1* in (7)-(8). In both panels, *Bond Characteristics* include *Bond Worse-Rated*, coupon rate, maturity, illiquidity, whether the bond was downgraded in *q-1*, and a dummy variable indicating whether the bond is in the NAIC 1 category. *Financial* is a vector including insurers' log assets, insurers' ratings, leverage, and the RBC ratio, all of which are from quarter *q-2*, except the RBC ratio. The RBC ratio is only available annually, so we use the RBC ratio from the year prior. Controls include interaction terms between each of the insurers' financials (assets, rating, leverage, and RBC ratio) and bond characteristics, that is all the independent variables used for estimation for Table 3, except the interaction terms between insurer size and bond characteristics in columns (1)-(2) of Panel A, between insurer rating and bond characteristics in columns (3)-(4) of Panel A, and the insurer RBC ratio and bond characteristics in columns (1)–(6) 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 *Bond Characteristics*. Panel C repeats columns (1) and (5) of Table 3 using subsamples. The subsamples correspond to the dummy variables used in Panels A and B. We estimate Eq. (1). Controls include interaction terms between each of the insurers' financials (assets, rating, leverage, and RBC ratio) and bond characteristics, that is all the variables included in Table 3. Sample period is from 2008 to 2014Q2. Standard errors are corrected for clustering at the bond CUSIP-year-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Table A.1 for variable definitions.

Panel A: Insurer Size, Insurer Rating, the 2008 Financial Crisis, and the Effect of Losses on Corporate Bond Investments

Dependent Variable:	Bond Holdings: Mrkt Value (i,j,q) *100 / Cash & Invested Assets (i,q)					
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)
Dummy*Loss (q-1)*Bond Worse-Rated (q-1)	-0.0932***	-0.0790***	-0.0972***	-0.1216***	-0.0886**	-0.0906**
	(-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)
Dummy*Bond Worse-Rated (q-1)	-0.0100***	-0.0101***	-0.0037***	-0.0032***		
	(-18.41)	(-21.22)	(-6.51)	(-6.51)		
Dummy*Loss (q-1)*Bond NAIC 1 Dummy (q-1)		0.4855***		0.7386***		0.4178**
		(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)
Dummy*Bond NAIC 1 Dummy (q-1)		0.0781***		0.0192***		
		(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	848,671	1,418,688	848,671	1,418,688	848,671	1,418,688

(*continued on next page*)

Table 4
(*continued*)

Panel B: Insurer RBC ratio and the Effect of Losses on Corporate Bond Investments

Dependent Variable:	Bond Holdings: Mrkt Value (i,j,q) *100 / Cash & Invested Assets (i,q)							
RBC-Related Measure:	Dummy: RBC (y-1) < 2		Dummy: RBC (y-1) < 5		Dummy: 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)
RBC-Related Measure	-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)
RBC-Related Measure	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)
RBC-Related Measure		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)
RBC-Related Measure		-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	848,671	1,418,688	848,671	1,418,688	848,671	1,418,688	848,671	1,418,688

Panel C: Coefficient on *Loss*Bond Worse-Rated* of Eq. (1) in Subsamples

Dependent Variable:	Bond Holdings: Mrkt Value (i,j,q) *100 / Cash & Invested Assets (i,q)			
	NAIC Category = 1		NAIC Category = 1&2	
	Coefficient on *Loss (q-1)*Bond Worse-Rated (q-1)*			
	(1)	(2)	(3)	(4)
By Insurers' Size:	Large	Small	Large	Small
	-0.0466*	-0.1598***	-0.0377*	-0.1367***
	(-1.75)	(-6.92)	(-1.88)	(-6.75)
By Insurers' Rating:	Better-Rated	Worse-Rated	Better-Rated	Worse-Rated
	-0.0400	-0.1545***	-0.0062	-0.1386***
	(-1.60)	(-7.08)	(-0.31)	(-7.33)
By Time Period:	Non-Crisis	Crisis	Non-Crisis	Crisis
	-0.1145***	-0.1637***	-0.0982***	-0.1358***
	(-5.88)	(-3.99)	(-6.20)	(-3.70)
By RBC Ratio: (cutoff is 2)	RBC Ratio > 2	RBC Ratio < 2	RBC Ratio > 2	RBC Ratio < 2
	-0.2222***	1.6871	-0.1907***	2.1865
	(-7.89)	(0.54)	(-7.78)	(0.86)
By RBC Ratio: (cutoff is 5)	RBC Ratio > 5	RBC Ratio < 5	RBC Ratio > 5	RBC Ratio < 5
	-0.2021***	-0.3298***	-0.1841***	-0.2335***
	(-6.43)	(-4.99)	(-6.71)	(-4.06)
By RBC Ratio: (cutoff is median)	RBC Ratio > Median	RBC Ratio < Median	RBC Ratio > Median	RBC Ratio < Median
	-0.2255***	-0.2401***	-0.1899***	-0.2147***
	(-5.88)	(-5.72)	(-5.71)	(-5.80)

safer bonds. In column (3), where the RBC ratio cutoff is 5, the coefficient on this interaction term is statistically significant and negative, but of much smaller magnitude than the one in column (1). The other six coefficients on *RBC-Related Measure***Loss***Worse-Rated* are not statistically significantly different from 0, suggesting that insurers close to the regulatory lower bound and those further away from it do not respond differently to operating losses. These results suggest that insurers' increased portfolio weights on safer bonds following losses are unlikely to be only driven by regulation.

