An Asset-Price Centric New Keynesian Model

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Abstract

This paper develops a New Keynesian model in which asset-price wealth effects drive consumption dynamics. Due to information frictions, aggregate asset-price movements driven by discount rates are misperceived as idiosyncratic shocks to individual wealth. The marginal propensity to consume (MPC) out of capital gains and the MPC out of income jointly determine equilibrium consumption. With MPCs calibrated to their empirical estimates and driven directly by realized asset prices, the model closely replicates US consumption during the 1998–2019 cycle. The framework offers a unified mechanism for the transmission of discount-rate shocks, in which aggregate MPCs and realized asset prices serve as sufficient statistics for consumption dynamics. Applied to monetary policy, it reconciles the gap between micro and macro estimates of the elasticity of intertemporal substitution (EIS). It provides a tractable approach to monetary policy that targets asset valuations. Asset prices determine aggregate demand and balance-sheet policies are modeled via an Asset-Price Taylor rule. A heterogeneous-agent extension reveals that inequality is a key determinant of macroeconomic volatility, in contrast to standard HANK models. Policies reducing inequality also stabilize the macroeconomy.

Keywords: Wealth effects; Asset prices; Monetary policy; Heterogeneous agents; Business Cycles. *JEL classification*: E21, G51, E52, G12, D31, E32

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1 Introduction

Do asset prices matter for the macroeconomy? Policy practice and everyday reality suggest a resounding yes. Asset prices co-move strongly with economic activity, and central banks care about stock-price wealth effects on consumption (Cieslak and Vissing-Jorgensen 2021). Yet, in many macroeconomic models, asset prices are secondary objects: they are determined by discount rates and dividends and do not exert an independent wealth effect on consumption. This limited role reflects a classic general-equilibrium insight: holding dividends fixed, a higher asset price and realized return today are offset by lower expected returns in the future, thus creating no net wealth (Sinai and Souleles 2005; Case, Glaeser and Parker 2000; Buiter 2010; Fagereng et al. 2022).

Whether this wealth-neutrality logic holds for real-world consumption-saving decisions and therefore policymaking depends on whether agents correctly anticipate the future reversal of returns. Empirically, however, the literature documents extrapolative beliefs (Vissing-Jorgensen 2003; Bacchetta, Mertens and Van Wincoop 2009; Greenwood and Shleifer 2014; Gennaioli, Ma and Shleifer 2016): investors associate high aggregate asset prices and realized returns with high return expectations, even though high valuations predict lower future returns. This paper rationalizes such expectations in the spirit of Lucas Jr (1972): agents confuse aggregate with idiosyncratic asset returns. Idiosyncratic returns empirically exhibit momentum (Moskowitz, Ooi and Pedersen 2012), so agents applying a "momentum heuristic" may mistakenly forecast a continuation of high aggregate returns.[1]

The nature of asset price movements matters for consumption responses. To the extent that a change in asset valuations is correctly attributed to, for instance, interest rates, consumption responds via intertemporal substitution. To the extent that the change is misperceived as idiosyncratic, agents believe their portfolios have outperformed or underperformed the market, and the resulting consumption response is driven by the marginal propensity to consume (MPC) out of capital gains.

Formally, I introduce information frictions between aggregate and idiosyncratic asset prices, and develop a New Keynesian model (APNK) in which discount rates drive consumption through asset-price wealth effects.[2] In equilibrium, the MPC out of capital gains and the MPC out of income jointly determine consumption. This mechanism delivers striking quantitative performance: with MPCs calibrated to empirical estimates

[1] Greenwood and Vayanos (2014) and Gennaioli, Ma and Shleifer (2016) document that the expectations of next 12-month S&P 500 returns are highly correlated with the past 12-month realized returns, consistent with the persistence in idiosyncratic returns for one to 12 months documented in Moskowitz, Ooi and Pedersen (2012). Vissing-Jorgensen (2003) and Kuchler and Zafar (2019) document that agents naively extrapolate personal experiences with their asset returns when forming aggregate expectations.

[2] Conditional on the confusion, different underlying mechanisms (information constraints, bounded rationality) lead to the same consumption-saving decision. Therefore, the canonical information-friction approach of this paper can also be interpreted as a modeling device to vary the degree of misperception.

and the model driven by realized asset prices, it closely tracks U.S. consumption over the 1998–2019 cycle. Crucially, this is not a reduced-form macroeconometric or estimated DSGE exercise: (i) the model is structural, with parameters disciplined by micro-level evidence rather than chosen to fit aggregate moments; (ii) it tracks consumption in "real time" without relying on unobservable demand disturbances (preference/risk-premium shocks). The mechanism is successful that a fully micro-founded model performs better than "macro-fitted" models.

The potential of wealth effects for explaining aggregate consumption dynamics can be illustrated with a back-of-the-envelope calculation. In a representative-agent (RA) setting, when the value of aggregate assets A increases by dA, the equilibrium consumption response is given by

$$dC = \frac{\text{MPC}^A}{1 - \text{MPC}^Y} dA.$$

The MPC out of asset capital gains, MPC^A, governs the direct consumption response $\text{MPC}^A dA$. This initial spending raises income Y, and the MPC out of income, MPC^Y, triggers a second-round consumption response, which will feed back into income again. This Keynesian spending-income feedback loop continues until consumption equals income and the market clears. In equilibrium, the direct wealth effect $\text{MPC}^A dA$ is amplified by the Keynesian multiplier $1/(1 - \text{MPC}^Y)$.[3]

Empirical estimates of yearly MPC^A out of stock wealth lie in the range $0.01 - 0.05$, while yearly MPC^Y estimates lie between 0.3 and 0.7. Taking the yearly wealth-to-consumption ratio A/C to be 3.5. For monetary policy, a 100-basis-point interest-rate cut raises stock prices by $\hat{P} = 4\% - 10\%$, so the consumption response in percentage is

$$\hat{C} = \frac{\text{MPC}^A}{1 - \text{MPC}^Y} \frac{A}{C} \hat{P} = \frac{0.02}{1 - 0.5} \times 3.5 \times 6\% = 0.84\%. \tag{1}$$

This magnitude is comparable to the standard New Keynesian model with log utility, where a 100-basis-point interest-rate cut raises consumption by 1%.[4]

The mechanism offers a unified framework for the transmission of discount-rate shocks. In standard models, distinct shocks operate through separate channels. For instance, interest-rate transmission depends on the elasticity of intertemporal substitution (EIS), risk shocks affect consumption through precautionary savings and the strength is governed by risk aversion, and house prices influence demand through the substitution between consumption and housing services. Under information frictions,

[3]Starting from $dC = \text{MPC}^A dA + \text{MPC}^Y dY$ and imposing market clearing $dC = dY$ yields $dC = \text{MPC}^A dA/(1 - \text{MPC}^Y)$, i.e., the Keynesian multiplier $1/(1 - \text{MPC}^Y)$.

[4]Section 4.3 provides an estimation taking into account housing wealth and household heterogeneity, and the estimated consumption response is 1.03%.

these shocks operate through a single wealth channel. The model setup is flexible to capture wealth effects arising from alternative sources of asset-price fluctuations and distinct asset classes. A key implication is that aggregate MPCs and realized asset prices serve as sufficient statistics for consumption responses, regardless of the underlying driver of asset prices.

When calibrated with empirical estimates of MPCs out of income, stock, and housing wealth, and driven by realized asset-price series, the consumption path implied by equation (1) closely tracks the timing and magnitude of U.S. consumption over the 1998–2019 cycle. When applied to monetary policy, the framework delivers an *Asset-Price Euler Equation*, which helps resolve the longstanding puzzle regarding the magnitude of EIS. In this formulation, the sensitivity of aggregate consumption to interest rates is not a primitive parameter but determined by: (i) MPC*s*, (ii) the wealth-consumption ratio and (iii) asset prices' elasticities to interest rates. Substituting empirical estimates of these objects yields a reasonable macro-level EIS.

Having established the causality betweeen consumption and asset prices, I develop a simple approach for monetary policy that targets asset valuations. Following the Great Recession, central banks engaged in large-scale asset purchases to support asset prices and stimulate aggregate demand. In the APNK model, policies that move asset prices directly transmit to spending via wealth effects. The approach replaces the Taylor rule on nominal interest rates with an *Asset-Price Taylor Rule*, which links asset prices to macroeconomic conditions and is a structural representation of balance-sheet tools.

The paper's last contribution is to show that, in the presence of wealth effects, there is an inherent link between inequality and macroeconomic volatility. While the empirical literature documents large heterogeneity in wealth, income, and MPCs, standard incomplete-market models limit the impact of MPC heterogeneity on aggregate shock transmission to a single mechanism: its covariance with shock-induced redistribution. Gong (2025) generalizes the result of Werning (2015) and shows that when agents have homogeneous consumption and labor-supply responses to an aggregate shock, the aggregate dynamics of an HA economy coincide with those of an RA economy. In this benchmark, the heterogeneity in MPCs (and MPNs, the marginal propensities to work) is irrelevant for business-cycle fluctuations.[5]

Micro-heterogeneity and macro-neutrality coexist because MPCs (and MPNs) are partial-equilibrium objects. Their levels matter for decomposing shock transmission into partial-equilibrium responses and general-equilibrium feedback—for example, the small direct and large indirect effects of monetary policy in Kaplan, Moll and Violante (2018)—but not necessarily for the overall response. For an interest-rate shock in an

[5]This benchmark applies to shocks that drive fluctuations in an RA economy. It excludes shocks like lump-sum fiscal transfers, which are neutral in an RA economy due to Ricardian equivalence. Such shocks are inherently redistributive and transmit via MPC heterogeneity.

RA model, the direct effect on consumption is EIS $(1 - \text{MPC}^Y)$. In general equilibrium, the $1 - \text{MPC}^Y$ term is exactly offset by the Keynesian multiplier $1/(1 - \text{MPC}^Y)$, so the overall elasticity depends only on the EIS. The same logic extends to heterogeneous agents: those who are highly responsive to income changes are, by construction, less responsive to interest-rate changes; otherwise, they would be optimizing along the intertemporal margin and exhibiting smaller income MPCs. Absent redistribution, individual direct and indirect effects sum to a constant across the population; thus, both individual and aggregate elasticities depend only on the EIS.[6]

Incorporating empirical evidence on expectations, the APNK model propagates partial-equilibrium features into general-equilibrium outcomes. The direct effects (determined by MPC^A) and indirect effects (determined by MPC^Y) tend to reinforce each other rather than cancel out. The framework explicitly embeds the feedback loop from higher initial spending to higher income and further spending, making it well-suited to analyze the consequences of inequality on aggregate fluctuations. Higher aggregate MPCs scale the transmission of exogenous shocks, making inequality a first-order determinant of macroeconomic volatility.

Simulations show an approximately linear relationship between aggregate MPCs and macro volatility: when the yearly aggregate MPC out of 1 dollar increases by 0.1, the unconditional standard deviations of output and consumption increase by 0.05 percentage points. Because inequality determines these aggregate MPCs in HA economies, policies that compress the wealth distribution stabilize fluctuations. In the policy experiment, a modest 1% annual wealth tax on illiquid wealth above \$3 million lowers the unconditional standard deviation of aggregate consumption from 0.8% to 0.75%, and reduces both the depth and the duration of the consumption slump in a Great Recession counterfactual.

Related literature. This paper contributes to several strands of literature. First, it addresses the longstanding debate on whether asset-price movements causally affect consumption. Classic general-equilibrium arguments suggest that aggregate asset price movements driven by discount rates create no net wealth. I incorporate empirical evidence on expectations and introduce information frictions that generates wealth illusion. The mechanism is distinct from other causality channels such as collateral constraints (Iacoviello 2005) and redistribution with heterogeneous agents (Buiter 2010; Fagereng et al. 2022), as it operates under complete markets and without reallocation of resources.

[6] Allowing for cyclical redistribution can break this neutrality. Depending on the correlation between individual MPCs and redistribution, the transmission of business-cycle shocks can be either amplified or dampened relative to the RA model. When calibrated with realistic redistribution forces, however, the deviation is typically mild. Furthermore, larger MPC heterogeneity strengthens both amplification and dampening forces; therefore, the net effect on volatility remains ambiguous and calibration-dependent.

In particular, it differs from the approach of Berger et al. (2018), Caballero and Simsek (2020), and Caballero and Simsek (2022), which exploit log utility to equate and re-interpret substitution and wealth effects. Under log utility (and related assumptions), the wealth effect becomes quantitatively equivalent to the substitution effect, effectively sidestepping the general-equilibrium neutrality result. This paper keeps the substitution and wealth channels both conceptually and quantitatively distinct. The economic interpretation of wealth effects is structural and not restricted to log utility. The quantitative contribution is to show that micro-founded wealth effects disciplined by MPC estimates are successful in explaining consumption dynamics.

Incorporating survey evidence on return expectations connects this paper to the finance literature studying the asset-pricing implications of extrapolative beliefs (see Barberis et al. 2015 for a review). This paper does not focus on extrapolative beliefs as a behavioral friction per se, but emphasizes the empirical alignment between expectations of aggregate returns and the dynamics of idiosyncratic returns experienced by individuals. The link between asset prices and consumption through wealth effects also naturally generates countercyclical equity premia: when an endowment boom occurs, asset prices must rise to make households feel rich enough to consume the additional endowment, and the misperceived consumption marginal rate of substitution does not impose downward pressure on interest rates, which narrows the gap between ex-post equity return and interest rates.

The misperception of aggregate variables connects this paper to the literature incorporating behavioral biases (Farhi and Werning 2019; Gabaix 2020; Woodford 2013) or information frictions (Angeletos and Lian 2018) into macroeconomic models, which typically feature myopia regarding future endogenous variables. Such forward-looking frictions are less suited to this paper's focus on wealth effects and how inequality shapes monetary policy transmission. Although agents may misforecast future aggregates, they do not confuse aggregate with idiosyncratic returns. Consequently, no structural wealth effects arise, and the direct and indirect effects of monetary policy remain inversely related.

By linking equilibrium consumption to MPCs, this paper evokes the "Old Keynesian" consumption function. This feature relates to Gabaix (2020), who demonstrates how myopia regarding future tax liabilities breaks Ricardian equivalence and places MPCs at the center of fiscal policy. For monetary policy, the proposed mechanism can be viewed as a synthesis of New Keynesian intertemporal substitution and Old Keynesian spending multipliers. Their weights depends on the degree of misperceptions.

