Rethinking Mortgage Design: The Trade-off Between Household Insurance and Financial Stability*

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Abstract

This paper investigates how mortgage structure shapes the transmission of inflation shocks through a "dual channel" where household wealth effects compete with bank credit supply. We develop a quantitative general equilibrium model featuring heterogeneous households and capital-constrained intermediaries to isolate these opposing forces. We demonstrate that in Fixed-Rate Mortgage (FRM) economies, the "Fisher channel" windfall for borrowers is mirrored by concentrated valuation losses for banks; this capital erosion triggers a financial accelerator that causes a severe recession. Conversely, the model shows that Adjustable-Rate Mortgage (ARM) economies mute systemic risk by preserving the real value of mortgage assets. The model reveals important distributional consequences of mortgage structure: the FRM economy "socializes" the cost of the shock, disproportionately harming renters and the poor through the recession, while benefiting the highly leveraged. The ARM economy, on the other hand, "privatizes" the risk, concentrating the impact on indebted borrowers. We validate these predictions empirically using the 2021-2023 U.S. tightening cycle, confirming that while household FRM exposure supports demand, bank FRM exposure sharply curtails credit.

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1 Introduction

Unexpected inflation fundamentally reshapes the economy by redistributing wealth between creditors and debtors, a mechanism classically known as the "Fisher channel." When inflation surges, the real value of nominal debt erodes, generating a windfall for borrowers at the expense of lenders. Conventional macroeconomic wisdom suggests that this redistribution can be expansionary: wealth transfers from older, lower-marginal-propensity-to-consume (MPC) creditors to younger, high-MPC debtors, thereby stimulating aggregate demand. However, this view relies on the assumption that the "lender" is an unconstrained household. This paper challenges that conclusion by analyzing what happens when the lender is a leveraged financial intermediary. We argue that the macroeconomic transmission of an inflation shock is not determined solely by household wealth gains, but by a "dual channel" where the credit supply response of leveraged banks works in direct opposition to the household demand channel.

The structure of mortgage contracts, Fixed-Rate Mortgages (FRMs) versus Adjustable-Rate Mortgages (ARMs), plays an important role on how this trade-off resolves. In an economy dominated by FRMs, unexpected inflation generates a potent Fisher effect. Households with fixed-rate debt receive a significant wealth windfall as the real value of their balances declines. However, because household liabilities are bank assets, these gains are mirrored by concentrated losses on the balance sheets of financial intermediaries. As inflation surges, the real value of bank assets declines, eroding bank capital and triggering a financial accelerator mechanism that forces banks to curtail lending. In stark contrast, these effects are muted in an economy dominated by ARMs, as the increase in inflation drives up nominal mortgage rates, leaving the real interest rate largely unchanged and limiting mortgage valuation changes for both households and banks.

To formalize these mechanisms and explore their general equilibrium implications, we develop a quantitative model with heterogeneous households and a constrained banking sector. The model features overlapping generations of households who make life-cycle decisions about consumption, savings, and housing tenure—choosing to rent, own a home outright, or finance a purchase with a mortgage. Banks issue both long-term defaultable mortgages (either FRMs or ARMs) to households and short-term working capital loans to firms.

To isolate the impact of inflation on these long-term nominal contracts, we assume that all prices are flexible. This modeling choice is deliberate. Long-term nominal debt represents

arguably the most significant nominal rigidity in the economy. Our goal is to isolate how unexpected inflation interacts with this rigidity to redistribute wealth (the Fisher channel) and impair financial intermediation (the bank capital channel). By abstracting from high-frequency price stickiness, we focus squarely on these powerful balance sheet effects and the resulting credit supply dynamics, rather than the aggregate demand channels typically emphasized in New Keynesian frameworks.

We first use the model to analyze the economy's response to an unexpected inflation shock similar to the one observed during 2021-23. We find that the two mortgage regimes (FRM and ARM) behave very differently. In the FRM economy, while households with fixed-rate debt receive a significant wealth windfall as inflation erodes the real value of their loans, the corresponding losses are concentrated on the leveraged and constrained balance sheets of banks. This triggers a severe "financial accelerator" dynamic: bank capital declines sharply (more than 40 percent), hence banks reduce credit supply (lending rate increases more than 4 percentage points). The economy experiences a recession with falling output (1.5 percent), consumption (0.7 percent), house prices (3.2 percent), and wages (3.2 percent).

While the U.S. economy did not enter a formal recession during 2021–2023, the model aligns closely with the underlying dynamics of this episode and offers key insights into this "missing recession." The acute financial instability observed in Spring 2023 directly validates the model's bank capital channel; the stress occurred precisely because of the valuation losses we identify. Our analysis suggests that the FRM-induced impairment of credit supply was a major, if partially obscured, headwind. The fact that a deep contraction was averted is attributable to several critical factors. First, residual pandemic-era fiscal buffers supported household demand. Second, extraordinary liquidity interventions (notably the Bank Term Funding Program) averted a systemic credit freeze when bank stress materialized. Third, as we demonstrate later, the FRM structure creates a severe conflict between price stability and financial stability, constraining the central bank's reaction function. A relatively accommodative stance early in the inflation episode, characterized by a delay in aggressive tightening, significantly mitigated the immediate valuation shock to bank capital. This constrained policy response likely prevented a severe financial accelerator from taking hold.

Beyond these aggregate outcomes, the model uncovers some important distributional consequences. We find that the FRM system effectively "socializes" the cost of the shock. The bank-driven recession disproportionately harms renters and the poor through income losses. Meanwhile, wealthy, and highly leveraged, homeowners enjoy a net welfare gain as their real debt burden declines. The ARM system, in contrast, "privatizes" the risk. The economic

pain is concentrated on indebted borrowers, who face immediate payment shocks, while the wider economy and non-indebted households remain largely insulated.

We utilize this framework to explore how the regulatory environment mediates these macroeconomic trade-offs, focusing first on the role of bank leverage. Our analysis reveals that the financial fragility inherent in the FRM system is highly sensitive to the initial capitalization of the banking sector. When banks are highly leveraged, the negative impact of rising rates on their fixed-rate assets is magnified, leading to a significantly deeper credit crunch and recession. In contrast, the ARM economy remains resilient across different levels of leverage, as the underlying interest rate risk is transferred away from financial intermediaries. This points to a critical policy implication: stringent macroprudential regulation, particularly concerning bank capital requirements, is essential for mitigating the systemic risks associated with FRM markets.

The model also sheds light on the interaction between mortgage structure and the central bank's policy stance. In an FRM economy, policymakers face a dilemma when responding to inflation. An aggressive tightening, while aimed at controlling prices, simultaneously exacerbates the valuation losses on bank balance sheets, amplifying financial instability and deepening the recession. This highlights a constraint on monetary policy efficacy due to the conflict between price stability and financial stability. Conversely, the central bank in an ARM economy is more flexible, as the banking sector is insulated from interest rate risk, allowing for a more decisive response to inflation without triggering systemic financial distress.

We empirically test this dual channel hypothesis by exploiting the 2021-2023 rise in inflation as a natural experiment. Our empirical strategy leverages this episode through a multi-layered approach that moves from state-level aggregate outcomes down to granular bank- and firm-level behavior.

We first provide evidence for the existence of the dual channel with a state-level "horse race" regression using a border-discontinuity design. This approach compares economic outcomes in neighboring states, controlling for unobserved regional shocks. After conditioning on a rich set of pre-determined state characteristics, we find that the two channels operate with opposing signs and are both economically and statistically significant. A higher share of FRMs held by consumers acts as a powerful insurance, significantly boosting state-level consumption, GDP, and personal income. Simultaneously, a higher exposure to banks holding FRMs acts as a significant drag to these same outcomes.

We then provide direct evidence for the credit supply mechanism through a series of more

granular tests. We first document market-based evidence for the underlying bank distress. Equity market data reveals that banks with greater exposure to FRMs experienced significantly larger stock price declines, deeper drawdowns, and heightened volatility during this period. Second, using bank-level Call Report data, we show that banks with higher pre-existing ARM shares (and thus lower FRM exposure) significantly increased their overall and commercial loan growth. Third, to cleanly separate supply from demand, we use bank-county lending data and employ county fixed effects. This specification confirms that, within the same local market, banks with more ARMs expanded lending to small businesses more aggressively. Finally, we link this credit expansion to real economic outcomes using a Rajan and Zingales (1998) framework. We find that employment in sectors with a high dependence on external finance grew significantly more in regions served by a more ARM-exposed banking sector.

Literature Review Our paper contributes to three interconnected strands of literature. First, our research complements studies analyzing the macroeconomic implications of mortgage design. Recently, Hedlund et al. (2025) focus on the "lock-in" effect of FRMs to explain cross-country housing market divergence during the 2021-2024. Elenev and Liu (2024) analyzes the balance between credit risk (ARMs) and interest rate risk (FRMs) in a real, endowment economy framework to optimize mortgage duration. In FRM-dominated economies, the literature often focuses on the Fisher channel—the wealth redistribution caused by unexpected inflation. Foundational work by Doepke and Schneider (2006b) (see also Doepke and Schneider (2006c), Doepke and Schneider (2006a), and Doepke et al. (2015)) quantified how inflation erodes the real value of nominal debt, benefiting young, middle-class debtors at the expense of wealthy, older creditors. In their general equilibrium analysis, aggregate effects arise purely from asymmetries in household responses: young borrowers adjust their labor supply and savings differently than old, often retired, lenders. Recent work by Pallotti (2023) and Pallotti (2022) documents the large scale of this wealth transfer during the 2021 U.S. inflation shock, arguing it significantly stimulated aggregate demand and contributed to the "missing recession."

Our paper contributes to this literature by introducing a constrained financial sector and highlighting the critical role of the bank capital channel. By doing so we argue that focusing only on the household side of the Fisher channel is incomplete. When banks hold fixed-rate assets, the household gains are mirrored by concentrated losses on the balance sheets of leveraged intermediaries. As a result, an inflation shock erodes bank capital, triggering a financial accelerator effect: a credit crunch that impacts firm hiring and wages. We provide evidence (empirical and general equilibrium) demonstrating that this credit supply contraction, driven

by bank balance sheet distress, can overwhelm the positive wealth effects experienced by households, leading to a recession rather than an expansion.

Second, our paper also relates to the literature that the effects of mortgage contract structure on monetary policy effectiveness. The conventional view emphasizes the "household cash-flow channel," where ARMs amplify policy transmission by directly exposing household balance sheets to interest rate changes. Cross-country evidence supports this view; Calza et al. (2013) show that policy has a stronger effect on housing markets in countries dominated by variable-rate mortgages. Quantitative models like Garriga et al. (2013) formalize this mechanism. Recently, Sciacovelli (2024) finds that the transmission through ARMs is powerful only when held by liquidity-constrained, high-MPC households. Similarly, Pallotti et al. (2024) highlights the real welfare costs borne by young ARM-holders during the recent tightening. Micro-level evidence from U.S. easing episodes also confirms that payment reductions for ARM-holders stimulate consumption (Di Maggio et al. (2017)).[1]

Our paper argues that focusing solely on this household-level transmission, however powerful, presents an incomplete and potentially misleading picture. While the literature convincingly documents the “household vulnerability” channel of ARMs, it often emphasizes the expansionary potential of the Fisher channel in FRM economies. We introduce a powerful and countervailing “bank vulnerability” channel associated with FRMs. Our contribution to this literature is threefold. First, we study an inflationary episode where nominal rates increased, where borrowing constraints may create asymmetries. Second, we empirically document and quantify the powerful supply-side contraction generated by the bank vulnerability channel, showing how the concentration of nominal valuation risk in FRMs can trigger a credit crunch that overwhelms the positive Fisher channel effects. This highlights a potential "missing intercept" problem in studies relying on regional variation: by focusing on cross-sectional household exposure, they may correctly identify the partial equilibrium response but fail to capture the general equilibrium credit contraction, leading to misleading conclusions about the aggregate effects of monetary policy. Third, by bringing the household and bank channels into a single quantitative calibrated framework, our “dual channel” approach provides a more complete understanding of transmission of an inflation shock and its distributional consequences.

Third, our paper contributes to the literature that studies the bank interest rate risk exposure.

[1]The importance of debt structure extend beyond household mortgages. Ippolito et al. (2018) identify a "floating-rate channel" for firms, where monetary policy directly affects the liquidity and investment of firms holding floating-rate corporate debt.

A line of research suggests banks are vulnerable; English et al. (2018) show bank stock prices decline following rate increases, particularly for banks with larger maturity mismatches. Relatedly, Gomez et al. (2021) find that banks with larger "income gaps" (more rate-sensitive assets than liabilities) maintain lending better when rates rise. And Altunok et al. (2025) argue that banks with a higher share of ARM mortgages, are perform relatively (e.g., lend more) better when monetary policy tightens, mitigating the monetary policy transmission. However, a significant strand of literature argues that banks possess effective natural hedges. Drechsler et al. (2021) emphasize the role of the "deposit franchise." They argue that sticky deposit rates allow banks to increase deposit spreads when rates rise, effectively hedging their net interest margins (NIM). We advance this literature by arguing that the composition of the mortgage portfolio is a critical source of balance sheet exposure that challenges the view of complete bank insulation. While the deposit franchise may protect NIM (cash flow), it does not protect against massive valuation losses on long-duration assets (balance sheet). As demonstrated by the 2023 banking stress, unrealized losses impair a bank's economic capital and constrain lending, regardless of short-term NIM stability. Our focus is on this capital erosion and the resulting financial accelerator.

2 Quantitative Model

We build on the framework developed in Arslan et al. (2025), extending their model to examine the differential effects of mortgage structure on the dynamics of the inflation shock. The economy features five sectors: households, banks (financial intermediaries), rental housing companies, production firms, and government. Households derive utility from consuming non-durable goods and housing services, with the former produced by firms that employ labor from working-age households and rent capital from all households. A key friction arises from firms' need to finance a portion of wage payments through bank credit.

Households access housing services via two channels: direct homeownership or rentals from rental housing companies. The banking sector intermediates between depositors and borrowers, originating long-term residential mortgages while providing short-term working capital loans to firms. There is a pay-as-you-go social security system, administered by the government and funded by payroll taxation.

The model abstracts from aggregate uncertainty but analyzes transitional dynamics following unanticipated shocks. There is perfect foresight except during shock realizations. We also abstract from nominal rigidities in prices and wages. By doing so, the model highlights how changes in the price level interact with the mortgage structure to affect the real economy.

Given household heterogeneity in equilibrium, prices, value functions, and decision rules depend on both aggregate conditions and the household distribution, though we suppress this notation for clarity. Housing supply remains fixed at $\bar{H}$, allocated between household ownership and the rental sector.

2.1 Households

Households provide labor services inelastically throughout their working years until reaching the mandatory retirement threshold J_r, with total lifespan extending to J periods where $J > J_r$. The income for household i at age j follows:

$$y(j, z_j) = \begin{cases} (1-\tau)w \exp(f(j) + z_j), & \text{if } j \leq J_r \\ w y_R(z_{J_r}), & \text{if } j > J_r \end{cases}$$

The specification incorporates a deterministic age-earnings profile through $f(j)$, while idiosyncratic productivity shocks z_j evolve stochastically according to a first-order autoregressive process:

$$z_j = \rho_\varepsilon z_{j-1} + \varepsilon_j, \quad \varepsilon_j \sim \text{i.i.d. } \mathcal{N}(0, \sigma_\varepsilon^2)$$

Here, w represents the market price per efficiency unit of labor, with τ denoting the payroll tax rate. Post-retirement benefits $y_R(z_{J_r})$ are calculated as a function of pre-retirement income and calibrated to mirror the U.S. Social Security benefit formula.

Household preferences follow Epstein-Zin specification over consumption goods and housing services:

$$V_{j,i} = \left(u(c_j^i, s_j^i) + \beta \mathbb{E}_j \left[V_{j+1,i}^{1-\sigma} \right]^{\frac{1-\rho}{1-\sigma}} \right)^{\frac{1}{1-\rho}}$$

where the discount factor β captures time preference, c_j^i denotes non-durable consumption, s_j^i represents housing service flows for household i at age j, $\mathbb{E}_j$ is the conditional expectation operator, the parameter ρ controls the elasticity of intertemporal substitution, and σ measures risk aversion.

Housing Tenure Decisions: Young households initially participate in rental markets, selecting their optimal housing quantity at the rental rate p_r per unit. We assume that rental properties and owner-occupied properties come in different sizes. The maximum rental size is set to $\underline{h}$, which also represents the minimum size for owner-occupied housing units.

The transition to homeownership remains available throughout the life cycle. Although the model excludes unsecured debt, households may utilize mortgage financing for home purchases, constrained by down payment requirements. Mortgage terms—including down payment size and interest rates—are endogenously determined and depend on household characteristics.

Current homeowners face a rich menu of options: continue in their existing residence, liquidate their property to return to renting, default, refinance, or adjust housing size by selling their current home and purchasing a new one. Real estate transactions are subject multiple frictions. Property sales incur a proportional transaction cost of φ_s, reflecting brokerage commissions and related expenses. Mortgage origination imposes both a fixed charge φ_f and a variable fee φ_m proportional to loan size.

Strategic default remains feasible but triggers exclusion from mortgage markets. Such households transition to inactive renter status, regaining mortgage market access stochastically with per-period probability π. This structure generates three distinct housing market states: (1) Owner-occupiers, (2) Active rental market participants, (3) Inactive renters.

Mortgage Structure: For tractability, we assume that mortgages are due by the end of life, so that the household's age captures the maturity of the mortgage contract. The mortgage contract can be characterized by its maturity, T, mortgage interest rate, r_m, and the periodic mortgage payment m. We assume that the mortgage payments, m, follow the standard amortization formula equating the presented discounted value of the mortgage payment discounted at the mortgage interest rate and the mortgage principal d:

$$\begin{aligned} d &= m + \frac{m}{1+r_m} + \frac{m}{(1+r_m)^2} + ... + \frac{m}{(1+r_m)^{T-1}} \\ m &= d\frac{r_m}{1+r_m-(1+r_m)^{1-T}} \end{aligned} \tag{1}$$

That is, knowing the mortgage principal, d, and the mortgage interest rate, r_m, together with the mortgage maturity, which is tied to the age of the household (j): $T = J - j + 1$,determines the mortgage payments. Given the default risk depends on the characteristics of households, mortgage interest rate is different for all households. However, to reduce the dimensionality of the problem, following Hatchondo et al. (2015) and Kaplan et al. (2020), we assume that mortgage interest rate is set to the same "risk-free" mortgage rate, $\bar{r}_m$, for all households, and the individual default risk is incorporated at the mortgage price during the origination. Higher default risk will show up as a lower mortgage price and result in resources lower than

mortgage principal for the household. The real life interpretation of this is that households pay an upfront fee to reduce the individual mortgage interest rate to a uniform "risk-free" mortgage interest rate.

The distinction between the FRM and ARM is how "risk-free" mortgage interest rate $\bar{r}_m$ is set. With FRM, we assume that this rate is set to the bank lending rate, r_ℓ, at the origination and does not change throughout the life of the mortgage contract. With ARM, this rate is reset to the current bank lending rate, r_ℓ, in every period. When there is no shock to the bank lending rate, FRM and ARM will be identical. However, as the economy experiences changes to the bank lending rate, these two contracts will have different implications.

Households' Problem (Home Buyer): This section presents the dynamic optimization problem faced by a home buyer. Additional dynamic optimization problems of the households are provided in Appendix B.2. If an active renter decides to purchase a home, she selects a mortgage debt level d, which determines the mortgage price at origination, denoted by $q^m(d; a', h, z, j)$. This price depends on the choice of the mortgage debt level d together with the other choices of the household, house size h, and asset a', and exogeneous characteristics of the households, income z and age j.

The optimization problem for an active renter who chooses to become a homeowner is formulated as:

$$V_j^{rh}(a,z) = \max_{c,d,h\geq \underline{h},a'\geq 0} \left\{ \left(u(c,h) + \beta E \left(V_{j+1}^h(a',h,d,z')^{1-\sigma} \right)^{\frac{1-\rho}{1-\sigma}} \right)^{\frac{1}{1-\rho}} \right\} \tag{2}$$

subject to the budget constraint:

$$c + (1+\delta_h)p_h h + \varphi_f + a' = y(j,z) + a(1+r_k) + d\left(q^m(d;a',h,z,j) - \varphi_m\right)$$

and the borrowing constraint:

$$d \leq (1-\iota)p_h h$$

where V^h is the continuation value for a homeowner, c is the non-durable consumption, p_h is the house price, δ_h is the proportional maintenance cost of housing, φ_f and φ_m are the fixed and variable costs of mortgage origination, r_k is the rate of return on financial assets, and ι is the minimum down payment requirement.

2.2 Firms

We consider a continuum of perfectly competitive firms that produce output using capital capital K and labor N. In addition to choosing the quantity of labor, each firm also determines the hours per worker (or labor utilization rate), denoted by, u. The wage per efficiency units of a worker $w\left(\overline{w}, u\right)$ (same as w in $y\left(j, z_j\right)$) is assumed to depend on the intensity of labor utilization. Specifically, the wage function is given by:

$$w\left(\overline{w}, u\right) = \bar{w} + \vartheta \frac{u^{1+\psi}}{1+\psi},$$

where ϑ and ψ are positive constants. This formulation implies that higher labor utilization increases the wage per efficiency unit, reflecting the rising marginal cost of more intensive labor use. In this setup, firms choose u optimally to minimize costs, workers are assumed to supply hours elastically and at no direct disutility cost, and the variables u, $\overline{w}$, and hence $w\left(\overline{w}, u\right)$ are determined in equilibrium.