We also estimate Eq. (1), repeating columns (1) and (5) of Table 3, with subsamples of insurers based on their RBC ratio using the three cutoffs mentioned above. We report the estimates of the coefficients on *Loss***Bond Worse-Rated* using these subsamples in the bottom half of Panel C of Table 4. The estimates are always negative in each of the subsamples except for insurers with an RBC ratio lower than two. The coefficients on *Loss***Bond Worse-Rated* are more negative for insurers with lower RBC ratios than those with higher RBC ratios, when we use 5 or the median as the cutoff. However, the differences between these subsamples are much smaller than the differences between subsamples sorted on insurers' size or ratings. In Panel B, the estimates of the coefficient on *RBC-Related Measure***Loss***Bond Worse-Rated* are usually not statistically significant, suggesting that the subsamples sorted on insurers' RBC ratios do not see a statistically significantly different effect of losses in choosing between riskier and safer corporate bonds. Overall, the results indicate that insurers' shift towards safer securities is unlikely due to regulatory pressure, because insurers with lower RBC ratios are more likely to be scrutinized by regulators, but they do not behave consistently differently from other insurers.

We next consider whether other regulatory rules or interventions drive our results that insurers shift towards safer bonds following losses. If regulators demand that insurers shift portfolio towards safer securities, presumably such regulatory actions should take place when an insurer's RBC ratio falls below the regulatory lower bound, when insurers are explicitly under regulators' scrutiny. We find that when insurers' RBC ratios fall below 2 in year *t-1*, 42% of the time they still purchase corporate bonds in the NAIC 2 category in the quarters of year *t*. The dollar amount they spend buying bonds in NAIC 2 category is on average 53% of the amount they spend buying bonds in the NAIC 1 category. These observations suggest that regulators are unlikely to urge insurers to stay away from bonds in the NAIC 2 category. Therefore, our results when restricting to bonds in the NAIC 1 category are unlikely a result of regulators forcing insurers to shift towards a safer portfolio.

In addition, we restrict our analysis to insurer-quarter observations for which the insurer buys NAIC 2 category bonds and only examine their investment within the NAIC 1 category in the same quarter. If an insurer buys bonds in the NAIC 2 category, then regulators would most likely give them the freedom to invest in bonds in the safer NAIC 1 category. When regulators allow insurers to invest in NAIC 2 category securities, they are unlikely to also steer insurers to shift to safer securities within the NAIC 1 category. Thus, the investment within the NAIC 1 category is likely to be free of the influence from the regulators when insurers purchase NAIC 2 category bonds. In Table 5, we repeat columns (1)-(4) of Table 3 while restricting to insurer-quarter observations in which insurers also purchased NAIC 2 category bonds in the same quarter.[15] The results remain similar to those in Table 3. Therefore, it is unlikely that insurers' shift toward safer bonds is only a result of regulators' pressure.

5.4. Extremely large losses and insurers' investments in corporate bonds

We have documented that as insurers' financial conditions worsen, their 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, such behavior would occur when they suffer large losses and are close to insolvency. We next evaluate whether the tendency toward safer securities when conditions worsen applies in the case of extremely large losses.

Table 6 estimates a spline specification by splitting the *Loss* variable into two variables. One is *Loss<=Cutoff*, which equals the losses if they are not larger than the cutoff, and equals the cutoff if losses are above the cutoff. The other variable is *Loss>Cutoff*, which equals losses minus the cutoff if losses are above the cutoff, and 0 otherwise. The cutoff is the median, the 75th percentile, or the 95th percentile of the positive losses of each quarter in different columns. For an insurer whose losses are below the cutoff, *Loss<=Cutoff* will equal the losses, and *Loss>Cutoff* will equal 0. For an insurer whose losses are above the cutoff, *Loss<=Cutoff* will equal the cutoff, and *Loss>Cutoff* will equal its losses minus the cutoff.

The negative and statistically significant coefficients on *Loss<=Cutoff***Bond Worse-Rated* suggest that the results in Table 3 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. The estimated coefficients on *Loss>Cutoff***Bond Worse-Rated* are smaller in absolute value than those on *Loss<=Cutoff***Bond Worse-Rated*, implying that an extra unit of *Loss* has a larger effect on insurers' shifting towards safer bonds when losses are small than when losses are large. This result could be due to the marginal cost of adjusting to a safer portfolio becoming higher when a lot of adjustment has already occured. The total effect of losses on insurers' portfolio shift is still larger when losses are larger, because most of the estimated coefficients on *Loss>Cutoff***Bond Worse-Rated* are negative: the losses beyond the cutoffs continue

[15] Why would insurers buy bonds in the NAIC 2 category while shifting towards safer bonds in the NAIC 1 category? There are many considerations in insurers' choices of securities to hold, including industry diversification, maturities, etc. Their desire to shift towards safer bonds changes the tradeoff between the riskiness and other aspects of the bonds, but do not completely preclude them from investing in bonds that are not the safest.

