

Homeowners Insurance and the Transmission of Monetary Policy*

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Abstract

We establish an insurer balance-sheet channel that amplifies the transmission of monetary policy to housing markets. Changes in interest rates revalue insurers' assets, affecting the tightness of regulatory capital constraints and, thereby, the shadow cost of capital. Using monetary policy surprises as an instrument and the universe of U.S. homeowners insurance price changes, we estimate that a one-percentage-point increase in long-term Treasury yields raises insurance prices by 3.8%, even though higher yields lower the present value of expected claims. Consistent with a balance-sheet channel, price responses are strongest among financially constrained insurers holding interest-rate-sensitive investment portfolios. Because homeowners insurance accounts for a substantial share of housing costs, these price responses matter for households: the insurance channel's effect on housing costs is roughly half as large as the traditional mortgage channel. As a consequence, house prices decline significantly more after contractionary monetary policy surprises in regions served by more exposed insurers, with larger effects in areas with higher insurance costs. Our findings identify homeowners insurance as an important channel of monetary policy transmission, complementing the traditional focus on credit markets.

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1 Introduction

Homeowners insurance is essential to obtain mortgage credit and, as a result, nearly all U.S. homeowners are insured. Households spend more than \$180 billion on premiums annually, which makes homeowners insurance an important component of housing costs: insurance premiums amount to 21% of mortgage principal and interest payments on average (Keys and Mulder, 2025), and insurance affordability is a concern for many households, with one in five homeowners unable to afford their preferred level of coverage (Board of Governors of the Federal Reserve System, 2026). At the same time, by investing insurance premiums in financial markets, property insurers are exposed to macroeconomic shocks, which they may pass on to households.

We study how the homeowners insurance market affects the transmission of monetary policy to households. The textbook prediction is that insurance prices fall when interest rates rise, as insurers discount future claims at a higher rate. We find that the opposite holds in the data, where changes in insurance prices are *positively* related to interest rate changes (Figure 1). Using monetary policy surprises as an instrument, we estimate that a 100 basis point (bps) increase in the 10-year Treasury yield raises insurance prices by 3.8% on average. A balance-sheet channel explains this positive relationship: higher interest rates reduce the market values of rate-sensitive assets and, thereby, tighten insurers' regulatory capital constraints, increasing the shadow cost of capital. Consistent with this channel, we find that the insurance price response is driven by insurers with interest-rate-sensitive investment portfolios and tight capital constraints.

The response of homeowners insurance prices to monetary policy has important implications for the cost of homeownership. We estimate that a 100 bps increase in Treasury yields raises average housing costs by 0.65% through higher homeowners insurance prices alone. On average, this effect through insurance amounts to about 40% of the analogous effect through mortgage interest payments. For households in the upper decile of insurance expenditures, the impact becomes comparable to the mortgage channel. Through its effect on housing costs, homeowners insurance amplifies the response of house prices to monetary policy. We find that a one-standard-deviation larger exposure of local insurer balance sheets is associated with a decline in house prices that is about 1.8 percentage points (ppt) larger in response to a 100 bps monetary policy surprise. Using an instrumental variable approach, we show that this is consistent with an elasticity of house prices to homeowners insurance prices of about -1. The response of house prices is stronger for households with large

insurance expenditures relative to their income, consistent with the presence of payment-to-income constraints. It is also larger in areas with higher risk of natural disasters, where insurance prices are typically higher. Our findings show that the homeowners insurance market constitutes an important channel of monetary policy transmission, complementing the traditional focus on capital-market intermediation and credit provision.

To identify the effects of monetary policy, we use high-frequency monetary policy surprises (Bauer and Swanson, 2023b) in combination with cross-sectional variation in insurer balance sheets. For this purpose, we combine three datasets. First, we observe the universe of U.S. homeowners insurance price changes. Each filing includes the percentage change in price, holding fixed any demand-side factors. Second, we use information on insurers' balance sheets. By regulation, insurers must hold sufficient capital relative to a risk-based capital requirement. We define an insurer as capital constrained when its risk-based capital (RBC) ratio (the ratio of available to required capital) is low relative to previous years. By comparing to an insurer-specific benchmark rather than a pooled average, this definition allows for different levels of risk appetite across insurers and exhibits less persistence than actual capital ratios. Furthermore, using security-level data on investment portfolios, we measure the interest-rate sensitivity of insurers' investment portfolios by aggregating security-level duration for fixed-income securities and the beta of daily equity returns with respect to monetary policy surprises for equity investments. Third, we measure house price dynamics at the county-month level and merge these data with county-level household characteristics.

The sensitivity of property insurers to monetary policy stems from an imbalance in the interest-rate sensitivity of their assets and liabilities. While insurance liabilities are composed of short-dated contracts with annual renewal, insurers invest premiums in interest-rate-sensitive assets. Because about 15% of the sector's investments are marked to market, fluctuations in their market values directly impact the insurers' statutory capital. To formalize how this exposure affects insurance pricing, we develop a stylized model in the spirit of Koijen and Yogo (2016), in which an insurer sets prices to maximize profits net of a shadow cost of capital. The equilibrium price decomposes into three terms: the actuarially fair value, a constant markup, and a regulatory wedge that increases with the shadow cost of capital. Monetary policy enters through two opposing forces. On the one hand, a higher interest rate lowers the actuarially fair value of future claims and pushes down insurance prices, implying a benchmark semi-elasticity of -1 . On the other hand, a higher interest rate depresses the market value of the insurer's interest-rate-sensitive assets, tightening

regulatory capital constraints and pushing up insurance prices.¹ Which force dominates depends on insurers' balance sheet characteristics: insurance prices increase with interest rates if the insurers' investment portfolios are sufficiently interest-rate sensitive and capital constraints sufficiently tight. This prediction guides our empirical design.

Our evidence points to an important role for financial frictions in insurance pricing. Using monetary policy surprises as an instrument, we estimate that a 100 bps increase in the 10-year Treasury yield increases insurance prices by 3.8% on average. The significantly positive estimate implies that financial frictions more than offset the lower present value of future claims. A back-of-the-envelope calculation shows that the estimated response is about one quarter of the price adjustment required to fully offset the change in statutory capital induced by monetary policy on average. This required adjustment is large because of leverage and balance sheet dynamics: insurance price adjustments apply only as contracts renew and additional premiums are earned only gradually over the contract term. Consequently, restoring \$1 of statutory capital by year-end – when insurers report their regulatory capital ratios – requires a price adjustment of more than \$1 today.

We provide evidence that the response of insurance prices is driven by a balance-sheet channel, exploiting cross-sectional variation in insurers' exposure to monetary policy. Specifically, we find that the price response significantly increases with insurers' capital constraints and the interest-rate sensitivity of their investment portfolios. Following a 100 bps increase in Treasury yields, constrained insurers at the 75th percentile of interest-rate sensitivity raise prices by about 0.6 ppt more than insurers with low exposure. The identifying assumption is that, conditional on controls and fixed effects, insurers with more exposed balance sheets do not respond differentially to monetary policy through other channels. By including granular state-by-time fixed effects, our cross-sectional estimate compares differentially exposed insurers within the same state at the same point in time, ruling out aggregate and local shocks as alternative explanations. We further discipline the identifying assumption by documenting the absence of sorting on local household characteristics, suggesting that differences in demand elasticities cannot explain the result. Moreover, we show that the result is driven by the *interaction* of capital constraints and the interest-rate sensitivity of investment portfolios: neither constraints nor sensitivity individually explains the result, ruling out that it is driven by differences in insurers' risk appetite.

1 Regulatory frictions may prevent insurers from hedging interest rate risk ex ante (Sen, 2023).

We also show that the result is driven by regulatory capital constraints rather than net worth constraints. Under statutory accounting rules, certain assets (primarily investment-grade bonds) are held at historical cost rather than at market value, such that fluctuations in their prices do not affect regulatory capital. This accounting treatment is irrelevant for a net-worth channel, which operates through the market value of *all* assets regardless of accounting treatment. We find that the sensitivity of the entire portfolio has no explanatory power in addition to that of mark-to-market assets, confirming that regulatory capital constraints govern the price response. Thus, whereas our mechanism shares the emphasis on financial frictions with the bank net worth channel (Bernanke and Gertler, 1989), it operates through regulatory frictions: insurers adjust prices in response to the marginal value of statutory capital rather than net worth.

To gauge the economic significance of the insurance channel for households, we decompose the response of housing costs, defined as insurance premiums plus principal and interest on mortgages, to monetary policy. The average insurance elasticity implies that housing costs rise by 0.65% through the insurance channel alone in response to a 100 bps increase in interest rates. For households in the upper decile of insurance expenditures, this semi-elasticity increases to 1.1%. To put this elasticity into perspective, we compare it to an upper bound for the response of housing costs via mortgage interest payments (either through the reset of an adjustable-rate mortgage or through refinancing).² We find that the response through insurance amounts to about 40% of the effect that monetary policy has through mortgages. For households with high insurance expenditures, the two channels have a comparable magnitude.

Finally, we document that homeowners insurance amplifies the response of house prices to monetary policy. We show that house prices respond significantly more to monetary policy surprises in regions served by insurers with more exposed balance sheets. A 100 bps contractionary monetary policy surprise lowers house prices by about 1.8 ppt more for a one standard deviation increase in the exposure of local insurance markets. This differential response is robust to controlling for local economic conditions, including interactions of time fixed effects with local characteristics that absorb heterogeneous shocks across regions. We show that the estimated magnitude is consistent with higher insurance prices operating through households' cash flow constraints and provide corresponding evidence from cross-sectional variation in the insurance cost-to-income ratio across counties. Moreover, we find

2 The comparison of housing costs concerns existing homeowners. For a prospective buyer financing a new purchase, the mortgage channel dominates the insurance channel.

that the response is amplified in counties with greater natural-disaster exposure, where insurance premiums are higher and account for a larger share of housing costs. Thus, the insurance channel is particularly important where climate risk makes insurance a key component of the cost of homeownership. Due to the importance of housing wealth for consumption (Mian et al., 2013; Aladangady, 2017), these results suggest that the homeowners insurance channel may have broader consequences for household balance sheets and aggregate demand.

Several additional analyses reinforce the interpretation of our main results. First, we verify that insurers' investment income (and, importantly, unrealized capital gains) responds to monetary policy. This response increases with the interest-rate sensitivity of insurers' investment portfolios, providing validation for our approach. Second, we study how actuarial pricing affects insurers' scope to adjust final prices. Actuarial target prices increase following monetary tightening, providing room for insurers to raise final prices. However, unlike final prices, the response of target prices does not significantly vary with insurers' interest-rate sensitivity and capital constraints. This result suggests that actuarial pricing rules do not interact with the balance-sheet channel. Finally, while the price response to monetary policy varies significantly with insurers' balance sheet exposure, we find no corresponding significant differences in filing probabilities or the number of policyholders and premiums affected by filings. This suggests that insurers largely follow predetermined repricing cycles.

The role of nonbank financial intermediaries in monetary policy transmission has attracted increasing attention since the 2008 Global Financial Crisis and is by now prominent in monetary policymaking at major central banks.³ However, this attention has focused primarily on capital-market intermediation and credit provision. Our results highlight a complementary and economically significant channel of monetary policy transmission through insurance markets, with effects on household borrowing capacity and significant interactions with climate risk exposure. These findings suggest that insurance markets constitute an important margin of monetary policy transmission that deserves greater attention in policymaking.

3 For examples, see the 2013 speech by Simon Potter, then Executive Vice President of the New York Fed (<https://www.newyorkfed.org/newsevents/speeches/2013/pot131202.html>), the ECB's 2021 Monetary Policy Strategy Review (https://www.ecb.europa.eu/mopo/strategy/strategy-review/ecb.strategyreview_monpol_strategy_overview.en.html), and the Bank of England's 2019 Report on Market-Based Finance (<https://www.bankofengland.co.uk/report/2019/future-of-finance>).

Related literature Our paper contributes to three literatures. The first is the literature on monetary policy transmission through financial intermediaries. A large body of work examines how interest-rate shocks affect bank balance sheets, funding conditions, deposit markets, and credit supply (e.g., Bernanke and Gertler, 1989; Kashyap and Stein, 2000; Gertler and Karadi, 2015; Drechsler et al., 2017). Recent work broadens this literature to nonbank intermediaries, documenting that monetary policy is transmitted through shadow banks, nonbank lenders, and capital-market intermediation (Xiao, 2020; Elliott et al., 2022; Drechsler et al., 2022; Cucic and Gorea, 2026), including insurance companies as investors (Kaufmann et al., 2023; Li, 2026; Aldasoro et al., 2026; Fang and Xiao, 2026). We instead consider the transmission through the core business of insurers: supplying insurance.⁴ Closest to our balance-sheet mechanism, Greenwald et al. (2024) show that losses on securities portfolios induced by monetary policy hikes reduce credit supply by banks.⁵ We instead study the pass-through to insurance prices, where balance-sheet shocks affect the supply of risk protection (insurers' liabilities) rather than credit (banks' assets). Our setting also sharpens the identification: statutory insurance accounting prescribes accounting rules that are heterogeneous across assets but uniformly across property insurers, allowing us to exploit differences in ex-ante portfolios. By contrast, banks endogenously reclassify the accounting of securities in response to shocks (Granja et al., 2025).

Second, our paper contributes to work on insurance markets and financial frictions. The classic insurance literature focuses on demand-side frictions (e.g., Rothschild and Stiglitz, 1976; Einav et al., 2010). Recent work highlights significant interactions between insurers' balance sheets, regulation, and product-market outcomes (Kojien and Yogo, 2015, 2016; Ge, 2022; Kojien and Yogo, 2022b; Barbu et al., 2024; Kalda et al., 2025; Oh et al., 2026; Knox and Sørensen, 2026; Kubitza, 2026).⁶ We show that these frictions transmit macroeconomic shocks: monetary policy affects insurers' balance-sheet capacity and thereby passes through to insurance prices. Moreover, we extend recent evidence on the significant effects of insurance costs on housing markets (Ge et al., 2025, 2026; Hu, 2026; Sastry,

4 Focusing on life rather than property insurers, Li and Wenning (2025) study the impact of interest rates on the composition of (savings) products offered by life insurers. Kojien and Yogo (2022a) and Brunetti et al. (2026) examine insurers' residual interest rate risk exposure using equity prices.

5 Losses in bank security portfolios also impair access to interbank funding (Giannetti et al., 2025).

6 Whereas Knox and Sørensen (2026) document the (long-run) effects of liquidity premia on insurance prices for unconstrained insurers, we focus on the immediate impact of monetary policy shocks working through constrained insurers.

2026; Sastry et al., 2026; Meisenzahl et al., 2026) by documenting the consequences of insurer balance-sheet frictions for housing affordability.

Third, this paper relates to the literature on monetary policy and housing markets. Monetary policy affects (prospective) homeowners through mortgage rates, refinancing, and mortgage-credit supply (e.g., Di Maggio et al., 2017; Beraja et al., 2019; Berger et al., 2021). We highlight homeowners insurance as an important additional margin through which monetary policy affects households.

2 Institutional Background

Homeowners insurance More than 90% of U.S. homeowners have homeowners insurance (Jeziorski and Ramnath, 2021). Banks rely on homeowners insurance to protect the collateral securing loans and therefore require coverage as a condition of mortgage approval. There are eight standard homeowners insurance contract forms, designated HO-1 through HO-8, which differ in coverage and policyholder type. HO-3, also known as “Special Form,” is the most common. It covers owner-occupied homes and belongings against a broad set of perils, including fire, certain forms of water damage and most weather-related losses (National Association of Insurance Commissioners, 2022).⁷ In our filings data set, most filings cover multiple contract forms, followed by filings about HO-3 forms. Together, these filings account for 85% of observations. Standard contracts insure the dwelling at replacement cost (subject to insurance-to-value requirements), guaranteeing restoration of the pre-damage state, while personal property is typically settled at actual cash value. Homeowners insurance premiums account for a substantial part of housing costs, particularly for mortgage-financed homes.⁸ Keys and Mulder (2025) estimate that homeowners insurance premiums are 21% of the principal and interest payments on mortgages for the average homeowner and more than 40% for the top 10% of homeowners, natural disaster exposure being a primary driver of cross-sectional price variation.

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

8 In August 2025, the average annual premium across U.S. states for an insurance contract with \$300,000 in insurance coverage (\$1,000 deductible) was \$2,470, with the highest premiums in Louisiana (\$6,274) and the lowest in Vermont (\$834), see bankrate.com.

Insurance pricing Property and casualty (P&C) insurers collected \$189 billion in premiums in 2025 on homeowners insurance contracts, representing more than 17 percent of all direct premiums written by U.S. P&C insurers.⁹ As specified in the McCarran-Ferguson Act of 1945, insurance markets are subject to regulation by individual U.S. states. Insurance companies file for adjustments in prices, terms, and conditions with the local regulatory authority in the relevant U.S. state. These filings allow us to distinguish between changes in prices and changes in quality (i.e., product characteristics).

Insurers typically adjust prices at an annual frequency (see Appendix Figure C.1 and Table D.1) and apply these adjustments to all policyholders within a state. This pattern suggests that the timing of a filing is largely governed by predetermined pricing cycles. Three institutional features support this interpretation. First, homeowners insurance policies are typically renewed annually. Second, insurers must accumulate sufficient experience on the affected contracts to justify price changes. Third, preparing rate filings entails fixed administrative costs, which further discourages high-frequency price adjustments. Consistent with this interpretation, we find no systematic evidence that monetary policy surprises or financial constraints affect the timing of filings (see Appendix Table D.5).

Rate filings In each filing, insurers submit two price (“rate”) changes: the actuarially indicated change and the change the insurer proposes to implement.¹⁰ State regulators review these filings and can require insurers to implement a different price change than proposed. Our baseline analysis uses the final price change implemented after regulatory review, which reflects the actual evolution of insurance prices. The indicated price change is based on an actuarial benchmark (“target”) price that reflects projected claims and underwriting expenses together with a profit provision chosen to achieve the insurer’s target return on equity (Section 8.2 formalizes this pricing rule). Appendix I provides examples from actual rate filings. These examples illustrate how insurers’ target return on equity, which enters the indicated price through the profit provision, varies with interest rates. Because insurers must support final price changes with actuarial documentation, indicated price changes can limit final price adjustments. At the same time, indicated price changes

9 See the 2025 NAIC Market Share Reports for Property/Casualty Groups and Companies <https://content.naic.org/sites/default/files/publication-msr-pb-property-casualty.pdf>.

10 Because policyholders pay different prices, for example because of differences in risk exposure, the price change in a filing is the *average* change across the insurer’s policyholders in a state, holding the insurer’s current policyholder composition fixed.

do not need to determine insurers' desired price changes, which may also reflect financial conditions and other economic factors. Indeed, Section 8.2 shows that actuarially indicated price changes explain only a third of the variation in final price changes.

Capital regulation State insurance regulation requires that insurers hold sufficient statutory capital to cover potential losses. For this purpose, statutory capital is defined as the value of assets in excess of liabilities, measured according to statutory accounting rules. The risk-based capital (RBC) ratio benchmarks an insurer's total statutory capital to the regulatory required capital:

$$\text{RBC ratio} = \frac{\text{Statutory capital}}{\text{Required capital}}. \quad (1)$$

The required capital is calculated as a formula that combines risk charges across asset, underwriting, credit, and other exposures. If an insurer's RBC ratio is below regulatory thresholds, the insurer is required to submit a capital restoration plan or may even be taken under control by the regulator. Thus, the RBC ratio, reported at year-end, is the main regulatory benchmark for insurers.

Investment income P&C insurers invest most of their assets in fixed-income securities and equities. Statutory accounting determines when and how these investments affect statutory capital. Coupon and dividend payments, as well as realized gains and losses from security sales, enter net income and thus directly affect statutory capital. Whether changes in a security's market value affect the statutory capital of P&C insurers, however, depends on the type of security. Equities and high-yield bonds are typically marked to market, such that changes in their market value are recognized immediately as changes in capital ("unrealized gains and losses"). In contrast, investment-grade bonds are carried at historical cost, insulating their book values, and hence statutory capital, from changes in market prices. Equities and high-yield bonds account for up to 30% of P&C insurers' invested assets, and unrealized gains and losses account for roughly one half of insurers' investment income (see Figure C.3), implying a significant exposure of insurers to changes in asset prices.

Anecdotal evidence The Federal Insurance Office (2023) highlights that monetary tightening in 2022 significantly reduced the statutory capital of the P&C insurance sector, largely because unrealized capital losses increased by nearly \$100 billion. Industry practitioners

explicitly associate unrealized losses from rising rates with insurance price increases. For example, Guy Carpenter (2023) writes that “[d]ue to unrealized investment losses and the absence of new capital, reinsurers [...] tend to deploy their capital strictly to risks with adequate pricing” and that reinsurers “must then focus on improving underwriting profit in order to minimize the negative impact on earnings (and capital) due to the fall in investment returns (and their returns on equity or ROEs).” In another example, in its financial results for the fourth quarter of 2022, Allstate reports that higher interest rates and wider credit spreads resulted in significant unrealized capital losses in 2022 and, in the same release, states that it increased prices on homeowners and auto insurance.¹¹

3 Model

To provide a simple conceptual framework, we develop a stylized model of insurance pricing in the presence of regulatory capital constraints in the spirit of Kojien and Yogo (2015, 2016). Time is discrete, $t \in \{0, 1\}$. An exogenous risk-free rate r_f determines the present value of a stylized insurer’s assets and liabilities and interacts with financial frictions through capital regulation. All proofs are provided in the Appendix.

Balance sheet dynamics At $t = 0$, the insurer is endowed with interest rate-sensitive initial assets A_0 and liabilities L_0 . The insurer sets a unit price P and underwrites Q one-period insurance contracts. Demand is downward sloping with constant elasticity:

$$\epsilon = -\frac{\partial \log Q}{\partial \log P}. \quad (2)$$

We assume $\epsilon > 1$ throughout, which ensures that the insurer’s pricing problem below is well posed.

The expected insurance claim on each insurance contract is equal to μ , implying a present value of $V = e^{-r_f} \mu$, where r_f is the risk-free rate set by the central bank. In order to focus on the first-order economic mechanism, we assume that neither μ nor ϵ is affected by

¹¹ Other anecdotal evidence includes the March 21, 2024, episode of Bloomberg’s *Odd Lots* podcast (transcript available at <https://www.bloomberg.com/news/articles/2024-03-21/why-insurance-rates-have-been-surging-in-california-and-florida?embedded-checkout=true>), in which Amias Gerety, a partner at QED Investors and board member of the insurance company Kin, notes that “[...] bonds repriced down when rates go [up]. [...] you had a capital supply shock over the last couple of years as bonds repriced on insurers’ balance sheet.”

r_f (we discuss and provide support for this assumption in Appendix H). After underwriting insurance contracts, the insurer's total assets and liabilities at $t = 0$ are

$$A = A_0 + PQ, \quad (3)$$

$$L = L_0 + VQ. \quad (4)$$

Assets combine legacy holdings A_0 and premium income PQ from new contracts written, while liabilities include legacy obligations L_0 and the present value of expected claims on new insurance business VQ .¹²

Financial friction and profit Capital regulation imposes a cost on holding (too little) statutory capital. Following Koijen and Yogo (2016), statutory capital K at $t = 0$ is defined as the excess of assets over weighted liabilities:

$$K = A - (1 + \rho)L, \quad (5)$$

where $\rho \geq 0$ captures the regulatory capital requirement. A higher ρ implies stricter capital constraints. The regulatory cost of capital is represented by a smooth, thrice differentiable function $C = f(K)$ that is strictly decreasing and strictly convex ($C' < 0 < C''$), which captures the shadow cost of scarce regulatory capital. The more capital an insurer has, the lower is C .¹³

The insurer chooses its price to maximize profits net of the regulatory cost of capital:

$$\max_P Y - C, \quad (6)$$

where profits are

$$Y = (P - V)Q. \quad (7)$$

¹² Note that insurance claims incurred during a contract's lifetime are not necessarily settled within the same period. This gives rise to liabilities that persist beyond contract maturity, commonly referred to as unpaid losses and incurred but not reported (IBNR) losses. A natural interpretation of L_0 is that it captures these outstanding liabilities.

¹³ This approach to model financial frictions is qualitatively similar to imposing a leverage constraint, $A/L \geq 1 + \omega \Leftrightarrow A - (1 + \omega)L \geq 0$, but significantly enhances tractability.

Balance sheet characteristics The insurer's balance sheet modulates the pass-through of monetary policy in two dimensions. First, the insurer's initial assets are interest rate sensitive as captured by

$$\alpha = -\frac{\partial A_0}{\partial r_f} > 0. \quad (8)$$

α measures the decline per unit rate increase; higher α indicates a more interest-rate-sensitive portfolio. The parameter α reflects both (i) the interest rate-sensitivity (duration) of the individual assets in the insurer's investment portfolio and (ii) the extent to which fluctuations in market values are passed through to book values. Specifically, investment-grade bonds accounted at historical cost are insulated from market fluctuations unless sold prior to maturity, whereas lower-rated bonds and equities are marked to market.

Second, the insurer's ex-ante leverage, i.e., the initial amount of assets A_0 relative to liabilities L_0 , determines the insurer's shadow cost of capital prior to underwriting new insurance contracts. For simplicity, we assume that the ex-ante liabilities are not interest rate-sensitive.

Equilibrium insurance prices We now derive the optimal insurance price in equilibrium and analyze how this price responds to monetary policy shocks, i.e., changes in the risk-free rate r_f .

Proposition 1. The equilibrium price is given by

$$P = \left(1 - \frac{1}{\epsilon}\right)^{-1} \left(\frac{1 + (1 + \rho)\chi}{1 + \chi}\right) V, \quad (9)$$

where

$$\chi = -\frac{\partial C}{\partial K} > 0 \quad (10)$$

denotes the insurer's shadow cost of capital.

Proposition 1 shows that the equilibrium insurance price consists of three components: (i) the markup reflecting market power, $\left(1 - \frac{1}{\epsilon}\right)^{-1}$; (ii) the term $\frac{1 + (1 + \rho)\chi}{1 + \chi}$, capturing the distortion due to regulatory capital constraints; and (iii) the actuarially fair price V , equal to the discounted expected claims. The shadow cost of capital χ measures the marginal reduction in regulatory costs from relaxing the capital constraint. When $\rho = 0$, the regulatory wedge $\frac{1 + (1 + \rho)\chi}{1 + \chi}$ collapses to 1 and the equilibrium price reduces to the standard monopoly markup over the actuarially fair value and the insurer only seeks to maximize profits. However, when $\rho > 0$, the wedge exceeds 1 and regulation introduces a tradeoff

between maximizing profits and conserving regulatory capital. This pricing equation is equivalent to that in Kojien and Yogo (2016).

Monetary policy Monetary policy operates through changes in the risk-free rate r_f , which affect equilibrium insurance prices through two distinct channels. First, a higher risk-free rate directly reduces the actuarially fair value of insurance contracts via discounting,

$$\frac{\partial \log V}{\partial r_f} = -1. \quad (11)$$

Second, a higher risk-free rate affects the insurer's statutory capital by lowering the market value of both the insurer's assets and liabilities:

$$\frac{dK}{dr_f} = - \underbrace{(\alpha - (1 + \rho)VQ)}_{\text{Net asset sensitivity}} + \underbrace{\frac{d \log P}{dr_f} v}_{\text{Price adjustment}}. \quad (12)$$

The first term in equation (12) captures the direct effect of a higher risk-free rate on statutory capital: asset values fall by α , partially offset by the decline in regulatory-weighted liabilities, $(1 + \rho)VQ$. The more interest-rate sensitive the asset portfolio (the larger α), the larger the reduction in the insurer's capital following a rate increase. The second term is the indirect, endogenous adjustment through insurance prices. A higher equilibrium price reduces the amount of underwriting the insurer does, which relaxes the capital constraint on the margin. $v = \frac{dK}{d \log P}$ is the semi-elasticity of statutory capital with respect to the insurance price, measuring the pass-through of insurance price changes to regulatory capital. Evaluated at the equilibrium price, it is $v = QV \epsilon \rho / (1 + \chi) \geq 0$.

Combining these channels yields the comparative static characterizing the overall sensitivity of equilibrium insurance prices to monetary policy.

Proposition 2. The semi-elasticity of the insurance price with respect to the risk-free rate is

$$\frac{d \log P}{dr_f} = -1 + \underbrace{\frac{\delta}{1 + \delta v}}_{\text{Effective price sensitivity to capital}} \left(\underbrace{\alpha - (1 + \rho)VQ}_{\text{Net asset sensitivity}} + v \right), \quad (13)$$

where δ measures how strongly changes in statutory capital are passed through to equilibrium insurance prices via the shadow cost of capital

$$\delta \equiv -\frac{\rho}{1 + \chi(1 + \rho)} \frac{\chi'}{1 + \chi} \geq 0, \quad (14)$$

with $\chi' = \frac{\partial \chi}{\partial K} < 0$ (by strict convexity of C) denoting the marginal effect of statutory capital on the shadow cost of capital, such that $\delta > 0$ whenever $\rho > 0$.

Mechanism In the absence of financial frictions ($\rho = 0$), insurance prices move one-for-one with the risk-free rate, $\frac{d \log P}{dr_f} = -1$, because higher rates reduce the present value of future insurance claims. However, in the presence of frictions ($\rho > 0$), changes in r_f also affect prices via their effects on the insurer's balance sheet: higher rates reduce both the value of assets ($\alpha > 0$) and the present value of (regulatory-weighted) expected claims ($(1 + \rho)VQ > 0$). The net direct effect on statutory capital ($-\alpha + Q(1 + \rho)V$) therefore depends on the relative interest rate sensitivity of assets and liabilities.

Moreover, even when the net direct effect on statutory capital is zero, $\alpha = Q(1 + \rho)V$, equation (13) shows that financial frictions dampen the price response to interest rate changes. The intuition is as follows: a higher r_f reduces the actuarially fair price V , which by itself would lead the insurer to lower the price P . However, this price reduction reduces statutory capital by raising insurance liabilities, which in turn increases the shadow cost of capital. To partially offset this effect, the insurer optimally adjusts the price less in response to r_f , attenuating the negative impact of higher rates on insurance prices.

How large should the price response be? By itself, equation (13) does not answer this question: it expresses the response in terms of model primitives (most importantly the slope of the shadow cost of capital) that are not directly observable. However, we can rewrite the price response as a weighted average of two benchmarks, each with an empirical counterpart. Define the *capital-preservation benchmark* Π^K as the hypothetical price response that would exactly insulate statutory capital from the interest rate shock, obtained by setting $\frac{dK}{dr_f} = 0$ in equation (12):

$$\Pi^K \equiv \frac{\alpha - (1 + \rho)VQ}{v}, \quad (15)$$

which is positive whenever the insurer's assets are more interest rate-sensitive than its regulatory-weighted liabilities.

Corollary 1. With financial frictions ($\rho > 0$), the equilibrium price response is a convex combination of the frictionless benchmark, -1 , and the capital-preservation benchmark, Π^K :

$$\frac{d \log P}{dr_f} = -(1 - \lambda) + \lambda \Pi^K, \quad \text{where } \lambda \equiv \frac{\delta v}{1 + \delta v} \in [0, 1). \quad (16)$$

The weight λ summarizes the severity of financial frictions: it increases with the pass-through of capital changes to prices (δ) and with the effectiveness of price increases at rebuilding capital (v). Without frictions, $\lambda = 0$ and prices track the present value of claims one-for-one. As the shadow cost of capital becomes steep ($\delta \rightarrow \infty$), $\lambda \rightarrow 1$ and the insurer prices as if fully defending its capital position, $\frac{d \log P}{dr_f} \rightarrow \Pi^K$. For intermediate values of λ , the insurer offsets only part of the capital shortfall: sacrificing underwriting profits to rebuild capital is worthwhile only up to the point where the marginal profit distortion equals the marginal capital relief. Because both polar benchmarks have direct empirical counterparts, the observed price response identifies λ ; Section 6 takes this mapping to the data.

Direction of the price response The denominator in equation (13) is strictly positive. Consequently, both the sign and magnitude of the price response depend on two key factors: (i) the interest rate sensitivity of the insurer's statutory capital, $-\alpha + Q(1 + \rho)V$, and (ii) the effective pass-through of changes in statutory capital to equilibrium prices, which reflects both the marginal shadow cost of capital via the pass-through, δ , and the offsetting effect of price increases on statutory capital, v . If the decline in statutory capital is sufficiently large, prices rise in response to higher interest rates, as the insurer raises markups to rebuild capital.

Corollary 2. Insurance prices increase following a rise in the risk-free rate if the insurer's assets are sufficiently interest rate sensitive (large α) and the marginal shadow cost of capital sufficiently high (large δ):

$$\frac{d \log P}{dr_f} > 0 \quad \Leftrightarrow \quad \alpha > Q(1 + \rho)V + \frac{1}{\delta}. \quad (17)$$

In terms of Corollary 1, condition (17) requires that the weighted capital-preservation motive dominates the weighted discounting motive, $\lambda \Pi^K > 1 - \lambda$. Condition (17) is most likely to hold for property and casualty (P&C) insurers, which typically hold short-

dated liabilities and long-duration assets. In contrast, life insurers tend to have long-dated liabilities relative to assets (Li, 2026), making the inequality less likely to bind.

The role of asset sensitivity The interest rate pass-through to prices, $\frac{d \log P}{dr_f}$, depends on both the sensitivity of assets (α) and the marginal shadow cost of capital, which moves with initial leverage (L_0). More interest rate sensitive assets (i.e., larger α) imply a stronger response to monetary policy since capital constraints tighten more as rates rise.

Proposition 3. With financial frictions ($\rho > 0$), the effect of higher risk-free rates on insurance prices is stronger when the insurer holds more interest-rate-sensitive assets, i.e., for higher values of α :

$$\frac{\partial}{\partial \alpha} \left\{ \frac{d \log P}{dr_f} \right\} > 0. \quad (18)$$

The role of leverage Similarly, insurers with higher ex-ante leverage (larger L_0) experience a stronger price response. A loss in asset value is more costly for highly levered insurers, tightening their regulatory constraint more sharply. In the Appendix, we show that this holds under two sufficient conditions: (i) the insurer's assets are at least as interest rate-sensitive as its regulatory-weighted liabilities, $\alpha \geq (1 + \rho)QV$, and (ii) the friction weight λ from Corollary 1 is increasing in initial leverage.¹⁴

Proposition 4. With financial frictions ($\rho > 0$) and under the two sufficient conditions stated above, the effect of higher risk-free rates on insurance prices is increasing in initial leverage:

$$\frac{\partial}{\partial L_0} \left\{ \frac{d \log P}{dr_f} \right\} > 0. \quad (19)$$

The role of market power Finally, equation (13) shows that, all else equal, the direct effect of changes in the demand elasticity ϵ operates through the sensitivity of statutory capital to insurance prices, v . In more competitive product markets (i.e., higher ϵ), v is larger. This raises the denominator in equation (13), thereby attenuating the impact of the asset sensitivity α on equilibrium insurance prices. Intuitively, stronger competition limits the insurer's ability to pass the shadow cost of capital to insurance prices.

Robustness For tractability, we have focused on one representative insurance company. Instead, heterogeneity in balance sheets across insurers likely results in strategic pricing

¹⁴ Condition (ii) requires the shadow cost of capital to be sufficiently convex; the Appendix provides the exact primitive characterization.

behavior: less constrained insurers may aim to capture market share from more constrained insurers. In Appendix J, we explicitly consider such market dynamics in a Hotelling-style framework, where equilibrium market shares are determined jointly with prices. The main qualitative insight remains unchanged: financial frictions soften competition and govern the pass-through of monetary policy to prices.

Summary In summary, our model shows that monetary policy affects insurance prices through two opposing channels. In a frictionless market, higher interest rates lower the present value of future claims, thereby exerting downward pressure on equilibrium insurance prices. In the presence of financial frictions, however, higher interest rates also depress the market value of insurers’ assets, reducing statutory capital and increasing the shadow cost of capital. This, in turn, exerts upward pressure on insurance prices as insurers seek to restore capital. Which channel dominates depends on the severity of financial frictions and balance sheet characteristics.

4 Data

We combine regulatory filings on homeowners insurance prices with insurer balance sheets, monetary policy surprises, and local housing data. Our main analysis uses data on insurance price changes from 2010 to 2023. Unless stated otherwise, we winsorize variables at the 1% and 99% levels. Table 1 reports summary statistics for the main variables, Table D.1 reports summary statistics for the controls, and Table B.1 provides an overview of variable definitions and data sources.

Insurance prices Insurers that change homeowners insurance prices must submit rate filings to the insurance regulator in the affected state. We obtain these filings from S&P’s SNL Insurance Product Filings database. For each filing, the data identify the insurer, state, insurance product type, submission date, effective date, final price change, actuarially indicated (“target”) price change, number of affected policyholders, and premiums written on the affected contracts.¹⁵ We exclude small insurers, defined as those with direct home-

¹⁵ Insurers submit an actuarially indicated price change, based on historical loss experience, a target return on equity, and other actuarial inputs, together with a proposal for a final price change. Depending on the state, regulators can reject proposed price changes, e.g., because they deem them excessive. We restrict the sample to approved filings, so that we focus on implemented price changes and abstract from the effect

owners premiums written below \$1 million or total assets below \$10 million. Appendix B.1 describes the sample construction in detail.

Our main outcome variable is the final price change in a filing f , denoted ΔPrice_f . It is defined as average percentage change in homeowners insurance prices paid by existing policyholders p weighted by their lagged insurance premiums $Q_{i,p,t-1}P_{p,f}^{\text{old}}$:

$$\Delta\text{Price}_f = \sum_p \underbrace{\frac{Q_{i,p,t-1}P_{p,f}^{\text{old}}}{\sum_p Q_{i,p,t-1}P_{p,f}^{\text{old}}}}_{\text{Lagged premium share}} \underbrace{\left(\frac{P_{p,f}^{\text{new}}}{P_{p,f}^{\text{old}}} - 1 \right)}_{\text{Price change}}. \quad (20)$$

Equivalently, it measures the hypothetical percentage change in total premiums on affected contracts if policyholders renewed at the new prices. Thus, this measure isolates price changes from demand (quantity) responses: unlike the dynamics of total premiums written, it does not capture changes in the number of policies, coverage amounts, or policyholder composition. The final sample contains more than 30,000 rate filings submitted between 2010 and 2023. Our baseline sample excludes all filings submitted during the NBER recession period associated with COVID-19, namely from February to April 2020. The average filing raises prices by 6.9%.