In this formulation, hours are chosen by the firm, and workers are assumed to supply hours at no cost, but u, $\overline{w}$, and hence $w\left(\overline{w}, u\right)$ are determined in equilibrium. This structure generates a positive relationship between aggregate hours and wages, effectively mimicking an aggregate labor supply response to changes in aggregate wages, even though individual labor supply is inelastic.

Following Cooley and Quadrini (1999), Mendoza (2010), and Jermann and Quadrini (2012) we assume that the firm finances a fraction μ of the wage payment in advance from banks and pays interest on that portion. Then, the firm's problem is given by

$$\max_{K,N,u} \mathbb{Z} K^{\alpha} \left(Nu\right)^{1-\alpha} - \left(r_k + \delta_k\right)K - \left(1 + \mu r_{\ell}\right) w\left(\overline{w}, u\right) N, \tag{3}$$

where $\mathbb{Z}$ is TFP, and δ_k is the depreciation rate of capital. Since a worker's labor income depends on hours worked, labor income and output decline when the firm reduces work hours in response to an increase in bank lending rate r_{ℓ}.[2]

2.3 Rental Companies

Rental housing firms begin each period holding $\left(1 - \delta_h\right) H_r$ units of housing capital, reflecting depreciation at rate δ_h. These firms make dynamic investment decisions, selecting next

[2]We could have achieved the same effect with endogenous labor supply. In that case, the firm would reduce labor demand, which would reduce wages. Households would reduce labor supply and output would decline. We choose this formulation because it is easier to handle computationally.

period's housing stock H_r'. Operating revenues consist of rental income net of maintenance expenses, $(p_r - \kappa) H_r'$, where p_r denotes the per-unit rental rate and κ captures ongoing maintenance costs.

Shareholder distributions equal:

$$x_r = p_h (1 - \delta_h) H_r - p_h H_r' - \frac{\eta}{2} p_h \left(H_r' - H_r\right)^2 + (p_r - \kappa) H_r'$$

The quadratic term $\frac{\eta}{2} p_h \left(H_r' - H_r\right)^2$ represents portfolio adjustment frictions, with parameter η governing the degree of market segmentation between owner-occupied and rental segments. Larger values of η indicate greater frictions in reallocating housing between these markets.

Value maximization requires solving:

$$(1 + r_k) V^{rc} (H_r) = \max_{H_r'} \left[p_h (1 - \delta_h) H_r - p_h H_r' - \frac{\eta p_h \left(H_r' - H_r\right)^2}{2} + (p_r - \kappa) H_r' + V^{rc} \left(H_r'\right) \right] \tag{4}$$

Returns on rental company equity match those on physical capital along the equilibrium path, deviating only during unanticipated shock realizations.[3] This return equalization yields the following optimality condition linking rental rates to housing prices:

$$p_r = \kappa + p_h + \eta p_h \left(H_r' - H_r\right) - \frac{(1 - \delta_h) p_h' + \eta p_h' \left(H_r'' - H_r'\right)}{1 + r_k'} \tag{5}$$

This expression characterizes the supply side of the rental market, with demand arising endogenously from household tenure decisions.

2.4 Banks

The financial intermediation sector features a competitive market structure populated by risk-averse banks maximizing expected utility over consumption streams: $u\left(c^B\right)$, with c^B denoting banker consumption. There is no entry or exit from the banking sector.

Financial intermediaries operate with two funding sources: internal equity capital ω and external wholesale funding B' obtained at the international risk-free rate r'. On the asset side, banks extend working capital loans L_k' to firms at rate r_ℓ' and maintain portfolios of residential mortgages through both origination and secondary market purchases.

[3] Unexpected shocks may generate temporary return differentials between physical capital and rental property holdings. These valuation surprises are allocated to household portfolios proportionally based on asset positions.

Consider mortgage type $\theta = (d; a, h, z, j)$ encompassing borrower characteristics. Let $\ell'(\theta)$ denote the bank's position in type-θ mortgages, including both new originations and seasoned loans. The bank's recursive problem becomes:

$$\Psi(L, B) = \max_{\left\{c^B, L'_k, \ell, B'\right\}} \left\{\log\left(c^B\right) + \beta_L \Psi\left(L', B'\right)\right\} \tag{6}$$

subject to the balance sheet identity:

$$c^B + L'_k + \int_\theta p_\ell(\theta)\, \ell'(\theta) = \omega + B'$$

Here, β_L captures banker patience and $p_\ell(\theta)$ represents the market price of type-θ mortgages. Net worth dynamics follow:

$$\omega' = \int_\theta \int_{\theta'} v^l\left(\theta'\right) \Pi\left(\theta'|\theta\right) \ell'(\theta) + L'_k\left(1 + r'_\ell\right) - B'\left(1 + r'\right)$$

The total payoff $v^l(\theta) = m_\ell(\theta) + p_\ell(\theta)$ combines current period cash flows $m_\ell(\theta)$ with continuation values, where $\Pi(\theta'|\theta)$ captures endogenous state transitions driven by household decisions.

Cash flows from mortgage holdings depend on borrower actions:

$$m_\ell(\theta) = \begin{cases} d & \text{upon prepayment} \\ p_h h\left(1 - \varphi_e\right) & \text{upon default} \\ \frac{\bar{r}_m}{1 + \bar{r}_m - (1 + \bar{r}_m)^{j-J}} d & \text{if continuing} \end{cases} \tag{7}$$

Limited commitment introduces a friction: banks may abscond with fraction ξ of assets, forfeiting future banking privileges but retaining access to savings at rate r. This outside option value $\tilde{\Psi}^D\left(\xi \tilde{L}'\right)$ depends on realizable asset values:

$$\tilde{L}' = \int_\theta \int_{\theta'} v^l\left(\theta'\right) \Pi\left(\theta'|\theta\right) \ell'(\theta) + L'_k\left(1 + r'_\ell\right)$$

Creditors impose an incentive-compatible borrowing limit ensuring repayment:

$$\Psi\left(L', B'\right) \geq \tilde{\Psi}^D\left(\xi \tilde{L}'\right)$$

The continuum structure within borrower types eliminates portfolio risk through perfect diversification.[4] Consequently, arbitrage requires uniform returns r'_ℓ across all assets, implying:

$$p_\ell(\theta) = \frac{1}{1+r'_\ell} \int_{\theta'} v^l(\theta') \Pi(\theta'|\theta) \quad \forall \theta$$

This return equalization permits aggregation without tracking portfolio composition. The incentive constraint simplifies to a leverage restriction:

$$(1-\phi')(1+r'_\ell) L' \geq (1+r') B'$$

where the endogenous haircut ϕ' emerges from the limited commitment friction.[5]

Optimal bank policies exhibit linear scaling in net worth:

$$L' = \beta_L \widehat{\lambda} \omega \quad \text{and} \quad B' = \beta_L (\widehat{\lambda} - 1) \omega$$

with leverage ratio $\widehat{\lambda} = \frac{(1+r')}{1+r'-(1-\phi')(1+r'_\ell)}$.

Competition drives mortgage pricing to break-even levels:

$$dq^m(d; a', h, z, j) = \int_{\theta'} v^l_{t+1}(\theta') \Pi(\theta'|\theta) \tag{8}$$

This condition determines the origination discount $q^m(d; a', h, z, j)$ as a function of borrower characteristics and loan amount.

2.5 Definition of Equilibrium

We provide the definition of equilibrium for the steady state. The equilibrium definition for the transition is similar.

Definition 1. A Stationary Competitive Equilibrium is a collection of value functions for households, V^o $(o \in \{h, r, d\})$, for banks Ψ, for real estate companies, V^{rc}, policy functions for households' consumption (g_c), saving (g_a), housing services (g_s), housing stock (g_h), mortgage debt (g_d), tenure decisions (g_o), firms' labor (N), capital (K), utilization (u), real

[4] Within each borrower type θ, the continuum assumption ensures deterministic portfolio returns via the law of large numbers, preserving analytical tractability despite rich household heterogeneity.

[5] The haircut follows the recursive relation $\phi = \xi^{1-\beta_L} \left[(1+r') / (1+r'_\ell) - (1-\phi')\right]^{\beta_L}$. Perfect commitment ($\xi = 0$) eliminates both haircuts and credit spreads.

estate companies' housing stock (H_r), banks' consumption (c_B), loans (ℓ, L^k, L), borrowing (B), prices for labor (w), capital (r_k), houses (p_h), rental properties (p_r), loans (r_ℓ, q^m), taxes (τ), and a stationary distribution (Γ) such that

1. Given prices and taxes, policy functions for households solve households' problems in equations B.1-B.5, and V^o is the associated value functions for households.
2. Given prices, firms' policy functions (K, N, u) solve firms' problem in equation 3.
3. Given prices, real estate companies' policy function (H_r) solves equation 4.
4. Given prices, banks' policy functions(c_B, L, B) solve equation 6.
5. q^m solves equation 8.Given stationary distribution Γ, markets clear:

$$\begin{aligned}
\text{asset market: } \int a d\Gamma(\theta) &= A = K + V^{rc}(H_r) \\
\text{labor market: } N &= 1 \\
\text{housing market: } \int s d\Gamma(\theta) &= \bar{H} \\
\text{credit market: } L_k + \int_\theta p_\ell(\theta)\,\ell(\theta) &= L \\
\text{rental market: } \int s d\Gamma(\theta, o \in \{r, d\}) &= H_r
\end{aligned}$$

   where $L_k = \mu w(\bar{w}, u) N$ is the firm's borrowing, $\ell(\theta) = \Gamma(\theta)$, i.e. banks' mortgage holding is equal to the demand for mortgages by households, p_ℓ is given by

$$p_\ell(\theta) = \frac{1}{1 + r'_\ell} \int_{\theta'} \left(m_\ell(\theta') + p_\ell(\theta')\right) \Pi(\theta'|\theta).$$

6. Given stationary distribution Γ, the government runs balanced-budget, i.e. τ solves equation B.6
7. The distribution Γ is stationary and consistent with the policy functions of households:

$$\Gamma = G(\Gamma)$$

   where the mapping G is obtained through the policy functions of households and evolution of exogenous states.

TABLE I – Parameters (externally set and internally calibrated)

		Value	
Parameter	Explanation	External	Internal
σ	risk aversion	2	
$1/\rho$	elasticity of intertemporal substitution	0.5	
ϵ	elasticity of substitution	1	
α	capital share	$\frac{1}{3}$	
ψ	curvature on hours	0.5	
ρ_ε	persistence of income	0.92	
σ_ε	std of innovation to AR(1)	0.31	
φ_h	selling cost for a household	7%	
φ_e	selling cost for foreclosures	25%	
ζ	fixed cost of mortgage origination	0.028	
τ	variable cost of mortgage origination	0.75%	
η	rental adjustment cost	1	
π	prob. of being an active renter	0.265	
$\bar{H}$	aggregate house supply	1	
ι	down payment requirement	0	
β	discount factor		0.927
$\underline{h}$	minimum house size		0.321
r	deposit rate		5.75%
γ	weight of housing services in utility		0.211
μ	share of wage bill financed from banks		0.447
β_L	bank discount factor		0.729
ξ	bank seizure rate		0.277
κ	rental maintenance cost		-0.006
δ_h	housing depreciation rate		4.68%
δ_k	capital depreciation rate		0.129

3 Calibration

A model period corresponds to two years. Agents enter the economy at age 25, participate in the labor force through age 65, and survive until age 85. The calibration strategy combines parameters drawn from existing literature ("External") with those determined through model fitting ("Internal"), as detailed in Table I.

Household Preferences The utility function incorporates consumption and housing services through a CES specification: $u(c,s) = [(1-\gamma)c^{1-\epsilon} + \gamma s^{1-\epsilon}]^{\frac{1-\rho}{1-\epsilon}}$. We adopt standard values

for the substitution elasticity between housing and consumption ($\epsilon = 1$), following empirical evidence from Piazzesi et al. (2007). The risk aversion and intertemporal elasticity parameters are set conventionally at $\sigma = \rho = 2$, yielding an intertemporal substitution elasticity of 0.5. The housing preference weight γ is chosen to match the contribution of housing services to GDP, while the discount factor β targets the capital-output ratio.

Labor Income Dynamics The stochastic component of working-age income follows an AR(1) process with biennial persistence $\rho_\varepsilon = 0.92$ and innovation volatility $\sigma_\varepsilon = 0.31$. These values translate to annual parameters of 0.96 and 0.17 respectively, aligning with estimates from Storesletten et al. (2004). Post-retirement benefits follow the structure outlined in Guvenen and Smith (2014), approximating the U.S. Social Security system.

Production Technology Production employs a Cobb-Douglas technology with capital share $\alpha = \frac{1}{3}$. We normalize steady-state values such that $N = 1$ and $\mathbb{Z} = 1$. We set the capital depreciation rate, δ_k, to match the non-residential investment-to-output ratio. Following Arslan et al. (2025), we set the hours elasticity parameter to $\psi = 0.5$. This allows us to generate employment responses consistent with empirical evidence, aligning with findings in Gertler and Gilchrist (2018). The scale parameter ϑ is calibrated to set the utilization rate to $u = 1$ as normalization.

Housing Market Total housing stock is normalized to $\bar{H} = 1$. The transition probability for credit-impaired households returning to mortgage eligibility is calibrated at $\pi = 0.265$, reflecting the approximately seven-year duration of adverse credit events. Transaction costs follow Campbell et al. (2011), with standard home sales incurring 7 percent costs (φ_s) while foreclosure proceedings require 25 percent (φ_e). Mortgage origination involves both fixed costs ($\zeta = 2\%$ of biennial GDP) and variable fees ($\tau = 0.75\%$ of loan value), based on (Board of Governors of the Federal Reserve System (2008). We impose no mandatory down payment ($\iota = 0$), though endogenous down payments emerge from households seeking better loan terms.

Housing depreciation occurs at δ_h matches the ratio of residential investment to output ratio. The rental maintenance parameter κ matches house price-rent ratio emerging from the steady-state pricing relationship: $p_r = \kappa + \frac{r_k + \delta_h}{1 + r_k} p_h$. The minimum owner-occupied unit size $\underline{h}$ (which is also the maximum rental size) is calibrated to match the homeownership rate. The rental market adjustment cost $\eta = 1$ generates realistic homeownership elasticities consistent with Greenwald and Guren (2024), though our results prove robust to alternative values.[6]

[6]Lower values of η produce implausibly high homeownership elasticities (exceeding 0.5) with respect to

Banking Sector There are four parameters to be calibrated related to the banking sector: the discount rate of the banks, β_L, the fraction of assets banks seize when they default, ξ, the borrowing rate of banks, r, and the fraction of wage bill firms finance from banks, μ. The first two of these parameters are identified through analytical moments obtained from bank's problem. In the steady-state, the spread between bank lending rate and borrowing rate satisfies $r_\ell - r = \frac{1-\beta_L(1+r)}{\widehat{\lambda}\beta_L}$, where leverage and haircut are defined as $\widehat{\lambda} = \frac{1+r}{1+r-(1-\phi)(1+r_\ell)}$, $\phi = \xi^{1-\beta_L}\left(\frac{1+r}{1+r_\ell} - 1 + \phi\right)^{\beta_L}$, respectively. The two targets, bank leverage rate, $\hat{\lambda}$, and the spread between the lending rate and the deposit rate, $r_\ell - r$, allow us to pin down the banker discount factor β_L and seizure parameter ξ. The other two parameters are identified through simulated moments of the model. The borrowing rate of banks effects the lending rate, which, then, effects the level of mortgage debt in the economy. We calibrate the deposit rate,r, to match the mortgage debt to GDP ratio . The fraction of wage bill financed by banks effects the level of corporate debt. We use the ratio of mortgage loans to corporate loans in bank balances to identify this parameter.

In total, we calibrate ten parameters internally: β, $\underline{h}$, r, γ, μ, β_L, ξ, κ, δ_h, and δ_k. The final five are determined analytically as described. The remaining five are jointly calibrated to match key moments in Table I: homeownership rate, mortgage debt-to-GDP ratio, capital-output ratio, ratio of mortgage loans to corporate loans in bank portfolios, and housing services share of GDP. All moments are computed as the averages of the period between 2015 and 2020. See the Appendix B.1 for the details of data sources.

price-rent ratios, as documented in Greenwald and Guren (2024).

TABLE II – Moments

Statistic	Data	Model
Capital-output ratio	3	3
Homeownership rate	64.03 percent	64.03 percent
Mortgage debt-GDP ratio	60.27 percent	60.27 percent
Share of housing services in GDP	12.49 percent	12.49 percent
Ratio of mortgage loans to total loans in bank assets	52.29 percent	52.29 percent
Mortgage premium	1.72 percent	1.72 percent
Bank leverage ratio	9.12	9.12
House price-rental price ratio	16.14	16.14
Residential investment-GDP	4.72 percent	4.72 percent
Non-residential investment-output ratio	19.32 percent	19.32 percent

Notes: Flow variables and interest rates are converted to annual frequency.

4 Results

The 2021-2023 period was characterized by a sharp rise in unexpected inflation. This inflation shock interacts differently with mortgage structure. It directly impacts the real value of nominal contracts (the Fisher channel). In an FRM economy, this generates a wealth windfall for households but concentrated valuation losses for banks. In an ARM economy, nominal rates adjust, muting the Fisher channel but affecting household cash flows (the tilting effect).

In the steady state, the FRM and ARM economies are identical, as there are no shocks to the mortgage interest rate. To analyze the differential effects of mortgage structure, we introduce an unexpected shock inflation shock where all prices, other than the nominal mortgage contracts, flexibly adjust. We solve for the full transition dynamics of the economy using global methods.

Implementation of the Inflation of Shock of 2021-2023 Between 2021 and 2023, the price level increased by 7 percent and by 2025 it increased by another 3 percent. We replicate this change in the price level by introducing the inflation shock as an unexpected 7 percentage point increase from an initial steady state of zero. Then, we assume the shock follows an AR(1) process with a biannual persistence of 0.4.[7] We assume perfect foresight regarding the

[7]These numbers are obtained by first fitting a linear trend to the price level between 2015 and 2020 (which generates trend inflation of 2 percent), and then calculating the deviation of the price level from this trend after 2020 to obtain the shock and its persistency.

path of the shock after the initial impact.[8]

In the presence of inflation, nominal mortgage payments are calculated using a similar formula as in 1:

$$D_0 = M + \frac{M}{1+R_0^m} + \frac{M}{(1+R_0^m)^2} + ... + \frac{M}{(1+R_0^m)^{T-1}} = M \sum_{t=0}^{T-1} \left(\frac{1}{1+R_0^m} \right)^t$$

where $(1+R_t^m) = (1+r_t^m)(1+\pi_t)$ with R_t^m is the nominal mortgage interest rate, r_t^m is the real interest rate, and π_t is the inflation rate at time t. D_0 is the nominal mortgage debt at time 0 and M is the constant nominal mortgage payment. This equation gives the nominal mortgage payment as a function of nominal mortgage debt, mortgage interest rate, and maturity:

$$M = \frac{D_t}{\sum_{\tau=t}^{T-1} \left(\frac{1}{1+R_0^m} \right)^{\tau-t}}$$

and nominal mortgage balance evolves according to:

$$D_{t+1} = (D_t - M)(1+R_0^m)$$

Then, real mortgage payments at time t is given by

$$m_t = \frac{M}{P_t} = \frac{D_t/P_t}{\sum_{\tau=t}^{T-1} \left(\frac{1}{1+R_0^m} \right)^{\tau-t}} = \frac{d_t}{\sum_{\tau=t}^{T-1} \left(\frac{1}{1+R_0^m} \right)^{\tau-t}}$$

and the evolution of real debt balances becomes

$$d_{t+1} = \frac{D_{t+1}}{P_{t+1}} = \frac{(D_t - M)(1+R_0^m)}{P_{t+1}} = \frac{(D_t - M)(1+R_0^m)}{P_t(1+\pi_t)} = \frac{(d_t - m_t)(1+R_0^m)}{(1+\pi_t)}$$

In the ARM economy, nominal mortgage interest rate, R_0^m, is set to the current nominal bank lending rate in every period. When inflation rises temporarily, the nominal interest rate also increases, so that $(1+R_0^m) = (1+r_t^\ell)(1+\pi_t)$. As a result, mortgage payments increase. However, this increase also accelerates the amortization of the real mortgage debt balance. Consequently, the real mortgage payment schedule becomes steeper rather than flat, as in the no-inflation case. In the FRM economy, the nominal mortgage interest rate and the nominal

[8]To maintain tractability in the FRM economy, we assume the risk-free mortgage interest rate, $\bar{r}_m$, remains constant after the shock. Allowing it to vary would require tracking the vintage of each mortgage, significantly increasing the state space. Changes in the bank lending rate still affect mortgage pricing, however. The ARM economy avoids this complexity as existing mortgage rates adjust periodically.

mortgage payment (M) are fixed for existing mortgages and are not affected by inflation. Thus, an unexpected increase in the price level (P_t) immediately reduces the real value of these nominal payments ($m_t = M/P_t$). Furthermore, the real mortgage principal declines at the rate of inflation, accelerating the reduction in the real debt burden over time.

These dynamics are illustrated in Figure 1, which shows the evolution of real mortgage payments, real mortgage balances, and the real market value of mortgage debt in bank assets for a 30-year mortgage with an initial balance of 1, originated at the steady state when the biannual mortgage interest rate is 9.2 percent and inflation rate is 0 percent. The solid blue lines depict the case without an inflation shock: real mortgage payments remain constant, the real mortgage debt gradually amortizes, and the book value and market value of the mortgage debt coincide.[9] The dashed red lines and long-dash black lines show the dynamics for an ARM and an FRM mortgage, respectively, when expected biannual inflation rate temporarily rises to 7 percent and then slowly reverts to its steady-state value of 0 percent, with a biannual persistence of 0.4, as in the benchmark economy.