The parsimonious framework for analyzing monetary policy targeting asset prices contributes to literature on balance-sheet policies.[7] This framework links asset prices

[7]Existing approaches include: intermediary balance sheets and credit (Gertler and Karadi 2011), portfolio balance and preferred habitat (Krishnamurthy and Vissing-Jorgensen 2011), signaling and forward

and consumption through simple wealth effects and embeds the balance-sheet rule which treats asset prices as a policy instrument. This approach is consistent with textual evidence from FOMC transcripts (Cieslak and Vissing-Jorgensen 2021), which shows that the central bank is concerned with stock prices primarily because of their impact on consumption via wealth effects. Caballero and Simsek (2022) also propose a framework where the central bank targets asset prices to manage aggregate demand, but they focus on the policy design. This paper focuses on microfounding the wealth effect through information frictions so I adopt a simple ad-hoc monetary policy rule.

Finally, the extension with heterogeneous agents connects to the broad literature on inequality and business cycles, dating back to Ríos-Rull (1996) and Krusell and Smith (1998), which investigates when heterogeneity and distributional dynamics matter for aggregate fluctuations (see more recently Oh and Reis 2012; McKay and Reis 2016; Bayer et al. 2019; Bayer, Born and Luetticke 2024; Bilbiie, Primiceri and Tambalotti 2023; Bilbiie et al. 2025; Auclert, Rognlie and Straub 2020). The extension contributes to this literature by showing that, when asset-price wealth effects are present, inequality directly amplifies aggregate shock transmission through higher aggregate MPCs, independent of the redistribution channel (Auclert 2019; Gong 2025). Therefore, the volatility of consumption and output rises with inequality.

The paper is organized as follows. Section 2 demonstrates why asset price movements do not generate wealth effects in standard full-information rational-expectation models. Section 3 develops and evaluates the framework with a representative agent. Section 4 validates the model against empirical evidence. Section 5 extends the analysis to a heterogeneous-agent environment, highlighting the role of heterogeneity and MPCs in the Great Recession. Section 6 quantifies how wealth inequality shapes macroeconomic volatility and Section 7 concludes.

2 Missing Wealth Effects in the Standard Model

This section shows that the wealth effects of asset price fluctuations are absent in the full information rational expectation general equilibrium models. As the basic environment, I adopt the New Keynesian model from Galí (2015) and assume certainty equivalence. Time is discrete and infinite. The economy is populated by a representative household, firms, and monetary policy authorities. I analyze the economy's response to an asset price shock induced by an interest rate cut.

guidance (Campbell et al. 2012), market functioning and liquidity restoration (D'Amico and King 2013), term-premium compression via public duration supply (Greenwood and Vayanos 2014); see also redistribution (Sterk and Tenreyro 2018), household liquidity (Cui and Sterk 2021), and expectations/bounded rationality (Iovino and Sergeyev 2023).

Households. The representative agent households solve the following problem:

$$\max_{\{C,N,B,V\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-1/\sigma}}{1-1/\sigma} - \varphi \frac{N_t^{1+1/\nu}}{1+1/\nu} \right)$$
$$s.t. \quad C_t + B_t + P_t S_t = R_t B_{t-1} + (P_t + D_t) S_{t-1} + W_t N_t. \tag{2}$$

Households derive utility from consumption and disutility from supplying labor. In each period, they consume C_t and supply the amount of labor N_t to firms. Labor income is $W_t N_t$ where W_t is the real wage. Households have access to government bonds B_t with gross real return R_t (net return $r_t \simeq \log R_t$). Households can also trade firm shares V_t at the price of P_t, which provides a dividend stream of D_t each period. The total share is normalized to 1. Define equity return as $R_t^A \equiv (P_t + D_t)/P_{t-1}$ and $A_{t-1} \equiv P_{t-1} S_{t-1}$. The household budget constraint can also be written as

$$C_t + B_t + A_t = R_t B_{t-1} + R_t^A A_{t-1} + W_t N_t. \tag{3}$$

Firms. A competitive final-good firm produces a final good from intermediate goods, indexed by j, according to the production function $Y_t = \left(\int y_{j,t}^{1/\mu^p} dj\right)^{\mu^p}$. The intermediate goods are produced by monopolistic competitive firms using labor as the only input with linear technology $y_{j,t} = Z l_{j,t}$, where $l_{j,t}$ denotes the labor hired by firm j in period t. Due to symmetry, aggregate labor demand $L_t = l_{j,t}$ and $Y_t = Z L_t$. Each intermediate firm sets its price to maximize profits subject to quadratic price adjustment costs as in Rotemberg (1982)

$$\Theta_t(p_{j,t}, p_{j,t-1}) = \frac{\mu^p}{\mu^p - 1} \frac{1}{2\kappa} \left(\log \frac{p_{j,t}}{p_{j,t-1}} \right)^2 Y_t \tag{4}$$

where $\kappa > 0$. The corresponding Phillips curve can be derived as

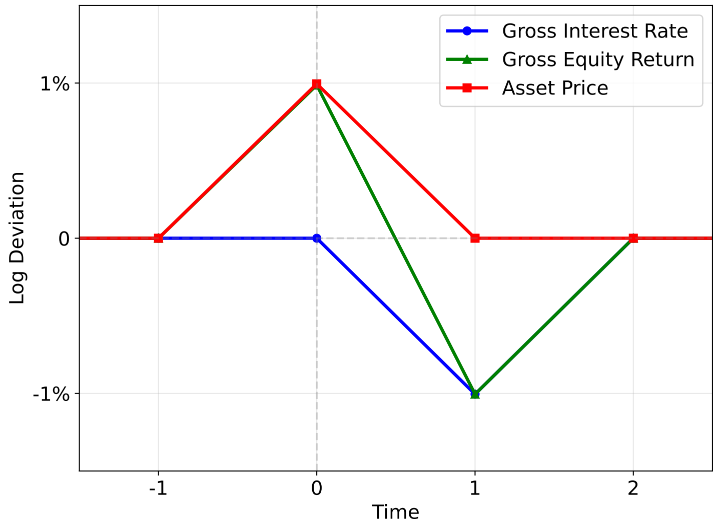
$$\log(1 + \pi_t) = \kappa \left(\frac{W_t}{Z} - mc_* \right) + \frac{1}{R_{t+1}} \frac{Y_{t+1}}{Y_t} \log(1 + \pi_{t+1}), \tag{5}$$

where π_t is inflation and $mc_* = 1/\mu^p$ is the marginal cost in the steady state. Firms issue equity to households, the price of each share is P_t, and each share provides dividends D_t. Dividends paid to shareholders equal the output net of labor expenditure

$$D_t = Y_t - W_t L_t.$$

I omit real resource losses induced by price adjustment costs for simplicity.

Figure 1: Time-0 unexpected shock to the real interest rate



Monetary and Fiscal Policy. The bond supply is zero in equilibrium, and there are no taxes. The central bank directly controls the real interest rate from $t = 1$.

Equilibrium. In each period $t \geq 0$, households maximize utility, firms maximize profits, and all markets clear. Goods market clearing implies $Y_t = C_t$, labor market clearing implies $N_t = L_t$, the stock market clears with $S_t = 1$, and the bond market clears with $B_t = 0$. In financial markets, equity is priced by the no-arbitrage condition $\mathbb{E}_t R^A_{t+1} = R_{t+1}$.

At the begining of time 0, the economy is in its steady state and denotes the steady-state variables with an asterisk. Log deviations from the steady state are denoted with a hat, e.g., $\hat{C}_t = \log(C_t/C_*)$. Consider a one-time interest rate cut on bonds: $R_1 < R_*$ and $R_{t\geq 2} = R_*$, as in Figure 1. The non-arbitrage condition requires that $\mathbb{E}_0 R^A_1 = (P_* + D_*)/P_0 = R_1 < R_*$. Keeping all else unchanged, the interest rate cut induces an asset price shock $P_0 > P_*$, and the time-0 equity return is subject to (unexpected) capital gains $R^S_0 = (P_0 + D_*)/P_* > R_*$.

Missing Wealth Effects. The one-time asset price shock has three effects, two through budget constraints and one through the F.O.C.: (i) realized income effect,[8] which make households richer due to the higher realized return at time-0 $R^A_0 > R_*$; (ii) expected income effect, which makes agents poorer because the future return on savings falls

[8] The wording "realized" here is different from what it typically means in empirical literature because aggregate capital gains can never be "realized", in constrast to idiosyncratic capital gains. Therefore, partial-equilibirum thinking can be another interpretation of this paper's assumption: if agents think they can always trade assets and realize capital gains, they fail to understand the general equilibrium constraint and confuse aggregate with idiosyncratic asset prices.

$\mathbb{E}_0 R_1^A = R_1 < R_*$; and (iii) intertemporal substitution effect (same as the interest rate cut on bond), since consumption at time 0 becomes cheaper relative to future consumption. Define *wealth effects* as the net of realized and expected income effects.[9]

Although there are capital gains at time 0 , the presence of wealth effects is not immediate because the expected return on savings falls. To see that these two forces exactly offset, note that the steady-state allocation $\{C_*, N_*\}$ satisfies the budget constraint irrespective of the path of asset prices:

$$C_* + B_* + P_t S_* = R_t B_* + P_t S_* + D_* S_* + W_* N_*. \tag{6}$$

The "Slutsky" compensation to afford the original bundle $\{C_*, N_*\}$ is zero. The asset price movement only has intertemporal substitution effect, same as the interest rate cut. The economy's equilibrium is characterized by the standard consumption Euler Equation and the Phillips curve, as in the New Keynesian model in Galí (2015).

This simple experiment shows that the stock markets are effectively redundant in determining real allocations. Suppose that the stock markets are shut down and the firm profits are paid directly to households as a lump sum transfer. The equilibrium is not affected. With stock markets operating, we have an additional non-arbitrage condition to characterize the asset price given the path of interest rates and dividend flow. However, the co-movement of consumption and asset prices is not causal; they are both the outcome of the interest rate shock. Muting the responses of asset prices does not affect the responses of consumption.

Wealth Illusion. Idiosyncratic asset price shocks, in contrast, have completely different implications for consumption-saving decisions. Consider an individual stock j priced according to

$$P_0^j = \frac{\mathbb{E}_0 \left[P_1^j + D_1^j \right]}{R_1}. \tag{7}$$

At time $t = 0$, news about future dividends D_1^j arrives, generating an idiosyncratic shock to the time-0 stock price P_0^j and the realized return $R_0^j \equiv (P_0^j + D_0^j)/P_{-1}^j$. If an agent's portfolio differs from the market portfolio, their time-0 realized return may outperform or underperform the market $R_0^j \neq R_0^A$. Importantly, such a shock does

[9]On terminology: other terms for realized income effect in the literature: endowment income effects (Berger et al. 2018), asset valuation (Caballero and Simsek 2020), revaluation gains (Fagereng et al. 2022). One could speak the net of realized and expected income effects of "income effects" rather than "wealth effects", in line with the standard substitution—income decomposition in consumer theory. In this paper, instead, I reserve "income" for the flow variable, which equals contemporaneous consumption under market clearing, and "wealth" to denote lifetime stock of resources. I thank Benjamin Moll for helpful suggestions on terminology.

not affect the expected return at time $t = 1$. Equation (7) is an outcome of the market efficiently incorporating the new information such that the expected $t = 1$ return on any stock or portfolio equals the market return:

$$\mathbb{E}_0 R_1^j = \frac{\mathbb{E}_0 \left[P_1^j + D_1^j \right]}{P_0^j} = \mathbb{E}_0 R_1^A = R_1, \quad \forall j.$$

Thus, both the expected income effect and the intertemporal substitution effect are absent and only the realized income effect remains.

Under market efficiency, the idiosyncratic shock to returns are unpredictable. The mechanism of realized income effects holds regardless of the shock source. For instance, if the news moveing the stock price P_0^j is about volatility of D_1^j, agents will adjust the portfolio carried forward according to their original risk preferences. The consumption response is driven not by a shock to future return/consumption risks, but by the realized income effect.

The economic interpretation of income effects is robust to extrapolative beliefs: to the extent that such beliefs generate perceived substitution effects on consumption—for instance, through expectations of higher average returns or lower return volatility that make saving more attractive—they affect consumption in the opposite direction as income effects. Consequently, any co-movement of consumption and individual asset prices must be driven by income (net of substitution) effects.

When validating the mechanism, I directly use the empirically estimated MPC out of capital gains as the measure of wealth effects on consumption expenditure. Since the empirical evidence about the MPC's dependence on the persistence of capital gains is limited, I assume market efficiency and treat the idiosyncratic return shock as i.i.d. throughout this paper. The expectations about future returns are constant rather than extrapolative. As discussed in the next section, this assumption implies that in equilibirum the expectation about contemperaneous asset prices pins down the dynamic household decisions.

Alternative Mechanisms. If the aggregate asset price movement is driven by future aggregate dividends, confusion with idiosyncratic asset price movement is inconsequential, as agents are indifferent to the source of dividend flows. Thus, as a modeling device to generate wealth effects, it is equivalent assuming that agents cannot perfectly distinguish between discount-rate shock and news about future aggregate dividends.

However, empirically, aggregate asset prices exhibit greater volatility than can be explained by dividends alone — a phenomenon known as the excess volatility puzzle. This makes it difficult to justify such confusion. At the same time, idiosyncratic return risk constitutes a substantial portion of total return volatility (see Campbell et al.

2001 and Goyal and Santa-Clara 2003). Therefore, it is more plausible to assume that information frictions exist between aggregate and idiosyncratic asset prices.[10]

Another advantage of this assumption is its flexibility: it accommodates any discount-rate shock that moves aggregate asset prices without requiring us to take a specific stance on the source of confusion—whether agents conflate interest rates with dividends, or aggregate risks with idiosyncratic risks. It also allows for distinct asset classes such as housing. Crucially, this implies that realized asset prices and MPCs serve as sufficient statistics for consumption dynamics, regardless of the underlying shock.

3 An Asset-Price Centric New Keynesian Model

This section develops a representative agent New Keynesian model where wealth effects drive consumption response to discount-rate shocks. Section 3.1 presents the the log-linearized model and characterizes the equilibrium to interest rate shocks. Section 3.2 extends the model to housing price and aggregate risk shocks. Section 3.3 derives the four-equation system.