Monetary policy surprises We obtain monetary policy surprises from the Monetary Policy Surprise database maintained by the Center for Monetary Research at the Federal Reserve Bank of San Francisco.¹⁶ Surprises are measured as changes in the 10-year U.S. Treasury yield in 30-minute windows around FOMC announcements. Following Bauer and Swanson (2023a), we orthogonalize these surprises with respect to macroeconomic and financial news available before each announcement, which removes the component that is predictable as markets partly anticipate the Fed’s response to economic conditions. We use the six variables suggested by Bauer and Swanson (2023a): the surprise component of the most recent nonfarm payrolls release; the log change in nonfarm payrolls over the preceding 12 months; the log change in the S&P 500 over the 13 weeks before the announcement; the change in the slope of the yield curve, measured as the spread between the 10-year and three-month constant-maturity U.S. Treasury yields, over the same 13 weeks; the log change in the Bloomberg Commodity Index (BCOM) over the same 13 weeks; and the implied

of price regulation, which Oh et al. (2026) examine in detail. About 5% of filings in the raw sample are not approved, withdrawn, or flagged with another regulatory outcome.

¹⁶ Available at frbsf.org.

skewness of the 10-year U.S. Treasury yield, computed from options on Treasury futures as in Bauer and Chernov (2024), on the day before the announcement. In robustness tests, we use two alternative surprise measures: the unorthogonalized change in the 10-year U.S. Treasury yield; and, to account for potential central bank information effects, the 10-year yield surprise adjusted using the poor-man’s sign restrictions of Jarociński and Karadi (2020).

Insurer balance sheets We obtain insurers’ financial statements as well as security holdings and transactions from Schedule D statutory filings to the National Association of Insurance Commissioners (NAIC), retrieved via S&P Global. We restrict the sample to P&C insurers that are also covered in our final sample of price filings. The quarterly statements provide balance-sheet and income-statement variables, including total assets, statutory capital, required regulatory capital, the risk-based capital (RBC) ratio (only reported at end of year), leverage, return on equity, underwriting gain, and investment income. The security-level investment schedules report insurers’ holdings in long-term assets, including bonds and stocks. For each holding, the data identify the insurer, asset class, asset identifier (CUSIP), NAIC designation (a metric based on credit ratings that determines the regulatory risk charges), book value, fair value, maturity date, and affiliation status. Throughout our analysis, we exclude investments in affiliated companies.

Asset prices In our main analysis, we use security-level holdings to measure the extent to which insurers’ statutory capital is exposed to asset-price changes induced by monetary policy, as detailed in Section 5. For this purpose, we combine NAIC data with bond characteristics from Mergent FISD, corporate bond prices from TRACE Enhanced, municipal bond prices from MSRB, stock and mutual fund prices from CRSP and LSEG Refinitiv, and Treasury yield-curve data from the Federal Reserve.¹⁷

House prices We measure local house price growth using the monthly county-level Zillow Home Value Index for single-family homes.¹⁸ We exclude counties whose population was below 10,000 inhabitants at any point during the sample period and keep only counties with complete data from January 2010 to December 2023. Because of large outliers in

¹⁷ The Federal Reserve publishes data on Treasury yield curves on federalreserve.org, following the methodology in Gürkaynak et al. (2007).

¹⁸ Source: [zillow.com](https://www.zillow.com).

house price changes, especially after 2020, we winsorize house price growth at the 5th and 95th percentiles. The average county experiences a monthly increase in home prices of 0.38 percent, equivalent to a 4.7 percent increase over a year (see Panel 4 of Table 1).

Controls We enrich our sample with data on macroeconomic conditions and local exposure to natural disasters. We measure natural-disaster exposure using the Spatial Hazard Events and Losses Database for the United States (SHELDUS). The database reports county-level damages by event type. Because standard homeowners insurance generally excludes flood risk, we exclude flood damages and use the 5-year trailing average and standard deviation of annual non-flood disaster damages to measure local insured-risk exposure. To control for local macroeconomic conditions, we include state-level GDP and income per capita, and the annual growth rate of the Federal Housing Finance Agency’s house price index. County-level controls include GDP, population, and population density.

5 Empirical Strategy

In our baseline results, we aim to identify the impact of monetary policy on insurance prices. In the first set of results, we provide time-series evidence from regressing insurance price growth on monetary policy surprises. In the second set of results, we provide cross-sectional evidence, exploiting differences in insurers’ portfolio sensitivity to monetary policy and their regulatory capital constraints.

5.1 Monetary Policy

Monetary policy surprises Identifying the causal effects of monetary policy is difficult because policy systematically responds to macroeconomic conditions that could also affect outcomes, such as insurance prices. The canonical solution is to isolate the *unexpected* component of policy decisions using monetary policy surprises measured around monetary policy events. Specifically, a large literature identifies monetary policy surprises from high-frequency movements in market interest rates in narrow windows (of typically 30 minutes) around announcements of the FOMC (Jarociński and Karadi, 2020; Bauer and Swanson, 2023b).

Aggregation Because insurers, at the median, file for price changes only once per year (see Figure C.1), we use the cumulative sum of monetary policy surprises in the 12 months

preceding each insurance rate filing as our main measure of monetary policy shocks. This approach captures the effects of multiple policy events and accounts for the fact that insurers may adjust prices with a lag after monetary policy changes. To ensure that auto-correlation in this variable does not bias the statistical inference, we cluster standard errors (at least) at entity level.¹⁹

Surprise maturity Insurers' fixed-income portfolios exhibit a time to maturity of close to 10 years on average (see Figure C.2). Similarly, the stock market exhibits a long duration of more than 10 years (Gormsen and Lazarus, 2026). Therefore, changes in the market values of insurers' investments are driven by fluctuations in long-term, rather than short-term, interest rates. Consequently, we focus on monetary policy surprises in long-term (10-year Treasury) rates. Long-term rates are also less constrained by the zero lower bound and thus enable us to capture the effects of (unconventional) monetary policy during the low-interest-rate period.

Relevance Prior studies document that monetary policy surprises have sizable and persistent effects on long-term rates (Hanson and Stein, 2015; Hanson et al., 2021; Adrian et al., 2024). Consistent with this evidence, Figure C.4 shows a strong linear relationship in our sample between monetary policy surprises and contemporaneous changes in the 10-year Treasury yield, both at monthly frequency and for 12-month cumulative surprises.

5.2 Portfolio Sensitivity

The model in Section 3 predicts that monetary policy affects insurance prices by changing insurers' asset values, tightening regulatory capital constraints, and increasing the shadow cost of capital. We provide empirical evidence for this mechanism using measures of insurers' portfolio sensitivity to monetary policy, described in this section, and regulatory constraints, described in the subsequent section. The portfolio-sensitivity measure combines two sources of cross-sectional heterogeneity: the composition of insurers' portfolios and the statutory accounting rules that determine which asset-price changes pass through to regulatory capital. Appendix E.1 describes the construction in detail.

19 de Fraisse et al. (2026) raise the concern that aggregated monetary policy surprises may be endogenous to the business cycle. We overcome this concern by using cross-sectional evidence that isolates the economic mechanism from our model. We discuss identification concerns in detail below and in Appendix H.

Regulatory accounting Statutory accounting rules create heterogeneity in the extent to which market-price changes affect insurers’ capital.²⁰ Investment-grade bonds are generally held at historical cost, whereas below-investment-grade bonds are carried at the lower of historical cost and market value. Common stocks and mutual funds are generally carried at market value. We construct an indicator variable (“mark-to-market indicator”) that captures assets held at market value: it equals one for high-yield bond holdings, common stocks, and mutual funds, and zero otherwise.²¹ In aggregate, the majority of so-classified mark-to-market (MTM) assets is comprised of stock holdings (see Figure E.4), while there is large heterogeneity in portfolio composition across insurers. Validating the MTM indicator, the statutory book value of MTM assets displays a higher volatility and more pronounced (negative) correlation with Treasury rates compared to that of non-MTM assets (see Figure E.6).

Security-level sensitivities For each security k held at quarter-end t , we compute the sensitivity $s_{k,t}$, defined as the decline in its market value in response to a one-percentage-point increase in long-term yields. For fixed-income securities, $s_{k,t}$ is the modified duration, using CUSIP-level duration estimates where available and imputed durations based on rating, coupon, and remaining maturity otherwise. For common stocks and mutual funds (which are sufficiently liquid to provide reliable daily price data), we estimate $s_{k,t}$ as the negative of the event-study beta of daily returns to high-frequency monetary policy surprises in 10-year Treasury rates around FOMC announcements, such that a positive $s_{k,t}$ again indicates a security that loses value when interest rates rise. The baseline equity and mutual-fund betas use a 5-year backward-looking rolling window of FOMC event days. Appendix E.2 discusses the matching of holdings to price information, imputation of sensitivities, and alternative constructions.

Portfolio sensitivity We aggregate the security-level sensitivities to the insurer-quarter level:

$$\text{Sensitivity}_{i,q} = \frac{\sum_{k \in \mathcal{H}_{i,q}} \mathbb{1}_{k,q}^{MTM} \times s_{k,t} \times FV_{i,k,q}}{TIA_{i,q}}, \quad (21)$$

²⁰ Table E.1 details the accounting treatment of all asset classes captured in our data

²¹ Throughout our analysis, we exclude affiliated common stock holdings, which are subject to special accounting treatment.

where $\mathcal{H}_{i,q}$ is insurer i 's set of Schedule D (containing long-term bonds and stocks) and BA (containing other long-term invested assets) holdings at the end of year-quarter q , $FV_{i,k,q}$ is the holding's end-of-quarter fair value, and $TIA_{i,q}$ is the statutory book value (NAIC Book/Adjusted Carrying Value) of insurer i 's total invested assets (excluding affiliated holdings) in year-quarter q . The measure is therefore a portfolio-level semi-elasticity: it captures the decline in the statutory book value of invested assets in response to a one-percentage-point monetary policy shock. Because most assets lose value when interest rates rise, $s_{k,q}$ is positive for the typical security and, thus, $Sensitivity_{i,q}$ is a positive number for virtually every insurer (akin to an accounting-adjusted portfolio duration). Validating the sensitivity measure, we find that unrealized gains decline more strongly in response to contractionary monetary policy for insurers with a higher $Sensitivity_{i,q}$ (Figure E.7). The average sensitivity is 0.4%, with wide variation across insurers and over time.

5.3 Regulatory Capital Constraints

RBC ratio Differences in book value sensitivity are important because they affect an insurer's risk-based capital (RBC) ratio, the key regulatory metric for insurers. The RBC ratio is defined as the ratio of an insurer's available statutory capital to its capital requirement and is reported at year-end. A lower RBC ratio indicates higher financial fragility of the insurer and, thus, a higher probability of regulatory intervention. Investment income affects an insurer's statutory capital through three statutory accounting items: (i) the net investment income earned, which is the sum of interest, dividends and rental income due and accrued; (ii) the realized capital gains (or losses) from the sale of assets at prices different than current book values; and (iii) the unrealized capital gains (or losses) from price changes of assets that are held at market values. Thus, changes in the market values of MTM assets directly feed into available capital one-to-one and, thus, into the RBC ratio (as documented in Table D.7).

Measuring constraints We follow prior literature (Ellul et al., 2011; Koijen and Yogo, 2015) and use (the negative of) the RBC ratio as a measure for the tightness of financial constraints. An important concern is that insurers persistently sort into different levels of the RBC ratio. Different RBC ratios may reflect persistent differences in business models across insurers, which may also correlate with the dynamics of insurance prices. For this reason, we focus on the *difference* of an insurer's RBC ratio to its five-year trailing average

RBC ratio just before the monetary policy surprise window:

$$\text{RBC gap}_{i,y-1} = -\frac{(\text{RBC}_{i,y-1} - \overline{\text{RBC}}_{i,(y-6):(y-2)})}{\overline{\text{RBC}}_{i,(y-6):(y-2)}} = 1 - \left(\frac{\text{RBC}_{i,y-1}}{\frac{1}{5} \sum_{\tau=2}^6 \text{RBC}_{i,y-\tau}} \right). \quad (22)$$

A larger *RBC gap* indicates an *unusually* low RBC ratio (i.e., tight regulatory capital constraints). Following our model’s predictions, we expect insurers with a larger *RBC gap* to increase prices more after more contractionary monetary policy surprises.

5.4 Empirical Specification

Time-series elasticity We regress insurance price growth ΔPrice_f in filing f on the lagged cumulative monetary policy surprises $\text{MPS}_{(t-12:t-1)}$:

$$\Delta \text{Price}_f = \beta_{\text{MP}} \text{MPS}_{(t-12:t-1)} + \gamma_I \mathbf{I} + \gamma_S \mathbf{S} + u_{i,s} + v_{p,s} + \epsilon_f. \quad (23)$$

The main coefficient of interest is β_{MP} , which measures the response of insurance prices to monetary policy. By estimating β_{MP} from price changes rather than levels, the estimate is not affected by slow-moving trends in the monetary policy stance or insurance prices. $u_{i,s}$ and $v_{p,s}$ are insurer-by-state and product-category-by-state fixed effects, which absorb time-invariant differences across insurers, products, and states. We two-way cluster standard errors at the insurer and year-month levels to account for aggregate shocks as well as serial correlation (partly induced by rolling windows of aggregated monetary policy surprises).

Identification and controls Interpreting β_{MP} as the effect of monetary policy on insurers’ shadow-cost-adjusted discounted liabilities (as in equation (13)) requires that, conditional on controls, monetary policy surprises are successfully purged from systematic policy responses to macroeconomic conditions. An important concern is that the extraordinary conditions during the COVID-19 pandemic may distort our estimates. We therefore exclude filings submitted during the NBER recession period associated with COVID-19 (February - April 2020) from the baseline sample (the results are also robust to restricting the sample to the period up to 2020, as we show in Appendix D). The two main remaining threats are, first, that monetary policy surprises may affect insurance markups by shifting insurance demand, and, second, that they may affect expected insurance claims through replacement costs, for example, by being correlated with construction cost inflation. We address these concerns by including a rich set of insurer and state controls, $\mathbf{I}$ and $\mathbf{S}$, respectively. $\mathbf{I}$ is

comprised of insurer i 's size (log assets), leverage, RBC ratio, underwriting gain, and net statutory investment income, all lagged by five quarters to the filing's submission date. These variables capture dynamics of insurer balance-sheet conditions and, importantly, profitability. State characteristics S are comprised of the logarithm of the average and standard deviation of state-level natural disaster damages in the past 5 years, the logarithm of GDP per capita, the logarithm of personal income per capita, and the one-year growth in the local house price index. These control variables capture macroeconomic conditions such as broad inflationary pressures and variation in disaster risk, a key component of homeowners insurance prices. We lag insurer controls and state-level house price growth by five quarters, and the annual controls state damages, per capita income and GDP by two years to ensure that they are measured before the monetary policy surprise window. Finally, we control for the time between subsequent filings by the same insurer in the same state.

Cross-sectional elasticity To precisely isolate the balance-sheet channel described by our model, we exploit cross-sectional variation in insurers' portfolio sensitivity and regulatory capital constraints to define an insurer's exposure to monetary policy in quarter q : $Exposure_{i,q} = Sensitivity_{i,q} \times Constrained_{i,q}$, where $Constrained_{i,q}$ is an indicator variable that equals one if the RBC gap is above the median of the gap's pooled distribution. We then estimate the differential effect of monetary policy for varying levels of balance sheet exposure, β_{Exp} :

$$\Delta Price_f = \beta_{Exp} Exposure_{i,q-5} \times MPS_{(t-12:t-1)} + \gamma_I \mathbf{I} + u_{i,s} + w_{p,s} + v_{s,t} + \epsilon_f. \quad (24)$$

Again, we exclude February to April 2020 and cluster standard errors at insurer and year-month levels. Controls $\mathbf{I}$ include $Exposure_{i,q-5}$ and the insurer controls from equation (23).

Identification The cross-sectional specification sharpens the identification by comparing insurers with different ex-ante balance-sheet exposure to the same aggregate monetary policy surprise. The granular fixed effects ensure that β_{Exp} compares different insurers at the same point in time, absorbing aggregate shocks. The key identifying assumption is that, conditional on controls and fixed effects, more exposed insurers do not respond differentially to monetary policy through channels other than financial frictions, i.e., neither through differential markups nor through differential replacement costs. Support for this assumption is provided by evidence against sorting of insurers into locations based on

monetary policy exposure and household characteristics as well as from the robustness of the results (as discussed in Section 6 and, in more detail, in Appendix H).

6 Empirical Results: Monetary Policy and Insurance Prices

6.1 Time-Series Evidence

In this section, we document that tighter (looser) monetary policy is, on average, associated with higher (lower) insurance prices.

Motivating evidence Figure 1 shows a strong positive relationship between long-term Treasury yields and insurance price growth. A similar pattern emerges for monetary policy surprises: Figure C.5 shows that larger contractionary surprises are followed by greater insurance price growth.

Baseline results Table 2 reports OLS estimates for the coefficient β_{MP} on monetary policy surprises in specifications following equation (23). 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, consistent with the evidence in Figure C.5. In column (2), we show that it is robust to controlling for insurer characteristics, local economic fundamentals as well as aggregate shocks such as economic growth and disaster exposure.

Economic magnitude The estimated coefficient on monetary policy surprises in column (2) implies that a 100 bps monetary policy surprise is associated with a 5.5% increase in insurance prices. Re-scaling this estimate, a one standard deviation monetary policy surprise (4 bps) is associated with a 20 bps increase in insurance prices. Monetary policy surprises do not necessarily translate one-to-one into longer-term changes in Treasury yield (Adrian et al., 2024). To gauge the relationship between Treasury yields and insurance prices, we use monetary policy surprises as an instrumental variable for 10-year Treasury rates over the same horizon in column (6). The second-stage estimate implies that insurance prices increase by 3.8% in response to a 100 bps increase in 10-year Treasury rates.²²

²² The elasticity to Treasury rates is lower than that to monetary policy surprises due to a strong response of long-term changes in Treasury rates to monetary policy surprises in the first stage.

Consistently across specifications, the estimated elasticity of insurance prices is positive rather than negative, which stands in contrast to the textbook prediction of the frictionless benchmark elasticity of -1 (see Section 3). Moreover, the absolute value of the elasticity is more than three times larger than the frictionless benchmark, pointing to the amplifying role of frictions.

Amplification A key amplification mechanism arises from statutory accounting. Offsetting the impact of interest rate changes on capital through premium income requires a larger price adjustment than the initial asset-valuation loss because repricing affects statutory capital only gradually. A price change applies only to contracts renewed after the repricing date, and the resulting additional premium is earned in terms of capital pro rata over the remaining contract term (illustrated in Appendix F). Because regulatory capital ratios are assessed at year-end, only the premium earned by then contributes to year-end capital. Under the benchmark assumption that renewal and repricing dates are uniformly distributed throughout the year, a 1% price change affects year-end statutory capital by only $1/6\%$ of annual written premiums on average (Appendix G.1 derives this factor and provides supporting evidence from the within-year timing of rate filings). Thus, generating one dollar of year-end capital on average requires six dollars of additional annualized premiums. As a consequence, the initial capital change is amplified sixfold when translated into the price change required to offset it. The implied capital relief per unit price increase—one-sixth of annual written premiums—is the statutory counterpart of v in the model.²³

Quantifying financial frictions Using the amplification factor above, Corollary 1 provides a quantitative benchmark for our baseline estimate: the equilibrium price response is a convex combination of the frictionless benchmark (1% price *decline* per 100 bps) and the capital-preservation benchmark Π^K (the hypothetical response that would fully insulate

23 Formally, v is the semi-elasticity of year-end statutory capital with respect to the insurance price: the dollars of capital generated by a one-percent price increase. The back-of-the-envelope calculation in Appendix G.1 provides an empirical statutory-accounting counterpart to this object, and the underlying mechanism is the same as in the model: a higher price raises the profitability of each insurance contract written, and this additional profitability accrues to statutory capital. The two settings differ only in the timing with which it accrues. In the one-period model, premiums are written and earned simultaneously, so the additional profitability reaches capital immediately; under statutory accounting, the higher price applies to contracts as they renew and the premium is earned pro rata over the remaining contract term, so that one-sixth of the additional annualized premium reaches capital by year-end. Because the capital-preservation benchmark Π^K divides the capital shock by this semi-elasticity, its empirical implementation requires only the magnitude of the year-end capital relief, which the statutory earning schedule pins down.

statutory capital). The empirical counterpart of Π^K combines three numbers. First, a 100 bps monetary policy surprise reduces statutory capital through investment income by 2.7% on average (see Section 8.1).²⁴ Second, statutory capital amounts to 1.4 times the annual premiums for the average P&C insurer in our sample (Appendix G.1). Third, the amplification factor of six converts the required year-end capital relief into prices. Together, these imply $\Pi^K = 6 \times 2.7\% \times 1.4 = 22.7\%$ per 100 bps. Comparing this benchmark with the estimated response of 5.5%, equation (16) implies that insurers' pricing response offsets approximately one quarter of the monetary policy-induced change in capital within a year. This result differs significantly from the frictionless benchmark, yet also from the capital-preservation benchmark.

Robustness and identification The time-series elasticity β_{MP} in equation (23) identifies the shadow-cost channel under the assumption that monetary policy does not also affect insurance prices through markups or replacement costs beyond what is controlled for. The main concern is an inflation channel operating through replacement costs: because monetary policy responds endogenously to inflation, contemporaneous inflation may raise replacement costs and, in turn, insurance prices. By extracting information within a short time window around monetary policy events, monetary policy surprises are designed to strip out precisely such variation driven by economic fundamentals. In addition, in our baseline results, we follow Bauer and Swanson (2023b) and orthogonalize monetary policy surprises with respect to macroeconomic variables that capture the state of the economy. Moreover, we show that controlling for inflation and macroeconomic conditions (such as personal consumption expenditures, lumber prices, or the VIX) does not meaningfully affect the results (see Table D.4). Finally, the results are also robust to removing information shocks from monetary policy surprises following Jarociński and Karadi (2020) (see Table D.2).

A second concern is that infrequent filing introduces selection on the timing of rate filings. Nonetheless, we find that the estimate is robust to aggregating monetary policy surprises over the time horizon since an insurer's previous filing in the same state (instead of a fixed 12-month horizon). Moreover, we only find weak evidence that filing probability reacts to monetary policy surprises (Table D.5), consistent with insurers following predetermined pricing cycles.

24 Because statutory loss reserves are not discounted, statutory liabilities are largely insensitive to interest rates, and the measured asset-side effect approximates the net capital sensitivity $\alpha - (1 + \rho)VQ$ in the model.

Finally, we find that monetary policy does not significantly affect other dimensions of rate filings, such as the number of policyholders or premiums affected (Table D.3), suggesting that insurers respond primarily via prices rather than other product characteristics.

6.2 Cross-Sectional Evidence and Economic Mechanism

The model in Section 3 proposes a balance-sheet channel for the transmission of monetary policy to insurance prices, operating through capital constraints and interest-rate sensitive assets. This channel becomes stronger when constraints are tighter and when the book value of insurers' assets is more sensitive to interest rates. We now provide empirical evidence for this mechanism.

Baseline cross-sectional results In Table 2, columns (3) to (5) report estimates for the coefficient β_{Exp} on the interaction of monetary policy exposure with policy surprises in equation (24). All specifications include insurer-state and product-state fixed effects, absorbing time-invariant heterogeneity. The estimate is positive and statistically significant at the 1% level, consistent with our model's prediction. We also add state-by-time fixed effects, which absorb any aggregate and state-specific shocks, such as local inflation, insurance demand, and construction cost dynamics.

Economic magnitude The coefficient in column (3) implies that insurers adjust prices significantly more to monetary policy surprises when their balance sheets are more exposed, i.e., when they are capital-constrained and invest in rate-sensitive assets. The estimated magnitude implies that a capital-constrained insurer with a portfolio sensitivity at the 75th percentile (with $\text{Exposure}_{i,q-5} = 0.58$) changes prices by 2.3 ppt more than an unexposed insurer in response to a 100 bps monetary policy surprise ($= 4 \times 0.58$). In column (7), we also estimate the implied elasticity to changes in interest rates, using monetary policy surprises as an instrument for 10-year Treasury rates. The estimate implies that a capital-constrained insurer with a portfolio sensitivity at the 75th percentile changes prices by 0.6 ppt more than an unexposed insurer ($= 1.1 \times 0.58$).

Isolating financial frictions A natural concern is that the coefficient on $\text{Exposure} \times \text{MPS}$ may reflect differences in insurer characteristics more generally, rather than the balance-sheet channel from our model. For example, more constrained insurers may follow systematically different pricing strategies, or insurers with higher portfolio sensitivity may

differ in their pricing behavior independently of capital constraints. To address this concern, in column (4), we separately control for the interactions of portfolio sensitivity and capital constraints with policy surprises, respectively. The coefficient on $\text{Exposure} \times \Delta\text{MPS}$ remains stable in magnitude and statistical significance. This result confirms that the cross-sectional differences in the response to monetary policy in column (3) reflect the *interaction* between balance sheet characteristics and capital constraints, consistent with the model’s prediction that financial frictions amplify asset-side shocks to insurance prices.

Disentangling regulatory and net-worth constraints Canonical models of monetary policy transmission emphasize net-worth constraints (Bernanke and Gertler, 1989), whereas the recent insurance literature stresses regulatory capital constraints (Kojien and Yogo, 2015, 2022b; Sen, 2023). Our institutional setting allows us to disentangle the two. The pass-through of monetary policy to net worth is governed by the market value of *all* assets, whereas the pass-through to statutory capital depends on their statutory accounting treatment. We exploit this distinction by constructing an alternative “net-worth exposure” measure, defined analogously to Exposure but with the interest rate sensitivity of all assets rather than only those that are marked to market. We additionally include this net-worth exposure in column (5) of Table 2. Its interaction with policy surprises enters with a coefficient close to zero and statistically insignificant, while the baseline exposure measure remains stable in magnitude and significance. Hence, the response of insurance prices to monetary policy is driven by regulatory capital constraints rather than net-worth constraints.

Robustness and identification The cross-sectional design strengthens the identification by comparing insurers with different ex-ante balance-sheet exposure to the same monetary policy shock within a state and month. State-by-time fixed effects therefore absorb any differential response that operates through local economic conditions that are common to insurers, including insurance demand, inflation, construction costs, and natural disasters. The identifying assumption is that more exposed insurers do not systematically serve policyholders whose demand or expected claims respond differently to monetary policy for reasons unrelated to insurers’ balance sheets.

We provide two pieces of evidence supporting this assumption. First, in Appendix H, we test whether more exposed insurers systematically serve different types of households. Using insurers’ state-level premium shares to characterize their customer base, we find no significant relation between monetary policy exposure and a broad set of household

characteristics that are associated with monetary-policy sensitivity in the literature, including income, liquid wealth, homeownership, and mortgage characteristics such as debt-to-income and loan-to-value ratios, mortgage amounts, and maturities. These results suggest that β_{Exp} does not result from systematic differences in policyholders or insured risks. Moreover, we show that controlling for the interaction of exposure with inflation or macroeconomic conditions (such as personal consumption expenditures, lumber prices, or the VIX) does not meaningfully affect the estimates (see Table D.4), alleviating the concern that our results may pick up spurious correlation between monetary policy surprises and other macroeconomic conditions.

6.3 Quantitative Importance

To gauge the economic significance of our estimates, we compute the implied pass-through of rate changes to households' housing costs and compare the insurance channel to the standard mortgage channel (the calculation is detailed in Appendix G). We focus on the mortgage principal and interest and insurance (PII) component of total housing costs and decompose its relative response as

$$\frac{\partial \log \text{PII}}{\partial \text{MP}} = \frac{\text{Insurance}}{\text{PII}} \frac{\partial \log \text{Insurance}}{\partial \text{MP}} + \frac{P+I}{\text{PII}} \frac{\partial \log(P+I)}{\partial \text{MP}},$$

where $P + I$ are mortgage principal and interest payments. For the insurance expenditure share, we draw on Keys and Mulder (2025), whose estimates imply an average insurance expenditure share of $\text{Insurance}/\text{PII} = 0.17$. Combining this average insurance share with the average rate elasticity of insurance prices of 3.8% (Table 2) implies that PII responds by 0.65% through the insurance channel ($= 0.17 \times 3.8\%$). For households with an insurance share in the upper decile in Keys and Mulder (2025) ($\text{Insurance}/\text{PII} = 0.3$), this PII elasticity increases to 1.1% ($= 0.3 \times 3.8\%$).

Comparison to mortgage channel For the mortgage channel, we assume a full pass-through of rate changes to mortgage rates. Because most U.S. mortgages carry fixed rates, changes in market rates affect existing borrowers primarily through refinancing, while adjustable-rate mortgages (ARMs) reprice when their rates reset. Calibrating to the representative U.S. household, we assume a fixed-rate mortgage share of 90.4%, an annual refinancing rate of 10.7%, and we assume that all ARMs reprice within one year. We then estimate the elasticity of average mortgage principal and interest payments using either

average mortgage characteristics or Freddie Mac loan-level data. Our estimates imply an elasticity of total principal, interest, and insurance (PII) payments of 1.5 to 1.7% for the average household due to mortgage repricing. Thus, the insurance channel effect on PII amounts to approximately 40% of the mortgage channel on average, and is of the same order of magnitude for households in the upper decile of insurance expenditures.

Comparison to the deposit market The elasticity of insurance prices is economically significant also when compared to that of deposit rates. Drechsler et al. (2017) estimate that deposit rates increase by 39 bps per 100 bps policy shock (i.e., a 61 bps increase in the deposit spread). In contrast, our estimates imply that policyholders' implicit return on insurance contracts moves in the *opposite* direction to the policy rate because insurance prices but not expected claim payments increase. Thus, the impact on the spread charged to households is larger for the insurance than for the deposits channel.²⁵

7 Effects on the Housing Market

This section shows that the insurance channel has real effects: insurer balance sheets strengthen the transmission of monetary policy to house prices.

Benchmark To guide our analysis, we derive a benchmark for the elasticity of house prices by considering homeowners insurance through the lens of monthly housing payments. Lenders require insurance coverage as a precondition for mortgage credit, and they cap borrowers' total housing cost (including payments of principal, interest, and insurance (PII)) at a fixed fraction of income. When monetary policy raises insurance prices, it raises the monthly housing cost. With housing supply fixed in the short run, the marginal buyer's payment capacity must cover the higher housing costs, and the house price must fall for the market to clear. Appendix G.3 formalizes this intuition and derives a benchmark elasticity of between 0.2% and 0.43% for house prices in response to a 1% increase in insurance prices.

²⁵ Market concentration in the U.S. homeowners insurance market is similar to that in the U.S. deposit market. For example, the Herfindahl–Hirschman index of premiums is 0.14 and that of deposits is 0.15 in the average state in 2010 (data source: FDIC BankFind Suite). The top 5% of insurers capture 46% of market share, whereas the 5% of banks capture 44% in the average state. Whereas the deposits channel in Drechsler et al. (2017) operates primarily through market power, the insurance channel operates primarily through capital constraints.

Local insurer exposure We first translate the insurer-level exposure measure into a measure of local insurance-market exposure to monetary policy, defined as

$$\text{Exposure}_{s,t}^{\text{Local}} = \sum_i \frac{\text{Affected premiums}_{i,s,t}}{\sum_j \text{Affected premiums}_{j,s,t}} \times \text{Exposure}_{i,q-5}. \quad (25)$$

$\text{Exposure}_{s,t}^{\text{Local}}$ is the average exposure of all insurers that submitted filings in state s in quarter q weighted by the premiums affected by the respective rate filings. A larger $\text{Exposure}_{s,t}^{\text{Local}}$ implies that local insurers have balance sheets that are more exposed to monetary policy.

Empirical specification We estimate the differential response of house prices in a county-month panel:

$$\Delta \log \text{HP}_{c,(t-1:t+h)} = \beta_{\text{HP}} \text{Exposure}_{s,t}^{\text{Local}} \times \text{MPS}_{(t-12:t-1)} + \gamma \text{Exposure}_{s,t}^{\text{Local}} + u_c + v_t + \varepsilon_{c,t+h}, \quad (26)$$

where $\Delta \log \text{HP}_{c,(t-1:t+h)}$ is the change in the logarithm of the Zillow single-family home value index in county c from year-month $t - 1$ to $t + h$, and $\text{MPS}_{(t-12:t-1)}$ is the 12-month cumulative monetary policy surprise in the 10-year Treasury yield, as in the insurance-price regressions. The coefficient of interest, β_{HP} , measures how the house-price response to monetary policy varies with the exposure of the local insurance sector. All specifications include county fixed effects, absorbing time-invariant local characteristics, and time fixed effects, absorbing the average effect of monetary policy as well as other aggregate shocks. We use two-way clustered standard errors at the county and time levels.

Identification The identifying assumption is that variation in the composition of affected premiums across insurers is not driven by local shocks that also affect the housing response to monetary policy. This assumption does not require affected premiums themselves to be invariant to monetary policy. An identification concern arises only if monetary policy or other contemporaneous shocks systematically re-weight affected premiums toward insurers with different balance-sheet exposures. We find no evidence of such differential re-weighting: neither filing probability nor affected premiums respond differentially to monetary policy with insurer exposure (Table D.5). Additionally supporting the identifying assumption, more exposed insurers also do not systematically operate in regions with different household and mortgage characteristics (Table H.2).

Main results Table 3 reports the baseline estimates, using a 12-month horizon for house price changes. Across all specifications, β_{HP} is negative and statistically significant, implying that house prices are more sensitive to monetary policy (i.e., decline more in response to hikes) in areas in which insurer balance sheets are exposed. Column (1) includes county and time fixed effects without additional controls, yielding a point estimate of -4.3 , which is statistically significant at the 1% level. Column (3) adds time fixed effects interacted with indicators for the quintiles of county GDP, population, and population density. These fixed effects absorb heterogeneous effects of monetary policy across geographies, ensuring that spurious correlation between insurer exposure and local macroeconomic characteristics does not bias the result. The point estimate remains virtually unchanged.

IV specification To elicit the implied elasticity of house prices to insurance prices, we convert the reduced-form specifications in columns (1) and (3) into instrumental-variable (IV) specifications in columns (2) and (4). For this purpose, we compute the change in state-level insurance prices implied by all approved rate filings in a given state (as detailed in Appendix B.2), which is then used as the main explanatory (instrumented) variable in the second-stage regression. The IV estimate on insurance price growth is also significantly negative, implying that higher insurance prices are associated with lower house prices.

Economic magnitude The reduced-form estimate in column (1) implies that a one-standard-deviation increase in local insurer exposure amplifies the decline in single-family house prices in response to a 100 bps surprise by 1.8 ppt ($= 0.41 \times 4.3$). Thus, the insurer-channel leads to economically significant amplification of monetary policy. The IV estimate in column (4) implies an elasticity of house prices to insurance prices of -1.2 , which is slightly larger than the benchmark elasticity derived above. This estimate likely provides an upper bound for the structural elasticity of house prices to insurance prices (and, specifically, those that are experienced by the marginal buyer) because the instrumented variable is based on price changes of the *average* policyholder rather than marginal buyer and because risk-updating, endogenous supply responses, and constraint switching may amplify the response, as we discuss in detail in Appendix G.3.

Insurance cost heterogeneity If payment-to-income constraints modulate the pass-through of insurance to house prices, then the house price response is increasing in the amount of household expenditures for insurance (as formally shown in Appendix G.3). We provide three cross-sectional tests of this prediction. First, we consider the county-level

ratio of insurance expenditures to household income from the American Community Survey (ACS) in 2023. We split counties at the median ratio based on the 2023 cross section and separately estimate equation (26). Table 4 reports the estimates. Households with larger expenditures relative to their income are more likely to be constrained by (implicit or explicit) lender caps on housing costs. We find that the baseline effect is larger for such households, with the coefficient on the interaction between insurer exposure and policy surprises being about 40% larger (in absolute value) than for households with low insurance expenditures. This finding suggests that payment-to-income constraints are a key driver for the pass-through of insurance prices to house prices.

Second, we use county-level data on annual homeowners insurance premiums from Keys and Mulder (2025). We split counties at the median premium in the previous calendar year and separately estimate equation (26).²⁶ The house-price response is concentrated in counties with high ex-ante insurance costs: the point estimate for households with low premiums is not significantly different from zero, while it is significantly negative for those with high premiums.

Disaster risk Finally, we consider the role of natural disasters, which are an important driver of homeowners insurance prices (Oh et al., 2026; Keys and Mulder, 2025). In disaster-prone areas, insurance is not only more expensive (and thus a larger component of housing payments), but insurance repricing may also lead to more pronounced updating of beliefs about local risks (Ge et al., 2025). Both channels suggest a stronger response of house prices in areas with greater disaster exposure. We split the sample by whether county c experienced above-median disaster damages over the preceding five years. The estimates in Table 4 show that, consistent with the prediction, house prices are significantly more responsive in areas with greater disaster exposure. Overall, the heterogeneous response across counties consistently reflects a stronger response of house prices to insurer exposure where homeowners insurance is more important.

²⁶ When the lagged premium is unavailable for a county, we use the closest available observation. The data are available at https://benkeys.github.io/insurance_data/.

8 Additional Results

8.1 Monetary Policy and Insurers' investment return

In this section, we document the impact of monetary policy on insurers' investment returns, which is an important ingredient of our mechanism.

Composition of investment returns Asset investments affect the dynamics of statutory capital through three components of investment returns. First, insurers earn interest and dividends as well as income from amortization or accretion of premiums and discounts on bonds carried at historical (amortized) cost. Second, security sales generate realized capital gains or losses equal to the difference between the book value and the sale price at the time of sale. Third, changes in the market prices of assets carried at fair value generate unrealized capital gains or losses. In contrast to the first two components, unrealized gains generally do not enter an insurer's statutory net income but flow into statutory capital.