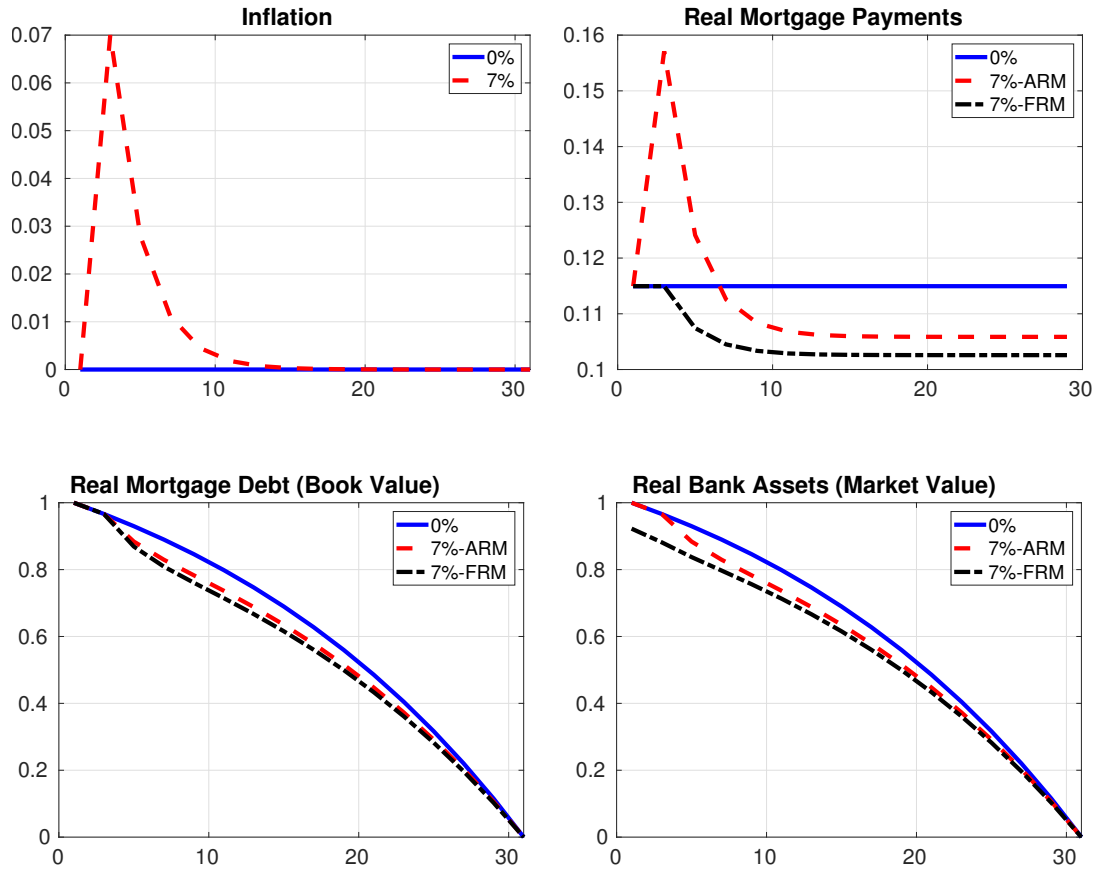
In the ARM economy, real mortgage payments spike before gradually declining to a level below their initial steady-state value. In the FRM economy, by contrast, they drop immediately below their initial steady-state level and continue to decline gradually over time. Despite the stark differences in the evolution of mortgage payments, the real mortgage debt balance (the book value of real mortgage debt) evolves similarly in both economies. However, the market value of real mortgage debt differs substantially. In the FRM economy, the sharp reduction in real mortgage payments lowers the present discounted value of mortgages, and thus the market value of the debt. In contrast, in the ARM economy, the effect is much smaller, since higher initial mortgage payments offset the reduction in future payments.

The evolution of real mortgage payments and the real market value of mortgage debt shows that the inflation shock generates real effects in the economy through two primary channels.[10] First, **unexpected** inflation drives the "Fisher effect." In the FRM economy, unexpected inflation immediately erodes the real value of existing fixed-rate mortgage payments and principals. This constitutes a wealth transfer from lenders (banks) to borrowers (households) and generates an immediate valuation shock to bank capital. This channel is largely absent in the ARM economy, where nominal interest rates adjust with inflation, stabilizing the real value of the mortgage balance. Second, higher **expected** inflation increases nominal interest

[9] With 0 percent inflation, both FRM and ARM economies yield the results for the evolution of mortgage payments and balances.

[10] Absent long-term contracts, changes in inflation would have no real effects in this framework.

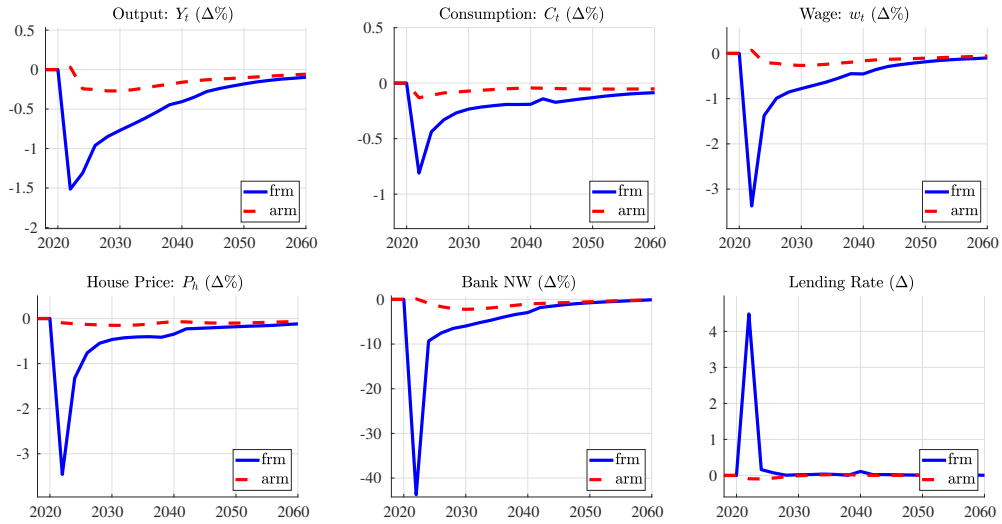
FIGURE 1 – Inflation Shock and Mortgage Dynamics



Notes: The figures show the comparison of the dynamics of real mortgage payments, real mortgage debt and real market value of mortgage debt in response to 7% inflation shock in FRM and ARM economies when initial debt balance is set to 1 and mortgage interest rate is set to a biannual value of 9.2 percent. Expected inflation is shocked to increase from 0 percent to 7 percent and reverts back to its initial value with biannual persistence 0.4. The solid blue line depicts the case without the inflation shock. The red dashed line is for ARM economy and long-dashed black line is for the FRM economy.

rates. In our benchmark, all prices (other than mortgages) are flexible, so nominal rates rise in parallel with expected inflation. Because standard amortization schedules assume constant nominal payments, positive expected inflation implies that the real value of these payments declines over time. This "tilting effect" front-loads the real payment burden, influencing household consumption and financial decisions. It is present in both FRM and ARM economies for new mortgages, and in the ARM economy for existing mortgages as they reprice.

FIGURE 2 – Model Dynamics with Inflation Shock: ARM versus FRM



Notes: The graph plots the dynamics of the model economy with the inflation shock for key variables when the mortgages ARM or FRM. The inflation shock is an unexpected 7 percentage point increase from an initial steady state of zero. The shock follows an AR(1) process with a biannual persistence of 0.4. Since there are no price rigidities other than nominal mortgage contracts, all prices, including the bank deposit rates, adjust nominally.

4.1 Aggregate Dynamics

Figure plots the aggregate effects of the inflation shock, comparing an economy comprised entirely of FRMs (blue solid line) with one entirely of ARMs (red dashed line). The divergence between the two economies highlights the critical role of the mortgage structure in macroeconomic dynamics.

The ARM Economy: Household Cash-Flow Effects and Stability In the ARM economy, the macroeconomic impact of the inflation shock is modest. Since ARM contracts pass payment risk to households, bank balance sheets are largely insulated. The primary transmission mechanism is the tilting effect on real mortgage payments: higher inflation increases current real payments while lowering future real payments. For liquidity-constrained households, this front-loading of real payments reduced consumption. However, the aggregate impact is limited, as most households smooth consumption by reducing savings, given the temporary nature of the shock.

The reduction in mortgage credit demand slightly lowers the bank lending rate. This temporarily reduces firms' financing costs, leading to a brief increase in labor demand, wages, and output. These gains are quickly reversed as reduced household savings lead to lower

capital accumulation in subsequent periods. Overall, the ARM economy show significant resilience, with output and consumption declining by only about 0.2 percent and 0.1 percent, respectively.

The FRM Economy: Financial Accelerator and Recession The dynamics in the FRM economy reveal a powerful, recessionary transmission mechanism driven by the vulnerability of the banking sector to inflation and interest rate risk. While FRM borrowers experience a wealth windfall as inflation erodes the real value of their fixed nominal debt, the corresponding real losses are concentrated on the balance sheets of the banks holding these assets. The market value of their long-term, fixed-rate mortgage portfolios declines sharply. As shown in the bottom-middle panel of Figure 2, bank net worth declines by more than 40 percent on impact.

This erosion of bank capital triggers a strong financial accelerator effect. Constrained banks significantly contract their credit supply, leading to a sharp spike in the bank lending rate (bottom-right panel), which increases by 4.5 percentage points. This highlights a crucial insight of our framework: a shock that benefits borrowers can simultaneously trigger a systemic credit crunch when the losses are borne by leveraged financial intermediaries.

The real consequences of this credit contraction are substantial and overwhelm the positive wealth effect on households. Facing sharply higher financing costs, firms reduce labor demand. This leads to a recession: output falls by about 0.8 percent, wages decline by 3.2 percent, and household consumption contracts by 0.8 percent. And house prices fall by more than 3.0 percent. These results imply that the structure of the mortgage market fundamentally alters the transmission of inflation shocks.

The model predicts a recession in the FRM economy, driven by a sharp contraction in bank net worth (over 40 percent) and a subsequent credit crunch. This contrasts with the actual U.S. experience during 2021–2023, where aggregate demand remained relatively resilient (no recession but growth slowed down significantly) despite significant stress in the banking sector—the so-called "missing recession." It is important to reconcile this discrepancy.

The model predicts a recession in the FRM economy driven by a sharp contraction in bank net worth. This contrasts with the actual U.S. experience, where growth slowed but remained positive. This divergence is not a failure of the mechanism, but rather highlights the extraordinary non-model forces that masked underlying fragility during this episode. Our framework isolates the structural vulnerability of the FRM system to assess the transmission mechanism. In reality, the negative credit supply shock was buffered by three massive interventions.

First, households entered the tightening cycle with unprecedented excess savings from fiscal transfers (CARES and ARP Acts). Second, regulatory interventions—specifically the Bank Term Funding Program (BTFP)—short-circuited the bank capital channel by valuing distressed collateral at par. Third, as discussed in Section 5.2, the central bank's initial delay in tightening acted as a form of forbearance, shielding banks from the full force of the valuation shock. Our results should therefore be interpreted as a *counterfactual of fragility*: they quantify the severe financial accelerator that *would have* materialized absent these extraordinary fiscal, regulatory, and monetary backstops.

Role of Bank Balance Sheets To isolate and quantify the contribution of the bank balance sheet channel, we conduct a counterfactual experiment. Figure 3 compares the benchmark FRM economy (solid blue line) with a counterfactual FRM economy where the bank balance sheet constraint is non-binding (dashed red line). In this counterfactual, banks still intermediate credit and price default risk, but their lending rates do not respond to changes in their own net worth. This effectively eliminates the financial accelerator mechanism.

The results clearly show that the constrained banking sector is the primary driver of the recession in the FRM economy. In the absence of the bank channel, the inflation shock is expansionary. The wealth transfer to FRM households boosts demand, leading to a 0.7 percent increase in consumption and approximate 0.3 percent increases in output, wages, and house prices.

When the bank channel is active, however, this positive demand-side impulse is entirely reversed. The credit crunch induced by the collapse in bank net worth is sufficiently large to push the economy into a significant recession. This exercise confirms that the adverse macroeconomic consequences of an inflation shock in an FRM-dominated economy are attributable to the vulnerabilities it creates within the leveraged financial sector.

This finding has critical implications for the interpretation of empirical research on the Fisher channel. Studies that focus solely on the household wealth gains from inflation often capture only the partial equilibrium demand-side response. Our general equilibrium analysis demonstrates that the offsetting credit supply contraction from the banking sector is powerful enough to overturn the sign of the aggregate impact. This highlights a fundamental "missing intercept" problem: empirical estimates of the household channel, while potentially internally valid, may provide a misleading guide to the ultimate macroeconomic consequences in an FRM system, where the general equilibrium effects of the bank balance sheet channel dominate.

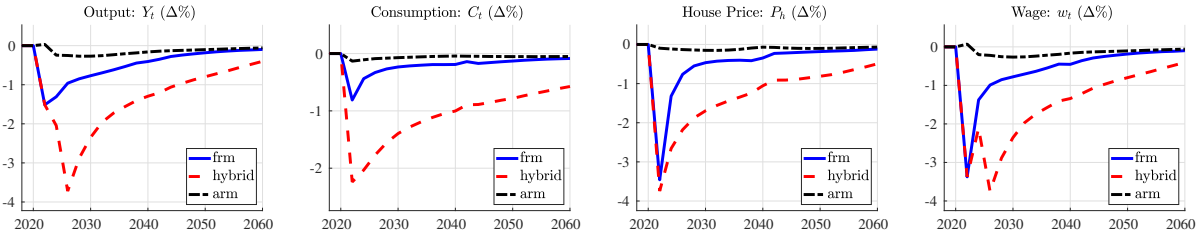
FIGURE 3 – Model Dynamics with Inflation Shock: The Role of Bank Balance Sheets

Notes: The graph plots the dynamics of the model economy with the inflation shock for key variables. The red dashed line plots where the bank balances sheet mechanism are closed. The inflation shock is an unexpected 7 percentage point increase from an initial steady state of zero. The shock follows an AR(1) process with a biannual persistence of 0.4. Since there are no price rigidities other than nominal mortgage contracts, all prices, including the bank deposit rates, adjust nominally.

In contrast to the FRM case, the bank balance sheet channel plays a very different, albeit modest, role in the ARM economy. The bottom panels of Figure 3 compare the benchmark ARM economy (solid blue line) with the counterfactual ARM economy where the bank constraint is non-binding (dashed red line). Notably, the benchmark economy performs slightly better than the "no-bank" counterfactual, indicating that the banking channel is actually supportive during this episode.

This stabilizing effect occurs through a general equilibrium adjustment in the lending rate. In the ARM economy, the inflation shock increases the real burden of current mortgage payments (the "tilting effect"), which causes a decline in the demand for new credit. In the benchmark model, this reduction in loan demand puts downward pressure on the equilibrium lending rate, causing it to fall temporarily. This lower lending rate reduces firms' financing costs for working capital, which slightly boosts labor demand and output. In the "no-bank" counterfactual, the lending rate cannot adjust downward in response to the weak loan demand, resulting in a slightly deeper contraction compared to the benchmark, where

FIGURE 4 – Decomposition of Household and Bank Effects



Notes: The graph plots the dynamics of the model economy with the inflation shock for key variables. The blue solid line is the benchmark FRM economy. The red dashed line is the ARM economy with lending rates from the benchmark FRM economy. The black long-dashed line is the benchmark ARM economy. The inflation shock is an unexpected 7 percentage point increase from an initial steady state of zero. The shock follows an AR(1) process with a biannual persistence of 0.4. Since there are no price rigidities other than nominal mortgage contracts, all prices, including the bank deposit rates, adjust nominally.

the interest rate flexibility provides a buffer.

4.2 Decomposition of Household and Bank Balance Sheets

To further disentangle the relative contributions of the household and bank balance sheet channels, Figure 4 presents an analysis comparing three scenarios following the inflation shock: the benchmark FRM economy (blue solid line), the benchmark ARM economy (black long-dashed line), and a hybrid economy (red dashed line). In the hybrid scenario, households hold ARMs, but the bank lending rate is exogenously set to the path observed in the distressed FRM economy. This scenario isolates the impact on households exposed simultaneously to direct payment shocks (via ARMs) and a severe credit crunch (from the exogenous rise in lending rates).

The hybrid economy (red line) experiences the deepest recession, with output and consumption declining 3.5 percent and 2.5 percent, respectively. This deeper downturn reflects the combined negative impact of the household cash-flow channel (due to ARMs) and the credit supply shock (due to high lending rates).

The difference between the hybrid (red) and FRM (blue) economies quantifies the household balance sheet advantage of FRMs during an inflation shock. In the FRM economy, households benefit from the Fisher channel windfall and avoid the payment shock (tilting effect) experienced by ARM holders, mitigating the consumption decline by nearly 1.6 percentage points compared to the hybrid case, holding the negative banking channel constant.

Conversely, comparing the hybrid (red) and ARM (black) economies isolates the impact of the bank balance sheet channel. In both economies, households hold ARMs, implying

identical direct exposure. The difference lies in the banking sector: the ARM economy has resilient banks and stable lending rates, while the hybrid economy suffers from a severe credit crunch. The divergence in outcomes–a mild downturn in the ARM economy versus a deep recession in the hybrid economy–demonstrates that the health of the banking sector is a primary determinant of macroeconomic stability during an inflation shock.

Overall, this decomposition clarifies that the recession in the FRM economy is the net result of a powerful negative credit supply shock, which is partially offset by the positive wealth effects provided to household balance sheets.

4.3 Distributional Implications of Mortgage Structure

The choice of mortgage structure fundamentally alters not only the magnitude of the economic downturn but also the distribution of its costs. We analyze these distributional consequences across three key dimensions: net worth, housing tenure (renters, outright owners, and indebted mortgage holders), and age. We classify households are based on their state variables immediately before the shock. We trace these individuals over time, presenting statistics relative to an economy without aggregate shocks to eliminate life-cycle effects.

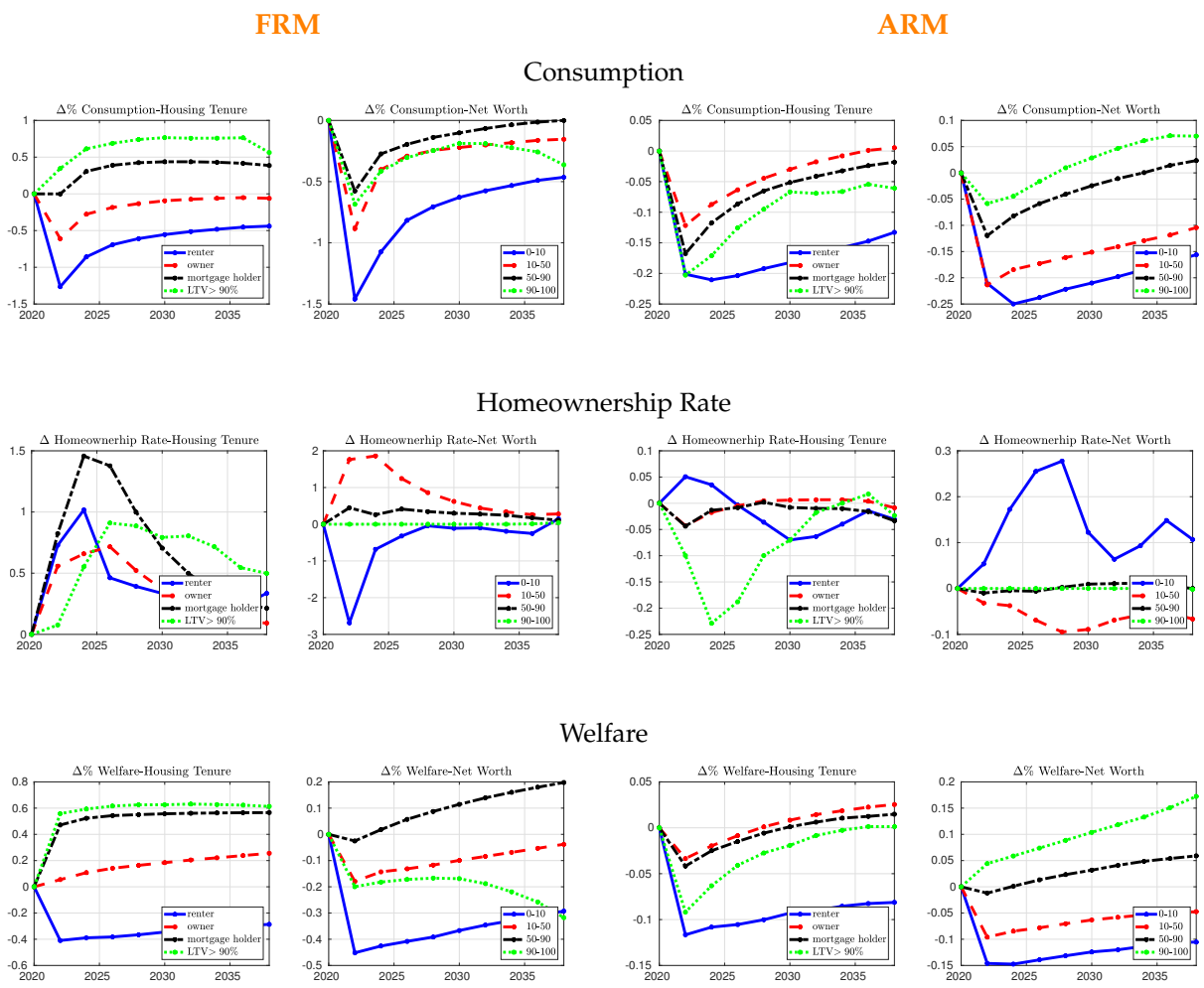
Consumption Figure 5 (top panels) plots the dynamics of consumption across different groups. In the FRM economy, the recession caused by the credit contraction generates widespread and significant consumption declines, particularly among the most vulnerable households. The poorest decile experiences a 1.5 percent drop in consumption. Renters face reductions of approximately 1.3 percent. These groups suffer large losses despite not necessarily holding mortgage debt, indicating that the transmission operates primarily through general equilibrium effects—specifically, the weak labor market and tight credit conditions. Indebted homeowners increase consumption (by more than 0.7 percent for high-LTV holders), driven by the erosion of their real debt burden.