3.1 Model Description and Equilibrium Characterization

The formulation of the household problem depends on whether the idiosyncratic shock applies to the return on savings or to the asset-price level. Below I assume the former, which captures unexpected capital gains in a reduced form regardless of asset class or the source of price fluctuations. This formulation is more common in the quantitative literature. In the Appendix, I lay out the alternative formulation, in which the price-level shock originates from news about future cash flows and is more intuitive for the wealth-illusion mechanism.

Household Problem. The log deviation of the aggregate asset price $\hat{P}_t \equiv \log P_t - \log P_*$ follows

$$\hat{P}_t = \rho\, \hat{P}_{t-1} + \epsilon_t, \text{ with } \epsilon_t \sim \mathcal{N}(0, \sigma_\epsilon^2), \tag{8}$$

where ϵ_t is the aggregate asset-price shock. Interest rates and aggregate asset prices are linked via no-arbitrage discussed later.

[10]A plausible transmission to consumption relies on two empirical regularities: (i) households hold imperfectly diversified portfolios, and (ii) idiosyncratic asset prices are more volatile than aggregate prices. Both facts are well documented; see, e.g., Fagereng et al. (2020), Calvet, Campbell and Sodini (2007), Campbell et al. (2001), and Vuolteenaho (2002).

Within the representative household, there is a continuum of agents $i \in I$ who hold shares $\int s_{it-1} di = 1$ and wealth $a_{it-1} = P_{t-1} s_{it-1}$ at the beginning of period t. In addition to the shock to aggregate return R_t^A, the return on its wealth is subject to an idiosyncratic shock v_{it} that is i.i.d. across agents:

$$v_{it} = \frac{e^{\epsilon_{it}^s}}{\int e^{\epsilon_{it}^s} di}, \qquad \epsilon_{it}^s \sim \mathcal{N}(0, \sigma_{\epsilon^s}^2), \qquad \epsilon_{it}^s \perp s_{it-1} \perp \epsilon_t. \tag{9}$$

Therefore, the value of agent i's after-return wealth is (given dividend D_t):

$$R_t^A v_{it} a_{it-1} = \frac{P_t + D_t}{P_{t-1}} v_{it} P_{t-1} s_{it-1} = (P_t + D_t) v_{it} s_{it-1}. \tag{10}$$

The representative household observes the value of each agent's after-return wealth $(P_t + D_t) v_{it} s_{it-1}$ but not the separate components of prices (dividends) $P_t + D_t$, the return shock v_{it}, and the share s_{it-1}. It forms the expectation for each agent and then aggregate these expectations. The household makes consumption-labor-saving decisions subject to the aggregate budget constraint:

$$C_t + \mathbb{E}_t^f P_t \cdot \mathbb{E}_t^f S_t = \mathbb{E}_t^f [P_t + D_t] \left(\frac{P_t + D_t}{\mathbb{E}_t^f [P_t + D_t]} \frac{S_{t-1}}{\mathbb{E}_t^f S_{t-1}} \right) \mathbb{E}_t^f S_{t-1} + E_t, \tag{11}$$

with $E_t = W_t N_t$ denoting labor income (earnings). The term in the parentheses is the perceived return shock at the aggregate level. Market clearing implies $C_t = Y_t = D_t + E_t$ and $\mathbb{E}_t^f P_t \cdot \mathbb{E}_t^f S_t = A_t = P_t$.

At the end of the period, the household returns wealth with value of $P_t v_{it} s_{it-1}$ to agent i. Agent i's wealth share is given by $s_{it} = v_{it} s_{it-1}$, and it carries savings $a_{it} = P_t s_{it}$ into period $t+1$.

Information Frictions. Agents form expectations about prices based on the history of wealth $P_{t-1} s_{it-1}$ and $P_t v_{it} s_{it-1}$. Write the state-space system as

$$\hat{P}_t = \rho \hat{P}_{t-1} + \epsilon_t, \qquad \text{(transition)} \tag{12}$$

$$x_{it} = \log \left(\frac{(P_t + D_t) v_{it} s_{it-1}}{P_{t-1} s_{it-1}} \right) \approx \hat{P}_t - \hat{P}_{t-1} + \epsilon_{it}^s - const, \qquad \text{(observation)} \tag{13}$$

where I approximate $\log[P_t + D_t] - \log[P_* + D_*] = \hat{P}_t / R_*^A + \hat{D}_t (1 - 1/R_*^A)$ with $\hat{P}_t$. Alternatively, one can explicitly map $\hat{D}_t$ to $\hat{P}_t$ through a coefficient to be determined in equilibrium, which does not affect the main analysis. Kalman filter implies

$$\mathbb{E}_{it}^f \hat{P}_t \equiv \mathbb{E} \left[\hat{P}_t \,|x_i^t \right] = \rho\, \mathbb{E}_{it-1}^f \hat{P}_{t-1} + K_t \left(\hat{P}_t - \hat{P}_{t-1} + \epsilon_{it}^s - (\rho - 1) \mathbb{E}_{it-1}^f \hat{P}_{t-1} \right), \tag{14}$$

Aggregating expectations across agents yields

$$\mathbb{E}_t^f \hat{P}_t \equiv \int \mathbb{E}_{it}^f \hat{P}_t \, di = \rho \, \mathbb{E}_{t-1}^f \hat{P}_{t-1} + K \left(\hat{P}_t - \hat{P}_{t-1} - (\rho - 1) \mathbb{E}_{t-1}^f \hat{P}_{t-1} \right). \tag{15}$$

The forecast error follows an AR(1) process:

$$\hat{P}_t - \mathbb{E}_t^f \hat{P}_t = \lambda (\hat{P}_{t-1} - \mathbb{E}_{t-1}^f \hat{P}_{t-1}) + (1 - K)\epsilon_t, \quad \text{with } \lambda = \rho(1 - K) + K. \tag{16}$$

Simplify the household problem. Below I simplify the household problem. The perceived return shock at the aggregate level can be decomposed as

$$\begin{aligned} \log\left(\frac{P_t + D_t}{\mathbb{E}_t^f [P_t + D_t]} \frac{S_{t-1}}{\mathbb{E}_t^f S_{t-1}} \right) &= \hat{P}_t \frac{1}{R_*^A} + \hat{D}_t (1 - \frac{1}{R_*^A}) - \mathbb{E}_t^f [\hat{P}_t \frac{1}{R_*^A} + \hat{D}_t (1 - \frac{1}{R_*^A})] - E_t^f \hat{S}_{t-1} \\ &\approx \left(\hat{P}_t - \mathbb{E}_t^f \hat{P}_t \right) + \left(\mathbb{E}_t^f \hat{P}_{t-1} - \hat{P}_{t-1} \right), \end{aligned} \tag{17}$$

The first term $\hat{P}_t - \mathbb{E}_t^f \hat{P}_t$ is the misperception about the time-t asset price. The second term $\mathbb{E}_t^f \hat{P}_{t-1} - \hat{P}_{t-1} = -E_t^f \hat{S}_{t-1}$ preserve the accouting identity of the total value of after-return wealth, given the misperceived shares $E_t^f \hat{S}_{t-1}$. When the perceived share is higher than the actual share $E_t^f S_{t-1} = A_{t-1}/E_t^f P_{t-1} > A_{t-1}/P_{t-1} = S_{t-1}$ due to underestimation of the previous price $\mathbb{E}_t^f \hat{P}_{t-1} < \hat{P}_{t-1}$, the perceived return lowers proportionally, and the household rationalizes the low return with a negative return shock.

Separating the perceived return shock into two components clarifies the role of persistence: misperceptions about returns can persist, whereas misperceptions about existing shares affect consumption only as a one-time shock. The assumption of i.i.d. return shocks simplifies the analysis, because the second term in the perceived return shock and the perceived shares can be absorbed into a constant, $S_{t-1} = 1$. Household decisions are therefore pinned down by the contemporaneous misperception, $\hat{P}_t - \mathbb{E}_t^f \hat{P}_t$, and the consumption response can be summarized by a single MPC^A.

Second, in general, the correctly identified fraction $\mu_t \equiv \mathbb{E}_t^f \hat{P}_t / \hat{P}_t$ is time-varying and history-dependent. For tractability, I assume that this fraction is constant over time, so that $\mathbb{E}_t^f \hat{P}_t = \mu \hat{P}_t$ with $\mu \in [0, 1]$. This result allows me to derive a simple Euler equation later, and also supports the linear relation between $\hat{D}_t$ and $\hat{P}_t$ in equilibrium I assumed in the signal extraction problem. This assumption is exact when the aggregate asset-price process becomes more persistent ($\rho \to 1$), the Kalman filter implies $\lambda \to 1$ and $\mu_t \equiv \mathbb{E}_t^f \hat{P}_t / \hat{P}_t \to K$ converges to a constant. In the case that the idiosyncratic shock is a price-level shock as discussed in the appendix, the constant fraction μ arises when the two asset price processes have the same persistence. The problem becomes static and the standard normal updating also implies a constant μ.

Model Solution. For a given asset price movement $\hat{P}_t$, the correctly identified part $\mathbb{E}_t^f \hat{P}_t$ relates to expected interest rate movements $\mathbb{E}_t^f \hat{R}_{t+i}$, and drives consumption response through intertemporal substitution (σ). The remaining part, $\hat{P}_t - \mathbb{E}_t^f \hat{P}_t$, is perceived as an one time shock to wealth and affects consumption through the MPC out of capital gains (MPC^A). The equilibrium consumption response is the sum of the two parts

$$\hat{C}_t = \hat{C}_t^{subs} + \hat{C}_t^{wealth} = \underbrace{-\sigma \mathbb{E}_t^f \sum_{i=1}^{\infty} \beta^i \hat{R}_{t+i} + \text{MPC}^Y \mathbb{E}_t^f \sum_{i=0}^{\infty} \beta^i \hat{Y}_{t+i}^{subs}}_{= \hat{C}_t^{subs}, \text{ intertemporal substitution channel}} \tag{18}$$

$$+ \underbrace{\text{MPC}^A (\hat{P}_t - \mathbb{E}_t^f \hat{P}_t) \frac{A_*}{C_*} + \text{MPC}^Y \hat{Y}_t^{wealth} + \text{MPC}^Y \frac{E_*}{Y_*} \mathbb{E}_t^f \sum_{i=1}^{\infty} \beta^i \hat{E}_{t+i}^{wealth}}_{= \hat{C}_t^{wealth}, \text{ wealth channel}}, \tag{19}$$

with $\text{MPC}^Y \equiv 1 - \beta$. Consumption also responds to (expected) income movements and the strength is governed by MPC^Y.[11]

I solve for the two parts separately. For the substitution-driven response $\hat{C}_t^{subs}$, imposing the market-clearing condition $C_t^{subs} = \hat{Y}_t^{subs}$ and solve for $\hat{C}_t^{subs}$:

$$\hat{C}_t^{subs} = -\sigma \mathbb{E}_t^f \hat{R}_{t+1} - \sigma \mathbb{E}_t^f \sum_{i=2}^{\infty} \beta^{i-1} \hat{R}_{t+i} + \text{MPC}^Y \mathbb{E}_t^f \sum_{i=1}^{\infty} \beta^{i-1} \hat{Y}_{t+i}^{subs}. \tag{20}$$

I assume that agents understand the relation $C_{t+i}^{subs} = Y_{t+i}^{subs}, \forall i \geq 1$ as an equilibrium outcome for the correctly identified part of the aggregate shock. Substituting this relation into (20) we can derive the standard Euler Equation

$$\hat{C}_t^{subs} = -\sigma \mathbb{E}_t^f \hat{R}_{t+1} + \mathbb{E}_t^f C_{t+1}^{subs} = -\sigma \mathbb{E}_t^f \sum_{i=1}^{\infty} \hat{R}_{t+i}.$$

For the wealth channel $\hat{C}_t^{wealth}$, the MPC out of capital gains (first term) summarizes the consumption reponse to the perceived return shock. However, there are no restrictions on the perceived future labor income $\mathbb{E}_t^f \hat{E}_{t+i}^{wealth}$ and we need to make an assumption. A natural assumption is that the equilibrium response of aggregate labor income $\hat{E}_t^{wealth}$ to the perceived return shock is also perceived as an idiosyncratic labor income shock. Assuming that the labor income process is AR (1) with persistence ρ_e, we have $\mathbb{E}_t^f \hat{E}_{t+i}^{wealth} = \rho_e^i \hat{E}_t^{wealth}$ and $\mathbb{E}_t^f \sum_{i=0}^{\infty} \beta^i \hat{E}_{t+i}^{wealth} = \hat{E}_t^{wealth} / (1 - \beta \rho_e)$. As shown in

[11] I allow MPC^A to differ from MPC^Y. With inelastic labor supply, $\text{MPC}^A = \text{MPC}^Y = 1 - \beta$. With endogenous labor supply, wealth effects induce households to work less, so $\text{MPC}^A = (1-\beta)\sigma/(\sigma + \nu/\mu^p) < \text{MPC}^Y$. Empirical studies document a substantial gap between MPC^A and MPC^Y; I use their empirical estimates directly for quantitative evaluation. Section 5 develops a heterogeneous-agent model that generates MPCs consistent with the data.