Table 5
Losses and NAIC 1 corporate bond holdings, conditional on purchasing NAIC 2 category bonds. This table repeats columns (1)-(4) of Table 3 conditional on the insurer purchasing any bond in the NAIC 2 category in quarter *q*. Controls include interaction terms between each of the insurers' financials (assets, rating, leverage, and RBC ratio) and bond characteristics, that is all the variables included in Table 3. Sample period is from 2008 to 2014Q2. Standard errors are corrected for clustering at the bond CUSIP-year-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Table A.1 for variable definitions.

	Bond Holdings, NAIC 1, Conditional on Purchasing NAIC 2 Bonds			
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)	
	OLS (1)	IV (2)	OLS (3)	IV (4)
Loss (q-1)*Bond Worse-Rated (q-1)	-0.1120***	-0.2096**	-0.3484***	-0.7418*
	(-4.81)	(-2.11)	(-3.96)	(-1.69)
Loss (q-1)*Bond Coupon Rate	0.0304*	-0.1718*	0.1411**	0.0533
	(1.81)	(-1.76)	(2.18)	(0.15)
Loss (q-1)*Bond Maturity (q)	-0.3144	29.6083	0.7201	439.7739
	(-0.35)	(0.55)	(0.19)	(0.58)
Loss (q-1)*Bond Illiquidity (q-1)	-0.0506	1.2298**	0.0255	3.8370**
	(-0.64)	(2.13)	(0.09)	(2.04)
Loss (q-1)*Bond Downgraded Dummy (q-1)	-0.1038	-0.7330	-0.4174	-1.1345
	(-1.16)	(-1.05)	(-1.22)	(-0.38)
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	505,578	505,372	505,578	505,372

Table 6
Losses and corporate bond holdings, spline specification. This table presents estimates of a spline specification of regressions in columns (1) and (5) of Table 3, 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 0 otherwise. The cutoff is the median, the 75th percentile, or the 95th percentile of the positive losses of each quarter. Controls include interaction terms between each of the insurers' financials (assets, rating, leverage, and RBC ratio) and bond characteristics, that is all the variables included in Table 3. Sample period is from 2008 to 2014Q2. Standard errors are corrected for clustering at the bond CUSIP-year-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Table A.1 for variable definitions.

Dependent Variable:	Bond Holdings: Mrkt Value (i,j,q) *100 / Cash & Invested Assets (i,q)					
NAIC Category	1			1 & 2		
Loss (q-1) Cutoff:	Median (1)	75 Pctl (2)	95 Pctl (3)	Median (4)	75 Pctl (5)	95 Pctl (6)
Loss (q-1)>Cutoff*Bond Worse-Rated (q-1)	-0.1873***	-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	848,671	848,671	848,671	1,418,688	1,418,688	1,418,688

to shift insurers' portfolios towards safer bonds in addition to the effect of the losses below the cutoffs.

5.5. Do insurers' losses affect which bonds they sell and which bonds they buy?

Table 7 examines the way in which insurers adjust their portfolios following losses in more detail, by considering the purchases and sales of bonds separately. In columns (1) and (2), we report estimates of Eq. (1) 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. We include all the corporate bonds that any P&C insurer bought in that quarter, and, thus, assume an insurer could conceivably buy any of these bonds. The dependent variable is 0 if insurer *i* does not purchase any of bond *j* in quarter *q*. The coefficients on the interaction term between *Loss* and *Bond Worse-Rated* are negative and statistically significantly different from 0, suggesting that following operating losses, insurers' preference for buying safer bonds relative to riskier bonds become stronger. Column (1) suggests that when losses in-

Table 7

Losses and corporate bond purchases & disposals. In Panel A, columns (1) and (2), the dependent variable is insurer *i's* actual costs for buying bond *j* in quarter *q*, divided by insurer *i's* cash and invested assets, then multiplied by 100,000. The dependent variable is 0 for insurers that do not buy the bond. We include all the corporate bonds that an insurer can theoretically buy—any corporate bond any P&C insurer bought in quarter *q*. We exclude insurer-quarter observations, for which the insurer does not acquire a single bond (including government bond and other fixed-income securities). These observations are likely due to institutional frictions that prevent insurers from buying any bonds in a certain quarter (e.g., the insurer may decide to wait until the end of the year to buy bonds after they see the entire year's financial performance). In columns (3) and (4) of Panel A, the dependent variable is the par value of bond *j* insurer *i* sold in quarter *q*, as a percentage of the par value of bond *j* insurer *i* held at the end of quarter *q-2*. Controls include interaction terms between each of the insurers' financials (assets, rating, leverage, and RBC ratio) and bond characteristics, that is all the variables included in Table 3. Sample period is from 2008 to 2014Q2. Standard errors are corrected for clustering at the bond CUSIP-year-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Table A.1 for variable definitions. In Panels B and C, we present summary statistics on the buying and selling of corporate bonds by insurers that experience losses in the prior quarter and those that do not. In Panel B, for each bond that is acquired by any P&C insurer in quarter *q*, we calculate the average purchase (actual costs divided by insurers' cash and invested assets then multiplied by 100,000, and 0 for insurers that do not buy the bond) for two subsamples: insurers that suffer losses in *q-1* and insurers that did not. Then, we group bonds into different groups and calculate the mean (median) of the bond-quarter-level average purchases for insurers with and without losses. A bond is put in the following groups in quarter *q* based on its NAIC designation and rating in quarter *q-1*. Bonds in the NAIC 1 category are sorted into safer (included in column (1)) and riskier (included in column (2)) groups based on their ratings with the median as the cutoff. Similarly, bonds in the NAIC 2 category are sorted by rating into safer (included in column (3)) and riskier (included in column (4)) groups. Bonds in the NAIC 3-6 categories are included in column (5). Therefore, from column (1) to (5), bonds become riskier. We also sort bonds based on their illiquidity, measured by the percentage of 0 trading days in quarter *q-1*, using the median as the cutoff. More liquid bonds are included in column (6). More illiquid bonds are included in column (7). In Panel B, row a (b) tabulates the mean of the bond-quarter average purchases among insurers with (without) losses in *q-1*. Row c tabulates the difference between rows a and b. Row d tabulates row c as a percentage of row b. Rows e-h repeat rows a-d, replacing the mean with the median of the bond-quarter average purchase. Row i tabulates the correlation of bond-quarter average purchase among insurers with losses and the average among those without losses in *q-1*. In Panel C, we conduct a similar exercise with insurers' disposal of bonds. For each bond held by any insurer in quarter *q*, we calculate the insurer-bond-quarter-level (*i,j,q*) disposal as the par value of bond *j* that insurer *i* sold in quarter *q* in percentages of the par value of bond *j* that insurer *i* held at the end of quarter *q-2*, and 0 if no sale was made. We then take the average disposal for each bond-quarter of the two subsamples of insurers: those with losses in *q-1* and those without losses in *q-1*. Similar to Panel B, we sort bonds into different categories, using the median in this sample as cutoffs for safer versus riskier and more liquid versus more illiquid. We tabulate the mean (and 90th percentile) of the average sales in the two subsamples of insurers, as well as the difference between the two. We report the 90th percentile in rows e-f instead of the median, because the median (and even 75th percentile) of the average sales is often 0. Sample period is from 2008 to 2016Q2 in Panels B and C.