Empirical specification We estimate the response of the three investment return components to monetary policy surprises at quarterly frequency:

$$\frac{\text{Outcome}_{i,q}}{\text{Capital}_{i,q-1}} = \beta_{\text{MP}} \text{MPS}_q \times \text{Sensitivity}_{i,q-1} + \gamma_I \mathbf{I}_{i,q-1} + u_{i,\text{season}} + \varepsilon_{i,q}. \quad (27)$$

$\text{Outcome}_{i,q}$ denotes an investment return component of insurer i in year-quarter q , which we scale by lagged statutory capital. MPS_q is the cumulative orthogonalized high-frequency monetary policy surprise in the 10-year U.S. Treasury yield over year-quarter q . $\mathbf{I}_{i,q-1}$ is a set of control variables that includes $\text{Sensitivity}_{i,q-1}$ and the same insurer controls as in Equation (23). $u_{i,\text{season}}$ are insurer dummies interacted with calendar-quarter dummies to absorb potential insurer-specific seasonality in investment returns. We use two-way clustered standard errors at the insurer and RBC ratio quintile-time level. The main coefficient of interest, β_{MP} , measures how the response of investment returns to monetary policy varies with portfolio sensitivity.

Unrealized gains Table 5 reports the estimated coefficients. The strongest response operates through unrealized capital gains. Larger monetary policy surprises significantly reduce unrealized gains (column 1). This effect grows with a larger portfolio sensitivity (column 2), consistent with our sensitivity measure capturing the exposure of statutory book

values to monetary-policy–induced asset price changes. The average effect in column (1) implies unrealized losses equal to 2.8% of statutory capital on average.

Coupons, dividends, and realized gains In contrast to unrealized gains, neither the response of coupon and dividend income (column 3) nor that of realized gains (column 4) significantly varies with insurers’ portfolio sensitivity. These results are consistent with the sensitivity measure capturing the sensitivity of asset prices rather than other asset characteristics.

Total investment return Finally, we estimate the overall response of investment returns to monetary policy. Consistent with the results above, larger monetary policy surprises significantly reduce total investment returns (column 5), and significantly more for insurers with high portfolio sensitivities (column 6). Thus, monetary policy shocks generate economically meaningful losses in statutory capital, primarily through asset revaluations, with larger effects for insurers holding more interest-rate-sensitive assets.

8.2 Actuarial Pricing

Industry practice An important benchmark for setting insurance prices is the actuarially indicated price that would achieve a target return on equity.²⁷ In general, this target price can be written as

$$P_{\text{Target}} = \frac{\text{Projected claims} + \text{Fixed expenses}}{1 - \text{Variable expenses} - \text{Profit provision}}. \quad (28)$$

The numerator combines projected claims (typically estimated from historical data) and fixed underwriting expenses (e.g., office rent). Variable expenses capture costs that scale with underwriting activity, e.g., reinsurance and brokers’ commissions.

The profit provision is chosen to achieve the target return on equity. Abstracting from taxes and underwriting expenses, an insurer’s return on equity combines underwriting profit and investment income:

$$r_E = \frac{\text{Underwriting profit} + \text{Investment income}}{\text{Capital}} = \frac{Q(P - \mu) + (A_0 + QP)r_A}{A_0}, \quad (29)$$

²⁷ See National Association of Insurance Commissioners (2024), p. 31.

where we adopt the notation and model setup from Section 3 and denote by μ the expected insurance claims per contract and r_A the return on invested assets. For simplicity, we assume that all claims are paid at contract maturity $t = 1$ and that the insurer has no initial liabilities at $t = 0$, implying that equity is equal to A_0 . Moreover, we denote by $\ell = A_0/(QP)$ the ratio of statutory capital to premiums. Then, the underwriting profit required to achieve a target return $\hat{r}_E$ is

$$\text{Profit provision} = \hat{\ell} \hat{r}_E - (1 + \hat{\ell}) \hat{r}_A, \quad (30)$$

where both the capital ratio $\hat{\ell}$ and investment income $\hat{r}_A$ are projected forward by the insurer. Substituting this expression into equation (28) and abstracting from expenses yields

$$P_{\text{Target}} = \frac{\hat{\mu}}{1 - (\hat{\ell} \hat{r}_E - (1 + \hat{\ell}) \hat{r}_A)}, \quad (31)$$

with $\hat{\mu}$ being projected claims.

Actuarial vs profit-maximizing pricing The target price in equation (31) can be interpreted as the discounted expected claims, similarly to the profit-maximizing price in equation (9) but with the proportional markup translated into a lower discount rate. There are important differences between target and profit-maximizing prices. First, the discount rate is adjusted by the capital ratio $\hat{\ell}$: the larger the insurer's capital relative to the amount of premiums written, the larger is the price P_{Target} necessary to achieve the target return on equity $\hat{r}_E$. This adjustment results from pricing “at the average” in equation (29) rather than pricing “at the margin” in equation (9). Moreover, $\hat{\ell}$ is typically estimated based on historical averages, effectively assuming inelastic insurance demand.

Second, the markup is not determined by the elasticity of insurance demand but by the target return on equity $\hat{r}_E$. $\hat{r}_E$ is typically based on current market yields, e.g., using the CAPM. Therefore, assuming an equity beta below one, it is $\frac{\partial \hat{r}_E}{\partial r_f} > 0$.

Third, the recognition of the investment return $\hat{r}_A$ widely differs across insurers and states. Typically, insurers determine $\hat{r}_A$ using a moving average of past investment yields. This insulates $\hat{r}_A$ from current interest rates.

Target prices and interest rates Assuming that projected investment income does not respond to current interest rate changes, $\frac{\partial \hat{r}_A}{\partial r_f} \approx 0$, the elasticity of target prices to interest

rates is given by

$$\frac{\partial \log P_{\text{Target}}}{\partial r_f} = \frac{1}{P_{\text{Target}}} \times \frac{\partial P_{\text{Target}}}{\partial r_f} = \frac{\hat{\ell}}{1 + (1 + \hat{\ell}) \hat{r}_A - \hat{\ell} \hat{r}_E} \times \frac{\partial \hat{r}_E}{\partial r_f} > 0, \quad (32)$$

i.e., target prices increase with higher interest rates.²⁸

Empirical evidence We examine the dynamics of target prices in Table 6. First, we document large deviations between final and target prices. Only one-quarter of target price changes translates into changes in final prices, and target price changes explain only one-third of the variation in final prices (column 1). Thus, target prices provide an important benchmark for price setting but they do not mechanically determine final prices.

Second, on average, a 100 bps monetary policy surprise increases target prices by approximately 10% (column 2).²⁹ This response in actuarial indications provides insurers with the scope to adjust final prices. Importantly, however, the response of target prices does not vary significantly with insurers' balance-sheet exposure (column 3), despite the response of final prices. This result suggests that actuarial pricing rules provide limited scope for conditioning target prices on insurers' financial conditions, consistent with actuarial guidance (National Association of Insurance Commissioners, 2024).

8.3 Rate Regulation

Homeowners insurance prices are subject to state-level regulation, which has two long-standing goals: to prevent excessive or unfairly discriminatory prices and to ensure insurer solvency (National Association of Insurance Commissioners, 2010). These objectives are implemented through a variety of rules that balance affordability, fairness, and financial stability.

The implementation of rate regulation is heterogeneous across U.S. states, with some state regulators exerting a tighter grip on insurance companies. To assess whether these differences affect the pass-through of monetary policy, we rely on the measure for state-level

28 In some instances, current interest rates may be used to determine $\hat{r}_A$. For example, the state of California requires insurers to compute the maximum permitted price change by using current market interest rates. In this more general case that projected investment income reacts to current interest rates, $\frac{\partial \hat{r}_A}{\partial r_f} > 0$ attenuates the response of target prices to interest rates.

29 The impact of monetary policy on final prices is not explained by target price dynamics (see column (1) in Table D.2).

regulatory frictions developed by Oh et al. (2026). In columns (4) to (6) in Table 6, we split the sample into states with low, medium, and high frictions and report our baseline estimate separately for these subsamples. These do not show a systematic effect of regulatory frictions on the transmission of monetary policy to insurance prices. A potential reason is that regulatory frictions may primarily affect insurers' ability to adjust expected claims rather than profit provisions.

9 Conclusion

This paper documents a balance-sheet channel of monetary policy operating through homeowners insurance. In contrast to the frictionless prediction that higher interest rates lower insurance prices by reducing the present value of future claims, we find that a 100 bps interest rate increase raises insurance prices by about 3.8%. Our model and empirical evidence attribute this response to regulatory capital constraints: higher rates reduce the value of interest-rate-sensitive assets, tightening capital constraints and increasing the shadow cost of supplying insurance.

Cross-sectional evidence isolates this mechanism. The price response is significantly stronger for financially constrained insurers with interest-rate-sensitive portfolios and is driven by the interaction of these characteristics. Moreover, the response is driven by the sensitivity of only those (mark-to-market) assets whose valuation affects statutory capital, pointing to a regulatory-capital rather than a generic net-worth channel.

The insurance channel amplifies monetary policy transmission to housing markets. Insurance-price increases raise housing costs by an economically significant amount relative to the conventional mortgage-interest channel, and house prices respond more strongly in areas served by more exposed insurers. The response is largest where insurance expenditures are high relative to household income and natural-disaster exposure is greater, consistent with household cash-flow constraints. These findings suggest that insurance markets constitute an important margin of monetary policy transmission that deserves greater attention in policymaking.

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Figures

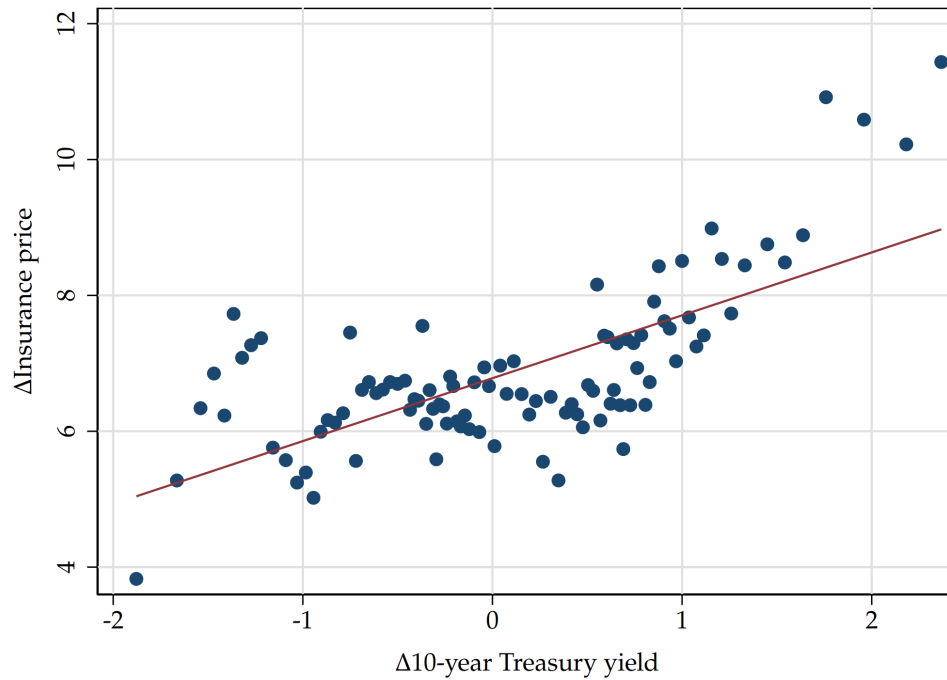


Figure 1
Insurance Prices and Interest Rates

This figure shows a binned scatter plot of the percentage price change in U.S. homeowners insurance rate filings (y-axis) against the change in the 10-year U.S. Treasury yield over the 12 months preceding the filing month (x-axis). Both variables are residualized on insurer fixed effects. The sample comprises all rate filings from 2010 to 2023.

Tables

Table 1
Summary Statistics

	N	Mean	SD	10 th	25 th	Median	75 th	90 th
Panel 1: Filing information								
Δ Price (%)	30,320	6.87	6.61	0.00	2.40	5.80	9.90	15.20
Filing time	30,320	446.84	428.12	120	250	366	468	797
Panel 2: Monetary policy surprises								
12-month cumulative	168	-0.01	0.04	-0.07	-0.05	-0.00	0.03	0.05
3-month cumulative	168	-0.00	0.02	-0.04	-0.01	0.00	0.02	0.03
Panel 3: Investment income & interest rate sensitivity								
Coupons & dividends (%)	28,366	1.33	0.83	0.44	0.76	1.20	1.72	2.38
Realized gains (%)	28,366	0.28	0.82	-0.13	-0.00	0.03	0.33	0.97
Unrealized gains (%)	28,366	0.37	2.06	-1.21	-0.02	0.03	1.01	2.51
Sensitivity (%)	28,261	0.40	0.59	0.00	0.00	0.17	0.58	1.19
Panel 4: Housing markets								
Δ HP (%)	279,219	0.38	0.68	-0.38	-0.02	0.34	0.72	1.23
Exposure ^{Local}	8,415	0.17	0.41	-0.15	0.00	0.06	0.28	0.71

This table reports summary statistics for the main variables used in the empirical analysis.

Filing information. Δ Price is the insurance price change in the filing. *Filing time* is the number of days between the filing and the insurer's previous filing in the same state.

Monetary policy surprises. *12-month cumulative* is the cumulative orthogonalized high-frequency monetary policy surprise in the 10-year U.S. Treasury yield over the 12 months preceding the filing month. *3-month cumulative* is the same surprise cumulated over the 3 months preceding the filing month.

Investment income & interest rate sensitivity. *Coupons & dividends* is the insurer's quarterly coupon and dividend income, scaled by lagged statutory capital. *Realized gains* is the insurer's quarterly realized gains and losses from security sales, scaled by lagged statutory capital. *Unrealized gains* is the quarterly change in the fair value of the insurer's mark-to-market assets, scaled by lagged statutory capital. *Sensitivity* is the value-weighted average interest rate sensitivity of the insurer's mark-to-market assets, measured as the percentage decline in value per 100-basis-point increase in interest rates.

Housing markets. Δ HP is the monthly growth rate of single-family home prices in the county. *Exposure^{Local}* is the premium-weighted average exposure to monetary policy of insurers operating in the state. Insurer-level exposure is the product of the interest rate sensitivity of an insurer's mark-to-market assets and an indicator for whether the insurer is capital-constrained.

Table 2
Monetary Policy and Insurance Prices

Specification:	Dependent variable: $\Delta Price_f$						
	Time series	+ Controls	Cross section	+ Interactions	Net worth channel	IV estimation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$MPS_{(t-12:t-1)}$	9.430*** [3.89]	5.509*** [3.32]					
$Exposure_{i,q-5} \times MPS_{(t-12:t-1)}$			4.043*** [4.57]	3.360*** [2.64]	4.352*** [4.23]		
$Exposure_{i,q-5}^{NW} \times MPS_{(t-12:t-1)}$					-0.027 [-0.11]		
$\Delta UST_{(t-12:t-1)}^{10YR}$						3.756* [1.83]	
$Exposure_{i,q-5} \times \Delta UST_{(t-12:t-1)}^{10YR}$							1.093*** [3.16]
Controls and lower-order terms		Yes	Yes	Yes	Yes	Yes	Yes
Insurer-State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product-State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-Time FE			Yes	Yes	Yes		Yes
<i>Sensitivity</i> $\times$ <i>MPS</i>				Yes			
<i>Constrained</i> $\times$ <i>MPS</i>				Yes			
No. of obs.	29,746	29,746	28,423	28,423	28,423	29,746	28,423
R^2	0.293	0.324	0.615	0.616	0.615	-0.105	-0.009
Within R^2	0.012	0.055	0.007	0.008	0.006		

This table reports estimates from specifications based on Equations (23) and (24). The dependent variable, $\Delta Price_f$, is the insurance price change in filing f , submitted by insurer i in state s in year-month t . $MPS_{(t-12:t-1)}$ is the cumulative orthogonalized high-frequency monetary policy surprise in the 10-year U.S. Treasury yield over the 12 months preceding year-month t . $Exposure_{i,q-5}$ is the product of the interest rate sensitivity of insurer i 's mark-to-market assets and an indicator for whether the insurer is capital-constrained, both measured five quarters before the filing. An insurer is classified as capital-constrained if its relative RBC gap, defined as the difference between its trailing five-year average RBC ratio and its current RBC ratio, divided by that average, is above the median of the gap's pooled distribution across insurers and quarters. $Exposure_{i,q-5}^{NW}$ is defined analogously but uses the interest rate sensitivity of all of the insurer's assets, regardless of their accounting treatment. Column (4) additionally controls for the interaction of $MPS_{(t-12:t-1)}$ with the interest rate sensitivity of the insurer's investment portfolio and with the capital-constraint indicator. Columns (6) and (7) report two-stage least squares estimates based on the change in the 10-year U.S. Treasury yield over the 12 months preceding year-month t , $\Delta UST_{(t-12:t-1)}^{10Y}$. In column (6), $\Delta UST_{(t-12:t-1)}^{10Y}$ is instrumented by $MPS_{(t-12:t-1)}$; in column (7), its interaction with $Exposure_{i,q-5}$ is instrumented by $Exposure_{i,q-5} \times MPS_{(t-12:t-1)}$. Controls, where not absorbed by fixed effects, include (i) at the filing level, the log time since insurer i 's previous filing in state s ; (ii) at the insurer level, measured five quarters before the filing, log total assets, leverage, the RBC ratio, underwriting gains scaled by total liabilities, and net statutory investment income scaled by total invested assets; and (iii) at the state level, the log mean and log standard deviation of disaster damages over the five years ending two years before the filing year, log personal income per capita and log GDP per capita two calendar years before the filing year, and one-year house-price growth measured five quarters before the filing. Variable definitions are in Table B.1. t -statistics are shown in brackets and based on standard errors that are two-way clustered at the insurer and the year-month levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Table 3
Monetary Policy, Insurance, and House Prices

Estimation:	Dependent variable: $\Delta \log HP_{c,(t-1:t+12)}$			
	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)
$Exposure_{s,q}^{Local} \times MPS_{(t-1:t-12)}$	-4.284*** [-3.89]		-4.837*** [-4.50]	
$\Delta Price_{s,(t-1:t+12)}$		-1.177** [-2.06]		-1.207** [-2.02]
County FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes		
Demographics-Time FE			Yes	Yes
No. of obs.	282,645	250,952	276,912	245,744
R^2	0.619	-0.293	0.646	-0.324
Within R^2	0.001		0.001	

This table reports reduced-form and two-stage least squares estimates from specifications based on Equation (26). The dependent variable, $\Delta \log HP_{c,(t-1:t+12)}$, is the log change in house prices in county c from year-month $t - 1$ to year-month $t + 12$. $Exposure_{s,q}^{Local}$ is the average exposure, as defined in Table 2, of all insurers that submitted filings in state s in year-quarter q , weighted by the premiums affected by the respective filings, where q is the year-quarter containing year-month t and each insurer's exposure is measured five quarters before q . $MPS_{(t-12:t-1)}$ is the cumulative orthogonalized high-frequency monetary policy surprise in the 10-year U.S. Treasury yield over the 12 months preceding year-month t . $\Delta Price_{s,(t-1:t+12)}$ is the change in the state-level insurance price index from year-month $t - 1$ to year-month $t + 12$, constructed as described in Appendix B.2. In columns (2) and (4), it is instrumented by the interaction of $Exposure_{s,q}^{Local}$ and $MPS_{(t-12:t-1)}$. Demographic-by-time fixed effects interact quintiles of county-level GDP per capita, population, and population density with year-month indicators. t -statistics are shown in brackets and based on standard errors that are two-way clustered at the county and year-month levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Table 4
Heterogeneous Effects of the Insurance Channel

Sample split	Coefficient [t-statistics] of $Exposure_{s,q}^{Local} \times MPS_{(t-12:t-1)}$	p-value of $H_0 : \beta_{High} = \beta_{Low}$
HO cost to average household income		
Low	-3.178** [-2.175]	.
High	-4.388*** [-3.591]	0.000
Average premium		
Low	-0.516 [-0.407]	.
High	-7.334*** [-7.346]	0.468
Disaster risk		
Low	-3.330*** [-2.674]	.
High	-5.196*** [-4.620]	0.000

This table reports estimates of Equation (26) for subsamples of counties split at the median of several county-level characteristics. The dependent variable, $\Delta \log HP_{c,(t-1:t+12)}$, is the log change in house prices in county c from year-month $t-1$ to year-month $t+12$. The first column lists the characteristic used to split the sample. The second column reports the coefficients on the interaction between $Exposure_{s,q}^{Local}$ and $MPS_{(t-12:t-1)}$, estimated separately for counties below and above the median. $Exposure_{s,q}^{Local}$ is the average exposure, as defined in Table 2, of all insurers that submitted filings in state s in year-quarter q , weighted by the premiums affected by the respective filings, where q is the year-quarter containing year-month t and each insurer's exposure is measured five quarters before q . $MPS_{(t-12:t-1)}$ is the cumulative orthogonalized high-frequency monetary policy surprise in the 10-year U.S. Treasury yield over the 12 months preceding year-month t . The third column reports the p -value for the coefficient on a triple-interaction term between the split indicator, local exposure, and monetary policy surprises estimated in the pooled sample. t -statistics are shown in brackets and based on standard errors that are two-way clustered at the county and the state-by-year-month levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Table 5
Monetary Policy and Insurers' Investment Return

Outcome:	Dependent variable: $\frac{Outcome_{i,q}}{Capital_{i,q-1}}$					
	Unrealized gains		Coupons & dividends	Realized gains	Total investment return	
	(1)	(2)	(3)	(4)	(5)	(6)
ΔMPS_q	-2.848*** [-2.63]				-2.686** [-2.00]	
$Sensitivity_{i,q-1} \times \Delta MPS_q$		-2.086** [-2.16]	-0.021 [-0.30]	0.262 [1.47]		-2.686** [-2.34]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Insurer-Season FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE		Yes	Yes	Yes		Yes
No. of obs.	27,379	27,278	27,278	27,278	27,379	27,278
R^2	0.187	0.390	0.766	0.199	0.199	0.287
Adj. R^2	0.007	0.007	0.202	0.004	0.017	0.014

This table reports estimates from specifications based on Equation (27). The dependent variable, $\frac{Outcome_{i,q}}{Capital_{i,q-1}}$, is insurer i 's investment income, or one of its components, in year-quarter q , scaled by capital at the end of year-quarter $q - 1$. MPS_q is the cumulative orthogonalized high-frequency monetary policy surprise in the 10-year U.S. Treasury yield over year-quarter q . $Sensitivity_{i,q-1}$ is the interest rate sensitivity of insurer i 's mark-to-market assets at the end of year-quarter $q - 1$. In columns (1) and (2), the outcome is unrealized gains and losses on assets held at market value; in column (3), coupon and dividend income; in column (4), realized gains and losses from security sales; and in columns (5) and (6), the sum of these three components. Controls include $Sensitivity_{i,q-1}$ and the same insurer-level controls as in Table 2. t -statistics are shown in brackets and based on standard errors that are two-way clustered at the insurer and RBC-ratio quintile-by-year-quarter levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Table 6
Actuarial Pricing

Sample:	Dependent variable					
	$\Delta Price_f$	$\Delta Target_f$		$\Delta Price_f$		
		All states		High friction	Medium friction	Low friction
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta Target_f$	0.233*** [17.97]					
$MPS_{(t-12:t-1)}$		10.152*** [3.22]				
$Exposure_{i,q-5} \times MPS_{(t-12:t-1)}$			3.218 [1.63]	4.064*** [2.96]	3.879*** [3.22]	4.867*** [3.35]
Controls		Yes	Yes	Yes	Yes	Yes
Insurer-State FE		Yes	Yes	Yes	Yes	Yes
Product-State FE		Yes	Yes	Yes	Yes	Yes
State-Time FE			Yes	Yes	Yes	Yes
No. of obs.	27,245	27,131	25,695	10,893	11,358	6,172
R^2	0.327	0.429	0.669	0.624	0.588	0.655
Within R^2	0.327	0.034	0.002	0.010	0.007	0.015

This table reports estimates from specifications based on Equation (24). In columns (1) and (4) to (6), the dependent variable, $\Delta Price_f$, is the insurance price change in filing f , submitted by insurer i in state s in year-month t . In columns (2) and (3), the dependent variable, $\Delta Target_f$, is the actuarially indicated price change in filing f . $MPS_{(t-12:t-1)}$ is the cumulative orthogonalized high-frequency monetary policy surprise in the 10-year U.S. Treasury yield over the 12 months preceding year-month t . $Exposure_{i,q-5}$ is the product of the interest rate sensitivity of insurer i 's mark-to-market assets and an indicator for whether the insurer is capital-constrained (as defined in Table 2), both measured five quarters before the filing. Controls are as in Table 2. Variable definitions are in Table B.1. t -statistics are shown in brackets and based on standard errors that are two-way clustered at the insurer and the year-month levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Internet Appendix for *Homeowners Insurance and Monetary Policy*

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Contents

A Proofs	IA.1
B Details on Data Construction	IA.8
B.1 Cleaning the SNL Filings Data	IA.12
B.2 Construction of the State-Level Insurance Price Index	IA.14
C Additional Figures	IA.16
D Additional Tables	IA.21
E Construction of Asset Sensitivity	IA.30
E.1 Baseline Measure	IA.30
E.2 Security-Level Sensitivities	IA.31
E.2.1 Fixed-income sensitivities	IA.31
E.2.2 Equity and mutual-fund sensitivities	IA.34
E.2.3 Final sample construction	IA.35
E.3 Statutory Accounting Treatment	IA.38
E.4 Aggregation and Winsorization	IA.41
E.5 Validation	IA.43
E.6 Alternative Specifications	IA.44

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F	Accounting of Insurance Contracts	IA.47
G	Magnitudes	IA.50
G.1	Back-of-the-Envelope Calculation	IA.50
G.2	Pass-Through to Housing Costs	IA.53
G.3	Pass-Through to House Prices	IA.58
H	Empirical Identification	IA.63
H.1	Empirical Framework	IA.63
H.2	Time-Series Elasticity	IA.64
H.3	Cross-Sectional Elasticity	IA.65
H.3.1	Inflation	IA.65
H.3.2	Sorting on insurer characteristics	IA.65
H.3.3	Sorting on household characteristics	IA.66
H.3.4	Other potential concerns	IA.68
H.4	Construction of Household Characteristics	IA.69
I	Exemplary Price Filings	IA.73
I.1	Grange Property & Casualty Insurance Company	IA.73
I.2	American Select Insurance Company	IA.76
I.3	United Services Automobile Association	IA.79
J	Model Extension: Market Dynamics in the Presence of Financial Frictions	IA.80
J.1	Model Setup	IA.80
J.2	Customer Choice and Market Shares	IA.81
J.3	Price Setting and Equilibrium	IA.81
J.3.1	Unconstrained insurer	IA.82
J.3.2	Constrained insurer	IA.82
J.4	Equilibrium Prices and Monetary Policy	IA.83
J.5	Proofs	IA.85

A Proofs

Lemma 1 (Regularity of the pricing problem). The insurer's objective $\varphi \equiv Y - C$ has at most one interior critical point; it is a strict local maximum, and the resulting equilibrium price is continuously differentiable in (r_f, L_0) .

Proof. Using $Q'(P)P = -\epsilon Q$ and $\chi = -C'$, the derivative of the objective satisfies

$$\begin{aligned} \frac{P}{Q} \varphi'(P) &= P - \epsilon(P - V) + \chi [P - \epsilon(P - (1 + \rho)V)] \\ &= (1 - \epsilon)(1 + \chi) [P - m(\chi)V], \quad \text{where } m(\chi) \equiv \frac{\epsilon}{\epsilon - 1} \frac{1 + (1 + \rho)\chi}{1 + \chi}. \end{aligned}$$

At an interior critical point, $P = m(\chi)V$ (the pricing equation of Proposition 1). Differentiating once more, all terms proportional to $P - m(\chi)V$ vanish at the critical point, leaving

$$\varphi'' = \frac{Q}{P} (1 - \epsilon)(1 + \chi) \left[1 - Vm'(\chi) \chi' \frac{\partial K}{\partial P} \right] = -\frac{Q}{P} (\epsilon - 1)(1 + \chi)(1 + \delta v) < 0, \quad (\text{A1})$$

where the second equality uses $Vm'(\chi) \chi' = P \frac{d \log m}{d \chi} \chi' = -\delta P$ (direct differentiation gives $\frac{d \log m}{d \chi} = \frac{\rho}{(1 + \chi(1 + \rho))(1 + \chi)}$; see the definition of δ in equation (14)) and $P \frac{\partial K}{\partial P} = QP(1 - \epsilon) + \epsilon(1 + \rho)VQ = v$ at the critical point (upon substituting the pricing equation; see the footnote in the proof of Proposition 2), and the sign follows from $\epsilon > 1$ and $\chi > 0$. Hence every interior critical point is a strict local maximum, which immediately implies uniqueness; existence follows from standard boundary-behavior arguments. Finally, since $\varphi'' < 0$ at the interior optimum and f is thrice differentiable, the implicit function theorem applied to the first-order condition $\varphi' = 0$ makes the equilibrium price continuously differentiable in (r_f, L_0) . $\square$

Proof of Proposition 1. The pricing equation stems from the FOC to the insurer's optimization problem:

$$\begin{aligned}
0 &= \frac{\partial Y}{\partial P} - \frac{\partial C}{\partial P} \\
&= Q + (P - V) \frac{\partial Q}{\partial P} + \chi \frac{\partial K}{\partial P} \\
&= Q + (P - V) \frac{\partial Q}{\partial P} + \chi \left[Q + \frac{\partial Q}{\partial P} \times (P - (1 + \rho)V) \right] \\
&= P - (P - V)\epsilon + \chi [P - \epsilon \times (P - (1 + \rho)V)] \\
&\Leftrightarrow P = \frac{\epsilon}{\epsilon - 1} \times \frac{1 + \chi(1 + \rho)}{1 + \chi} V,
\end{aligned}$$

where $\epsilon = -\frac{\partial Q}{\partial P} \frac{P}{Q}$ and $\chi = -\frac{\partial C}{\partial K}$. By Lemma 1, the first-order condition characterizes the unique interior optimum. $\square$

Proof of Proposition 2. By Lemma 1, the equilibrium price is differentiable in r_f , so the total derivatives below are well defined. We first recall that:

$$K = A - (1 + \rho)L \quad (\text{A2})$$

$$= A_0 + QP - Q(1 + \rho)V - (1 + \rho)L_0, \quad (\text{A3})$$

which implies that

$$\frac{dK}{dr_f} = \frac{dA_0}{dr_f} + \frac{d}{dr_f} \{QP\} - \frac{d}{dr_f} \{Q(1 + \rho)V\} \quad (\text{A4})$$

$$= -\alpha + \frac{dQ}{dr_f} P + Q \frac{dP}{dr_f} - (1 + \rho) \left[\frac{dQ}{dr_f} V + Q \frac{dV}{dr_f} \right] \quad (\text{A5})$$

$$= -\alpha + \left[\frac{\partial Q}{\partial P} P + Q \right] \frac{dP}{dr_f} - (1 + \rho)V \left[\frac{dQ}{dr_f} - Q \right] \quad (\text{A6})$$

$$= -\alpha - QP(\epsilon - 1) \frac{d \log P}{dr_f} + Q(1 + \rho)V \left[1 + \epsilon \frac{d \log P}{dr_f} \right] \quad (\text{A7})$$

$$= -\alpha + Q(1 + \rho)V + \frac{d \log P}{dr_f} v, \quad (\text{A8})$$

where¹

$$v = QV\epsilon \frac{\rho}{1 + \chi} \geq 0.$$

From Equation (A8), we see that the effect of a rate hike on insurer capital operates through three channels. First, it lowers the value of the insurer's initial assets (by $\alpha > 0$). Second, it lowers the present value of the insurer's liabilities ($Q(1 + \rho) \frac{dV}{dr_f} = -Q(1 + \rho)V < 0$). Third, it changes the optimal insurance price, and thus the optimal amount of underwriting that an insurer undertakes ($\frac{d \log P}{dr_f} v$). With this in mind, we next get that:

$$\frac{d}{dr_f} \log P = \frac{d}{dr_f} \log \left(\frac{1 + \chi(1 + \rho)}{1 + \chi} \right) + \frac{d}{dr_f} \log V \quad (\text{A12})$$

$$= \frac{1}{1 + \chi(1 + \rho)} \frac{\rho}{1 + \chi} \frac{d\chi}{dr_f} - 1 \quad (\text{A13})$$

$$= -\delta \left(Q(1 + \rho)V - \alpha + \frac{d \log P}{dr_f} v \right) - 1 \quad (\text{A14})$$

$$= -\frac{1 + \delta (Q(1 + \rho)V - \alpha)}{1 + \delta v} \quad (\text{A15})$$

$$= -1 + \frac{\delta}{1 + \delta v} (\alpha - Q(1 + \rho)V + v), \quad (\text{A16})$$

where

$$\delta = -\frac{\rho}{1 + \chi(1 + \rho)} \frac{\chi'}{1 + \chi} \geq 0, \quad \chi' = \frac{\partial \chi}{\partial K}.$$

□

Proof of Corollary 1. Setting $\frac{dK}{dr_f} = 0$ in Equation (A8) yields the capital-preservation benchmark

$$\Pi^K = \frac{\alpha - Q(1 + \rho)V}{v}.$$

Substituting $\lambda = \frac{\delta v}{1 + \delta v}$ into the right-hand side of Equation (16) gives

$$-(1 - \lambda) + \lambda \Pi^K = -\frac{1}{1 + \delta v} + \frac{\delta v}{1 + \delta v} \frac{\alpha - Q(1 + \rho)V}{v} = -\frac{1 + \delta (Q(1 + \rho)V - \alpha)}{1 + \delta v},$$

1 To see how we arrive at v , note that

$$v = QV\epsilon \left((1 + \rho) - P \frac{\epsilon - 1}{\epsilon} \frac{1}{V} \right) \quad (\text{A9})$$

$$= QV\epsilon \left((1 + \rho) - \frac{1 + (1 + \rho)\chi}{1 + \chi} \right) \quad (\text{A10})$$

$$= QV\epsilon \left(\frac{\rho}{1 + \chi} \right) \geq 0. \quad (\text{A11})$$

which is the expression for $\frac{d \log P}{dr_f}$ derived in the proof of Proposition 2. With financial frictions ($\rho > 0$), we have $\delta \geq 0$ and $v > 0$, such that $\lambda = \frac{\delta v}{1 + \delta v} \in [0, 1)$. $\square$

Proof of Corollary 2. From the proof of Proposition 2, $\frac{d \log P}{dr_f} = -\frac{1 + \delta(Q(1 + \rho)V - \alpha)}{1 + \delta v}$, with $1 + \delta v > 0$. Hence $\frac{d \log P}{dr_f} > 0$ if and only if $\delta(\alpha - Q(1 + \rho)V) > 1$. With $\rho > 0$, strict convexity of C implies $\delta > 0$, so this is equivalent to $\alpha > Q(1 + \rho)V + \frac{1}{\delta}$. $\square$

Proof of Proposition 3. The comparative static varies the sensitivity $\alpha = -\frac{\partial A_0}{\partial r_f}$ while holding the level of A_0 (and all other primitives) fixed. Because the date-0 equilibrium conditions involve A_0 only through its level, the equilibrium objects P , Q , K , and χ — and hence δ and v — are invariant to α ; only the capital response $\frac{dK}{dr_f}$ depends on it. Proposition 2 then implies

$$\frac{\partial}{\partial \alpha} \left\{ \frac{d \log P}{dr_f} \right\} = \frac{\delta}{1 + \delta v} > 0, \quad (\text{A17})$$

where $\delta > 0$ follows from $\rho > 0$ and strict convexity of C . $\square$

The proof of Proposition 4 uses the following intermediate comparative statics, which establish how the equilibrium responds to initial liabilities. Throughout, derivatives with respect to L_0 denote responses along the equilibrium, i.e., they account for the endogenous adjustment of the equilibrium price (differentiability follows from Lemma 1).

Lemma 2. With $\rho > 0$, the equilibrium responses to initial liabilities L_0 (holding all other primitives fixed) are

$$\frac{\partial \log P}{\partial L_0} = \frac{\delta(1 + \rho)}{1 + \delta v} > 0, \quad \frac{\partial K}{\partial L_0} = -\frac{1 + \rho}{1 + \delta v} < 0, \quad \frac{\partial Q}{\partial L_0} = -\epsilon Q \frac{\delta(1 + \rho)}{1 + \delta v} < 0. \quad (\text{A18})$$

Proof. Differentiating the pricing equation, $\log P = \log \frac{\epsilon}{\epsilon - 1} + \log \left(\frac{1 + \chi(1 + \rho)}{1 + \chi} \right) + \log V$, with respect to L_0 gives

$$\frac{\partial \log P}{\partial L_0} = \frac{\rho}{(1 + \chi(1 + \rho))(1 + \chi)} \chi' \frac{\partial K}{\partial L_0} = -\delta \frac{\partial K}{\partial L_0}. \quad (\text{A19})$$

Statutory capital responds to L_0 directly and through the price:

$$\frac{\partial K}{\partial L_0} = -(1 + \rho) + v \frac{\partial \log P}{\partial L_0}, \quad (\text{A20})$$

using that the semi-elasticity of statutory capital with respect to the price equals v at the equilibrium price (as in the proof of Proposition 2). Substituting the first equation into the second and solving yields the first two expressions, and $\frac{\partial Q}{\partial L_0} = -\epsilon Q \frac{\partial \log P}{\partial L_0}$ follows from the constant demand elasticity. The strict signs use $\delta > 0$, which is implied by $\rho > 0$ and strict convexity of C ; note that $\frac{\partial K}{\partial L_0} < 0$ holds regardless: the endogenous repricing dampens the direct effect $-(1 + \rho)$ by the factor $1 + \delta v$ but never overturns it. $\square$

Proof of Proposition 4. To ease notation, let $\omega = Q(1 + \rho)V - \alpha$, and recall from Corollary 1 that

$$\frac{d \log P}{dr_f} = -1 + \lambda (1 + \Pi^K), \quad \lambda = \frac{\delta v}{1 + \delta v}, \quad \Pi^K = \frac{-\omega}{v}, \quad (\text{A21})$$

where $\delta > 0$ and $v > 0$ follow from $\rho > 0$ and strict convexity of C ($\chi' = -C'' < 0$). The two sufficient conditions are

$$\alpha \geq Q(1 + \rho)V, \quad \text{i.e., } \omega \leq 0, \quad (\text{A22})$$

$$\frac{\partial \lambda}{\partial L_0} > 0. \quad (\text{A23})$$

Differentiating the decomposition with respect to L_0 ,

$$\frac{\partial}{\partial L_0} \left\{ \frac{d \log P}{dr_f} \right\} = \frac{\partial \lambda}{\partial L_0} (1 + \Pi^K) + \lambda \frac{\partial \Pi^K}{\partial L_0}. \quad (\text{A24})$$

By Lemma 2, $\frac{\partial \omega}{\partial L_0} = \frac{\partial Q}{\partial L_0} (1 + \rho)V < 0$ and

$$\frac{\partial v}{\partial L_0} = \underbrace{V \epsilon \frac{\rho}{1 + \chi}}_{>0} \underbrace{\frac{\partial Q}{\partial L_0}}_{<0} - \underbrace{Q V \epsilon \frac{\rho}{(1 + \chi)^2}}_{>0} \underbrace{\chi' \times \frac{\partial K}{\partial L_0}}_{>0} < 0. \quad (\text{A25})$$

Under Condition (A22), $\omega \leq 0$ therefore implies

$$\frac{\partial \Pi^K}{\partial L_0} = \frac{-\frac{\partial \omega}{\partial L_0} v + \omega \frac{\partial v}{\partial L_0}}{v^2} > 0 \quad \text{and} \quad 1 + \Pi^K \geq 1 > 0. \quad (\text{A26})$$

Since $\lambda > 0$, both terms in (A24) are strictly positive under Conditions (A22) and (A23), which proves the proposition.

