Homeowners Insurance and the Transmission of Monetary Policy*

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Abstract

We document a novel transmission channel of monetary policy through the homeowners insurance market. On average, contractionary monetary policy shocks result in higher homeowners insurance prices. Using granular data on insurers' balance sheets, we show that this effect is driven by the interaction of financial frictions and the interest rate sensitivity of investment portfolios. Specifically, rate hikes reduce the market value of insurers' assets, tightening insurers' balance sheet constraints and increasing their shadow cost of capital. These frictions in insurance supply amplify the effects of monetary policy on real estate and mortgage markets by making housing less affordable. We find that monetary policy shocks have a stronger impact on home prices and mortgage applications when local insurers are more sensitive to interest rates. This channel is particularly pronounced in areas where households face high climate risk exposure. Our findings highlight the role of insurance markets in amplifying macroeconomic shocks and the interconnections between homeowners insurance, residential real estate, and mortgage lending.

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Financial intermediaries are central to the transmission of monetary policy. While a substantial body of literature has explored the transmission through the banking sector (e.g., Drechsler et al., 2017), the role of the insurance sector remains underexplored, despite its importance in intermediating between households and financial markets.[1] Homeowners insurance in particular plays a pivotal role in both property ownership and acquisition: banks require insurance for mortgage approval to secure their collateral, while insurance costs significantly impact homeowners' finances. In fact, insurance premiums amount to 21% of the average borrower's principal and interest payments, and substantially more in disaster-exposed regions (Keys and Mulder, 2024).[2] With mounting financial losses from extreme weather events, homeowners insurance has become a central pillar of household risk management.

In this paper, we document the transmission of monetary policy through the homeowners insurance market and its implications for the real estate and mortgage markets. First, exploiting granular data on the entire U.S. homeowners insurance market, we find that insurance prices on average increase in response to contractionary monetary policy shocks. This response is driven by financial frictions in insurance supply as contractionary monetary policy shocks depress the market value of insurers' assets and, thereby, tighten their balance sheet constraints. Second, homeowners insurance amplifies the effects of monetary policy on the real estate and mortgage markets, as higher insurance prices increase housing costs. Specifically, we document that monetary policy shocks have a stronger effect on home prices and mortgage applications when local insurers are more sensitive to interest rates. In contrast to traditional channels of monetary policy transmission, the transmission through homeowners insurance interacts with the exposure of households to climate risks.

The relationship between insurance supply and monetary policy is not obvious. To guide the empirical analysis, we propose a stylized model of insurance intermediation. In the absence of financial frictions, higher interest rates *reduce* insurance prices because they reduce the present value of future insurance claims. However, if insurance supply is subject to financial frictions, higher interest rates can tighten balance sheet constraints, inducing insurers to *raise* prices to bolster their balance sheets.[3] We show that the net effect hinges on two determinants: (1) the interest rate sensitivity of insurers' assets and liabilities, which determines how much an interest rate hike reduces net worth, and (2) the severity of financial frictions. In the cross section, insurers with more interest-rate–sensitive assets and higher leverage are more sensitive to monetary policy shocks.

1 The U.S. insurance sector collects insurance premiums of nearly $2 trillion from households annually and manages $8.5 trillion in financial assets corresponding to more than one-third of the banking sector's financial assets. *Sources:* NAIC Market Share Reports, NAIC Capital Markets Bureau Special Reports, and FRED.

2 Cost for homeowners insurance in Pacific Palisades, CA, an area ravaged by the 2025 California wildfires, reached up to $18,000 in 2024 (www.latimes.com).

3 The impact of rate hikes on insurance prices through their adverse effects on asset investments has been highlighted by market practitioners, e.g., in the March 21, 2024, episode of the Bloomberg podcast *Odd Lots*: `https://www.bloomberg.com/news/articles/2024-03-21/why-insurance-rates-have-been-surging-in-california-and-florida?embedded-checkout=true`.

In the first part of our empirical analysis, we test our model's propositions and document that monetary policy strongly impacts the supply of homeowners insurance. For this purpose, we combine information on all changes in U.S. homeowners insurance prices from 2010 to 2019 at the insurer-state level with micro-level data on insurers' balance sheets. For example, we observe when and by how much an insurer changes its homeowners insurance prices and link this price change to monetary policy shocks and to the composition of the insurer's balance sheet. Following the macroeconomic literature, we identify monetary policy shocks as high-frequency changes in interest rates measured in a narrow time window around monetary policy events (e.g., Gürkaynak et al., 2005; Nakamura and Steinsson, 2018; Jarociński and Karadi, 2020; Bauer and Swanson, 2023), commonly referred to as monetary policy *surprises*. These surprises remove the effects of macroeconomic conditions by capturing the unexpected component of monetary policy decisions. To match the long duration of insurers' financial investments, we focus on monetary policy surprises in the 10-year U.S. Treasury yield. Because insurers adjust prices infrequently, we use the sum of monetary policy surprises in the six months preceding an insurance price change as the main explanatory variable.

We find that a 1 percentage point (ppt) monetary policy surprise is associated with a 7 to 9.6 ppt increase in insurance prices. The result remains robust across various definitions of monetary policy surprises, including alternative horizons for accumulating these surprises. It also holds when controlling for insurer and economic characteristics, including lagged underwriting performance and lagged GDP and inflation.

In our model, contractionary monetary policy shocks increase insurance prices through their adverse impact on asset values, amplifying financial frictions. We exploit two sources of cross-sectional variation in insurers' balance sheets to provide empirical evidence for this mechanism: interest rate sensitivity of investment portfolios and financial constraints. We construct two measures of the interest rate sensitivity of investment portfolios. First, we consider the share of assets that are mark-to-market on insurers' balance sheets. Regulation requires property & casualty insurers to hold stocks and high-yield bonds at market values, whereas investment-grade bonds are held at historical costs. Thus, insurers that invest more in stocks and high-yield bonds are more exposed to market value fluctuations. Second, we estimate the value-weighted duration of the insurer's fixed-income assets based on security-specific asset prices and cash flow dynamics. Validating these measures, we show that the investment income of insurers with larger mark-to-market shares and longer durations are significantly more sensitive to monetary policy surprises.[4] To elicit ex-ante financial constraints of insurers, we compute the deviation in an insurer's regulatory capital ratio from its trailing moving average, accounting for persistent differences in insurer business models. A large negative deviation indicates an unusually low capitalization.[5]

4 Changes in investment income pass through one-to-one to insurers' statutory capital and, thus, directly affect their regulatory capital ratios.

Consistent with our model's predictions, we find that, in the cross section, constrained insurers respond significantly more to monetary policy surprises, with the impact on prices being more than twice as large as for unconstrained ones. The differential effect remains significantly positive when absorbing state-level shocks, such as state-specific macroeconomic trends, which narrows in on insurer-specific variation in financial frictions. The effect of constraints is amplified by investment portfolios that are more interest rate sensitive, i.e., with a larger share of mark-to-market assets or a longer portfolio duration. These findings emphasize the role of financial frictions as mechanism driving the effect of monetary policy on insurance supply.

In the second part of the empirical analysis, we show that the frictions in homeowners insurance supply amplify the effects of monetary policy on home prices and mortgage markets. For this purpose, we combine county-level data on home prices and mortgage applications with local insurers' balance sheets. Building on our analysis above, we measure the sensitivity of local insurance prices to monetary policy at the state level based on local insurers' lagged capital ratios and investment portfolio characteristics. Due to the geographic fragmentation of U.S. insurance markets, these state-level differences in sensitivity directly affect local households as they cannot easily switch to outside insurers. The identifying assumption is that insurers' sensitivity to monetary policy is uncorrelated with unobserved determinants of monetary policy transmission to the housing and mortgage markets.

We document that contractionary monetary policy surprises have a stronger impact on home prices when local insurance companies are more sensitive to monetary policy. Specifically, home prices drop by roughly 0.7 ppt more in high-sensitivity relative to low-sensitivity states in the 6 months following a 1 ppt cumulative monetary policy surprise. The result is robust to absorbing potentially confounding variation from macroeconomic conditions, such as lagged inflation, as well as local economic conditions, such as GDP growth and population density. Moreover, we find that in states with sensitive insurers, the impact of monetary policy on home prices is larger in counties that are more exposed to natural disasters, where households face higher insurance costs on average.

Finally, we provide consistent evidence from residential mortgage markets, focusing on mortgage applications in the Home Mortgage Disclosure Act (HMDA) data. We find that contractionary monetary policy surprises reduce the total number and volume of mortgage applications significantly more when local insurers are more sensitive to monetary policy. This finding is consistent with insurance supply shocks affecting the marginal borrowers' willingness to pay for housing and ability to obtain mortgage financing. To absorb potentially confounding effects driven by differences in local economic characteristics, we include granular time fixed effects interacted with county-specific GDP growth and population count. Thus, our estimates compare the response to monetary policy in counties with similar economic characteristics at the same point in time that differ in insurer characteristics.

5 U.S. insurance regulation prescribes minimum thresholds for risk-based capital ratios. Insurers that breach these thresholds face increased scrutiny by regulators. In the most extreme case, state insurance commissioners are required to take control of an insurer.

Our analysis yields three key insights for policy. First, frictions in the homeowners insurance market significantly affect the transmission of monetary policy. This applies especially for the households that are most exposed to climate risks and, thus, face both the largest need for insurance and the highest costs of insurance on average. As the intensity of natural disasters continues to increase, these effects are likely to become even more pronounced. Second, our findings reveal substantial spillovers from the insurance sector to real estate and mortgage markets, underscoring the complex interlinkages between banking and insurance. Higher insurance costs not only directly affect household finances but also constrain households' borrowing capacity and, thereby, amplify monetary policy transmission through the banking sector. Third, the role of financial frictions in monetary policy transmission suggests that the homeowners insurance channel is countercyclical. During economic downturns, when insurers face tighter financial constraints, monetary policy has stronger effects on insurance supply and, consequently, on housing markets.

Related literature This paper documents the role of the homeowners insurance market in the transmission of monetary policy. The literature on monetary policy transmission through financial intermediaries has traditionally focused on the banking sector (e.g., Bernanke and Gertler, 1995). Similar to the bank balance sheet channel of monetary policy (Stein, 1998; Kashyap and Stein, 2000), rate hikes tighten the constraints of property insurers. The resulting response in insurance supply is reminiscent of the bank deposit channel documented by Drechsler et al. (2017) and suggests that insurers manage interest rate risk through market power in insurance markets.[6]

Whereas a growing literature examines the transmission of monetary policy transmission through non-bank financial intermediaries in capital and loan markets (Xiao, 2020; Elliott et al., 2022; Drechsler et al., 2022; Cucic and Gorea, 2024), we extend these studies by documenting the unique role of the homeowners insurance market and its interconnectedness with the real estate and loan markets. Existing evidence on the impact of monetary policy through insurance companies is scarce and confined to their role as investors (Ozdagli and Wang, 2019; Koijen et al., 2021; Kaufmann et al., 2023; Kubitza et al., 2023; Kirti and Singh, 2024; Li, 2024). Instead, we focus on insurers' core business: selling insurance. Complementing recent studies that emphasize the importance of supply-side frictions in insurance markets (Koijen and Yogo, 2015, 2022; Ge, 2022; Oh et al., 2023; Barbu et al., 2024), we document the role of these frictions for monetary policy transmission.[7] By highlighting the interaction between insurers' investments, financial frictions, and product pricing, we also complement studies on the impact of insurers' financial constraints on insurer investment behavior (Ellul et al., 2011, 2015; Ge and Weisbach, 2021; Becker et al., 2022) and on the interlinkages between insurers' investment and underwriting business (Knox and Sørensen, 2024; Kubitza, 2024).[8]

6 Relatedly, Brunetti et al. (2024) highlight the ability to create net worth as an important ingredient of interest rate risk management by insurers.

7 Our results also contribute to the current debate in macroeconomics on the effects of financial frictions on prices (Gilchrist et al., 2017; Kim, 2021) by documenting the countercyclical behavior of non-life insurance prices.

Finally, we contribute to a growing literature on the role of insurance supply in real estate and loan markets. Blickle and Santos (2022), Sastry (2022), Ge et al. (2023), and Blickle et al. (2024) document the effects of U.S. flood insurance regulation on home prices and mortgage lending. Most closely related to our paper are Sastry et al. (2023), who provide evidence that mortgage lenders are sensitive to the financial fragility of property insurers, and Ge et al. (2024), who document the impact of homeowners insurance supply on mortgage delinquencies and prepayment. Complementing these studies, we document the impact of frictions in homeowners insurance supply on mortgage applications and home prices, emphasizing the importance of insurance affordability for housing demand.

1 Institutional Setting and Stylized Facts

Homeowners insurance Homeowners insurance is one of the most important products for households in the U.S.; Jeziorski and Ramnath (2021) report that more than 90% of U.S. homeowners have homeowners insurance coverage. An important reason is that homeowners insurance is mandatory to obtain a mortgage. There are eight types of homeowners insurance policies, called HO-1 to HO-8, which vary in coverage and policyholder type. HO-3, also called "Special Form", is the most common policy, covering damages related to owner-occupied home and belongings, such as the costs of fixing broken pipes, most natural disaster damages, and fire damages (National Association of Insurance Commissioners, 2022).[9] Only certain risks like flooding and earthquakes may be excluded from the policy and require additional insurance protection.[10] Homeowners can choose to insure their homes at replacement cost or actual cash value. While the former guarantees to restore broken parts or the entire home to the pre-damage state, the latter deducts depreciation from the estimated damage. Homeowners insurance premiums account for a substantial part of housing costs, particularly for mortgage-financed homes.[11] Keys and Mulder (2024) estimate that homeowners insurance premiums are 20% of the principal and interest payments on mortgages for the average homeowners and more than 40% for the top 10% of homeowners, with exposure to natural disasters being a key determinant of prices.

Insurance pricing Property & casualty (P&C) insurers collected close to $152 billion in premiums written in 2023 on homeowners insurance contracts, representing more than 15 percent of all direct premiums written by U.S. P&C insurance companies (National Association of Insurance Commissioners,

8 While Knox and Sørensen (2024) document the effects of liquidity premia on insurance prices, we focus on the immediate impact of monetary policy shocks.

9 In 2021, HO-3 contracts represented more than 50% of homeowners insurance markets and more than 75% of contracts for owner-occupied homes (National Association of Insurance Commissioners, 2023a).

10 Homeowners insurance typically excludes damages resulting from floods and inundation. Flood insurance is almost exclusively provided by the National Flood Insurance Program (NFIP) and is mandatory in high risk areas.

11 In April 2024, the average annual premium across U.S. states for $300,000 in insurance coverage was $2,151, with the highest premiums in Florida ($5,770) and the lowest in Vermont ($799). For more information, see bankrate.com.

2023b). As specified in the McCarran-Ferguson Act of 1945, insurance markets are subject to regulation by individual U.S. states. Insurance companies seeking to adjust prices, terms, and conditions must submit a filing with the local regulatory authority in the affected U.S. state. Throughout this paper, we exclusively consider filings for price changes unless indicated otherwise. In all states, most insurers adjust their prices once per year (see Appendix Figure C.1). This dynamic is driven by institutional characteristics. First, homeowners insurance contracts are predominantly one-year contracts. Second, insurers need to collect data on the performance of affected contracts to justify price changes to regulators. Third, documenting and justifying price changes to regulatory authorities creates a fixed cost for each filing.

Insurer balance sheets P&C insurers invest most of their assets in fixed-income securities and equity to generate investment income, an important determinant of insurance prices (Knox and Sørensen, 2024). Insurers' financial investments account for more than 70 percent of their total assets (see panel (a) of Appendix Figure C.3). These investments generate income through interest and dividend payments, capital gains if marked to market, and realized gains upon sale. Equity investments contribute to insurers' investment income mainly through capital gains as these are mark-to-market. Investment-grade bonds are held at historical cost and, therefore, mainly contribute through interest payments (see panel (b) of Appendix Figure C.3). In contrast, high-yield bonds contribute to both as they are held at market values.

Regulation Regulation requires that insurers hold sufficient statutory capital to cover potential losses. The risk-based capital (RBC) ratio benchmarks an insurer's total statutory capital to the regulatory required capital:

$$\text{RBC ratio} = \frac{\text{Statutory capital}}{\text{Required capital}}. \tag{1}$$

If an insurer's RBC ratio is below regulatory thresholds, the insurer is required to lay out a strategy on how to strengthen its capital position or may even be taken under control by the regulator. The required capital is calculated as a weighted sum of individual asset and liability positions, with weights corresponding to their respective risk.

2 A Model of Insurance Prices and Monetary Policy

To understand the impact of monetary policy on insurance prices, we consider a stylized model of insurance markets in which insurers are subject to regulatory capital constraints in the spirit of Koijen and Yogo (2016). Our model features two periods $t \in \{0, 1\}$ and a continuum of risk-neutral insurers indexed by $i \in [0, 1]$ which are subject to regulatory capital constraints. An exogenous risk-free rate determines the value of insurers' assets and liabilities and, thus, interacts with financial frictions. All proofs are relegated to the Appendix.

Balance sheet dynamics At $t = 0$, each insurer i is endowed with interest-rate–sensitive initial assets A_i^0 and liabilities L_i^0. The insurer sets the unit price P_i and underwrites Q_i one-period insurance contracts, where Q_i is a downward-sloping demand function with constant elasticity ϵ.[12] The expected claims on all insurance contracts are normalized to 1, meaning that the present value of each insurance contract is $V = e^{-r_f}$, where r_f is the risk-free rate set by the central bank. At $t = 0$, after selling insurance contracts, an insurer's total assets are therefore equal to the sum of the insurer's legacy assets and the funds raised from insurance underwriting:

$$A_i = A_i^0 + P_i Q_i. \tag{3}$$

The insurer's total liabilities are the sum of the insurer's initial liabilities and the present value of the expected claims of the insurance contracts underwritten:

$$L_i = L_i^0 + V Q_i. \tag{4}$$

Financial friction and profit Capital regulation induces a regulatory cost of statutory capital. Insurer i's statutory capital K_i at time 0 is defined as the total assets in excess of weighted liabilities:

$$K_i = A_i - (1 + \rho) L_i. \tag{5}$$

The parameter $\rho \geq 0$ captures the capital requirement for insurance underwriting, with a higher ρ implying a higher capital requirement. The regulatory cost of capital is captured by the cost function

$$C_i = f(K_i), \tag{6}$$

which we assume to be downward-sloping, convex, continuous, and thrice differentiable. Taken together, each insurer's objective is to set the price of insurance to maximize profits Y_i less the regulatory cost of capital:

$$\max_{P_i} Y_i - C_i, \tag{7}$$

where profits are given by $Y_i = (P_i - V) Q_i$.