Panel A: Losses and Corporate Bond Purchase/Disposal, Regression Estimates

Dependent Variable:	Purchase Actual Costs*10E5 / Cash & Invested Assets (i,j,q)		Disposal % of Par Value Sold (i,j,q)	
NAIC Category	1 (1)	1 & 2 (2)	1 (3)	1 & 2 (4)
Loss (q-1)*Bond Worse-Rated (q-1)	-2.4386**	-1.8262**	0.0020	0.0023
	(-2.48)	(-2.34)	(1.14)	(1.40)
Loss (q-1)*Bond Coupon Rate	-0.1543	-0.3370	0.0026	0.0011
	(-0.30)	(-0.97)	(1.28)	(0.69)
Loss (q-1)*Bond Maturity (q)	2.3106**	-4.5742	0.0015	-0.5878
	(2.21)	(-1.17)	(0.00)	(-1.15)
Loss (q-1)*Bond Illiquidity (q-1)	-0.0866**	-0.0898***	0.0001	0.0001
	(-2.52)	(-3.96)	(0.69)	(0.89)
Loss (q-1)*Bond Downgraded Dummy (q-1)	6.4897	6.2845*	0.0107	-0.0053
	(1.47)	(1.92)	(1.20)	(-0.72)
Loss (q-1)*Bond NAIC 1 Dummy (q-1)		9.3325***		-0.0082
		(2.71)		(-0.99)
Log Assets (q-2)*Bond Worse-Rated (q-1)	0.0093*	0.0139***	-0.0087	-0.0056
	(1.84)	(3.49)	(-0.72)	(-0.53)
Log Assets (q-2)*Bond Coupon Rate	-0.0010	-0.0009	-0.0655***	-0.0613***
	(-0.32)	(-0.41)	(-4.98)	(-5.92)
Log Assets (q-2)*Bond Maturity (q)	0.0454**	0.0381***	11.6512***	12.7424***
	(2.57)	(2.66)	(2.77)	(3.93)
Log Assets (q-2)*Bond Illiquidity (q-1)	0.0031***	0.0024***	-0.0009*	-0.0009**
	(15.15)	(18.96)	(-1.70)	(-2.00)
Log Assets (q-2)*Bond Downgraded Dummy (q-1)	0.0147	0.0062	0.1270*	0.0682
	(0.60)	(0.37)	(1.79)	(1.22)
Log Assets (q-2)*Bond NAIC 1 Dummy (q-1)		-0.1614***		0.0766
		(-9.09)		(1.41)
Insurer Rating (larger=worse) (q-2)	0.0016	0.0016	0.0287*	0.0273**
*Bond Worse-Rated (q-1)	(0.30)	(0.38)	(1.94)	(1.97)
Insurer Rating (q-2)*Bond Coupon Rate	-0.0030	0.0028	0.0297*	0.0092
	(-0.83)	(1.16)	(1.71)	(0.68)
Insurer Rating (q-2)*Bond Maturity (q)	-0.0249*	0.0422	23.6296***	20.1346***
	(-1.89)	(1.00)	(3.98)	(4.05)
Insurer Rating (q-2)*Bond Illiquidity (q-1)	-0.0016***	-0.0014***	-0.0015**	-0.0025***
	(-8.15)	(-10.38)	(-2.02)	(-3.76)
Insurer Rating (q-2)*Bond Downgraded Dummy (q-1)	-0.0174	0.0131	0.0913	0.0389
	(-0.86)	(0.82)	(0.76)	(0.42)
Insurer Rating (q-2)*Bond NAIC 1 Dummy (q-1)		-0.0100		-0.1599**
		(-0.55)		(-2.11)
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	17,457,838	34,467,944	819,578	1,366,253