Primitive characterization of Condition (A23) Because λ is an increasing transformation of δv , Condition (A23) is equivalent to $\frac{1}{\delta} \frac{\partial \delta}{\partial L_0} + \frac{1}{v} \frac{\partial v}{\partial L_0} > 0$. Differentiating $\delta = -\frac{\rho}{1+\chi(1+\rho)} \frac{\chi'}{1+\chi}$ along the equilibrium (all dependence on L_0 runs through K) and factoring gives

$$\frac{\partial \delta}{\partial L_0} = -\underbrace{\frac{\rho}{1+\chi(1+\rho)} \frac{1}{1+\chi} \frac{\partial K}{\partial L_0}}_{>0} \left\{ \chi'' - \left(\frac{1+\rho}{1+\chi(1+\rho)} + \frac{1}{1+\chi} \right) \chi'^2 \right\}, \quad (\text{A27})$$

while (A25) together with $\frac{1}{Q} \frac{\partial Q}{\partial L_0} = -\epsilon \frac{\partial \log P}{\partial L_0} = \epsilon \delta \frac{\partial K}{\partial L_0}$ (Lemma 2) gives $\frac{1}{v} \frac{\partial v}{\partial L_0} = \left(\epsilon \delta - \frac{\chi'}{1+\chi} \right) \frac{\partial K}{\partial L_0}$. Since $\frac{\partial K}{\partial L_0} < 0$, collecting terms shows that Condition (A23) is equivalent to

$$\frac{\chi''}{\chi'^2} > \frac{1+\rho}{1+\chi(1+\rho)} + \frac{2}{1+\chi} + \frac{\epsilon \rho}{(1+\chi(1+\rho))(1+\chi)} \quad (\text{A28})$$

at the equilibrium: the shadow cost of capital must be sufficiently convex (in particular, $\chi'' = -C''' > 0$ there). For the cost function $C = -\log(K)$ used below, condition (A28) reduces to $2K^2 + (1+\rho-\epsilon\rho)K > 1+\rho$.

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 as

$$C = -\log(K)$$

and set the parameters to be $A_0 = 4$, $\epsilon = 3$, $\rho = 0.5$, $r_f = 0$, $\mu = 1$ (so $V = 1$), demand $Q = P^{-\epsilon}$, and $\alpha = 20$ (an asset duration of $\alpha/A_0 = 5$). Condition (A22) holds throughout the plotted domain ($\alpha = 20$ against $Q(1+\rho)V \leq 0.5$). By the characterization (A28), Condition (A23) reduces to $2K^2 + (1+\rho-\epsilon\rho)K > 1+\rho$, which at these parameters is $K > \sqrt{(1+\rho)/2} \approx 0.87$, i.e., $L_0 \lesssim 2.13$. Both sufficient conditions therefore hold jointly on the shaded region. Figure A.1 shows that the interest rate sensitivity of insurance prices is increasing in insurer leverage throughout — on the shaded region, as Proposition 4 guarantees, and beyond it as well, illustrating that Conditions (A22)–(A23) are sufficient but not necessary. 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 the interest rate hike improves the insurer's regulatory capital ($Q(1+\rho)V - \alpha > 0$).

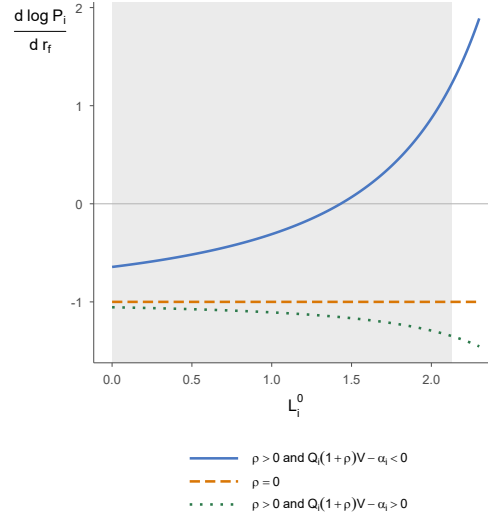


Figure A.1
Sensitivity of Insurance Prices to Interest Rate Increases

This figure shows the sensitivity of insurance prices to the risk-free rate, $\frac{d \log P}{d r_f}$, as a function of insurer leverage, L_0 . The solid line uses the parameter values $C = -\log(K)$, $A_0 = 4$, $\epsilon = 3$, $\rho = 0.5$, $r_f = 0$, $\mu = 1$, and $\alpha = 20$. In the shaded region ($L_0 \lesssim 2.13$), both sufficient conditions of Proposition 4 hold. To the right of this region, the friction weight λ no longer increases with leverage, yet the comparative static continues to hold, which illustrates that the conditions are sufficient but not necessary. The dashed (orange) line shows the case without financial frictions ($\rho = 0$). The dotted (green) line shows a case in which the insurer's liabilities are more interest rate sensitive than its assets ($Q(1 + \rho)V - \alpha > 0$).

□

B Details on Data Construction

Table B.1
Variable Definitions and Data Sources

Variable	Definition
<i>Filing information</i>	
Δ Price	The final rate impact reported in an approved homeowners insurance rate filing, in percent. <i>Source: Insurance Product Filings (RateWatch).</i>
Δ Target	The actuarially indicated percentage rate change reported in the filing. <i>Source: Insurance Product Filings (RateWatch).</i>
Filing time	The number of days since the insurer's previous homeowners insurance filing in the same state, based on submission dates. The regression control is the natural logarithm of this number. <i>Source: SNL Insurance Product Filings (RateWatch) and own calculations.</i>
Policyholders	The number of policyholders affected by the rate filing. <i>Source: Insurance Product Filings (RateWatch).</i>
Premiums written	The amount of premiums written on policies affected by the rate filing. <i>Source: Insurance Product Filings (RateWatch).</i>
<i>Insurer characteristics</i>	
Total assets	The insurer's total statutory assets at the end of a quarter. The regression control is the natural logarithm of total assets. <i>Source: NAIC statutory financial statements.</i>
Total invested assets	The statutory book value of the insurer's invested assets, excluding affiliated holdings. <i>Source: NAIC Schedules D and BA, and own calculations; see Appendix E.</i>
Statutory capital	The insurer's statutory capital at the end of a quarter. <i>Source: NAIC statutory financial statements.</i>
RBC ratio	The insurer's statutory capital divided by its authorized control level risk-based capital requirement, multiplied by 100 (percent), measured at year-end. <i>Source: NAIC statutory financial statements.</i>
RBC gap	The difference between the average RBC ratio in the preceding five calendar years and the current year-end RBC ratio, divided by that five-year average and multiplied by 100 (percent). <i>Source: NAIC statutory financial statements and own calculations.</i>
Constrained	An indicator equal to one if the insurer's RBC gap exceeds the median of the pooled insurer-year distribution, and zero otherwise. <i>Source: NAIC statutory financial statements and own calculations.</i>

Table B.1 continued.

Variable	Definition
Sensitivity	The fair-value-weighted sum of the security-level interest rate sensitivities of the insurer's mark-to-market holdings, divided by total invested assets. Security-level sensitivities are the modified duration for bonds and the negative value of the beta of daily return with respect to 10-year Treasury yield surprises on FOMC announcement days for common stocks and mutual funds. Measured as the percentage decline in invested asset value for a one-percentage-point increase in the yield (percent). <i>Source: NAIC Schedules D and BA; Mergent FISD, TRACE Enhanced, MSRB, CRSP, LSEG Refinitiv, Federal Reserve yield-curve data, and own calculations; see Appendix E.</i>
Sensitivity ^{NW}	The same portfolio sensitivity measure as <i>Sensitivity</i> but calculated using all invested holdings for which security-level interest rate sensitivities are available, regardless of their statutory accounting treatment. <i>Source: Same sources as Sensitivity; see Appendix E.</i>
Exposure	The product of <i>Sensitivity</i> and <i>Constrained</i> , measured five quarters before the filing. <i>Source: NAIC statutory financial statements and security holdings; own calculations.</i>
Exposure ^{NW}	The product of <i>Constrained</i> and <i>Sensitivity^{NW}</i> , measured five quarters before the filing, irrespective of statutory accounting treatment, measured five quarters before the filing. <i>Source: NAIC statutory financial statements and security holdings; own calculations.</i>
Leverage	The insurer's total liabilities divided by total assets, multiplied by 100 (percent), at the end of a quarter. <i>Source: NAIC statutory financial statements.</i>
ROE	The insurer's net income over the current and preceding three quarters divided by the 4-quarters-lagged statutory capital, multiplied by 100 (percent). <i>Source: NAIC statutory financial statements and own calculations.</i>
UW gain	The insurer's underwriting gain over the current and preceding three quarters divided by the 4-quarters-lagged policy reserves, multiplied by 100 (percent). <i>Source: NAIC statutory financial statements and own calculations.</i>
Investment income	The insurer's total investment income over the current and preceding three quarters divided by the 4-quarters-lagged total invested assets, multiplied by 100 (percent). <i>Source: NAIC statutory financial statements and own calculations.</i>
Duration	The fair-value-weighted modified duration of the insurer's long-term fixed-income holdings. <i>Source: NAIC Schedule D; TRACE Enhanced, MSRB, Mergent FISD, and Federal Reserve Treasury yield-curve data; see Appendix E.</i>
Coupons & dividends	The insurer's quarterly net statutory investment income, including interest and dividends, divided by statutory capital at the end of the preceding quarter, multiplied by 100 (percent). <i>Source: NAIC quarterly income and capital gains exhibits, and own calculations.</i>
Realized gains	The insurer's quarterly net realized capital gains and losses, divided by 1-quarter-lagged statutory capital, multiplied by 100 (percent). <i>Source: NAIC quarterly capital gains exhibits and statutory financial statements, and own calculations.</i>

Table B.1 continued.

Variable	Definition
Unrealized gains	The quarterly change in unrealized capital gains, net of changes attributed to disposals, divided by 1-quarter-lagged statutory capital, multiplied by 100 (percent). <i>Source: NAIC quarterly capital gains exhibits and Schedule D transactions, and own calculations.</i>
Total investment return	The sum of quarterly net statutory investment income, realized gains, and unrealized gains, as defined above, divided by 1-quarter-lagged statutory capital, multiplied by 100 (percent). <i>Source: NAIC quarterly income and capital gains exhibits, and own calculations.</i>
<i>State characteristics</i>	
Mean 5-yr damage	The average of annual property damages from natural disasters other than floods over five years. <i>Source: Spatial Hazard Events and Losses Database for the United States (SHELDUS) and own calculations.</i>
SD 5-yr damage	The standard deviation of the annual property-damage amounts underlying Mean 5-yr damage. <i>Source: SHELDUS and own calculations.</i>
GDP per capita	The state's gross domestic product divided by its population. The filing-level control is its natural logarithm. <i>Source: U.S. Bureau of Economic Analysis (BEA).</i>
Income per capita	The state's annual personal income per capita. The filing-level control is its natural logarithm. <i>Source: BEA.</i>
Δ HPI	The percentage change in the seasonally adjusted state house price index. <i>Source: Federal Housing Finance Agency (FHFA) and own calculations.</i>
Exposure ^{Local}	The average insurer exposure in a state-quarter, weighted by premiums affected by each insurer's rate filings during that quarter. Insurer exposures are measured with a 5-quarter lag. <i>Source: S&P RateWatch; NAIC statutory financial statements and security holdings; own calculations.</i>
$\Delta \text{Price}_{s,(t-1:t+h)}$	The log change, multiplied by 100, in the monthly state homeowners insurance price index from year-month $t - 1$ to year-month $t + h$. The index aggregates filing-level rate changes using affected-premium shares within insurer-state and lagged homeowners premiums written across insurers. <i>Source: S&P RateWatch; NAIC statutory premium filings; own calculations; see Appendix B.2.</i>
<i>County characteristics</i>	
$\Delta \log \text{HP}_{c,(t-1:t+h)}$	The difference between the log Zillow Home Value Index for single-family homes in year-month $t + h$ and its log value in year-month $t - 1$, multiplied by 100. <i>Source: Zillow and own calculations.</i>
Population	The county population in a given calendar year. <i>Source: BEA.</i>
GDP	Annual real GDP in the county. <i>Source: BEA.</i>
Population density	County population divided by land area (inhabitants per square kilometer). <i>Source: BEA; U.S. Census Bureau (county land area); own calculations.</i>

Table B.1 continued.

Variable	Definition
5-yr damages	The average quarterly property damage from natural disasters other than floods during the preceding 20 quarters. <i>Source: SHELDUS and own calculations.</i>
Average premium	The average homeowners insurance premium in the county in the preceding calendar year. <i>Source: Keys and Mulder (2025).</i>
HO cost to average household income	The county-level average annual homeowners insurance premium divided by estimated average annual household income among owner-occupied households with a mortgage, in the 2023 ACS cross section. Average income is approximated from reported income brackets using bracket midpoints, with USD 275,000 assigned to the open-ended bracket above USD 150,000. <i>Source: American Community Survey (ACS), 2023, and own calculations.</i>
HO cost to housing costs	The county-level average annual homeowners insurance premium divided by average owner costs of mortgaged owner-occupied housing units, in the 2023 ACS cross section. <i>Source: ACS, 2023, and own calculations.</i>
<i>Macroeconomic variables</i>	
$\Delta \log \text{PCE}$	The log change in the Personal Consumption Expenditures (PCE) price index over 12 months. <i>Source: FRED.</i>
$\Delta \log \text{Lumber}$	The log change in the producer price index for lumber and wood products over 12 months. <i>Source: FRED.</i>
ΔGDP	Cumulative U.S. real GDP growth over 12 months, based on the Brave–Butters–Kelley monthly GDP index (Brave et al., 2019). <i>Source: FRED.</i>
$\Delta \log \text{VIX}$	The log change in the CBOE Volatility Index (VIX) over 12 months. <i>Source: FRED.</i>
<i>Monetary policy</i>	
$\text{MPS}_{(t-12:t-1)}$	The sum of orthogonalized high-frequency changes in the 10-year U.S. Treasury yield around FOMC announcements during the 12 calendar months preceding year-month t (percentage points). Orthogonalization uses pre-announcement economic and financial indicators from the Bauer–Swanson data. <i>Source: Bauer and Swanson (2023a) and own calculations.</i>
MPS_q	The sum of orthogonalized high-frequency changes in the 10-year U.S. Treasury yield around FOMC announcements within year-quarter q (percentage points). <i>Source: Bauer and Swanson (2023a) and own calculations.</i>
$\Delta \text{UST}^{10\text{Y}}$	The change in the 10-year U.S. Treasury rate over the preceding 12 months (percentage points). <i>Source: FRED St. Louis.</i>

B.1 Cleaning the SNL Filings Data

We obtain all filings that P&C insurers submitted to U.S. state regulators from S&P's SNL Insurance Product Filings database. The data cover every filing in which an insurer licensed in the United States asked a state regulator to change the pricing (rate filings), underwriting rules (rule filings), or policy forms and required documents (form filings) of an existing product, or to introduce a new product. We focus on filings for homeowners insurance products, product code "04" in the NAIC's product matrix, submitted between 2010 and 2023. The raw data set features 210,077 filings over this period. We then apply the following cleaning steps to arrive at the sample for our analysis of insurance prices:

1. We drop rate filings that have not been approved by regulators. This step removes 11,262 filings.
2. We drop filings without information on the submitting insurer. This step removes 5,967 filings.
3. We drop filings in which the regulator's decision pre-dates the insurer's submission date or in which the regulator took more than one and a half years to decide. This step removes 2,510 filings.
4. We keep only rate filings, in which the insurer seeks to change the prices of its policies, and discard rule and form filings. This step removes 103,935 filings.
5. We drop filings without information on the implemented price change. This step removes 20,779 filings.
6. We drop filings that change only the price of an endorsement or optional coverage while leaving the base rate unchanged. Such filings report an implemented rate change of zero and an actuarially indicated rate change of either zero or missing. As these filings only pertain to optional add-on coverages or features not included in standard homeowners policy forms, the insurer requests no change to the base rate and the regulator approves none. For example, on June 8, 2018, Griggs Nelson Mutual, an insurance company located in North Dakota, submitted a rate filing to the North Dakota Insurance Department (SERFF tracking number GMTP-131535033) that introduced a rate for an optional coverage, the "Home-Guard Plus Endorsement," supplementing its main homeowners insurance product, "Home-Guard," for an additional premium of \$50. This step removes 15,609 filings.

7. We drop filings that the insurer submits before the price change from its previous filing in the same state for the same product has taken effect, as well as filings for which this information is missing. This step removes 5,501 filings.
8. We drop filings by insurers for which we cannot match financials. This step removes 11,284 filings.
9. We drop filings by insurers with less than \$1 million in homeowners premiums written or less than \$10 million in total assets in the year before the filing. This step removes 225 filings.
10. Finally, we drop filings for the product category “04.0003 Mobile Homeowners.” This step removes 2,130 filings.

The final sample consists of 30,875 rate filings submitted by 584 insurers. Table B.2 summarizes the main cleaning steps. In the main analysis, we additionally exclude the 570 filings submitted during the COVID-19 recession, February to April 2020, as dated by the NBER. This leaves 30,305 filings, before singleton observations are dropped in the fixed-effects regressions.

Table B.2
Cleaning Procedure for the Main Sample

No. of filings in raw sample (2010-2023)	210,077
<i>Withdrawn, disapproved or other</i>	11,262
<i>No NAIC ID</i>	5,967
<i>Unrealistic or missing decision time</i>	2,510
<i>Not a rate filing</i>	103,935
<i>Missing rate change</i>	20,779
<i>Rate filing for endorsement or optional coverage</i>	15,609
<i>Unrealistic or missing business renewal date</i>	5,501
<i>Not matched to controls</i>	11,284
<i>HO premiums < \$1 mn / Assets < \$10 mn</i>	225
<i>Filings for Mobile Homeowners products</i>	2,130
Final sample	30,875

This table describes the construction of the rate filing sample and reports the number of observations removed at each step.

B.2 Construction of the State-Level Insurance Price Index

We construct a monthly state-level homeowners insurance price index from rate filings. Consider filing f by insurer i in state s . Let ΔP_f denote the proportional price change reported in the filing, A_f the premiums affected by the filing, and $DPW_{i,s,y-1}$ the insurer's homeowners premiums written in the state in the preceding calendar year. We first calculate the share of the insurer's state-level premiums affected by a filing as²

$$a_f = \min \left\{ \frac{A_f}{DPW_{i,s,y-1}}, 1 \right\}.$$

2 If the affected-premium share is unavailable, we impute it using the median share, sequentially at the insurer-state, insurer, state-year, and full-sample levels.

If an insurer submits multiple filings $f \in \mathcal{F}_{i,s,d}$ on the same day d , we aggregate them into an insurer-state price change,

$$g_{i,s,d} = \frac{\sum_{f \in \mathcal{F}_{i,s,d}} a_f \Delta P_f}{\max \left\{ 1, \sum_{f \in \mathcal{F}_{i,s,d}} a_f \right\}}.$$

We aggregate all price changes within a year-month t to obtain the insurer-state monthly log price change,

$$\Delta \log P_{i,s,t} = \sum_{d \in t} \log(1 + g_{i,s,d}).$$

We assign a price change of zero to months without a filing and retain insurer-state observations only in years in which the insurer reports positive homeowners premiums written in the state.

We then aggregate insurer-level price changes to the state level, weighting insurers by homeowners premiums written in the preceding calendar year. Specifically,

$$g_{s,t} = \sum_i \omega_{i,s,t} [\exp(\Delta \log P_{i,s,t}) - 1], \quad \omega_{i,s,t} = \frac{\text{DPW}_{i,s,y(t)-1}}{\sum_j \text{DPW}_{j,s,y(t)-1}}.$$

This procedure yields a Laspeyres price index based on lagged premium weights. We calculate state-level monthly log price growth as $\Delta \log P_{s,t} = \log(1 + g_{s,t})$. The h -month insurance price growth used in the housing-market analysis is

$$\Delta \text{Price}_{s,(t-1:t+h)} = 100 [\log P_{s,t+h} - \log P_{s,t-1}].$$

C Additional Figures

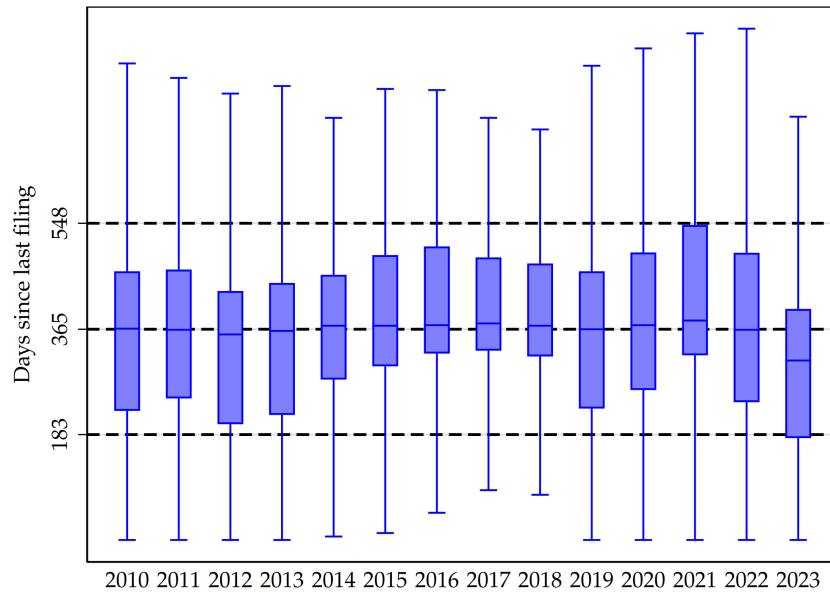


Figure C.1
Time between Subsequent Filings

This figure shows, by the year of the filing, box plots of the number of days between an insurer's rate filing and its previous rate filing in the same state. Boxes show the interquartile range and median; whiskers extend to the most extreme values within 1.5 times the interquartile range of the box. Outliers are not shown.

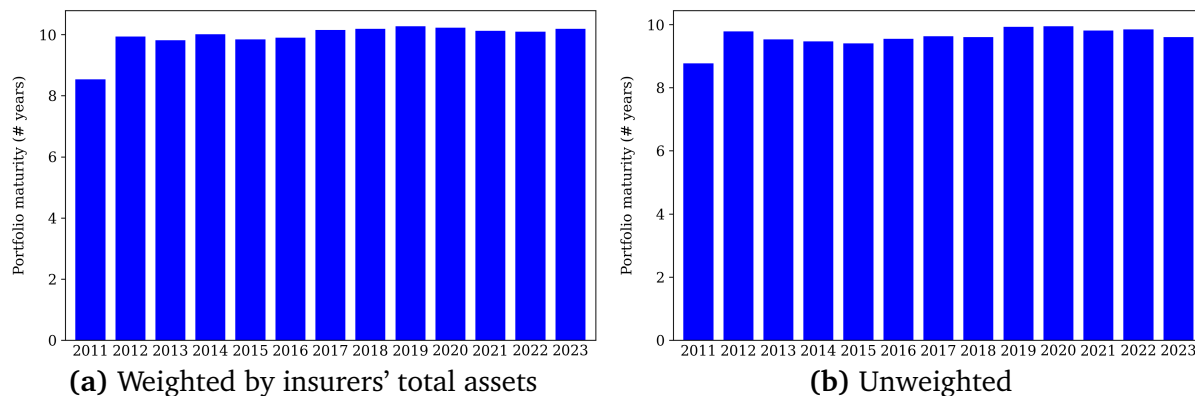
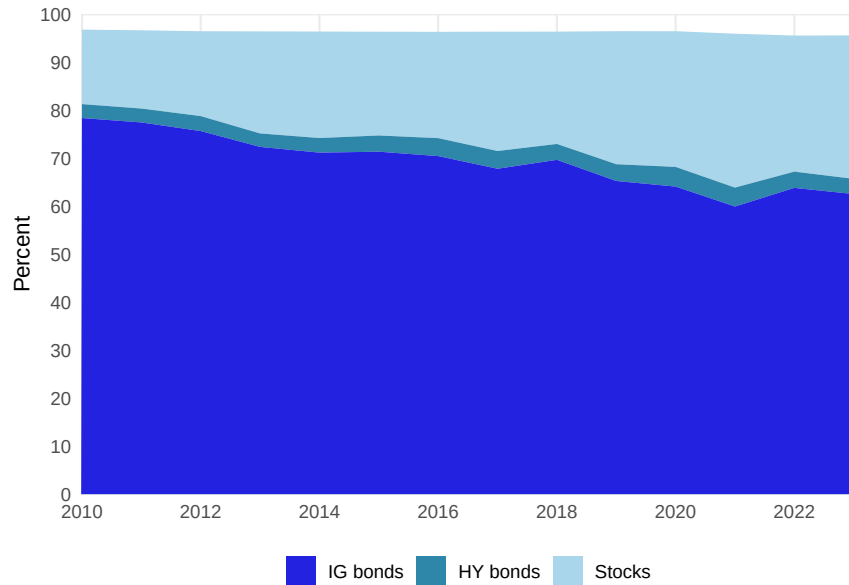


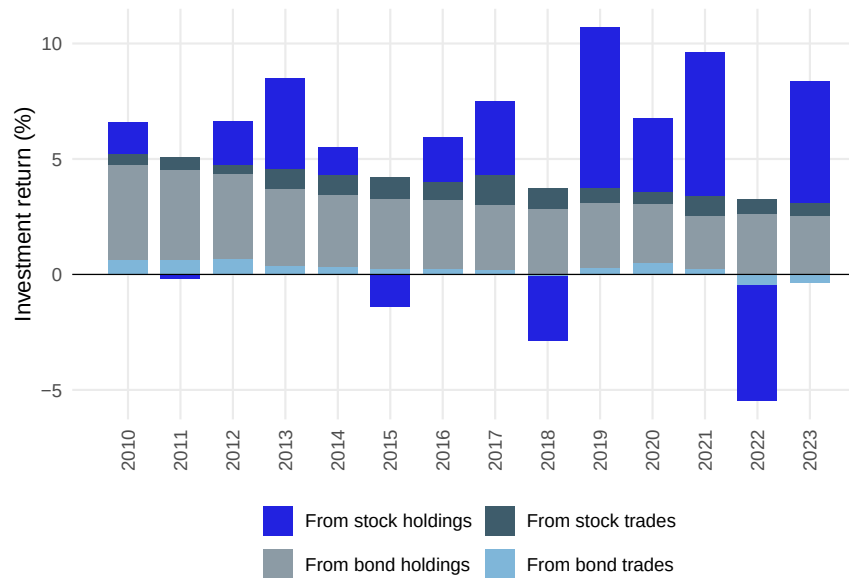
Figure C.2

Maturity of Property Insurers' Fixed Income Portfolio

This figure shows the average remaining maturity of the fixed-income portfolios of insurers in our sample. Panel (a) weights insurers by total assets; panel (b) shows the unweighted average across insurers. The series begins in 2011, the first year in which insurers report the maturity dates of their fixed-income holdings to the NAIC. *Source: NAIC Schedule D, Part 1.*



(a) Asset composition

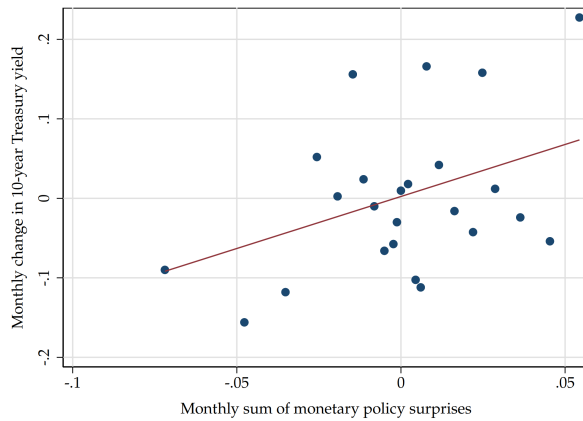


(b) Investment income composition

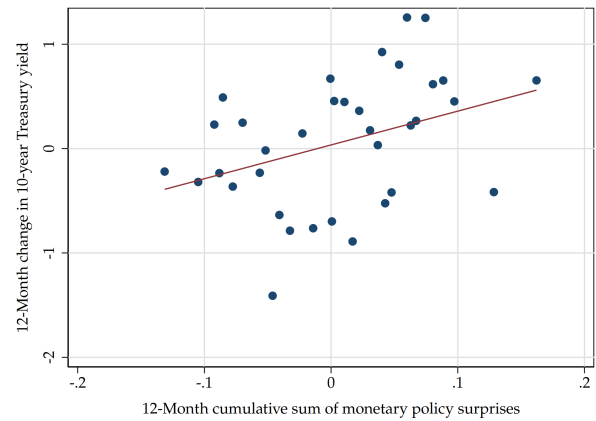
Figure C.3

Asset and Investment Income Composition of Property Insurers

This figure shows (a) the composition of insurers' invested assets and (b) the composition of their investment income scaled by total invested assets. The sample covers all property and casualty insurers from 2010 to 2023. In panel (a), assets are measured at statutory carrying value. Bonds include all fixed-income securities reported on Schedule D Part 1, primarily corporate bonds, municipal bonds, U.S. Treasuries, and asset-backed securities. Stocks include common and preferred stocks reported on Schedule D Part 2. Other investments, which are not reported on Schedule D, include mortgages, real estate, and cash equivalents. *Source: NAIC Annual Statements.*



(a) Monthly frequency



(b) 12-month rolling windows

Figure C.4

Monetary Policy Surprises and 10-year Treasury Rates

This figure shows binned scatter plots of orthogonalized high-frequency monetary policy surprises in the 10-year U.S. Treasury yield, measured in 30-minute windows around FOMC announcements, against lower-frequency changes in the same yield. Panel (a) uses monthly sums of surprises and monthly changes in end-of-month yields. Panel (b) uses sums of surprises and yield changes over 12-month windows, matching the baseline regressions. The blue line shows the fitted values from a linear regression of yield changes on surprises.

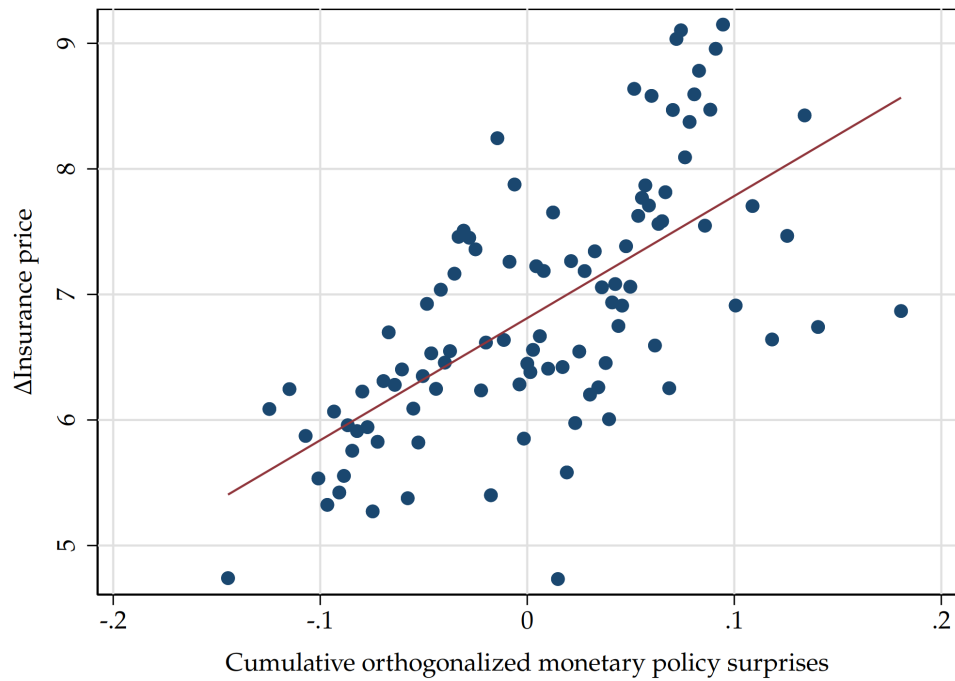


Figure C.5
Monetary Policy and Insurance Prices

This figure shows a binned scatter plot of filing-level insurance price changes (y-axis) against the cumulative orthogonalized monetary policy surprise in the 10-year U.S. Treasury yield over the 12 months preceding the filing month (x-axis). Surprises are measured in 30-minute windows around FOMC announcements. Both variables are residualized on insurer fixed effects.

D Additional Tables

Table D.1
Additional Summary Statistics

	N	Mean	SD	10 th	25 th	Median	75 th	90 th
Panel 1: Filing characteristics								
ΔTarget (%)	27,762	17.23	16.30	0.50	6.50	13.60	23.90	38.10
Policyholders (thd)	30,188	19.25	50.63	0.23	1.09	4.21	13.95	42.14
Premiums (mn USD)	30,256	20.18	48.41	0.26	1.19	4.66	15.76	47.27
Panel 2: Insurer characteristics								
Assets (bn USD)	9,409	2.98	7.31	0.06	0.15	0.45	1.99	6.94
RBC	9,409	11.89	15.71	4.41	5.90	8.53	12.21	17.85
Leverage	9,409	58.45	13.90	40.20	51.14	60.17	68.73	74.30
ROE (%)	9,409	4.75	11.77	-5.19	0.82	5.37	9.87	14.50
UW gain (%)	9,409	-4.66	28.20	-29.14	-9.93	-0.85	4.54	14.98
Investment income (%)	9,409	3.02	1.30	1.44	2.16	2.92	3.82	4.59
Affected book (%)	5,176	86.30	88.40	0.00	38.86	92.89	105.91	149.27
Panel 3: State characteristics								
Mean 5-yr damages (mn USD)	682	205.81	659.78	2.57	9.03	32.39	105.83	412.73
SD 5-yr damages (mn USD)	682	307.04	1,072.50	1.79	6.97	39.00	136.84	590.85
GDP per capita (thd USD)	682	57.23	22.82	40.66	45.66	52.99	62.51	73.34
Income per capita (thd USD)	682	47.83	10.34	35.92	40.22	46.08	53.57	61.37
ΔHPI (%)	682	4.08	6.43	-4.19	0.81	4.46	7.27	12.30
Panel 4: County characteristics								
5-year damages (thd USD)	95,928	1,261.52	17,346.17	0.00	0.00	0.00	73.90	433.75
Population (thd)	23,958	169.38	428.56	16.09	25.18	50.98	141.25	395.40
Population density	23,870	123.17	271.52	8.60	15.77	32.53	96.65	287.54
GDP (bn USD)	23,520	10.36	35.29	0.51	0.90	1.95	6.32	22.16

Table D.1 continued.

This table reports summary statistics for additional variables used in the empirical analysis.

Filing information. $\Delta Target$ is the actuarially indicated price change reported in the filing. *Policyholders* is the number of policyholders affected by the filing. *Premiums* is the amount of premiums written, in millions of USD, on the policies affected by the filing. *Affected book* is the share of the insurer's homeowners insurance premiums in the state that is affected by the filing.

Insurer characteristics. *Assets* is the insurer's total assets in billions of USD. *RBC* is the insurer's risk-based capital ratio at the end of the quarter. *Leverage* is the insurer's total liabilities divided by total assets at the end of the quarter. *ROE* is the insurer's annualized return on equity. *UW gain* is the insurer's annualized underwriting gain scaled by lagged total liabilities. *Investment income* is the insurer's annualized net investment income scaled by lagged total invested assets.

State characteristics. *Mean 5-yr damages* is the state's average annual damages, in millions of USD, from all natural disasters except floods over the past five years. *SD 5-yr damage* is the standard deviation of these annual damages over the same period. *GDP per capita* is the state's annual GDP per capita, in thousands of USD. *Income per capita* is the state's annual personal income per capita, in thousands of USD. ΔHPI is the annual growth rate of the state's house price index.

County characteristics. *5-yr damages* is the county's total damages from all natural disasters except floods, in thousands of USD, over the past five years, measured quarterly. *Population* is the county's annual population. *Population density* is the county's number of inhabitants per square kilometer, measured annually. *GDP* is the county's annual GDP, in billions of USD.