The ARM economy shows a different pattern. As we have shown above, the aggregate consumption response is significantly smaller, reflecting the overall macroeconomic stability. However, the costs of the inflation shock are concentrated on certain groups. The poorest decile sees consumption fall by 0.25 percent. High-LTV mortgage holders reduce consumption by about 0.2 percent, reflecting the direct cash-flow effect of increased real mortgage payments. Renters also face reductions (around 0.2 percent on impact), but the impact is much milder than in the FRM case.

Homeownership Rate Figure 5 (middle panels) reveals how mortgage structure affects the housing market across different groups in our model economy. In the FRM economy, while homeownership rates increase across all housing tenure statuses, it declines by more than 2 percentage points for the poorest decile. This decline occurs primarily through the extensive margin—the inability of new buyers to secure financing due to high lending rates and tighter credit conditions. Existing homeowners, particularly those with mortgages, largely increase their ownership status (compared to their status in the no-shock case) as they benefit from lower real debt burdens.

In the ARM economy, the impact of the inflation shock on homeownership is minimal across all groups. While high-LTV owners face increased payment burdens, this translates to only marginal declines in ownership rates. The preservation of credit availability and stable lending rates means that potential new entrants face fewer barriers to homeownership.

FIGURE 5 – Distributional Effects of Inflation with FRMs and ARMs



Notes: The graph plots the percentage change in the consumption of different groups as classified in the steady-state. The changes are computed with respect to the economy without any shocks to remove the age effects. The top figures plot the dynamics for the benchmark FRM economy whereas the bottom figures plot them for the benchmark ARM economy. The figures on the left plot the differential effects along the net worth. The figures in the middle plot them across different housing statuses. The figures on the right plot them along the age dimension.

Welfare Figure 5 (bottom panels) presents the welfare effects in consumption equivalent terms. The FRM economy generates a stark divergence between winners and losers. The poorest households and renters experience significant welfare losses of approximately 0.4 percent. These losses reflect the combined impact of wage declines, and exclusion from homeownership.

Remarkably, existing mortgage holders, in particular the highly leveraged ones experience

welfare gains of more than 0.5 percent as the benefit of real debt erosion outweighs the negative macroeconomic environment. This creates a perverse redistribution: those with mortgage debt benefit from the inflation shock, while those without bear the adjustment costs through the recession.

The ARM economy produces more modest and concentrated welfare effects. High-LTV borrowers experience a small, less than 0.1 percent, welfare decline. And the poorer consumers, and renters loose, but their loss is about one third of the losses in the FRM economy. The preservation of macroeconomic stability, in particular the wages and the credit, means that other groups experience minimal welfare losses. The absence of a systemic credit crunch prevents the broad-based suffering observed in the FRM case.

Balance Sheet Adjustments The mechanisms underlying these welfare dynamics become clearer when examining household balance sheet adjustments. Figure 6 (top panels) reveals different patterns of financial asset depletion across the two regimes.

In the FRM economy (top-left panels), renters face the most severe adjustment, depleting approximately 9 percent of their financial assets to maintain consumption amid the recession. The 10-50th percentile group reduces assets by roughly 7 percent. Mortgage holders and high-LTV borrowers (>90 percent) both deplete less than 2 percent of their assets.

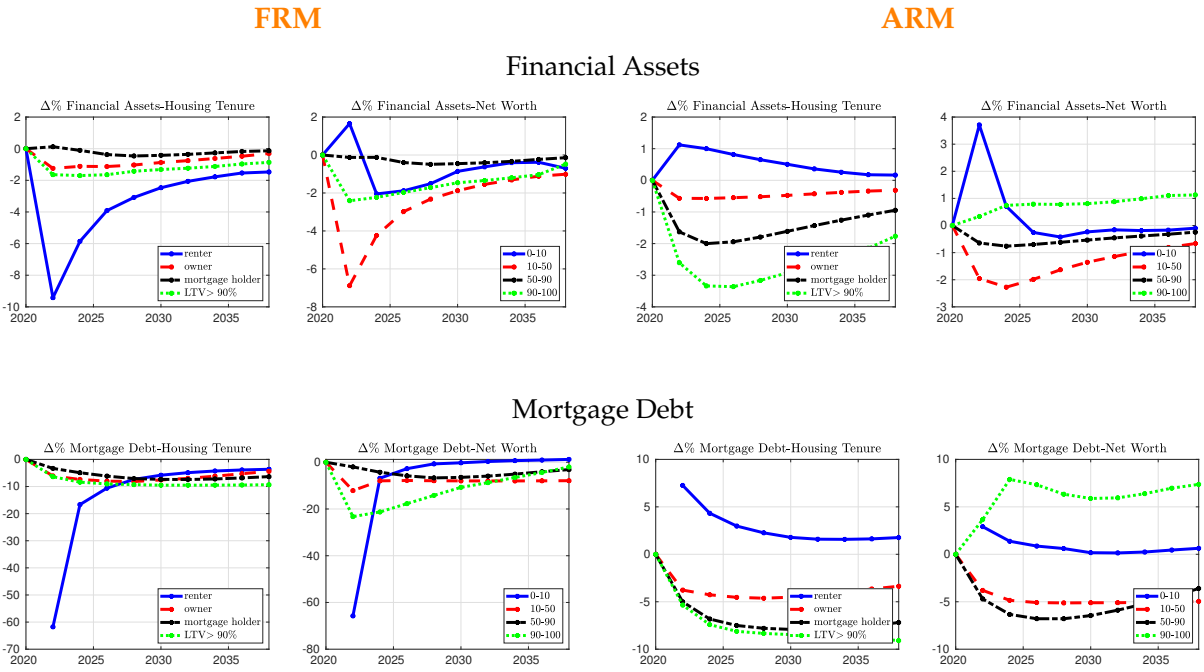
The ARM economy (top-right panels) shows more modest and concentrated adjustments. High-LTV mortgage holders experience the largest reduction at approximately 3.5 percent. Regular mortgage holders see their assets fall by about 2 percent. Crucially, renters and poorer ones increase their financial assets, in part to purchase homes later in their ligfe. This pattern reflects the preservation of macroeconomic stability—most groups avoid significant dissaving because the economy avoids a deep recession.

Deleveraging Patterns The dynamics of mortgage debt across the population further show the divergent adjustment mechanisms (Figure 6 in Appendix). In the FRM economy (top panels), the poorest decile experiences a 70 percent reduction in mortgage debt—reflecting not voluntary prepayment but exclusion from mortgage markets amid the credit crunch. Even renters, who begin with minimal mortgage exposure, show a 60 percent decline from their already-low baseline, indicating blocked entry into homeownership.

The ARM economy (bottom panels) displays more heterogeneous and modest adjustments. High-LTV borrowers deleverage by approximately 9 percent in response to higher payment burdens, while regular mortgage holders reduce debt by about 8 percent. The poorest

households and renters maintain relatively stable mortgage positions, neither dramatically deleveraging nor significantly increasing debt. This pattern—modest deleveraging by the constrained combined with opportunistic borrowing by the unconstrained—stands in sharp contrast to the FRM economy's widespread credit market exclusion.

FIGURE 6 – Distributional Effects of Inflation with FRMs and ARMs



Notes: The graph plots the percentage change in the consumption of different groups as classified in the steady-state. The changes are computed with respect to the economy without any shocks to remove the age effects. The top figures plot the dynamics for the benchmark FRM economy whereas the bottom figures plot them for the benchmark ARM economy. The figures on the left plot the differential effects along the net worth. The figures in the middle plot them across different housing statuses. The figures on the right plot them along the age dimension.

Synthesis of Distributional Implications These distributional patterns reveal a fundamental trade-off inherent in mortgage design. The FRM system effectively "socializes" the risk of inflation shocks. While it generates significant wealth windfalls for borrowers via the Fisher channel, it does so by concentrating nominal valuation risk in the banking sector. When this risk materializes, the resulting financial instability and credit crunch generate a broad recession whose costs are borne disproportionately by the most vulnerable–the poor, the and renters–through job losses and exclusion from the housing market.

In contrast, the ARM system "privatizes" the risk. It protects the financial system and ensures

macroeconomic stability, but concentrates the adjustment costs on indebted borrowers who face immediate payment shocks. While this creates acute distress for affected households, it limits spillovers to the wider economy and avoids the broad, persistent scarring effects that characterize the FRM response.

5 Policy Implications

So far we have shown that mortgage market structure is a primary determinant of how economic shocks propagate through the banking system and household balance sheets. This section explores how the macroeconomic transmission is mediated by the regulatory environment and the central bank's policy stance. First, we examine how the initial leverage (banking and household sectors) amplifies shocks under different mortgage regimes, highlighting the interaction between mortgage design and macroprudential policy. Second, we investigate how the central bank's reaction function–specifically, the aggressiveness of its response to inflation–interacts with the mortgage structure to influence macroeconomic stability.

5.1 Macroprudential Policies

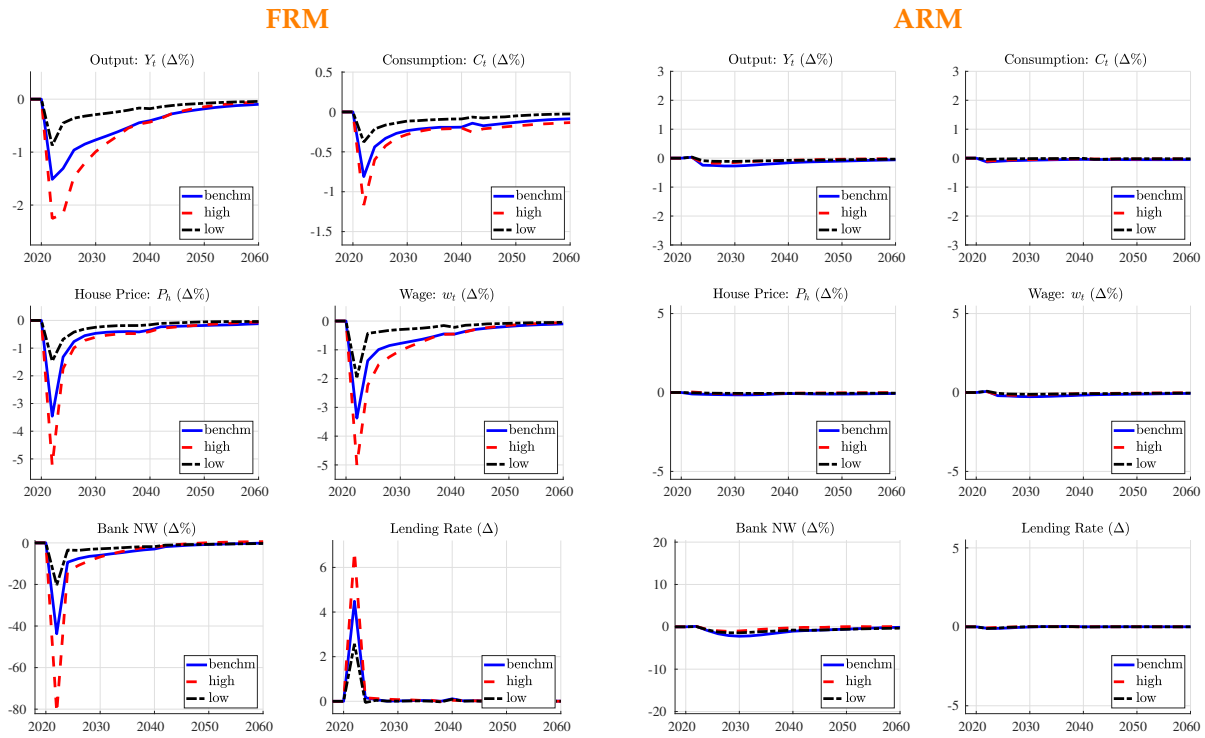
We study two main types of macroprudential policies: bank based and household based. We start with bank based capital requirements.

The Role of of Bank Leverage To assess how the initial capitalization of the banking system affects shock transmission, we conduct a counterfactual exercise varying the steady-state bank leverage ratio. We compare our benchmark calibration (leverage of 9.12) with high-leverage (12.5) and low-leverage (7.5) scenarios.

Figure 7 (left panels) shows the response of the FRM economy to the inflation shock under these three scenarios. The results imply that bank leverage acts as a powerful amplifier of financial instability in an FRM system. When leverage is high, the initial shock to bank net worth—caused by the inflation-induced valuation losses on fixed-rate assets—is magnified, leading to a much deeper and more persistent recession. Output falls by 1.8 percent in the high-leverage case, compared to 1.0 percent in the low-leverage case. This occurs because highly leveraged banks operate closer to their borrowing constraints; a given loss of net worth forces a larger contraction in credit supply, resulting in a sharper spike in lending rates and a more severe downturn in wages, consumption, and house prices.

Figure 7 (right panels) repeats the experiment for the ARM economy, revealing a significantly more stable dynamic. The amplification effect of leverage is substantially muted compared

FIGURE 7 – Bank Leverage and the Model Dynamics



Notes: The graph plots the dynamics of the model economy with the inflation shock for key variables for different levels of initial bank leverage when the mortgages are FRM. We compare our benchmark calibration (leverage of 9.12) with high-leverage (12.5) and low-leverage (7.5) scenarios.

to the FRM economy. This resilience stems from the core mechanism of our dual channel framework: because ARMs insulate bank balance sheets from inflation and interest rate risk, the initial shock has a much smaller impact on bank net worth. Consequently, the credit supply channel remains largely intact, even when banks are highly leveraged.

These results provide a crucial policy insight. The ARM structure intrinsically reduces the link between bank leverage and macroeconomic outcomes by mitigating the underlying inflation risk on bank balance sheets. This suggests that macroprudential policies aimed at managing bank leverage are far more critical for ensuring macroeconomic stability in economies dominated by fixed-rate debt.

The Role of Borrower-Based Macroprudential Policies We further explore how borrower-based macroprudential regulations—specifically Loan-to-Value (LTV) and Payment-to-Income (PTI) restrictions—interact with mortgage structure during an inflationary episode. These

tools are often deployed to enhance the resilience of both household and financial sector balance sheets, but our analysis reveals that their effectiveness depends on the prevailing mortgage design and the nature of the underlying risks.

Tighter LTV restrictions (Figure C.3 in Appendix) prove effective in mitigating the adverse effects of the inflation shock, particularly in the FRM economy. By reducing the initial level of household leverage, stringent LTV caps decrease the aggregate volume of fixed-rate debt held by the banking sector. This directly limits the banks' exposure to inflation-induced valuation losses. Consequently, when the inflation shock hits, the erosion of bank capital is less severe, dampening the financial accelerator and resulting in a significantly milder recession. In the ARM economy, tighter LTV limits also provide modest stabilization by reducing household vulnerability to payment shocks. This suggests that LTV restrictions are a robust tool for enhancing macroeconomic stability as they address the leverage underlying both the bank fragility (FRM) and household vulnerability (ARM) channels.

In contrast, the impact of tighter PTI restrictions (Figure C.4 in Appendix) reveals a policy trade-off. While stricter PTI constraints stabilize the FRM economy—again, by reducing overall leverage and the associated bank exposure—they amplify the downturn in the ARM economy. This divergence occurs because PTI limits bind on current cash flows. In an ARM system, the inflation shock front-loads real mortgage payments (the "tilting effect"). If households are already tightly constrained by their PTI limits, this increase in payment burdens forces a contraction in consumption. By amplifying the sensitivity of household demand to cash-flow shocks, stringent PTI regulations can deepen the recession in an ARM system, even as they promote stability in an FRM environment.

5.2 The Role of Monetary Policy Reaction to the Inflation Shock

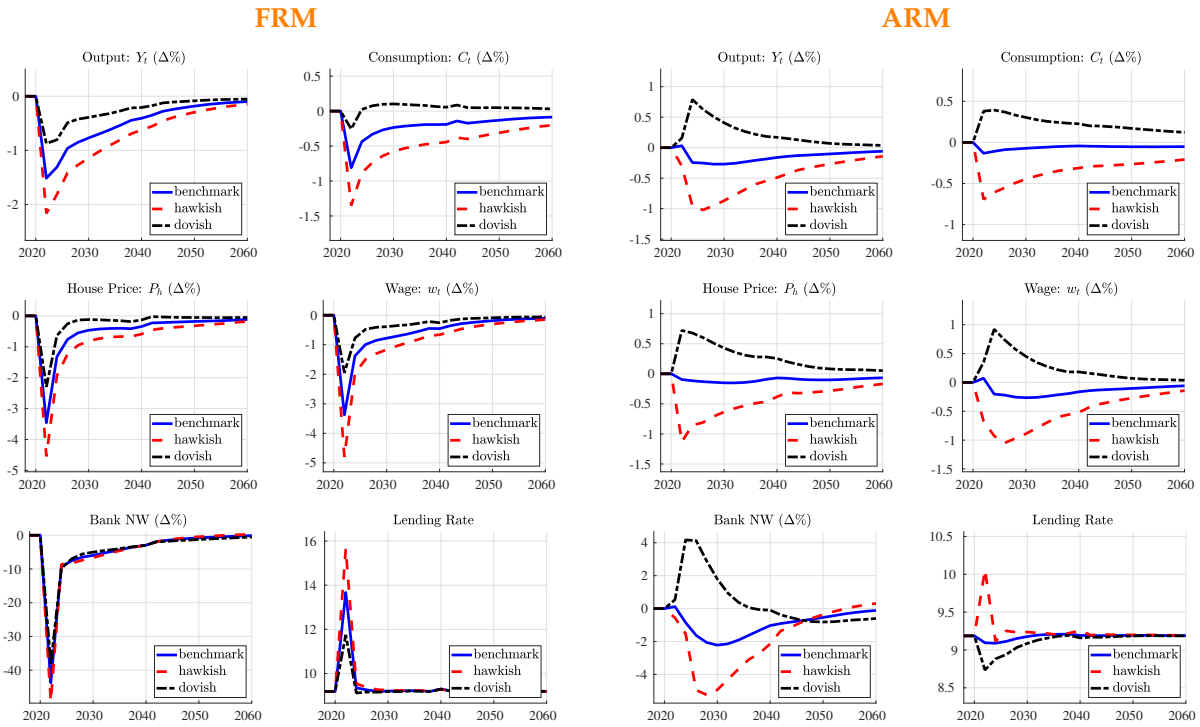
In the benchmark analysis, we assumed that the monetary policy is passive and the interest rates respond one-to-one to the inflation shock, following the rule $R_t = \phi^m (1 + i_t)$, with $\phi^m = 1$. We now explore the implications of more or less aggressive monetary policy by setting $\phi^m = 1.15$ (hawkish) and $\phi^m = 0.85$ (dovish).

Figure 8 (left panels) shows the results for the FRM economy. A more aggressive monetary policy response significantly deepens the recession. By raising rates more sharply in response to inflation, the central bank exacerbates the pressure on bank balance sheets. The value of banks' fixed-rate assets falls further, eroding their net worth more severely (dropping by 7.5 percent in the hawkish case compared to 2 percent in the dovish case). The resulting credit

crunch is more pronounced, leading to a larger contraction in output (1.8 percent fall vs. 0.5 percent fall).

This highlights a critical dilemma for policymakers in an FRM system: a hawkish stance aimed at controlling inflation simultaneously amplifies the financial instability risks that drive the recession. The central bank faces a stark trade-off between price stability and financial stability.

FIGURE 8 – Monetary Policy Tightness and Mortgages



Notes: The graph plots the dynamics of the model economy with the inflation shock for key variables for different levels of monetary policy response when the mortgages are FRM. In blue line monetary policy responds one to one to inflation. In red line monetary policy responds 1p.p. more to inflation and in black line it responds 1p.p. less.

Crucially, this dynamic offers an explanation for the so-called "missing recession" during the 2021-2023 episode. As shown in Figure 8, in the FRM economy, a dovish stance (black line), characterized by a less aggressive response to inflation, nearly eliminates the output contraction compared to the hawkish stance (red line). The Federal Reserve's initial delay in tightening, while allowing inflation to rise, simultaneously shielded the banking sector from a sudden, severe valuation shock. If the central bank is constrained by the underlying

financial fragility, either by tightening more slowly initially or by rapidly deploying liquidity support when stress emerges (as occurred in Spring 2023), the aggregate economy avoids a severe recession. The U.S. experience aligns closely with this constrained scenario, where the imperatives of financial stability tempered the monetary policy response.

Figure 8 (right panels) shows that in the ARM economy, the central bank's stance also affects the depth of the recession, but the mechanism is different and the trade-off is less severe. A more aggressive policy leads to a larger downturn compared to a dovish stance. However, the recessions are substantially milder than in the FRM economy across all policy stances. This occurs because the ARM structure preserves bank capital and stabilizes the credit supply. The primary transmission mechanism is the direct household cash-flow channel. Consequently, the central bank in an ARM economy can pursue price stability with less concern for inducing systemic financial instability.