Introduction, the magnitude of consumption response to monetary policy already fits the data well without income expectation persistences. I simply assume this income shock is also (perceived as) i.i.d. so $\mathbb{E}_t^f \hat{E}_{t+i}^{wealth} = 0, \forall i \geq 1$. Impose the market clearing condition $\hat{C}_t^{wealth} = \hat{Y}_t^{wealth}$ and solve for $\hat{C}_t^{wealth}$:

$$\hat{C}_t^{wealth} = \sigma^A(\hat{P}_t - \mathbb{E}_t^f \hat{P}_t), \quad \text{with } \sigma^A = \frac{\text{MPC}^A}{1 - \text{MPC}^Y} \frac{A_*}{C_*}. \tag{21}$$

Sum these two parts, the equilibrium consumption response is

$$\hat{C}_t = \hat{C}_t^{subs} + \hat{C}_t^{wealth} = -\sigma \mathbb{E}_t^f \sum_{i=1}^{\infty} \hat{R}_{t+i} + \sigma^A(\hat{P}_t - \mathbb{E}_t^f \hat{P}_t).$$

To derive the Euler Equation, I impose the approximation of the non-arbitrage condition $\hat{P}_t = -\hat{R}_{t+1} + \mathbb{E}_t \hat{P}_{t+1}$ and iterate forward to obtain $\hat{P}_t = -\mathbb{E}_t \sum_{i=1}^{\infty} \hat{R}_{t+i}$.[12] The substitution-drive response follows $C_t^{subs} = -\sigma \mathbb{E}_t^f \sum_{i=1}^{\infty} \hat{R}_{t+i} = \sigma \mathbb{E}_t^f \hat{P}_t = \mu\sigma\hat{P}_t$, so

$$\hat{C}_t = \left(\mu\sigma + (1-\mu)\sigma^A\right)\hat{P}_t. \tag{23}$$

Take the difference between $\hat{C}_t$ and $\mathbb{E}_t\hat{C}_{t+1}$ and notice $\hat{P}_t - \mathbb{E}_t\hat{P}_{t+1} = -\hat{R}_{t+1}$,

$$\hat{C}_t = -\sigma^{macro}\hat{R}_{t+1} + \mathbb{E}_t\hat{C}_{t+1}, \text{ with } \sigma^{macro} = \mu\sigma + (1-\mu)\sigma^A. \tag{24}$$

Information frictions on aggregate asset prices change the aggregate elasticity of consumption to interest rates σ^{macro}. Under full information $\mu = 1$, we are back to the standard model. In the extreme case where all aggregate asset price fluctuations are perceived as idiosyncratic $\mu = 0$, the macro-level EIS is not related to its micro-level counterpart at all. With $\mu \in (0,1)$, the above Euler Equation synthesizes the textbook dictomoy of income and substitution effects.

3.2 Extensions

This section extends the analysis in two directions: introducing aggregate risk shocks and incorporating housing assets. These extensions demonstrate the framework's flexi-

[12] From non-arbitrage $P_t = \mathbb{E}_t[P_{t+1} + D_{t+1}]/R_{t+1}$ we have

$$\hat{P}_t = -\hat{R}_{t+1} + \mathbb{E}_t\hat{P}_{t+1}\frac{P_*}{P_* + D_*} + \mathbb{E}_t\hat{D}_{t+1}\frac{D_*}{P_* + D_*} = -\hat{R}_{t+1} + \mathbb{E}_t\hat{P}_{t+1}\frac{1}{R_*} + \mathbb{E}_t\hat{D}_{t+1}(1 - \frac{1}{R_*}). \tag{22}$$

With constant price-dividend ratio $\hat{P}_{t+1} = \hat{D}_{t+1}$ it follows that $\hat{P}_t = -\hat{R}_{t+1} + \mathbb{E}_t\hat{P}_{t+1}$. In the case $\hat{P}_{t+1} \neq \hat{D}_{t+1}$, the effects of asset price fluctuations $\hat{P}_{t+1}$ on return $\hat{R}_{t+1}$ are two orders of magnitude larger than the effects of dividend $\hat{D}_{t+1}$. I approximate $\mathbb{E}_t\hat{P}_{t+1}/R_* + \mathbb{E}_t\hat{D}_{t+1}(1 - 1/R_*)$ with $\mathbb{E}_t\hat{P}_{t+1}$. Empirically, a better reduced-form relation is $\hat{P}_t = -\eta_R^P\hat{R}_{t+1} + \mathbb{E}_t\hat{P}_{t+1}$ and $\hat{P}_t = -\eta_R^P \sum_{i=1}^{\infty} \hat{R}_{t+i}$ where $-\eta_R^P$ is the elasticity of gross equity return to interest rates.

bility in capturing wealth effects arising from distinct classes of assets and alternative sources of asset price fluctuations.

3.2.1 Risk shocks

The representative household has standard CRRA expected utility, and use $\gamma = 1/\sigma$ to denote the coefficient of relative risk aversion. Under conditional log-normality,

$$\hat{C}_t = \mathbb{E}_t \hat{C}_{t+1} - \frac{1}{\gamma} \hat{R}_{t+1} - \frac{\gamma}{2} \operatorname{Var}_t(\hat{C}_{t+1}). \tag{25}$$

The last term is the precautionary-saving term: higher expected consumption growth variance depresses current consumption for a given real interest rate. Financial markets price equity using the household stochastic discount factor requiring a risk premium. The pricing equation for equity,

$$1 = \mathbb{E}_t \left[M_{t+1} R^A_{t+1} \right], \qquad M_{t+1} = \beta \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma}, \tag{26}$$

implies, under the same log-normal approximation,

$$\mathbb{E}_t \hat{R}^A_{t+1} - \hat{R}_{t+1} = -\operatorname{Cov}_t(\hat{M}_{t+1}, \hat{R}^A_{t+1}) = \gamma \operatorname{Cov}_t(\hat{C}_{t+1}, \hat{R}^A_{t+1}), \tag{27}$$

This covariance term is the risk premium.

I introduce time-varying aggregate risk through a shock to the volatility of fundamental interest rates. Denote the shock to the interest rate between $t+1$ and $t+2$ as $\epsilon^R_{t+1} \sim \mathcal{N}(0, \sigma^2_{\epsilon^R,t})$, the variance of which is known at time t. For simplicity, I assume that there is a one-time unexpected innovation to the variance:

$$\sigma^2_{\epsilon^R,t} - \sigma^2_{\epsilon^R,*} = \epsilon^{\text{risk}}_t, \tag{28}$$

and there is a one-to-one pass-through from fundamental interest-rate volatility to the variance of $t+1$ consumption. Below, I assume the interest rate between time t and $t+1$ does not respond to the risk shock, i.e., $R_{t+1} = R_*$, to isolate the transmission to time t consumption and asset prices.

A risk shock ϵ^{risk}_t increases uncertainty about future consumption outcomes. Using the one-to-one pass-through assumption and imposing $\hat{R}_{t+1} = 0$ yields

$$\hat{C}_t = -\frac{\gamma}{2} \epsilon^{\text{risk}}_t. \tag{29}$$

Let $\beta^C_A = \operatorname{Cov}_t(\hat{C}_{t+1}, \hat{R}^A_{t+1}) / \operatorname{Var}_t(\hat{C}_{t+1})$ denote the exposure of equity returns to consumption (the quantity of risk) at $t+1$.[13] With $\hat{R}_{t+1} = 0$,

$$\mathbb{E}_t \hat{R}^A_{t+1} = \gamma \beta^C_A \epsilon^{\text{risk}}_t, \quad \hat{P}_t = -\mathbb{E}_t \hat{R}^A_{t+1} = -\gamma \beta^C_A \epsilon^{\text{risk}}_t. \tag{30}$$

So an increase in uncertainty lowers both current consumption, through precautionary saving, and equity valuations, through higher required risk premia. But the co-movement of asset prices and consumption is not casual, as they are both the outcome of the risk shock. Muting the response of asset prices to the shock does not change the consumption response. There are no wealth effects as the original allocation always satisfies the budget constraint.

With information frictions, households do not directly observe the risk shock and may misinterpret the asset price decline as a return shock. The consumption response is the sum of the standard precautionary savings effect and the wealth effect:

$$\hat{C}_t = \hat{C}^{risk}_t + \hat{C}^{wealth}_t = \frac{\mathbb{E}^f_t \hat{P}_t}{2\beta^C_A} + \frac{\text{MPC}^A}{1-\text{MPC}^Y} \frac{A_*}{C_*} (\hat{P}_t - \mathbb{E}^f_t \hat{P}_t). \tag{31}$$

$$= \left(\mu \frac{1}{2\beta^C_A} + (1-\mu)\sigma^A \right) \hat{P}_t. \tag{32}$$

To obtain $\hat{C}^{risk}_t$ from equation (29), I use equation (30) to substitute the unobservable risk shock with the observable price movements. The wealth component arises from misperceived asset price movements, which is the same as in the previous section.

Writing in the form of the risk-adjusted Euler Equation:

$$\hat{C}_t = \mathbb{E}_t \hat{C}_{t+1} - \frac{\gamma^{macro}}{2} \epsilon^{\text{risk}}_t, \quad \gamma^{macro} = \mu\gamma + 2(1-\mu)\gamma\beta^C_A \sigma^A. \tag{33}$$

The macro-level risk aversion γ^{macro} now incorporates both the precautionary savings channel (γ) and the wealth effect channel (σ^A).

3.2.2 Housing

I embed a housing block into the model following standard setups with housing services, such as Iacoviello (2005). For clarity, I let the tradable assets be a riskless real bond B_t and a durable housing stock H_t owned by the representative household. The representative household derives utility from non-durable consumption C_t and

[13] If interest rates shock is the only fundamental shock, we can substitute the consumption—asset-price relation derived in the previous section $\hat{C}_{t+1} = \sigma^{macro} \hat{P}_{t+1}$ to obtain $\beta^C_A = 1/\sigma^{macro}$.

housing services H_t:

$$\max_{\{C_t, H_t, B_t\}_{t \geq 0}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-1/\sigma}}{1-1/\sigma} + \psi \frac{H_t^{1-1/\eta}}{1-1/\eta} \right], \tag{34}$$

with housing curvature $\eta > 0$. Let P_t^H denote the real price of one unit of housing (in units of the consumption good), and omit housing depreciation. The budget constraint is

$$C_t + P_t^H H_t + B_t = R_t B_{t-1} + P_t^H H_{t-1} + Y_t, \tag{35}$$

where R_t is the gross real return on bonds and $Y_t = E_t + D_t$ includes labor and firm profit income.

Under full information, taking $\{P_t^H, R_t\}$ as given, the first-order condition for housing equates the marginal utility from an extra unit of housing services to its user cost in utility units:

$$P_t^H C_t^{-1/\sigma} = \psi H_t^{-1/\eta} + \beta \mathbb{E}_t \left[P_{t+1}^H C_{t+1}^{-1/\sigma} \right] = \psi H_t^{-1/\eta} + \mathbb{E}_t \sum_{i=1}^{\infty} \beta^i \left[\psi H_{t+i}^{-1/\eta} \right], \tag{36}$$

The right-hand side of equation (36) is the present value of the flow of housing services provided by one unit of housing. We can derive a non-arbitrage condition for housing by combing equation (36) and the Euler equation for bonds:

$$P_t^H = \underbrace{\frac{\psi H_t^{-1/\eta}}{C_t^{-1/\sigma}}}_{\equiv \text{rent}_t} + \frac{\mathbb{E}_t P_{t+1}^H}{R_{t+1}} = \frac{\psi H_t^{-1/\eta} / \beta \mathbb{E}_t [C_{t+1}^{-1/\sigma}]}{R_{t+1}} + \frac{\mathbb{E}_t P_{t+1}^H}{R_{t+1}}. \tag{37}$$

Consider a one-time unexpected interest rate shock that lowers R_1 and raises P_0^H. In partial equilibrium, there can be both income and substitution effects on consumption. On the substitution side, in addition to the intertemporal substitution channel (housing as a saving device), higher house prices also affect consumption through intratemporal substitution between non-durable consumption and housing services. Higher house prices make housing services relatively more expensive, thus inducing more non-durable consumption.[14] On the income side, the household faces (i) the revaluation of housing wealth by $H_{-1} dP_0^H$, which makes it richer; and (ii) the higher time-0 rental cost and lower expected return on savings (through housing), $\mathbb{E}_0 P_*^H / P_0^H < \mathbb{E}_0 P_*^H / P_*^H$, which make it poorer. The net income effect is zero since the original allocation $\{C_*, H_*\}$ satisfies the budget constraint exactly under the new price. The higher rental cost and

[14] For a permanent house price shock, as considered in Berger et al. (2018), only the intratemporal substitution channel operates.

lower expected return on housing wealth together offset the higher revaluation.

The confusion between aggregate and idiosyncratic house price movements generates wealth effects from housing capital gains. The perceived budget constraint is

$$C_t + \mathbb{E}_t^f P_t^H \cdot \mathbb{E}_t^f H_t + B_t = R_t B_{t-1} + \mathbb{E}_t^f P_t^H \frac{P_t^H}{\mathbb{E}_t^f P_t^H} H_{t-1} + Y_t. \tag{38}$$

Log-linearizing the consumption policy and separating substitution and wealth components yields $\hat{C}_t = \hat{C}_t^{\text{subs}} + \hat{C}_t^{\text{wealth}}$. On the substitution side, the correctly perceived part $\mathbb{E}_t^f \hat{P}_t^H$ is associated with the path of real interest rates. Imposing house market clearing $H_t = H_*$ for all t in equation (36) gives $\hat{C}_t = \sigma \hat{P}_t^H$, thus

$$\hat{C}_t^{\text{subs}} = \sigma \mathbb{E}_t^f \hat{P}_t^H = \mu\sigma \hat{P}_t^H, \tag{39}$$

On the wealth side, the misperceived component $\hat{P}_t^H - \mathbb{E}_t^f \hat{P}_t^H$ is treated as an idiosyncratic capital gain on housing. Let MPC^H be the MPC out of housing-wealth capital gains and define steady-state housing wealth as $A_*^H \equiv P_*^H H_*$. As in the equity case, the wealth-channel consumption response is

$$\hat{C}_t^{\text{wealth}} = \sigma^H \left(\hat{P}_t^H - \mathbb{E}_t^f \hat{P}_t^H\right) = (1-\mu)\sigma^H \hat{P}_t^H, \quad \sigma^H = \frac{\text{MPC}^H}{1-\text{MPC}^Y} \frac{A_*^H}{C_*}. \tag{40}$$

Adding both components, equilibrium consumption is

$$\hat{C}_t = \left(\mu\sigma + (1-\mu)\sigma^H\right) \hat{P}_t^H. \tag{41}$$

3.3 Four-Equation New Keynesian Model

I assume $\mu = 0$ to focus on the proposed mechanism, implying that $\hat{C}_t = \sigma^A \hat{P}_t$ always hold except preference shocks which this paper abstracts from. In the presence of information frictions, the policy and shock's transmission to consumption depend on how much they move equilibrium asset prices. Taking the difference of $\hat{C}_t = \sigma^A \hat{P}_t$ and $\mathbb{E}_t \hat{C}_{t+1} = \sigma^A \mathbb{E}_t \hat{P}_{t+1}$ and approximating $\hat{R}_{t+1}^A$ with $-\hat{P}_t + \hat{P}_{t+1}$ yields the *Asset-Price Euler Equation*:

Proposition 1. *(Asset-Price Euler Equation) Equilibrium consumption satisfies:*

$$\hat{C}_t = -\sigma^A \mathbb{E}_t \hat{R}_{t+1}^A + \mathbb{E}_t \hat{C}_{t+1} \tag{42}$$

Returns of different assets enter additively into aggregate demand. Explicitly distinguishing between stock (S) and housing (H) assets, the consumption response is:

$$\hat{C}_t = -\sigma^S \mathbb{E}_t \hat{R}^S_{t+1} - \sigma^H \mathbb{E}_t \hat{R}^H_{t+1} + \mathbb{E}_t \hat{C}_{t+1} \tag{43}$$

where $\hat{R}^H_{t+1} = -\hat{P}^H_t + \hat{P}^H_{t+1}$ is the return variation of housing assets.