(*continued on next page*)

Table 7
(*continued*)

Panel B: Mean and Median of Average Purchase for Insurers with and without Losses

		NAIC 1		NAIC 2		NAIC 3-6	More	More
		Safer (1)	Riskier (2)	Safer (3)	Riskier (4)	(5)	Liquid (6)	Illiquid (7)
		Mean						
a.	Loss>0	2.151	1.704	0.963	0.856	0.162	1.160	0.989
b.	Loss=0	1.873	1.529	0.928	0.867	0.170	1.017	0.949
c.	a minus b	0.278	0.175	0.035	-0.011	-0.008	0.143	0.040
d.	c as % of b	14.842	11.445	3.772	-1.269	-4.706	14.061	4.215
		Median						
e.	Loss>0	0.545	0.420	0.168	0.112	0.009	0.131	0.043
f.	Loss=0	0.390	0.320	0.184	0.159	0.019	0.132	0.059
g.	a minus b	0.155	0.100	-0.016	-0.047	-0.010	-0.001	-0.016
h.	c as % of b	39.744	31.250	-8.696	-29.560	-52.632	-0.758	-27.119
		Correlation between Rows a & b						
i.	ρ (a, b)	0.734	0.670	0.498	0.433	0.274	0.614	0.728

Panel C: Mean and 90th Percentile of Average Disposal for Insurers with and without Losses

		NAIC 1		NAIC 2		NAIC 3-6	More	More
		Safer (1)	Riskier (2)	Safer (3)	Riskier (4)	(5)	Liquid (6)	Illiquid (7)
		Mean						
a.	Loss>0	5.811	5.139	5.519	6.091	12.823	8.547	7.669
b.	Loss=0	5.424	4.850	5.283	5.830	11.245	8.098	6.833
c.	a minus b	0.387	0.289	0.236	0.261	1.578	0.449	0.836
d.	c as % of b	7.135	5.959	4.467	4.477	14.033	5.545	12.235
		90th Percentile						
e.	Loss>0	14.815	13.333	16.667	19.231	50.000	25.000	16.667
f.	Loss=0	13.105	11.765	13.961	16.667	40.000	23.133	12.590
g.	a minus b	1.710	1.568	2.706	2.564	10.000	1.867	4.077
h.	c as % of b	13.048	13.328	19.383	15.384	25.000	8.071	32.383
		Correlation between Rows a & b						
i.	ρ (a, b)	0.170	0.207	0.212	0.220	0.138	0.284	0.130

crease by one standard deviation, insurers decrease their purchase of A- relative to AAA bonds by 68% of the mean.

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 over less liquid bonds becomes stronger. Columns (1)-(2) also suggest that smaller insurers buy more bonds that are safer, more liquid, and in the NAIC 1 category than do larger insurers. In addition, worse-rated insurers tend to buy more liquid bonds than those purchased by better-rated insurers.

In columns (3) and (4), we estimate Eq. (1), 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* that insurer *i* held. We exclude transactions that are involuntary, for example, due to bond maturing or being called by the issuer. If insurer *i* holds bond *j* in quarter *q*, but does not sell bond *j* in quarter *q*, the dependent variable for *i,j,q* is 0. The estimated coefficients on the interaction term between *Loss* and *Bond Worse-Rated* are positive, suggesting that insurers sell more riskier bonds than safer bonds following losses. However, these estimated coefficients are not statistically significantly different from 0.

The results in Panel A of Table 7 are consistent with the idea that when more constrained, insurers increase the portfolio weight on safer and more liquid assets. However, the effect is much larger for purchases than for sales. Rather than paying the transaction costs of selling bonds in their portfolios, insurers likely change their portfolios following losses by replacing bonds that mature with safer ones.

Next, we present summary statistics on the buying and selling of corporate bonds by insurers that experience losses in the prior quarter and those that do not. For each bond that is acquired by any P&C insurer in quarter *q*, we calculate the average purchase (costs scaled by insurers' cash and invested assets, 0 for insurers that do not buy the bond) for two subsamples: insurers that suffered losses in *q-1* and insurers that did not. Thus, each bond-quarter observation has two averages. Then, we group bonds into different groups and calculate the mean (median) of the bond-quarter level average purchases for insurers with and without losses. Panel B of Table 7 presents the results. A bond is put in the following groups in quarter *q* based on its NAIC designation and rating in quarter *q-1*. Bonds in the NAIC 1 category are sorted into safer (included in column (1)) and riskier (included in column (2)) groups based on their ratings with the median as the cutoff. Similarly, bonds in the NAIC 2 category are sorted by ratings into safer (included in column (3)) and riskier (included in column (4)) groups. Bonds in the NAIC 3-6 categories are included in column (5). Therefore, from column (1) to column (5), bonds become riskier.

Row a (b) tabulates the mean of the bond-quarter average purchases among insurers with (without) losses in *q-1*. Row c tabulates the difference between rows a and b. Row d tabulates the difference (row c) as a percentage of row b, the mean across bonds of the average purchase among insurers without losses. Rows e-h repeat rows a-d, replacing the mean with the median of the bond-quarter average purchase.