Financial Dominance and the "Missing Recession." Crucially, these dynamics offer a structural explanation for the so-called "missing recession" during the 2021–2023 inflation episode. While our benchmark FRM model predicts a recession under a standard reaction function, the counterfactuals reveal that aggregate outcomes are highly sensitive to the central bank's policy stance. The "dovish" scenario—characterized by a delayed or less aggressive reaction to inflation—nearly eliminates the output contraction compared to the "hawkish" stance. This suggests that the Federal Reserve's initial delay in tightening, often criticized as being "behind the curve," effectively acted as an implicit macroprudential buffer. By allowing inflation to persist longer rather than crushing it with immediate, sharp rate hikes, the policy path shielded the banking sector from the acute valuation losses that trigger the financial accelerator. Consequently, our framework implies that the avoidance of a deep recession was not merely a result of fiscal buffers, but was also the product of a monetary policy that, constrained by the fragility of the FRM system, traded higher inflation persistence for financial stability.

Robustness to Endogenous Inflation. In the benchmark analysis above, we assumed an exogenous inflation path to cleanly isolate the transmission of the shock through mortgage balance sheets. To ensure our conclusions are not driven by this simplification, in Appendix C.2 we relax this assumption and allow inflation to respond endogenously to the central bank's policy stance via a standard Phillips curve relationship. We find that our core results are robust to this extension.

6 Empirical Evidence

In the preceding quantitative analysis we have shown that the macroeconomic impact of an inflation shock is governed by a "dual channel," where household balance sheet effects (including the Fisher channel) and the bank lending channel operate in opposition. To provide empirical evidence for this mechanism, we leverage the 2021-2023 U.S. monetary tightening cycle as a natural experiment. This episode, characterized by a rapid and substantial increase in inflation and nominal interest rates, generated significant variation in the pressures faced by households and banks depending on their pre-existing mortgage compositions.

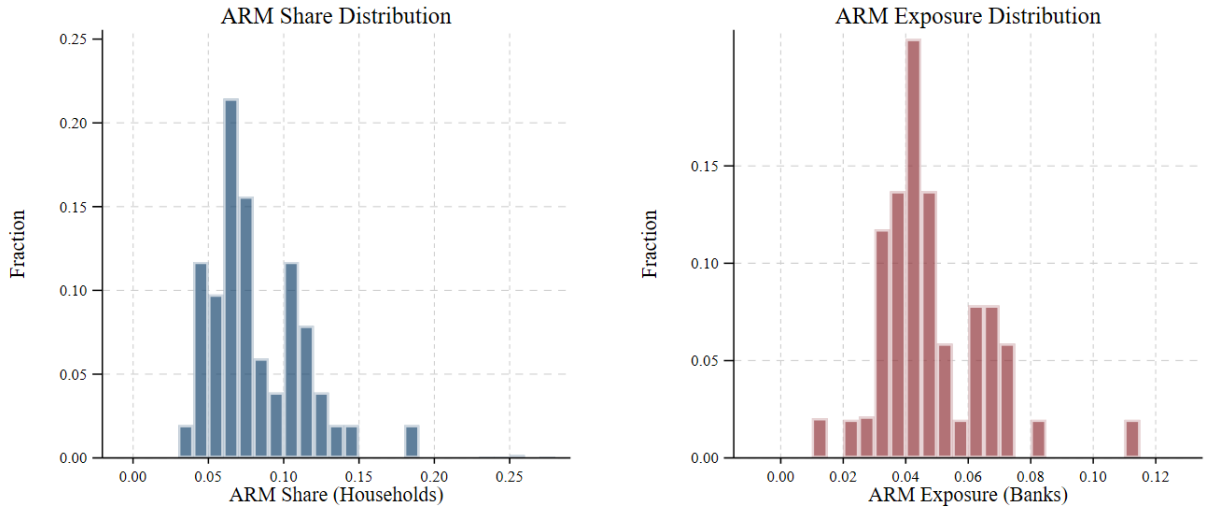
Our empirical strategy proceeds in three stages. First, we use state-level data and a border-discontinuity design to test the simultaneous presence of the opposing household and bank channels. Second, we utilize granular bank- and bank-county-level data to isolate the credit supply mechanism, controlling for local demand. Finally, we employ a Rajan-Zingales methodology to trace the real effects of this credit supply channel on employment in financially dependent sectors. We begin by detailing the construction of our dataset and the key variables used in this analysis.

We operationalize this analysis by using the share of ARMs, where a high ARM share implies a low FRM share. The impact of high bank ARM exposure identifies the benefit of banks being insulated from the valuation losses inherent in FRMs (the bank resilience channel). The impact of high household ARM exposure identifies the household vulnerability to rising rates (the cash-flow channel), in contrast to the wealth benefits FRM holders receive via the Fisher channel.

6.1 Data

Our analysis combines multiple data sets covering mortgage composition, bank characteristics, and economic outcomes at various granularity.

FIGURE 9 – Mortgage Distributions



Note: The upper left-hand panel plots the share of ARMs from the household side, at the state-level. The right-hand panel plots states' exposure ARMs via banks. See the text for the construction. The correlation is 0.12.

The 2021-2023 Tightening Episode and the Mortgage Market Two features make this episode particularly suitable for our analysis. First the 30-year mortgage rate increased from 2.8 percent to 7.1 percent, creating the one of largest gap between market rates and existing mortgage rates in history. Second, despite national trends toward FRMs, significant regional variation persisted (Figure 9, see below to see how we construct these shares).

Mortgage Data We obtain mortgage data from CoreLogic's Loan-Level Market Analytics (LLMA) database, which covers approximately 75 percent of the U.S. mortgage market. For each loan, we observe a wide array of characteristics. Most importantly for this study, we observe the loan types (ARM or FRM). We aggregate this data to the state, and MSA level to construct annual ARM shares, calculated as the fraction adjustable-rate contracts compared to outstanding total mortgage balances.

Banking Data Bank balance sheet information comes from quarterly Call Reports filed with federal regulators. We primarily use the data set constructed by Drechsler et al. (2021), update it with the recent data, and complement with ARMs loan data from WRDS. We restrict our sample to commercial banks with assets exceeding $50 million as of 2019 to exclude institutions too small to have meaningful lending operations.

Our key variables include: (i) ARM holdings: "Adjustable rate closed-end loans secured by

TABLE III – Summary Statistics for State-Level Data

	N	Mean	SD	Min	p25	p50	p75	Max
ARM VARIABLES AND MAIN CONTROLS (2019)								
ARM share of mortgages (Households)	51	0.073	0.029	0.029	0.052	0.065	0.097	0.173
Bank ARM exposure (Banks)	51	0.049	0.017	0.005	0.038	0.045	0.061	0.114
Log per capita income	51	10.881	0.106	10.687	10.806	10.863	10.948	11.214
Log median scheduled monthly payment	51	6.800	0.262	6.433	6.561	6.760	6.990	7.448
Log median scheduled principal	51	5.720	0.240	5.371	5.568	5.661	5.863	6.392
Unemployment rate	51	3.6	0.8	2.1	3.0	3.5	4.1	5.6
Debt-to-Income Ratio	51	1.42	0.30	0.75	1.17	1.45	1.66	2.06
MAIN ECONOMIC GROWTH VARIABLES (2021-2023, percent change)								
Real GDP growth	51	0.054	0.021	0.004	0.039	0.050	0.070	0.116
Personal income growth	51	0.098	0.025	0.052	0.077	0.100	0.114	0.165
Employment growth	51	0.062	0.014	0.038	0.051	0.060	0.070	0.110
Consumption growth	51	0.162	0.018	0.129	0.147	0.160	0.174	0.216
House price growth	51	0.270	0.086	-0.003	0.233	0.278	0.321	0.454
STATE WEALTH and DEBT VARIABLES (LOG, 2019)								
Median Net Worth	49	11.683	0.531	10.086	11.346	11.612	12.114	12.830
Median Net Worth Excl. Home	49	10.626	0.633	8.897	10.171	10.686	11.055	11.788
Median Assets at Financial Inst.	49	8.718	0.521	6.932	8.412	8.711	9.105	9.680
Median Checking Account Balance	49	7.645	0.403	6.397	7.378	7.619	8.006	8.294
Median Other Interest Accounts	47	8.389	0.496	7.170	8.055	8.294	8.700	9.668
Median Home Equity	44	11.725	0.426	11.082	11.406	11.657	11.928	12.848
Median Vehicle Equity	47	8.921	0.199	8.568	8.781	8.905	9.066	9.543
Median IRA or Keogh Accounts	36	10.868	0.285	10.130	10.757	10.847	11.014	11.408
Median 401(k) & Thrift Savings Plan	40	10.692	0.274	10.135	10.563	10.703	10.839	11.350

This table presents summary statistics for the state-level analysis. ARM variables and control variables are measured as of 2019. ARM Share (Households) is the fraction of outstanding mortgage balances that are adjustable-rate, sourced from CoreLogic LLMA. Bank ARM exposure is the deposit-weighted average ARM share of banks operating in the state, constructed using Call Reports and FDIC SOD data. Main economic growth variables measure the cumulative percentage change from 2021 to 2023, sourced from the BEA Regional Economic Accounts and Zillow. State wealth and debt variables are sourced from SIPP summary tables.

first liens on 1-4 family residential properties" (RCON5370), (ii) total assets, loans, deposits, and equity, (iii) securities holdings by maturity bucket, and (iv) various loan categories including commercial and industrial loans, consumer loans, and real estate loans by maturity.

To identify credit supply channel, we merge the Call Reports data with the Community Reinvestment Act (CRA) annual bank-county-level small business loan data. The CRA data provides granular information on lending to small businesses at the county level, allowing us to control for local loan demand through county fixed effects. We focus on the total dollar amount of loans originated to small businesses with gross annual revenues less than $1 million.

TABLE IV – Summary Statistics for Banking and Credit Analysis Data

	N	Mean	SD	Min	p25	p50	p75	Max
ARM VARIABLES AND MAIN CONTROLS (2019)								
ARM Share (percent of Total Assets)	4895	0.064	0.087	0.000	0.004	0.029	0.089	0.749
Log Total Assets	4936	12.725	1.367	10.562	11.771	12.477	13.328	21.574
Equity to Assets Ratio	4936	0.127	0.070	0.022	0.101	0.115	0.134	0.998
Loans to Deposits Ratio	4915	0.804	0.315	0.000	0.692	0.831	0.932	17.300
Personal Loans/Assets	4931	0.033	0.067	0.000	0.006	0.016	0.035	0.993
C&I Loans/Assets	4931	0.085	0.071	0.000	0.040	0.070	0.111	0.816
RE Loans >15yr/Assets	4931	0.047	0.085	0.000	0.001	0.010	0.052	0.833
Loans & Leases >15yr/Assets	4931	0.073	0.103	0.000	0.006	0.027	0.097	0.835
Demand Deposits/Assets	4931	0.164	0.109	0.000	0.077	0.154	0.224	0.886
Savings Deposits/Assets	4931	0.316	0.168	0.000	0.199	0.276	0.405	1.183
Time Deposits/Assets	4931	0.255	0.131	0.000	0.163	0.243	0.331	0.843
1-Year Interest Income Gap	4931	0.207	0.123	-0.523	0.128	0.195	0.271	0.848
DEPENDENCE ON EXTERNAL FINANCE (2010-19 average)								
$DoEF_i$	97	-4.553	56.414	-342.528	-4.530	0.751	10.016	193.297
DEPENDENT VARIABLES (2021-2023, percent change)								
C&I Loan Growth	4078	-2.274	66.982	-96.409	-40.065	-15.159	16.930	389.697
Total Loan Growth	4078	27.396	32.704	-29.902	9.023	21.691	38.278	193.841
Other Individual Loan Growth	4010	57.482	232.947	-95.169	-10.915	14.379	45.442	1936.544
Small Business Lending	52298	-0.169	-1.0	-1.0	-1.0	-0.617	0.077	8.69

This table presents summary statistics for the bank-level and bank-county level analyses. The bank-level sample includes commercial banks with assets exceeding $50 million in 2019. Bank characteristics and ARM shares are measured as of year-end 2019, sourced from Call Reports. ARM Share is defined as adjustable-rate closed-end loans secured by first liens on 1-4 family residential properties (RCON5370) scaled by total assets. Dependence on External Finance ($DoEF_i$) is the industry-level average reliance on external financing $(CAPX - CashFlow)/CAPX$, calculated using Compustat data from 2011-2019. Dependent variables measure the cumulative percentage change in lending from 2021 to 2023. Small Business Lending growth is based on the bank-county CRA dataset.

We further restrict the sample to bank-county pairs where the bank originated at least $50,000 in small business loans (to firms with revenues less than $1 million) in 2021. This filter ensures we analyze meaningful lending relationships rather than sporadic or negligible lending activity, and helps mitigate concerns about zeros or outliers driving our results. The final bank-county sample contains over 50,000 observations, providing substantial variation to identify the credit supply channel while controlling for local demand conditions.

We use daily bank-level stock prices from the Center for Research in Security Prices (CRSP) at the University of Chicago. To link the Call Reports data with CRSP data, we use the link file maintained by the Federal Reserve Bank of New York.

Mortgage Exposure via Banks We measure a region's (state, and MSA) exposure to ARMs via the banking sector by linking bank balance sheets data (which has the ARM information)

to banks deposit data from the FDIC's Summary of Deposits (SOD), which provides branch-level deposit amounts. With this, we construct region-level exposure to bank ARM shares as:

$$\text{Region's ARM Exposure}_{i,2019} = \sum_b \omega_{b,i,2019} \times \text{Bank ARM Share}_{b,2019} \tag{9}$$

where $\omega_{b,i,2019}$ is bank b's share of deposits in region i. This measure captures how exposed county residents are to banks with different mortgage portfolios.

Regional Data For state-level consumption, GDP, employment and income, we use Regional Economic Accounts data from Bureau of Economic Analysis. We use Quarterly Census of Employment and Wages (QCEW), providing employment, by state, county, and industry at sectoral level. For house prices we use Zillow data. We use Census data and SIPP state-level summary tables to control for demographics, assets, and debt.

Dependence on External Finance

We construct 3-digit industry-level measures of external finance dependence following the methodology of Rajan and Zingales (1998), adapted to our sample period. Using Compustat data from 2011-2019, we calculate each firm's reliance on external financing as the share of capital expenditures not funded through internally generated cash flow: $(CAPX - CashFlow)/CAPX$. We then aggregate these firm-level ratios to the 3-digit NAICS industry level by taking within-industry means across all firm-years in our sample period. This approach captures the structural financing needs of different industries during the period immediately preceding our analysis, providing a plausibly exogenous variation in credit dependence that we exploit to identify the bank lending channel. Industries with higher values rely more heavily on external financing and should therefore be more sensitive to credit supply shocks transmitted through the banking sector.

Institutional Context The U.S. mortgage market presents unique institutional features, notably the role of Government-Sponsored Enterprises (GSEs). It is crucial to clarify how this feature interact with our identification of the bank lending channel.

While GSEs facilitate the securitization of conforming FRMs, allowing originators to offload interest rate risk, this risk transfer is far from complete. Banks retain significant portfolios of mortgages on their balance sheets. According to Federal Reserve Z.1 data (Table L.218), as of Q4 2019, commercial banks held approximately $2.3 trillion in one-to-four-family residential mortgages directly on their books, out of $11.1 trillion total outstanding. These retained portfolios often include non-conforming "Jumbo" loans, which exceed conforming limits and

are ineligible for GSE purchase, as well as loans held for portfolio lending strategies. Our empirical analysis, based on Call Report data (specifically RCON5370 for ARMs), explicitly measures the composition of these on-balance-sheet portfolios. Thus, our measure of bank ARM exposure captures the interest rate risk directly borne by the banks themselves, net of securitization.

Moreover, the 2023 banking turmoil have shown that unrealized losses on long-duration, fixed-rate assets erode a bank's economic capital and constrain its behavior, even if regulatory capital ratios appear adequate under held-to-maturity accounting standards. Our analysis captures the realized impact of this fundamental interest rate exposure on the banking sector during the tightening cycle.

6.2 Empirical Analysis

We measure pre-period characteristics as of 2019 to avoid contamination from pandemic-related disruptions and to mitigate the endogeneity concerns related to the ARM shares and ARM exposures. The key assumption is that mortgage portfolio composition as of 2019 is uncorrelated with unobserved factors driving differential economic outcomes during the 2021-2023 tightening cycle. We structure our empirical analysis to first show the existence of the dual channel at the state level from the US data, and then to provide granular evidence for the banking and the credit mechanism using bank- and sector-level data.

6.2.1 Regional Analysis

At the state-level we estimate:

$$\Delta Y_{s,21-23} = \beta_1 \text{ARM Share}^{HH}_{s,19} + \beta_2 \text{ARM Exposure}^{Bank}_{s,19} + \Gamma X_{s,19} + \mu_{s-b} + \epsilon_{s-b} \tag{10}$$

where ΔY_{21-23} represents changes in consumption, GDP, employment, income and several other variables from 2021 to 2023. $\text{ARM Share}^{HH}_{19}$ is the household ARM share in a state, capturing demand effects, while $\text{ARM Exposure}^{Bank}_{19}$ measures a state's exposure to the ARMs via the banking sector operating in that region, capturing credit supply effects.

Crucially for our identification strategy, the cross-sectional correlation between the household ARM share and the bank ARM exposure is very low (0.12, as shown in Figure 9). This indicates that the composition of household demand for mortgage types is largely independent of the portfolio choices of the banks operating in the same region. This near-orthogonality is essential: it provides the necessary independent variation to simultaneously identify and

disentangle the opposing demand-side (household) and supply-side (bank) channels in our regression analysis.

To identify the effects of mortgage structure while accounting for unobserved regional heterogeneity, we employ a spatial regression discontinuity design utilizing state-border pair fixed effects (μ_{s-b}). This approach restricts the comparison to contiguous states, leveraging their geographic proximity to control for localized confounders. This strategy is particularly crucial for the 2021–2023 period, which was characterized by spatially correlated shocks related to pandemic recovery, extreme weather events, and supply chain disruptions. The inclusion of μ_{s-b} absorbs all unobserved factors common to the specific geographic region.

To mitigate potential state-specific omitted variable bias, we include a comprehensive set of pre-determined controls, $X_{s,19}$, measured in 2019. First, to isolate the household vulnerability channel, we must account for differences in households' pre-existing capacity to absorb payment shocks. We therefore include detailed measures of household balance sheet strength: net worth, holdings of liquid assets (checking and other interest-bearing accounts), and retirement savings. We also control for leverage, including the state-level debt-to-income ratio and non-mortgage debt levels. These variables ensure that the estimated effect of the ARM share is not confounded by underlying differences in household financial resilience.

Second, we control for baseline macroeconomic conditions, including the log of per-capita income and the unemployment rate, to account for differential pre-trends. Finally, we include initial mortgage market characteristics, such as average mortgage payment levels and foreclosure rates. This allows us to disentangle the effect of the contract type (ARM vs. FRM) from the initial level of mortgage burden in the state.

While our border-discontinuity design and rich set of controls mitigate many standard endogeneity concerns, we acknowledge that the allocation of ARMs is not random. We argue that the 2019 ARM shares are plausibly exogenous to the subsequent tightening cycle because the magnitude and speed of the 2021-2023 rate hikes were largely unanticipated. Furthermore, regional variation in mortgage structure tends to be highly persistent, driven by historical borrower preferences and local banking conventions. Nonetheless, our identification strategy relies on the assumption that unobserved differences between high- and low-ARM regions do not systematically correlate with the economic response to the 2021-2023 tightening, conditional on our controls and fixed effects.

Table 3 presents the results of this "horse race" estimation. Across multiple measures of economic activity during the 2021–2023 tightening cycle, we find strong evidence for the dual

channel mechanism, with the two exposures operating simultaneously and in opposition. Across all key macroeconomic outcomes—consumption, GDP, and personal income—the coefficient on the household ARM share (ARM Share^{HH}) is negative and statistically significant. This reflects the strong household cash-flow channel, where ARM borrowers face immediate payment shocks (consistent with prior literature such as Di Maggio et al. (2017) and Cloyne et al. (2020)), and the absence of the Fisher channel windfall that benefits FRM households.

However, we simultaneously identify the bank supply channel. The coefficient on bank ARM exposure (ARM Exposure^{Bank}) is positive and statistically significant across these same specifications. This confirms the bank resilience channel predicted by our model: states served by a banking sector with higher concentrations of ARMs were insulated from the valuation risk that impaired FRM-heavy banks. This positive outcome is direct evidence of the systemic vulnerability created by FRMs. As demonstrated in the model, the inflation-induced valuation losses on FRM portfolios erode bank capital, triggering a credit crunch. Consequently, states with higher exposure to these FRM-heavy banks experienced significantly worse economic performance.

This finding provides direct evidence for the bank resilience channel, highlighting the positive credit supply effect discussed in Altunok et al. (2025). Our analysis is the first to simultaneously identify and quantify these two opposing mechanisms within a single empirical framework during a tightening cycle.

These results are economically meaningful. For personal income, a 1-percentage point increase in the household ARM share is associated with about 0.66 percentage points lower income growth. In contrast, a 1 percentage point increase in ARM exposure via banks is associated with 0.45 percent higher consumption and income growth. These results show the opposing forces at work: the consumer ARM exposure generated a powerful negative impulse, while the bank ARM exposure creates a substantial support. The net effect on a state's economy therefore depends critically on this trade-off between the household wealth effects generated by FRMs (the Fisher channel) and the financial stability risks they introduce.