With endogenous asset prices and returns, the model can be closed with a standard New Keynesian Phillips curve, a Taylor rule, and a non-arbitrage condition between asset returns and interest rates:

Proposition 2. *The equilibrium of the Asset-Price Centric New Keynesian (APNK) model is characterized by:*

$$\hat{C}_t = -\sigma^A \mathbb{E}_t \hat{R}^A_{t+1} + \mathbb{E}_t \hat{C}_{t+1}, \tag{44}$$

$$\pi_t = \kappa(mc_t - mc_*) + \beta \mathbb{E}_t \pi_{t+1}, \tag{45}$$

$$\mathbb{E}_t \hat{R}^A_{t+1} = \hat{R}_{t+1} + v^A_t, \tag{46}$$

$$i_t = i_* + \phi^i_\pi \pi_t + v^i_t. \tag{47}$$

The disturbance v^A_t captures discount-rate shocks other than interest rates that moves asset prices and the expected equity premia $\mathbb{E}_t \hat{R}^A_{t+1} - \hat{R}_{t+1}$. News about future fundamentals (levels, volatility), or sentiment, can be easily incorporated into the model as components of v^A_t. Regardless of its source, the discount-rate shock affects consumption through the wealth effect. The disturbance v^i_t is the standard monetary policy shock.

For balance-sheet policies, the central bank directly intervenes in financial markets, making the asset-price a more relevant policy variable. Therefore, I explicitly incorporate asset prices into the system:

$$\hat{C}_t = \sigma^A \hat{P}_t, \tag{48}$$

$$\pi_t = \kappa(mc_t - mc_*) + \beta \mathbb{E}_t \pi_{t+1}, \tag{49}$$

$$\hat{P}_t = \phi^P_\pi \pi_t + v^P_t. \tag{50}$$

I replace the non-arbitrage condition and the standard Taylor rule with the asset-price Taylor rule (50). The interpretation is direct: quantitative easing/tightening moves asset valuations in response to macro conditions ($\phi^P_\pi < 0$). The central bank has imperfect control over asset prices due to financial market volatility embeded in v^P_t. The realized asset price is a sufficient statistic for consumption dynamics.

3.4 APNK as an Asset Pricing Model

The preceding analysis treated asset prices as inputs determining consumption. Alternatively, the framework can be viewed through the lens of asset pricing. In a standard endowment economy, consumption is fixed at the endowment level ($C_t = Y_t$), and the stochastic discount factor (SDF), determined by the endowment process $\{Y_t\}$, prices assets through the F.O.C..

In the APNK framework, information frictions break this link. The perceived consumption and returns deviate from the true process ($\mathbb{E}_t^f C_{t+1} \neq \mathbb{E}_t C_{t+1}$ and $\mathbb{E}_t^f R_{t+1}^A \neq \mathbb{E}_t R_{t+1}^A$). Consequently, one must solve for the perceived SDF and asset prices jointly. Combining the Euler equation with the budget constraint under information frictions:

$$\mathbb{E}_t^f [M_{t+1} R_{t+1}^A] = 1, \text{ with } M_{t+1} = \beta \left(\frac{C_{t+1}}{C_t} \right)^{-1/\sigma} \tag{51}$$

$$C_t + \mathbb{E}_t^f P_t \cdot \mathbb{E}_t^f S_t = \mathbb{E}_t^f P_t \frac{P_t}{\mathbb{E}_t^f P_t} S_{t-1} + Y_t, \tag{52}$$

we can derive consumption as a function of asset prices and endowment, $C_t = \mathcal{C}(P_t, Y_t)$. The equilibrium price is pinned down by the market-clearing condition $\mathcal{C}(P_t, Y_t) = Y_t$.

Consider an endowment boom. In the standard model, interest rates fall and asset prices rise to lower expected returns, aligning them with the expected marginal rate of substitution between present and future consumption. With information frictions ($\mu = 0$), fluctuations in asset prices affect perceived wealth rather than future returns. Given market-clearing $C_t = Y_t$, asset prices must rise to inflate perceived lifetime resources and future consumption such that the perceived consumption marginal rate of substitution aligns with constant return expectations.

The proposed mechanism only pins down asset prices, not interest rates, with consumption. The mis-perceived consumption marginal rate of substitution does not impose downward pressure on interest rates (under extrapolative return expectations, it may even generate upward pressure). The interest rates dynamics come from outside the model. For instance, through a finance or central bank block as discussed above. Temporarily assuming a constant interest rate corresponding to the misperceived part of asset price movements. Ex post, the realized equity return falls short of expectations and equity premia decreases. This mechanism naturally generates a countercyclical equity premia, not due to time-varying risks/preferences but due to wealth effects of long-term assets.

4 Model Validation

This section validates the proposed mechanism with data. The key message is that the model does not need (i) "macro-fit" parameters whose values are inconsistent with micro evidence; (ii) unobservable preference shocks which are effectively residuals, to fit the data. Realized asset prices are sufficient to explain the consumption dynamics. Section 4.1 examines the model's predictions for monetary policy transmission. Section 4.2 applies the model to the 1998–2019 cycle. Section 4.3 contrasts the implications of wealth effects on heterogeneous consumption responses to monetary policy with the empirical evidence.

4.1 Monetary Policy

To connect the model to monetary policy evidence, I first estimate asset-price and consumption responses to monetary policy shocks. For each horizon h and outcome y, the quarterly baseline estimates the local projection

$$y_{t+h} = \beta_{h,0} + \beta_{h,1}t + \beta_{h,2}\varepsilon_t + \boldsymbol{\beta}'_{h,3}\mathbf{X}_{t-1} + \boldsymbol{\beta}'_{h,4}\mathbf{D}_t + u_{t+h}, \tag{53}$$

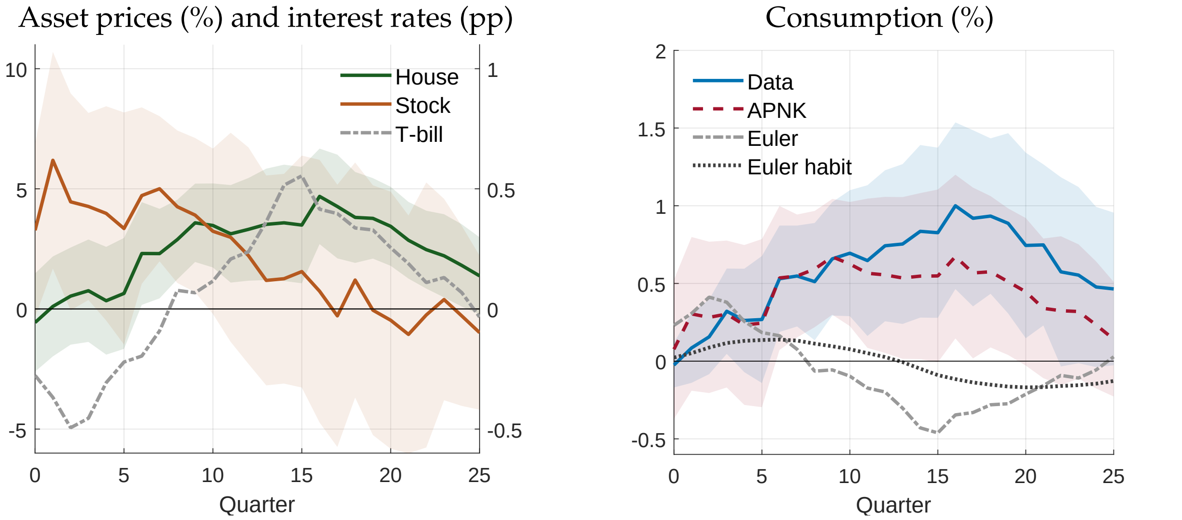
where ε_t is the high-frequency monetary policy shock identified in Bauer and Swanson (2023), t is a linear time trend, $\mathbf{X}_{t-1}$ is the vector of lagged control variables, and $\mathbf{D}_t$ is the vector of COVID dummy indicators for 2020Q1–2021Q2. In the quarterly baseline, $\mathbf{X}_{t-1}$ contains one lag of output, consumption, investment, the federal funds rate, unemployment, CPI, and the monetary policy shock. The baseline estimation spans 1988Q3–2023Q4 after lag trimming. Appendix B.1 reports the responses of output, CPI, unemployment, and investment, together with the estimation based on monthly data.

Figure 2 shows that monetary policy moves both stock prices and house prices. Stock prices react more quickly, whereas house prices adjust more gradually and persistently, while the T-bill rate quickly reverts. The estimated asset-price responses $\{\hat{P}_t^S, \hat{P}_t^H\}_t$ are mapped into a model-implied consumption response:

$$\hat{C}_t^{model} = \frac{\text{MPC}^S}{1-\text{MPC}^Y}\frac{A_*^S}{C_*}\hat{P}_t^S + \frac{\text{MPC}^H}{1-\text{MPC}^Y}\frac{A_*^H}{C_*}\hat{P}_t^H. \tag{54}$$

I distinguish between stock wealth (S) and housing wealth (H). Here $\hat{P}_t^S$ and $\hat{P}_t^H$ denote the estimated horizon-t responses of stock prices and house prices, while $A_*^S/C_* = 5.00$ and $A_*^H/C_* = 8.72$ are the quarterly sample-average stock- and housing-wealth–consumption ratios. The quarterly aggregate MPCs are set as $\text{MPC}^S = 0.03/4$, $\text{MPC}^H = 0.05/4$, and $\text{MPC}^Y = 0.2$. Feeding the estimated asset-price responses into the mapping generates a consumption response that tracks the data closely. The correlation between

Figure 2: Monetary Policy Transmission Through Asset Prices



Notes: Quarterly local-projection estimates for 1988Q3–2023Q4. The left panel shows how asset prices (left y-axis) and the interest rates (right y-axis) respond to the monetary policy shock identified in Bauer and Swanson (2023). The right panel compares the estimated consumption response with the APNK prediction, the standard Euler fit, and a habit-smoothed Euler fit. Estimated responses are normalized so that the peak consumption response equals 1%. Inference uses 90% Newey–West confidence intervals. Stock-price (S&P 500) and house-price data are from the Shiller website; consumption (PCEC), interest-rates (TB3MS), and wealth series (HNOCEA, BOGZ1LM653064155Q, HNOREMV) are from FRED.

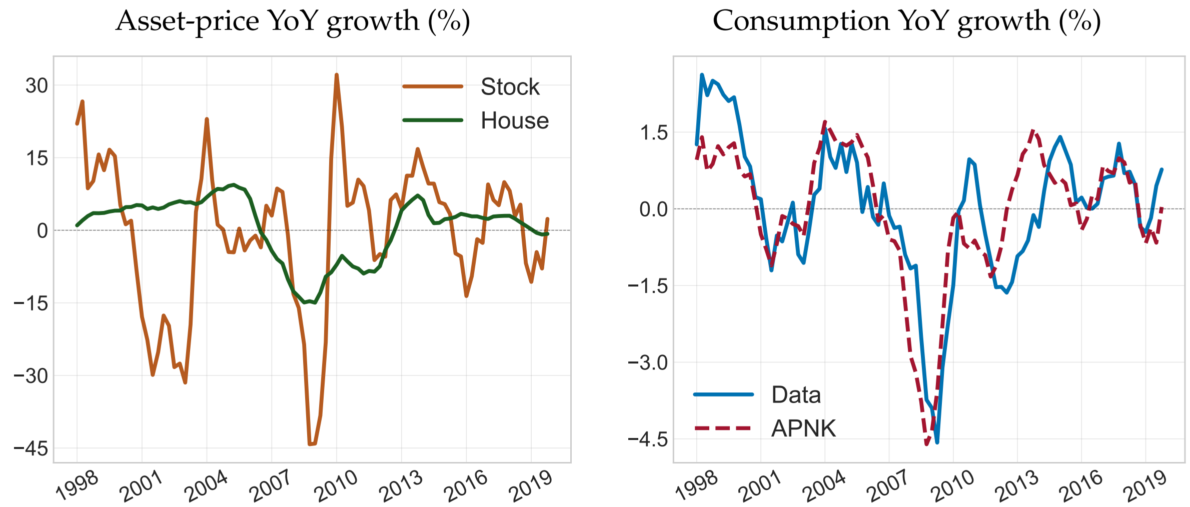
the estimated and model-implied consumption responses is 0.762 and the normalized RMSE is 0.843.[15]

Consumption implied by the estimated interest-rate responses through the Euler equation fits poorly. Due to the quick reversal of interest rates, the cumulative change of interest rates does not deliver a positive consumption response. Therefore, I construct the Euler-implied consumption by $\hat{C}_t^{euler} = -\sigma \hat{R}_{t+1}/(1-\rho)$ with $\sigma = 1$ and $\rho = 0.7$. Both the timing and the magnitude of this Euler prediction are off: its correlation with the data is -0.907 and its normalized RMSE is 2.984. To allow for the idea that habit formation may delay aggregate consumption adjustment, I also report a simple habit-smoothed consumption series constructed as $\hat{C}_t^{habit} = h\hat{C}_{t-1}^{habit} + (1-h)\hat{C}_t^{euler}$ with $h = 0.9$, where $\hat{C}_t^{euler}$ is the Euler prediction. The habit formation delays the immediate response, but it attenuates the overall response and still fails to match the empirical consumption dynamics: its correlation is -0.542 and its normalized RMSE is 2.534.