12 Following Knox and Sørensen (2024), we assume monopolistic competition among insurers, which results in all insurers facing downward-sloping demand for their insurance products with constant and identical demand elasticities:

$$\epsilon = -\frac{\partial \log Q_i}{\partial \log P_i}. \tag{2}$$

Heterogeneity Insurers differ along two dimensions. First, the (accounting) value of the insurers' initial assets have different interest rate sensitivities across insurers, which is captured by the parameter

$$\alpha_i = \frac{\partial A_i^0}{\partial r_f} < 0. \tag{8}$$

A lower (more negative) α_i corresponds to a more interest-rate–sensitive investment portfolio. α_i captures both how interest rate sensitive the market value of the insurer's assets are (e.g. the duration of insurers' bond investments) as well as the degree to which market value fluctuations are passed through to the book value of the insurer's assets. For example, investment grade bonds are accounted at historical cost which means they are insulated from market fluctuations as long as the insurer does not sell them before maturity. Lower rated bonds and stocks, on the other hand, are accounted at market value.

The second dimension along which insurers differ is the amount of initial liabilities L_i^0, i.e., ex-ante leverage. We assume for simplicity that the initial liabilities are not interest rate sensitive. Instead, the heterogeneity in initial liabilities implies varying levels of ex-ante regulatory constraints driven by ex-ante leverage.

Equilibrium insurance prices We now consider how insurers optimally set insurance prices in equilibrium and how these prices react to monetary policy shocks given by changes in the risk-free rate r_f. First, we compute the optimal insurance price set by an insurer i.

Proposition 1. In equilibrium, the price of insurance set by insurer i is equal to

$$P_i = \left(1 - \frac{1}{\epsilon_i}\right)^{-1} \left(\frac{1 + (1+\rho)\chi_i}{1 + \chi_i}\right) V, \tag{9}$$

where

$$\chi_i = -\frac{\partial C_i}{\partial K_i} > 0 \tag{10}$$

is insurer i's shadow cost of capital.

Proposition 1 shows that the equilibrium insurance price is the product of the markup that insurers can charge due to market power, $\left(1 - \frac{1}{\epsilon_i}\right)^{-1}$, the term $\frac{1+(1+\rho)\chi_i}{1+\chi_i}$, which captures the effect of regulatory constraints on the cost of underwriting insurance contracts, and the actuarial price, V.[13] The shadow cost of capital χ_i is the decrease in the cost of capital resulting from a one unit higher level of statutory capital. If $\rho = 0$, then maximizing profits and minimizing cost of capital is equivalent because both are based on net assets. However, $\rho > 0$ induces a wedge between profits and statutory capital because the regulation puts a larger weight on liabilities.

13 The pricing equation of Proposition 1 is identical to that of Koijen and Yogo (2016).

Monetary policy In our model, monetary policy operates through changes in the risk-free rate. The effect of monetary policy on insurance prices is captured by the following comparative static.

Proposition 2. The semi-elasticity of insurer i's insurance price to changes in the risk-free interest rate is given by

$$\frac{\partial \log P_i}{\partial r_f} = -\frac{1 + \delta_i \left(\alpha_i + Q_i(1+\rho)V\right)}{1 + \delta_i \upsilon_i} \tag{11}$$

where

$$\delta_i = -\frac{\rho}{1 + \chi_i(1+\rho)} \frac{\chi_i'}{1 + \chi_i} \geq 0 \tag{12}$$

and $\chi_i' = \frac{\partial \chi_i}{\partial K_i}$ and $\upsilon_i = Q_i V \epsilon \left(\frac{\rho}{1+\chi_i}\right) \geq 0$.

The denominator of Equation (11) is strictly positive. Thus, whether higher interest rates decrease or insurance prices is determined by the interest-rate–sensitivity of the insurer's statutory capital, $\alpha_i + Q_i(1+\rho)V$, and the sensitivity of the cost of capital δ_i. To see this, first note that in the absence of financial frictions ($\rho = 0$), insurance prices move one-to-one (negatively) with the risk-free rate, $\frac{\partial \log P_i}{\partial r_f} = -1$, as a higher risk-free rate implies a lower present value of future expected claims. However, in the presence of financial frictions ($\rho > 0$), insurance prices are sensitive to changes in statutory capital. Higher interest rates affect the insurers' statutory capital by decreasing both the value of the insurer's assets, $\alpha_i < 0$, and the present value of the insurer's expected claims, $-Q_i(1+\rho)V < 0$. The net effect of an interest rate hike on an insurer's statutory capital, $\alpha_i + Q_i(1+\rho)V$, is therefore determined by the difference in interest rate sensitivities of assets and liabilities. If assets are more interest rate sensitive than liabilities, then the insurer's statutory capital falls in response to higher rates.

The pass-through of changes in statutory capital to insurance prices is governed by δ_i, which is an increasing function of the financial frictions parameter ρ. In fact, if the insurer's assets are sufficiently interest rate sensitive relative to the regulatory cost of capital, a higher risk-free interest rate results in higher, not lower, insurance prices because the increase in capital costs dominates the discounting of future expected claims. This causes insurers to increase insurance prices in order to replenish capital. This intuition is formalized in the following corollary.

Corollary 1. Insurance prices increase in response to higher risk-free interest rates if an insurer's assets are sufficiently interest rate sensitive and regulatory costs of capital sufficiently high:

$$\frac{\partial \log P_i}{\partial r_f} > 0 \Leftrightarrow \alpha_i + Q_i(1+\rho)V < -\frac{1}{\delta_i}. \tag{13}$$

Inequality (13) likely applies to P&C insurers because these have relative short-dated liabilities but invest in long-dated assets. In contrast, life insurers have the opposite duration gap with relative long-dated liabilities relative to assets (Li, 2024).

Comparative statics In the cross section and in the presence of frictions, the interest rate sensitivity of insurance prices $\frac{\partial \log P_i}{\partial r_f}$ varies with the interest rate sensitivity of insurers' assets α_i and their initial liabilities L_i^0. More interest-rate–sensitive assets (i.e., lower, more negative α_i) implies a larger $\frac{\partial \log P_i}{\partial r_f}$. The reason is that the more interest rate sensitive an insurer's assets are, the more its regulatory constraints tighten with higher interest rates.

Proposition 3. In the presence of financial frictions, $\rho > 0$, the effect of a higher risk-free rate on insurance prices is increasing in the interest rate sensitivity of insurer i's assets:

$$\frac{\partial}{\partial \alpha_i} \left\{ \frac{\partial \log P_i}{\partial r_f} \right\} < 0. \tag{14}$$

Analogously, a loss in the market value of the insurer's assets is more costly, the more initial liabilities L_i^0, i.e., ex-ante leverage, the insurer has. This effect causes the interest-rate–sensitivity of insurance prices, $\frac{\partial \log P_i}{\partial r_f}$, to be increasing in the amount of initial liabilities L_i^0. In the appendix, we prove that sufficient conditions for this result are sufficiently interest-rate–sensitive assets, $\alpha_i + Q_i(1+\rho)V < -\frac{1}{\delta_i}$, and a cost function with convexity declining sufficiently fast, $\frac{C_i'''}{C_i''^2} < -(2+\rho)$. The first condition corresponds to Corollary 1 and the latter condition is equivalent to assuming that the shadow cost of capital is a sufficiently convex function of capital.

Proposition 4. In the presence of financial frictions, $\rho > 0$, sufficient conditions exist for the interest-rate–sensitivity of insurer's assets and the cost of capital such that the effect of a higher risk-free rate on insurance prices is increasing with initial liabilities L_i^0:

$$\frac{\partial}{\partial L_i^0} \left\{ \frac{\partial P_i}{\partial r_f} \right\} > 0. \tag{15}$$

Summary In our model, monetary policy shocks affect insurance prices through two competing channels. In a frictionless insurance market, higher interest rates reduce the present value of future insurance claims, reducing insurance prices. However, due to the adverse effect of higher rates on the market values of insurers' asset investments, higher interest rates depress statutory capital. This increases the shadow cost of capital, inducing upward pressure on insurance prices. Differences in leverage (L_i^0) and in the interest rate sensitivity of assets (α_i) imply heterogeneous responses to monetary policy across insurers with different balance sheet characteristics.

3 DATA

In this section, we describe the data we use in our empirical analysis. We construct three datasets to, first, analyze insurance prices, second, insurers' balance sheets, and third, housing and mortgage markets. All continuous variables, except for macroeconomic characteristics, are winsorized at the 1% and 99% levels.

Insurance prices U.S. insurance companies report all changes in homeowners insurance prices to state regulators at the subsidiary level. We obtain these filings, called “rate filings”, submitted between 2010 and 2019 from S&P’s Rate Watch database. In states that require regulatory approval of price changes, we only consider approved changes.[14] From rate filings, we obtain information on insurance price growth. It is defined as the percentage change in the price of insurance weighted by affected insurance premiums, i.e., the hypothetical percentage change in total affected premiums if all affected policyholders would roll over their contracts at the new price. Thus, this measure for price changes is not confounded by changes in the *quantity* of insurance in response to price changes (in contrast, e.g., to total premiums written), which is a key advantage of the data for understanding price dynamics. Moreover, the data includes information on the insurer and state, date of submission, effective date, and total premiums written on affected products for each filing. Panel 1 of Table 1 describes the final sample comprising more than 27,000 rate filings submitted from 2010 to 2019. On average, insurers submit a rate filing once a year, increasing prices by 6 percent.

Insurer balance sheets We retrieve security-level data on each insurer’s end-of-year security holdings and all security transactions from their filings to the National Association of Insurance Commissioners (NAIC). The data contains extensive information about book and market values and security characteristics (such as coupon rates, credit risk scores, and maturity dates). We use this data to decompose insurers’ investment income according to the underlying assets (stocks or fixed income) and revenue source (unrealized capital gains from holding the asset or realized gains from asset sales). Throughout the analyses, we only consider insurers that sell homeowners insurance, i.e., property insurers.

We compute two measures of portfolio sensitivity to interest rate changes. First, we calculate the share of insurers’ total assets that are mark-to-market according to statutory accounting rules. P&C insurers must hold stocks and high-yield bonds at their market values, whereas investment-grade bonds and redeemable preferred stocks are held at historical costs. Applying these rules, we compute the end-of-year share of mark-to-market assets on insurers’ balance sheets as a fraction of the total book value of assets.

Second, we compute the average duration of fixed-income portfolios based on the end-of-year Macaulay duration of individual fixed income securities. For this purpose, we use information on the time to maturity, coupon rates and interest frequency from Mergent FISD and compute bond yields based on corporate bond prices from TRACE Enhanced (cleaned following Dick-Nielsen, 2014), municipal bond prices from MSRB, all merged using CUSIP identifiers, and U.S. Treasury yields from the Federal Reserve.[15] Appendix E gives a detailed description of our approach. We are able to compute durations for most corporate, municipal, and U.S. Treasury bonds, matching approximately 60 percent

14 See Appendix Table D.1 for details on the data cleaning.

15 The Federal Reserve publishes data on Treasury yield curves on federalreserve.org. The data is based on the approach in Gürkaynak et al. (2007) with minor modifications.

of the overall fixed-income portfolio and close to 40 percent of total assets (see Appendix Figure E.1). Security-level durations are then aggregated at the insurer level by weighting by book values.

Home prices and mortgages We download data on county-level monthly home prices from Zillow.[16] In our baseline analyses, we use home prices including all types of homes, i.e., single-family residences as well as condos, from 2010 to 2019 at the county level and monthly frequency. Furthermore, we aggregate annual application-level data from the Home Mortgage Disclosure Act (HMDA) to the county level. The average county experiences a monthly increase in home prices of 0.26 percent, equivalent to a 3.2 percent increase over a year (see Panel 3 of Table 1). On average, 3,590 mortgage applications in a year are reported in a county, amounting to $813 million, which implies that an average mortgage amount of about $225,000.

Controls We enrich our sample with detailed information on insurer characteristics, macroeconomic conditions, and risk exposure. From insurers' quarterly regulatory filings to the NAIC, we access balance sheet and income information, including total assets, leverage, return on equity (ROE), risk-based capital (RBC) ratio, annualized underwriting gain (scaled by lagged policy reserves), and investment income (scaled by lagged total invested assets). We use the Spatial Hazard Events and Losses Database for the United States (SHELDUS) to calculate the 5-year trailing average and standard deviation of annual disaster damages (excluding floods) at the state and county levels. Moreover, we obtain information on state-level annual GDP per capita from the Bureau of Economic Analysis (BEA), population numbers from the U.S. Census Bureau, and the annualized change in the state's house price index (HPI) from the Federal Housing Finance Agency.

Finally, we use the real GDP growth, CBOE Volatility Index (VIX), and national inflation measured by the Consumer Price Index, all obtained from FRED, to control for U.S. aggregate macroeconomic conditions. Table D.2 in the Appendix provides detailed summary statistics for all control variables.

Monetary policy We use monetary policy surprises computed as changes in the 10-year U.S. Treasury yield in a 30-minute window around FOMC meetings by Bauer and Swanson (2023). To document the robustness of our results, we also consider alternative measures for monetary policy surprises from Nakamura and Steinsson (2018) and Gürkaynak et al. (2005), which are based on changes in short-term rates.[17] To remove variation from central bank information surprises in the spirit of Jarociński and Karadi (2020), we construct a control variable composed of the monetary policy surprises for which the S&P 500 moves in the "wrong" direction (i.e., when it increases upon a contractionary surprises or decreases upon expansionary surprises). Taking into account the low frequency of insurance price changes, we use six-month lagged cumulative monetary policy surprises in the main analyses.

16 Source: zillow.com.

17 For the shocks of Gürkaynak et al. (2005), we download the updated shock series from Acosta (2022), Miguel Acosta makes available on his webpage.

4 Monetary Policy and Insurance Prices: Baseline Results

In this section, we document that contractionary monetary policy is associated with higher insurance prices.

Empirical specification Identifying the impact of monetary policy on insurance supply is challenging because monetary policy reacts to macroeconomic conditions that simultaneously affect insurance prices. Extracting the *surprise* component from monetary policy decisions is the canonical approach to address this concern. Specifically, we use changes in the 10-year U.S. Treasury yield in 30-minute windows around FOMC meetings motivated as follows.[18] First, high-frequency changes in market rates are widely used in the macroeconomic literature to elicit unanticipated monetary policy shocks (Gürkaynak et al., 2005; Gertler and Karadi, 2015; Nakamura and Steinsson, 2018; Swanson, 2021; Bauer and Swanson, 2023). Second, the average maturity of insurers' fixed income portfolio is approximately equal to ten years (see Figure C.2). Therefore, fluctuations in long-term rather than short-term rates drive insurers' investment income. Finally, in contrast to short-term rates, the zero lower bound does not constrain long-term rates during the time horizon of our sample. Thus, whereas the impact of monetary policy events on short-term rates is relatively muted during this period, the impact on long-term rates is highly significant and, thus, also reflects unconventional monetary policy measures.

Figure 1 depicts the relationship between insurance price changes and monetary policy surprises in 10-year Treasury yields as a binned scatter plot. The figure shows a strong positive correlation: more restrictive monetary policy is associated with higher insurance prices.

In our baseline specification, we regress insurance price growth at the rate filing level on lagged monetary policy surprises, controlling for aggregate and local macroeconomic conditions as well as insurer characteristics:

$$\Delta \text{Price}_f = \beta_{MP}\ \Delta \text{MP}_{(t-1:t-6)} + \boldsymbol{\gamma}_I \boldsymbol{I} + \boldsymbol{\gamma}_S \boldsymbol{S} + \boldsymbol{\gamma}_M \boldsymbol{M} + u_{i,s} + v_{p,s} + \epsilon_f, \tag{16}$$

where ΔPrice_f is the insurance price growth in rate filing f by insurer i in state s in month t. $\Delta MP_{(t-1:t-6)}$ is the sum of high-frequency surprises in the 10-year Treasury yield around FOMC meetings during the six months preceding filing f. The main coefficient of interest is β_{MP}, which measures the sensitivity of insurance prices to a one standard deviation monetary policy surprise tightening. We use cumulative monetary policy events to account for insurers adjusting prices only once per year (the results are robust to using the one-year trailing sum of monetary policy surprises).

18 The significant impact of monetary policy on long-term rates has been highlighted by prior literature (Hanson and Stein, 2015). Hillenbrand (2023) documents that fluctuations of long-term Treasury yields around FOMC meetings capture a significant share of transient yield changes.

By estimating β_{MP} in (16) from price *changes* we remove the impact of possibly correlated trends in monetary policy (surprises) and insurance prices.

$\boldsymbol{I}$, $\boldsymbol{S}$, and $\boldsymbol{M}$ are insurer-specific, state-specific, and aggregate controls, respectively. $\boldsymbol{I}$ includes insurer i's *Log(Assets)*, *Leverage*, *ROE*, *RBC ratio*, *Underwriting (UW) gain*, and *Investment income*, all lagged by three quarters relative to filing f (i.e., measured before the monetary policy surprises). These variables reflect insurers' financial characteristics and, in particular, profitability. State characteristics $\boldsymbol{S}$ include *Log(Mean 5-yr damage)*, *Log(SD 5-yr damage)*, *Log(GDP per capita)*, all for the year preceding filing f, and Δ*HPI*, lagged by three quarters. Aggregate controls $\boldsymbol{M}$ include the 6-months trailing national GDP growth, Δ*GDP*, and CPI growth, Δ*CPI*, the CBOE Volatility Index, *VIX* as well as the cumulative sum of information surprises. These control variables capture macroeconomic conditions that may affect monetary policy decisions and variation in disaster risk, a key component of homeowners insurance prices. Finally, $u_{i,s}$ and $v_{p,s}$ are insurer-by-state and homeowners insurance product-by-state fixed effects, which absorb time-invariant differences across insurers, products, and states. We cluster standard errors at the insurer, the state, and the year-month level, accounting for potential auto-correlation in price growth and cross-sectional correlation due to the aggregate level of monetary policy surprises.

Baseline results Table 2 reports OLS estimates for Equation (16). In column (1), we include insurer-state and product-state fixed effects but no control variables. The coefficient on monetary policy surprises is highly statistically significant at the 1% level. Its magnitude and significance are robust to including insurer, state, and aggregate control variables, as we show in columns (2) and (3). Moreover, we document the robustness to using alternative measures of monetary policy surprises, namely those of Nakamura and Steinsson (2018) and Gürkaynak et al. (2005). In both cases, the coefficient on monetary surprises is positive and statistically significant (columns 4 and 5). Because these alternative measures rely on high-frequency surprises in *short-term* rates, magnitudes are not directly comparable to the baseline results. Therefore, we re-scale the coefficients by the respective coefficients in regressions of $\Delta\text{MP}_{(t-1:t-6)}$ on the alternative measures. The magnitude of the re-scaled coefficients is comparable to that in column (3), emphasizing the robustness of the result. The point estimates imply that a 1 ppt monetary policy surprise is associated with 7 to 10% higher insurance prices for the average rate filing.