Since house prices react to economics shocks relatively sluggishly we use a dynamic setup where we regress monthly growth in state house prices relative to its level in 2021. Figure 10 plots the results. The results confirms our earlier findings. States with higher ARM shares via households experience lower house prices. And states with higher ARM exposures via banks experience stronger house prices. While for most horizons the point estimates for the ARM exposures are not significant, since the estimates have consistently the expected sign, they

TABLE V – The Effect of Mortgage Structure on State Economies

Dependent Variables: State (percent change)				
Variables	(1) Consumption	(2) Real GDP	(3) Personal Income	(4) Per-capita Personal Income
ARM Share$^{HH}_{s,19}$	-0.440***	-0.599***	-0.666***	-0.464***
Std. Error	(0.155)	(0.181)	(0.207)	(0.135)
ARM Exposure$^{Bank}_{s,19}$	0.453**	0.585***	0.448**	0.321**
Std. Error	(0.187)	(0.212)	(0.218)	(0.143)
Observations	126	126	126	126
R-squared	0.509	0.635	0.683	0.702
All Controls	Yes	Yes	Yes	Yes
State-Border FE	Yes	Yes	Yes	Yes

Notes: This table examines the relationship between adjustable-rate mortgages (ARMs) and state-level economic outcomes. ARM Share (via households) captures the state-level proportion of ARMs held by households, while ARM Exposure (via banks) measures the state's exposure to ARM through bank lending patterns. All models include: loan characteristics (payment, principal, balance, interest), economic controls (income, unemployment), asset controls (net worth, home equity, retirement accounts, liquid assets), DTI ratio, vehicle equity, and foreclosure rates. Fixed effects: border-pair. Standard errors are clustered at the state level. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

jointly provide a strong support for the dual mechanism that argue in this paper.

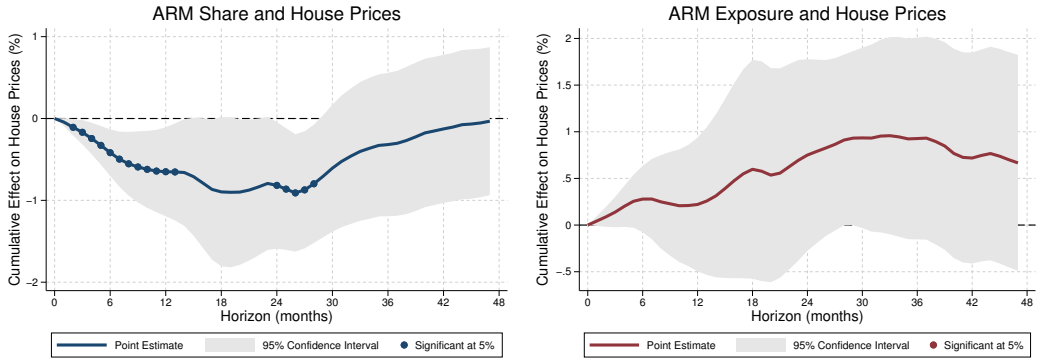
6.2.2 Banking and the Credit Supply Channel

Our regional results confirm the simultaneous operation of the dual channel mechanism: household ARM exposure depressed economic activity, while bank ARM exposure supported it. However, conclusively identifying the credit supply mechanism requires isolating bank behavior from local demand conditions. We now turn to granular bank-level data to achieve this isolation. Specifically, we investigate how the concentration of valuation risk via FRMs impaired bank lending capacity during the recent rise in inflation. We hypothesize that banks with higher ARM shares (and thus lower FRM exposure) were better positioned to maintain credit supply.

Bank-Level Evidence: Equity Valuations To provide market-based evidence for the bank balance sheet channel, we first examine how banks' mortgage portfolio composition has influenced their equity valuations during the 2021-2023 monetary tightening cycle. If ARMs indeed shield banks from interest rate risk as we predict, we should observe superior stock price performance among banks with higher ARM shares.

We first study the overall banking sector equity prices in the US, a very high FRM country.

FIGURE 10 – Mortgage Structure and State House Prices



Notes: These figures present impulse response functions from Jordà (2005) local projections examining the dynamic effects of adjustable-rate mortgage prevalence on house prices. The specification follows:$y_{s,t+h} - y_{s,t-1} = \alpha^h + \beta_1^h \text{ARM Share}_{s,19}^{HH} + \beta_2^h \text{ARM Exposure}_{s,19}^{Bank} + \gamma^h X_{s,t} + \mu_{s-b,h} + \varepsilon_{i,t+h}$, where $y_{i,t+h} - y_{i,t-1}$ represents the cumulative percentage change in house prices from the base period $(t-1)$ to horizon h, measured monthly for up to 48 months. $\text{ARM Share}_{s,19}^{HH}$ captures the state-level proportion of ARMs held by households, while $\text{ARM Exposure}_{s,19}^{Bank}$ measures the state's exposure to ARMs through bank lending patterns. $X_{i,t}$ includes pre-determined state-level controls: loan characteristics (scheduled monthly payment, scheduled principal), economic conditions (per capita income, unemployment rate), household balance sheet variables (net worth excluding home, home equity, motor vehicle equity, retirement accounts, liquid assets), debt measures (credit card debt), debt-to-income ratio, homeownership rate, and foreclosure rates. $\mu_{s-b,h}$ represents border-pair $\times$ horizon fixed effects to control for time-invariant unobserved heterogeneity between neighboring states and horizon-specific shocks. Standard errors are clustered at the border-pair level to account for spatial correlation. The shaded areas represent 95% confidence intervals, with solid markers indicating statistical significance at the 5% level. The identification strategy exploits cross-state variation in ARM prevalence at state borders, controlling for local economic conditions that might affect both mortgage choice and house price dynamics.

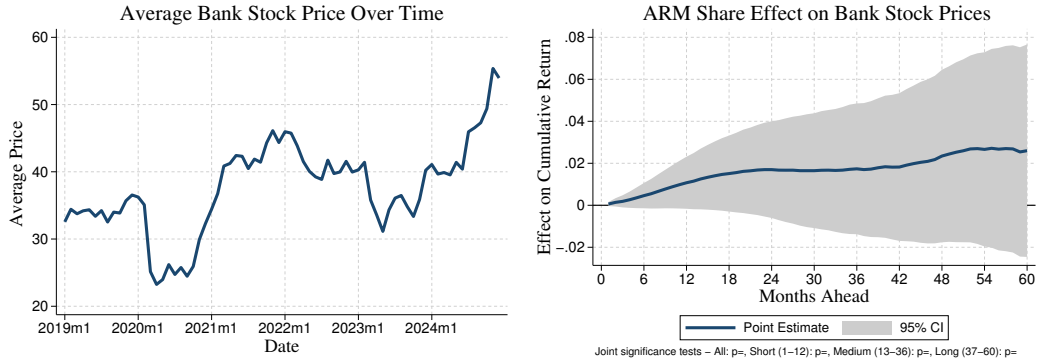
Using daily stock price data from CRSP for all publicly traded bank holding companies in our sample, we calculate monthly average prices for each bank. We then compute the cross-sectional average of these individual bank indices for each month, providing a sector-wide view of performance. Following a pandemic-induced decline in early 2020, bank equities recovered steadily, which slowed down with the rise in inflation and nominal rates. Starting early 2022 banking sector stock prices declined by about 30 percent.

To quantify the relationship between ARM exposure and bank stock returns, we employ a Jordà-style local projections. For each horizon h from 1 to 60 months, we estimate:

$$\triangle BankStockPrice_{i,t+h} = \beta_h \text{Bank ARM Share}_{b,19} + \gamma' X_{i,2019} + \delta_h + \varepsilon_{i,t+h}$$

where $\triangle BankStockPrice_{i,t+h}$ is the percentage change in bank i's stock price index from month t to $t+h$, $ARMShare_{i,2019}$ is the bank's pre-period share of ARMs, and $X_{i,2019}$ includes bank-level controls (log assets, equity ratio, liquidity ratios, and other balance sheet characteristics). We include horizon fixed effects δ_h and cluster standard errors at the bank level. The coefficient β_h traces out the dynamic effect of a one percentage point increase in ARM share

FIGURE 11 – Bank Equity Prices: 2021:2023



Notes: This figure examines the relationship between bank mortgage composition and equity market performance during the 2019-2024 period, using data from CRSP for publicly traded U.S. bank holding companies. The left panel plots the cross-sectional average of bank stock prices over time. The right panel presents impulse response functions from JordÃ (2005) local projections, estimating the dynamic effect of a bank's pre-period (2019) ARM share (as a percentage of total assets) on cumulative stock returns over 1 to 60 months. The specification is: $\triangle BankStockPrice_{i,t+h} = \beta_h \times ARMShare_{i,2019} + \gamma' X_{i,2019} + \delta_t + \varepsilon_{i,t+h}$. Controls ($X_{i,2019}$) include bank size (log assets), risk measures (equity, cash, and liquidity ratios), detailed asset maturity structure, liability composition, and securities holdings. The regressions include time (year-month) fixed effects (δ_t). Standard errors are clustered at the bank holding company level. The shaded area represents the 95% confidence interval.

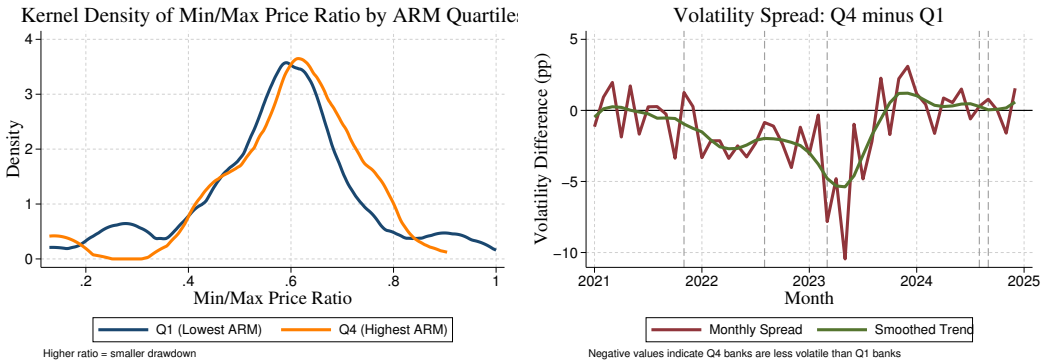
on cumulative returns at each horizon. The results reveal a positive relationship: banks with higher ARM shares outperformed their FRM-heavy counterparts throughout the tightening cycle.

The point estimates indicates that a 10 percentage point increase in ARM share is associated with approximately 0.25 percentage points higher cumulative returns by month 60. The 95 percent confidence bands, shown as shaded areas, widen over time reflecting increasing dispersion, but the effect remains consistently positive. And jointly, these positive coefficients imply that banks with higher ARM shares performed better in the equity market.[11]

To examine tail risk and downside protection, we calculate each bank's minimum-to-maximum price ratio over the 2022-2024 period. This ratio, bounded between 0 and 1, measures the worst drawdown experienced: a ratio of 0.60 indicates the stock fell to 60 percent of its peak value at its worst point. We sort banks into quartiles based on their 2019 ARM share and plot kernel density distributions of the min/max ratio for each quartile. Banks in the highest ARM quartile (Q4) experience a rightward-shifted distribution relative to the lowest quartile (Q1), indicating smaller drawdowns and greater resilience. The median bank in Q4 maintained a min/max ratio of approximately 0.62, compared to 0.54 for Q1 banks. This 8 percentage

[11]To formally assess the overall significance of these findings, we conduct a Wald test for the joint significance of the coefficients (β_h) across all horizons. Utilizing a fully saturated stacked regression approach, which rigorously accounts for the cross-horizon covariance of the estimates, we strongly reject the null hypothesis that the ARM share has no effect over the 60-month horizon ($F(60, 324) = 2.27$, $p < 0.0001$).

FIGURE 12 – Bank Equity Price Distribution by ARM Quartiles



Notes: This figure analyzes the relationship between bank ARM exposure and equity market risk (drawdowns and volatility), comparing banks in the lowest (Q1) and highest (Q4) quartiles of 2019 ARM share (weighted by assets). Data is sourced from CRSP. The left panel plots the kernel density distribution of the minimum-to-maximum price ratio during the 2022-2024 period. A higher ratio indicates a smaller drawdown. The right panel plots the time series of the volatility spread between Q4 and Q1 banks from 2021 onwards. For each bank-month, annualized volatility is calculated as the standard deviation of daily returns within the month, multiplied by $\sqrt{252}$. The spread is the difference between the average volatility of Q4 banks and Q1 banks (Q4-Q1). A negative spread indicates Q1 (low ARM/high FRM) banks are more volatile.

point difference in drawdown protection translates to meaningful preservation of market capitalization.

To examine the time-varying nature of risk differentials, for each bank-month, we calculate the standard deviation of daily returns within that month, then annualize. Banks are sorted into quartiles based on their pre-period (2019) ARM share weighted by assets, with Q1 representing the bottom 25 percent (lowest ARM exposure) and Q4 the top 25 percent (highest ARM exposure). For each month, we compute the average volatility within each quartile, then calculate the spread as the difference between Q4 and Q1 average volatilities.

The figure supports our bank balance sheet channel hypothesis. Starting early 2021 the volatility spread starts increasing from near zero values, indicating similar risk profiles across ARM quartiles early 2021. During the March 2023 banking crisis the differences between low and high ARM banks become much higher. The spread declines to approximately -10 percentage points, meaning that Q1 banks (with predominantly FRMs) became significantly more volatile than their Q4 (ARM-heavy) counterparts. This reversal is when FRM-heavy banks faced stress due to fixed-rate mortgage portfolios and deposit flight concerns, while ARM-heavy banks remained relatively stable due to their naturally hedged positions. As the acute phase of the crisis passed and extraordinary policy support was provided, the volatility spread gradually normalized.

This volatility evidence also supports our hypothesized mechanism. The equity market

priced the differential exposure to inflation and interest rate risk embedded in the mortgage portfolios. Market participants understood that FRM-heavy banks faced substantial valuation losses on their long-duration assets as inflation surged, eroding their capital base. In contrast, ARM-heavy banks were insulated from this valuation shock, preserving their financial stability.

Bank-Level Lending Evidence Having provided evidence that the market recognized the differential impact of mortgage structure on bank valuations, we now turn to bank-level data to study the credit supply mechanism. Specifically, we investigate how the concentration of interest rate risk via FRMs impaired bank lending capacity during the recent tightening cycle. We hypothesize that banks with higher ARM shares (and thus lower FRM exposure) were better positioned to maintain credit supply. To study bank-level credit supply effects, we estimate:

$$\Delta L_{b,21-23} = \gamma \text{Bank ARM Share}_{b,19} + \Psi Z_{b,19} + \epsilon_b \tag{11}$$

where $\Delta L_{b,21-23}$ is several measures of loan growth including C&I loans.

To isolate the effect of a bank's ARM share on its lending growth, we control for a comprehensive set of pre-determined bank characteristics, $Z_{b,19}$, that could otherwise confound the relationship. All control variables are measured as of year-end 2019 to mitigate endogeneity concerns and capture the bank's condition immediately prior to the monetary tightening cycle. First, we include standard size and risk controls, such as the logarithm of total assets to account for scale effects, and the equity-to-assets ratio, cash-to-assets ratio, and loan-to-deposit ratio to capture the bank's capitalization, liquidity, and overall risk posture. Second, we incorporate detailed measures of balance sheet composition, including the maturity structure of both the asset side (real estate loans, other loans, and securities) and the liability side (demand deposits, savings deposits, and time deposits of varying maturities). These controls are crucial for distinguishing the effect of ARM holdings from broader maturity mismatch exposures. Finally, we include a set of controls designed to capture other sources of interest rate sensitivity that are distinct from the mortgage portfolio. These include the bank's holdings of trading assets and derivatives, as well as standard measures of interest rate exposure like the one-year "income gap" (the difference between rate-sensitive assets and rate-sensitive liabilities maturing within one year, scaled by assets).

Table VI presents the results. Column 1 shows that for total loans, a 1-percentage point increase in a bank's ARM share is associated with 0.14 percent higher loan growth. Column 2 focuses on Commercial and Industrial (C&I) loans, where the effect is even stronger: a

TABLE VI – The Effect of Fixed-Rate Mortgage on Bank Total Lending

Dependent Variable: Percent Change in Bank Loans			
Variables	Total Loans	C&I Loans	Individual Loans
Bank's ARM Share	0.137**	0.265*	1.122***
Std. Error	(0.622)	(0.157)	(0.385)
Observations	3,931	3,931	3,931
R-squared	0.038	0.041	0.028
All Bank Controls	Yes	Yes	Yes

Notes: This table estimates the relationship between banks' fixed-rate mortgage (FRM) share and percent changes in various measures of bank lending from 2021 to 2023. The main explanatory variable is FRM Share, calculated as one minus the proportion of ARMs in the bank's residential mortgage portfolio, measured as of 2019. All specifications include comprehensive bank-level controls measured in 2019: size controls (log assets), bank risk controls (equity ratio, liquidity ratio, cash ratio), interest rate sensitivity measures (trading assets ratio, maturity gap, income gap), asset maturity controls (various loan and securities maturity buckets), securities portfolio controls (securities by maturity), and liability structure controls (deposit composition by type and maturity). Standard errors are clustered at the bank holding company level. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

1-percentage point increase in ARM share leads to a 0.26 percent increase in C&I lending. Column 3 examines individual loans (refers to consumer loans to individuals that are not secured by real estate), showing the largest effect with an 1.12 percent increase.

These results provide strong support for the bank balance sheet channel identified in our model. The significantly stronger loan growth among high-ARM banks shows the severe impact of valuation risk on the lending capacity of FRM-heavy banks. Consistent with the model's financial accelerator mechanism, banks that heavily invested in long-duration FRMs faced substantial balance sheet pressure as inflation eroded the real value of their assets, depleting their capital and forcing them to contract credit supply.

Bank-County Small Business Lending Evidence To cleanly separate credit supply from demand effects, we examine bank lending at the bank-county level using CRA data. To control for loan demand we perform a separate analysis where we run bank lending to small firms at county-level, and control for loan demand with county fixed effects (μ_{county}). With this approach, we compare the loans of banks with different ARM shares, in a given county.

Specifically, we estimate the following regression by using the CRA data:

$$\Delta L_{b,county,21-23} = \gamma \text{Bank ARM Share}_{b,19} + \Psi Z_{b,19} + \mu_{county} + \epsilon_{b,county}. \tag{12}$$

Table VII presents the results of this analysis. The coefficient on a bank's ARM share is positive and highly statistically significant across all columns, even as we progressively saturate the model with a comprehensive set of bank-level controls. In our most stringent specification (Column 4), which includes controls for bank size, risk, interest rate sensitivity, and the full maturity structure of assets and liabilities, we find that a 1-percentage point increase in a bank's pre-period ARM share is associated with an 1.23 percent increase in its lending to small businesses.

This finding robustly isolates the credit supply channel. Within the same local market, banks with a higher share of ARMs significantly expanded their supply of credit. Equivalently, this implies that the prevalence of FRMs, by concentrating valuation risk on bank balance sheets, directly led to a contraction in credit supply to small businesses by the exposed banks during the inflationary episode.

6.2.3 Evidence on the Credit Supply Channel: A Rajan-Zingales Approach

Having established that FRM exposure directly curtails banks' credit supply (Section 6.2.2), we now investigate the real economic consequences of this contraction. We employ a difference-in-differences strategy inspired by Rajan and Zingales (1998) to test whether this credit supply shock disproportionately affected industries dependent on external finance. The core idea is that if the bank resilience channel operates by easing credit constraints, its positive effects should be most pronounced in industries that are structurally more dependent on external finance. We test this by interacting our state-level measures of household and bank ARM exposure with a pre-determined, industry-level measure of external financial dependence (DoEF). This specification, which includes both state and industry fixed effects, isolates whether financially dependent industries performed differentially better in states served by more resilient, high-ARM banks. We estimate:

$$\Delta Y_{i,21-23} = \gamma \text{ARM Exposure}^{Bank}_{s,19} * DoEF_i + \gamma \text{ARM Share}^{HH}_{s,19} * DoEF_i + \Gamma X_{s,19} + \mu_s + \mu_i + \epsilon_{i,t} \tag{13}$$

where $\Delta Y_{i,21-23}$ is several measures of labor market peformance and $DoEF_i$is the dependence of external finance of 3-digit sector i. Other regional controls include income, unemployment rate, household balance sheets, and regional mortgage characteristics (same controls in the

TABLE VII – The Effect of Fixed-Rate Mortgage on Bank CRA Loans

Dependent Variable: Percent Change in CRA Loans				
Variables	(1)	(2)	(3)	(4)
Bank's ARM Share	0.818***	1.360***	0.939***	1.230***
Std. Error	(0.192)	(0.274)	(0.282)	(0.284)
Observations	52,204	51,626	51,626	51,626
R-squared	0.064	0.088	0.101	0.122
Controls:				
Size Controls	Yes	Yes	Yes	Yes
Bank Risk Controls	Yes	Yes	Yes	Yes
Interest Rate Sensitivity Controls	No	Yes	Yes	Yes
Asset Maturity Controls	No	Yes	Yes	Yes
Securities Controls	No	No	Yes	Yes
Liability Controls	No	No	No	Yes
County FE	Yes	Yes	Yes	Yes

Notes: This table estimates the relationship between banks' adjustable-rate mortgage (ARM) share and the percent change in dollar amounts of loans to small businesses with gross annual revenues less than $1 million from 2021 to 2023. The main explanatory variable is ARM Share, measured as the proportion of ARMs in the bank's residential mortgage portfolio as of 2019. All specifications include county fixed effects to control for local loan demand. Column (1) includes size controls (log assets) and basic risk controls (equity ratio, liquidity ratio, cash ratio). Column (2) adds interest rate sensitivity measures (trading assets ratio, maturity gap, 1-year income gap) and asset maturity controls (personal loans ratio, C&I loans ratio, real estate loans by maturity, loans and leases by maturity, MBS ratio). Column (3) incorporates securities portfolio controls (securities holdings by maturity buckets). Column (4) presents the full specification with liability structure controls (demand deposits, savings deposits, time deposits, brokered deposits, and time deposits by maturity). Standard errors are clustered at the county level. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. P-values are reported below standard errors in brackets.

regional analysis above). We also include sector and state fixed effects.[12]

Table VIII presents the results. Our primary variable of interest is the interaction between ARM Exposure$_{s,19}^{Bank}$ and external finance dependence, $DoEF_i$. For both Employment and Total Wages, this interaction is positive and highly statistically significant.