Table D.2
Robustness: Monetary Policy and Insurance Prices

Specification:	Dependent variable: $\Delta Price_f$					
	Add controls	Alternative MPS measures			Sample windows	
	Details:	Last filing	Plain changes	JK	Excl 2020	Pre 2020
	(1)	(2)	(3)	(4)	(5)	(6)
$MPS_{(t-12:t-1)}$	3.549*** [3.17]		8.406*** [5.76]	10.589*** [5.62]	5.358*** [3.25]	2.708** [2.13]
$\Delta Target_f$	0.250*** [23.21]					
$MPS_{(f-1:t-1)}$		5.101*** [3.52]				
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Insurer-State FE	Yes	Yes	Yes	Yes	Yes	Yes
Product-State FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	27,131	29,746	29,746	29,746	28,337	20,876
R^2	0.553	0.324	0.336	0.336	0.329	0.387
Within R^2	0.367	0.054	0.072	0.071	0.052	0.060

This table reports robustness checks for the baseline estimates of Equation (23). The dependent variable, $\Delta Price_f$, is the insurance price change in filing f , submitted by insurer i in state s in year-month t . $MPS_{(t-12:t-1)}$ denotes the cumulative high-frequency monetary policy surprise over the 12 months preceding year-month t . Columns (1), (5), and (6) use the baseline measure, the orthogonalized surprise in the 10-year U.S. Treasury yield. Column (1) additionally controls for $\Delta Target_f$, the actuarially indicated price change in filing f . In column (2), $MPS_{(t-12:t-1)}$ is replaced by $MPS_{(f-1:t-1)}$, the cumulative orthogonalized surprise in the 10-year U.S. Treasury yield from the insurer's previous filing in the same state through the month preceding the current filing. Columns (3) and (4) replace the baseline surprise with alternative measures: in column (3), the unorthogonalized surprise in the 10-year U.S. Treasury yield; and in column (4), the 10-year U.S. Treasury yield surprise adjusted using the poor man's sign restrictions of Jarociński and Karadi (2020). Columns (5) and (6) estimate the baseline specification over alternative sample periods. Controls are as in Table 2. Variable definitions are in Table B.1. t -statistics are shown in brackets and based on standard errors that are two-way clustered at the insurer and the year-month levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Table D.3

Robustness: Cross-Sectional Elasticity between Monetary Policy and Insurance Prices

Specification: Details:	Dependent variable: $\Delta Price_f$					
	Add controls	Alternative MPS measures			Sample windows	
		Last filing	Plain changes	JK	Excl 2020	Pre 2020
	(1)	(2)	(3)	(4)	(5)	(6)
$Exposure_{i,q-5} \times MPS_{(t-12:t-1)}$	3.281*** [4.22]		1.867** [2.33]	1.986** [2.30]	3.863*** [4.36]	4.042*** [3.98]
$Exposure_{i,q-5} \times \Delta Target_f$	-0.005 [-1.03]					
$Exposure_{i,q-5} \times MPS_{(f-1:t-1)}$		2.396*** [3.62]				
Controls and lower-order terms	Yes	Yes	Yes	Yes	Yes	Yes
Insurer-State FE	Yes	Yes	Yes	Yes	Yes	Yes
Product-State FE	Yes	Yes	Yes	Yes	Yes	Yes
State-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	25,695	28,423	28,423	28,423	27,080	19,889
R^2	0.734	0.615	0.615	0.615	0.617	0.637
Within R^2	0.282	0.006	0.006	0.006	0.007	0.011

This table reports robustness checks for the baseline estimates of Equation (24). The dependent variable, $\Delta Price_f$, is the insurance price change in filing f , submitted by insurer i in state s in year-month t . $Exposure_{i,q-5}$ is the product of the interest rate sensitivity of insurer i 's mark-to-market assets and an indicator for whether the insurer is capital-constrained (as defined in Table 2), both measured five quarters before the filing. $MPS_{(t-12:t-1)}$ denotes the cumulative high-frequency monetary policy surprise over the 12 months preceding year-month t . Columns (1), (5), and (6) use the baseline measure, the orthogonalized surprise in the 10-year U.S. Treasury yield. Column (1) additionally controls for the interaction of $Exposure_{i,q-5}$ and $\Delta Target_f$, the actuarially indicated price change in filing f . In column (2), $MPS_{(t-12:t-1)}$ is replaced in the interaction with $Exposure_{i,q-5}$ by $MPS_{(f-1:t-1)}$, the cumulative orthogonalized surprise in the 10-year U.S. Treasury yield from the insurer's previous filing in the same state through the month preceding the current filing. Columns (3) and (4) replace the baseline surprise with alternative measures: in column (3), the unorthogonalized surprise in the 10-year U.S. Treasury yield; and in column (4), the 10-year U.S. Treasury yield surprise adjusted using the poor man's sign restrictions of Jarociński and Karadi (2020). Columns (5) and (6) estimate the baseline specification over alternative sample periods. Controls are as in Table 2. Variable definitions are in Table B.1. t -statistics are shown in brackets and based on standard errors that are two-way clustered at the insurer and the year-month levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Table D.4
Robustness to Inflation and Macro Controls

	Dependent variable: $\Delta Price_f$					
	(1)	(2)	(3)	(4)	(5)	(6)
$MPS_{(t-12:t-1)}$	5.316*** [3.23]	7.141*** [4.01]	7.240*** [4.00]			
$Exposure_{i,q-5} \times MPS_{(t-12:t-1)}$				4.107*** [4.27]	4.049*** [4.55]	4.032*** [4.37]
$\Delta \log PCE_{(t-12:t-1)}$	0.341** [2.36]					
$\Delta \log Lumber_{(t-12:t-1)}$		-0.044*** [-7.09]	-0.048*** [-8.14]			
$\Delta GDP_{(t-12:t-1)}$			0.005 [1.24]			
$\Delta \log VIX_{(t-12:t-1)}$			-0.000*** [-2.67]			
$Exposure_{i,q-5} \times \Delta \log PCE_{(t-12:t-1)}$				-0.009 [-0.14]		
$Exposure_{i,q-5} \times \Delta \log Lumber_{(t-12:t-1)}$					-0.003 [-0.90]	-0.003 [-0.82]
$Exposure_{i,q-5} \times \Delta GDP_{(t-12:t-1)}$						-0.002 [-0.51]
$Exposure_{i,q-5} \times \Delta \log VIX_{(t-12:t-1)}$						0.000 [1.00]
Controls and lower-order terms	Yes	Yes	Yes	Yes	Yes	Yes
Insurer-State FE	Yes	Yes	Yes	Yes	Yes	Yes
Product-State FE	Yes	Yes	Yes	Yes	Yes	Yes
State-Time FE				Yes	Yes	Yes
No. of obs.	29,746	29,746	29,746	28,423	28,423	28,423
R^2	0.327	0.340	0.343	0.615	0.615	0.615
Within R^2	0.059	0.077	0.081	0.007	0.007	0.007

This table reports robustness checks for the baseline estimates of Equations (23) and (24). The dependent variable, $\Delta Price_f$, is the insurance price change in filing f , submitted by insurer i in state s in year-month t . $Exposure_{i,q-5}$ is the product of the interest rate sensitivity of insurer i 's mark-to-market assets and an indicator for whether the insurer is capital-constrained (as defined in Table 2), both measured five quarters before the filing. $MPS_{(t-12:t-1)}$ is the cumulative orthogonalized high-frequency monetary policy surprise in the 10-year U.S. Treasury yield over the 12 months preceding year-month t . Columns (1) to (3) add macroeconomic controls, each measured over the 12 months preceding year-month t : $\Delta \log PCE_{(t-12:t-1)}$, the log change in the PCE price index; $\Delta \log Lumber_{(t-12:t-1)}$, the log change in the producer price index for lumber and wood products; $\Delta GDP_{(t-12:t-1)}$, the cumulative U.S. real GDP growth based on the Brave–Butters–Kelley monthly GDP index (Brave et al., 2019); and $\Delta \log VIX_{(t-12:t-1)}$, the log change in the VIX. Columns (4) to (6) add interactions of these variables with $Exposure_{i,q-5}$. Controls are as in Table 2. Variable definitions are in Table B.1. t -statistics are shown in brackets and based on standard errors that are two-way clustered at the insurer and the year-month levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Table D.5
Robustness: Monetary Policy and Filing Behavior

	Dependent variable									
	$\text{Log}(\text{Policyholders})_f$		$\text{Log}(\text{Premiums})_f$		$\mathbf{1}(\text{Rate filing})_{i,s,t}$		$\mathbf{1}(\text{Any filing})_{i,s,t}$		$\Delta\text{Price}_{i,s,t}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\text{MPS}_{(t-12:t-1)}$	0.070 [0.49]		-0.103 [-0.99]		0.028** [2.22]		0.020 [1.50]		0.756*** [4.31]	
$\text{Exposure}_{i,q-5} \times \text{MPS}_{(t-12:t-1)}$		-0.125 [-0.77]		-0.006 [-0.04]		-0.006 [-0.35]		0.001 [0.06]		0.287** [2.19]
Controls and lower-order terms	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						
State-Time FE		Yes		Yes		Yes		Yes		Yes
State-Season FE					Yes		Yes		Yes	
No. of obs.	29,613	28,284	29,679	28,351	477,906	477,537	477,906	477,537	477,906	477,537
R^2	0.809	0.868	0.856	0.898	0.039	0.074	0.038	0.074	0.031	0.069
Within R^2	0.026	0.026	0.070	0.033	0.018	0.018	0.017	0.017	0.015	0.012

This table reports estimates of the relationship between monetary policy and insurers' filing behavior. Columns (1) to (4) estimate specifications based on Equations (23) and (24) with alternative filing-level outcomes: in columns (1) and (2), the log number of policyholders affected by filing f , and in columns (3) and (4), the log amount of premiums affected. Columns (5) to (10) examine the extensive and intensive margins of insurers' filing behavior in an insurer-state-month panel. Year-month t denotes the filing month in columns (1) to (4) and the panel month in columns (5) to (10). The dependent variable in columns (5) to (10) is one of three outcomes. In columns (5) and (6), $\mathbf{1}(\text{Rate filing})_{i,s,t}$ is an indicator equal to one if insurer i submits a rate filing in state s in year-month t . In columns (7) and (8), $\mathbf{1}(\text{Filing})_{i,s,t}$ is an indicator equal to one if insurer i submits any filing in state s in year-month t . In columns (9) and (10), $\Delta\text{Price}_{i,s,t}$ is the average insurance price change across all rate filings submitted by insurer i in state s in year-month t , weighted by the premiums affected by each filing. $\text{MPS}_{(t-12:t-1)}$ is the cumulative orthogonalized high-frequency monetary policy surprise in the 10-year U.S. Treasury yield over the 12 months preceding year-month t . $\text{Exposure}_{i,q-5}$ is the product of the interest rate sensitivity of insurer i 's mark-to-market assets and an indicator for whether the insurer is capital-constrained (as defined in Table 2), both measured five quarters before year-month t . Controls are as in Table 2. Variable definitions are in Table B.1. t -statistics are shown in brackets and based on standard errors that are two-way clustered at the insurer and the year-month levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Table D.6
Robustness: Monetary Policy, Insurance, and House Prices

Estimation:	Dependent variable: $\Delta \log HP_{c,(t-1:t+6)}$			
	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)
$Exposure_{s,q}^{Local} \times MPS_{(t-1:t-12)}$	-1.828*** [-2.65]		-2.077*** [-3.28]	
$\Delta Price_{s,(t-1:t+6)}$		-1.041* [-1.72]		-1.055* [-1.85]
County FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes		
Demographics-Time FE			Yes	Yes
No. of obs.	282,645	260,858	276,912	255,404
R^2	0.590	-0.320	0.615	-0.341
Within R^2	0.000		0.000	

This table reports reduced-form and two-stage least squares estimates from specifications based on Equation (26). The dependent variable, $\Delta \log HP_{c,(t-1:t+6)}$, is the log change in house prices in county c from year-month $t - 1$ to year-month $t + 6$. $Exposure_{s,q}^{Local}$ is the average exposure, as defined in Table 2, of all insurers that submitted filings in state s in year-quarter q , weighted by the premiums affected by the respective filings, where q is the year-quarter containing year-month t and each insurer's exposure is measured five quarters before q . $MPS_{(t-12:t-1)}$ is the cumulative orthogonalized high-frequency monetary policy surprise in the 10-year U.S. Treasury yield over the 12 months preceding year-month t . $\Delta Price_{s,(t-1:t+6)}$ is the change in the state-level insurance price index from year-month $t - 1$ to year-month $t + 6$, constructed as described in Appendix B.2. In columns (2) and (4), it is instrumented by the interaction of $Exposure_{s,q}^{Local}$ and $MPS_{(t-12:t-1)}$. Demographic-by-time fixed effects interact quintiles of county-level GDP per capita, population, and population density with year-month indicators. t -statistics are shown in brackets and based on standard errors that are two-way clustered at the county and the state-by-year-month levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Table D.7
Insurers' Investment Income and Changes in Statutory Capital

	Dependent variable: $\Delta Capital_{i,y}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Investment income (in USD) $_{i,y}$	0.687*** [6.98]	0.687*** [6.98]				
<i>From stocks</i>			0.945*** [9.79]	0.945*** [9.79]		
<i>From bonds</i>			0.123 [1.25]	0.123 [1.25]		
<i>From holding stocks</i>					0.917*** [12.29]	0.917*** [12.29]
<i>From trading stocks</i>					0.918** [2.50]	0.918** [2.50]
<i>From holding bonds</i>					0.552 [1.65]	0.552 [1.65]
<i>From trading bonds</i>					1.903*** [6.99]	1.903*** [6.99]
Insurer FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE		Yes		Yes		Yes
No. of obs.	6,361	6,361	6,361	6,361	6,361	6,361
R^2	0.489	0.489	0.574	0.574	0.613	0.613
Within R^2	0.385	0.385	0.488	0.488	0.534	0.534

This table reports estimates of how investment income from insurers' securities portfolios affects their statutory capital, based on the regression:

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

The dependent variable, $\Delta Capital_{i,y}$, is the change in insurer i 's statutory capital, in USD, from year $y - 1$ to year y . The independent variable, $\text{Investment income}_{i,y}$, is insurer i 's investment income in year y , in USD. Columns (3) to (6) decompose total investment income into its components: in columns (3) and (4), by the type of security – bonds or stocks – generating the income; in columns (5) and (6), additionally by whether the income arises from holding or from selling the security. t -statistics are shown in brackets and based on standard errors that are two-way clustered at the insurer and the size-quartile-by-year levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Table D.8
Insurance Groups' Impact on Pricing

Sample:	Dependent variable: $\Delta Price_f$					
	All	Group affiliates			With life affiliate	Only P&C affiliates
	(1)	(2)	(3)	(4)	(5)	(6)
$Exposure_{i,q-5} \times MPS_{(t-12:t-1)}$			3.136*** [2.68]	4.766*** [4.70]	2.433* [1.90]	3.230** [2.26]
$Exposure_{i,q-5}^{Group} \times MPS_{(t-12:t-1)}$	0.207*** [2.84]	0.206*** [2.81]	0.089 [1.05]			
Controls and lower-order terms	Yes	Yes	Yes	Yes	Yes	Yes
Insurer-State FE	Yes	Yes	Yes	Yes	Yes	Yes
Product-State FE	Yes	Yes	Yes	Yes	Yes	Yes
State-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	18,794	18,719	18,719	26,268	13,288	8,291
R^2	0.679	0.679	0.680	0.629	0.726	0.768
Within R^2	0.015	0.015	0.016	0.007	0.005	0.014

This table reports estimates from specifications based on Equation (24). The dependent variable, $\Delta Price_f$, is the insurance price change in filing f , submitted by insurer i in state s in year-month t . $MPS_{(t-12:t-1)}$ is the cumulative orthogonalized high-frequency monetary policy surprise in the 10-year U.S. Treasury yield over the 12 months preceding year-month t . $Exposure_{i,q-5}$ is the product of the interest rate sensitivity of insurer i 's mark-to-market assets and an indicator for whether the insurer is capital-constrained (as defined in Table 2), both measured five quarters before the filing. $Exposure_{i,q-5}^{Group}$ is defined analogously at the level of the insurance group to which insurer i belongs: it is the product of the interest rate sensitivity of the group's aggregate mark-to-market assets and an indicator for whether the group is capital-constrained. A group is classified as capital-constrained if its relative RBC gap, defined as in Table 2 but computed from the group-level RBC ratio, is above the median of the gap's distribution pooled across groups and quarters. Controls are as in Table 2. Columns (1) to (3) additionally include group-level controls, measured five quarters before the filing: log total assets, leverage, the RBC ratio, underwriting gains scaled by total liabilities, and net statutory investment income scaled by total invested assets. Variable definitions are in Table B.1. t -statistics are shown in brackets and based on standard errors that are two-way clustered at the insurer and the year-month levels. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

E Construction of Asset Sensitivity

This section describes how we construct the insurer-level measure of portfolio sensitivity to monetary policy. The measure captures, for each insurer and at each quarter-end, the decline in statutory book value of the insurer’s invested assets, as a share of total invested assets, implied by a 100 bps contractionary monetary policy shock. Section E.1 presents the baseline definition. Sections E.2–E.4 describe its three ingredients: security-level sensitivities, statutory accounting treatment, and portfolio-level aggregation. Section E.5 validates the measure against insurers’ unrealized capital gains, and Section E.6 describes the alternative specifications used for robustness.

E.1 Baseline Measure

For insurer i at the end of year-quarter q , let $\mathcal{H}_{i,q}$ denote the set of securities reported on NAIC Schedules D and BA with strictly positive end-of-quarter fair value $FV_{i,k,q}$, excluding holdings of affiliated companies. Each security k is assigned a security-level sensitivity $s_{k,q}$, defined as the relative decline in its market value in response to a 100 bps monetary policy shock, and an indicator $\mathbb{1}_{k,q}^{\text{MTM}} \in \{0, 1\}$ that takes the value one if security k is marked to market, and zero if it is held at historical cost. Our baseline portfolio sensitivity measure is

$$\text{Sensitivity}_{i,q} \equiv \frac{\sum_{k \in \mathcal{H}_{i,q}} \mathbb{1}_{k,q}^{\text{MTM}} s_{k,q} FV_{i,k,q}}{\text{TIA}_{i,q}}, \quad (\text{E1})$$

where $\text{TIA}_{i,q}$ denotes insurer i ’s *total invested assets* at the end of year-quarter q , which we measure as the statutory book (carrying) value of the insurer’s invested assets reported on NAIC Schedules D and BA, excluding holdings of affiliated companies.³ The numerator in Equation (E1) sums, across holdings that are marked to market, the product of each security’s price decline in response to a 100 bps monetary policy surprise and its fair value. For holdings carried at fair value, book value equals fair value, so the numerator measures the change in statutory book value induced by the surprise. Normalizing by total invested

3 Statutory carrying values are reported only in year-end filings. We reconstruct quarterly book value as follows: at year-ends, we use the reported carrying value; at interim quarters, for holdings carried at historical cost or at the lower of historical cost or fair value, we scale the holding’s current par value by its carrying-value-to-par ratio from the most recent filing within the preceding 365 days; for all remaining holdings we use the end-of-quarter fair value.

assets implies that $\text{Sensitivity}_{i,q}$ is the portfolio-level semi-elasticity, which is comparable across insurers.

As most assets on insurers' balance sheets lose value when rates rise, $\text{Sensitivity}_{i,q}$ is non-negative and strictly positive for about two thirds of insurer-quarters in our sample (see Table 1). Thus, a contractionary monetary policy shock ($\text{MPS} > 0$) reduces the book value of the insurer's portfolio, depressing the insurer's statutory capital by $\text{Sensitivity}_{i,q} \times \text{TIA}_{i,q} \times \text{MPS}$ in dollar terms.

E.2 Security-Level Sensitivities

The construction of security-level sensitivities $s_{k,q}$ depends on the asset class. For fixed-income securities, we use the modified duration. For equities and mutual funds, we use the negative of the slope coefficient from event-study regressions of daily returns on high-frequency monetary policy surprises around FOMC announcements.

E.2.1 Fixed-income sensitivities

For a bond k outstanding at the end of year-quarter q , the Macaulay duration is defined as

$$D_{k,q}^{\text{Mac}} = \frac{1}{P_{k,q}} \sum_{j=1}^{n_k} \frac{j C_{k,j}}{(1 + y_{k,q})^j}, \quad (\text{E2})$$

where $C_{k,j}$ is the cash flow generated by the asset in period j , $y_{k,q}$ is the yield to maturity per coupon period (e.g., one-half of the annual quoted yield when coupons are paid semiannually), and $P_{k,q}$ is the bond's market price. Modified duration is defined as

$$D_{k,q} = \frac{D_{k,q}^{\text{Mac}}}{1 + y_{k,q}}. \quad (\text{E3})$$

Equation (E3) provides the standard first-order approximation of the relative price change of a bond for a 100 bps change in its annual yield.

We collect coupon rates, maturity dates, and bond features from Mergent FISD. Transaction prices and yields come from Trade Reporting and Compliance Engine (TRACE) Enhanced for corporate bonds⁴ and from the Municipal Securities Rulemaking Board (MSRB) for municipal bonds. These are identified via their CUSIP. Municipal bonds and U.S.

4 We clean the TRACE enhanced database following Dick-Nielsen (2009, 2014).

Treasury bonds are assumed to follow the standard market convention of paying semiannual coupons.

Treasury yields are given by the Federal Reserve’s yield curve (Gürkaynak et al., 2007), from which we compute their modified duration. For corporate and municipal bonds with observed transactions, we construct durations in each year-quarter q in three steps:

1. For each CUSIP, we aggregate all trades observed on a given day to a value-weighted daily price and yield.
2. Using the bond’s contractual cash flows together with the price and yield, we compute the modified duration at daily frequency.
3. We then define $D_{k,q}$ as the average modified duration across all trading days of bond k in quarter q .

Modified duration measures the price decline per percentage point of the bond’s own yield, whereas the equity sensitivities below are measured per unit of the monetary policy surprise MPS_τ . To put both on the same scale, we define the fixed-income sensitivity as

$$s_{k,q} = \lambda_q D_{k,q}, \quad (\text{E4})$$

where λ_q is the slope coefficient from a regression of the 30-minute change in the 10-year Treasury yield around FOMC announcements on MPS_τ , estimated over the same set of FOMC event days $\mathcal{T}_q$ that we use for the equity betas in Equation (E6). For the raw 10-year surprise, $\lambda_q = 1$ by construction. For the orthogonalized surprise used in the paper, it is close to one (between 0.88 and 1.10 across quarters for the five-year rolling window, and between 0.98 and 1.00 for the expanding window), so the adjustment is minor.

When a corporate or municipal bond held by an insurer lacks a CUSIP-level match or does not have a complete cash-flow schedule, we impute the modified duration from bonds with similar characteristics.⁵ Specifically, in each quarter we sort all bonds into cells defined by the bond’s NAIC designation (1 to 6, as reported by the insurers holding the bond), three coupon buckets ($[0\%, 4\%)$, $[4\%, 6\%)$, $> 6\%$), and the integer number of years to maturity.⁶

5 Variable-coupon bonds (indicated by a “V” coupon type in FISD) are assigned zero duration, as their cash flows reset with the underlying reference rate.

6 Corporate bonds without a reported designation form a separate group; municipal bonds without a designation receive no imputed duration.

For each year-quarter q and each designation–coupon group, we estimate the parameters γ and τ to fit

$$\tilde{D}_{k,q} = \gamma \tau \left(1 - \exp(-\text{TTM}_{k,q}/\tau)\right) + \varepsilon_{k,q}, \quad 0.05 \leq \gamma \leq 1, \quad 0.25 \leq \tau \leq 100, \quad (\text{E5})$$

where $\tilde{D}_{k,q}$ denotes the modified duration. The functional form equals zero at $\text{TTM}_{k,q} = 0$ by construction, has initial slope γ at the origin, and flattens as $\text{TTM}_{k,q}$ grows, reflecting that modified duration is concave in $\text{TTM}_{k,q}$ and bounded from above by the remaining time to maturity. We estimate (γ, τ) by least squares within each quarter-designation-coupon bucket using the L-BFGS-B optimizer with the bounds above. We then evaluate Equation (E5) on a grid of integer years to maturity.

Finally, at each grid point, we either use the sample mean of observed durations in that (quarter, designation, coupon, maturity-year) cell when at least five bonds are available, or otherwise the fitted value from Equation (E5). The fitted curve is monotone in $\text{TTM}_{k,q}$ by construction, but the preference for the observed mean at integer maturities can introduce non-monotonicity. We therefore enforce weak monotonicity by adjusting the sequence across successive integer maturities such that duration is non-decreasing in time-to-maturity, iteratively replacing any downward step with the value at the adjacent shorter maturity until no violations remain. To impute the modified duration for bond holdings without price data, we use the information from this adjusted grid.

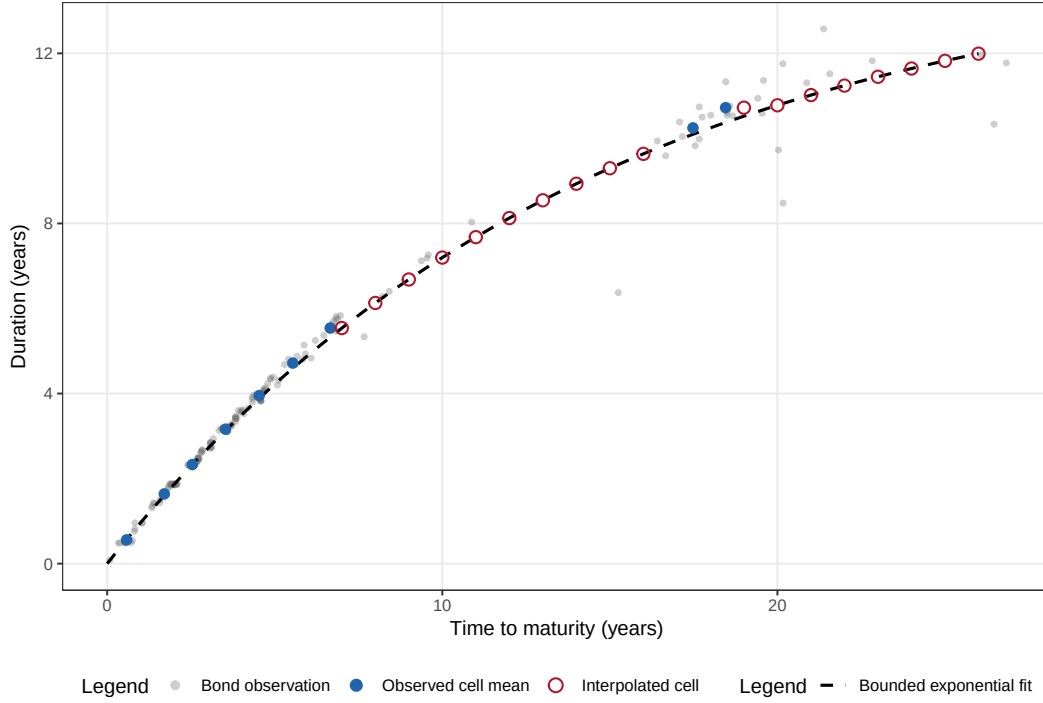


Figure E.1
Duration Imputation for Corporate Bonds

This figure illustrates the duration imputation for corporate bonds with an NAIC designation of 3 and coupon rates between 4% and 6% in 2025 Q2. Gray dots show the observed durations of individual bonds against their time to maturity. The dashed black curve shows the fitted duration function $D = \gamma \tau (1 - \exp(-\text{TTM}/\tau))$, where γ and τ are estimated from all bonds in this designation–coupon group. The imputation assigns a duration to each cell, defined by integer time to maturity. Solid blue dots mark cells that use the group mean duration, which requires at least five bonds in the cell; open red dots mark cells imputed from the fitted curve. Monotonicity smoothing is applied to the reported values so that duration does not decrease with maturity.

E.2.2 Equity and mutual-fund sensitivities

For a common stock k at the end of year-quarter q , we define its sensitivity, $s_{k,q}$, to be the negative of the slope coefficient, $-\hat{\beta}_{k,q}$, from the regression

$$R_{k,\tau} = \alpha_{k,q} + \beta_{k,q} \text{MPS}_\tau + \varepsilon_{k,\tau,q}, \quad \tau \in \mathcal{T}_q, \quad (\text{E6})$$

where $R_{k,\tau}$ is the daily return of stock k on FOMC event day τ , from CRSP or, when CRSP coverage is missing, LSEG Refinitiv; MPS_τ is the monetary policy surprise used throughout the paper, namely the change in the 10-year U.S. Treasury yield in a 30-minute window around the FOMC announcement, orthogonalized with respect to macroeconomic and

financial information available before the announcement following Bauer and Swanson (2023b); and $\mathcal{T}_q$ is the set of FOMC event days used to estimate the regression as of quarter q . Because stock prices typically fall when Treasury yields rise unexpectedly, $\hat{\beta}_{k,q}$ is negative for the typical stock, such that $s_{k,q}$ is positive.

To ensure the estimates do not reflect any anticipation effects, $\beta_{k,q}$ is backward looking. In our baseline specification, $\mathcal{T}_q$ is the *five-year rolling window* of all FOMC event days in the 5 years prior to the end of year-quarter q . We require at least twenty return observations and that the stock traded within one year of the end of year-quarter q . The regression is estimated using OLS separately for each stock at each quarter-end, such that $\hat{\beta}_{k,q}$ summarizes the history of the stock's sensitivity to monetary policy as of year-quarter q .

Mutual-fund sensitivities are constructed from analogous regressions of daily CRSP mutual-fund NAV returns on MPS_τ .

E.2.3 Final sample construction

Fixed income Security-level sensitivities are assigned to each fixed income security holding by using the first non-missing observation according to the following priority structure:

1. TRACE CUSIP-level modified duration for corporate bonds
2. MSRB CUSIP-level modified duration for municipal bonds
3. Treasury modified duration for U.S. Treasury securities
4. Imputed TRACE modified duration for remaining corporate bonds
5. Imputed MSRB modified duration for remaining municipal bonds.

This procedure yields duration estimates for roughly 80% of insurers' long-term bond holdings by fair value.

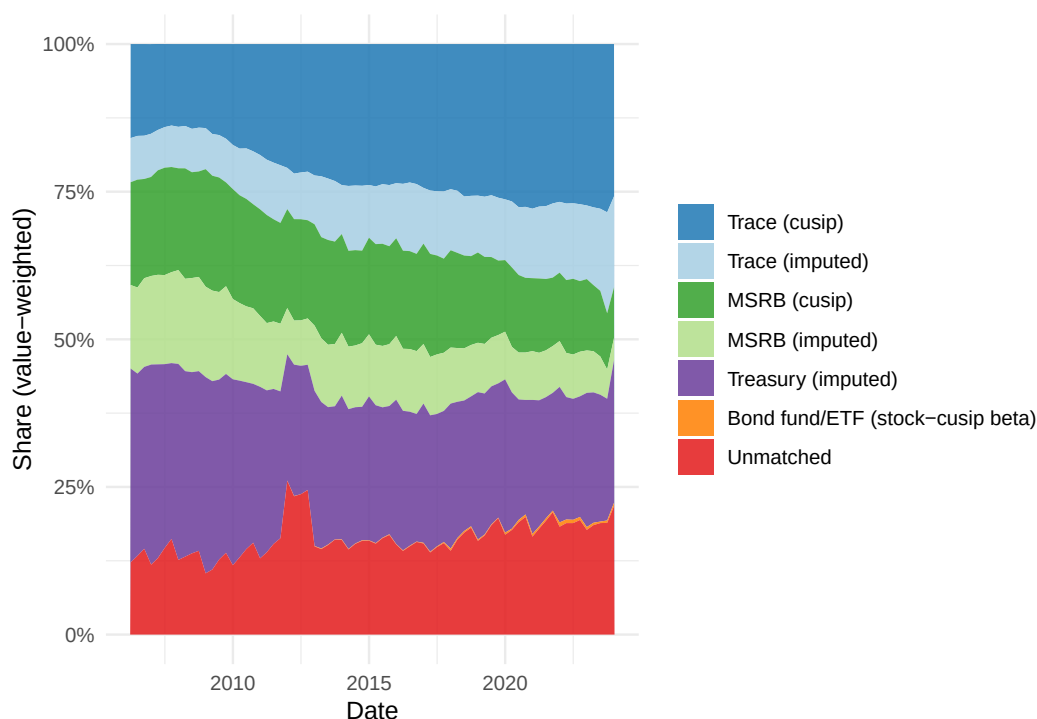


Figure E.2

Sensitivity Estimation Method for Insurers' Long-term Bond Holdings

This figure shows the share of insurers' long-term bond holdings, measured at fair value, by the source of each holding's modified duration: TRACE or MSRB transaction data (direct or imputed), the Treasury yield curve, or bond fund and ETF data. The remaining holdings are unmatched.

Equity Security-level sensitivities are assigned to each stock/mutual-fund holding by using the first non-missing observation according to the following priority structure:

1. The negative value of the monetary-policy beta ($-\hat{\beta}_{k,q}$) for common-equity holdings and mutual funds, preferring those based on return data from CRSP and, if that is not available, from LSEG Refinitiv,
2. Industry-level average negative value of the monetary-policy beta for remaining common stocks. Specifically, we assign to each stock the industry from an 8-digit-CUSIP-to-industry crosswalk built from CRSP SIC codes (using the modal SIC for each 8-digit CUSIP within the calendar year), which we map to Fama–French 49 industries using Ken French's SIC ranges⁷. For each quarter-end q , we then average

⁷ https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/det_49_ind_port.html

the CUSIP-level event betas obtained in step 1 within Fama–French 49-industry cells, requiring at least ten matched stocks per industry.

Common-stock and mutual-fund holdings that cannot be matched to any of the above are assigned the cross-sectional average monetary-policy beta across all matched securities in their asset class at the end of year-quarter q .

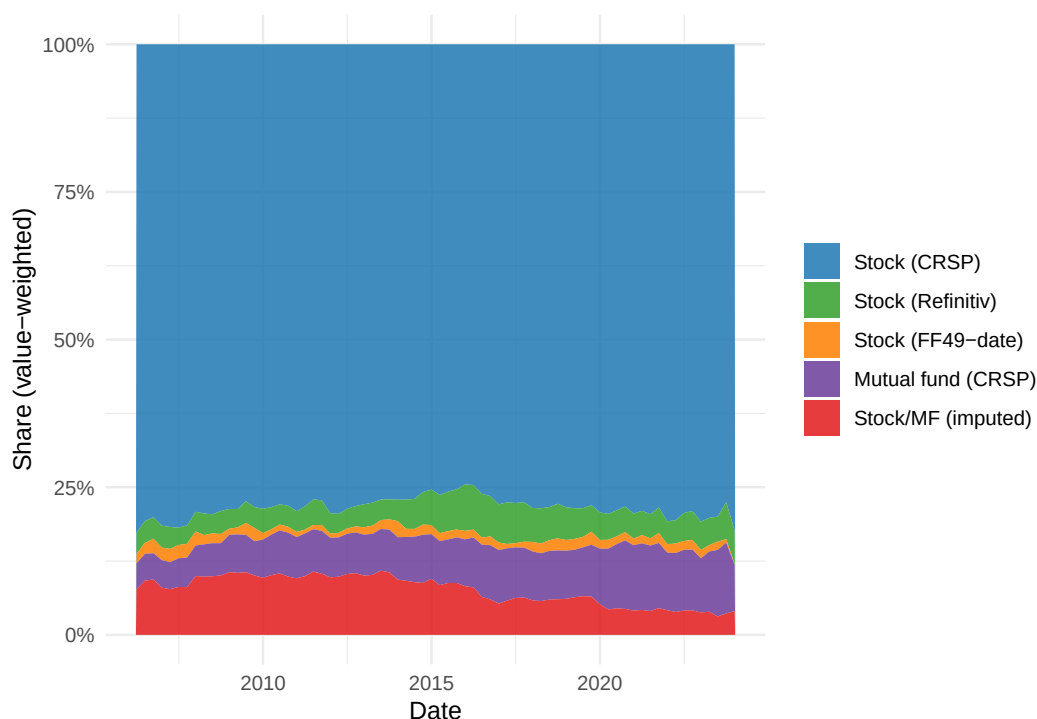


Figure E.3
Sensitivity Estimation Method for Insurers' Stock and Mutual Fund Holdings

This figure shows the share of insurers' non-affiliated stock and mutual fund holdings, measured at fair value, by the data used to estimate each holding's sensitivity to monetary policy surprises: CRSP returns, Refinitiv returns, the industry average, or the cross-sectional average.

Holdings that fall outside all eight categories – such as asset-backed securities, bank loans, residential and commercial mortgage-backed securities, and most Schedule BA assets – are assigned $s_{k,q} = 0$ and thus contribute nothing to the numerator; they remain in the portfolio through the denominator $TIA_{i,q}$. While some of these assets may be held at market values, we cannot estimate their interest-rate sensitivities due to limited data. The same applies to preferred stock and foreign government bonds, which remain in $TIA_{i,q}$ while almost never receiving an estimated sensitivity; together, these two asset classes account for only 1.7% of insurers' holdings. As a consequence, our estimated portfolio sensitivities may

slightly underestimate the insurers' true portfolio sensitivities and can therefore be thought of as a lower bound on the interest-rate sensitivity of the insurers' investment portfolios.

E.3 Statutory Accounting Treatment

Statutory accounting requires all P&C insurers to hold a given security at either historical cost or market (fair) value. The accounting treatment depends on the asset class and, in some cases, on the credit rating, as summarized in Table E.1.

Only securities carried at market values transmit market-price changes to the insurer's statutory capital, while securities at historical cost are insulated absent other-than-temporary-impairment.⁸ When the accounting guidelines require insurers to hold a security at the lower of the historical cost and market value (such as high-yield bonds), the accounting treatment is a function of the price level itself as well as of the insurer holding the security because it depends on the price at which the security was purchased. To simplify the construction and remove potentially confounding factors (such as an insurer's ability to time the market), we treat such instances as *potential* mark-to-market cases.

To capture the statutory accounting principles for the main asset classes, we define our baseline indicator as follows:

$$\mathbb{1}_{k,q}^{\text{MTM}} = \begin{cases} 1 & \text{if the credit rating is below investment grade (i.e., NAIC designation} > 2), \\ 1 & \text{if holding } k \text{ is an unaffiliated common stock or a mutual fund,} \\ 0 & \text{otherwise.} \end{cases} \quad (\text{E7})$$

For robustness, we also consider stricter definitions of $\mathbb{1}_{k,q}^{\text{MTM}}$ (see Section E.6).