Robustness In Appendix Table D.3, we show that the baseline results are robust in various alternative specifications. First, the elasticity of insurance prices to monetary policy surprises is stable across different subsamples, including periods that exclude 2010 or start in 2012. Second, the baseline result is robust to using alternative measures to control for inflation, such as PCE and state-level inflation (Hazell et al., 2022). Third, the estimate is robust to aggregating monetary policy surprises between two consecutive filings, accounting for heterogeneity in filing frequency. Furthermore, we document that insurers do not significantly adjust other variables in their rate filings in response to monetary policy, such as the number of policyholders affected or the terms and conditions of insurance contracts.

Finally, we address the concern that adjustments in the frequency of filing for price changes may affect the main result. For this purpose, we extend our sample to the insurer-by-state-by-year-month level and, first, test whether monetary policy affects filing frequencies:

$$\mathbf{1}(\text{Rate filing}_{i,s,t}) = \beta_{MP}\ |\Delta\text{MP}_{(t-1:t-6)}| + \boldsymbol{\gamma}_I \boldsymbol{I} + \boldsymbol{\gamma}_S \boldsymbol{S} + \boldsymbol{\gamma}_M \boldsymbol{M} + u_{i,s} + v_{s,season} + \epsilon_{i,s,t}, \tag{17}$$

where $\mathbf{1}(\text{Rate filing}_{i,s,t})$ is a dummy variable that equals one if insurer i files in state s in year-month t for a change in insurance prices. All other variables are defined as before. $u_{i,s}$ and $v_{s,season}$ are insurer-state fixed effects and state dummies interacted with calendar month dummies, absorbing state-specific seasonality in filing behavior. We use a three-way clustering of standard errors at the insurer, state, and year-month level. $|\Delta\text{MP}_{(t-1:t-6)}|$ is the absolute value of lagged cumulative monetary policy surprises. Thus, β_{MP} estimates whether insurers are more likely to file for insurance price changes in response to larger absolute (either contractionary or expansionary) monetary policy surprises.

We find that the estimate for β_{MP} in Equation (17) is close to zero and with a low t statistic (-1.69) (see Appendix Table D.3), suggesting a weak impact of monetary policy surprises on the probability to change prices. The result is similar when we use an indicator for all product filings as the dependent variable, reflecting price changes and other changes in insurance supply, e.g., in the terms and conditions of products. Finally, we construct a balanced panel of price changes at the monthly frequency for each insurer-state pair, including zeros in months without rate filings. The result is consistent with our baseline findings, emphasizing their robustness and the absence of confounding effects at the extensive margin.[19]

5 Monetary Policy and Insurers' Investment Income

We argue that the impact of monetary policy surprises on insurance prices is governed by their effect on insurers' asset investments, which we document in the following.

Investment income Insurers invest insurance premiums in financial assets to generate investment income. In aggregate, property insurers invest 80 percent of total assets in stocks and bonds (see panel (a) of Appendix Figure C.3), which includes preferred and common stocks, corporate bonds, municipal bonds, government bonds, and asset-backed securities. The investment income from these assets affects statutory balance sheets primarily in two ways. First, holding securities generates income from interest and dividends collected, amortization and accruals (of assets held at historical costs), and unrealized

19 If an insurer submits two rate filings in the same state in the same month, we consider the weighted average of $\Delta Price_f$ with premiums affected as weights. It is important to note that the coefficient in the balanced panel is different from that in the baseline results because it includes months without rate filings. In the balanced panel, the point estimate for the coefficient on monetary policy surprises equals 0.724. Given that the average insurer submits a new rate filing every 12 months, this approximately corresponds to a 8.7% increase in insurance prices *conditional* on a rate filing, which is consistent with the estimate in Table 2.

gains from market price fluctuations (of assets held at market values). Second, if insurers trade these securities, they realize gains or losses from differences between market and book values on asset sales. Panel (b) of Appendix Figure C.3 decomposes insurers' investment income in aggregate. The largest contributors to investment income are holdings of stocks and bonds, which, on average, account for approximately 30% and 50% of total investment income, respectively.

Empirical specification We examine the impact of monetary policy surprises on investment income in the following specification at quarterly frequency:

$$\text{Outcome}_{i,q} = \beta_{MP}\ \Delta\text{MP}_q + \boldsymbol{\gamma}_I \boldsymbol{I}_{i,q-1} + \boldsymbol{\gamma}_M \boldsymbol{M}_{q-1} + u_i + \varepsilon_{i,q}, \tag{18}$$

where $\text{Outcome}_{i,q}$ is insurer i's investment income component in year-quarter q scaled by lagged total invested assets. $\boldsymbol{I}_{i,q-1}$ and $\boldsymbol{M}_q$ are the same insurer and macroeconomic controls as in Equation (16), respectively, and u_i are insurer fixed effects. We use two-way clustered standard errors at the insurer and RBC ratio quintile-time level. The main coefficient of interest is β_{MP}, which reflects the elasticity of investment income to the cumulative monetary policy surprises in 10-year Treasuries in year-quarter q.

Results Table 3 shows the estimated coefficients. Insurers collect significantly less coupons and dividends in response to contractionary monetary policy shocks (column 1), consistent with tighter financial constraints of security issuers. The decline in income collected is offset by an increase in realized gains (column 2). This result suggests that insurers actively sell securities held at historical costs with high market values to bolster their investment income, similarly to the dynamics documented in Ellul et al. (2015).

The impact of monetary policy on income collected and realized gains is dwarfed by that on unrealized gains of mark-to-market assets. Total unrealized gains significantly decline in response to contractionary monetary policy surprises (column 3), with the elasticity being close to an order of magnitude larger than that for the other investment income components. The point estimate implies that unrealized gains (relative to invested assets) decline by 1.24 ppt in response to a 1 ppt monetary policy surprise.

The effect on total unrealized gains is driven by portfolio composition. We use cross-sectional quartiles of portfolio duration to sort insurers into those with particularly short (lowest quartile) and long (highest quartile) durations (columns 4 and 5).[20] Analogously, we use cross-sectional quartiles of the share of mark-to-market assets (MTM share) to sort insurers into those with particularly low (lowest quartile) and high (highest quartile) MTM share (columns 6 and 7). We find that insurers with longer durations and higher MTM shares exhibit substantially larger elasticities to monetary policy

20 In Appendix E2, we show that the prices of individual bonds with a longer duration respond significantly more to monetary policy surprises.

surprises, reaching of 1.5 and 3.5, respectively. Thus, the response of unrealized gains to monetary policy surprises is driven by the interest rate sensitivity of insurers' portfolios.

6 MONETARY POLICY AND INSURANCE PRICES: ECONOMIC MECHANISM

The model in Section 2 predicts that contractionary monetary policy shocks increase insurance prices because they dampen insurers' investment income, which tightens financial constraints. This effect strengthens with the severity of financial frictions and with the sensitivity of investment income to monetary policy. In the following, we provide empirical evidence for this mechanism.

Financial frictions First, we examine the role of financial frictions. Following prior literature (Ellul et al., 2011; Koijen and Yogo, 2015), we focus on cross-sectional heterogeneity in insurers' risk-based capital (RBC) ratio. The RBC ratio is defined as the ratio of statutory capital to regulatory required capital. A lower RBC ratio indicates a higher financial fragility of the insurer and, thus, a higher probability of regulatory interventions. Investment income is an important determinant of statutory capital. In regressions of annual changes in statutory capital on investment income, we estimate that a \$1 higher investment income translates into a nearly \$1 increase in statutory capital (see Appendix Table D.4).[21] Thus, everything else equal, declines in investment income translate into lower RBC ratios.

To take heterogeneity in insurers' business models into account, we focus on the deviation in an insurer's RBC ratio from its trailing average, defined as

$$\text{RBC gap}_{i,y-1} = \overline{\text{RBC}}_{i,(y-7):(y-2)} - \text{RBC}_{i,y-1} = \frac{1}{6}\sum_{\tau=2}^{7} \text{RBC}_{i,y-\tau} - \text{RBC}_{i,y-1}. \tag{19}$$

The larger *RBC gap*$_{i,y-1}$, the lower the capital ratio in year $y-1$ relative to its trailing average and, thus, the more constrained is the insurer. Following our model's predictions, we expect insurers with a larger *RBC gap* to increase prices more after contractionary monetary policy surprises.

To test this hypothesis, we saturate Equation (16) by interacting monetary policy surprises with indicator variables for the terciles of *RBC gap*$_{i,y-1}$:

$$\begin{aligned}\Delta\text{Price}_f = {} & \beta_C \text{ Constrained}_{i,y-1} \times \Delta\text{MP}_{(t-1:t-6)} + \beta_I \text{ Intermediate}_{i,y-1} \times \Delta\text{MP}_{(t-1:t-6)} \\ & + \beta_{MP}\ \Delta\text{MP}_{(t-1:t-6)} + \gamma_I \boldsymbol{I} + \gamma_S \boldsymbol{S} + \gamma_M \boldsymbol{M} + u_{i,s} + v_{s,p} + \epsilon_f,\end{aligned} \tag{20}$$

where ΔPrice_f is the insurance price growth in rate filing f submitted at time t (in months) in year y. *Constrained*$_{i,y-1}$ and *Intermediate*$_{i,y-1}$ are indicator variables that take the value 1 if insurer i's *RBC gap*

21 In unreported regressions, we verify that this relationship is robust to scaling both variables with lagged regulatory capital. Moreover, the relationship between investment income and statutory capital is robust to controlling for aggregate shocks by including year fixed effects and it is primarily driven by the pass-through of investment income from holding rather than trading securities.

is in the third and second tercile of its distribution, respectively. All other variables are defined as before. β_C and β_I estimate the differential impact of monetary policy surprises on highly and intermediately constrained insurers relative to unconstrained insurers, respectively.

Table 4 reports the estimated coefficients. The estimate for β_{MP} on the baseline term is positive and statistically significant (t-statistic: 2.08), but quantitatively lower than the average effect (7-10%) uncovered earlier (column 1). The estimate for β_I is close to and not significantly different from zero, pointing to no significant differences between unconstrained and intermediately constrained insurers. In contrast, the estimate for β_C on the interaction term with constrained insurers is positive and statistically significant (t-statistic: 2.16). The magnitude implies that constrained are more than twice as sensitive to monetary policy surprises as other insurers, increasing prices by more than 10% ($\beta_{MP} + \beta_C$) in response to a 1 ppt hike.

An important concern is that the estimate for β_C in column (1) is affected by a potential correlation between insurers' financial constraints and the monetary policy stance. Moreover, the effects of monetary policy may differ across product markets independently of insurer balance sheets, e.g., due to policyholder characteristics, which might correlate with financial constraints. To address these concerns, we assess the robustness of the results to including state-by-time fixed effects in column (2) and state-by-time-by-product fixed effects in column (3). These granular fixed effects absorb the aggregate, state-specific, and product-by-state-specific effects of monetary policy as well as other macroeconomic shocks. The inclusion of these fixed effects does neither reduce the statistical significance nor the point estimate for β_C. Instead, the coefficient becomes more statistically significant and larger, which points to the absence of confounding variation at the aggregate, state, or product levels.

Portfolio sensitivity Second, we examine the interaction of financial frictions with the sensitivity of insurers' investment income to monetary policy surprises. For this purpose, we build on the cross-sectional heterogeneity documented in Section 5 and interact the indicators for constraints with two measures of portfolio sensitivity in Equation (20).

Mark-to-market The first measure of portfolio sensitivity is the share of insurers' assets that are held at market values. We define an indicator variable that takes the value one if an insurer's lagged mark-to-market (MTM) share is in the fourth quartile of the annual cross-sectional distribution. In the specification in column (4), we include triple interaction terms of monetary policy surprises and indicators for the level of constraints and a high MTM share. As before, we use granular fixed effects at the product-by-state-by-time level to absorb any potentially confounding state-specific shocks to insurance product markets. The coefficient on the triple interaction term for constrained insurers is significantly different from zero at the 5% level and positive. Thus, constrained insurers with a higher MTM share respond significantly more to monetary policy surprises compared to unconstrained insurers. This result further substantiates the interest rate sensitivity of insurers' investment income as a main driver of the baseline effect. The coefficients imply that constrained insurers with a high

MTM share increase prices by almost 16 ppt more than unconstrained insurers with low MTM shares ($= 3.846 + 0.000 + 12.040$).

The coefficient on the triple interaction term for constrained insurers significantly differs from zero at the 5% level and is positive. Thus, regulatory-constrained insurers with a larger MTM share respond significantly more to monetary policy surprises than less constrained insurers.

Duration The second measure is the interest rate duration of insurers' bond portfolio. We define an indicator variable that takes the value one if an insurer's lagged fixed income portfolio duration is in the fourth quartile of the annual cross-sectional distribution. In the specification in column (5), we include triple interaction terms of monetary policy surprises and indicators for the level of constraints and a long portfolio duration. We use granular fixed effects at the product-by-state-by-time level to absorb any potentially confounding state-specific shocks to insurance product markets. Thus, the coefficients are identified based on variation in constraints and durations across insurers within the same state and for the same type of products. The coefficient on the triple interaction term for constrained insurers is significantly different from zero at the 1% level and positive. Thus, constrained insurers with a longer portfolio duration respond significantly more to monetary policy surprises compared to unconstrained insurers. This result is consistent with the effects of monetary policy being governed by the interest rate sensitivity of insurers' investment income. Similarly, we find a positive coefficient on the triple interaction term for intermediately constrained insurers, yet, with lower magnitude and statistical significance. The coefficients imply that constrained insurers with long duration portfolios increase prices by 17 ppt more than unconstrained insurers with short durations ($= 1.346 + 0.000 + 15.762$), emphasizing the substantial cross-sectional heterogeneity in the response to monetary policy.

These results are consistent with our model's predictions. They suggest that monetary policy surprises are transmitted to insurance markets through their effect on asset prices, amplified by regulatory frictions.

7 Effects on the Housing and Mortgage Markets

This section presents evidence that monetary policy-induced changes in homeowners insurance supply affect the housing and mortgage markets.

Importance of homeowners insurance As documented in Section 1, premiums for homeowners insurance account for a substantial share of housing costs. Therefore, changes in insurance supply may have significant effects on home purchase decisions. Specifically, higher insurance prices may reduce the marginal buyer's willingness to pay for housing, especially in areas with (high) risk of natural disasters. In these areas, owning homes without insurance is more risky. At the same time, insurance prices are particularly high in absolute terms as well as relative to total housing costs and to household income.

Local insurer sensitivity To narrow in on the transmission through homeowners insurance markets, we construct a measure for the sensitivity of *local* insurance companies to monetary policy, denoted by $\phi_{s,t}$. $\phi_{s,t}$ is defined as the differential impact of monetary policy surprises on insurance prices in state s driven by heterogeneity in local insurers' constraints and interest rate sensitivity. For this purpose, we use the specifications in columns (4) and (5) in Table 4 and, for each specification, define by $\hat{\phi}_f = \frac{\partial \Delta Price_f}{\partial \Delta \text{MP}_{(t-1:t-6)}}$ the estimated filing-specific effect of monetary policy surprises. By construction, $\hat{\phi}_f$ varies across (but not within) insurers depending on the tightness of their constraints and their interest rate sensitivities, both measured with a lag to t. Then, $\phi_{s,t}$ is defined as the average of $\hat{\phi}_f$ at the state-by-month level weighted by the lagged amount of premiums affected by rate filing f.[22] We distinguish between monetary policy sensitivity $\phi_{s,t}$ based on the MTM share and that based on the fixed income portfolio duration.

Home prices First, we examine the impact on home prices. For this purpose, we estimate local projections (Jordà, 2005) with the following specification:

$$P_{c,t+h} - P_{c,t-7} = \beta_I^h \ \phi_{s,t} \times \Delta \text{MP}_{(t-1:t-6)} + \beta_{MP}^h \ \Delta \text{MP}_{(t-1:t-6)} + \boldsymbol{\gamma}^h \boldsymbol{X} + u_{c,season} + \varepsilon_{c,t+h}. \tag{21}$$

$P_{c,t+h}$ and $P_{c,t-7}$ are the natural logarithm of the average home price in county c in month $t+h$ and $t-7$, respectively. $\Delta MP_{(t-1:t-6)}$ are the cumulative high-frequency surprises in the 10-year Treasury yield during the previous 6 months. $\boldsymbol{X}$ is a vector of county-level controls, which include the county's population density, annual growth in GDP per capita, and population, and macroeconomic controls, i.e., the VIX, GDP growth, and CPI inflation over the past six months. β_I^h estimates the differential response of home prices in states in which insurers are more sensitive to monetary policy. Following Jordà (2005), we control for lags of monthly price changes in county c. $u_{c,season}$ denotes county-by-calendar month fixed effects, which absorb county-specific seasonality in home prices throughout the calendar year.

Identification An important identification concern is that differences in insurer sensitivity $\phi_{s,t}$ might correlate with other spatial characteristics that modulate the transmission of monetary policy to housing markets. To alleviate this concern we include a county's population density, the logarithm of GDP per capita and the logarithm of population count on their own and interacted with the monetary policy surprises as control variables. Moreover, in refined specifications, we include a triple-interaction term of monetary policy surprises, state-level insurer sensitivity, and county-level exposure to natural disasters, exploiting within-state variation.

Figure 3 depicts the estimated coefficients for MTM-based sensitivity in panel (a) and for duration-based sensitivity in panel (b). The black dashed line plots the effect of monetary policy on home

22 This approach exploits that monetary policy surprises do not significantly affect the probability of rate filings (see Appendix Table D.3).

prices for counties with less-exposed insurers (defined as those in the 10th percentile of $\phi_{s,t}$), whereas the blue solid line plots that for exposed insurers (defined as those in the 90th percentile). For both sensitivity measures, home prices decline more when local insurance companies are more sensitive to monetary policy. The differential effect is economically significant. Considering the results from panel (b) of Figure 3, a 1 ppt monetary policy surprise reduces home prices over the following six months by about 0.7% in counties with a low insurer sensitivity and by approximately twice as much in counties with a high insurer sensitivity. The result is qualitatively similar for MTM-based sensitivity, emphasizing its robustness. Moreover, in Appendix Figures C.4 and C.5, we show that the results are robust to across different types of homes, such as single-family homes and condos, and across different terciles of the home value distribution.

Disaster exposure To further narrow in on the insurance channel, we additionally consider variation in natural disaster exposure across counties within states, which is a key determinant of the level of insurance prices. We expect that home prices in states with monetary policy-sensitive insurers are more responsive in counties that are more exposed to natural disasters. To test this hypothesis, we interact monetary policy surprises in Equation (21) with an indicator variable *High risk*$_{c,t}$ that takes the value of 1 if county c experienced natural disaster damages over the lagged 5 years and zero otherwise.[23] There is substantial variation in *High risk*$_{c,t}$ both in the cross section of counties and over time (see Appendix Figure C.6). Some counties rarely experience disaster damage, while other counties are at high risk, especially those in coastal areas. The identifying assumption is that variation in disaster exposure does not correlate with other determinants of monetary policy transmission, conditional on the county characteristics described above.