Micro-founded macroeconomics is built on the premise that aggregate outcomes derive from the optimization behavior of individual agents in equilibrium. A common concern is model mis-specification. While the AP-Euler equation adopts the form of (log-linearized) Euler Equation as correctly specified, it argues that the mechanism linking consumption and interest rates is mis-specified. The consequence of the mis-specified mechanism is that the parameter value consistent with aggregate evidence

[15]The normalized RMSE is $\sqrt{\sum_t (y_t^{data} - y_t^{model})^2/N}/\sigma(y^{data})$.

Figure 3: APNK Model Fit, 1998Q1–2019Q4



Notes: The left panel shows (demeaned) four-quarter growth in stock and house prices; the right panel compares realized consumption growth with the APNK prediction in equation (55). The fit statistics are correlation 0.779 and normalized RMSE 0.652. Stock-price (S&P 500) and house-price data are from the Shiller website; consumption (PCEC) and wealth series (HNOCEA, BOGZ1LM653064155Q, HNOREMV) are from FRED. Appendix B shows the corresponding robustness exercises.

— EIS in our context — does not align with the value estimated from individual data that reflects the behavior of true agents. In contrast, the AP-Euler equation is consistent with both cross-sectional evidence on consumption behavior and time-series evidence on aggregate outcomes.

4.2 The 1998–2019 Cycle

I apply the model to the period of 1998–2019. From the extensions of risk shocks and housing we can see that, under $\mu = 0$ and driven by realized asset prices, the consumption dynamics reflect all shocks moving equilibrium asset prices (except shocks to preferences), not only interest rates.

In terms of growth rates, the model-implied consumption is given by

$$g_t^{C,model} = \frac{\text{MPC}^S}{1 - \text{MPC}^Y} \frac{A_{t-4}^S}{C_{t-4}} g_t^S + \frac{\text{MPC}^H}{1 - \text{MPC}^Y} \frac{A_{t-4}^H}{C_{t-4}} g_t^H. \tag{55}$$

Here $g_t^S = (P_t^S - P_{t-4}^S)/P_{t-4}^S$ denote four-quarter stock price growth rates (demeaned over the sample) and similar for house prices and consumption. The quarterly aggregate MPCs are set as $\text{MPC}^S = 0.03/4$, $\text{MPC}^H = 0.05/4$, and $\text{MPC}^Y = 0.2$, respectively, same as the monetary-policy validation exercise.

Figure 3 shows the consumption growth data and the APNK prediction from 1998Q1 to 2019Q4. The model captures both the timing and the magnitude of consumption over the cycle. Over this sample, the correlation between model and data is 0.779 and the normalized RMSE is 0.652. The late-1990s equity boom is associated with strong consumption growth, while the mid-2000s housing boom adds a sizable second source of demand. During the Great Recession, the collapse in both stock and house prices generates the sharp contraction in consumption growth, and the subsequent recovery is tracked by the rebound in asset prices. Appendix B shows a decomposition of the benchmark 1998–2019 model fit into stock and housing components in Figure 11.

Figure 13 in the appendix evaluates the standard Euler equation over the same period. Conditioning only on realized interest rates, the Euler equation predicts consumption dynamics that are largely opposite to the data. This discrepancy arises because policy rates are endogenous and typically "lean against the wind". Consequently, standard models must rely on unobservable preference or risk shocks to match the data. By contrast, the APNK model establishes realized asset prices as sufficient statistics for consumption, allowing it to track actual consumption without unobservable disturbances.

The appendix reports several robustness checks, including the monthly fit over the 1998-2019 period, the fit over the longer sample 1953–2025, and the post-COVID-19 period. I also measure consumption fluctuations by the deviation from trend rather than growth rates. Overall the model fits data well, with the exception that fit of magnitude weakens over the sample before 1990s. Note that the current calibration fixes aggregate MPCs using estimates of average MPCs from the recent literature. It does not weight individual MPCs with asset and income shares nor incorporate the evidence of unequal incidences to business cycle fluctuations across the wealth and income distributions. Therefore, the result on the earlier sample period is better interpreted as showing comovement. A promising avenue for future research is to allow time-varying aggregate MPCs to improve the model fit over earlier samples.

4.3 Heterogeneous Consumption Responses to Monetary Policy

The most direct evidence for the proposed mechanism comes from heterogeneous consumption responses to monetary policy across housing-tenure groups. Cloyne, Ferreira and Surico (2020) document that, for the US and UK, households with mortgages (M) show stronger consumption adjustments following a monetary policy shock than renters (R) and outright homeowners (O): $\hat{C}_M > \hat{C}_R > \hat{C}_O$. They also show that these heterogeneous responses are not due to redistribution.

Can wealth effects explain the pattern documented in Cloyne, Ferreira and Surico (2020)? Extending the back-of-the-envelope calculation in the Introduction to the heterogeneous-agent setting,

$$dC_i = \text{MPC}_i^S dA_i^S + \text{MPC}_i^H dA_i^H + \text{MPC}_i^Y dY_i, \quad \forall i \in \{M, R, O\} \tag{56}$$

$$\hat{C}_i = \underbrace{\text{MPC}_i^S \frac{A_i^S}{C_i} \hat{P}^S + \text{MPC}_i^H \frac{A_i^H}{C_i} \hat{P}^H}_{\text{wealth channel}} + \underbrace{\text{MPC}_i^Y \frac{Y_i}{C_i} \hat{Y}}_{\text{income channel}} . \tag{57}$$

I distinguish between stock wealth and housing wealth because their distributions across households differ substantially. The consumption response of a group depends on the group-level MPCs and asset and income positions, which are treated as parameters and estimated in Table 1.[16] Wealth- and income-consumption ratios are estimated from CEX and SCF 2004. Since renters have negligible wealth compared to the other two groups, their wealth-consumption ratios are set to zero.

To estimate MPC^S for each housing tenure group, I first assign the estimates in Table III of Di Maggio, Kermani and Majlesi (2020) to individual households in SCF 2004 by their net worth group. Then I compute the weighted average MPC^S for each housing tenure group with weight equal to the financial assets owned by individual households in that group. Mortgagors (0.04) have a higher MPC^S than outright homeowners (0.03). The estimates of MPC^H are taken from Aladangady (2017). The MPC^H of outright homeowners is not statistically different from zero.

The estimates of MPC^Y are taken from Crawley and Kuchler (2023). Renters are close to the "poor hand-to-mouth" households defined in Kaplan, Violante and Weidner (2014). They have few assets and the highest MPC^Y. Mortgagors have relatively high MPC^Y and are comparable to the "rich hand-to-mouth" households in Kaplan, Violante and Weidner (2014). They have a considerable amount of illiquid assets (housing) and few liquid assets. Outright homeowners hold most of the liquid assets of the economy, and their MPC^Y is the lowest.

Consider a monetary policy shock increasing aggregate consumption by $\hat{C} = 1\%$ and asset prices by $\hat{P}^S = 5\%$, $\hat{P}^H = 3\%$, which represents a typical monetary policy expansion scenario and aligns with this paper's estimation in Appendix B.1. Given $\hat{Y} = 1\%$, the model-implied consumption response is shown in the last column of Table 1. Mortgagors' consumption is more responsive than that of the other two groups. The wealth channel, due to capital gains, and the income channel, due to the general-

[16] For the estimatation of MPC out of stock wealth, see Di Maggio, Kermani and Majlesi 2020; Chodorow-Reich, Nenov and Simsek 2021; Case, Quigley and Shiller 2005; Cooper and Dynan 2016; Paiella and Pistaferri 2017. For the MPC out of housing wealth, see Aladangady (2017); Mian and Sufi (2011); Campbell and Cocco (2007), and the summary in Table 1 of Cloyne et al. (2019). For the estimation of MPC^Y, see the summary in Crawley and Kuchler (2023). For monetary policy's effects on stock prices, see Galí and Gambetti (2015); Bjørnland and Leitemo (2009); Bernanke and Kuttner (2005); Rigobon and Sack (2004). For monetary policy's effects on house prices, see Jordà, Schularick and Taylor (2015); Del Negro and Otrok (2007), and Iacoviello (2005), among others.

Table 1: Heterogeneous MPCs, Asset Positions, and Consumption Responses

	MPC_i^S	MPC_i^H	MPC_i^Y	A_i^S/C_i	A_i^H/C_i	Y_i/C_i	Wealth channel	Income channel	$\hat{C}_i$
M	0.04	0.074	0.6	0.69	3.16	1.05	0.87%	0.63%	1.4%
R	N.A.	N.A.	0.8	0	0	0.9	0	0.72%	0.72%
O	0.03	0	0.3	1.65	3.26	1	0.25%	0.3%	0.55%

Sources: MPC^S is (estimated) from Di Maggio, Kermani and Majlesi (2020), MPC^H is from Aladangady (2017), MPC^Y is from Crawley and Kuchler (2023), and wealth-consumption and income-consumption ratios are estimated from CEX and SCF 2004. Measures of households M:R:O = 0.5:0.3:0.2

equilibrium output boom, both contribute to their expenditure increase. Renters benefit only from the income increase. Outright homeowners have smaller MPC and adjust their spending less than the other groups. The aggregated response is $0.5 \times 1.4\% + 0.3 \times 0.72\% + 0.2 \times 0.55\% = 1.03\%$, very close to the initial assumption.

In the standard full-information model, the direct shock transmission operates through intertemporal substitution. Decomposing the consumption response into direct substitution and indirect income channels yields:

$$\hat{C}_i = \underbrace{-\sigma(1 - \text{MPC}_i^Y)\hat{R}}_{\text{substitution channel}} + \underbrace{\text{MPC}_i^Y \frac{Y_i}{C_i}\hat{Y}}_{\text{income channel}} .$$

Assuming $\hat{R} = 1\%$ and log utility ($\sigma = 1$) such that $\hat{C} = \hat{Y} = 1\%$. The calibration from Table 1 implies that the responses are $\hat{C}_M = 1.03\%$, $\hat{C}_R = 0.92\%$, and $\hat{C}_O = 1.00\%$. The three groups exhibit nearly identical responses, with renters slightly less responsive than the other two groups. Theoretically, all groups should have the same response absent redistribution. Here, the differences in income-to-consumption ratios (Y_i/C_i) generate implicit redistribution when we assume proportional income rises. However, these differences cannot account for the consumption gap among groups documented in Cloyne, Ferreira and Surico (2020).

This exercise shows that the wealth-effect mechanism delivers reasonable consumption response heterogeneity. In the following, I extend the model to the heterogeneous agent setting (AP-HANK) and revisit the Great Recession with a quantitatively richer model.

5 An Asset-Price Centric HANK Model

This section extends the model to a heterogeneous-agent economy (AP-HANK), and shows that heterogeneity is central to explaining the slump-style recovery after the Great Recession.

5.1 Model Description

The model is a two-asset model as Kaplan, Moll and Violante (2018), Bayer et al. (2019), Luetticke (2021). I model illiquidity a la Calvo as in Bayer et al. (2019) and Luetticke (2021). The model focuses on the economy's transition under an exogenous path of asset prices so I abstract from monetary and fiscal blocks. In Section 6, I treat asset prices as endogenous, incorporate monetary and fiscal policy, and discuss the economy's responses to exogenous business-cycle shocks.

Households. Households have access to save in two assets: (i) liquid assets a^{liq} with gross real return R^{liq}; (ii) illiquid assets a^{illiq} with gross real return R^{illiq}. Households maximize their utility subject to the following budget and borrowing constraints:

$$\max_{\{c,n,a^{liq},a^{illiq}\}} E\left[\sum_{t=0}^{\infty} \beta^t u(c_{it}, n_{it})\right]; \tag{58}$$

$$\text{s.t. } c_{it} + a_{it}^{liq} + a_{it}^{illiq} = R_t^{liq} a_{it-1}^{liq} + R_t^{illiq} a_{it-1}^{illiq} + z_{it} W_t n_{it}; \tag{59}$$

$$a_{it}^{liq} \geq 0; \quad a_{it}^{illiq} \geq 0, \tag{60}$$

Households face portfolio adjustment constraints and they can only adjust their holdings of illiquid assets at period t when $s_t = 1$, which occurs with i.i.d. probability λ. So, in each period, a randomly selected λ fraction of households can adjust their holdings of illiquid assets. When $s_t = 0$, the illiquid assets accumulate in the background:

$$a_{it}^{illiq} = R_t^{illiq} a_{it-1}^{illiq}, \text{ if } s_t = 0. \tag{61}$$

A constant wedge $\xi < 1$ differentiates liquid and illiquid return $R_t^{liq} = \xi R_t^{illiq}$. Both assets are invested in firm equity with real gross return $R_t^S = (D_t + P_t)/P_{t-1}$ thus $R_t^{illiq} = R_t^S$ and $R_t^{liq} = \xi R_t^S$. The amount of equity held by households is given by $s_{it-1}^{liq} = a_{it-1}^{liq}/P_{t-1}$ and $s_{it-1}^{illiq} = a_{it-1}^{illiq}/P_{t-1}$.

Labor Supply. I borrow the labor market modeling from Alves et al. (2020) to simplify the labor-supply analysis. Households supply the same amount of labor $n_{it} = N_t$ to firms, and the aggregate labor supply follows the wage schedule,

$$W_t = W_* \left(\frac{N_t}{N_*} \right)^{\epsilon_W}. \tag{62}$$

If $\epsilon_W = 0$, wages are perfectly rigid, and employment is determined by only labor demand. If $\epsilon_W > 0$, there is pressure on wages whenever employment differs from its steady-state level. The wage rigidity affects the cyclicality of labor and dividend income and the redistribution between equity holders and workers.

Firms. The firm sector is the same as the representative-agent model in Section 2.

At time $t = 0$, the economy is initialized at the time-invariant steady-state distribution $\Phi_*(a_-^{liq}, a_-^{illiq}, z, s)$. I analyze the economy's transitional dynamics in response to an unexpected, exogenous path of asset prices $\{P_t\}_{t=0}^{\infty}$. The distribution $\Phi_t(a_-^{liq}, a_-^{illiq}, z, s)$ evolves according to the households' policy functions and the law of motion of exogenous individual states.