Figure E.4 shows that the majority of mark-to-market holdings classified according to Equation (E7) is composed of stock investments, followed by (high-yield) corporate bonds.

⁸ Securities may also be carried at market value due to other-than-temporary-impairments (Ellul et al., 2015). Because few holdings are affected by such impairments and such impairments can be insurer-specific, we do not incorporate other-than-temporary-impairments in our measure.

Table E.1
NAIC Statutory Accounting Guidelines

Type	Filing years	Measurement basis
Bonds, except mandatory convertible	2010–2024	NAIC 1–2: HC NAIC 3–6: min(HC, MTM)
Mandatory convertible bonds	2010–2013	NAIC 1–2: HC NAIC 3–6: min(HC, MTM)
	2014–2024	min(HC, MTM)
Loan-backed & structured securities	2010–2024	NAIC 1–2: HC NAIC 3–6: min(HC, MTM)
Residual tranches or interests	2010–2021	NAIC 1–2: HC NAIC 3–6: min(HC, MTM)
	2022–2024	min(HC, MTM)
Unaffiliated common stocks	2010–2024	MTM
Redeemable preferred stocks	2010–2024	NAIC 1–2: HC NAIC 3–6: min(HC, MTM)
Perpetual preferred stock	2010–2020	NAIC 1–2: MTM NAIC 3–6: min(HC, MTM)
	2021–2024	MTM
Mandatory convertible preferred stocks	2010–2020	NAIC 1–2: MTM NAIC 3–6: min(HC, MTM)
	2021–2024	MTM

This table summarizes the NAIC statutory accounting treatment of each asset type by filing year. *HC* denotes historical cost and *MTM* denotes mark-to-market accounting. NAIC guidance addresses mandatory convertible preferred stock separately only from 2021 onward. For earlier years, we assign it the same treatment as perpetual preferred stock. Because it features a required conversion into common stock rather than a cash redemption right, it would usually not satisfy the definition of redeemable preferred stock. Perpetual preferred stock includes publicly traded preferred stock warrants, which NAIC guidance explicitly includes in this category only from 2021 onward. “Residual tranches or interests” comprise securitization tranches, beneficial interests, and other structures that represent loss layers without any contractual payments of principal or interest. NAIC 1 to 6 are the NAIC credit-quality designations: NAIC 1 and 2 correspond to investment-grade ratings and NAIC 3 to 6 correspond to below-investment-grade (high-yield) ratings. Fund holdings are generally treated as common stock, unless the fund qualifies for bond treatment. Sources: NAIC Accounting Practices and Procedures Manuals for the respective filing years, specifically SSAP No. 26 and No. 26R (bonds), SSAP No. 43R (loan-backed and structured securities), SSAP No. 30 and No. 30R (common stock), and SSAP No. 32 and No. 32R (preferred stock).

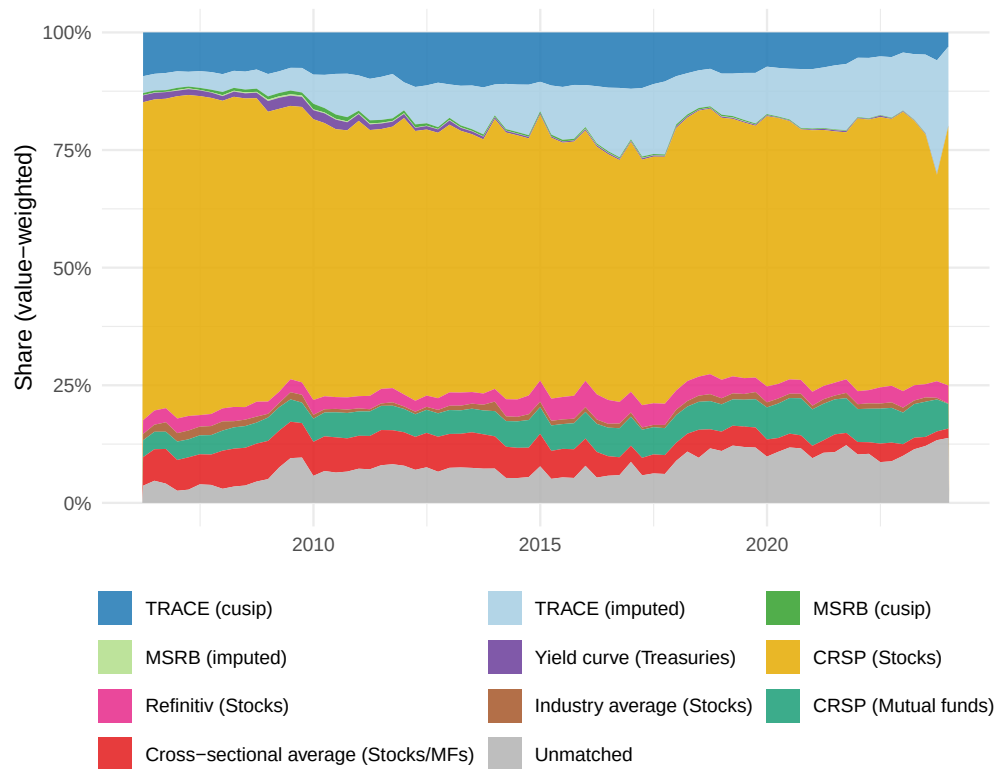


Figure E.4
Composition of Mark-to-Market Holdings

This figure breaks down insurers' holdings of non-affiliated fixed-income securities, stocks, and mutual funds, measured at fair value, by asset class and by the data source used to compute each holding's interest-rate sensitivity.

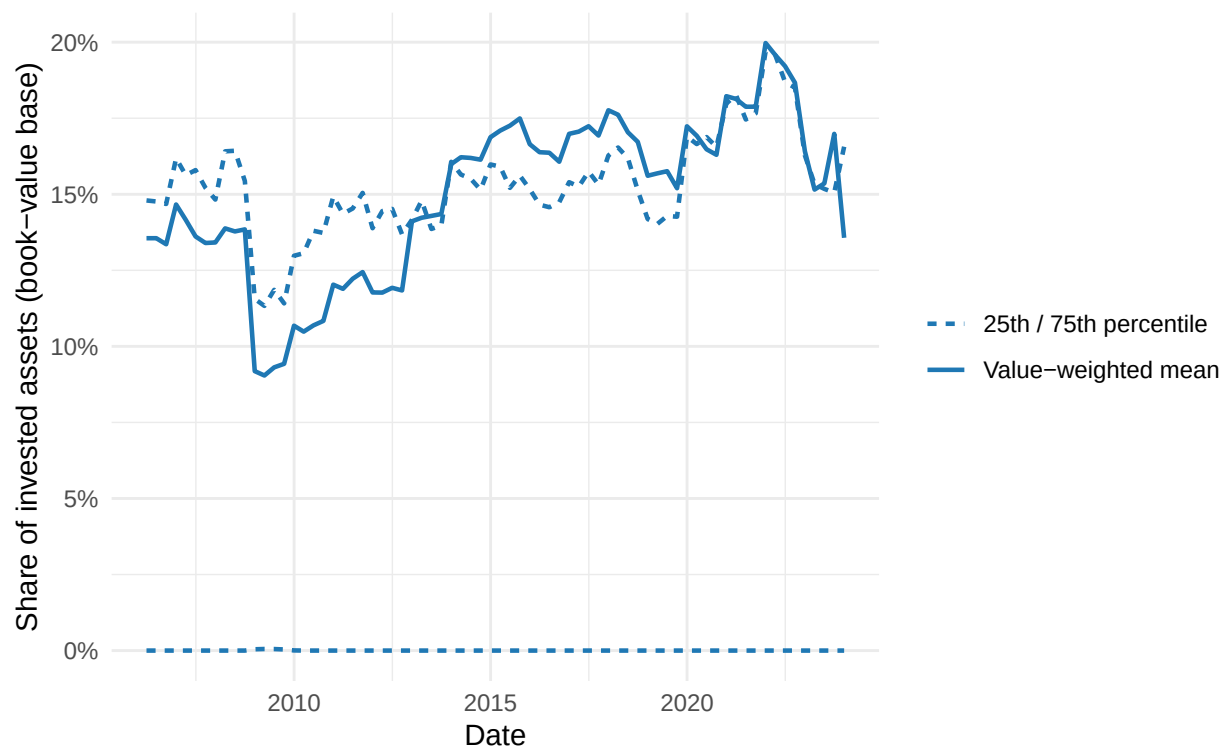


Figure E.5
Share of Insurers' Assets Being Marked to Market

This figure shows the fair value of insurers' mark-to-market holdings, as classified by the baseline indicator in Equation (E7), scaled by total invested assets. The solid line shows the aggregate ratio across insurers; the dashed lines show the 25th and 75th percentiles of the insurer-level distribution.

E.4 Aggregation and Winsorization

For each insurer-quarter pair (i, q) from 2009 to 2023, we compute $\text{Sensitivity}_{i,q}$ as in Equation (E1). We winsorize $\text{Sensitivity}_{i,q}$ at the 1st and 99th percentiles within each quarter. We drop insurer-quarter observations for which total invested assets are missing or non-positive.

Summary statistics for $\text{Sensitivity}_{i,q}$ are reported in Panel 3 of Table 1. Table E.2 reports summary statistics for its security-level inputs across all security-insurer-quarter observations from 2009 to 2023: the modified durations of fixed-income holdings, the event-study betas of stocks and mutual funds, and the mark-to-market indicator. Modified durations average about five years for corporate bonds, eight years for municipal bonds, and ten years for Treasury securities. Equity betas are of similar magnitude on average but far more dispersed across securities.

Table E.2
Summary Statistics: Security-level Sensitivities

	N	Mean	VW mean	SD	10 th	25 th	Median	75 th	90 th
Fixed-income securities (modified duration)									
Corporate bonds	3,900,285	4.73	4.62	3.10	0.99	2.55	4.45	6.38	7.99
Municipal bonds	2,875,609	7.89	8.26	4.03	2.76	4.88	7.67	10.56	13.07
Treasury securities	3,016,290	9.84	9.66	5.30	2.93	5.58	9.32	13.64	17.33
Equities and funds (negative FOMC event β)									
Common stock	2,291,772	4.80	4.68	8.50	-2.82	1.44	4.85	8.47	12.85
Mutual funds	48,313	3.40	3.94	3.79	-0.28	1.22	3.08	5.01	8.17
Mark-to-market indicator	13,878,184	0.228	0.129	0.420	0.000	0.000	0.000	0.000	1.000

This table reports summary statistics for the security-level inputs to the portfolio sensitivity measure in Equation (E1), at the security-by-insurer-by-quarter level, from 2009 to 2023. The sample comprises the holdings of the insurers in the baseline rate-filing dataset, keeping each insurer's quarters through its last filing quarter in that dataset. For fixed-income securities, the sensitivity $s_{k,q}$ is the modified duration; for stocks and mutual funds, it is the negative of the security's event-study beta with respect to FOMC monetary policy surprises, Equation (E6). All sensitivities measure the percentage decline in value per one-percentage-point increase in the 10-year U.S. Treasury yield and are therefore positive on average. The mark-to-market indicator is the baseline indicator in Equation (E7). "VW mean" is the fair-value-weighted mean. Summary statistics for the portfolio-level measure, Sensitivity $_{i,q}$, are reported in Table 1.

E.5 Validation

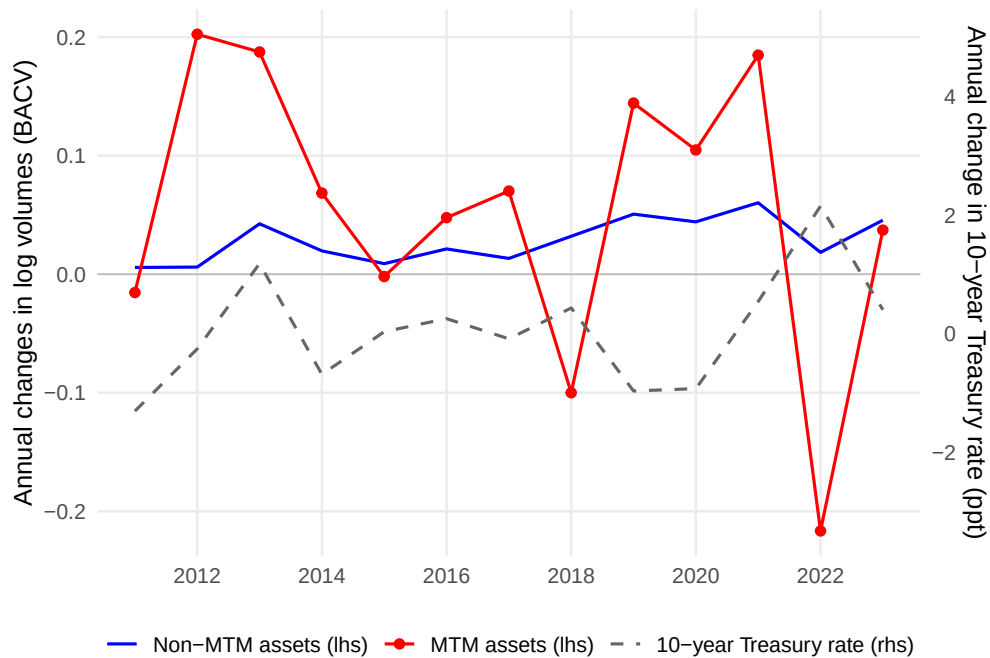


Figure E.6
Asset Growth and Regulatory Accounting

This figure shows annual log changes in the aggregate holdings of insurers in the baseline sample from 2010 to 2023, separately by accounting treatment (left axis). MTM assets are holdings carried at market value under our baseline classification: below-investment-grade bonds, non-affiliated common stocks, and mutual fund shares. Non-MTM assets are all remaining holdings. Holdings are measured at statutory book/adjusted carrying value (BACV). The dashed line (right axis) shows the change in the 10-year U.S. Treasury yield between year-ends, in percentage points.

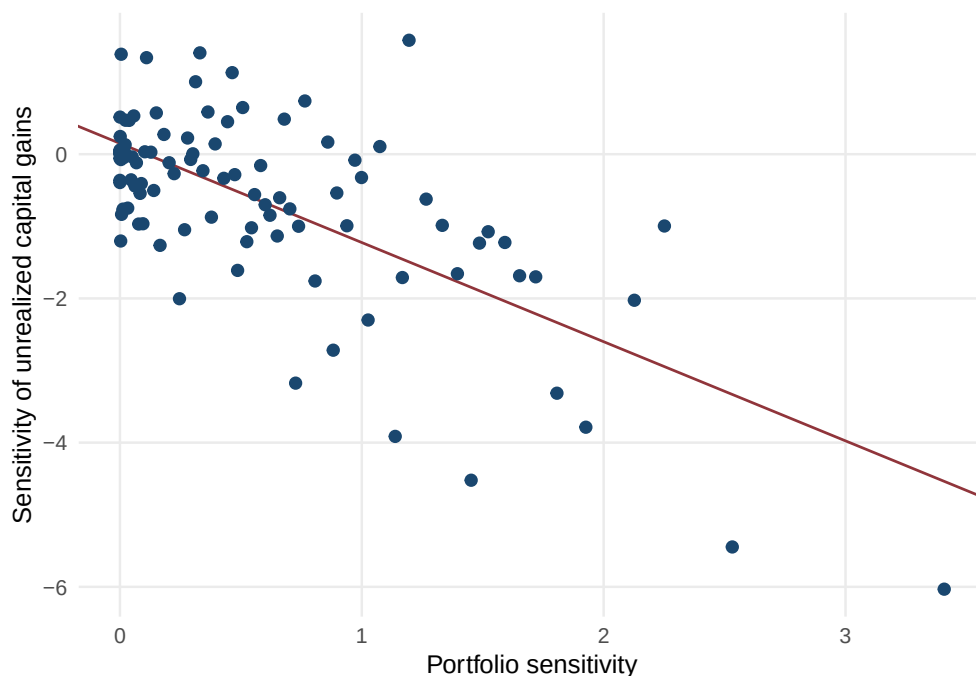


Figure E.7
Validation of Portfolio Sensitivity

This figure shows a binned scatter plot (100 quantile bins) relating our measure of insurers' interest-rate sensitivity to the estimated sensitivity of their unrealized capital gains to monetary policy. For each insurer with at least 24 quarters of data, we regress quarterly unrealized capital gains, scaled by lagged total invested assets, on the orthogonalized monetary policy surprise in the 10-year U.S. Treasury yield cumulated over the quarter. The regressions use quarterly data from 2010 to 2023 and control for the insurer-level controls from Table 5 and calendar-quarter fixed effects. The y-axis shows the estimated insurer-specific coefficient on the monetary policy surprise, winsorized at the 1st and 99th percentiles. The x-axis shows the insurer's average one-quarter-lagged interest-rate sensitivity, as described in Section 5.2. The solid line is an OLS fit.

E.6 Alternative Specifications

We assess the robustness of our results to alternative constructions of the sensitivity measure. All constructions share the structure of Equation (E1), use the same monetary policy surprise MPS_{τ} in the event-study regression in Equation (E6), and are scaled by the same denominator $TIA_{i,q}$. They differ in two choices:

1. *Mark-to-market indicator*. The baseline indicator in Equation (E7) is compared with (i) a stricter, data-based indicator that classifies a holding as marked to market based on the NAIC schedule on which it is reported and its reported accounting basis; and (ii) no indicator at all, i.e., the average sensitivity of all non-affiliated holdings

regardless of their accounting treatment. As in the baseline, all variants exclude affiliated holdings from the numerator, mirroring their exclusion from $TIA_{i,q}$.

2. *Estimation window.* The set of FOMC event days $\mathcal{T}_q$ used to estimate the equity and mutual-fund betas in Equation (E6) is either a five-year rolling window (the baseline), a ten-year rolling window, or an expanding window that uses all event days since February 1988.

The alternative constructions thus comprise the $3 \times 3 = 9$ combinations of indicator and estimation window listed in Table E.3. Figure E.8 shows that our main cross-sectional results are robust to these alternative constructions.

Table E.3
List of Sensitivity Measures

Specification	Mark-to-market indicator	Estimation window
(1)	Baseline, Equation (E7)	5-year rolling
(2)	Baseline, Equation (E7)	10-year rolling
(3)	Baseline, Equation (E7)	Expanding
(4)	Data-based	5-year rolling
(5)	Data-based	10-year rolling
(6)	Data-based	Expanding
(7)	None (all non-affiliated holdings)	5-year rolling
(8)	None (all non-affiliated holdings)	10-year rolling
(9)	None (all non-affiliated holdings)	Expanding

This table defines the nine measures of insurers' portfolio sensitivity used in Figure E.8. Specification (1) is the baseline measure. All measures share the structure of Equation (E1), use the same monetary policy surprise, and are scaled by total invested assets, $TIA_{i,q}$, the statutory book value of invested assets reported on Schedules D and BA, excluding affiliated holdings. The mark-to-market indicator is either the baseline indicator in Equation (E7), a stricter indicator based on the NAIC schedule and accounting basis of each holding ("Data-based"), or no indicator. The estimation window is the set of FOMC event days used to estimate the equity and mutual-fund betas in Equation (E6).

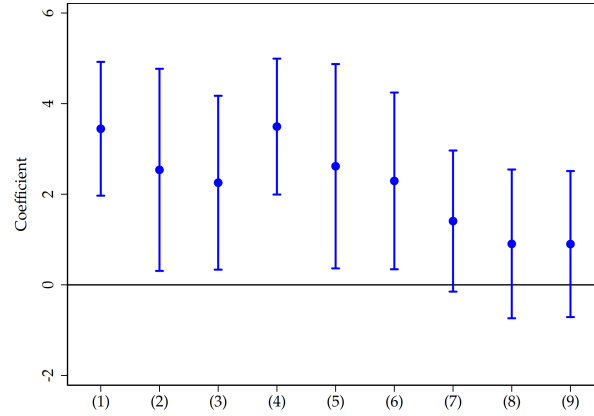


Figure E.8
Robustness: Cross-Sectional Elasticity of Insurance Prices

This figure shows the robustness of the cross-sectional results in Table 2 to alternative measures of insurers' interest-rate sensitivity. Each point shows the estimated coefficient on the interaction $MPS_{(t-12:t-1)} \times Exposure_{i,q-5}$ in Equation (24) for one sensitivity measure, together with its 95% confidence interval. $Exposure_{i,q-5}$ is standardized to unit variance, so the coefficients are comparable across measures. Each label on the x-axis denotes a sensitivity measure; Table E.3 defines each measure. Controls are as in Table 2. Variable definitions are in Table B.1. Standard errors are two-way clustered at the insurer and the year-month levels.

F Accounting of Insurance Contracts

This section provides an illustration of the accounting treatment of typical homeowners insurance contracts following the guidance laid out in the Statutory Accounting Principles (SSAP) No. 53 in the NAIC's Accounting Practices and Procedures Manual (content.naic.org).⁹

Suppose that an insurer writes a one-year contract with a premium of \$1,000 on March 31, 2024. The premium is paid upfront at contract inception. At that date, the insurer records the full premium as a liability because the insurer has not yet provided any coverage.¹⁰ The premium is *unearned* and contributes to the insurer's "float," commonly referred to as "funds held but not owned."¹¹ On the asset side, the insurer has \$1,000 available, which can be invested or held as cash. The balance sheet on March 31 is therefore:

Assets		Liabilities and Capital	
Assets	1,000	Unearned Premiums	1,000
		Capital & Surplus	0
Total Assets	1,000	Total Liabilities + Capital	1,000

Over time, unearned premiums are recognized as revenue in proportion to the time since contract inception; that is, the insurer gradually "earns" the premiums for the coverage provided.¹² Suppose that no claims occur until September 30. At that point, the insurer has earned half of the premiums, implying that \$500 has gone from unearned premiums into statutory capital ("Capital & Surplus"). In addition, invested assets generate returns (ROA), e.g., dividend and interest income or market value changes of mark-to-market assets, with

9 Despite insurance law being subject to state legislation, note that all states follow SSAP No. 53 in the accounting of insurance contracts. For more information, see the NAIC's publication on "States' Prescribed Differences from NAIC Statutory Accounting Principles" (content.naic.org).

10 See SSAP No. 53, point 6.

11 Warren Buffett explained "float" in the 2002 letter to the shareholders of Berkshire Hathaway: "To begin with, the float is money we hold but don't own. In an insurance operation, float arises because premiums are received before losses are paid, an interval that sometimes extends over many years." (Buffett (2002), p. 7)

12 SSAP No. 53 prescribes either a daily pro rata or monthly pro rata method. For more information, see SSAP No. 53, point 8.

both affecting capital. Assuming all investment income is reinvested, the balance sheet on September 30 is:

Assets		Liabilities and Capital	
Assets	1,000(+ROA)	Unearned Premiums	500
		Capital & Surplus	500(+ROA)
Total Assets	1,000(+ROA)	Total Liabilities + Capital	1,000(+ROA)

Now suppose that on December 31, the policyholder reports a loss of \$500. By that date, the insurer has earned three-quarters of premium (\$750). However, the insurer must set aside a reserve for the expected claim payments, recorded as “unpaid losses.”¹³ This reserve reduces capital.¹⁴ Accounting for both earned premiums and loss reserves, the balance sheet on December 31 is:

Assets		Liabilities and Capital	
Assets	1,000(+ROA)	Unearned Premiums	250
		Unpaid Losses	500
		Capital & Surplus	250(+ROA)
Total Assets	1,000(+ROA)	Total Liabilities + Capital	1,000(+ROA)

If no further losses occur, the remaining unearned premium is fully earned by the contract’s expiration date. On March 30, 2025, assuming the insurer has not yet paid out the claims, the balance sheet is:

¹³ For more details, see SSAP No. 55, point 4.

¹⁴ Unpaid losses arise as claims handling takes considerable time. For example, Jotikasthira et al. (2025) report that only 47% of homeowners insurance losses are paid within the year of occurrence. The lag between claim occurrence and payment is due to insurers’ investigation of claims, administrative processes, and potential legal arbitration.

Assets		Liabilities and Capital	
Assets (+ROA)	1,000(+ROA)	Unearned Premiums	0
		Unpaid Losses	500
		Capital & Surplus	500(+ROA)
Total Assets	1,000(+ROA)	Total Liabilities + Capital	1,000(+ROA)

For the accounting year 2024, the insurer generated an underwriting income of \$250, i.e., earned premiums of \$750 minus incurred losses of \$500. The remaining \$250 of earned premium is recognized in the 2025 income statement.

This example illustrates a key feature of statutory accounting: premium income only gradually increases capital as it is earned over the contract's lifetime. As a result, changes in insurance prices do not immediately translate into higher statutory capital.

G Magnitudes

G.1 Back-of-the-Envelope Calculation

This appendix derives the statutory-accounting inputs behind the capital-preservation benchmark Π^K defined in Section 3 (Corollary 1). We proceed in two steps. First, we derive the impact of an insurance price increase on year-end statutory capital. This corresponds to the statutory accounting counterpart of the capital relief per unit price increase, v , in the model. Second, we compute the premium increase required to offset the effect of an interest-rate shock on regulatory capital, i.e., the empirical counterpart of Π^K .

Setup Time runs continuously within a calendar year, indexed by $t \in [0, 1]$, where $t = 0$ denotes the beginning of the year and $t = 1$ the end of the year. Insurance contracts have unit duration and are renewed uniformly throughout the year. A contract renewed at time t generates premium income that is *written* at time t but *earned* uniformly over the remaining contract term. Accordingly, by the end of the calendar year, the insurer has earned a share

$$1 - t = \int_t^1 dx$$

of the premium written on that contract.

Suppose the insurer raises the price of its contracts by the proportional amount ΔPrice at time $\tau \in [0, 1]$. This price increase does not apply immediately to the entire existing book but applies only to contracts renewed after τ .¹⁵ We assume that contract renewal dates are uniformly distributed over the year, consistent with regulatory guidance. We hold expected claims and costs fixed, implying that each additional dollar of earned premium eventually translates one-for-one into statutory capital. The only wedge between a price increase and year-end capital is therefore timing: higher prices affect only renewed contracts and are earned only gradually over the remaining contract term.

Impact of a price increase on year-end capital All contracts renewed between τ and the end of the year are written at the higher premium, but only a fraction of those premiums is earned by year-end. The resulting increase in year-end statutory capital, relative to annual

¹⁵ For simplicity, we assume inelastic demand, i.e., all contracts renew.

written premium, is

$$\int_{\tau}^1 \Delta \text{Price} (1 - t) dt = \Delta \text{Price} \int_{\tau}^1 (1 - t) dt = \frac{\Delta \text{Price}}{2} (1 - \tau)^2. \quad (\text{G1})$$

Importantly, this capital effect is smaller than the original price change ΔPrice because contracts renewed later in the year contribute less to year-end earned premiums.

To obtain the average effect of a price increase implemented at an average time during the year, consider a uniformly distributed random repricing date τ . On average, this yields

$$\int_0^1 \frac{\Delta \text{Price}}{2} (1 - \tau)^2 d\tau = \frac{\Delta \text{Price}}{2} \int_0^1 (1 - \tau)^2 d\tau = \frac{\Delta \text{Price}}{6}. \quad (\text{G2})$$

Thus, in this benchmark environment, a 1% increase in premiums raises year-end statutory capital by only 0.16% of annual written premiums. Equivalently, generating one additional dollar of year-end statutory capital requires six dollars of additional annual premiums.

Required price change to offset an interest-rate shock Using equation (G2), the premium change required to offset the impact of an interest-rate shock on insurers' capital position is

$$\Delta \text{Price}^* = (-6) \times \frac{\partial \log \text{Capital}}{\partial r} \times \frac{\text{Capital}}{\text{DPW}}. \quad (\text{G3})$$

The estimate in column (5) in Table 5 implies that a 100 bps monetary policy surprise reduces insurers' capital by 2.7% via its effects on investment returns. Among the P&C insurers in our sample, the average ratio of statutory capital to direct premiums written is 1.4 (after winsorizing at the 5th and 95th percentiles). Thus, the implied premium change required to offset the effect of a 100 bps monetary policy surprise on statutory capital is 22.7% in absolute value ($= 6 \times 2.7\% \times 1.4$). This is the empirical counterpart of the capital-preservation benchmark Π^K in Section 3. Comparing it with the estimated price response of 5.5% implies that insurers adjust prices to offset roughly one quarter of the capital shock within a year.

Supporting evidence At the heart of this back-of-the-envelope calculation is the insight that a \$1 increase in year-end capital requires a price increase larger than \$1 because (1) the new price applies only when contracts are renewed and (2) higher premiums written translate into higher capital only gradually over time. Therefore, the later within the year

the price is changed, the larger is the necessary price increase, as implied by equation (G1). Consistent with this insight, Figure G.1 (a) shows that the price response to monetary policy tends to be larger at the end of the year. In addition, Figure G.1 (b) shows that filings do not cluster in particular months, with filing occurrence being uniformly distributed across calendar months, consistent with the assumption we make above.

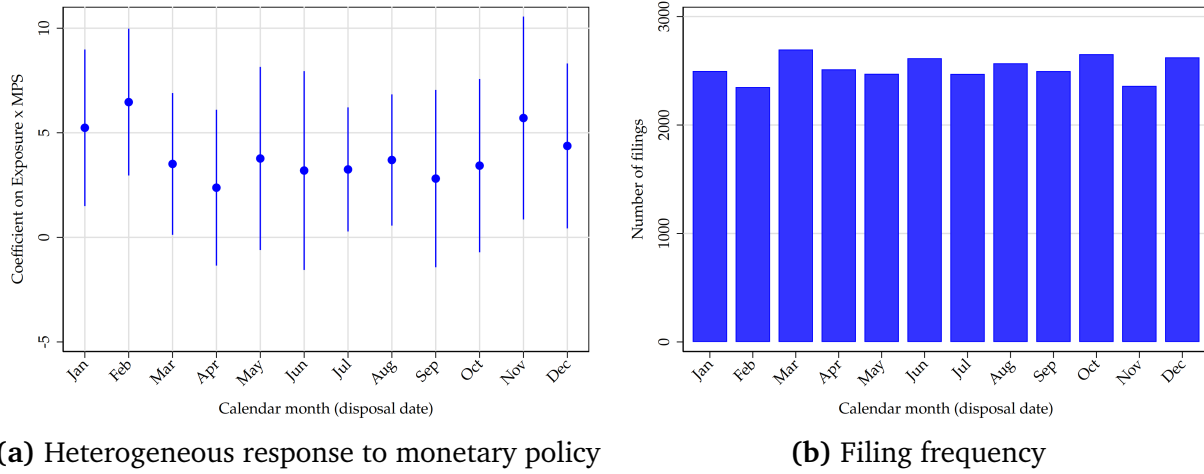


Figure G.1
Timing of Rate Filings

This figure shows (a) the point estimates and 90% confidence intervals for the vector of coefficients β in:

$$\Delta \text{Price}_f = \beta' \mathbf{1}_M \times \text{Exposure}_{i,q-5} \times \text{MPS}_{(t-12:t-1)} + \gamma \mathbf{I} + u_{i,s} + w_{p,s} + v_{s,t} + \epsilon_f,$$

where $\mathbf{1}_M$ is the vector of calendar-month indicators for the disposition date of filing f , which is the date on which the regulator approves the filing's price change; $\mathbf{I}$ contains the insurer-level controls and $\text{Exposure}_{i,q-5}$ as defined in Table 2; and $u_{i,s}$, $w_{p,s}$, and $v_{s,t}$ are insurer-by-state, product-by-state, and state-by-year-month fixed effects. Panel (b) shows the number of rate filings by calendar month of disposition. Standard errors are two-way clustered at the insurer and year-month levels.

Interpretation This back-of-the-envelope calculation is intentionally stylized. It abstracts from demand responses and from the impact of premium growth on required regulatory capital. In particular, the calculation matches the effect of monetary policy on the *level* of statutory capital, not necessarily on the insurer's full regulatory slack as measured by the RBC ratio. When higher premium volume also raises capital requirements, the premium increase needed to preserve a given degree of regulatory tightness would be larger in absolute terms. With this caveat in mind, this back-of-the-envelope calculation highlights

the amplification mechanism behind the empirically estimated pass-through of monetary policy into homeowners insurance prices.

G.2 Pass-Through to Housing Costs

Quantitative importance To gauge the importance of the insurance channel for households, we consider its effect on principal and interest payments for mortgages and homeowners insurance payments (PII) within a one-year horizon. In Table D.1, we document that insurers, on average, reprice homeowners insurance contracts annually. Keys and Mulder (2025) estimate that homeowners insurance premiums equal 21% of principal and interest payments for the average household, implying an insurance share of total PII of 17%. Combining this share with the estimated average insurance price response of 3.8% to a 100 bps increase in interest rates (Table 2) implies a 0.65% increase in PII through the insurance channel alone.

Comparison with the mortgage channel We benchmark this magnitude against the direct effect of higher interest rates on mortgage payments over the same one-year horizon. The vast majority of U.S. mortgages have fixed rates. For these, a change in market rates does not affect payments unless the borrower refinances. By contrast, payments on adjustable-rate mortgages (ARMs) change when their contractual rate resets. This distinction is central to the mortgage channel of monetary policy: Di Maggio et al. (2017) exploit variation in ARM reset timing to identify the effect of changes in mortgage rates on household payments, while Beraja et al. (2019) document that changes in market rates reach existing fixed-rate mortgage borrowers only through refinancing.

Based on these contractual differences, we estimate the fraction of mortgages whose payments may change within one year. First, the Federal Housing Finance Agency’s (FHFA) National Mortgage Database reports that ARMs accounted for 9.6% of outstanding mortgages in 2014, implying a fixed-rate share of 90.4%.¹⁶ Second, using the New York Fed Consumer Credit Panel/Equifax, the Federal Reserve estimates that 10.7% of borrowers with an outstanding mortgage at the end of 2009 refinanced during 2010.¹⁷ We apply

16 FHFA, National Mortgage Database Outstanding Residential Mortgage Statistics. FHFA also reports that ARMs accounted for 3.5% of outstanding mortgages in 2024—roughly one third of the value from 2014, implying that our estimate for the relative importance of insurance is conservative.

17 Federal Reserve Bulletin, “The Mortgage Market in 2010: Highlights from the Data Reported under the Home Mortgage Disclosure Act,” Table 13. The calculation focuses on borrowers with one closed-end

this refinancing rate to fixed-rate borrowers. For ARMs, we assume that all outstanding mortgages reprice within one year. This assumption provides an upper bound because many U.S. ARMs are hybrid contracts with initial fixed-rate periods and therefore may not reset within a given year (Di Maggio et al., 2017; Beraja et al., 2019).

Conditional on repricing, we assume a one-for-one pass-through of interest rate changes to mortgage rates. For a mortgage with annual interest rate r and n remaining monthly payments, the monthly principal and interest payment per dollar of mortgage balance is

$$M(r, n) = \frac{r/12}{1 - (1 + r/12)^{-n}}. \quad (\text{G4})$$

We estimate this mortgage payment factor using two alternative approaches.

Estimate 1: Average calibration As a first estimate, we use the average 30-year fixed mortgage rate over 2010–2023 of 4.22% from the Freddie Mac Primary Mortgage Market Survey (FRED series MORTGAGE30US). For fixed-rate mortgages that refinance, we assume that the new mortgage has a 30-year maturity. A 100 bps increase from 4.22% to 5.22% then raises scheduled principal and interest payments $M(r, n)$ by 12.3%. For ARMs, the relevant maturity is the remaining maturity at the time of repricing. We approximate this distribution by assigning equal weight to remaining maturities from one to 30 years. Averaging the corresponding payment responses yields an average ARM payment response of 6.8%.

Combining these conditional payment responses with the fixed-rate share, ARM share, and refinancing rate implies an elasticity of principal and interest payments of

$$\frac{\Delta(P + I)}{P + I} = 0.904 \times 0.107 \times 12.3\% + 0.096 \times 6.8\% = 1.8\%. \quad (\text{G5})$$

Because principal and interest account for 83% of PII for the average household, the implied increase in PII is approximately 1.5%.

Estimate 2: Freddie Mac loan-level calibration Because the payment function in equation (G4) is nonlinear in both the mortgage rate and maturity, the response evaluated at average characteristics may not be equal to the average response across mortgages. To

mortgage of at least \$50,000 who remained in the same census block during 2010, thereby excluding movers.

provide a more precise estimate, we now estimate the mortgage payment factors using Freddie Mac's Single-Family Loan-Level Dataset. This improves the average calibration because it computes the payment response separately for each mortgage before averaging.

For refinancing loans, we combine the Standard and Non-Standard datasets and retain cash-out, no-cash-out, and unspecified refinancings. For each refinancing loan i originated in year y , we use its original mortgage rate r_i and original loan term n_i to compute (conditional on refinancing)

$$\Delta M_i^{\text{Refi}} = \frac{M(r_i + 0.01, n_i)}{M(r_i, n_i)} - 1. \quad (\text{G6})$$

We compute the average of ΔM_i^{Refi} within each year and then take the simple average across 2010–2023, excluding 2020 as in our baseline empirical analysis. This yields an average payment response of 10.4%.¹⁸

For ARMs, we use Freddie Mac's Non-Standard Single-Family Loan-Level Dataset, which contains adjustable-rate mortgages and monthly loan performance until 2021:Q2. To construct the outstanding ARM stock, we consider all available origination vintages from 1999 onward and merge them to their monthly performance records. For each year from 2010 through 2021, to ensure each contract is counted only once per year, we take the June cross-section of all active ARMs, excluding modified mortgages. For each outstanding ARM i in June of year y , we use its current mortgage rate $r_{i,y}$ and remaining months to maturity $n_{i,y}$ to compute

$$\Delta M_{i,y}^{\text{ARM}} = \frac{M(r_{i,y} + 0.01, n_{i,y})}{M(r_{i,y}, n_{i,y})} - 1. \quad (\text{G7})$$

We average $\Delta M_{i,y}^{\text{ARM}}$ across outstanding ARMs in each June cross-section and then take the simple average across years, again excluding 2020. This yields an average payment response of 10.3%.¹⁹

Figure G.2 shows the annual payment responses and the underlying mortgage rates and maturities.