Figure 4 shows the effect of monetary policy surprises on home prices in exposed states (within the 90th percentile of $\phi_{s,t}$) for high-risk counties (solid blue line)and low-risk counties (dashed black line). The figure shows that home prices in high-risk counties respond approximately twice as much to monetary policy surprises as those in low-risk counties. Again, the findings are robust across definitions of the exposure measure $\phi_{s,t}$.

Mortgage applications Finally, we examine the spillovers to the mortgage market. Banks require that the total principal, interest, tax, and insurance (PITI) payments of prospective mortgage borrowers do not exceed a fixed fraction of their income, typically close to 30%. Thus, by raising PITI payments, higher insurance premiums may reduce mortgage demand and supply.[24] We estimate the effect of monetary policy-driven contractions in insurance supply on county-level mortgage applications in the

23 We exclude damages from floods because these are not covered by homeowners insurance.

24 Lender often hold mortgage borrowers' insurance payments in escrow and pay insurance companies directly. Various online tools allow households to compute their PITI payments and estimate the house price they can afford paying, e.g., at `https://www.chase.com/personal/mortgage/calculators-resources/affordability-calculator` or `https://www.bankrate.com/mortgages/mortgage-calculator/`. Homeowners insurance premiums directly feed into this calculation.

following specification:

$$\Delta\text{Log(Mortgage outcome)}_{c,y} = \beta_I\ \phi_{s,y} \times \Delta\text{MP}_{H2(y-1)} + \beta_{MP}\ \Delta\text{MP}_{H2(y-1)} + u_c + v_{GDP,y} + w_{pop,y} + \varepsilon_{c,y} \tag{22}$$

where *Log(Mortgage outcome)*$_{c,y}$ is either the logarithm of the number or total volume of mortgage applications submitted in county c in state s in year y. These include all originated loans as well as withdrawn and denied applications. $\Delta\text{MP}_{H2(y-1)}$ is the sum of monetary policy surprises during the previous 6 months, i.e., second half of year $y-1$, in 10-year Treasuries. $\phi_{s,y}$ is local insurers' sensitivity to monetary policy as of the first month of year y. β_I estimates the differential effect of monetary policy surprises in counties with more monetary policy-sensitive insurers. We absorb variation in mortgage applications driven by monetary policy and other aggregate shocks with granular fixed effects. To ensure that β_I is not confounded by the differential monetary policy sensitivity of counties with different economic fundamentals, we sort counties into quintiles of GDP and population count and interact indicators for these quintiles with time fixed effects. Thus, β_I is estimated from differences across counties with similar economic fundamentals but different local insurance sectors within the same years.

Table 5 reports the estimated coefficients. We find that mortgage applications decline significantly more with contractionary monetary policy surprises when local insurers are more sensitive to monetary policy. This differential effect is statistically significant for both the number of mortgage applications (columns (1) and (2)) and loan amounts (column (3) and (4)). It is also robust across the two approaches to measure insurer sensitivity, i.e., using the MTM share as well as using portfolio duration. These results support a negative effect of higher insurance prices on total mortgage borrowing. By exploring mortgage applications rather than successful originations, the results point to an effect running through mortgage demand, consistent with lower housing affordability due to monetary policy-driven insurance supply contractions. Nonetheless, as borrowers may anticipate potential supply effects when applying for mortgages, changes in mortgage supply may contribute to the findings.

8 Conclusion

Insurance companies are important financial intermediaries, linking households to financial markets by investing insurance premiums in financial assets. In this paper, we explore the transmission of monetary policy through the homeowners insurance market, an essential insurance product to obtain mortgages and the first line of defense against climate risks. In a stylized model, we show that financially constrained insurers suffer from the negative impact of monetary policy on their investment income and, as a result, reduce insurance supply. Consistent with this prediction, we document a dampening effect of contractionary monetary policy surprises on insurance supply on average.

Exploiting disaggregated data on insurer balance sheets, we provide empirical evidence for the mechanism behind this effect. Insurers' investment income is more sensitive to monetary policy when insurers hold larger amounts of interest-rate-sensitive assets and when a larger share of their assets is mark-to-market on their balance sheets. We document that these insurers, if they are severely financially constrained, raise insurance prices significantly more in response to contractionary monetary policy surprises.

Monetary policy-driven shocks to insurance supply transmit to the broader economy by affecting housing and mortgage market outcomes. We measure insurers' ex-ante sensitivity to monetary policy from their balance sheet characteristics and provide evidence that home prices and mortgage applications decrease significantly more in response to contractionary monetary policy surprises when local insurers are more sensitive to monetary policy.

Overall, our results emphasize the importance of the homeowners insurance sector in the economy and the important interlinkages with housing and loan markets.

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Figures

Figure 1
Monetary policy and insurance prices

This figure shows a binned scatter plot of insurance price changes at filing level (y-axis) and the cumulative of monetary policy surprises measured as the cumulative changes in the 10-year U.S. Treasury yield in 30-minute windows around FOMC meetings over the preceding six months (x-axis) after absorbing insurer fixed effects.

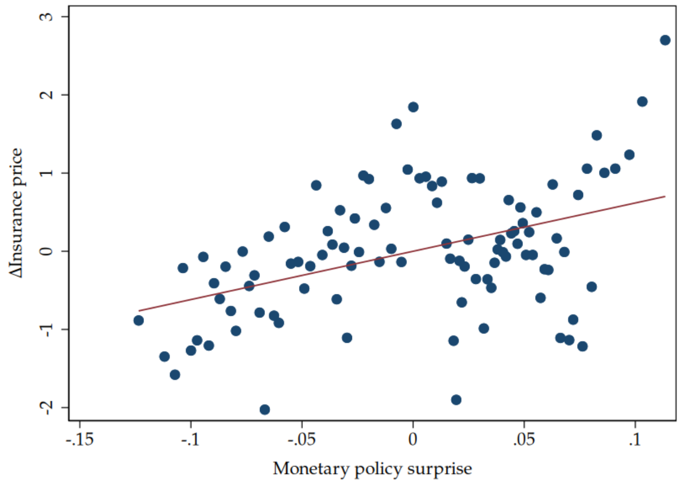


Figure 2
Monetary policy surprises

This figure shows the time series of monetary policy surprises, i.e., the cumulative changes in the 10-year U.S. Treasury yield in 30-minute windows around FOMC meetings over the preceding six months.

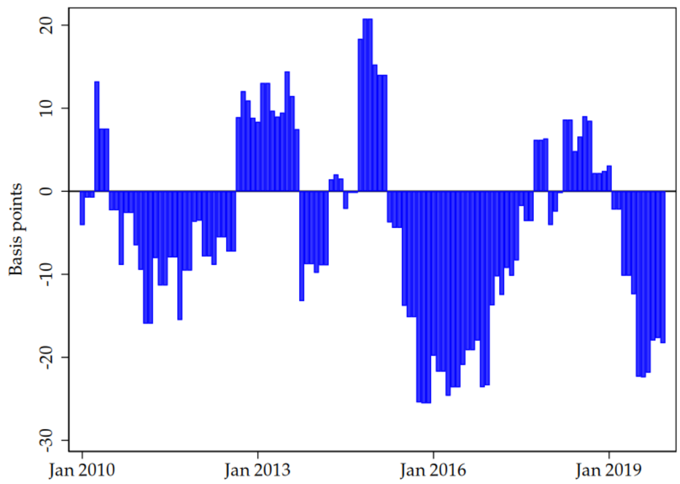
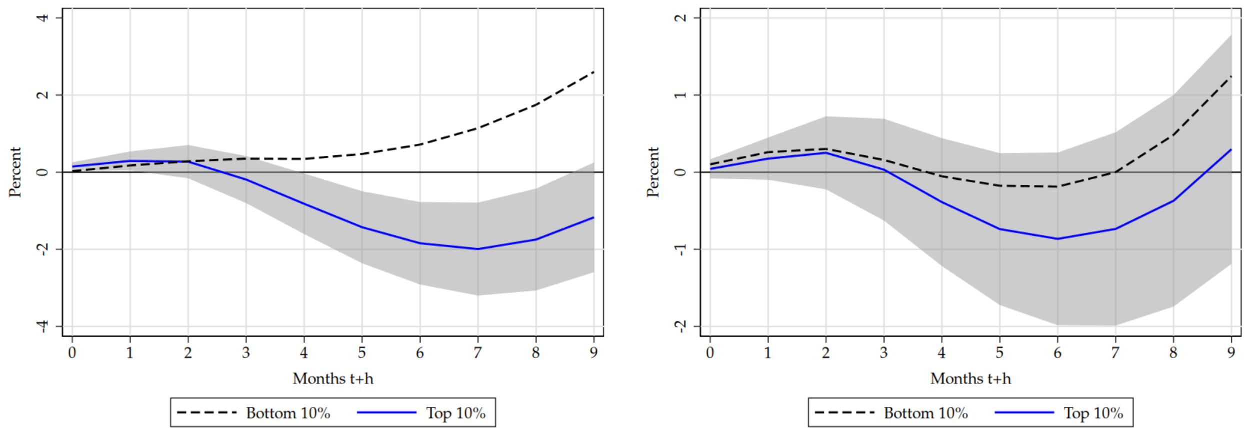


Figure 3
Home prices and monetary policy transmission

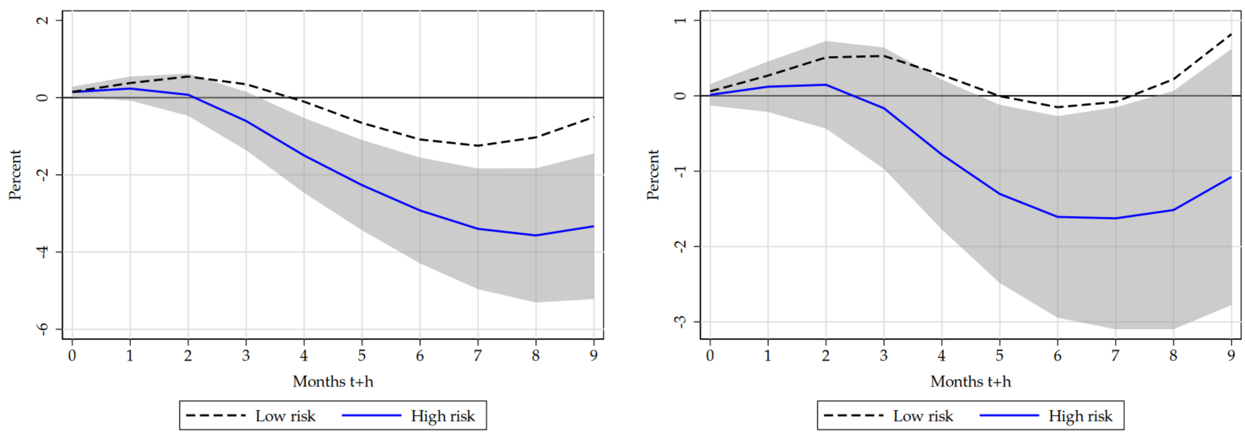
This figure shows estimates from the local projections in Equation (21). We regress the cumulative growth in home prices on monetary policy surprises interacted with local insurers' sensitivity to monetary policy ϕ. The black dashed line represents the effect of a 1 percentage point cumulative monetary policy surprise on home prices at the 10th percentile of the pooled distribution of insurers' sensitivity. The blue solid line represents the effect at the 90th percentile of the pooled distribution of insurers' sensitivity. The gray area plots the corresponding 90% confidence intervals. Insurer sensitivity ϕ is based on financial constraints and mark-to-market share in panel (a) and on financial constraints and fixed income duration in panel (b).



(a) MTM ϕ **(b)** Duration ϕ

Figure 4
Disaster exposure, home prices, and monetary policy transmission

This figure shows estimates from the local projections in Equation (21) separately for counties exposed to natural disasters (high risk) and other counties (low risk). Both lines represent the effects of a 1 percentage point cumulative monetary policy surprise on home prices at the 90th percentile of the pooled distribution of insurers' sensitivity to monetary policy. The black dashed line is for low-risk counties, defined as those that did not experience disaster damages in the preceding 5 years. The solid blue line is for high-risk counties, defined as those that experienced disaster damages in the preceding 5 years. The gray area plots the corresponding 90% confidence intervals. Insurer sensitivity ϕ is based on financial constraints and mark-to-market share in panel (a) and on financial constraints and fixed income duration in panel (b).



(a) MTM ϕ **(b)** Duration ϕ

TABLES

Table 1
Summary statistics

This table shows the summary statistics for the main variables used in the empirical analysis.
Filing information. Δ*Price* is the effective change in the insurance price. *Filing time* is the number of days between the insurer's current and most recent filing in the same state.
Monetary policy surprises. *6-month cumulative* is the sum of all high-frequency surprises in the 10-year U.S. Treasury yield around FOMC meetings over the preceding six months. *July-December* is the sum of all high-frequency surprises in the 10-year U.S. Treasury yield around FOMC meetings from July to December of the preceding year.
Insurer investment income & portfolio sensitivity. *Investment income* is the insurer's quarterly investment income scaled by lagged total invested assets. *MTM* is the share of an insurer's total end-of-year assets that are marked to market on the statutory balance sheet. *Duration* is the average duration of the insurer's end-of-year fixed income portfolio.
Housing markets. Δ*Home value* is the county's monthly growth rate of home prices, including all types of homes.
Mortgage markets. *Mortgage applications* is the total number of mortgage applications in a county and year. *Amount* is the total volume of mortgage applications in a county and year.

	N	Mean	SD	1^{st}	25^{th}	Median	75^{th}	99^{th}
Panel 1: Filing information								
ΔPrice (%)	27,357	6.01	6.30	-8.20	0.70	5.00	9.60	27.00
Filing time	27,357	420.12	427.35	5.00	195.00	358.00	452.00	2,238.00
Panel 2: Monetary policy surprises								
6-month cumulative	120	-0.01	0.06	-0.12	-0.06	-0.00	0.03	0.09
July-December	10	-0.01	0.06	-0.11	-0.05	-0.01	0.02	0.10
Panel 3: Investment income & portfolio sensitivity								
Coupons & dividends (%)	29,976	0.63	0.32	-0.15	0.42	0.62	0.81	1.93
Trading gains (%)	29,976	0.15	0.42	-0.70	0.00	0.02	0.15	2.56
MTM changes (%)	29,976	0.21	1.01	-3.71	-0.00	0.01	0.43	4.36
MTM (%)	8,023	12.67	15.43	0.00	0.24	7.57	19.61	70.04
Duration (years)	8,003	5.94	2.30	1.65	4.43	5.69	7.11	13.19
Panel 4: Housing markets								
ΔHome value (%)	289,503	0.26	0.59	-1.31	-0.07	0.28	0.60	1.78
Panel 5: Mortgage markets								
Mortgage applications (thd)	30,745	3.59	11.48	0.01	0.25	0.72	2.23	45.20
Amount (mn USD)	30,745	813.16	3,894.17	1.02	25.20	84.53	335.90	12,387.90

Table 2
Monetary policy and insurance prices

This table reports estimated coefficients for specifications based on Equation (16). The dependent variable $\Delta Price_f$ is the insurance price change in filing f. The main explanatory variable is the sum of all monetary policy surprises in the six months preceding the month the filing f was submitted. In columns (1) to (3), monetary policy surprises $\Delta \text{MP}_{(t-1:t-6)}$ are computed as high-frequency changes in the 10-year U.S. Treasury yield. In column (4), monetary policy surprises $\Delta \text{NS}_{(t-1:t-6)}$ are computed following the methodology in Nakamura and Steinsson (2018). In column (5), monetary policy surprises $\Delta \text{Target}_{(t-1:t-6)}$ are computed as high-frequency changes in the Fed Funds target rate following Gürkaynak et al. (2005). Insurer control variables are lagged *Log(Assets)*, *Leverage*, *RBC ratio*, *ROE*, *UW gain*, and *Investment income*. State control variables are lagged *Log(Mean 5-yr damages)*, *Log(SD 5-yr damages)*, *Log(GDP per capita)*, and Δ*House price index*. Macro control variables are Δ*GDP*, *VIX*, Δ*Consumer price index*, and central bank information surprises. Variable definitions are in Table B.1. *Rescaled coefficients* are the coefficients of the main explanatory variables scaled by the estimate for ν in the regression $\Delta \text{MP}_{(t-1:t-6)} = \nu Y_t + \varepsilon_t$, where Y_t is either $\Delta \text{NS}_{(t-1:t-6)}$ (in column 4) or $\Delta \text{Target}_{(t-1:t-6)}$ (in column 5). t-statistics are shown in brackets and based on standard errors that are three-way clustered at the insurer, the state, and the year-month levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

	Dependent variable: $\Delta Price_f$				
	(1)	(2)	(3)	(4)	(5)
$\Delta \text{MP}_{(t-1:t-6)}$	9.713***	8.118***	7.350***		
	[3.84]	[3.87]	[3.63]		
$\Delta \text{NS}_{(t-1:t-6)}$				18.042***	
				[4.64]	
$\Delta \text{Target}_{(t-1:t-6)}$					29.552***
					[5.02]
Rescaled coefficient				8.244	10.044
Insurer controls		Yes	Yes	Yes	Yes
State controls			Yes	Yes	Yes
Macro controls			Yes	Yes	Yes
Insurer-State FE	Yes	Yes	Yes	Yes	Yes
Product-State FE	Yes	Yes	Yes	Yes	Yes
No. of obs.	27,357	27,357	27,357	27,357	27,357
R^2	0.315	0.331	0.346	0.350	0.352
Within R^2	0.007	0.030	0.052	0.058	0.060

Table 3
Monetary policy and insurers' investment income

This table reports estimated coefficients for specifications based on Equation (18). The dependent variable $\frac{Outcome_{i,q}}{Invested\ assets_{i,q-1}}$ is insurer i's investment income (component) in year-quarter q scaled by lagged total invested assets. The main explanatory variable ΔMP_q is the sum of all monetary policy surprises in the 10-year U.S. Treasury yield in year-quarter q. The outcome in column (1) is the total amount of coupon and dividend payments received, in column (2), the total amount of realized gains and losses from security transactions, and in columns (3) to (7), the total amount of unrealized gains and losses due to changes in market values of assets. In columns (4) and (5), we split the sample into insurers with a low and high lagged share of mark-to-market assets, and in columns (6) and (7), into those with a short and long lagged fixed income portfolio duration, using the first and fourth quartiles of the respective variables. Insurer and macro control variables are defined as in Table 2. t-statistics are shown in brackets and based on standard errors that are two-way clustered at the insurer and the RBC ratio quintile-by-quarter levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