Based on rows a, b, e, and f in columns (1)-(5), the average purchase of bonds decreases if the bond is riskier, for both insurers with and without losses. Based on rows d and h in columns (1)-(5), the mean (or median) of the average purchase by insurers with losses minus that by insurers without losses is positive for the safer bonds and decreases to negative for riskier bonds. For example, the median of the average purchase of the safest group of bonds by insurers with losses is 40% larger than that by insurers without losses. The median of the average purchase of the riskiest group of bonds by insurers with losses is 53% smaller than that by insurers without losses. The patterns suggest that insurers with losses have a stronger preference for safer bonds than insurers without losses, either within the same NAIC designation or across different ones.

We also sort bonds based on their illiquidity, measured by the fraction of zero trading days in quarter *q-1*, using the median as the cutoff. More liquid bonds are included in column (6), and more illiquid bonds in (7). Columns (6)-(7) indicate that insurers with or without losses both buy more of liquid than illiquid bonds. Comparing the differences between the two groups of insurers in their purchase of liquid versus illiquid bonds, the results suggest that insurers with losses have a stronger preference for more liquid bonds.

Row i tabulates the correlation of bond-quarter average purchase among insurers with losses and the average among those without losses in *q-1*. The correlations are higher for the safer than the riskier bonds. The correlation is around 0.7 for bonds in the NAIC 1 category, suggesting that the average purchase of such bonds by insurers with losses and that by insurers without losses are highly correlated.

In Panel C of Table 7, we conduct a similar exercise with insurers' disposal of bonds. For each bond held by any insurer in quarter *q*, we calculate the insurer-bond-quarter (*i,j,q*) level disposal as the percentage of the par value of the bond *j* insurer *i* sold in *q*, and 0 if no sale was made. We then take the average disposal for each bond-quarter of the two subsamples of insurers: those with and those without losses in *q-1*. Similar to Panel A, we sort bonds into different categories, using the median in this sample as cutoffs for safer versus riskier and more liquid versus more illiquid. We tabulate the mean and 90th percentile[16] of the average sales in the two subsamples of insurers, as well as the difference between the two.

The numbers in row a (e) are always larger than the numbers in row b (f), implying that insurers with losses sell more bonds on average than insurers without losses in all the categories of bonds. This result could be due to insurers with losses having a larger need to rebalance their portfolio following the shock. Across bond categories of different riskiness, the largest difference between the two subsamples of insurers is in the riskiest category of bonds, namely those with NAIC 3-6 designations. The result implies that insurers with losses have a stronger "distaste" for these riskiest bonds than insurers without losses.

Columns (6) and (7) suggest that insurers with and without losses both sell more of liquid bonds, presumably because selling these bonds incurs smaller discounts (or trading costs) than selling illiquid bonds. The difference between the two subsamples of insurers is larger for illiquid than liquid bonds. The results suggest that insurers with losses are more willing to incur the larger trading costs associated with selling illiquid bonds to achieve a more liquid portfolio.

Row i tabulates the correlation of bond-quarter average disposals among insurers with losses and that among those without losses in *q-1*. The correlations are much lower than those in Panel A, suggesting that the sell decisions among insurers with and without losses are less correlated than their purchase decisions.

Overall, the results in Panels B and C echo those in Panel A. Together, they suggest that following losses, insurers' preferences for safer and more liquid bonds become stronger.

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 much less work studying 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' fi-

[16] Because the median (and even 75th percentile) of the average sales is often zero, we report the 90th percentile in rows e-f instead of the median.

nancial conditions due to their operations affect the management of their financial portfolios.

We consider a sample of 2,926 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 document that insurers' size and ratings are correlated with their portfolio allocation across different asset categories. Larger and better-rated insurers allocate more of their portfolios to riskier and more illiquid assets. We estimate the way in which operating losses affect P&C insurers' portfolios. Our results suggest that following operating losses, 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.

We also find that smaller or worse-rated insurers, whose financial conditions can be more negatively affected by losses, shift more towards safer bonds following losses. The effect of losses on insurers' corporate bond portfolios was also larger during the 2008 financial crisis. These results suggest that insurers have stronger risk-management incentives when they become more financially constrained. As argued by Froot et al. (1993), risk management incentives can become stronger because of the costs of financial constraints.

Since insurers are regulated, the observed change in portfolios following losses could potentially occur because of regulatory pressure. We control econometrically for the regulatory effects of security choices within an asset class. We also restrict our analysis to insurers that purchase bonds rated worse than A- and study their investment in bonds rated A- or better. Our results on how losses affect insurers' corporate bond portfolios hold. It is unlikely that regulators restrict insurers' choices among bonds rated A- or better when insurers are allowed to purchase bonds rated worse than A-. Overall, our evidence suggests that insurers' shift toward safer bonds following losses occurs at least partially because of voluntary responses and not merely due to regulatory pressure.

Institutional investors who are not delegated money managers are some of the most important investors in the economy. However, we do not know much 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 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 conditions. The desire to maintain financial flexibility appears to lead insurers to forgo 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.

Appendix

Table A.1
Variable definitions.