This is our key finding: industries with a greater structural reliance on external finance experienced significantly stronger employment and wage growth in states where the banking sector was less exposed to the risks of long-duration FRMs (i.e., more ARM-heavy). The economic magnitude is meaningful: a 1-percentage point increase in ARM exposure via

[12]See Appendix for the analysis at the county-industry level.

TABLE VIII – The Effect of Mortgage Structure on State Labour Markets: Evidence from Dependence on External Finance

Dependent Variables: State-sector level labour market outcomes (percent change)			
Variables	Establishments	Employment	Total Wages
ARM Share (via Households) $\times DoEF_i$	-0.110	0.081	0.018
	(0.214)	(0.084)	(0.132)
ARM Exposure (via Banks) $\times DoEF_i$	1.432***	0.681***	0.823***
	(0.452)	(0.154)	(0.236)
Observations	11,315	11,315	11,315
R-squared	0.513	0.532	0.557
All Regional Controls	Yes	Yes	Yes
State-Border and Industry Fixed Effects	Yes	Yes	Yes
All Regional Controls$\times DoEF_i$	Yes	Yes	Yes

Notes: This table examines the effect of mortgage structure on labour market outcomes at sectoral level. The coefficient of interest is the coefficient on the interaction term: ARM Exposure (via Banks) $\times DoEF_i$. $DoEF_i$captures external finance dependence of 3-digit industries. A positive coefficient indicates that industries with higher external finance dependence performed better when they were in the regions with high ARM Exposure (via Banks). All models include: loan characteristics (payment, principal, balance, interest), economic controls (income, unemployment), asset controls (net worth, home equity, retirement accounts, liquid assets), DTI ratio, vehicle equity, and foreclosure rates. All specifications include state and industry fixed effects. Standard errors are clustered at the state level. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

banks is associated with approximately 0.35 percent higher employment growth for a one-standard-deviation increase in financial dependence.

6.3 Synthesis of Empirical Findings

Our empirical analysis of the 2021–2023 U.S. inflation and tightening cycle provides evidence validating the "dual channel" hypothesis derived from our quantitative model. At the aggregate state level, we confirm that these channels operate simultaneously and in opposite direction. Consistent with the household demand channel, regions with higher household ARM exposure—where borrowers faced payment shocks and lacked the Fisher channel windfall of FRMs—experienced significant contractions in consumption, GDP, and income. Crucially, however, we identify a powerful countervailing force: regions exposed to banking sectors with higher ARM shares—and thus insulated from the valuation risk inherent in FRMs—performed significantly better. This divergence confirms that mortgage structure generates opposing demand- and supply-side (credit) forces during the inflationary episode

Our banking analysis robustly isolates the mechanisms underlying this bank resilience channel, aligning with the model's predictions regarding the systemic risks posed by FRMs. By utilizing bank-county data to control for local demand, we show that banks heavily exposed to long-duration FRMs were forced to contract their credit supply significantly more than their ARM-heavy counterparts. This behavior validates the model's financial accelerator mechanism, where rising inflation erode the capital of FRM-heavy banks, triggering a credit crunch. Furthermore, the Rajan-Zingales analysis confirms the real consequences of this instability, as employment in credit-dependent sectors suffered significantly more in areas served by these vulnerable, FRM-exposed banks. The empirical evidence thus confirms the critical trade-off highlighted by the model: the household wealth gains provided by FRMs (the Fisher channel) come at the macroeconomic cost of increased financial instability and a potent credit supply contraction during inflationary episodes.

7 Conclusion

In this paper we have studied how mortgage market structure shapes the transmission of inflation shocks. We challenge the conventional view that the Fisher channel (wealth redistribution from lenders to borrowers) is necessarily expansionary, by documenting a powerful, countervailing force when the lender is a leveraged intermediary. Our central contribution is the identification of a "dual channel" where household wealth effects compete with bank credit supply. In FRM economies, the Fisher channel windfall for borrowers is mirrored by concentrated losses for banks, eroding capital and triggering a credit crunch. Conversely, ARM economies mute this systemic risk. This "dual channel" framework fundamentally reframes how we understand the macroeconomic role of mortgage contracts.

Our quantitative model shows why these aggregate patterns emerge and uncovers important distributional consequences. Under fixed-rate contracts, inflation shocks trigger systemic banking distress that transforms into economy-wide recession. The resulting credit contraction disproportionately harms those without assets—young workers, renters, and the poor—who bear adjustment costs through unemployment and exclusion from homeownership. Paradoxically, the very households FRMs purport to protect often benefit least, while established homeowners gain from debt erosion. Adjustable-rate systems concentrate adjustment on exposed borrowers through immediate payment shocks and foreclosures, but preserve broader economic stability by maintaining functional credit markets.

Our empirical investigation leveraging the 2021-2023 monetary tightening provides evidence for both channels operating simultaneously. The multi-tiered analysis reveals that ARM

prevalence among households depresses local economic activity, yet ARM concentration in bank portfolios supports it. These opposing effects manifest across multiple levels of aggregation—from state-level consumption to bank-specific lending decisions to employment in credit-dependent industries. The robustness of these patterns across different identification strategies strengthens confidence in the underlying mechanism.

These results challenge conventional wisdom about optimal mortgage design. Rather than simply focusing on the expansionary effects of the Fisher channel, mortgage structure determines the distribution of macroeconomic risk across the society. Fixed-rate systems generate individual wealth gains by creating collective vulnerability—transforming nominal valuation risk into systemic banking fragility with regressive incidence. This trade-off suggests monetary authorities face an uncomfortable reality: in FRM-dominated economies, the response to inflation shocks is dominated by financial instability rather than the stimulative effects of the Fisher channel.

Several research priorities emerge from our findings. Most pressing is whether regulatory frameworks can decouple household insurance from systemic risk, perhaps through mandatory hedging requirements or countercyclical mortgage regulations that preserve FRM benefits while limiting banking sector exposure. Furthermore, exploring innovative mortgage designs that incorporate automatic stabilization features—such as options to switch rates or adjust payments during recessions (e.g., Eberly and Krishnamurthy (2014), Campbell et al. (2021))—warrants further investigation within a general equilibrium framework that fully accounts for the dual channel that we highlight in this paper. We leave this for future research.

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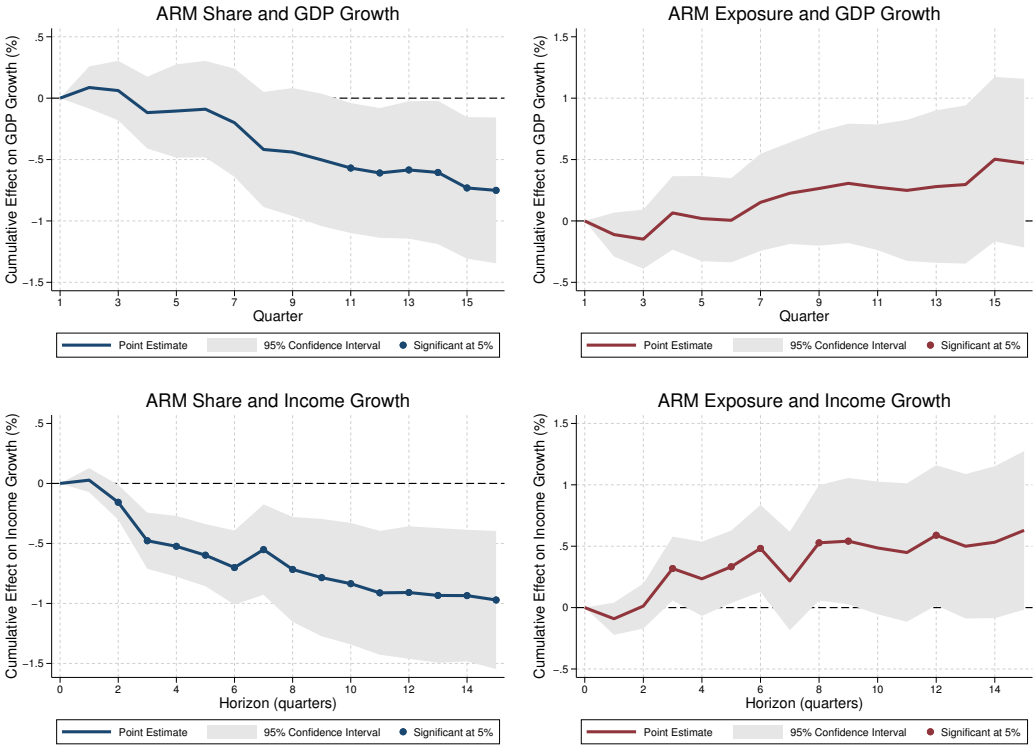
A Further Empirical Evidence

A.1 State-level further results

FIGURE A.1 – Mortgage Structure and State Economies



Notes: These figures present impulse response functions from Jordà (2005) local projections examining the dynamic effects of adjustable-rate mortgage prevalence on state economies. The specification follows:$y_{s,t+h} - y_{s,t-1} = \alpha^h + \beta_1^h \text{ARM Share}_{s,19}^{HH} + \beta_2^h \text{ARM Exposure}_{s,19}^{Bank} + \gamma^h X_{s,t} + \mu_{s-b,h} + \varepsilon_{i,t+h}$, where $y_{i,t+h} - y_{i,t-1}$ represents the cumulative percentage change in each depedent variable from the base period $(t-1)$ to horizon h, measured monthly for up to 15 quarters. ARM $\text{Share}_{s,19}^{HH}$ captures the state-level proportion of ARMs held by households, while ARM $\text{Exposure}_{s,19}^{Bank}$ measures the state's exposure to ARMs through bank lending patterns. $X_{i,t}$ includes pre-determined state-level controls: loan characteristics (scheduled monthly payment, scheduled principal), economic conditions (per capita income, unemployment rate), household balance sheet variables (net worth excluding home, home equity, motor vehicle equity, retirement accounts, liquid assets), debt measures (credit card debt), debt-to-income ratio, homeownership rate, and foreclosure rates. $\mu_{s-b,h}$ represents border-pair $\times$ horizon fixed effects to control for time-invariant unobserved heterogeneity between neighboring states and horizon-specific shocks. Standard errors are clustered at the border-pair level to account for spatial correlation. The shaded areas represent 95% confidence intervals, with solid markers indicating statistical significance at the 5% level. The identification strategy exploits cross-state variation in ARM prevalence at state borders, controlling for local economic conditions that might affect both mortgage choice and house price dynamics.

A.2 MSA-level evidence

To provide further support for the dual channel mechanism and ensure that our state-level findings are not driven by unobserved regional shocks, we conduct a more granular analysis at the Metropolitan Statistical Area (MSA) level. We employ a spatial regression discontinuity design, utilizing state-border pair fixed effects. This rigorous approach compares MSAs located near each other but on opposite sides of a state border, effectively controlling for localized economic conditions common to

the border region. We estimate the following specification:

$$\Delta Y_{m,s,b,21-23} = \beta_1 \text{ARM Share}^{HH}_{m,19} + \beta_2 \text{ARM Exposure}^{Bank}_{m,19} + \Gamma X_{m,19} + \mu_{s-b} + \epsilon_{m,s,b} \quad \text{(A.1)}$$

where $\Delta Y_{m,s,b,21-23}$ represents the log change in economic outcomes for MSA m in state s belonging to border pair b. ARM Share$^{HH}_{m,19}$ and ARM Exposure$^{Bank}_{m,19}$ are the MSA-level exposures measured in 2019. $X_{m,19}$ includes a detailed set of MSA-level controls, including loan characteristics, economic indicators, market concentration measures, and detailed household income distribution data (see table notes). Crucially, μ_{s-b} denotes the state-border pair fixed effects. The regressions are weighted by the inverse of the number of borders the MSA's state shares.

TABLE A.1 – The Effect of Mortgage Structure on MSA Economies

Dependent Variables: MSA-level Growth (2021-2023)			
	(1)	(2)	(3)
Variables	Per-capita Personal Income	Personal Income	GDP
ARM Share 2019 (HH)	-0.210***	-0.268***	-0.224*
	(0.077)	(0.102)	(0.134)
Bank ARM Exposure 2019	0.0788**	0.068**	0.080**
	(0.033)	(0.029)	(0.032)
Observations	1575	1575	1575
R-squared	0.487	0.5047	0.307
MSA Controls	Yes	Yes	Yes
State-Border Pair FE	Yes	Yes	Yes

Notes: This table examines the relationship between adjustable-rate mortgages (ARMs) and MSA-level economic outcomes using a border-pair fixed effects design. The dependent variables are the log changes in Per Capita Income, Total Income, and GDP (2021-2023). All models include the following MSA-level controls measured pre-period: loan characteristics (log average balance, principal, monthly payment, FICO score), economic/wealth controls (log income 2021, log deposits 2021, pension share), labor market and concentration controls (employment, HHI, number of banks), and detailed household income distribution brackets. All specifications include State-Border Pair Fixed Effects. Regressions are weighted by the inverse of the number of borders the MSA's state shares. Standard errors (in parentheses) are clustered at the border-pair level. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Table A.1 presents the results. The findings at the MSA level strongly corroborate the state-level evidence, confirming that the dual channel mechanism operates consistently even when controlling for fine-grained local shocks.

The coefficient on the household ARM share (ARM Share^{HH}) is negative and highly statistically significant across all measures of economic activity: Per Capita Income Growth (Column 1), Total Income Growth (Column 2), and GDP Growth (Column 3). This demonstrates that MSAs with higher household exposure to adjustable rates experienced significantly weaker economic performance. For instance, a one percentage point increase in the household ARM share is associated with an approximate 0.21 percentage point decrease in per capita income growth.

Conversely, the coefficient on bank ARM exposure (ARM Exposure^{Bank}) is positive and statistically significant across all specifications ($p<0.05$). This indicates that MSAs served by banking sectors with higher ARM concentration—and thus greater insulation from interest rate risk—performed

significantly better. A one percentage point increase in bank ARM exposure is associated with an approximate 0.08 percentage point increase in both per-capita income and GDP growth.

The consistency of these results, utilizing a border-discontinuity design, reinforces our main findings: the household demand channel (via ARM exposure) acts as a drag on the local economy, while the bank resilience channel (via ARM exposure) provides significant support during an inflationary period.

B Model Appendix

In this section, we provide data sources that we use for numerical calibration. We also give the detailed formulations of all optimization problems.

B.1 Data Sources for the Model Moments

All data come from the Federal Reserve Economic Data (FRED). All data moments are calculated as the average of the period between 2015 and 2020. In our model output is denoted as Y and GDP is the sum of output and the housing services consumption, which is imputed at the rental price for the owner-occupied units as in the data. Thus, GDP is $Y_A = Y + p_r \bar{H}$ at the steady-state. The data counterpart of GDP in our model is total GDP subtracted by government spending and net exports, i.e. the sum of personal consumption expenditure and gross domestic investment. This value is obtained by summing Personal Consumption Expenditures (PCE) and the Gross Private Domestic Investment (GPDI) in FRED dataset. Output, Y, is obtained by subtracting housing services from GDP. Housing services is the sum of Personal consumption expenditures: Services: Housing: Rental of tenant-occupied nonfarm housing (DTENRC1A027NBEA) and Personal consumption expenditures: Services: Housing: Imputed rental of owner-occupied nonfarm housing (DOWNRC1A027NBEA) in FRED.

Mortgage Debt-GDP Ratio: Mortgage Debt to GDP ratio is obtained by dividing the series One-to-Four-Family Residential Mortgages; Liability of Households and Nonprofit Organizations (HHMSDODNS) to GDP. The average of this series between 2015 and 2020 is 60.27 percent.

Homeownership Rate: Homeownership rate is obtained from the series RSAHORUSQ156S labeled as Homeownership Rate in the United States. The average rate between 2015 and 2020 is 64.03 percent.

Housing Services Share in GDP: Housing Services Share in GDP is calculated by dividing the sum of Personal consumption expenditures: Services: Housing: Rental of tenant-occupied nonfarm housing (DTENRC1A027NBEA) and Personal consumption expenditures: Services: Housing: Imputed rental of owner-occupied nonfarm housing (DOWNRC1A027NBEA) to GDP. The average of this series between 2015 and 2020 is 12.49 percent.

Non-residential Investment-Output Ratio: Non-residential Investment-Output ratio is calculated by dividing Private Nonresidential Fixed Investment (PNFI) to output, Y. The average of this series between 2015 and 2020 is 19.32 percent.

Residential Investment-GDP Ratio: Residential Investment to GDP ratio is calculated by dividing the Private Residential Fixed Investment (PRFI) to GDP. The average of this series between 2015 and 2020 is 4.72 percent.

House Price-Rent Ratio: House Price to Rent ratio is calculated by dividing Households; Owner-Occupied Real Estate at Market Value (BOGZ1FL155035013Q) to the Imputed rental of owner-occupied housing (A2013C1A027NBEA). The average of this series between 2015 and 2020 is 16.14.

Mortgage Share in Bank Assets: Mortgage Share in bank assets is calculated by dividing Households and Nonprofit Organizations; One-to-Four-Family Residential Mortgages; Liability (BOGZ1FL153165105A) to the sum of Households and Nonprofit Organizations; One-to-Four-Family Residential Mortgages; Liability (BOGZ1FL153165105A) and Nonfinancial Business; Loans; Liability (BOGZ1FL144123005A), representing corporate debt in bank balance sheets. The average of this series between 2015 and 2020 is 52.29 percent.

Bank Leverage: Bank Leverage is calculated by dividing Total Assets, All Commercial Banks (TLAACBM027SBOG) to Residual (Assets Less Liabilities), All Commercial Banks (RALACBM027SBOG). The average of this series between 2015 and 2020 is 9.12.

Mortgage Premium: Mortgage Premium is calculated as the difference between 30-Year Fixed Rate Mortgage Average in the United States (MORTGAGE30US) and Market Yield on U.S. Treasury Securities at 10-Year Constant Maturity (WGS10YR). The average of this series between 2015 and 2020 is 1.72 percent.

Capital-Output Ratio: This ratio is set to 3 as it is usual in the literature.

Inflation: Inflation data is obtained using the series Consumer Price Index for All Urban Consumers: All Items Less Food and Energy in U.S. City Average (CPILFESL). We first fit a linear line to the data between 2015 and 2020, remove the trend from the actual series, and compute the deviation from the trend after 2020 to obtain the shock fed to the model.

B.2 Value Functions for Households

B.2.1 Active Renters

An active renter has two choices: continue to rent or purchase a house, that is, $V^r = \max\left\{V^{rr}, V^{rh}\right\}$ where V^{rr} is the value function if she decides to continue renting and V^{rh} is the value function if she decides to purchase a house. If she decides to continue to rent, she chooses rental unit size s at price p_r per unit, makes her consumption and saving choices, and remains as an active renter in the next period. After purchasing a house, she begins the next period as a homeowner. The value function of an active renter who decides to remain as a renter is given by

$$V_j^{rr}(a,z) = \max_{c,s\leq \underline{h},a'\geq 0}\left\{\left(u(c,s)+\beta E\left(V_{j+1}^{r}(a',z')^{1-\sigma}\right)^{\frac{1-\rho}{1-\sigma}}\right)^{\frac{1}{1-\rho}}\right\} \tag{B.1}$$

subject to $$c + a' + p_r s = y(j,z) + a\,(1+r_k)\,,$$

where a is the beginning-of-period financial wealth, $p_r s$ is the rental payment, r_k is the return to savings, and w is the wage rate per efficiency unit of labor. The expectation operator is over the income shock z'.

B.2.2 Inactive Renters

Inactive renters are not allowed to purchase a house because of their default in previous periods. However, they can become active renters with probability π. Since they cannot buy a house; they only make rental size, consumption, and saving decisions. The value function of an inactive renter is given by

$$V_j^{e}(a,z) = \max_{c,s\leq \underline{h},a'\geq 0}\left\{\left(u(c,s)+\beta\left[\pi E V_{j+1}^{r}(a',z')^{1-\sigma}+(1-\pi)E V_{j+1}^{e}(a',z')^{1-\sigma}\right]^{\frac{1-\rho}{1-\sigma}}\right)^{\frac{1}{1-\rho}}\right\} \tag{B.2}$$

subject to

$$c + a' + p_r s \quad = \quad y(j,z) + a\,(1 + r_k)\,.$$

B.2.3 Homeowners

The options of a homeowner are: 1) stay as a homeowner, 2) refinance, 3) sell the current house (become a renter or buy a new house), or 4) default. The value function of an owner is given as the maximum of these four options, that is, $V^h = \max\left\{V^{hh}, V^{hf}, V^{hr}, V^{he}\right\}$, where V^{hh} is the value of staying as a homeowner, V^{hf} is the value of refinancing, V^{hr} is the value of selling, and V^{he} is the value of defaulting (being excluded from the ownership option).