	Dependent variable: $\frac{Outcome_{i,q}}{Invested\ assets_{i,q-1}}$						
Outcome:	Coupons & dividends	Trading gains	MTM gains				
Sample:	All			Low MTM	High MTM	Short duration	Long duration
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ΔMP_q	-0.113	0.250***	-1.083**	-0.220*	-2.977**	-0.717	-1.365**
	[-1.59]	[2.64]	[-2.15]	[-1.68]	[-2.43]	[-1.47]	[-2.57]
Insurer controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Insurer-Season FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	29,891	29,891	29,891	7,266	7,291	7,013	7,022
R^2	0.728	0.220	0.319	0.261	0.430	0.356	0.368
Within R^2	0.210	0.007	0.122	0.008	0.275	0.093	0.152

Table 4
Monetary policy and insurance prices: Mechanism

This table reports estimated coefficients for specifications based on Equation (20). The dependent variable $\Delta Price_f$ is the insurance price change in filing f. The main explanatory variable $\Delta \text{MP}_{(t-1:t-6)}$ is the sum of all monetary policy surprises in the 10-year U.S. Treasury yield in the six months preceding the month the filing was submitted. *Constrained*$_{i,y-1}$ (*Intermediate*$_{i,y-1}$) is an indicator variable that is equal to one if insurer i's RBC gap at the end of year $y-1$ is in the third (second) tercile of its pooled distribution, defined as the difference between its six-year-trailing average RBC ratio and its current RBC ratio. *High sensitivity*$_{i,y-1}$ is an indicator variable for insurers that are highly sensitive to monetary policy. In column (4), *High sensitivity*$_{i,y-1}$ is equal to one if insurer i's share of mark-to-market assets is in the fourth quartile of its annual cross-sectional distribution at the year-end preceding filing f. In column (5), *High sensitivity*$_{i,y-1}$ is equal to one if insurer i's fixed income portfolio duration is in the fourth quartile of the annual cross-sectional distribution at the year-end preceding filing f. Insurer, state, and macro control variables are defined as in Table 2. t-statistics are shown in brackets and based on standard errors that are three-way clustered at the insurer, the state, and the year-month levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

	Dependent variable: $\Delta Price_f$				
Constraints:	Regulatory capital			+High MTM	+Long duration
	(1)	(2)	(3)	(4)	(5)
$\Delta \text{MP}_{(t-1:t-6)}$	5.202**				
	[2.08]				
Intermediate$_{i,y-1}$ × $\Delta \text{MP}_{(t-1:t-6)}$	0.427	0.902	0.390	-1.408	-1.040
	[0.16]	[0.35]	[0.16]	[-0.50]	[-0.42]
Constrained$_{i,y-1}$ × $\Delta \text{MP}_{(t-1:t-6)}$	5.510**	6.708***	6.281***	3.846*	1.521
	[2.16]	[3.05]	[3.21]	[1.87]	[0.74]
High sensitivity$_{i,y-1}$ × Intermediate$_{i,y-1}$ × $\Delta \text{MP}_{(t-1:t-6)}$				8.162	8.728
				[1.64]	[1.65]
High sensitivity$_{i,y-1}$ × Constrained$_{i,y-1}$ × $\Delta \text{MP}_{(t-1:t-6)}$				12.040**	15.320***
				[2.14]	[3.15]
Other interaction terms	Yes	Yes	Yes	Yes	Yes
Insurer controls	Yes	Yes	Yes	Yes	Yes
Insurer-State FE	Yes	Yes	Yes	Yes	Yes
State controls	Yes				
Macro controls	Yes				
Product-State FE	Yes				
Product FE		Yes			
State-Year-Month FE		Yes			
Product-State-Year-Month FE			Yes	Yes	Yes
High sensitivity-Year-Month FE			Yes	Yes	Yes
No. of obs.	27,356	26,549	23,527	23,527	23,418
R^2	0.347	0.572	0.671	0.676	0.682
Within R^2	0.052	0.015	0.014	0.014	0.017

Table 5
Impact on the mortgage market

This table reports estimated coefficients for specifications based on Equation (22). The dependent variable Δ*Mortgage outcome*$_{c,y}$ is the annual change in the natural logarithm of the total number of mortgage applications in columns (1) and (2) and of the total amount of mortgage applications in columns (3) and (4) in county c in state s. The main explanatory variable $\Delta MP_{H2(y-1)}$ is the sum of all monetary policy surprises in the 10-year U.S. Treasury yield in the second half of year $y-1$. $\phi_{s,y}$ is the sensitivity of insurers operating in state s to monetary policy as of the first month of year y. In columns (1) and (3), the sensitivity is based on insurers' financial constraints and mark-to-market share; in columns (2) and (4) on financial constraints and fixed income portfolio duration. We control for dummies indicating the quintiles of the county-specific *Log(GDP)* and *Log(Population)* interacted with year fixed effects. t-statistics are shown in brackets and based on standard errors that are two-way clustered at the county and GDP quintile-year levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

	Dependent variable: Δ*Log(Mortgage outcome)*$_{c,y}$			
Mortgage outcome:	No. of applications		Amount of applications	
	(1)	(2)	(3)	(4)
$\phi_{s,y}^{MTM} \times \Delta \text{MP}_{H2(y-1)}$	-0.037***		-0.037**	
	[-2.87]		[-2.45]	
$\phi_{s,y}^{Dur} \times \Delta \text{MP}_{H2(y-1)}$		-0.021**		-0.024**
		[-2.36]		[-2.31]
County FE	Yes	Yes	Yes	Yes
GDP Quintile-Year FE	Yes	Yes	Yes	Yes
Population Quintile-Year FE	Yes	Yes	Yes	Yes
No. of obs.	30,745	30,745	30,745	30,745
R^2	0.488	0.486	0.459	0.458
Within R^2	0.003	0.001	0.002	0.001

Online Appendix

A Proofs

Proof. of Proposition 1

The pricing equation stems from the FOC to the insurer's optimization problem.

$$
\begin{aligned}
0 &= \frac{\partial Y_i}{\partial P_i} - \frac{\partial C_i}{\partial P_i} \\
&= Q_i + (P_i - V)\frac{\partial Q_i}{\partial P_i} + \chi_i \frac{\partial K_i}{\partial P_i} \\
&= Q_i + (P_i - V)\frac{\partial Q_i}{\partial P_i} + \chi_i \left[Q_i + \frac{\partial Q_i}{\partial P_i} \times (P_i - (1+\rho)V) \right] \\
&= P_i - (P_i - V)\epsilon + \chi_i \left[P_i - \epsilon \times (P_i - (1+\rho)V) \right] \\
\Leftrightarrow \; P_i &= \frac{\epsilon}{\epsilon - 1} \times \frac{1 + \chi_i(1+\rho)}{1+\chi_i} V
\end{aligned}
$$

where $\epsilon = -\frac{\partial Q_i}{\partial P_i}\frac{P_i}{Q_i}$ and $\chi_i = -\frac{\partial C_i}{\partial K_i}$. □

Proof. of Proposition 2

We first recall that:

$$
\begin{aligned}
K_i &= A_i - (1+\rho)L_i && \text{(A1)} \\
&= A_i^0 + Q_i P_i - Q_i(1+\rho)V - (1+\rho)L_i^0 && \text{(A2)} \\
\Rightarrow \frac{\partial K_i}{\partial r_f} &= \frac{\partial A_i^0}{\partial r_f} + \frac{\partial}{\partial r_f}\{Q_i P_i\} - \frac{\partial}{\partial r_f}\{Q_i(1+\rho)V\} && \text{(A3)} \\
&= \alpha_i + \frac{\partial Q_i}{\partial r_f} P_i + Q_i \frac{\partial P_i}{\partial r_f} - (1+\rho)\left[\frac{\partial Q_i}{\partial r_f} V + Q_i \frac{\partial V}{\partial r_f}\right] && \text{(A4)} \\
&= \alpha_i + \left[\frac{\partial Q_i}{\partial P_i} P_i + Q_i\right] \frac{\partial P_i}{\partial r_f} - (1+\rho)V \left[\frac{\partial Q_i}{\partial r_f} - Q_i\right] && \text{(A5)} \\
&= \alpha_i - Q_i P_i (\epsilon - 1) \frac{\partial \log P_i}{\partial r_f} + Q_i(1+\rho)V \left[1 + \epsilon \frac{\partial \log P_i}{\partial r_f}\right] && \text{(A6)} \\
&= \alpha_i + Q_i(1+\rho)V + \frac{\partial \log P_i}{\partial r_f} \upsilon_i && \text{(A7)}
\end{aligned}
$$

where $\upsilon_i = Q_i V \epsilon \left(\frac{\rho}{1+\chi_i}\right) \geq 0$.[25] From (A7), we see that the effect of a rate hike on insurer capital operates through three channels. First, it lowers the value of insurer's initial assets ($\alpha_i < 0$). Second, it lowers the present value of the insurer's liabilities ($Q_i(1+\rho)\frac{\partial V}{\partial r_f} = -Q_i(1+\rho)V < 0$). Third, it changes the optimal insurance price, and thus the optimal amount of underwriting than an insurer undertakes ($\frac{\partial \log P_i}{\partial r_f}\upsilon_i$). With this in mind, we next get that:

$$\frac{\partial}{\partial r_f}\log P_i = \frac{\partial}{\partial r_f}\log\left(\frac{1+\chi_i(1+\rho)}{1+\chi_i}\right) + \frac{\partial}{\partial r_f}\log V \tag{A11}$$

$$= -1 + \frac{1+\chi_i}{1+\chi_i(1+\rho)}\left(\frac{(1+\rho)}{1+\chi_i} - \frac{1+\chi_i(1+\rho)}{(1+\chi_i)^2}\right)\frac{\partial \chi_i}{\partial r_f} \tag{A12}$$

$$= -1 + \frac{1}{1+\chi_i(1+\rho)}\frac{\rho}{1+\chi_i}\frac{\partial \chi_i}{\partial r_f} \tag{A13}$$

$$= -1 - \delta_i \times \left(\alpha_i + Q_i(1+\rho)V + \frac{\partial \log P_i}{\partial r_f}\upsilon_i\right) \tag{A14}$$

$$= -\frac{1+\delta_i \times (\alpha_i + Q_i(1+\rho)V)}{1+\delta_i \upsilon_i} \tag{A15}$$

where

$$\delta_i = -\frac{\rho}{1+\chi_i(1+\rho)}\frac{\chi_i'}{1+\chi_i} \geq 0 \tag{A16}$$

and $\chi_i' = \frac{\partial \chi_i}{K_i}$ □

Proof. of Proposition 3. Proposition 3 follows directly from Proposition 2:

$$\frac{\partial}{\partial \alpha_i}\left\{\frac{\partial \log P_i}{\partial r_f}\right\} = -\frac{\delta_i}{1+\delta_i \upsilon_i} < 0. \tag{A17}$$

□

Proof. of Proposition 4

25 To see how we arrive at υ_i, note that

$$\upsilon_i = Q_i V \epsilon \left((1+\rho) - P_i \frac{\epsilon - 1}{\epsilon}\frac{1}{V}\right) \tag{A8}$$

$$= Q_i V \epsilon \left((1+\rho) - \frac{1+(1+\rho)\chi_i}{1+\chi_i}\right) \tag{A9}$$

$$= Q_i V \epsilon \left(\frac{\rho}{1+\chi_i}\right) \geq 0. \tag{A10}$$

To ease notation, let:

$$\omega_i = \alpha_i + Q_i(1+\rho)V < 0, \tag{A18}$$

$$\delta_i = -\frac{\rho}{1+\chi_i(1+\rho)}\frac{\chi_i'}{1+\chi_i} \geq 0, \text{ and} \tag{A19}$$

$$\upsilon_i = Q_i V \epsilon \left(\frac{\rho}{1+\chi_i}\right) \geq 0 \tag{A20}$$

Further, note that

$$\chi_i' = -\frac{\partial}{\partial K_i} f'(K_i) = -C_i'' < 0 \tag{A21}$$

and

$$\chi_i'' = -\frac{\partial}{\partial K_i} f''(K_i) = -C_i''' > 0. \tag{A22}$$

To prove that

$$\frac{-C_i'''}{C_i''^2} = \frac{\chi''}{\chi_i'^2} > 2+\rho \quad \text{and} \tag{A23}$$

$$-\omega_i > \frac{1}{\delta_i} \tag{A24}$$

are sufficient conditions for $\frac{\partial}{\partial L_i^0}\left\{\frac{\partial P_i}{\partial r_f}\right\} > 0$, we show that

$$\frac{\partial \log P_i}{\partial r_f} = -\frac{1+\delta_i\omega_i}{1+\delta_i\upsilon_i} \Rightarrow \tag{A25}$$

$$\frac{\partial}{\partial L_i^0}\left\{\frac{\partial \log P_i}{\partial r_f}\right\} = -\frac{1}{1+\delta_i\upsilon_i}\left(\frac{\partial \delta_i}{\partial L_i^0}\times\omega_i + \delta_i \times \frac{\partial \omega_i}{\partial L_i^0}\right) + \frac{1+\delta_i\omega_i}{(1+\delta_i\upsilon_i)^2}\left(\frac{\partial \delta_i}{\partial L_i^0}\times\upsilon_i + \delta_i\times\frac{\partial \upsilon_i}{\partial L_i^0}\right) \tag{A26}$$

$$= \frac{\partial \delta_i}{\partial L_i^0}\times\frac{\upsilon_i-\omega_i}{(1+\delta_i\upsilon_i)^2} + \frac{1+\delta_i\omega_i}{(1+\delta_i\upsilon_i)^2}\times\delta_i\times\frac{\partial\upsilon_i}{\partial L_i^0} - \frac{\delta_i}{1+\delta_i\upsilon_i}\frac{\partial\omega_i}{\partial L_i^0} \tag{A27}$$

The last term, $-\frac{\delta_i}{1+\delta_i\upsilon_i}\frac{\partial\omega_i}{\partial L_i^0}$ is positive because,

$$\frac{\partial\omega_i}{\partial L_i^0} = \frac{\partial Q_i}{\partial L_i^0}(1+\rho)V < 0. \tag{A28}$$

The middle term is positive under condition (A24) since:

$$\frac{\partial\upsilon_i}{\partial L_i^0} = \underbrace{V\epsilon\frac{\rho}{1+\chi_i}}_{>0}\underbrace{\frac{\partial Q_i}{\partial L_i^0}}_{<0} - \underbrace{QV\epsilon\frac{\rho}{(1+\chi_i)^2}}_{>0}\underbrace{\chi_i'\times\frac{\partial K_i}{\partial L_i^0}}_{>0} < 0. \tag{A29}$$

Finally, the first term is positive because $\upsilon_i - \omega_i > 0$ under condition (A24) as $-\omega_i > \frac{1}{\delta_i} > 0$ and $\frac{\partial \delta_i}{\partial L_i^0} > 0$ under condition (A23):

$$\frac{\partial \delta_i}{\partial L_i^0} = \frac{\rho}{(1+\chi_i(1+\rho))^2} \frac{\chi_i'}{1+\chi_i}(1+\rho)\frac{\partial \chi_i}{\partial L_i^0} \tag{A30}$$

$$+ \frac{\rho}{1+\chi_i(1+\rho)} \frac{\chi_i'}{(1+\chi_i)^2} \frac{\partial \chi_i}{\partial L_i^0} \tag{A31}$$

$$- \frac{\rho}{1+\chi_i(1+\rho)} \frac{1}{1+\chi_i} \frac{\partial \chi_i'}{\partial L_i^0} \tag{A32}$$

$$= \frac{\rho}{1+\chi_i(1+\rho)} \frac{1}{1+\chi_i} \left\{ \left(\frac{1+\rho}{1+\chi_i(1+\rho)} + \frac{1}{1+\chi_i} \right) \chi_i' \frac{\partial \chi_i}{\partial L_i^0} - \frac{\partial \chi_i'}{\partial L_i^0} \right\} \tag{A33}$$

$$= \underbrace{- \frac{\rho}{1+\chi_i(1+\rho)} \frac{1}{1+\chi_i} \frac{\partial K_i}{\partial L_i^0}}_{>0} \left\{ \chi_i'' - \left(\frac{1+\rho}{1+\chi_i(1+\rho)} + \frac{1}{1+\chi_i} \right) \chi_i'^2 \right\} \tag{A34}$$

$$\geq - \frac{\rho}{1+\chi_i(1+\rho)} \frac{1}{1+\chi_i} \frac{\partial K_i}{\partial L_i^0} \left\{ \chi_i'' - (2+\rho)\, \chi_i'^2 \right\} \tag{A35}$$

$$> 0 \quad \text{if } \frac{\chi''}{\chi_i'^2} > 2+\rho \tag{A36}$$

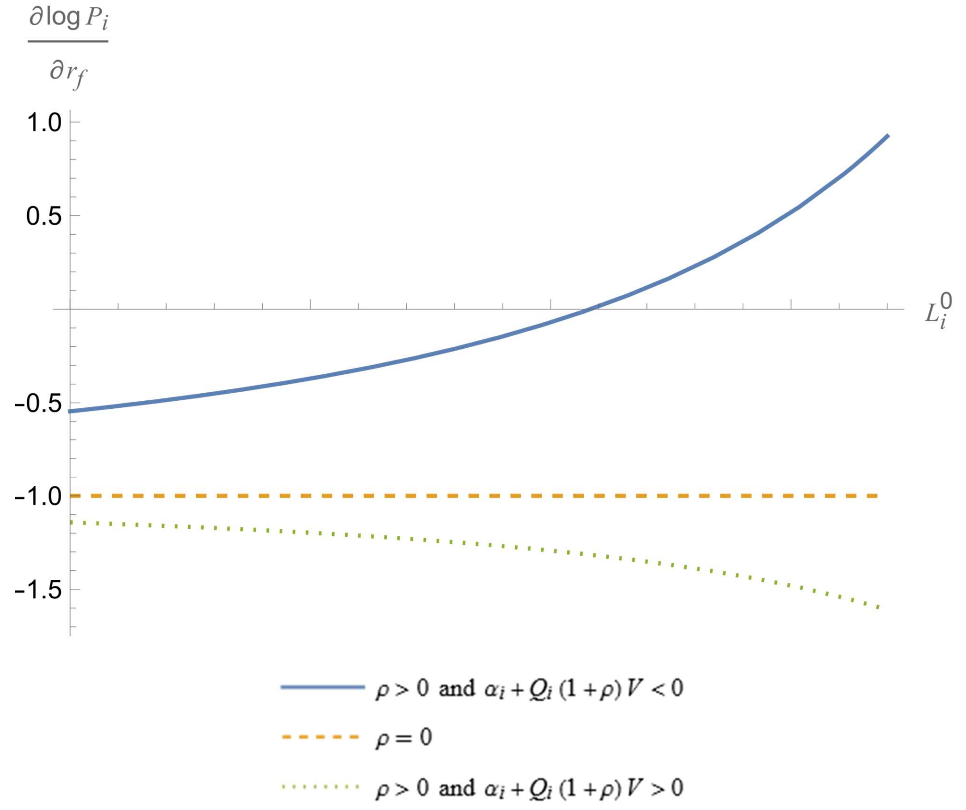
Below, we provide a numerical example to illustrate the effect of insurer leverage on the interest rate sensitivity of insurance prices. We specify the cost function:

$$C_i = -\log(K_i)$$

and set the parameters to be $A_i^0 = 2$, $\epsilon = 3$, $\rho = 0.5$, $r_f = 0$, and $\alpha = -10$. Under these assumptions, Figure A.1 demonstrates that the interest rate sensitivity of insurance prices is increasing with insurer leverage over the domain. For comparison we also plot the relationship for a scenario with no financial frictions ($\rho = 0$), and a scenario where financial frictions are present ($\rho > 0$), but where the interest rate hike improves the insurer's regulatory capital ($\alpha_i + Q_i(1+\rho)V > 0$).