¹⁸ Including 2020 yields 10.5%. Because the Non-Standard dataset ends in 2021:Q2, the combined sample contains only Standard loans in 2022–2023. Restricting the calculation to the Standard dataset throughout yields 10.3% when excluding 2020.

¹⁹ Including 2020 yields 10.2%. The historical data begin with 1999 origination vintages and, thus, early years omit legacy ARMs that are outstanding but not observed.



Figure G.2
Mortgage Payment Sensitivity in Freddie Mac Loan-Level Data

This figure shows (a) the average change in monthly principal and interest payments following a 100 bps increase in the mortgage rate, (b) the corresponding average mortgage rates, and (c) the average original maturity of refinancing loans and average remaining maturity of ARMs. The refinancing sample covers 2010 to 2023, and the ARM sample covers June 2010 to June 2021. The figure includes 2020, whereas the baseline averages reported in the text exclude 2020. *Source: Freddie Mac Single-Family Loan-Level Dataset.*

Using the same refinancing and ARM shares as in the calibration with average characteristics, the Freddie Mac estimates imply a change in principal and interest payments in response to a 100 bps rate increase over a 1-year horizon, conditional on refinancing

decisions, of

$$\frac{\Delta(P + I)}{P + I} = 0.904 \times 0.107 \times 10.4\% + 0.096 \times 10.3\% = 2\%. \quad (\text{G8})$$

Because principal and interest account for 83% of PII for the average household, the implied increase in PII is approximately 1.7%.

Households with high insurance expenditures The insurance channel becomes stronger when the insurance share in PII is larger. At the 90th percentile of insurance expenditures, insurance accounts for approximately 30% of PII (Keys and Mulder, 2025), implying $(P + I)/\text{PII} = 0.70$. The resulting insurance effect on PII is 1.1% ($= 0.3 \times 3.8\%$). Owing to a lower share of mortgage payments, in this case the mortgage channel raises PII by only 1.3% under the average calibration and 1.4% under the Freddie Mac loan-level calibration.

Summary Table G.1 summarizes our estimates for the insurance- and mortgage-driven PII response to interest rate changes. It shows that the insurance channel amounts to approximately 40% of the mortgage channel on average. For high-insurance-expenditure households, the insurance channel has the same order of magnitude as mortgage repricing. Because we assume a full pass-through of rate changes to mortgage rates and rate resets for all adjustable-rate mortgages within a year, these estimates provide an upper bound for the mortgage channel and, thus, a conservative estimate for the importance of the insurance channel.

Table G.1
Magnitude of the Insurance Channel

	Average household	High-expenditure household
Insurance / $(P + I)$	0.21	0.43
Insurance / PII	0.17	0.30
$(P + I) / \text{PII}$	0.83	0.70
Insurance price response (%)	3.8	3.8
Insurance-driven PII response (%)	0.65	1.1
Mortgage-driven PII response, average calibration (%)	1.5	1.3
Mortgage-driven PII response, Freddie calibration (%)	1.7	1.4

High-expenditure households are those with the share of insurance to mortgage expenditures in the 90th percentile in Keys and Mulder (2025).

G.3 Pass-Through to House Prices

We next translate the housing-cost effect from Section G.2 into a benchmark for the response of house prices.

Setup We consider a marginal buyer whose housing demand is limited by a maximum affordable monthly principal, interest, and insurance (PII) payment, consistent with Meisenzahl et al. (2026) highlighting the importance of debt-to-income constraints for the pass-through of insurance premiums to the mortgage market. The monthly PII payment consists of a mortgage component and an insurance component,

$$\text{PII} = \kappa_m \text{HP} + \iota S, \quad (\text{G9})$$

where HP is the house price, κ_m is the monthly principal-and-interest payment per dollar of house value, S is the replacement cost, and ι is the insurance premium per dollar of insured (replacement) value. The distinction between the two components is important: the mortgage payment scales with the house price (including land), whereas the insurance premium scales with the cost of rebuilding the structure (excluding land). In the short run, S is invariant to changes in house prices.

Buyer heterogeneity (Potential) Buyers differ in income. Let buyers be indexed by income y with distribution F and density f , with total mass M exceeding the housing stock H . Lenders cap the PII payment at a fraction $\bar{d}$ of income, such that a buyer with income y can pay at most

$$B(y) = \frac{\bar{d}y - \iota S}{\kappa_m}. \quad (\text{G10})$$

The market clears when the mass of buyers whose capacity weakly exceeds the price equals the housing stock, $M(1 - F(y^*)) = H$, and the equilibrium price is set by the capacity of this marginal buyer, $\text{HP} = B(y^*)$. Because an insurance price change $d\iota$ shifts *every* buyer's payment capacity down by the same dollar amount $S/\kappa_m d\iota$, the identity of the marginal buyer is unchanged and the price falls exactly by $S/\kappa_m d\iota$:

$$d\text{HP} = -\frac{S}{\kappa_m} d\iota, \quad (\text{G11})$$

which implies that the house price elasticity equals the ratio of insurance to mortgage payments:

$$\frac{d \log \text{HP}}{d \log \iota} = - \frac{\iota S}{\kappa_m \text{HP}}. \quad (\text{G12})$$

Using the expenditure shares from Keys and Mulder (2025), this elasticity equals 0.20 on average and 0.43 in the right tail, respectively.

Interpretation of our estimates The price changes implied by rate filings measure the change in the insurance premium of the average existing policyholder upon contract renewal. The pass-through to house prices, by contrast, is determined by the insurance price facing the *marginal* house buyer, who purchases a new contract at the current price. Below we discuss five reasons why the IV estimate in Table 3 may exceed the benchmark developed above and, at the same time, provide an upper bound for the structural elasticity. Reasons (1), (2) and (3) are amplification mechanisms: the house price response may exceed the frictionless benchmark because housing supply may react endogenously, payment constraints operate on the extensive margin, and because insurance prices carry information about risk. Reasons (3) and (4) are measurement wedges: the insurance price change experienced by the marginal buyer exceeds the renewal-book average that our data measures, such that the estimated elasticity overstates the structural elasticity with respect to the buyer-relevant price.

(1) Endogenous supply of homes for sale The benchmark holds the housing stock H fixed. As a result, an insurance price change operates purely through buyers' payment capacity. But the stock *offered for sale* is itself likely increasing in insurance prices: Meisenzahl et al. (2026) show that premium increases sharply raise denials of mortgage refinancing applications and Ge et al. (2026) document that higher premiums raise prepayment and delinquency and induce homeowners to move toward lower-premium areas. Adding this margin to the stylized model above would further amplify the price response to insurance price changes.

(2) Amplification through constraint switching The benchmark above assumes that the marginal buyer adjusts her bid continuously, so that a premium increase is capitalized exactly one-for-one into the financeable portion of the payment. Greenwald (2018) shows in a general-equilibrium model calibrated to U.S. mortgage microdata that this assumption

understates the response when a *mass* of borrowers is limited by payment-to-income constraints: payment shocks change which constraint binds for inframarginal borrowers. The mass of households near binding constraints with respect to insurance costs is empirically large: Sastry et al. (2025) estimate that 17% to 31% of households would hit binding loan-to-value constraints and be forced to reduce coverage substantially if premiums continued growing at historical rates. These findings suggest a structural elasticity above the frictionless one: the marginal buyers displaced by a premium increase are not smoothly replaced, and the price must fall by more than the pure crowd-out to clear the market.²⁰

(3) Risk updating by households and lenders The benchmark treats an insurance price change as a pure cash-flow shock. But insurance prices are also public signals about the loss distribution of the property: Ge et al. (2025) show that real estate markets update beliefs about property risk in response to insurance price changes in the context of flood insurance subsidy reforms. A buyer who interprets a premium increase as news about future premium growth and insurability adjusts the expected *path* of insurance costs (and non-renewal risk) rather than the contemporaneous change alone. Relative to the static benchmark, this raises the house price response. Lenders plausibly update in parallel: lower insurance supply leads to tighter borrowing constraints imposed by lenders (Sastry, 2026). Meisenzahl et al. (2026) show that local property insurance premium increases raise mortgage denial probabilities. In the stylized model above, lender updating operates as an endogenous tightening of $\bar{d}$ in response to $d\iota$, which compounds the direct crowd-out: the house price falls both because higher insurance prices reduce payment capacity and because the capacity limit itself contracts. Both borrower and lender belief channels imply that part of the estimated response reflects forward-looking capitalization of risk information rather than the static pass-through of the current premium. This leads to an amplification of the house-price response relative to the frictionless benchmark.

(4) Marginal vs. average policyholder Our data measures $d \log \iota$ for the average renewing incumbent insurance policyholder; instead, the model's ι is the premium rate of the marginal buyer's newly written contract. Two institutional features drive a wedge between the two, all in the same direction. First *rating*: renewal repricing is often dampened by transition

²⁰ A complementary source of amplification is that denied or priced-out applicants exit the market within the relevant horizon rather than immediately re-bidding at lower target prices. Agarwal et al. (2024) document that anticipated rejection shapes mortgage search behavior, consistent with denial deterring rather than redirecting marginal demand.

rules (so-called “premium capping”) as well as tenure and bundling discounts, while new business is written at the undamped rate.²¹ The marginal buyer’s price ι , and hence the insurance payment ιS , therefore exceeds that of the average policyholder, raising the effective scaling factor in equation (G12) at the margin. Second, *risk composition*: filed average insurance price changes mask substantial heterogeneity across geographic areas and risk classes, and premium increases are systematically larger for riskier properties (Keys and Mulder, 2025). Transacted homes (and, thus, a value-weighted price index such as Zillow’s) overweight expensive properties, which are disproportionately located in amenity-rich but hazardous areas: coastal prices embed both a positive view and proximity premium (Bin et al., 2008; Walls et al., 2018), and sorting by risk-optimistic buyers sustains elevated price levels in exactly these segments (Bakkensen and Barrage, 2022). The price change experienced at the transaction margin thus exceeds the book average whenever repricing is concentrated in riskier areas.

(5) Measurement error in experienced price changes The first stage measures the filed price changes of insurers present in our filings data. When this coverage is incomplete, our results may underestimate insurance price changes and, thus, provide an upper bound for the house price elasticity. Two features of the data make this concern concrete. First, consistent with attenuation bias, the estimated elasticity is larger in states with lower filing coverage. Second, the segments missing from the filings data are not missing at random: residual-market entities such as state FAIR plans and Florida Citizens, as well as capital-lines carriers, absorb precisely the riskiest exposures, and their pricing is either absent from rate filings or administratively suppressed (Sastry et al. (2026) show that fragile insurers’ exits push high-risk policies toward the residual market). Our measured price changes are therefore truncated from above in the market segments where repricing is largest. Finally, insurers ration on other quantity margins: non-renewals and cancellations rise with risk exposure (Keys and Mulder, 2025), and coverage per policy declines as constrained households trim protection (Sastry et al., 2025). Each of these margins raises the effective, quality-adjusted price of insurance experienced by market participants relative to the filed

21 Credit-based insurance scores rise with age, credit-history length, and years of on-time mortgage payments; incumbents have all three, and survivorship reinforces the gap because owners who default (with low credit scores) exit the ownership stock. Blonz et al. (2026) show that credit scores have a significant impact on insurance prices.

price, such that the true buyer-relevant price change may exceed our measured one even within covered segments.

H Empirical Identification

In this section, we lay out in detail the identifying assumptions underlying our empirical results and provide supporting empirical evidence.

H.1 Empirical Framework

We assume that insurance prices take the following form:

$$\text{Price} = \mathcal{M} \times \mathcal{W} \times e^{-r_f} \times \mu. \quad (\text{H1})$$

$\mathcal{W}$ is the markup associated with the shadow cost of capital. $\mathcal{M}$ as a residual component, capturing variation in prices in excess of the present value and shadow cost of capital, e.g., due to imperfect competition or alternative discount rates (Knox and Sørensen, 2026).²² μ denotes the expected marginal cost of providing insurance, which is primarily driven by insured losses, but also includes the operational costs of underwriting and claims handling, e.g., loss adjustment expenses. We model μ as the expected product of insured damages and the replacement cost (defined as the cost of replacing one unit of damage):

$$\mu = \mathbb{E}[\text{Damages} \times \text{RepCost}] \quad (\text{H2})$$

$$= \mathbb{P}(\text{Event}) \times \mathbb{E}[\text{Damages} \times \text{RepCost} \mid \text{Event}] \quad (\text{H3})$$

$$= \mathbb{P}(\text{Event}) \times \mathbb{E}[\text{Damages} \mid \text{Event}] \times \mathbb{E}[\text{RepCost} \mid \text{Event}], \quad (\text{H4})$$

where, for simplicity, we assume that unit replacement costs RepCost are independent of the (physical) extent of insured damages, e.g., the damaged surface area or the number of damaged structural units.

²² Note that Equation (H1) readily generalizes to actuarial pricing described in Section 8.2 as well as to more general discount rates.

H.2 Time-Series Elasticity

Because monetary policy neither affects the frequency nor the severity of insured events it is

$$\frac{\partial \log \mu}{\partial \text{MP}} = \underbrace{\frac{\partial \log \mathbb{P}(\text{Event})}{\partial \text{MP}}}_{=0} + \underbrace{\frac{\partial \log \mathbb{E}[\text{Damages} \mid \text{Event}]}{\partial \text{MP}}}_{=0} + \frac{\partial \log \mathbb{E}[\text{RepCost} \mid \text{Event}]}{\partial \text{MP}} \quad (\text{H5})$$

$$= \frac{\partial \log \mathbb{E}[\text{RepCost} \mid \text{Event}]}{\partial \text{MP}}, \quad (\text{H6})$$

i.e., monetary policy affects $\log \mu$ exclusively through its impact on replacement cost. As a result, the semi-elasticity of insurance prices with respect to monetary policy is given by (normalizing $\frac{\partial r_f}{\partial \text{MP}} = 1$)

$$\frac{\partial \log \text{Price}}{\partial \text{MP}} = \frac{\partial \log \mathcal{M}}{\partial \text{MP}} + \frac{\partial \log \mathcal{W}}{\partial \text{MP}} + \frac{\partial \log e^{-r_f}}{\partial \text{MP}} + \frac{\partial \log \mu}{\partial \text{MP}} \quad (\text{H7})$$

$$= \frac{\partial \log \mathcal{M}}{\partial \text{MP}} + \frac{\partial \log \mathcal{W}}{\partial \text{MP}} - 1 + \frac{\partial \log \mu}{\partial \text{MP}} \quad (\text{H8})$$

$$= \underbrace{\frac{\partial \log \mathcal{W}}{\partial \text{MP}} - 1}_{=\beta} + \underbrace{\frac{\partial \log \mathcal{M}}{\partial \text{MP}}}_{=\nu_1} + \underbrace{\frac{\partial \log \mathbb{E}[\text{RepCost} \mid \text{Event}]}{\partial \text{MP}}}_{=\nu_2}. \quad (\text{H9})$$

We aim to identify β , the elasticity of the shadow-cost-adjusted discounted expected insurance cost.

Based on the decomposition in equation (H9), the estimated coefficient in Equation (23) provides an unbiased estimate of β if $\nu_1 = \nu_2 = 0$, i.e., if monetary policy does not affect markups and/or replacement costs beyond what is controlled for. Thus, the primary concern is that rate hikes, by dampening aggregate demand, may also affect insurance demand and, thus, markups (ν_1) as well as construction costs and, thus, replacement costs (ν_2).²³ Controlling for inflation and insurer characteristics mitigates these concerns. Nonetheless, if the controls are imperfect, the identifying assumption may be violated. However, the direction of the bias is not obvious: whereas a reasonable assumption is that monetary policy hikes reduce construction costs, implying $\nu_2 < 0$, monetary policy hikes might reduce markups by dampening aggregate demand, implying $\nu_1 < 0$, or increase markups by reducing households' propensity to take risk (Kekre and Lenel, 2022) and, thus,

²³ Moreover, de Fraisse et al. (2026) raise the concern that aggregated monetary policy surprises may be endogenous to the business cycle.

raise their willingness to pay, implying $\nu_1 > 0$. To tighten the identification, we leverage cross-sectional variation in insurers' exposure to monetary policy, discussed in the following.

H.3 Cross-Sectional Elasticity

The cross-sectional specification in equation (24) estimates

$$\frac{\partial^2 \log \text{Price}}{\partial \text{MP} \partial \text{Exposure}} = \underbrace{\frac{\partial^2 \log \mathcal{W}}{\partial \text{MP} \partial \text{Exposure}}}_{=\beta'} + \underbrace{\frac{\partial^2 \log \mathcal{M}}{\partial \text{MP} \partial \text{Exposure}}}_{=\nu'_1} + \underbrace{\frac{\partial^2 \log \mathbb{E}[\text{RepCost} \mid \text{Event}]}{\partial \text{MP} \partial \text{Exposure}}}_{=\nu'_2}. \quad (\text{H10})$$

The identifying assumption is that the prices of insurers with larger monetary policy exposure do not respond differently to monetary policy through other channels than through the shadow cost of capital, i.e., $\nu'_1 = \nu'_2 = 0$.

Including state-by-time fixed effects in the baseline specification absorbs any state-level differential responses to monetary policy, including differences in insurance demand, inflation, and construction costs. Any potential residual confounding variation is therefore limited to within-state variation, requiring insurers to systematically sort into households or regions depending on their exposure to monetary policy.

H.3.1 Inflation

Because monetary policy responds to inflation, a natural concern is that our estimates may capture an inflation channel rather than the causal effect of monetary policy. In this case, higher inflation may raise replacement costs and, in turn, insurance prices, biasing the estimate. To isolate monetary policy shocks, we follow the extensive macroeconomics literature that uses monetary policy surprises as exogenous variation.

H.3.2 Sorting on insurer characteristics

By construction, insurers with higher exposure exhibit unusually low risk-based capital ratios and hold riskier assets (with lower credit ratings and longer durations). These characteristics may be individually correlated with a differential exposure to monetary policy. For example, riskier insurers may follow different pricing strategies than other insurers. Moreover, if insurers with riskier investments attracted households with less liquid wealth, insurance demand may respond differentially to monetary policy. A potential

concern is therefore that the estimated differential response may be driven by investment risk or insurer capitalization individually, rather than by their joint effect through financial frictions.

To address this concern, in column (4) of Table 2, we control for the interaction between portfolio sensitivity and monetary policy surprises, absorbing differential responses arising from heterogeneity in investment risk, and the interaction between regulatory capital constraints and monetary policy, absorbing differential responses arising from heterogeneity in constraints. These controls have a negligible effect on the estimated coefficient on the interaction Exposure $\times$ MPS. This result shows that our baseline estimate is not driven by differences in investment risk or capitalization in isolation. Instead, it reflects the interaction between asset-side sensitivity and regulatory constraints, consistent with our model.

H.3.3 Sorting on household characteristics

The identifying assumption would be violated if more exposed insurers sorted into households that are also more exposed to monetary policy, suggesting an effect through markups, i.e., $\nu'_1 \neq 0$. For example, previous studies argue that households are more exposed to monetary policy in the presence of low liquid wealth (Kaplan et al., 2018), low income (Coibion et al., 2017), and adjustable-rate mortgages (Di Maggio et al., 2017). Thus, if more exposed insurers sorted into households with these characteristics, then more-exposed insurers would plausibly face more pronounced declines in insurance demand in response to monetary policy hikes, which may lead to lower markups, biasing the estimate downward. Instead, a negative correlation between these household characteristics and insurer exposure may lead to upward bias. By including state-by-time fixed effects, our baseline specification already absorbs any potential sorting at the state level. Thus, the remaining identification concern is restricted to more granular, within-state sorting.

To assess the relevance of sorting, we examine household characteristics that proxy for the main channels through which household demand may respond differentially to monetary policy. Because information on policyholder characteristics is not available at the insurer level, we approximate an insurer's customer base by using the geographic distribution of its policyholders.

For this purpose, we exploit variation in household characteristics across all U.S. states, weighting each insurer's exposure to a state by its lagged direct premiums written in that state. We examine the liquid wealth and income of households, capturing their ability to smooth expenditures following interest-rate shocks, while housing-market and household-

balance-sheet characteristics—including homeownership, borrower age, debt-to-income ratios, loan-to-value ratios, mortgage amounts, and mortgage term—proxy for the extent to which local households are exposed to housing and mortgage-payment channels of monetary transmission. These variables exhibit significant cross-insurer variation (see Table H.1) and, hence, provide a meaningful basis for detecting sorting patterns. We standardize all variables to mean zero and unit variance. Table H.2 reports estimates from specifications without additional controls (while including time fixed effects). The vast majority of coefficients is statistically not significant and within- R^2 values are essentially zero. Thus, the data does not show a systematic correlation of insurer exposure with local household characteristics.

Table H.1
Summary Statistics of Household Characteristics

	N	Mean	SD	Cross-SD	10 th	25 th	Median	75 th	90 th
Exposure	13,143	0.160	0.848	0.731	0.000	0.000	0.000	0.017	0.631
Constrained	13,143	0.495	0.456	0.451	0.000	0.000	0.250	1.000	1.000
Sensitivity	13,143	0.308	1.191	0.973	-0.254	0.000	0.000	0.341	1.585
Log(Income)	13,143	10.854	0.195	0.104	10.615	10.703	10.834	10.998	11.128
Log(GDP)	13,143	10.992	0.202	0.132	10.747	10.850	10.973	11.121	11.273
Household Age	13,143	38.714	1.367	1.203	37.077	37.929	38.748	39.540	40.341
Homeownership Rate	13,143	65.109	4.724	4.609	58.399	62.811	65.605	68.228	70.232
Borrower Age	13,143	45.468	1.475	1.253	44.000	44.460	45.181	46.200	47.649
Mortgage DTI	13,143	35.551	1.929	1.222	33.192	34.160	35.408	36.900	38.111
Mortgage Amount	13,143	5.477	0.284	0.224	5.129	5.257	5.456	5.675	5.861
Mortgage LTV	13,143	75.888	3.560	2.865	71.184	73.700	76.411	78.290	79.600
Mortgage Term	13,143	26.159	1.324	0.789	24.300	25.291	26.295	27.163	27.845
Log(Liquid Wealth)	13,132	10.551	0.277	0.247	10.211	10.381	10.549	10.731	10.852
Liquid Wealth Share	13,132	0.110	0.021	0.020	0.084	0.099	0.109	0.121	0.137

This table reports summary statistics for insurer-level averages of household characteristics. For each insurer, we average household characteristics across the states in which it operates, weighting each state by the insurer’s lagged premiums in that state. “Cross-SD” is the time-series average of the cross-sectional standard deviation across insurers. All other statistics are computed from the pooled sample.

Table H.2
Testing for Sorting of Insurers on Household Characteristics

	Dependent variable: <i>Exposure</i>											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log(Income)	0.055 [1.63]											0.004 [0.05]
Log(GDP)		0.035 [1.40]										0.079 [1.05]
Household Age			0.027 [1.57]									0.006 [0.21]
Homeownership Rate				0.006 [0.37]								0.053* [1.69]
Borrower Age					-0.007 [-0.51]							0.020 [0.51]
Mortgage DTI						-0.013 [-0.56]						0.023 [0.53]
Mortgage Amount							0.013 [0.62]					-0.047 [-0.81]
Mortgage LTV								-0.033** [-2.26]				-0.044* [-1.89]
Mortgage Term									-0.013 [-0.52]			0.006 [0.13]
Log(Liquid Wealth)										0.024 [1.56]		0.009 [0.35]
Liquid Wealth Share											0.028* [1.83]	0.018 [0.93]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	13,143	13,143	13,143	13,143	13,143	13,143	13,143	13,143	13,143	13,132	13,132	13,132
R^2	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.121
Within R^2	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.001	0.003

This table tests whether insurers with higher exposure to monetary policy serve different households, using cross-state variation in household characteristics. We collapse insurer-by-state-by-year data to the insurer-year level by averaging state-level household characteristics across the states in which an insurer operates, weighted by the insurer's lagged direct premiums written in each state. We then estimate OLS regressions of the form

$$\text{Exposure}_{i,y} = \beta X_{i,y} + \gamma C_{i,y} + u_y + \varepsilon_{i,y},$$

where $\text{Exposure}_{i,y}$ is the product of the interest rate sensitivity of insurer i 's mark-to-market assets and an indicator for whether the insurer is capital-constrained (as defined in Table 2), both measured in year y ; $C_{i,y}$ is a vector of controls, and u_y are year fixed effects. The explanatory variable $X_{i,y}$ is one of the following premium-weighted household characteristics in year y : log income per capita, log GDP per capita, household age, homeownership rate, borrower age, mortgage debt-to-income ratio, log mortgage amount, mortgage loan-to-value ratio, mortgage term, log liquid wealth per capita, or liquid wealth share. All variables are standardized to have a mean of zero and a standard deviation of one. t -statistics are shown in brackets and based on standard errors clustered at the insurer level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

H.3.4 Other potential concerns

Sorting on construction costs The identifying assumption would be violated if more exposed insurers sorted into regions in which construction costs are more responsive to

monetary policy, in which case $\nu'_2 \neq 0$. For instance, regions with tighter financial conditions or labor scarcity may see a larger response to monetary policy. Because it is natural to expect rate hikes to reduce construction costs, if more exposed insurers sorted into regions with more exposed construction costs, they would experience a more pronounced decline in replacement costs than other insurers, leading to relatively lower prices (i.e., $\nu_2 < 0$).

Our baseline specification addresses this potential concern by including state-by-time fixed effects. Moreover, we do not find evidence for sorting on a broad set of income, housing, mortgage, and household balance-sheet characteristics in Tables H.2. While these variables are not directly linked to construction costs, the absence of sorting across such local characteristics is inconsistent with the broader view that more exposed insurers disproportionately operate in systematically different local economic environments.

Sorting on property risk Exposed insurers may also differ in the risk profile of the homes they insure. A natural concern is that such differential risk profile might itself mediate the effects of monetary policy. However, equation (H9) shows that, under mild conditions, this is not the case. The reason is that the impact of monetary policy on the expected marginal cost of insurance, if there is any, operates exclusively through its effect on replacement costs.

Heterogeneous actuarial pricing Exposed insurers may incorporate the effects of monetary policy on replacement costs differently into their actuarial pricing models. For example, insurers that hold more mark-to-market assets might also be more sensitive in adjusting expected replacement costs to market conditions. In this case, $\nu'_2 < 0$, with $\mathbb{E}[\text{RepCost}]$ being an insurer-specific (actuarial) estimate of replacement cost. However, unlike for final insurance prices, we only find a weak differential response of actuarial prices to monetary policy (column (2) in Table 6). In addition, controlling for Sensitivity $\times$ MPS leaves the coefficient on Exposure $\times$ MPS largely unchanged (column (5) in Table 2). This evidence suggests that our results are not driven by heterogeneity in actuarial pricing practices.

H.4 Construction of Household Characteristics

We construct insurer-level measures of household characteristics by aggregating geographic information using each insurer's lagged exposure in each geography as weights. We lag the weights by one year relative to the household characteristics to mitigate any mechanical contemporaneous correlation between an insurer's exposure to a geography

and the realization of household variables in that geography. All continuous household variables are winsorized at the 1% and 99% level.

We obtain insurer-by-state-by-year direct premiums written ($DPW_{i,s,t-1}$) for property insurers from NAIC regulatory filings. We combine these with state-by-year measures of household characteristics drawn from a number of public sources: state-level income per capita, nominal GDP per capita, and population count from the U.S. Bureau of Economic Analysis (2010 to 2023), the homeownership rate and average household age from the Census (2010 to 2024), mortgage characteristics (average borrower age, debt-to-income ratio, loan amount, loan-to-value ratio, and mortgage term) from the U.S. National Mortgage Database (2010 to 2024), and average household liquid wealth and the share of liquid wealth in total wealth constructed from the Survey of Income and Program Participation (2010 to 2024) as described in Section H.4 below.²⁴ We then collapse the resulting insurer-by-state-by-year data set to the insurer-year level by computing the premium-weighted average of each state-level characteristic $X_{s,t}$ across the states in which the insurer operates:

$$X_{i,t} = \frac{\sum_s DPW_{i,s,t-1} X_{s,t}}{\sum_s DPW_{i,s,t-1}}. \quad (H11)$$

Kaplan et al. (2018) highlight the role of liquid wealth in shaping households' exposure to monetary policy. Their empirical approach relies on the Survey of Consumer Finances (SCF), which provides rich information on household balance sheets but does not allow a state-level breakdown. To construct an analogous measure at the state level, we instead use the Survey of Income and Program Participation (SIPP), which allows us to measure liquid wealth at the household level and then aggregate it to the state-year level.

Our sample uses the 2018–2024 SIPP releases, corresponding to reference years 2017–2023. We examine the cross section of each December record and use the annual person weight for that record.

We construct an approximation to the notion of net liquid assets in Kaplan et al. (2018). Specifically, liquid wealth equals deposits in checking and savings accounts, money market holdings, government securities, and municipal/corporate bonds, minus credit-card and store-bill debt.²⁵

24 For the SIPP-based measures, we extrapolate observations outside the survey window using the nearest available year and exclude state-year cells based on fewer than 50 sampled households.

25 This measure closely follows Kaplan et al. (2018) (KMV), but several departures are unavoidable in SIPP. First, SIPP does not provide an exact counterpart to KMV's call-account measure, so this component is omitted. Second, the SIPP money-market category combines money market deposit accounts and money

Operationally, we first construct person-level liquid wealth and then aggregate to the household level because the SIPP distinguishes individually owned assets from spouse-joint and other-joint holdings. Letting i index persons and h households, we define

$$L_{i,h} = \text{checking}_{i,h} + \text{savings}_{i,h} + \text{money market}_{i,h} + \text{government securities}_{i,h} \\ + \text{municipal/corporate bonds}_{i,h} - \text{credit-card/store-bill debt}_{i,h}, \quad (\text{H12})$$

where each component aggregates individual, spouse-joint, and other-joint shares when available. A household's liquid wealth is then defined as

$$L_{h,t} = \sum_{i \in h} L_{i,h,t}. \quad (\text{H13})$$

We obtain the household weight by inheriting the annual person weight of the household reference person and assigning the household's state from the same record. We use these household weights to ensure that state-year estimates are representative of the underlying population (i.e., to correct for unequal sampling probabilities and nonresponse). We then estimate state-level means using Fay's balanced repeated replication. Thus, for state s in year t , our main object is the survey-weighted mean

$$\bar{L}_{s,t} = \frac{\sum_{h \in (s,t)} w_{h,t} L_{h,t}}{\sum_{h \in (s,t)} w_{h,t}}, \quad (\text{H14})$$

where $w_{h,t}$ denotes the weight of household h . We consider the individual weight of the household's reference person as the household weight to ensure that aggregation to the state level is based on a representative of the underlying population. The final output is an annual state-by-year panel of average household liquid wealth.

Analogously, we also construct a measure of total household wealth. Specifically, we define illiquid wealth as the sum of home equity, rental and other real-estate equity, business equity, vehicle equity, and stocks and mutual funds. Total wealth is then measured as liquid wealth plus illiquid wealth, in both the baseline and the variant. Because the mean of the household-level liquid wealth ratio is unstable when total wealth (in the

market funds, making it somewhat broader than KMV's preferred concept. Third, SIPP combines municipal and corporate bonds in a single category, so the bond component is broader than KMV's corporate-bond measure. Fourth, the available debt concept is credit-card and store-bill debt, which is the closest proxy to revolving consumer credit. We therefore interpret the resulting series as a consistent state-level proxy for KMV-style liquid wealth rather than as a literal replication of the SCF-based measure.

denominator) is close to zero (or negative), we define the state-level ratio of liquid wealth as the ratio of average state-level liquid wealth to average state-level total wealth. To ensure reliable measurement at state level, we exclude state-level observations with less than 50 households. Finally, for years not available in the survey (i.e., before 2017 and after 2023), we extrapolate the series by using the earliest/most recent available observations, exploiting persistence in the variables.

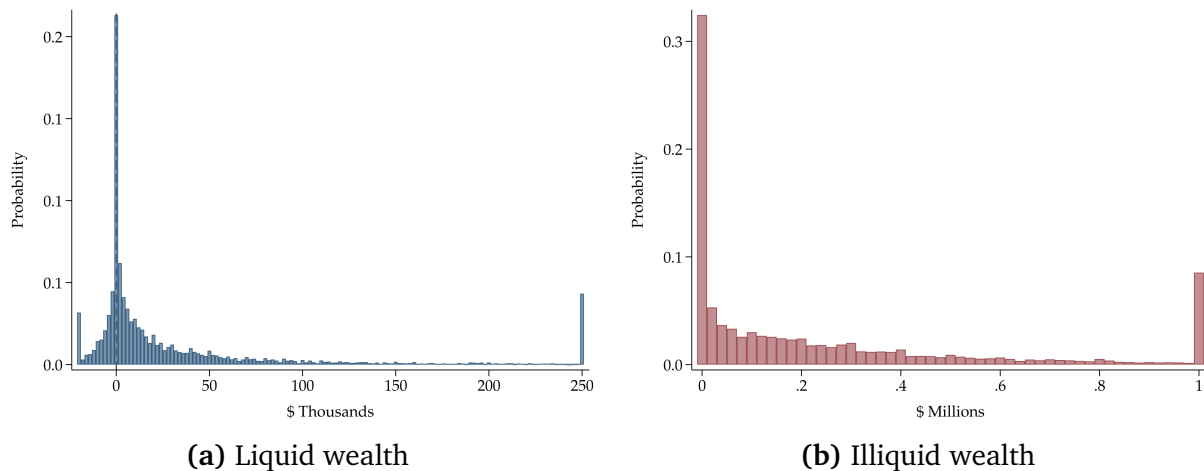


Figure H.1
Distribution of Liquid and Illiquid Wealth

This figure shows the distribution of household (a) liquid and (b) illiquid wealth, in thousands of USD, in the 2024 wave of the SIPP pooled across states and weighted by household survey weights.

Figure (H.1) plots the distribution of liquid and illiquid wealth in our data. The distributions closely resemble those in Figure 1 in Kaplan et al. (2018), supporting the validity of our SIPP-based state-level liquid wealth measure as a proxy for the SCF-based measure.

I Exemplary Price Filings

This section presents case studies of homeowners insurance rate filings by two insurance companies, Grange Property & Casualty Insurance Company and American Select Insurance Company, illustrating how cost-of-capital and profitability considerations translate into filed price changes.

I.1 Grange Property & Casualty Insurance Company

Grange Property & Casualty Insurance Company (“Grange”), NAIC ID 11982, is an affiliate of Grange Mutual Holding Company, an Ohio-based mutual holding company formerly known as Grange Casualty Mutual Company. As a mutual corporation, Grange is ultimately owned by its policyholders, returns excess profits through policyholder dividends, and has no access to external capital markets. In 2022, Grange wrote \$99.13 million in homeowners insurance across four states, including \$44.8 million in Ohio. Throughout the sample period, Grange invested virtually all assets in fixed-income securities; our interest-rate sensitivity measure equals zero for Grange in every year, reflecting that Grange accounted for all fixed-income holdings at historical cost.

Between January 2010 and December 2023, Grange submitted 15 rate filings for homeowners insurance products to the Ohio Department of Insurance. Two filings pertained to mobile homeowners policies, whereas the remaining 13 filings revised the rates of Grange’s “Homeowners Program,” which covers the standard HO-3 policy form. The actuarial target rate change indicated in each filing is an actuarial estimate of the price adjustment required to sustain underwriting expenses plus a selected profit margin. Grange derives this target price by comparing projected loss ratios – claims divided by premiums, extrapolated from historical experience and adjusted for loss-cost trends and catastrophe developments – against a permissible target loss ratio. The permissible loss ratio is defined as the maximum loss ratio consistent with covering all non-claims underwriting expenses (e.g., broker commissions, premium taxes, and administrative costs) and earning a selected profit margin (see Figure I.1).

The main discretionary parameter in this approach is the profit provision (“profit ratio”), which the insurer derives from cost of capital considerations. More specifically, Grange targets a return on equity, translates this into a target net income by adjusting with the ratio of earned premiums to capital (“policyholder surplus”) – a proxy for Grange’s leverage –, and further accounts for corporate taxes, investment income, and other income sources

to arrive at an implied profit ratio for the underwriting business. However, Grange has discretion to select a profit ratio below the indicated level for undisclosed reasons. For example, in its January 2013 filing, the target return on equity of 15% implied a profit ratio of 13.1%, yet Grange selected a profit ratio of 7%.

Expenses Incurred	Permissible Loss Ratio
Commission & Brokerage (W)	16.2%
Other Acquisition Expense & General Expense (E)	11.9%
Taxes, Licenses, & Fees (W)	1.7%
Net Cost of Reinsurance	2.7%
Adjusting and Other (E)	8.4%
Total Expenses	40.9%
Target Loss Ratio (Break Even)	59.1%
Profit & Contingencies	7.0%
Target Loss Ratio (Permissible)	52.1%

Figure I.1

Target Loss Ratio Calculations of Grange Property & Casualty Insurance Company

This figure shows the permissible loss ratio calculation from the rate filing that Grange Insurance submitted in Ohio on January 18, 2013 (SERFF tracking number GRAN-128836930). *Source: Ohio SERFF Filing Access.*

Profit Summary	
Justified Profit	13.1%
Selected Profit	7.0%

Profit Calculation	
2011 Net Earned Premium	1,043,499
2011 Year End Surplus	874,466
Ratio	1.193
Profit	13.1%
Net Fee Income *	2.27%
Net Investment Gain *	4.0%
Income Before Federal Income Tax	19.3%
Federal Income Tax	35.0%
Net Income from Operations	12.57%
Return on Equity	15.0%
* expected values	

Figure I.2
Profit Summary of Grange Mutual Casualty Group

This figure shows the profit provision calculation from the rate filing that Grange Insurance submitted in Ohio on January 18, 2013 (SERFF tracking number GRAN-128836930). *Source: Ohio SERFF Filing Access.*

Table I.1 reports the key parameters of Grange's rate filings from 2010 to 2023. Throughout the sample, Grange maintained a constant target return on equity of 15% and a fixed profit provision of 7%, raising it to 8% only in 2022. Two features account for this stability. First, as a mutual insurer, Grange faces a trade-off between price increases—which raise retained earnings and ultimately benefit policyholders as residual claimants—and lower premiums that directly benefit those same policyholders; this balance supports a policy of stable, conservative pricing. Second, Grange's investment portfolio consisted entirely of fixed-income assets held at historical cost, insulating the book values and reported investment income of existing assets from interest rate changes. Investment returns accrued through coupon payments and amortization of bonds held to maturity, with no mark-to-market exposure.