Equilibrium Definition. Given the initial joint distribution over individual states $\Phi_0 = \Phi_*$, the exogenous path of asset prices $\{P_t\}$, an equilibrium consists of the path for aggregates $\{Y_t, W_t, N_t, L_t, D_t, \pi_t\}$, firm choices $\{l_{j,t}, p_{j,t}\}$, household choices $\{c_{it}, a_{it}^{liq}, a_{it}^{illiq}\}$, such that:

(i) individual optimization: given initial individual states and the expected path of aggregates, households choose $\{c_{it}, a_{it}^{liq}, a_{it}^{illiq}\}$ to maximize their utility function subject to the budget constraints and borrowing constraints; given wages and output, firms choose $\{l_{j,t}, p_{j,t}\}$ to maximize profits, subject to price adjustment costs and aggregate demand, resulting in the Phillips Curve (5);

(ii) The aggregate labor supply (62) and aggregate dividend payment (6) conditions hold for $t = 0, 1, \cdots$;

(ii) aggregation and market-clearing: for $t = 0, 1, \cdots$, the labor, goods and asset markets clear:

$$N_t = L_t; \tag{63}$$

$$C_t = Y_t, \textit{ where } C_t = \int c_{it} di; \tag{64}$$

$$A_t = P_t, \textit{ where } A_t = \int (a_{it}^{liq} + a_{it}^{illiq}) di. \tag{65}$$

5.2 Model Solution

Linear Solution. I use the sequence space jacobian developed in Auclert et al. (2021) to solve the model linearly. Linearization allows to have the solution as a linear combination of full-information and infinite-noise cases. I omit the difference between liquid and illiquid assets for a simple illustration. Given the perceived path of aggregate labor income $\mathbf{E} = \{E_t\}_{t=0}^{\infty}$ and equity return $\mathbf{R}^A = \{R_t^A\}_{t=0}^{\infty}$, the aggregate consumption $\mathbf{C} = \{C_t\}_{t=0}^{\infty}$ is given by the consumption policy function

$$\mathbf{C} = \mathcal{C}(\mathbf{E}, \mathbf{R}^A). \tag{66}$$

Denote $\mathbf{C}_X$ as the matrix of intertemporal MPCs. Specifically,

$$\mathbf{C}_E \equiv \frac{\partial \mathcal{C}}{\partial \mathbf{E}}; \quad \mathbf{C}_{R^A} \equiv \frac{\partial \mathcal{C}}{\partial \mathbf{R}^A}, \tag{67}$$

with the derivative evaluated at the deterministic steady state. For example, the ts entry of $\mathbf{C}_E$, $M_{ts}^E = \partial \mathcal{C}_t / \partial E_s$, gives the first-order response of time-t consumption to an aggregate shock to labor income at time-s, and the ts entry of $\mathbf{C}_{R^A}$, $M_{ts}^{R^A} = \partial \mathcal{C}_t / \partial R_s^A$, gives the response of time-t aggregate consumption to a shock to equity return at time-s.

Define myopic agents as those who perceive the movements of aggregate equity return (and labor income) as due to purely idiosyncratic i.i.d. shocks. Myopic agents ignore future movements of aggregates and only learn about the movement when it happens. Denote the full-information Jacobian as $\mathbf{C}^{full-info}$. The Jacobian for myopic agents is given by

$$\mathbf{C}^{myopic} = \begin{pmatrix} M_{00}^{full-info} & 0 & 0 & \cdots \\ M_{10}^{full-info} & M_{00}^{full-info} & 0 & \cdots \\ M_{20}^{full-info} & M_{10}^{full-info} & M_{00}^{full-info} & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{pmatrix}.$$

The other columns of the myopic Jacobian are obtained by shifting the first column of the full-information Jacobian down. For myopic agents, the persistent perturbations to aggregates act as a sequence of time-0 unexpected shocks.

Information frictions affect the expected path of aggregate labor income and equity return. The Jacobian is the weighted average of the myopic and the full-information Jacobian. For $X \in \{R^A, E\}$,

$$\mathbf{C}_X = \mu \mathbf{C}_X^{full-info} + (1-\mu)\mathbf{C}_X^{myopic}. \tag{68}$$

With the Jacobian built, we can solve the model as in Auclert, Rognlie and Straub (2024).

The path of aggregate consumption is

$$d\mathbf{C} = \mathbf{C}_{R^A} d\mathbf{R}^A + \mathbf{C}_E d\mathbf{E} = \mathbf{C}_{R^A} \frac{\partial \mathbf{R}^A}{\partial \mathbf{P}} d\mathbf{P} + \mathbf{C}_{R^A} \frac{\partial \mathbf{R}^A}{\partial \mathbf{D}} \frac{\partial \mathbf{D}}{\partial \mathbf{Y}} d\mathbf{Y} + \mathbf{C}_E \frac{\partial \mathbf{E}}{\partial \mathbf{Y}} d\mathbf{Y} \tag{69}$$

$$= \mathbf{C}_{R^A} \frac{\partial \mathbf{R}^A}{\partial \mathbf{P}} d\mathbf{P} + \left(\mathbf{C}_{R^A} \frac{1}{P_*} \frac{\partial \mathbf{D}}{\partial \mathbf{Y}} + \mathbf{C}_E \frac{\partial \mathbf{E}}{\partial \mathbf{Y}} \right) d\mathbf{Y}. \tag{70}$$

The jacobian of aggregate MPC out of income $\mathbf{C}_Y$ and asset price $\mathbf{C}_P$ are given by[17]

$$\mathbf{C}_P \equiv \mathbf{C}_{R^A} \frac{\partial \mathbf{R}^A}{\partial \mathbf{P}}; \quad \mathbf{C}_Y \equiv \mathbf{C}_{R^A} \frac{1}{P_*} \frac{\partial \mathbf{D}}{\partial \mathbf{Y}} + \mathbf{C}_E \frac{\partial \mathbf{E}}{\partial \mathbf{Y}}. \tag{71}$$

The consumption response as a function of the asset price and output is

$$d\mathbf{C} = \mathbf{C}_P d\mathbf{P} + \mathbf{C}_Y d\mathbf{Y} \tag{72}$$

and the equilibrium consumption satisfies $d\mathbf{C} = d\mathbf{Y}$. This is the HA counterpart of the RA model's consumption response to an asset price shock.

Nonlinear Solution. I solve the model non-linearly by value (policy) function iteration in the case of $\mu = 0$. In the sequence space, household value function satisfies

$$V_t^f(a_{it-1}, h_{it}) = \max_{c_{it}, a_{it}} u(c_{it}) + \beta \mathbb{E}_h [S_*(a_{it}, h_{it+1}) | h_{it}],$$
$$\text{s.t. } c_{it} + a_{it} = R_t^A a_{it-1} + e_{it}.$$

I use the guess-and-verify method to find the equilibrium path of aggregates.

5.3 Household Heterogeneity and Asset Price Shock Transmission

A striking feature of the standard HA model is that heterogeneity matters for aggregate shock transmission only insofar as individual MPCs are correlated with the redistribution triggered by the shock. When redistribution is muted, the magnitude of aggregate MPCs is irrelevant for the elasticities between aggregate variables.[18] In this case, aggregate consumption follows the fictitious Euler Equation:

$$C_t^{-1/\sigma} = \tilde{\beta} R_{t+1} C_{t+1}^{-1/\sigma}, \text{ with } \tilde{\beta} \equiv 1/R_*^{illiquid};$$

[17] In the RA model, MPCs out of labor and dividend income are equal. Here, they differ so we need to distinguish them. I also omit the resource cost induced by the return wedge ξ between liquid and illiquid assets to simplify the exposition.

[18] See, for example, Gong (2025), Bilbiie (2020) and Werning (2015). Gong (2025) shows that for the two-asset HANK presented above, there exist counterfactual transfers among agents to mute the redistribution and ensure that all agents have homogeneous consumption responses to the shock.

and individual consumption share is constant conditional on the history of individual shocks

$$\frac{c_t(h^t)}{C_t} = \frac{c_*(h^t)}{C_*},$$

where $h^t \equiv ((b_{-1}, a_{-1}), (z_0, s_0), \ldots, (z_t, s_t))$ is the individual's history of idiosyncratic shocks including initial wealth portfolio.

The intuition is that, in standard models, the response to interest rate changes is negatively correlated with the response to income changes (see Kaplan, Moll and Violante 2018). High-MPC households respond strongly to income but weakly to interest rates, while low-MPC households do the reverse. Without redistribution, direct and indirect effects sum to constant, so that MPCs do not affect individual consumption responses, and MPCs heterogeneity does not affect aggregate dynamics.

In the APNK framework, however, the magnitude of aggregate MPCs plays a central role in determining aggregate dynamics. With heterogeneous agents, equation (72) implies that, to first order, the time-0 consumption response to an unexpected asset price shock is

$$dC_0 = \mathrm{MPC}_0^{R^A} \frac{\partial R^A}{\partial P_0} dP_0 + \mathrm{MPC}_0^Y dY_0 = \mathrm{MPC}_0^A A_* \hat{P}_0 + \mathrm{MPC}_0^Y dY_0,$$
$$\hat{C}_0 = \frac{\mathrm{MPC}_0^A}{1 - \mathrm{MPC}_0^Y} \frac{A_*}{C_*} \hat{P}_0.$$

The time-0 consumption response mirrors the representative-agent result. Crucially, the direct effect (MPC^A) and the indirect multiplier effect (MPC^Y) tend to move in the same direction rather than offsetting each other. As a result, economies with higher aggregate MPCs exhibit stronger consumption responses.

In the HA economy, the levels of aggregate MPCs are endogenous objects determined by the wealth distribution and portfolio composition. I leverage this feature to study how liquidity conditions and inequality shape consumption dynamics during the Great Recession.

5.4 Calibration

The model is calibrated to quarterly frequency. The calibration targets the US economy in 2004. The EIS parameter σ is set to 1. The value of equity relative to annual output is set to $A/Y = 3.1$, which is the sum of housing wealth and stock wealth over the annual consumption of 1998. The government bond supply and government spending are set to zero. The annual real return on illiquid assets is $r^{illiq} = 6.25\%$ and on liquid assets is $r^{liq} = -1.18\%$. The quarterly adjustment probability λ is set to 0.11, and the discount factor β is calibrated to match the supply of equity. The calibrated discount factor is 0.98 (quarterly). The value of wealth and equity return pin down dividends share $\alpha = 3.1 * 6.25\% = 19\%$ and labor share 81%. The implied steady-state markup $1 - 1/\mu^p$ is 0.19, giving $\mu^p = 1.23$. The slope of the Phillips curve is $\kappa = 0.1$. The wage rigidity ϵ_W is set to zero so that the aggregate income accrued to labor $(1 - \alpha)$ and equity (α) are constant shares of output. This assumption is to mute redistribution such that agents have homogenous income elasticities to aggregate income regardless individual equity and income shares.

Income Process. The (log) income process is the quarterly process estimated in Kaplan and Violante (2022), which is the sum of two independent components. The first component is a typical AR (1) process with persistence 0.988 and variance of innovations 0.0108, and the second component is i.i.d. with variance 0.2087 (see the second row of Table A.2 in Kaplan and Violante 2022).

Aggregate MPCs. We first define individual MPCs. Writing individual budget constraints as follows:

$$c_{it} + a_{it}^{liq} + a_{it}^{illiq} = P_t s_{it-1}^{liq} + P_t s_{it-1}^{illiq} + D_t s_{it-1}^{liq} + D_t s_{it-1}^{illiq} + z_{it} W_t N_t,$$

Individual MPCs out of capital gains MPC_i^a, dividend income MPC_i^d and labor income MPC_i^l are defined as

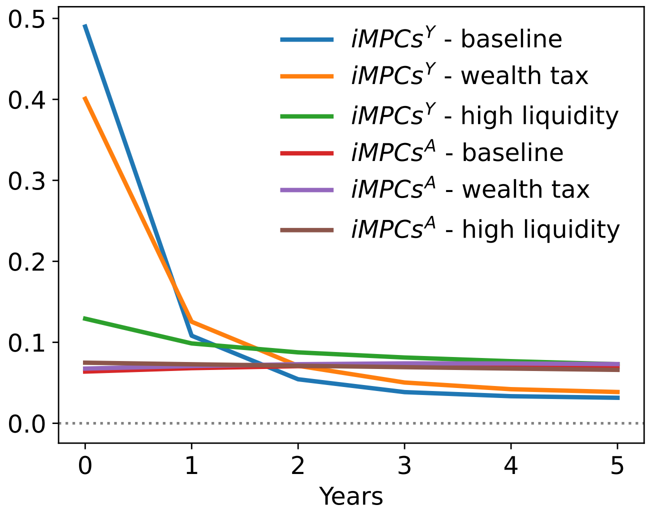
$$\text{MPC}_i^{d,liq} \equiv \frac{\partial c_{it}}{\partial (D_t s_{it-1}^{liq})}, \quad \text{MPC}_i^{d,illiq} \equiv \frac{\partial c_{it}}{\partial (D_t s_{it-1}^{illiq})}, \quad \text{MPC}_i^l \equiv \frac{\partial c_{it}}{\partial (z_{it} W_t N_t)};$$
$$\text{MPC}_i^{a,liq} \equiv \frac{\partial c_{it}}{\partial (P_t s_{it-1}^{liq})}, \quad \text{MPC}_i^{a,illiq} \equiv \frac{\partial c_{it}}{\partial (P_t s_{it-1}^{illiq})}.$$

And aggregate MPCs are computed as

$$\text{MPC}^Y = \frac{\partial D}{\partial Y} \left(\int \text{MPC}_i^{d,liq} s_i^{liq} di + \int \text{MPC}_i^{d,illiq} s_i^{illiq} di \right) + \frac{\partial Y^l}{\partial Y} \int \text{MPC}_i^l z_i di,$$
$$\text{MPC}^A = \int \text{MPC}_i^{a,liq} s_i^{liq} di + \int \text{MPC}_i^{a,illiq} s_i^{illiq} di. \tag{73}$$

Note that the definition of MPC^Y differs from that in Auclert, Rognlie and Straub (2024). There, MPC^Y is the aggregate MPC out of labor income, computed as the average of individual MPCs out of labor income weighted by labor income shares z_i. Here, MPC^Y is the aggregate MPC out of total (labor and dividend) income, computed as the average of individual MPCs weighted by their respective income and equity shares $(z_i, s_i^{liq}, s_i^{illiq})$. This measure is more informative for the model solution (72), as goods market clearing

Figure 4: Intertemporal MPCs



Notes: Intertemporal MPCs of the two-asset model under the baseline, wealth tax and high-liquidity calibration, respectively. High-liquidity scenario: the illiquid wealth adjustment probability $\lambda = 0.999$. Wealth tax scenario: 1% annually tax on illiquid wealth above \$3 million.

requires consumption to equal total income. In both papers, MPC^A is the equity-share-weighted average of individual MPCs out of capital gains. Figure 4 shows that the model delivers realistic magnitudes for intertemporal MPCs. The contemporaneous values are $\text{MPC}_0^Y = 0.5$ and $\text{MPC}_0^A = 0.06$. The unweighted averages are $\text{MPC}_0^Y = 0.62$ and $\text{MPC}_0^A = 0.20$ (weighted within individuals' portfolios but not across individuals). See the Appendix for details on individual MPCs.