Figure A.1
Insurance prices' sensitivity to interest rate hikes

The sensitivity of insurance prices to interest rate hikes ($\frac{\partial \log P_i}{\partial r_f}$) as a function of insurer leverage (L_i^0). The solid line plots the relationship for the parameters: $A_i^0 = 2$, $\epsilon = 3$, $\rho = 0.5$, $r_f = 0$, and $\alpha = -10$. For the dashed (yellow) line, there are no financial frictions ($\rho = 0$). For the dotted (green) line the insurer's liabilities are more interest rate sensitive than the insurer's assets ($\alpha > 0$).



$\square$

B Data

Table B.1
Variable definitions and data sources

This table contains the definitions and data sources of all variables used in the analysis.

Variable	Definition (Unit)
	Filing information
ΔPrice	The relative change in insurance prices specified in the rate filing. *Source: S&P Rate Watch.*
Filing time	The number of days between the insurer's current and last filing in the same state. *Source: S&P Rate Watch.*
Policyholders	The number of policyholders affected by the price change. *Source: S&P Rate Watch.*
Premiums written	The total insurance premiums written by the insurer for the insurance products subject to the filing. *Source: S&P Rate Watch.*
	Insurer characteristics
Assets	The insurer's total assets at the end of a quarter. *Source: NAIC Regulatory Filings.*
RBC ratio	The insurer's risk-based capital ratio, defined as the ratio of available capital to required capital. *Source: NAIC Regulatory Filings.*
ROE	The insurer's annualized return on equity. *Source: NAIC Regulatory Filings.*
Leverage	The insurer's leverage at the end of a quarter. *Source: NAIC Regulatory Filings.*
UW gain	The insurer's annualized underwriting gain as a percentage of total policy reserves. *Source: NAIC Regulatory Filings.*
Investment income	The insurer's annualized investment income as a percentage of total invested assets. *Source: NAIC Regulatory Filings.*
RBC gap	The difference between the insurer's average RBC ratio over the preceding six years and the insurer's current RBC ratio. *Source: NAIC Regulatory Filings.*
MTM share	The insurer's share of *Assets* mark-to-market. *Sources: NAIC Regulatory Filings and own calculations.*
Duration	The duration of the insurer's fixed-income portfolio. *Source: See Appendix E.*
Regulatory capital	The total amount of insurer's regulatory capital. *Source: NAIC Regulatory Filings.*
Coupons & dividends	The insurer's quarterly investment income stemming from coupon payments and dividends collected on its invested assets. *Source: NAIC Regulatory Filings and S&P.*
Trading gains	The insurer's quarterly investment income stemming from realized gains and losses on security transactions. *Source: NAIC Regulatory Filings and S&P.*
MTM gains	The insurer's quarterly investment income stemming from unrealized gains, i.e., changes in the valuation of its mark-to-market assets. *Source: NAIC Regulatory Filings and S&P.*

Table B.1 continued.

	State characteristics
Mean 5-yr damage	The average yearly damage caused by natural disasters (excluding floods) in a state over the preceding 5 years. *Source: SHELDUS.*
SD 5-yr damage	The standard deviation of yearly damage caused by natural disasters (excluding floods) in a state over the preceding 5 years. *Source: SHELDUS.*
GDP per capita	The state's annual gross domestic product per capita. *Source: BEA.*
ΔHPI	The annual growth rate of the House Price Index in the state. *Source: FHFA.*
ϕ	Sensitivity of local insurance companies' prices to monetary policy surprises. *Source: Own calculations.*
	County variables
Home value	The county's monthly Zillow Home Value Index value. *Source: Zillow.*
Mortgages	The annual number of mortgages applied for, i.e., originated and denied, in the county. *Source: HMDA.*
Amount	The annual mortgage amounts applied for, i.e., originated and denied, in the county. *Source: HMDA.*
Population	The county's population in a given year. *Source: Census.*
GDP	The county's annual gross domestic product. *Source: BEA.*
Population density	The county's population density. *Source: Own calculations.*
	Macroeconomic variables
ΔGDP	The annualized growth rate of the national real gross domestic product. *Source: FRED.*
VIX	The CBOE Volatility Index (VIX). *Source: FRED.*
ΔCPI	The annualized national inflation measured by the Consumer Price Index. *Source: FRED.*
ΔPCE	The annualized national inflation measured by the Personal Consumption Expenditures Index. *Source: FRED.*
	Monetary policy shocks
ΔMP	The high-frequency change in the 10-year US Treasury rate around FOMC meetings. *Source: Bauer and Swanson (2023).*
ΔMP^{inf}	The central bank information component in high-frequency changes in the 10-year US Treasury rate around FOMC meetings. *Source: Bauer and Swanson (2023).*
ΔNS	The high-frequency monetary policy shocks identified by Nakamura and Steinsson (2018). *Source: Emi Nakamura's webpage.*
ΔTarget	The surprises in the target factor around FOMC meetings identified by Gürkaynak et al. (2005). *Source: Updated shock series from Miguel Acosta's webpage.*

C Additional figures

Figure C.1
Time between filings

This figure shows for each state a boxplot for the distribution of *Filing time*, defined as the time horizon (in years) between an insurer's current and most recent rate filing in the same state. The red line marks a filing time of one year; the black dashed lines mark filing times of half a year and one and half years. The figure does not plot outside values of the boxplots.

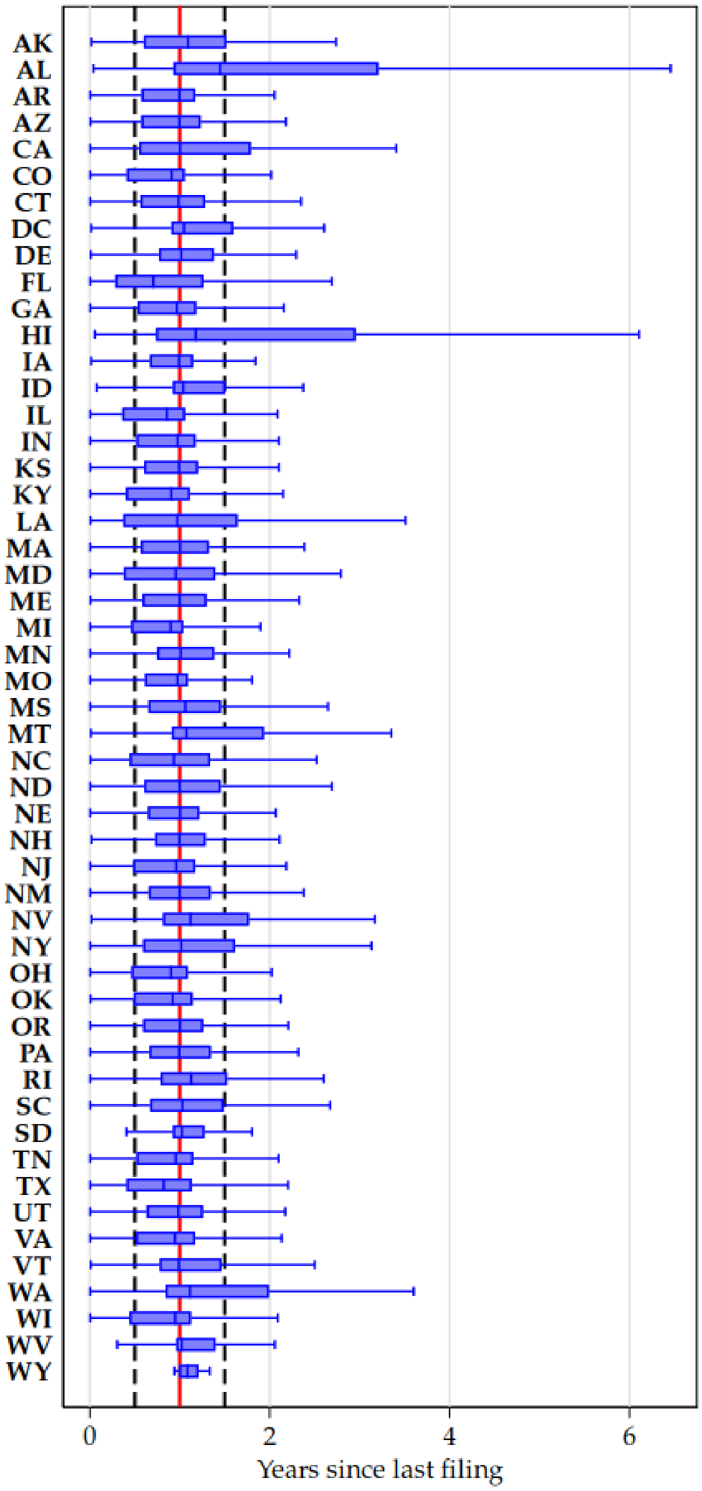
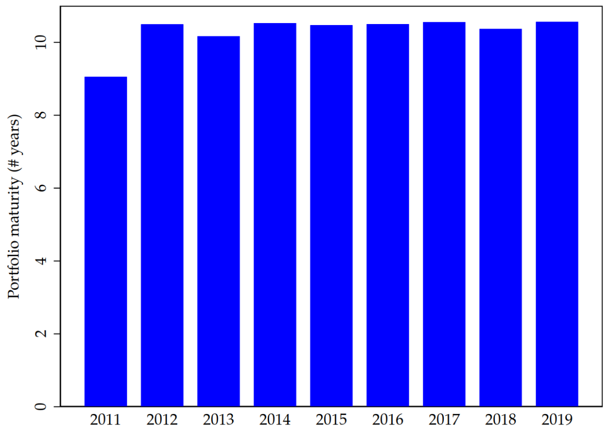
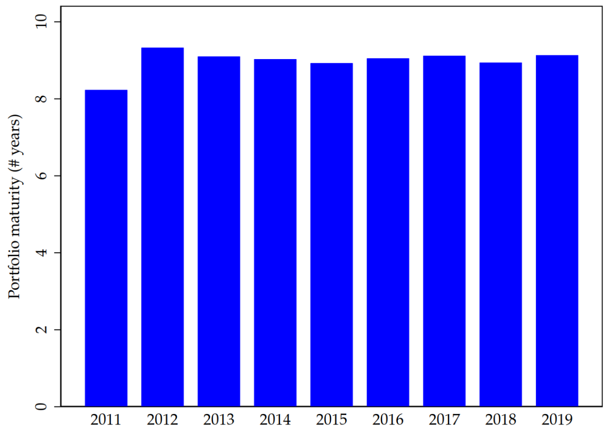


Figure C.2
Maturity of insurers' fixed income portfolio

This figure shows the average maturity of insurers' fixed-income portfolios for all insurance companies in our sample. Panel (a) shows the weighted average with insurers' total assets as weights; panel (b) shows the unweighted average. The data begins in 2011 because insurers have to report the maturity date of their fixed-income investments to the NAIC since 2011. *Source: NAIC Schedule D Part 1.*



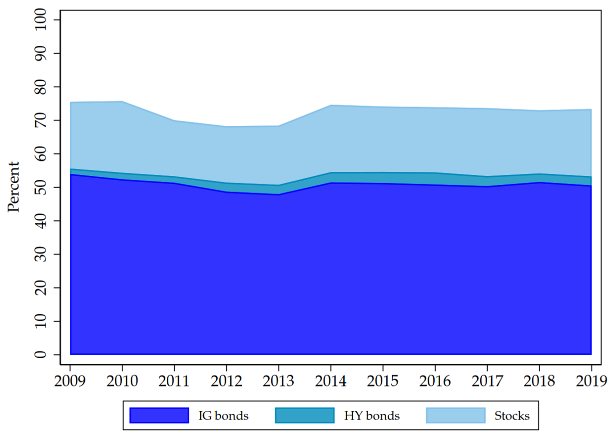
(a) Weighted by insurers' total assets



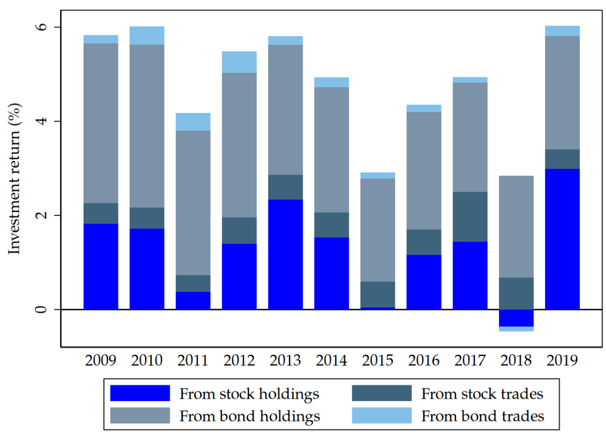
(b) Unweighted

Figure C.3
Asset and investment income composition of insurers

This figure shows (a) the asset side composition split by bond and stock holdings and (b) the annual investment income composition split by investment income generated from bond and stock holdings and trades of property insurers over the sample period. Bond holdings and trades include all fixed-income securities, i.e., mainly corporate bonds, municipal bonds, U.S. Treasuries, and asset-backed securities. *Source: NAIC Schedule D.*



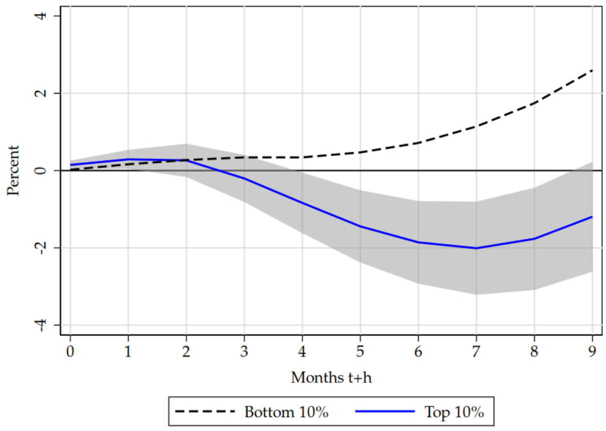
(a) Asset composition



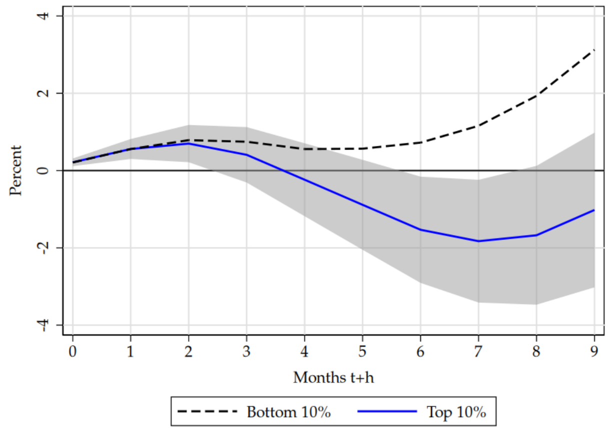
(b) Investment income composition

Figure C.4
Robustness: Local projections with MTM share-based ϕ

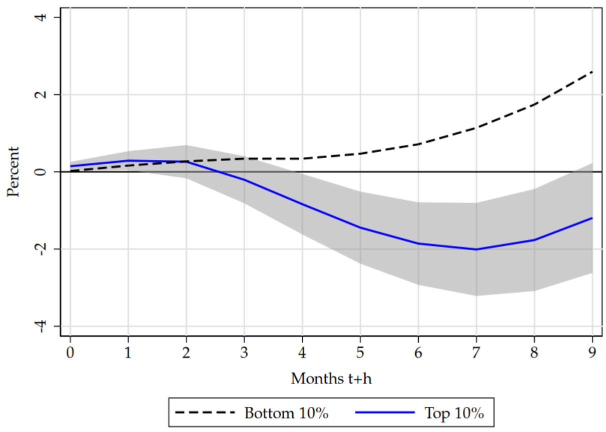
This figure shows the local projection of monetary policy's effect on home prices and the interaction with insurers' sensitivity ϕ for various subsectors of real estate markets. The black dashed line represents the effect of a 1 percentage point surprise in the 10-year U.S. Treasury yield over the previous six months on home prices at the 10th percentile of the pooled distribution of insurers' sensitivity. The blue solid line represents the effect at the 90th percentile of the pooled distribution of insurers' sensitivity. The gray area plots the corresponding 90% confidence intervals. Insurers' sensitivity ϕ is constructed with the share of insurers' assets mark-to-market.