Firm-Level Financial Variables	
Assets	Net admitted assets.
Leverage	Total liabilities/net admitted assets.
RBC ratio	Risk-based capital ratio, total adjusted capital divided by the required capital.
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-, etc.
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 Growth	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 0 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 0. 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 scaled by lagged assets if net underwriting gain is positive, and 0 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).
Operating-Income Volatility	For P&C insurers, operating income is net underwriting gain as a percengate of assets. For life insurers, operating income is net total gain minus investment income as a percengate of assets. Volatility is calculated as the standard deviation over five years.
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	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).
Bond Maturity	Number of years until the bond matures divided by 1,000.
Coupon Rate	As reported by the insurers in the regulatory filings.
Downgraded Dummy	Dummy variable that equals 1 if the bond has been downgraded in a time period by any rating agency.
Bond Illiquidity	0-Trading Day, which is the fraction (or percentage if specified so in the table) of days when no trading for this bond happened relative to the number of trading days; imputed round-trip costs in a robustness test in Table A.6.
NAIC 1 Dummy	Dummy variable that equals 1 if the bond belongs to NAIC 1 category (when insurers report different NAIC designations for the same bond in the same quarter, we take the riskiest NAIC category, as it is likely the most truthful designation since insurers are unlikely to manipulate bonds' NAIC designation to a riskier one).

Table A.2
Conversion from bond rating to numeric value. We transform bond ratings to numeric values and take the average across different rating agencies. This table shows how we convert the mean rating to the variable *Worse-Rated*, which can also be not an integer.

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 insurers' size correlates with operating-income volatility and ratings. In Panel A, the dependent variable is insurers' five-year operating-income volatility from year *y-4* to year *y*, and the independent variables are from year *y-5*. Columns (1)-(2) use P&C insurers, and (3)-(4) use life insurers. All columns include year fixed effects. Columns (2) and (4) also include firm fixed effects. The sample period is from 2001 to 2015. Standard errors are corrected for clustering at the insurer level. Panel B estimates how insurers' ratings are related to their lagged financial variables. The dependent variable is insurers' ratings in year *y*. Columns (1)-(3) use P&C insurers, and (4)-(6) use life insurers. All columns include year fixed effects. Columns (3) and (5) also include firm fixed effects. The sample period is from 2003 to 2013. Standard errors are corrected for clustering at the insurer group level (insurer level if the insurer is standalone), because AM Best considers the financial strength of the entire group when assigning an individual insurer's rating. In both panels, ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Table A.1 for other variable definitions.

Panel A: Insurers' Size and Operating-Income Volatility

Dependent Variable:	Operating-Income Volatility (y-4 to y)			
	P&C Insurers		Life Insurers	
	(1)	(2)	(3)	(4)
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	21,333	21,333	12,989	12,989

Panel B: Insurers' Size and Financial Strength Ratings

Dependent Variable:	Insurers' Rating (y) (Larger Number = Worse Rating)					
	P&C Insurers			Life Insurers		
	(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**	0.00	0.00	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)	0.002***	0.00	0.00	0.002**	-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 Growth (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	11,665	11,665	11,531	7,864	7,864	7,756
Adj R2	0.047	0.172	0.879	0.162	0.344	0.915

Table A.4
Insurers' investment returns and corporate bond portfolio returns and yields. In columns (1)-(2), 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. Columns (1)-(2) present results estimating the relationship between insurers' realized returns and their lagged financial variables. In columns (3)-(4), we replace the dependent variable with insurers' realized returns from their corporate bond portfolios. The returns are calculated as the value-weighted average of the realized returns of the corporate bonds in insurers' portfolios: the market price of the position at the end of the quarter, plus the approximated interest received during the quarter, plus any sales proceeds from selling (some of) the position during the quarter, divided by the sum of the market value at the beginning of the quarter and the actual costs spent buying additional amount during the quarter, minus 1. *Avg. Bond Rating* is the value-weighted average of bonds' ratings in insurers' holdings. A worse rating is assigned a larger integer: for example, AAA rated bonds are assigned 1, BBB+ rated bonds are assigned 8. *Avg. 0-Trading Day* is the value-weighted average of bonds' 0-trading day in insurers' holdings. The weights for bond returns and characteristics are the mean of market value at the beginning of the quarter plus actual costs spent acquiring the bond during the quarter and the market value at the end of the quarter plus considerations received from selling the bonds. Because these approximated returns are highly skewed on the right, we winsorize them at the 1st and 95th percentile. In columns (5)-(6), we replace the dependent variable with insurers' value-weighted average corporate bond portfolio yield. The weights for all bond yields and characteristics are the market value at the end of the quarter. Yields are winsorized at the 1st and 99th percentiles. Column (1) uses life insurers. Columns (2)-(6) use P&C insurers. The sample period is from 2001 to 2014Q1 in columns (1) and (2), from 2008 to 2014Q1 in columns (3)-(6). Standard errors are corrected for double clustering at the insurance firm and year-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Table A.1 for variable definitions.