Table I.1
Rate Filings by Grange Property & Casualty Insurance Company in Ohio

SERFF ID	Product Code	Submitted	Disposed	$\Delta Target Price$ (%)	$\Delta Price$ (%)	Target Loss Ratio (%)	Profit Provision (%)	Target ROE (%)
GRAN-126511759	04.0002	2/24/10	3/30/10	33.60	18.80	48.8	7	15
GRAN-126489784	04.0000	2/24/10	4/13/10	75.50	18.30	48.8	7	15
GRAN-127043978	04.0000	2/25/11	4/19/11	31.00	9.20	52.5	7	15
GRAN-127044583	04.0002	2/25/11	4/5/11	23.60	8.60	52.5	7	15
GRAN-128084560	04.0000	2/16/12	3/20/12	32.80	10.40	NA	NA	NA
GRAN-128836930	04.0000	1/18/13	3/6/13	37.10	13.90	52.1	7	15
GRAN-129423640	04.0000	3/31/14	7/18/14	24.00	9.10	51.9	7	15
GRAN-129978529	04.0000	3/25/15	5/28/15	9.50	2.80	53.1	7	15
GRAN-130526905	04.0000	4/20/16	5/6/16	10.50	1.80	53.3	7	15
GRAN-131041462	04.0000	5/23/17	6/27/17	11.30	1.80	53.7	7	15
GRAN-131503478	04.0000	5/18/18	5/22/18	14.60	1.90	53.4	7	15
GRAN-131942064	04.0000	5/16/19	5/21/19	3.40	2.00	53.8	7	15
GRAN-132645878	04.0000	12/16/20	1/12/21	7.20	2.00	54.7	7	15
GRAN-133289418	04.0000	6/10/22	8/1/22	6.90	4.10	53.8	8	15
GRAN-133676025	04.0000	5/31/23	6/30/23	24.90	6.40	52.4	8	15

The historical-cost investment portfolio and mutual ownership structure stabilized Grange’s cost of capital. Therefore, Grange’s target prices (“actuarial rate indications”) were driven primarily by variations in loss projections: the largest target rate changes appear in filings from 2010–2013, whose loss projections incorporated the severe hurricane seasons of 2008 (Hurricane Ike) and 2011–2012.²⁶

I.2 American Select Insurance Company

American Select Insurance Company (“American Select”), NAIC ID 19992, is a mid-sized affiliate of Ohio Farmers Insurance Company – an Ohio-based property and casualty insurer – and together with other affiliates constitutes the Westfield Group. At end-2023, American

²⁶ Data from the National Oceanic and Atmospheric Administration show that the five-year average insured disaster costs in Ohio reached record levels between 2008 and 2012 (see noaa.gov).

Select had \$330 million in total assets. In 2022, American Select wrote \$224 million in homeowners insurance premiums across 10 states, of which \$69.3 million came from Ohio.

Because American Select invests a substantial amount of its assets in equities, its balance sheet is sensitive to interest rate changes. Our sensitivity estimates range from 0.5 to 4.2 percentage points over the sample period, consistent with an equity share exceeding 30% during the 2010s that declined to below 17% towards the end of the sample.

Between January 2010 and December 2023, American Select submitted 16 rate filings for homeowners insurance products to the Ohio Department of Insurance. As with Grange, the actuarial target rate change derives from comparing projected loss ratios against a permissible loss ratio that accounts for non-claims underwriting expenses and a profit margin (see Figure I.3). The profit margin is determined by a target return on equity, adjusted for corporate taxes and expected investment yields (see Figure I.4).

Commission:	16.7%
Other Acquisition:	2.5%
General Expense:	7.5%
Taxes, Licenses, & Fees:	1.7%
ULAE:	4.4%
Profit & Contingencies:	8.0%
Total:	40.7%
Permissible Loss Ratio:	59.3%

Figure I.3

Permissible Loss Ratio Calculations of American Select Insurance Company

This figure shows the permissible loss ratio calculation from the rate filing that American Select Insurance submitted in Ohio on October 27, 2023 (SERFF tracking number WSFG-133869406).

Source: Ohio SERFF Filing Access.

<u>Model Inputs</u>			
(1) Target Return on Equity (ROE)	15.0%		
(2) Premium-to-Surplus	1.77		
(3) Reserve-to-Surplus	6.19		
(4) Tax Rate	21.0%		
(5) Pre-Tax Investment Yield	5.2%		
(6) Net-to-Direct Difference	3.5%		
(7) Initial Premium	\$1.00		
(8) Underwriting Expense Ratio	30.4%		
<u>Model Output</u>			
(9) Expected Loss & LAE Ratio	64.9%		
(10) Target Combined Ratio - Net	95.3%	= (8) + (9)	
(11) Target Combined Ratio - Direct	91.8%	= (10) – (6)	
<u>Direct Profit and Contingencies Provision</u>			
(12) Indicated	8.2%	= 1 – (11)	
Selected	8.0%		

Figure I.4

Profit Provision Calculations of American Select Insurance Company

This figure shows the profit provision calculation from the rate filing that American Select Insurance submitted in Ohio on October 27, 2023 (SERFF tracking number WSFG-133869406). *Source: Ohio SERFF Filing Access.*

Table I.2 reports the key parameters for all 16 rate filings.²⁷ American Select’s target return on equity varied over the sample period: it opened at 15%, declined to 12% in the low-rate environment following Covid-19, and recovered to 15% by the end of the sample as the Federal Reserve tightened monetary policy. These changes in the target return on equity translated into corresponding adjustments in the profit ratio and, in turn, into the target price.

27 Several filings do not report a target price change (“actuarial rate indication”) because American Select undertook a comprehensive revision of its homeowners insurance policies in November 2012, introducing an entirely new rating plan. Due to limited historical experience under the new plan, subsequent filings relied solely on average loss trends. For more information, see filing “WSFG-128674697” in the Ohio SERFF Filing Access platform.

Table I.2
Rate Filings by American Select Insurance Company in Ohio

SERFF ID	Product Code	Submitted	Disposed	$\Delta Target Price$ (%)	$\Delta Price$ (%)	Target Loss Ratio (%)	Profit Provision (%)	Target ROE (%)
WSFG-126903632	04.0000	11/18/10	12/21/10	12.4	4.3	62.95	8.5	15
WSFG-127860960	04.0000	12/6/11	1/20/12	17.5	7.8	64.85	7.5	15
WSFG-129313166	04.0000	11/25/13	1/10/14	0.7	0.7	NA	NA	NA
WSFG-129855946	04.0000	12/22/14	2/6/15	NA	3.7	NA	NA	NA
WSFG-130338505	04.0000	11/19/15	1/15/16	NA	5	62.56	NA	NA
WSFG-130835247	04.0000	12/7/16	1/24/17	8.6	2	63.6	NA	NA
WSFG-131283294	04.0000	11/29/17	12/11/17	25.4	6.9	63.35	7	15
WSFG-131723301	04.0000	11/15/18	12/14/18	13.5	6	62.71	7	12.6
WSFG-131904169	04.0000	4/15/19	5/1/19	NA	-2.7	NA	NA	NA
WSFG-132154631	04.0000	11/14/19	12/17/19	5.3	0.9	56.2	7	12.6
WSFG-132572565	04.0000	10/19/20	12/4/20	8	1.3	56.9	7	12.6
WSFG-132827083	04.0000	05/05/21	6/21/21	8.3	0.9	57.9	7	12.6
WSFG-133041965	04.0000	11/04/21	11/22/21	15.8	4.4	58.1	7.5	12
WSFG-133345311	04.0000	7/26/22	7/27/22	13.5	1.7	58.5	7.5	12
WSFG-133450304	04.0000	11/1/22	11/18/22	16.4	4.6	58.5	7.5	12
WSFG-133869406	04.0000	10/27/23	10/30/23	21.4	4.6	59.3	8	15

I.3 United Services Automobile Association

In its March 2017 homeowners insurance rate filing in Ohio (Exhibit XXV), USAA describes how changes in risk-free rates have changed the CAPM-implied rate of return for their company and, in response, their chosen target return on equity: “Results from the Capital Asset Pricing Model (CAPM), commonly used in evaluating investments, suggest a required rate of return of 8.0%. The recent decrease in the calculated CAPM return has been driven by the unusually poor market performance and subsequent decrease in the risk-free rate of return. Historically, USAA selected a 10.0% total rate of return which was fully supported by CAPM calculations until the recent market downturn. In balancing responsiveness to the changing financial climate as well as overall stability, we believe 9.0% is an appropriate selection for the total rate of return.”

J Model Extension: Market Dynamics in the Presence of Financial Frictions

Extending our stylized model in Section 3, below we explicitly consider the dynamics of insurance markets in which insurers differ in their exposure to monetary policy. For this purpose, we construct a model of imperfect competition following the canonical Hotelling (1929) model of horizontal differentiation. Two insurers compete in prices over a continuum of customers with heterogeneous preferences, where the “transportation cost” captures differentiation in contract attributes or customer relationships. One insurer (denoted C) is subject to financial frictions and, thus, faces regulatory costs when capital is low. The other insurer (denoted U) is unconstrained. The equilibrium outcome trades off the shadow cost of capital, market power arising from differentiation, and competitive price pressure.

J.1 Model Setup

We consider a unit mass of insurance customers who each demand one unit of homeowners insurance. There are two insurance companies in the market, denoted by C (the *constrained* insurer) and U (the *unconstrained* insurer). The two insurers compete in prices, and customers decide from which insurer to purchase coverage.

The distribution of customers follows the standard Hotelling (1929) framework. Each customer is indexed by $x \in [0, 1]$, representing their location on the unit interval. The two insurers are located at the endpoints of the line: insurer C at $x = 0$ and insurer U at $x = 1$.

Customers incur a *transportation cost* that captures (the monetary equivalent of) the dis-utility to purchase insurance from a more distant provider—for example, in terms of preference mismatch, search cost, contractual frictions, or absence of an existing relationship with the insurer or its insurance brokers. A customer located at position x faces a cost x when purchasing insurance from the constrained insurer C , and a cost $1 - x$ when purchasing insurance from the unconstrained insurer U . This setup reflects a one-dimensional differentiation in contract or insurer characteristics. Customers closer to C may prefer its product features, while those closer to U are better matched with the unconstrained insurer’s offering.

Let P_C and P_U denote the prices set by insurers C and U , respectively. Then, the utility of a customer located at x from purchasing insurance from insurer $i \in \{C, U\}$ is given by

$$U_C(x) = \hat{V} - P_C - x, \quad (\text{J1})$$

$$U_U(x) = \hat{V} - P_U - (1 - x), \quad (\text{J2})$$

where $\hat{V}$ represents the gross value of insurance coverage, assumed common to all consumers.

J.2 Customer Choice and Market Shares

The marginal customer $\bar{x}$ is indifferent between the two insurers, i.e.

$$U_C(\bar{x}) = U_U(\bar{x}). \quad (\text{J3})$$

Substituting from above yields

$$\hat{V} - P_C - \bar{x} = \hat{V} - P_U - (1 - \bar{x}), \quad (\text{J4})$$

which simplifies to

$$\bar{x} = \frac{1 + P_U - P_C}{2}. \quad (\text{J5})$$

All customers located to the left of $\bar{x}$ (i.e., with $x < \bar{x}$) purchase from insurer C , while those to the right purchase from U . Therefore, the market shares are

$$Q_C = \int_0^{\bar{x}} dx = \bar{x} = \frac{1 + P_U - P_C}{2}, \quad (\text{J6})$$

$$Q_U = \int_{\bar{x}}^1 dx = 1 - \bar{x} = \frac{1 - P_U + P_C}{2}. \quad (\text{J7})$$

J.3 Price Setting and Equilibrium

Having characterized the demand functions, we now turn to the insurers' pricing decisions. Both insurers act as Bertrand competitors in a horizontally differentiated market, taking the competitor's price as given.

J.3.1 Unconstrained insurer

The unconstrained insurer U chooses its price P_U to maximize profit in the absence of financial frictions:

$$\max_{P_U} \pi_U(P_U; P_C) = (P_U - V)Q_U \quad (\text{J8})$$

$$= \frac{1 - P_U + P_C}{2}(P_U - V), \quad (\text{J9})$$

where V represents the constant marginal cost of providing coverage: $V = e^{-r_f}$. The first-order condition (FOC) with respect to P_U is

$$\frac{\partial \pi_U}{\partial P_U} = \frac{1 - P_U + P_C}{2} + \frac{-1}{2}(P_U - V) = 0. \quad (\text{J10})$$

Solving for the optimal price yields

$$P_U = \frac{1 + P_C + V}{2}. \quad (\text{J11})$$

The unconstrained insurer thus sets its price as a weighted average of the competitor's price and its own marginal cost, reflecting the usual Hotelling trade-off: higher P_C allows U to increase its price, while higher cost V increases the optimal markup. This pricing rule captures the strategic complementarity of prices in horizontally differentiated markets.

J.3.2 Constrained insurer

As in our baseline model in Section 3, the constrained insurer C faces additional costs stemming from regulatory capital requirements. These distort its pricing decision relative to the unconstrained benchmark. Using the same notation as in Section 3, the constrained insurer's profit is given by

$$\pi_C(P_C; P_U) = (P_C - V)Q_C - C, \quad (\text{J12})$$

where $C = f(K_C)$ is the regulatory cost of capital and K_C is the statutory capital defined as in Equation (5). This optimization problem is equivalent to that in the baseline model and,

thus, using Equation (9), the constrained insurer's optimal price is given by

$$P_C = \frac{\frac{P_C}{1+P_U-P_C}}{\frac{P_C}{1+P_U-P_C} - 1} \frac{1 + \chi(1 + \rho)}{1 + \chi} V, \quad (\text{J13})$$

using that the demand elasticity is equal to

$$\epsilon = -\frac{\partial Q_C}{\partial P_C} \frac{P_C}{Q_C} = \frac{P_C}{1 + P_U - P_C}, \quad (\text{J14})$$

and denoting $\chi = -\frac{\partial C}{\partial K_C}$. Simplifying, we obtain

$$P_C = \frac{P_C}{2P_C - (1 + P_U)} \frac{1 + \chi(1 + \rho)}{1 + \chi} V, \quad (\text{J15})$$

which is equivalent to

$$P_C = \frac{1 + P_U}{2} + \frac{1}{2} \frac{1 + \chi(1 + \rho)}{1 + \chi} V. \quad (\text{J16})$$

This expression highlights that the constrained insurer's equilibrium price is an average of (i) the competitor's price and (ii) a shadow cost-adjusted valuation term. When $\rho = 0$ (no friction), the pricing rule collapses to the standard Hotelling pricing relation, $P_C = (1 + P_U + V)/2$. As ρ increases, regulatory costs raise the effective marginal cost and thus the equilibrium price.

J.4 Equilibrium Prices and Monetary Policy

Having derived each insurer's best-response function, we now characterize the equilibrium prices and their sensitivities to interest rates. The equilibrium in this Hotelling-type framework arises from the intersection of the two insurers' best-response curves, capturing both strategic interactions in price setting and the role of financial frictions that distort the constrained insurer's effective marginal cost.

Proposition J.1 (Frictionless Benchmark). Consider first the case without financial frictions, $\rho = 0$. Then, the equilibrium price of the constrained insurer is given by

$$P_C = 1 + V, \quad (\text{J17})$$

and, therefore,

$$\frac{\partial \log P_C}{\partial r_f} = -\frac{V}{1+V}. \quad (\text{J18})$$

Proposition J.1 provides the benchmark pricing outcome in the absence of financial frictions. Both insurers operate symmetrically and competition leads to a constant markup of one above marginal cost. The markup reflects the degree of horizontal differentiation, captured by the unit length of the Hotelling line, limiting the extent of price competition despite identical cost structures.

The semi-elasticity of equilibrium prices with respect to the risk-free rate, $\frac{\partial \log P_C}{\partial r_f}$, depends inversely on $1+V$. This implies that as the actuarial value V of insurance coverage rises, the proportional sensitivity of prices to interest rate movements declines. Intuitively, when insurance coverage is more valuable, the absolute markup becomes less responsive to changes in financing costs.

This differs from the baseline model (without Hotelling differentiation) where demand elasticity ϵ is constant. In the spatial Hotelling setting, ϵ is endogenous (i.e., depending on the relative positioning of firms) and thus induces a nonlinear response of equilibrium prices to changes in interest rates.

Proposition J.2 (With Financial Frictions). Assume now that $\rho > 0$. Then, the semi-elasticity of the constrained insurer's equilibrium price with respect to the risk-free rate r_f is given by

$$\frac{\partial \log P_C}{\partial r_f} = -\frac{\frac{\frac{3}{2}+\hat{\rho}}{1+\hat{\rho}} + \frac{\delta V}{4} ((1+\rho)V - P_C) + \delta((1+\rho)Q_C V - \alpha)}{\frac{\frac{3}{2}+\hat{\rho}}{1+\hat{\rho}} + \frac{\frac{3}{2}}{(1+\hat{\rho})V} + \frac{\delta P_C}{4} ((1+\rho)V - P_C) + \delta Q_C P_C}, \quad (\text{J19})$$

where

$$1 + \hat{\rho} = \frac{1 + \chi(1 + \rho)}{1 + \chi}. \quad (\text{J20})$$

Proposition J.2 incorporates financial frictions into the insurer's cost of capital. The parameter ρ represents the required return on regulatory capital, while χ captures the strength of regulatory cost pass-through.

The semi-elasticity $\frac{\partial \log P_C}{\partial r_f}$ measures how sensitive the constrained insurer's equilibrium premium is to changes in the risk-free rate. Several effects interact in determining the sign and magnitude of this sensitivity:

1. Higher interest rates typically reduce the present value of liabilities and therefore decrease the actuarial value V of coverage, exerting downward pressure on P_C . This effect dominates in the absence of frictions.
2. The constrained insurer's assets and liabilities both depend on interest rates. When the insurer's asset sensitivity (captured by $\alpha = -\frac{\partial A_C}{\partial r_f} > 0$) exceeds that of liabilities, higher rates erode asset values disproportionately, tightening capital constraints.
3. Financial frictions, summarized by δ and χ , amplify the impact of interest rate changes by magnifying how balance sheet adjustments affect the shadow cost of capital. This amplification shifts the best-response curve upward, leading to higher equilibrium prices even as funding costs rise.

As in the baseline model, a sufficiently large asset sensitivity ($\alpha \gg 0$) may reverse the sign of $\frac{\partial \log P_C}{\partial r_f}$, implying that prices increase when interest rates rise. Intuitively, the loss of capital induced by rate hikes tightens financial constraints, forcing the insurer to rebuild equity buffers by charging higher premiums. The presence of Hotelling-type horizontal differentiation dampens but does not eliminate this effect, as competition remains less aggressive than in an environment with perfectly elastic demand.

J.5 Proofs

Proof of Proposition J.1. Assume that $\rho = 0$. Then,

$$P_C = \frac{1 + P_U}{2} + \frac{1}{2} \frac{1 + \chi}{1 + \chi} V = \frac{1 + P_U + V}{2}. \quad (\text{J21})$$

Putting in the FOC for P_U gives

$$P_C = \frac{1 + \frac{1 + P_C + V}{2} + V}{2} \quad (\text{J22})$$

$$\Leftrightarrow \frac{3}{2} P_C = \frac{3}{2} + \frac{3}{2} V \quad (\text{J23})$$

$$\Leftrightarrow P_C = 1 + V. \quad (\text{J24})$$

□

Proof of Proposition J.2. It is useful to note that, because $P_U = (1 + P_C + V)/2$ from above and $\frac{\partial V}{\partial r_f} = -V$, it is

$$\frac{\partial P_U}{\partial r_f} = \frac{1}{2} \frac{\partial P_C}{\partial r_f} + \frac{1}{2} \frac{\partial V}{\partial r_f} \quad (\text{J25})$$

$$= \frac{1}{2} \frac{\partial P_C}{\partial r_f} - \frac{1}{2} V \quad (\text{J26})$$

Therefore,

$$\frac{\partial Q_C}{\partial r_f} = \frac{\partial}{\partial r_f} \frac{1 + P_U - P_C}{2} \quad (\text{J27})$$

$$= \frac{\frac{\partial P_U}{\partial r_f} - \frac{\partial P_C}{\partial r_f}}{2} \quad (\text{J28})$$

$$= \frac{\frac{1}{2} \frac{\partial P_C}{\partial r_f} - \frac{1}{2} V - \frac{\partial P_C}{\partial r_f}}{2} \quad (\text{J29})$$

$$= -\frac{1}{4} \frac{\partial P_C}{\partial r_f} - \frac{1}{4} V \quad (\text{J30})$$

Therefore, with the notation from the paper,

$$\frac{\partial K_C}{\partial r_f} = \frac{\partial A}{\partial r_f} + \frac{\partial}{\partial r_f} Q_C P_C - \frac{\partial}{\partial r_f} Q_C (1 + \rho) V \quad (\text{J31})$$

$$= -\alpha + \frac{\partial Q_C}{\partial r_f} P_C + Q_C \frac{\partial P_C}{\partial r_f} - (1 + \rho) \left[\frac{\partial Q_C}{\partial r_f} V + Q_C \frac{\partial V}{\partial r_f} \right] \quad (\text{J32})$$

$$= -\alpha + \left[-\frac{1}{4} P_C + Q_C \right] \frac{\partial P_C}{\partial r_f} - \frac{1}{4} V P_C - (1 + \rho) V \left[-\frac{1}{4} \frac{\partial P_C}{\partial r_f} - \frac{1}{4} V - Q_C \right] \quad (\text{J33})$$

$$= -\alpha + \left[-\frac{1}{4} P_C + Q_C + (1 + \rho) V \frac{1}{4} \right] \frac{\partial P_C}{\partial r_f} + (1 + \rho) V Q_C - \frac{1}{4} V (P_C - V(1 + \rho)) \quad (\text{J34})$$

$$= -\alpha + \left[-\frac{1}{4} P_C + Q_C + (1 + \rho) V \frac{1}{4} \right] P_C \frac{\partial \log P_C}{\partial r_f} + (1 + \rho) V Q_C - \frac{1}{4} V (P_C - V(1 + \rho)) \quad (\text{J35})$$

$$= -\alpha + \left[-\frac{1}{4} P_C + Q_C + (1 + \rho) V \frac{1}{4} \right] P_C \frac{\partial \log P_C}{\partial r_f} + \left[-\frac{1}{4} P_C + (1 + \rho) Q_C + \frac{1}{4} V (1 + \rho) \right] V. \quad (\text{J36})$$

From the pricing equation above, it is

$$\frac{\partial \log P_C}{\partial r_f} = \frac{\partial}{\partial r_f} \log \frac{P_C}{2P_C - (1 + P_U)} + \frac{\partial}{\partial r_f} \log \frac{1 + \chi(1 + \rho)}{1 + \chi} + \frac{\partial \log V}{\partial r_f}. \quad (\text{J37})$$

The second term gives

$$\frac{\partial}{\partial r_f} \log \frac{1 + \chi(1 + \rho)}{1 + \chi} \quad (\text{J38})$$

$$= \frac{1 + \chi}{1 + \chi(1 + \rho)} \frac{\partial}{\partial r_f} \frac{1 + \chi(1 + \rho)}{1 + \chi} \quad (\text{J39})$$

$$= \frac{1 + \chi}{1 + \chi(1 + \rho)} \frac{\frac{\partial \chi}{\partial r_f} (1 + \rho)(1 + \chi) - (1 + \chi(1 + \rho)) \frac{\partial \chi}{\partial r_f}}{(1 + \chi)^2} \quad (\text{J40})$$

$$= \frac{1 + \chi}{1 + \chi(1 + \rho)} \frac{\rho}{(1 + \chi)^2} \frac{\partial \chi}{\partial r_f} \quad (\text{J41})$$

$$= \frac{1 + \chi}{1 + \chi(1 + \rho)} \frac{\rho}{(1 + \chi)^2} \chi' \frac{\partial K_C}{\partial r_f} \quad (\text{J42})$$

$$= \frac{1 + \chi}{1 + \chi(1 + \rho)} \frac{\rho}{(1 + \chi)^2} \chi' \left(-\alpha + \left[-\frac{1}{4} P_C + Q_C + (1 + \rho) V \frac{1}{4} \right] P_C \frac{\partial \log P_C}{\partial r_f} \right. \\ \left. + \left[-\frac{1}{4} P_C + (1 + \rho) Q_C + \frac{1}{4} V(1 + \rho) \right] V \right) \quad (\text{J43})$$

with $\chi' = \frac{\partial \chi}{\partial K_C}$. The first term gives

$$\frac{\partial}{\partial r_f} \log \frac{P_C}{2P_C - (1 + P_U)} \quad (\text{J44})$$

$$= \frac{2P_C - (1 + P_U)}{P_C} \frac{\partial}{\partial r_f} \frac{P_C}{2P_C - (1 + P_U)} \quad (\text{J45})$$

$$= \frac{2P_C - (1 + P_U)}{P_C} \frac{\frac{\partial P_C}{\partial r_f} (2P_C - (1 + P_U)) - P_C (2\frac{\partial P_C}{\partial r_f} - \frac{\partial P_U}{\partial r_f})}{(2P_C - (1 + P_U))^2} \quad (\text{J46})$$

$$= \frac{2P_C - (1 + P_U)}{P_C} \frac{\frac{\partial P_C}{\partial r_f} (2P_C - (1 + P_U)) - P_C (2\frac{\partial P_C}{\partial r_f} - \frac{1}{2}\frac{\partial P_C}{\partial r_f} + \frac{1}{2}V)}{(2P_C - (1 + P_U))^2} \quad (\text{J47})$$

$$= \frac{2P_C - (1 + P_U)}{P_C} \frac{\frac{\partial P_C}{\partial r_f} \left[(2P_C - (1 + P_U)) - P_C (2 - \frac{1}{2}) \right] - \frac{1}{2}P_C V}{(2P_C - (1 + P_U))^2} \quad (\text{J48})$$

$$= \frac{2P_C - (1 + P_U)}{P_C} \frac{\frac{\partial P_C}{\partial r_f} \left[(0 - (1 + P_U)) - P_C (0 - \frac{1}{2}) \right] - \frac{1}{2}P_C V}{(2P_C - (1 + P_U))^2} \quad (\text{J49})$$

$$= \frac{1}{P_C} \frac{P_C \frac{\partial \log P_C}{\partial r_f} \left[\frac{1}{2}P_C - (1 + P_U) \right] - \frac{1}{2}P_C V}{(2P_C - (1 + P_U))} \quad (\text{J50})$$

$$= \frac{\frac{\partial \log P_C}{\partial r_f} \left[\frac{1}{2}P_C - (1 + P_U) \right] - \frac{1}{2}V}{(2P_C - (1 + P_U))}. \quad (\text{J51})$$

Putting these together with $\frac{\partial \log V}{\partial r_f} = \frac{\partial -r_f}{\partial r_f} = -1$ gives

$$\frac{\partial \log P_C}{\partial r_f} = -\frac{\frac{\partial \log P_C}{\partial r_f} \left[1 + P_U - \frac{1}{2}P_C\right] + \frac{1}{2}V}{(2P_C - (1 + P_U))} + \frac{1 + \chi}{1 + \chi(1 + \rho)} \frac{\rho}{(1 + \chi)^2} \chi' \frac{\partial K_C}{\partial r_f} - 1 \quad (\text{J52})$$

$$\begin{aligned} &= -1 - \frac{\frac{\partial \log P_C}{\partial r_f} \left[1 + P_U - \frac{1}{2}P_C\right] + \frac{1}{2}V}{2P_C - (1 + P_U)} + \frac{1 + \chi}{1 + \chi(1 + \rho)} \frac{\rho}{(1 + \chi)^2} \chi' \left(-\alpha \right. \\ &\quad \left. + \left[-\frac{1}{4}P_C + Q_C + (1 + \rho)V\frac{1}{4} \right] P_C \frac{\partial \log P_C}{\partial r_f} + \left[-\frac{1}{4}P_C + (1 + \rho)Q_C + \frac{1}{4}V(1 + \rho) \right] V \right) \end{aligned} \quad (\text{J53})$$

$$\begin{aligned} &= -1 + \frac{\partial \log P_C}{\partial r_f} \left[-\frac{1 + P_U - \frac{1}{2}P_C}{2P_C - (1 + P_U)} + \frac{1 + \chi}{1 + \chi(1 + \rho)} \frac{\rho}{(1 + \chi)^2} \chi' \left[-\frac{1}{4}P_C + Q_C + (1 + \rho)V\frac{1}{4} \right] P_C \right] \\ &+ V \left[-\frac{1}{2} \frac{1}{2P_C - (1 + P_U)} + \frac{1 + \chi}{1 + \chi(1 + \rho)} \frac{\rho}{(1 + \chi)^2} \chi' \left[-\frac{1}{4}P_C + (1 + \rho)Q_C + \frac{1}{4}V(1 + \rho) \right] \right] \\ &- \frac{1 + \chi}{1 + \chi(1 + \rho)} \frac{\rho}{(1 + \chi)^2} \chi' \alpha \end{aligned} \quad (\text{J54})$$

$$\begin{aligned} &= -1 + \frac{\partial \log P_C}{\partial r_f} \left[-\frac{1 + P_U - \frac{1}{2}P_C}{2P_C - (1 + P_U)} - \delta \left[-\frac{1}{4}P_C + Q_C + (1 + \rho)V\frac{1}{4} \right] P_C \right] \\ &+ V \left[-\frac{1}{2} \frac{1}{2P_C - (1 + P_U)} - \delta \left[-\frac{1}{4}P_C + (1 + \rho)Q_C + \frac{1}{4}V(1 + \rho) \right] \right] + \delta \alpha \end{aligned} \quad (\text{J55})$$

$$\Leftrightarrow \frac{\partial \log P_C}{\partial r_f} = \frac{-1 + V \left[-\frac{1}{2} \frac{1}{2P_C - (1 + P_U)} - \delta \left(-\frac{1}{4}P_C + (1 + \rho)Q_C + \frac{1}{4}V(1 + \rho) \right) \right] + \delta \alpha}{1 + \frac{1 + P_U - \frac{1}{2}P_C}{2P_C - (1 + P_U)} + \delta \left[-\frac{1}{4}P_C + Q_C + (1 + \rho)V\frac{1}{4} \right] P_C} \quad (\text{J56})$$

$$= -\frac{1 - V \left[-\frac{1}{2} \frac{1}{2P_C - (1 + P_U)} - \delta \left(-\frac{1}{4}P_C + \frac{1}{4}V(1 + \rho) \right) \right] + \delta((1 + \rho)Q_C V - \alpha)}{1 + \frac{1 + P_U - \frac{1}{2}P_C}{2P_C - (1 + P_U)} + \delta \left[-\frac{1}{4}P_C + Q_C + (1 + \rho)V\frac{1}{4} \right] P_C} \quad (\text{J57})$$

with $\delta = -\frac{\rho}{(1 + \chi(1 + \rho))(1 + \chi)} \chi' \geq 0$.

Note that the FOC for P_U implies that

$$\frac{1 + P_C + V}{2} = P_U \quad (\text{J58})$$

$$\Leftrightarrow 1 + \frac{1 + V}{2} = 1 + P_U - \frac{1}{2}P_C \quad (\text{J59})$$

$$\Leftrightarrow \frac{3 + V}{2} = 1 + P_U - \frac{1}{2}P_C \quad (\text{J60})$$

$$(\text{J61})$$

Moreover, the equilibrium price for P_C gives that

$$2P_C - (1 + P_U) = 2\frac{1 + P_U}{2} + 2\frac{1}{2}\frac{1 + \chi(1 + \rho)}{1 + \chi}V - (1 + P_U) \quad (\text{J62})$$

$$= 1 + P_U + 2\frac{1}{2}\frac{1 + \chi(1 + \rho)}{1 + \chi}V - (1 + P_U) \quad (\text{J63})$$

$$= \frac{1 + \chi(1 + \rho)}{1 + \chi}V \quad (\text{J64})$$

Using this above yields

$$\frac{\partial \log P_C}{\partial r_f} = - \frac{1 - V \left[-\frac{1}{2} \frac{1}{\frac{1 + \chi(1 + \rho)}{1 + \chi} V} - \delta \left(-\frac{1}{4} P_C + \frac{1}{4} V(1 + \rho) \right) \right] + \delta((1 + \rho)Q_C V - \alpha)}{1 + \frac{\frac{3 + V}{2}}{\frac{1 + \chi(1 + \rho)}{1 + \chi} V} + \delta \left[-\frac{1}{4} P_C + Q_C + (1 + \rho)V\frac{1}{4} \right] P_C} \quad (\text{J65})$$

Simplifying:

$$\frac{\partial \log P_C}{\partial r_f} = - \frac{1 - V \left[-\frac{1}{2} \frac{1}{\frac{1 + \chi(1 + \rho)}{1 + \chi} V} - \delta \left(-\frac{1}{4} P_C + \frac{1}{4} V(1 + \rho) \right) \right] + \delta((1 + \rho)Q_C V - \alpha)}{1 + \frac{\frac{3 + V}{2}}{\frac{1 + \chi(1 + \rho)}{1 + \chi} V} + \delta \left[-\frac{1}{4} P_C + Q_C + (1 + \rho)V\frac{1}{4} \right] P_C} \quad (\text{J66})$$

$$= - \frac{1 + \frac{1}{2} \frac{1}{1 + \hat{\rho}} + \frac{\delta V}{4} ((1 + \rho)V - P_C) + \delta((1 + \rho)Q_C V - \alpha)}{1 + \frac{3}{2} \frac{1}{(1 + \hat{\rho})V} + \frac{1}{1 + \hat{\rho}} + \frac{\delta P_C}{4} ((1 + \rho)V - P_C) + \delta Q_C P_C} \quad (\text{J67})$$

$$= - \frac{\frac{\frac{3}{2} + \hat{\rho}}{1 + \hat{\rho}} + \frac{\delta V}{4} ((1 + \rho)V - P_C) + \delta((1 + \rho)Q_C V - \alpha)}{\frac{(1 + \hat{\rho})V + \frac{3}{2} + \frac{1}{2} V}{(1 + \hat{\rho})V} + \frac{\delta P_C}{4} ((1 + \rho)V - P_C) + \delta Q_C P_C} \quad (\text{J68})$$

$$= - \frac{\frac{\frac{3}{2} + \hat{\rho}}{1 + \hat{\rho}} + \frac{\delta V}{4} ((1 + \rho)V - P_C) + \delta((1 + \rho)Q_C V - \alpha)}{\frac{\frac{3}{2} + \hat{\rho}}{1 + \hat{\rho}} + \frac{\frac{3}{2}}{(1 + \hat{\rho})V} + \frac{\delta P_C}{4} ((1 + \rho)V - P_C) + \delta Q_C P_C} \quad (\text{J69})$$

$$(\text{J70})$$

where $1 + \hat{\rho} = \frac{1 + \chi(1 + \rho)}{1 + \chi}$.

Finally, we check whether $\frac{1}{4}((1+\rho)V - P_C) + Q_C > 0$. From the equilibrium price, it is

$$P_C = \frac{1+P_U}{2} + \frac{1}{2} \frac{1+\chi(1+\rho)}{1+\chi} V \quad (\text{J71})$$

$$= \frac{1+\frac{1+P_C+V}{2}}{2} + \frac{1}{2} \frac{1+\chi(1+\rho)}{1+\chi} V \quad (\text{J72})$$

$$= \frac{1}{2} + \frac{P_C+V}{4} + \frac{1}{2} \frac{1+\chi(1+\rho)}{1+\chi} V \quad (\text{J73})$$

$$\Leftrightarrow P_C = \frac{4}{3} \frac{1}{2} + \frac{4}{3} \frac{V}{4} + \frac{4}{3} \frac{1}{2} \frac{1+\chi(1+\rho)}{1+\chi} V \quad (\text{J74})$$

$$= \frac{2}{3} + \frac{1}{3} \left[1 + 2 \frac{1+\chi(1+\rho)}{1+\chi} \right] V \quad (\text{J75})$$

$$= \frac{2}{3} + V + \frac{2}{3} \frac{\rho\chi}{1+\chi} V \quad (\text{J76})$$

and, thus,

$$\frac{1}{4}((1+\rho)V - P_C) + Q_C > 0 \quad (\text{J77})$$

$$\Leftrightarrow (1+\rho)V - P_C + 4Q_C > 0 \quad (\text{J78})$$

$$\Leftrightarrow (1+\rho)V - P_C + 4 \frac{1+P_U - P_C}{2} > 0 \quad (\text{J79})$$

$$\Leftrightarrow (1+\rho)V - P_C + 4 \frac{1+\frac{1+P_C+V}{2} - P_C}{2} > 0 \quad (\text{J80})$$

$$\Leftrightarrow (1+\rho)V - P_C + 2 \left(1 + \frac{1+P_C+V}{2} - P_C \right) > 0 \quad (\text{J81})$$

$$\Leftrightarrow (1+\rho)V - P_C + 2 + 1 + P_C + V - 2P_C > 0 \quad (\text{J82})$$

$$\Leftrightarrow (2+\rho)V + 3 - 2P_C > 0 \quad (\text{J83})$$

$$\Leftrightarrow \frac{(2+\rho)V + 3}{2} > \frac{2}{3} + V + \frac{2}{3} \frac{\rho\chi}{1+\chi} V \quad (\text{J84})$$

$$\Leftrightarrow \frac{\rho V}{2} - \frac{2}{3} \frac{\rho\chi}{1+\chi} V + \frac{3 \times 3 - 4}{2 \times 3} > 0 \quad (\text{J85})$$

$$\Leftrightarrow \frac{1}{6(1+\chi)} [3\rho(1+\chi) - 4\rho\chi] V + \frac{5}{6} > 0 \quad (\text{J86})$$

$$\Leftrightarrow \frac{3-\chi}{1+\chi} \rho V + 5 > 0, \quad (\text{J87})$$

which provides an upper bound for the marginal cost of capital.

□