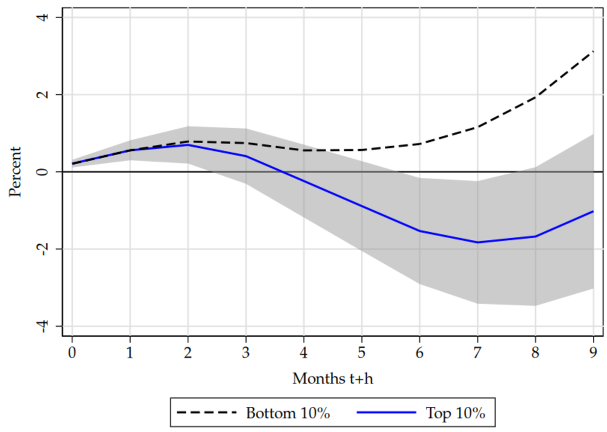
(a) Single family homes - MTM ϕ



(b) Condos - MTM ϕ



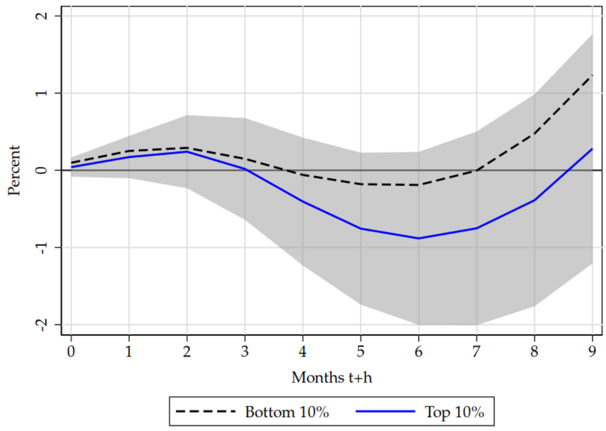
(c) Top tier - MTM ϕ



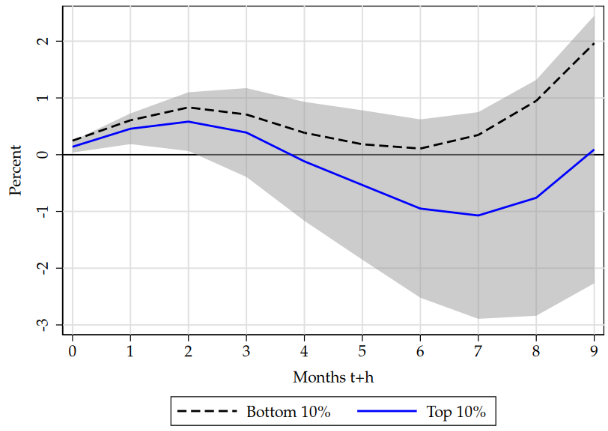
(d) Bottom tier - MTM ϕ

Figure C.5
Robustness: Local projections with duration-based ϕ

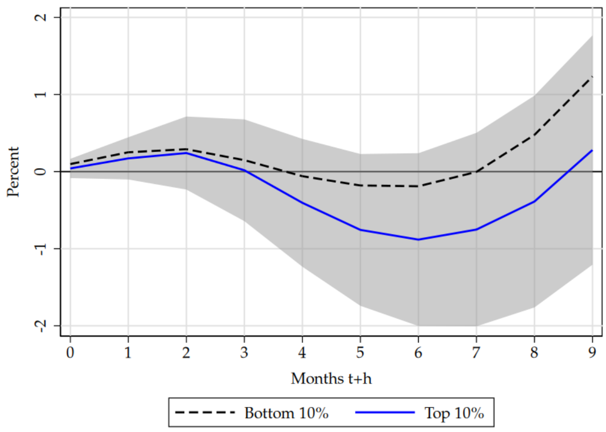
This figure shows the local projection of monetary policy's effect on home prices and the interaction with insurers' sensitivity ϕ for various subsectors of real estate markets. The black dashed line represents the effect of a 1 percentage point surprise in the 10-year U.S. Treasury yield over the previous six months on home prices at the 10th percentile of the pooled distribution of insurers' sensitivity. The blue solid line represents the effect at the 90th percentile of the pooled distribution of insurers' sensitivity. The gray area plots the corresponding 90% confidence intervals. Insurers' sensitivity ϕ is constructed with the duration of the insurer's fixed income portfolio.



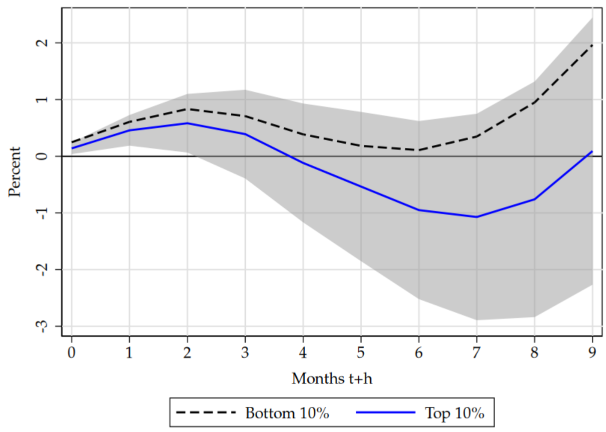
(a) Single family homes - Duration ϕ



(b) Condos - Duration ϕ



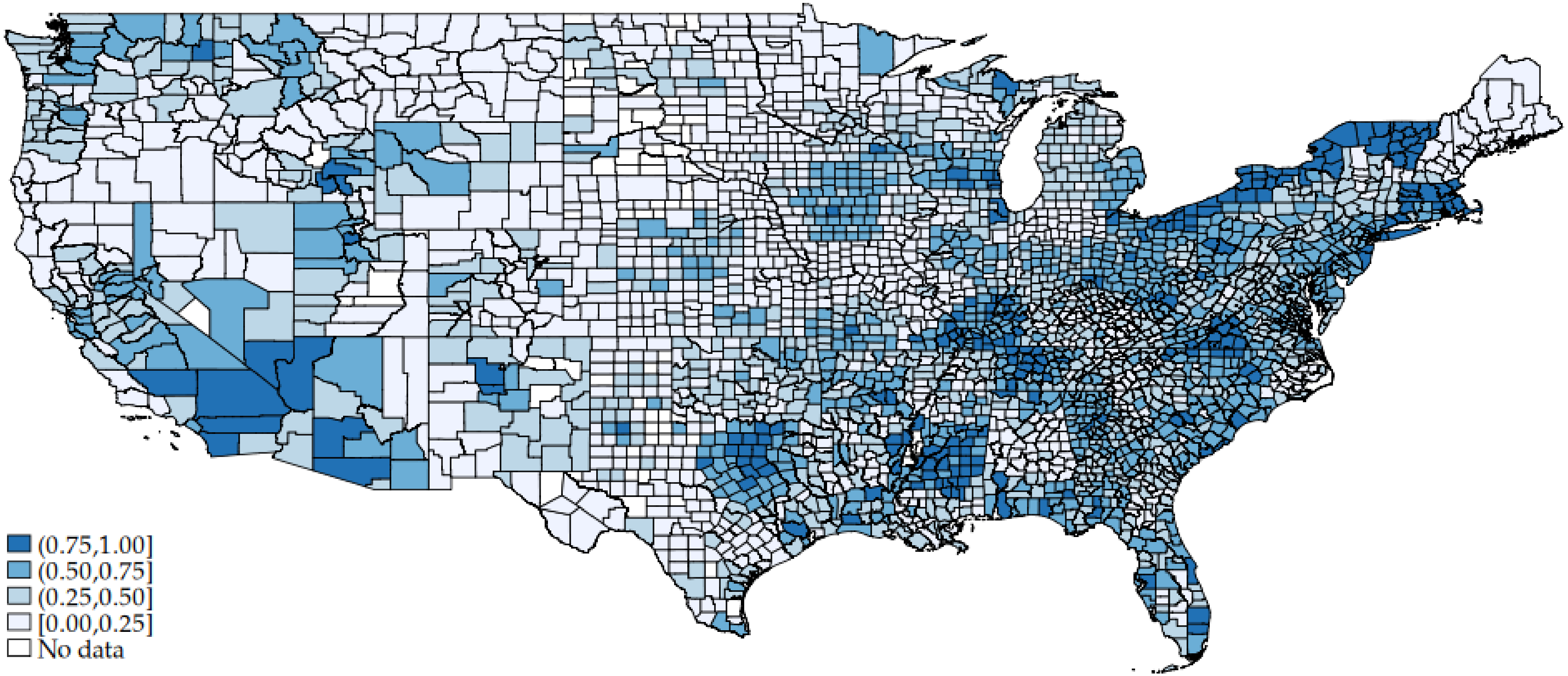
(c) Top tier - Duration ϕ



(d) Bottom tier - Duration ϕ

Figure C.6
Disaster exposure of U.S. counties

This figure shows each county's share of monthly observations between January 2010 and December 2019 for which the county incurred natural disaster damages over the past 5 years.



D ADDITIONAL TABLES

Table D.1
Cleaning procedure for the main sample

This table displays the cleaning procedure of the rate filings sample and the number of observations discarded in each step.

Homeowners insurance filings	149,400
Withdrawn, disapproved or other	9,284
No or missing rate change	103,119
Missing NAIC ID	505
Disposal date before submission date	8
Pending or reopened according to SERFF	18
Not matched to controls	9,109
Final sample	27,357

Table D.2
Summary statistics of other variables

This table shows the summary statistics for the control variables used in the different parts of the empirical analysis.
Filing information. *Policyholders* is the number of policyholders affected by the filing. *Premiums* is the amount of premiums written in million USD on the insurance policies affected by the filing.
Insurer characteristics. *Assets* are an insurer's total assets. *RBC ratio* is an insurer's risk-based capital ratio at the end of a quarter. *Leverage* is the insurer's leverage at the end of a quarter. *ROE* is the insurer's annualized return on equity. *UW Gain* is the insurer's annualized underwriting gain scaled by lagged total assets. *Investment Income* is the annualized net investment income scaled by lagged total invested assets.
State characteristics. *Mean 5-yr damages* is the state's average annual damage in million USD caused by all natural disasters except floodings over the past five years. *SD 5-Yr damage* is the state's standard deviation in annual damages in million USD caused by all natural disasters except floodings over the past five years. *GDP per capita* is the state's annual GDP per capita in USD. Δ*HPI* is the state's annual change in the house price index.
County characteristics. *5-yr damages* (quarterly) is the amount of natural disaster damages in USD in a county over the past 5 years. *Population* (annual) is a county's population. *Population density* (annual) is the number of inhabitants per square kilometer in a county. *GDP* is a county's annual GDP in USD.
Macroeconomic variables. Δ*GDP* is the monthly growth of the U.S. gross domestic product. *VIX* is the CBOE Volatility Index. Δ*CPI* is the monthly national inflation in the Consumer Price Index. *Information shock (6-month cum)* is the sum of the information components in the high-frequency surprises in the 10-year U.S. Treasury yield around FOMC meetings over the past six months.
Insurer sensitivity. ϕ (monthly) is the sensitivity of insurers operating in state s in month t to monetary policy. The sensitivity is constructed based on the duration of insurers' fixed income portfolio or the share of insurers' assets mark-to-market.

	N	Mean	SD	1st	25th	Median	75th	99th
Panel 1: Filing information								
Policyholders (thd)	26,617	17.74	45.24	0.00	0.94	3.81	13.17	328.25
Premiums (mn USD)	26,132	16.82	39.97	0.00	0.92	3.81	13.18	272.30
Panel 2: Insurer characteristics								
Assets (mn USD)	8,062	2,411.89	6,113.35	8.95	115.51	359.81	1,615.49	34,711.19
RBC ratio	8,062	12.12	15.98	3.21	5.96	8.44	12.39	128.69
Leverage	8,062	58.23	14.11	9.13	51.07	60.32	68.44	81.81
ROE (%)	8,062	5.24	9.09	-20.87	1.01	5.44	10.04	32.65
UW gain (%)	8,062	-2.50	31.07	-101.52	-10.15	-1.08	4.88	111.61
Investment income (%)	8,062	3.01	1.27	0.24	2.15	2.96	3.86	6.58
Panel 3: State characteristics								
Mean 5-yr damages (mn USD)	506	210.30	692.95	0.20	11.69	40.72	130.05	2,800.06
SD 5-yr damages (mn USD)	506	325.69	1,262.37	0.23	10.40	43.94	153.15	6,029.35
GDP per capita (thd USD)	506	54.61	21.21	34.28	44.06	50.98	58.93	177.71
ΔHPI (%)	506	2.81	4.28	-10.68	0.62	3.46	5.75	11.69
Panel 4: County characteristics								
5-year damages (thd USD)	97,244	992.57	16,880.32	0.00	0.00	0.00	64.45	10,740.00
Population (thd)	24,628	122.40	359.59	2.47	15.90	34.63	89.91	1,470.34
Population density	24,628	116.86	766.63	0.63	9.71	21.97	55.94	1,320.56
GDP (bn USD)	24,628	6.45	25.25	0.09	0.50	1.21	3.56	87.41

Table D.2 continued.

	N	Mean	SD	1^{st}	25^{th}	Median	75^{th}	99^{th}
Panel 5: Macroeconomic variables								
ΔGDP (%)	120	2.21	1.91	-3.07	1.07	2.36	3.44	6.38
VIX	120	17.15	5.47	10.18	13.43	16.01	19.09	34.54
ΔCPI (%)	120	0.14	0.19	-0.31	0.03	0.17	0.26	0.54
Information shock (6-month cum)	120	0.00	0.01	-0.03	0.00	0.00	0.00	0.03
Panel 6: Insurer sensitivity (ϕ)								
MTM ϕ	5,999	2.30	3.30	-1.41	0.00	1.07	3.85	15.89
Duration ϕ	5,999	1.65	3.75	-1.04	-0.00	0.05	1.52	16.84

Table D.3
Robustness: Monetary policy and insurance prices

This table shows robustness checks for the relationship between monetary policy and changes in insurance prices. In columns (1) to (5), the dependent variable $\Delta Price_f$ is the effective insurance price change of filing f. In columns (6) to (7), we examine the impact of monetary policy on other variables of insurers' rate filings. In column (6), $P'holders_f$ is the natural logarithm of the number of policyholders affected by the rate change of filing f. In column (7), $Premiums_f$ is the natural logarithm of the premiums written on the insurance policies affected by the rate change of filing f. In columns (8) to (10), we employ regression equation (17) in an insurer-state-month panel with three different dependent variables. In column (8), $\mathbf{1}(Rate\ filing_{i,s,t})$ is an indicator variable taking the value 1 if insurer i submits a rate filing in state s in month t. In column (9), $\mathbf{1}(Filing_{i,s,t})$ is an indicator variable taking the value 1 if insurer i submitted any filing in state s in month t. In column (10), $\Delta Price_{i,s,t}$ is the average effective price change of all rate filings submitted by an insurer in state s in month t. Price changes are weighted by the premiums written on products affected by the rate filing. In columns (1) to (4), (6), (7), and (10) [(8) and (9)], the independent variable, $\Delta \mathrm{MP}_{(t-1:t-6)}$ [$|\Delta \mathrm{MP}_{(t-1:t-6)}|$], is the [absolute value of the] sum of all monetary policy surprises in the 10-year U.S. Treasury yield in the six months preceding the month the filing was submitted. In column (5), the independent variable, $\Delta \mathrm{MP}_{(t-1:f_{-1})}$, is the sum of all surprises from the month of the insurer's last filing until the month preceding the same filing in the same state. Insurer, state, and macro control variables are defined as in Table 2. All variables are defined in Table 1 and Appendix Table D.2. All continuous insurer-level variables are winsorized at the 1% and 99% levels. t-statistics are shown in brackets and based on standard errors that are three-way clustered at the insurer, the state, and the year-month levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

	Dependent variable: $\Delta Price_f$									
	Sample windows		Inflation controls			Other filing variables		Extensive margin		
Specification:	Post 2010	Post 2011	PCE	U.S. states	MP horizon	$P'holders_f$	$Premiums_f$	$\mathbf{1}(Rate\ filing_{i,s,t})$	$\mathbf{1}(Filing_{i,s,t})$	$\Delta Price_{i,s,t}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\Delta \mathrm{MP}_{(t-1:t-6)}$	6.199**	5.551**	7.189***	8.662***		0.248*	0.178			0.771***
	[2.68]	[2.31]	[3.52]	[3.94]		[1.76]	[0.99]			[3.37]
$\Delta \mathrm{MP}_{(t-1:f_{-1})}$					6.003***					
					[4.80]					
$\lvert\Delta \mathrm{MP}_{(t-1:t-6)}\rvert$								-0.047	-0.031	
								[-1.49]	[-0.90]	
Insurer controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Insurer-State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product-State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
State-Season FE								Yes	Yes	Yes
No. of obs.	24,387	21,337	27,357	16,871	27,357	26,017	26,111	348,378	348,378	348,378
R^2	0.375	0.399	0.346	0.363	0.349	0.809	0.829	0.043	0.043	0.033
Within R^2	0.069	0.072	0.052	0.058	0.056	0.027	0.053	0.020	0.019	0.014

Table D.4
Insurers' investment income and changes in available capital

This table shows estimates for the impact of investment income collected from insurers' security investments on the change in insurers' regulatory capital, i.e., we estimate:

$$\Delta\text{Regulatory capital}_{i,y} = \alpha + \beta \text{ Investment income}_{i,y} + \varepsilon_{i,y}.$$

The dependent variable Δ*Regulatory capital*$_{i,y}$ is the change in insurer i's regulatory capital in USD from year $y-1$ to year y. The independent variable *Investment income*$_{i,y}$ is the investment income of insurer i generated in year y in USD. In columns (3) to (6), we split insurers' investment income into the different components. t-statistics are shown in brackets and based on standard errors that are two-way clustered at the insurer, and the size quartile-year levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

	Dependent variable: Δ*Regulatory capital*$_{i,y}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Investment income (in USD)$_{i,y}$	0.966***	0.966***				
	[11.94]	[11.94]				
From stocks			1.013***	1.013***		
			[13.15]	[13.15]		
From bonds			0.757***	0.757***		
			[5.15]	[5.15]		
From holding stocks					0.998***	0.998***
					[10.36]	[10.36]
From trading stocks					0.316*	0.316*
					[1.78]	[1.78]
From holding bonds					0.850***	0.850***
					[9.34]	[9.34]
From trading bonds					0.375	0.375
					[0.47]	[0.47]
Insurer FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE		Yes		Yes		Yes
No. of obs.	7,063	7,063	7,063	7,063	7,063	7,063
R^2	0.561	0.561	0.562	0.562	0.608	0.608
Within R^2	0.308	0.308	0.310	0.310	0.382	0.382

Table D.5
State-level information on insurance markets

This table displays information on the insurance markets and regulators of the 51 U.S. states in our filing-level sample. *# Filings* is the number of rate filings in the state over the sample period. *# Insurers* is the number of insurers that submitted at least one filing in the state over the sample period. *Mean decision time (# days)* is the average number of days between the submission and the approval of a rate filing in the state. *Mean $\Delta Price$* is the average effective price change of a rate filing in the state over the sample period.