Dependent Variable:	Realized Return on Cash & Invested Assets (q)		Corp Bond Portfolio Realized Return (q)		Corp Bond Portfolio Yield (q)	
Insurers:	Life	P&C				
	(1)	(2)	(3)	(4)	(5)	(6)
Log Assets (q-1)	0.0264***	0.0377***	0.2021***	0.1652***	0.0767*	-0.0469
	(4.43)	(8.09)	(3.18)	(3.93)	(1.79)	(-1.42)
Avg. Bond Rating (q-1)				0.2145**		0.7202***
				(2.41)		(7.15)
Avg. 0-Trading Day (%) (q-1)				-0.0103		0.0069
				(-1.06)		(1.57)
Avg. Imputed Round-Trip Cost (q-1)				0.0747		0.3147***
				(0.94)		(6.68)
Leverage (q-1)	0.5121***	0.0360	-0.0018	0.0001	-0.0088**	-0.0046**
	(8.47)	(0.97)	(-0.42)	(0.03)	(-2.52)	(-2.38)
RBC Ratio (y-1)	0.0000	0.0004	-0.0024**	-0.0019*	-0.0021	-0.0002
	(0.16)	(1.48)	(-2.30)	(-1.85)	(-1.33)	(-0.18)
Insurer's Rating (q-1)	-0.0102**	-0.0078***	0.0913***	0.0851***	-0.0044	-0.0102
(larger number = worse)	(-2.50)	(-4.05)	(3.12)	(3.00)	(-0.17)	(-0.67)
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster SE by Firm&Year-Quarter	Yes	Yes	Yes	Yes	Yes	Yes
N	24,225	57,310	26,937	26,937	27,005	27,005

Table A.5
Losses and corporate bond holdings, instrumental variable approach, first stage. This table presents the first-stage results estimating Eq. (1) using the instrumental variable approach, corresponding to column (4) in Table 3, in which the sample period is from 2008 to 2014Q2. Controls include interaction terms between each of the insurers' financials (assets, rating, leverage, and RBC ratio) and bond characteristics, that is all the independent variables used for estimation for Table 3. Standard errors are corrected for clustering at the bond CUSIP-year-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Table A.1 for variable definitions.

Dependent Variable:	Loss (q-1)*Bond Worse-Rated (q-1)	Loss (q-1)*Bond Coupon Rate	Loss (q-1)*Bond 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)	0.5563***	0.0117	-1.1704	0.0019	-0.0021
*Bond Worse-Rated (q-1)	(24.91)	(1.23)	(-1.64)	(0.84)	(-1.54)
Weather Exposure (q-1)	-0.0018	0.4468***	0.9749	0.0005	0.0003
*Bond Coupon Rate	(-0.17)	(32.16)	(0.45)	(0.24)	(0.24)
Weather Exposure (q-1)	-0.0000	0.0000	0.4695	-0.0000*	-0.0000
*Bond Maturity (q)	(-0.84)	(0.31)	(0.54)	(-1.75)	(-0.22)
Weather Exposure (q-1)	0.0717	0.0545	1.6083	0.5761***	-0.0097*
*Bond Illiquidity (q-1)	(1.40)	(1.18)	(0.21)	(33.46)	(-1.88)
Weather Exposure (q-1)	-0.1370*	-0.0213	1.5895	-0.0273**	0.5790***
*Bond Downgraded Dummy (q-1)	(-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	848,722	848,722	848,722	848,722	848,722

Table A.6

Robustness tests for losses and corporate bond holdings, gains and bond holdings. This table presents robustness tests for results at the corporate bond level for P&C insurers. Panel A presents robustness results on how insurers' losses are correlated with their allocation across bonds by altering column (5) in Panel A, Table 3. In columns (1)-(3), 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. In column (4), we use bonds' yield to maturity from the previous quarter as the measure for bond risk. In columns (1)-(4), controls include interaction terms between each of the insurers' financials (assets, rating, leverage, and RBC ratio) and bond characteristics, that is all the independent variables in Table 3. In column (5), we repeat the original specification, replacing the insurance firm-year-quarter fixed effects with firm fixed effects and adding insurers' lagged financial variables as controls in addition to those included in Table 3. In Panel B, we repeat the OLS specifications in Table 3, replacing insurers' operating *Loss* with operating *Gain*, and present the OLS results. *Gain* equals net underwriting gain scaled by lagged assets if net underwriting gain is positive, and 0 otherwise. The control variables include all those in Table 3. Sample starts in 2008 and ends in 2014Q2. Standard errors are corrected for clustering at the bond CUSIP-year-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Table A.1 for variable definitions.

Panel A: Losses and Corporate Bond Holdings, Robustness Tests

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)				0.0050	
				(0.43)	
Loss (q-1)*Bond Duration (q-1)	0.0053	0.0029	0.0032		
	(0.84)	(0.46)	(0.50)		
Loss (q-1)*Bond Coupon Rate	-0.0457***		-0.0471***	-0.0403***	-0.0727***
	(-2.63)		(-2.69)	(-3.27)	(-2.64)
Loss (q-1)*Bond Maturity (q)	-0.7055		-0.9774*	-0.2024	-0.3428
	(-1.28)		(-1.74)	(-1.27)	(-0.84)
Loss (q-1)*Bond Illiquidity (q-1)	0.0305	0.0464	8.5013	-0.0859	-0.2323*
	(0.38)	(0.57)	(0.86)	(-1.60)	(-1.80)
Loss (q-1)*Bond Downgraded (q-1)	-0.1456	-0.1486	-0.1603	-0.0888	-0.0760
	(-1.30)	(-1.33)	(-1.44)	(-1.40)	(-0.47)
Loss (q-1)*Bond NAIC 1 Dummy (q-1)	0.6522***	0.7108***	0.6457***	0.0232	0.6538***
	(5.52)	(5.89)	(5.59)	(0.68)	(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	868,140	868,233	863,661	1,236,430	1,342,243

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	848,671	1,418,688	849,175	1,419,495

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