A stayer makes a consumption and saving decision given his income shock, housing, mortgage debt, and assets. Therefore, the problem of the stayer can be formulated as follows:

$$V_j^{hh}(a,h,d,z) = \max_{c,a'\geq 0}\left\{\left(u(c,h) + \beta\left(EV_{j+1}^h\left(a',h,d',z'\right)^{1-\sigma}\right)^{\frac{1-\rho}{1-\sigma}}\right)^{\frac{1}{1-\rho}}\right\} \tag{B.3}$$

subject to

$$\begin{aligned} c + \delta_h p_h h + a' + m &= y(j,z) + a\,(1 + r_k) \\ d' &= (d - m)\,(1 + r_\ell)\,, \end{aligned}$$

where m is the mortgage payment following the standard amortization schedule computed at the bank lending rate r_ℓ.

The second choice for the homeowner is to refinance, which also includes prepayment. Refinancing requires paying the full balance of any existing debt and getting a new mortgage. We assume that refinancing is subject to the same transaction costs as new mortgage originations. So, we can formulate the problem of a refinancer as

$$V_j^{hf}(a,h,d,z) = \max_{c,d',a'\geq 0}\left\{\left(u(c,h) + \beta\left(EV_{j+1}^h(a',h,d',z')^{1-\sigma}\right)^{\frac{1-\rho}{1-\sigma}}\right)^{\frac{1}{1-\rho}}\right\} \tag{B.4}$$

subject to

$$c + d + \delta_h p_h h + \varphi_f + a' \quad = \quad y(j,z) + a\,(1 + r_k) + d'\left(q^m(d';a,h,z,j) - \varphi_m\right).$$

The third choice for the homeowner is to sell the current house and either stay as a renter or buy a new house. Selling a house is subject to a transaction cost that equals fraction φ_s of the selling price. Moreover, a seller has to pay the outstanding mortgage debt, d, in full to the lender. A seller, upon selling the house, can either rent a house or buy a new one. Her problem is identical to a renter's problem. So, we have

$$V_j^{hr}(a,h,d,z) = V_j^r\left(a + p_h h(1 - \varphi_s) - d, z\right).$$

The fourth possible choice for a homeowner is to default on the mortgage, if she has one. A defaulter has no obligation to the bank. The bank seizes the house, sells it on the market, and returns any positive amount from the sale of the house, net of the outstanding mortgage debt and transaction costs, back to the defaulter. For the lender, the sale price of the house is assumed to be $(1 - \varphi_e)\,p_h h$. Therefore, the defaulter receives $\max\{(1 - \varphi_e)\,p_h h - d, 0\}$ from the lender. The defaulter starts the next period as an active renter with probability π. With probability $(1 - \pi)$, she stays as an inactive

renter. The problem of a defaulter becomes the following:

$$V_j^{he}(a,d,z) = \max_{c,s\leq \underline{h},a'\geq 0} \left\{ \left(u(c,s) + \beta E\left[\pi V_{j+1}^{r}\left(a',z'\right)^{1-\sigma} + (1-\pi) V_{j+1}^{e}\left(a',z'\right)^{1-\sigma} \right]^{\frac{1-\rho}{1-\sigma}} \right)^{\frac{1}{1-\rho}} \right\} \tag{B.5}$$

subject to

$$c + a' + p_r s = a(1+r_k) + y(j,z) + \max\left\{(1-\varphi_e)\, p_h h - d, 0\right\}.$$

The problem of a defaulter is different from the problem of a seller in two ways. First, the defaulter receives $\max\left\{(1-\varphi_e)\, p_h h - d, 0\right\}$ from the housing transaction, whereas a seller receives $(1-\varphi_s)\, p_h h - d$. We assume that the default cost is higher than the sale transaction cost, that is, $\varphi_e > \varphi_s$, and the defaulter receives less than the seller as long as $(1-\varphi_s)\, p_h h - d \geq 0$ (i.e., the home equity net of the transaction costs for the homeowner is positive). Second, a defaulter does not have access to the mortgage in the next period with some probability. Such an exclusion lowers the continuation utility for a defaulter. In sum, since defaulting is costly, a homeowner will choose to sell the house instead of defaulting as long as $(1-\varphi_s)\, p_h h - d \geq 0$ (i.e., net home equity is positive). Hence, negative equity is a necessary condition for default in the model. Therefore, in equilibrium, a defaulter gets nothing from the lender.

B.3 Firm's Problem

The firm's first-order conditions are given as

$$\begin{aligned}
\alpha \mathbb{Z}\left(\frac{K}{Nu}\right)^{\alpha-1} &= r_k + \delta \\
(1-\alpha)\,\mathbb{Z} u\left(\frac{K_t}{Nu}\right)^{\alpha} &= \left(1+\mu r_\ell'\right)\left(\bar{w} + \vartheta \frac{u^{1+\psi}}{1+\psi}\right) \\
(1-\alpha)\,\mathbb{Z}\left(\frac{K_t}{Nu}\right)^{\alpha} &= \left(1+\mu r_\ell'\right)\vartheta u^{\psi}.
\end{aligned}$$

B.4 Government

The government runs a pay-as-you-go pension system. It collects social security taxes from working-age households and distributes to retirees. We assume the pension system runs a balanced budget:

$$\sum_{j=1}^{J_R}\sum_{z} \tau y(j,z)\,\pi_j(z) = \sum_{j=J_R+1}^{J}\sum_{z} y_R(j,z)\,\pi_j(z), \tag{B.6}$$

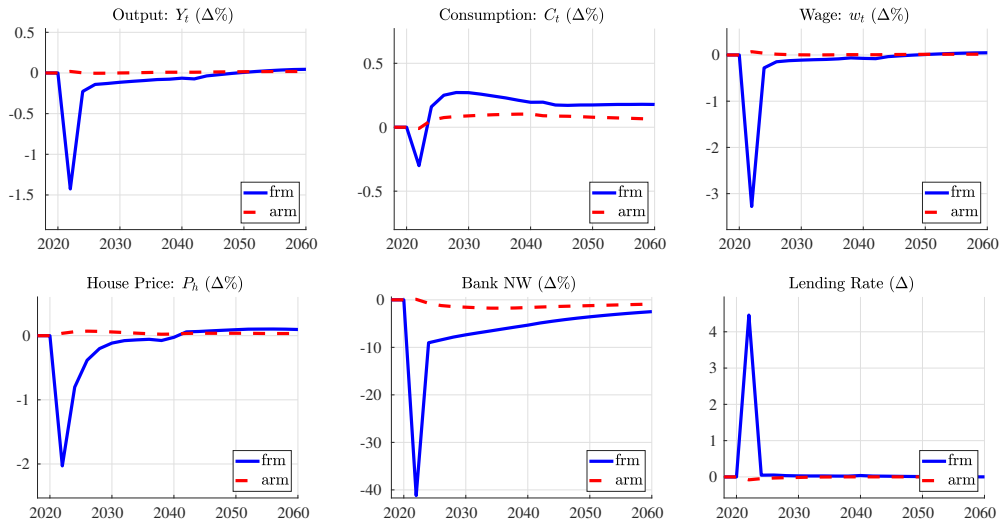
where $\pi_j(z)$ is the measure of individuals with income shock z at age j.

C Additional Model Results

C.1 General Equilibrium

In this section we study a version of the model where the economy is closed, and the bank funding rate is determined in the equilibrium. Figure C.2 presents the dynamics of the model economy in a closed general equilibrium framework where the bank deposit rate clears the market for savings (relaxing the open economy assumption). The core divergence between the mortgage regimes remains robust to endogenous funding costs. In the FRM economy (solid blue line), the inflation shock precipitates

FIGURE C.2 – Model Dynamics with Inflation Shock: ARM versus FRM



Notes: The graph plots the dynamics of the model economy with the inflation shock for key variables when the mortgages ARM or FRM where the deposit rate is determined in general equilibrium. The inflation shock is an unexpected 7 percentage point increase from an initial steady state of zero. The shock follows an AR(1) process with a biannual persistence of 0.4. Since there are no price rigidities other than nominal mortgage contracts, all prices, including the bank deposit rates, adjust nominally.

a sharp contraction in bank net worth due to the duration mismatch. Although the equilibrium deposit rate adjusts, it is insufficient to offset the quantity restriction on credit supply driven by the erosion of bank capital. Consequently, the spread between the lending rate and the deposit rate widens significantly, and the economy experiences a recession driven by the financial accelerator. This confirms that the systemic fragility of the FRM system is driven by the solvency constraint on intermediaries rather than the specific assumption regarding funding elasticity.

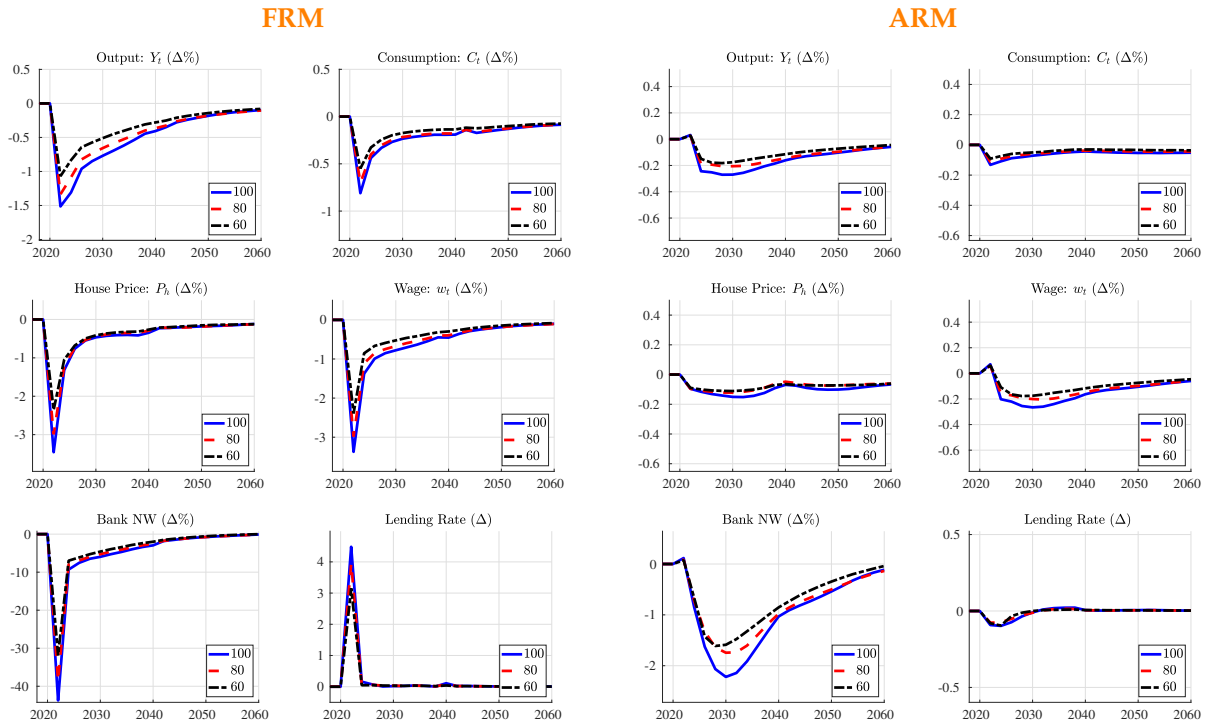
C.2 Alternative Macroprudential Policies: LTV and PTI

We explore how ex-ante borrower-based macroprudential regulations mediate the transmission of the inflation shock.

Loan-to-Value (LTV) Restrictions. Figure C.3 illustrates the economy's response under varying LTV caps (100%, 80%, and 60%). Tighter LTV limits significantly dampen the recessionary dynamics in the FRM economy. By enforcing lower initial household leverage, these policies reduce the aggregate stock of nominal assets held by the banking sector. This lower exposure reduces the magnitude of the valuation loss banks suffer when inflation spikes, thereby preserving bank capital and mitigating the severity of the credit crunch.

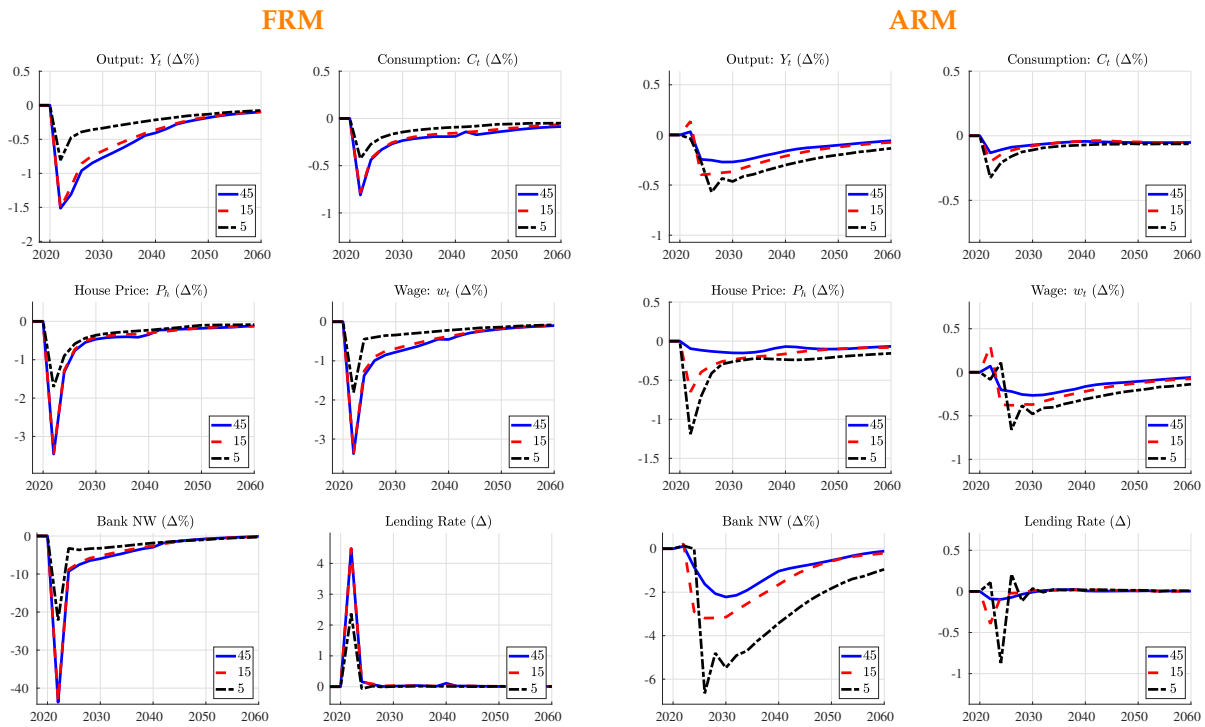
Payment-to-Income (PTI) Restrictions. Figure C.4 presents the dynamics under different Payment-to-Income restrictions (45%, 15%, and 5%). Unlike LTV limits, PTI restrictions generate asymmetric effects across mortgage regimes. In the FRM economy, tighter PTI limits stabilize the economy by limiting total indebtedness. However, in the ARM economy, tighter PTI limits *exacerbate* the downturn. This occurs because PTI constraints bind on current cash flows. The inflation shock triggers the "tilting effect" in ARMs, front-loading real payments. If households are strictly constrained by PTI limits, this payment shock forces a sharp, immediate contraction in consumption to satisfy the constraint. Thus, strictly binding PTI policies can amplify consumption volatility in floating-rate regimes during inflationary episodes.

FIGURE C.3 – Loan-to-Value Restrictions and the Model Dynamics



Notes: The graph plots the dynamics of the model economy with the inflation shock for key variables for different levels of loan-to-value restrictions. We compare our benchmark calibration (LTV restriction of 100 percent) with 80 and 60 percent scenarios.

FIGURE C.4 – Payment-to-Income Restrictions and the Model Dynamics



Notes: The graph plots the dynamics of the model economy with the inflation shock for key variables for different levels of payment-to-income restrictions. We compare our benchmark calibration (PTI restriction of 45 percent) with 15 and 5 percent scenarios.

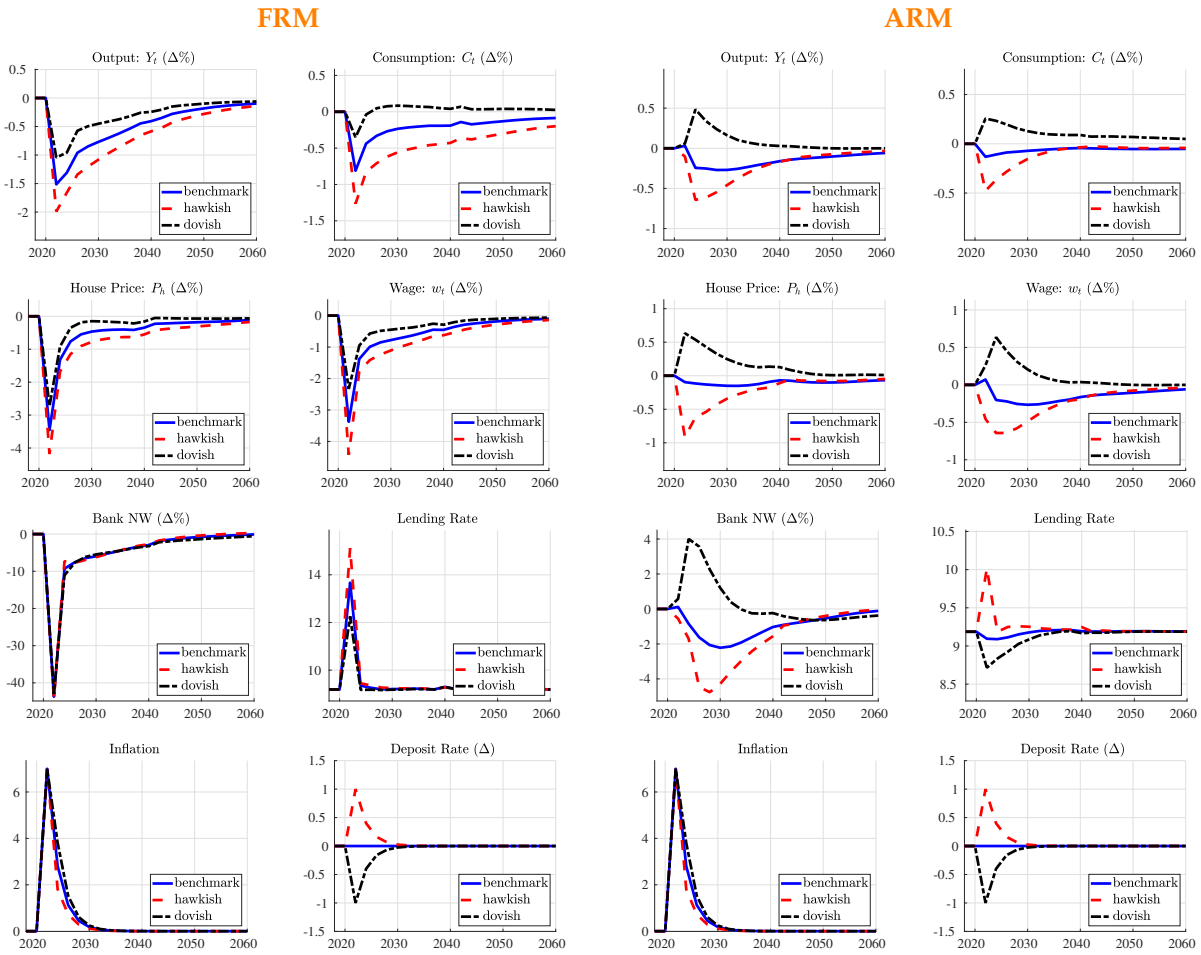
C.3 Monetary Policy with Endogenous Inflation

In the main text, we assumed an exogenous inflation path to isolate transmission channels. C.5 relaxes this assumption, allowing inflation to respond endogenously to the central bank's policy stance via a standard Phillips curve relationship (consistent with estimates in Coibion (2012)). We compare the benchmark response to a "hawkish" rule (reacting more aggressively to inflation) and a "dovish" rule (reacting less aggressively).

The results confirm that the conflict between price and financial stability is structural. The hawkish policy (red dashed line) compresses inflation but induces a deeper decline in bank net worth. This triggers a bigger spike in lending rates and a deeper recession. Conversely, the dovish policy (black dashed line) moderates the decline in output and bank capital, albeit at the cost of higher persistent inflation. This confirms that the "financial dominance" constraint identified in our main analysis is robust to endogenous price determination.

Figure C.5 (right panels) shows that in the ARM economy, the central bank's stance also affects the depth of the recession, but the mechanism is different and the trade-off is less severe. A more aggressive policy leads to a larger downturn compared to a dovish stance. However, the recessions are substantially milder than in the FRM economy across all policy stances. This occurs because the ARM structure preserves bank capital and stabilizes the credit supply. The primary transmission mechanism is the direct household cash-flow channel. Consequently, the central bank in an ARM economy can pursue price stability with less concern for inducing systemic financial instability.

FIGURE C.5 – Monetary Policy Tightness and Mortgages: When Inflation Responds



Notes: The graph plots the dynamics of the model economy with the inflation shock for key variables for different levels of monetary policy response. In blue line monetary policy responds one to one to inflation. In red line monetary policy responds 1p.p. more to inflation and in black line it responds 1p.p. less. Here, inflation in the next period responds to monetary policy one to one consistent with the estimates in Coibion (2012).