	# Filings	# Insurers	Mean decision time (# days)	Mean $\Delta Price(\%)$
Alabama	63	17	126.79	5.04
Alaska	87	12	59.11	4.89
Arizona	764	104	10.63	5.23
Arkansas	535	67	26.02	7.69
California	326	56	188.89	5.67
Colorado	923	96	204.23	7.77
Connecticut	629	91	94.06	5.35
Delaware	281	50	77.94	5.89
District Of Columbia	139	29	113.83	4.4
Florida	598	68	102.42	6.07
Georgia	848	112	62.28	8.73
Hawaii	72	16	148.74	5.62
Idaho	397	63	57.89	5.72
Illinois	1220	134	27.92	5.14
Indiana	934	122	44	4.99
Iowa	702	92	14.19	6.84
Kansas	682	94	27.42	6.8
Kentucky	693	82	16.36	5.93
Louisiana	418	66	54.53	5.73
Maine	420	65	26.34	5.33
Maryland	227	54	162.1	4.82
Massachusetts	610	93	108.68	3.93
Michigan	621	74	33.48	4.75
Minnesota	608	100	63.01	6.28
Mississippi	386	54	81.74	7.7
Missouri	828	100	46.88	6.33
Montana	319	58	39.58	7.53
Nebraska	601	82	42.46	8.9
Nevada	339	63	59.23	4.78
New Hampshire	454	70	40.4	4.68
New Jersey	634	90	41.45	4.79
New Mexico	394	59	12.46	7.37
New York	697	117	76.01	3.63
North Carolina	426	55	21.42	4.15
North Dakota	373	53	38.5	4.93
Ohio	1073	125	38.25	5.65
Oklahoma	752	88	34.94	8.49
Oregon	534	79	29.09	4.99
Pennsylvania	840	128	33.47	5.61
Rhode Island	342	58	97.01	6.96
South Carolina	557	89	76.59	6.66
South Dakota	451	63	6.24	8.44
Tennessee	860	114	29.58	7.05
Texas	598	78	98.27	6.11
Utah	386	64	33.09	5.45
Vermont	288	48	37.01	3.41
Virginia	876	111	45.04	5.18
Washington	395	72	97.1	5.61
West Virginia	281	45	58.77	7
Wisconsin	868	112	2.4	5.49
Wyoming	8	1	43.13	6.32

Table D.6
Robustness: Home prices, insurance markets, and monetary policy

This table shows estimates for the transmission of monetary policy through insurance markets on home prices. The dependent variable, Δ*Log(ZHVI)*$_{c,y}$, is the cumulative change in the Zillow Home Value Index for all types of homes in county c from month $m-7$ to month $m+6$. $\Delta MP_{(m-1):(m-6)}$ is the sum of all monetary policy surprises in the 10-year U.S. Treasury yield over the six months preceding m. $\phi_{s(c),m}$ is the sensitivity of insurers operating in state $s(c)$ to monetary policy in month m. In column (1) the sensitivity is constructed based on the share of insurers' assets mark-to-market; in column (2) on the duration of insurers' fixed income portfolio. We control for six lags of changes in *Log(ZHVI)*. County controls are lagged *Population density* and changes in *Log(GDP per capita)*, and *Log(Population)*. Macro controls are lagged Δ*GDP*, *VIX*, Δ*CPI*, and the information component of the monetary policy shock, ΔMP^{inf}. All variables are defined in Table 1 and Appendix Table D.2. t-statistics are shown in brackets and based on standard errors that are two-way clustered at the county level and the state-month levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Dep. variable:	Δ*Log(ZHVI)*$_{c,m+6}$	
	(1)	(2)
$\Delta \text{MP}_{(m-1:m-6)}$	-8.830***	-9.709***
	[-3.48]	[-3.84]
$\phi^{MTM}_{s,m} \times \Delta \text{MP}_{(m-1:m-6)}$	-0.356***	
	[-2.78]	
$\phi^{Duration}_{s,m} \times \Delta \text{MP}_{(m-1:m-6)}$		-0.096
		[-0.85]
Lags Dep. Variable	Yes	Yes
County controls	Yes	Yes
Macro controls	Yes	Yes
County controls $\times$ ΔMP	Yes	Yes
County-Season FE	Yes	Yes
No. of obs.	289,386	289,386
R^2	0.778	0.777
Within R^2	0.736	0.736

E Calculating bond durations

E1 Constructing the duration measure

We compute the end-of-year duration for the universe of insurers' fixed-income securities (reported in NAIC Schedule D Part 1). The Macaulay duration of an asset is defined as,

$$\text{Duration}_{b,t} = \left[\sum_{j=1}^{n} \frac{j \times C_{b,j}}{(1 + y_{b,t})^j} \right] \Big/ P_{b,t}, \tag{E1}$$

where $C_{b,j}$ is the cash flow from asset b received at time $j > t$, $y_{b,t}$ is the appropriate discount rate for asset b at time t, and $P_{b,t}$ is the market price of asset b at time t. We collect information on the payment schedule of the asset, maturity date, coupon rate, discount rates, and market prices from the following data sources.

- **Mergent FISD:** The data set contains issue-level information on corporate bonds, U.S. Treasuries, and some asset-backed securities. We retrieve information on bonds' coupon rates, maturity dates, and bond features.
- **TRACE Enhanced:** The data set contains all corporate bond transactions in the U.S. market. We use the data to calculate market prices for corporate bonds after applying the cleaning procedure from Dick-Nielsen (2009) and Dick-Nielsen (2014).
- **MSRB:** The data set contains all municipal bond transactions in the U.S. market. We use the data to calculate market prices for municipal bonds.
- **Federal Reserve :** The Fed calculates daily U.S. Treasury yields based on the procedure in Gürkaynak et al. (2007). We access the data via federalreserve.gov.

Where we can obtain all necessary information, we directly compute the Macaulay duration. For municipal bonds, we assume a semiannual coupon payment as this is the most common form of payment structure among municipal bonds (msrb.org). All Treasury securities, i.e., notes and bonds, generally pay interest on a semiannual basis (treasurydirect.gov).

When we lack information on the payment schedule, we infer durations from assets with a similar rating and coupon structure. To do so, we cluster all bond-year observations into a year-rating-coupon-time to maturity (TTM) grid defining three buckets for ratings, i.e., "Prime/High grade", "Medium grade", and "Speculative/default", and three buckets for coupon rates, i.e., $[0\%, 4\%)$, $[4\%, 6\%)$, and $> 6\%$. The grid includes all TTMs from 0 to the maximum years available. Using the calculated durations from the first step, we then calculate the average bond duration for each cluster and assign it to the bonds lacking information on the payment schedule (except municipal bonds). We require at least 5 observations in a bucket to calculate the average. For the remaining buckets, we impute the duration by estimating for each year-rating-coupon bucket the regression,

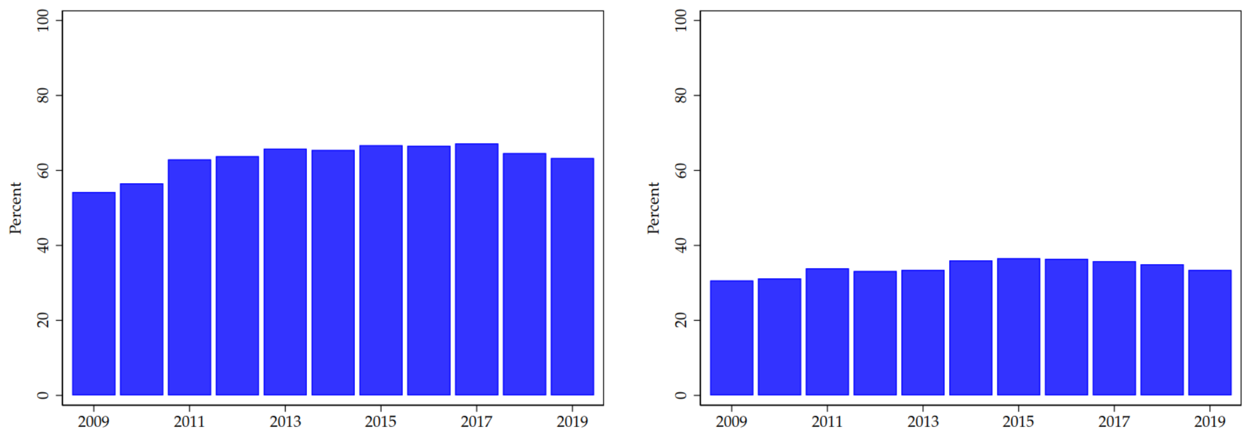
$$\text{Duration}_b = \beta_1 \times \text{TTM}_b + \beta_2 \times \text{TTM}_b^2 + \epsilon_b, \tag{E2}$$

where $Duration_b$ is the duration of bond b, and TTM_b is the remaining time to maturity of bond b in years. We merge the estimates $\{\hat{\beta}_1, \hat{\beta}_2\}$ from equation (E2) to the year-rating-coupon buckets and interpolate values for the different bonds.

This procedure allows us to compute durations for more than 1.01 million (1.52 million) bond-year observations from 2009 to 2019 (2006 to 2020). Our duration measure matches around 60 percent of insurers' fixed income portfolio - mainly corporate bonds, U.S. Treasuries, and municipal bonds - and more than 30 percent of insurers' total assets.

Figure E.1
Match of duration measure with insurers' portfolios and assets

This figure shows (1) the aggregate share of insurers' fixed income portfolio and (2) the aggregate share of total assets matched with our duration measure between 2009 and 2019.



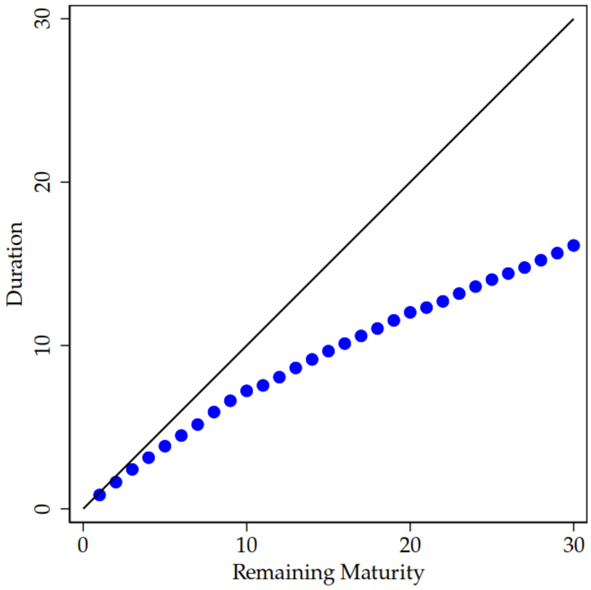
(a) Fixed income portfolio **(b)** Total assets

E2 Validation of the duration measure

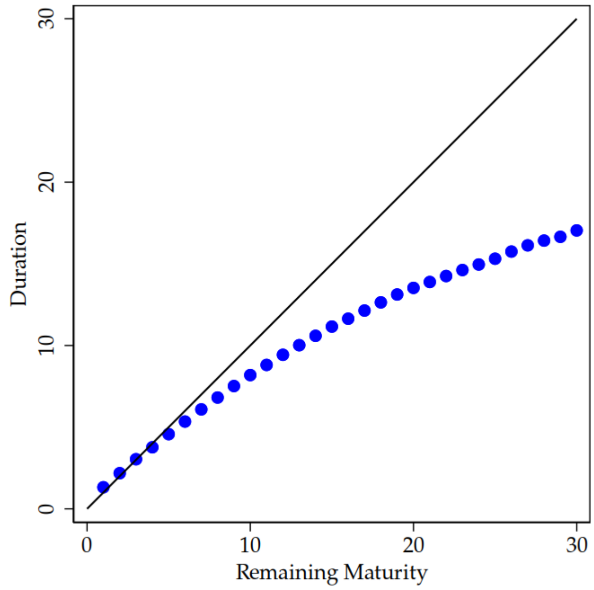
To validate our duration measure, we first compare it to the remaining maturity of the asset. We consider the main asset categories (as defined by the NAIC) for which we can calculate the Macaulay duration: corporate bonds, municipal bonds, U.S. Treasuries, and foreign bonds. Figure E.2 shows the relationship between the remaining time to maturity and the Macaulay duration of the asset categories. The black line represents the $x = y$ line. The figure shows that our duration measure behaves as expected from a Macaulay duration. For short-term assets, the duration is almost the same as the remaining maturity. However, with increasing maturity, the duration measure diverges from the remaining maturity and is substantially shorter than the remaining maturity (for long-term assets). Furthermore, comparing the different asset classes shows that the gap between duration and remaining maturity is the largest for corporate bonds, the smallest for U.S. Treasuries, and in between for municipal bonds. This aligns with the intuition that corporate bonds have a higher yield and, thus, a lower duration than U.S. Treasuries.

Figure E.2
Relationship between remaining maturity and duration

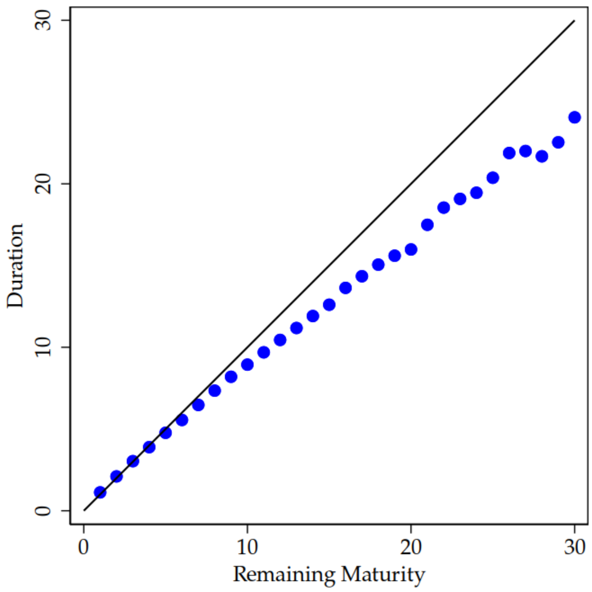
This figure shows the relationship between the remaining time to maturity and the Macaulay duration of the asset categories for which we can calculate the Macaulay duration. We follow the asset categories defined in the NAIC Schedule D regulatory filings of insurers. The black line represents the $x = y$ line.



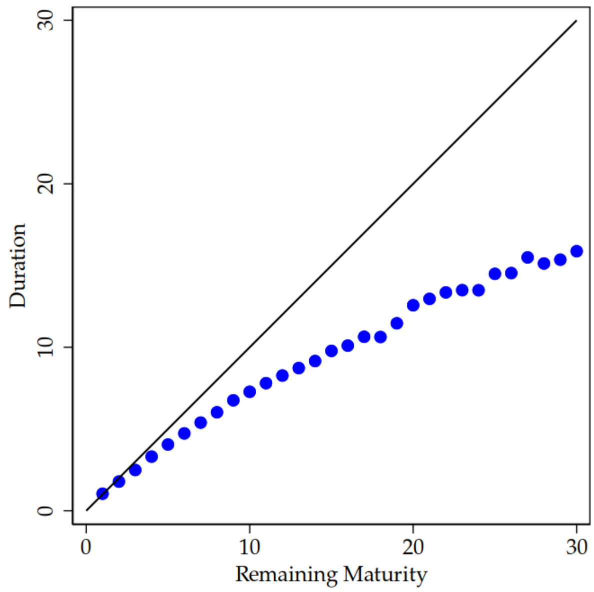
(a) Corporate bonds



(b) Municipal bonds



(c) U.S. Treasuries



(d) Foreign bonds

To further check the validity of our duration estimates, we estimate the relationship between bond returns and bond duration. For this purpose, we calculate monthly bond returns,

$$R_{b,m} = \frac{P_{b,m} - P_{b,m-1}}{P_{b,m-1}} \tag{E3}$$

where $P_{b,m}$ is the price of bond b in month m. To calculate returns, we construct bonds' monthly prices from Trace Enhanced after applying the cleaning procedure laid out in Dick-Nielsen (2009) and Dick-Nielsen (2014). We then estimate the following regression model,

$$R_{b,m} = \alpha + \beta\ \Delta\text{MP}_{m-1} \times \text{Duration}_{b,y(m)-1} + \gamma\ \Delta\text{MP}_{m-1} + \delta\ \text{Duration}_{b,y(m)-1} + u_b + \varepsilon_{b,m}, \tag{E4}$$

where $R_{b,m}$ is the return of bond b from month $m-1$ to month m. ΔM.P.$_{t-1}$ is the sum of changes in the 10-year U.S. Treasury yield around a 30-minute window of FOMC meetings taken from Bauer and Swanson (2023). Duration$_{b,y(m)-1}$ is our calculated Macaulay duration of bond b at the end of the preceding year. To exploit only the time series of bonds, we include bond fixed effects and cluster standard errors at the bond level. To be valid, the interaction of monetary policy shocks and duration measures must be negative and significant, as bonds with a higher duration react more strongly to monetary policy.

Table E.1 shows the results of our validation exercise. In the first three columns, we calculate returns based on median prices of bonds in a month for a sample period from January 2009 to December 2019, i.e., the sample period we consider in our main analysis. The results confirm the validity of our duration measure. First, monetary policy negatively affects bond returns, and second, the effect is stronger for bonds with a higher duration. In column (4), we additionally include the years 2007 to 2008, the years of the financial crisis. The results stay the same. In columns (5) and (6), we repeat regression E4 for both sample periods using this time the average price in a month to calculate the returns. Again, the interaction between our duration measure and the monetary policy shock is negative and highly significant. Overall, we conclude that our duration estimates are valid and can be used to analyze the impact of monetary policy on insurance companies' asset portfolios.

Table E.1
Monetary policy, duration, and asset prices

This table shows estimates for the relationship between bond returns, monetary policy, and bond duration. The dependent variable, $R_{b,m}$, is the monthly return of bond b from month $m-1$ to month m. The main independent variable, ΔMP_{m-1}, is the sum of all surprises in the 10-year U.S. Treasury yield in month m. $Duration_{b,y(m)-1}$ is the Macaulay duration of bond b at the end of year $y(m)-1$. The dependent variable is the monthly return of bond b from month $m-1$ to month m. In columns (1) to (4), we calculate the return based on the median price of bond b in month m and $m-1$; in columns (5) and (6), we calculate the return based on the average price of bond b in month m and $m-1$. We include bond-level controls in columns (3) to (6). More specifically, we control for the natural logarithm of a bond's monthly trade volume and the average Bid-Ask spread. t-statistics are shown in brackets and based on standard errors that are clustered at the bond level. ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % levels.

	Dependent variable: $R_{b,m}$					
Price variable:	Median price				Average price	
Sample period:	2009:M1-2019:M12			2006:M1-2019:M12	2009:M1-2019:M12	2006:M1-2019:M12
	(1)	(2)	(3)	(4)	(5)	(6)
ΔMP$_{m-1}$	-9.516***	-8.996***	-1.929**	-1.620	-1.460**	-0.833
	[-15.64]	[-15.39]	[-2.00]	[-1.55]	[-2.32]	[-1.39]
Duration$_{b,y(m)-1}$	0.146***	0.116***	0.117***	-0.046***	0.115***	-0.042***
	[29.23]	[19.21]	[19.47]	[-8.17]	[20.45]	[-7.77]
Duration$_{b,y(m)-1} \times \Delta$MP$_{m-1}$	-0.433***	-0.550***	-0.313***	-0.160**	-0.258***	-0.146***
	[-6.14]	[-7.89]	[-4.43]	[-2.38]	[-4.63]	[-2.65]
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls		Yes	Yes	Yes	Yes	Yes
ΔMP$_{m-1}$ × Controls			Yes	Yes	Yes	Yes
No. of obs.	1,000,808	789,995	789,995	899,405	789,995	899,405
R^2	0.086	0.125	0.128	0.055	0.105	0.057
Within R^2	0.009	0.015	0.018	0.019	0.018	0.019