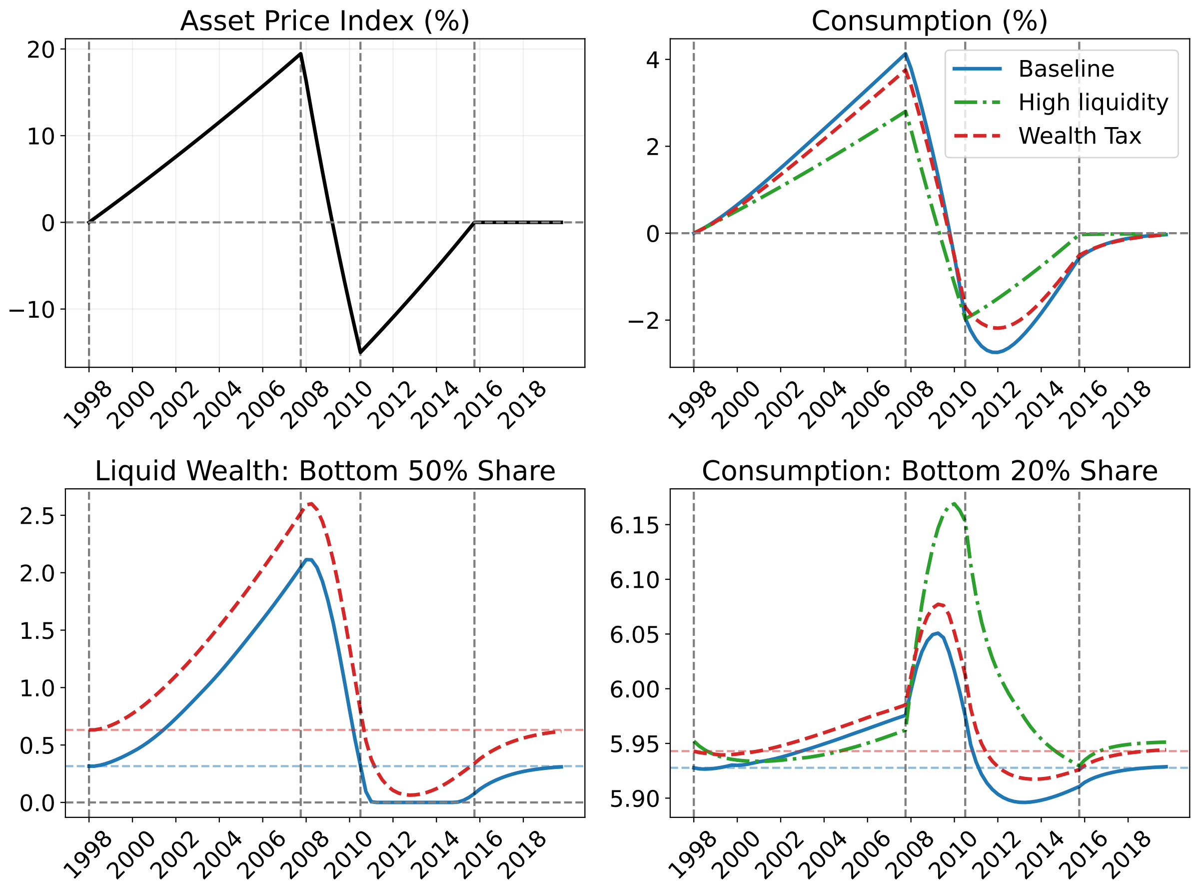
5.5 Application: The Great Recession with Heterogeneous Agents

I evaluate the Great Recession with the heterogeneous-agent model built above. In Figure 5, I input an exogenous path of the asset price into the model and solve the IRFs.

In the representative agent setting, aggregate consumption is synchronized with contemporaneous asset prices (Proposition 1) so consumption and asset prices move together. The AP-HANK economy, however exhibits strong persistence of consumption response and a more state-dependent asymmetric recovery after the bust. The appendixs show that the linear solution overestimates the expansion in the boom period and underestimate the severity of the bust and the slow recovery. Aggregate consumption remains depressed for several years even as asset valuations begin to recover, due to a slow rebuilding of liquid buffers and infrequent rebalancing among constrained households.

Panels (iii) and (iv) make the heterogeneity central for the analysis of the slow recovery. The liquid-wealth bottom-50% share declines towards zero through the crisis, indicating that losses and subsequent buffer rebuilding are concentrated away

Figure 5: Great Recession with Heterogeneous Agents (AP-HANK)



Notes: The AP-HANK model's response to the Great-Recession asset-price shock. Units: (i) asset price index and (ii) aggregate consumption response: percentage deviations from 1998 levels; (iii) Liquid wealth bottom-50% share and (iv) consumption bottom-20% share: percentage points. Vertical lines mark the approximate boom, crisis, and recovery phase boundaries. High-liquidity scenario is where the illiquid wealth adjustment probability is 0.999. The wealth tax scenario is discussed in Section 5.3 where 1% annual tax is applied to illiquid wealth over \$3 million.

from the median. In parallel, the consumption share of bottom-20% goes significantly below the trend level and normalizes only slowly, showing that spending cuts are disproportionately borne by high-MPC and liquidity-constrained households during the bust.

To see the important role of liquidity in the 1998-2019 cycle, the model is in addition calibrated to a variant of high liquidity with low MPC^Y. This is done by choosing a larger adjustment probability for illiquid assets. In the baseline calibration, the quarterly probability of adjusting illiquid asset holdings is 0.11; in the high-liquidity calibration, this parameter is set to $\lambda = 1$ and the illiquid assets become fully liquid (λ is set to 0.999 in the numerical solution to still keep the two-asset structure). The illiquid-asset return decreases from annually 6.25% to 6% to clear the market. Figure 4 shows MPC_0^Y in the high-liquidity scenario is only 0.13, much smaller than the baseline value of 0.5.

With high liquidity and low MPC^Y, the consumption response to the asset price shock is dampened. The slow recovery disappears and the dynamics is similar to that of a representative-agent model.

Taken together, these series quantify how balance-sheet dispersion shapes aggregates in AP-HANK: holding the asset-price path fixed, the marginal dollar shifts away from higher-MPC agents in the downturn, deepening the contraction and slowing the recovery relative to the representative-agent and high-liquidity benchmarks.

6 Inequality and Macroeconomic Volatility

How long-run inequality affects short-run aggregate fluctuations has been a central question since the beginning of the heterogeneous-agent literature. In the last section, I show that aggregate MPCs directly scale the transmission of asset price shocks when wealth effects are present, in contrast to the full-information model. This section leverages this feature to study how inequality shapes macroeconomic volatility through MPCs.

6.1 Business-Cycle Shock Transmission

I extend the AP-HANK economy in Section 5.1 by incorporating monetary and fiscal policy blocks and briefly discuss the transmission of three business-cycle shocks: productivity, discount rate (asset price), and government spending.

Households. Households pay proportional labor income taxes $\tau_{it} = z_t T_t^E$ to the government where T_t^L is the aggregate labor income tax. The household budget constraint is given by

$$c_{it} + a_{it}^{liq} + a_{it}^{illiq} = R_t^{liq} a_{it-1}^{liq} + R_t^{illiq} a_{it-1} + z_t W_t n_{it} - \tau_{it}. \tag{74}$$

Both liquid and illiquid assets can be invested in firm equity with real gross return R_t^S and government bonds with real gross interest rates R_t. The non-arbitrage condition between equity and bond holds and we can back out interest rates via $R_t^S = R_t, \forall t \geq 1$. At time $t = 0$, equity return can differ from interest rates due to unexpected capital gains. The portfolio choices between equity and bonds for both assets is the same as the aggregate portfolio. The illiquid asset return is given by

$$R_t^{illiq} = R_t^S \frac{P_{t-1}}{P_{t-1} + B} + R_t \frac{B}{P_{t-1} + B}. \tag{75}$$

The liquid asset return is given by $R_t^{liq} = \xi R_t^{illiq}$ as in the last section.

Firms. The aggregate TFP follows the process

$$dZ_t = \rho_Z dZ_{t-1} + \epsilon_t^Z, \quad \epsilon_t^Z \sim \mathcal{N}(0, \sigma_{\epsilon^Z}^2),$$

where $dZ_t = Z_t - Z_*$ and ρ_Z is the persistence of the TFP shock. I restate the Phillips Curve

$$\log(1+\pi_t) = \kappa \left(\frac{W_t}{Z_t} - \frac{1}{\mu^p} \right) + \frac{1}{R_{t+1}} \frac{Y_{t+1}}{Y_t} \log(1+\pi_{t+1}). \tag{76}$$

Firm profits are subject to lump-sum taxes so aggregate dividends paid to share holders equal the output net of labor expenditure and taxes on profits T_t^F:

$$D_t = Y_t^{GDP} - W_t N_t - T_t^F = \alpha Y_t^{GDP} - T_t^F.$$

Fiscal Policy. The government maintains zero public debt ($B = 0$) and adjusts taxes to balance its budget

$$T_t = G_t. \tag{77}$$

Taxes T_t apply proportionally to gross labor and firm profits with $T_t^E = (1-\alpha)T_t$ and $T_t^F = \alpha T_t$. Under this rule, post-tax labor and dividend income are constant shares of aggregate disposable income $Y_t \equiv Y_t^{GDP} - G_t$. On the individual level, agents have identical elasticities of disposable income to aggregate disposable income. Government spending G_t is exogenous and follows

$$dG_t = \rho_G dG_{t-1} + \epsilon_t^G, \quad \epsilon_t^G \sim \mathcal{N}(0, \sigma_{\epsilon^G}^2), \tag{78}$$

where ρ_G is the shock persistence.

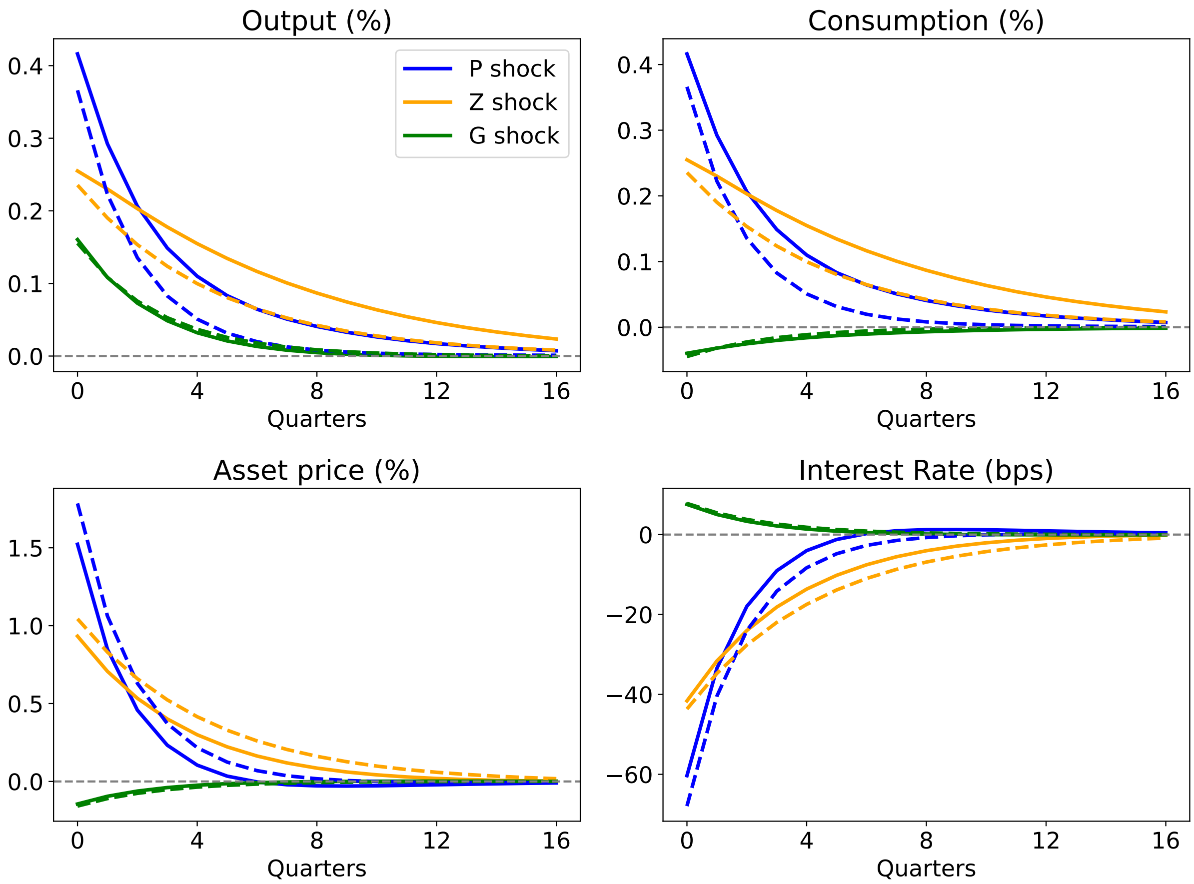
Monetary Policy. The monetary authority sets the asset price according to the Asset-Price Taylor rule

$$\hat{P}_t = \phi_\pi^P \pi_t + v_t^P, \text{ where } v_t^P = \rho_v v_{t-1}^P + \epsilon_t^P \text{ and } \epsilon_t^P \sim \mathcal{N}(0, \sigma_{\epsilon^P}^2), \tag{79}$$

with $v_t^P = 0$ in the steady state. The innovation ϵ_t^P captures the exogenous discount rate (asset price) shocks.

Figure 6 plots impulse responses to one-standard-deviation asset-price (discount-rate), productivity, and government-spending shocks under the baseline and high-liquidity calibrations. Consistent with Proposition 2, a discount-rate shock operates

Figure 6: IRFs to Asset-Price, Productivity, and Government-Spending Shocks



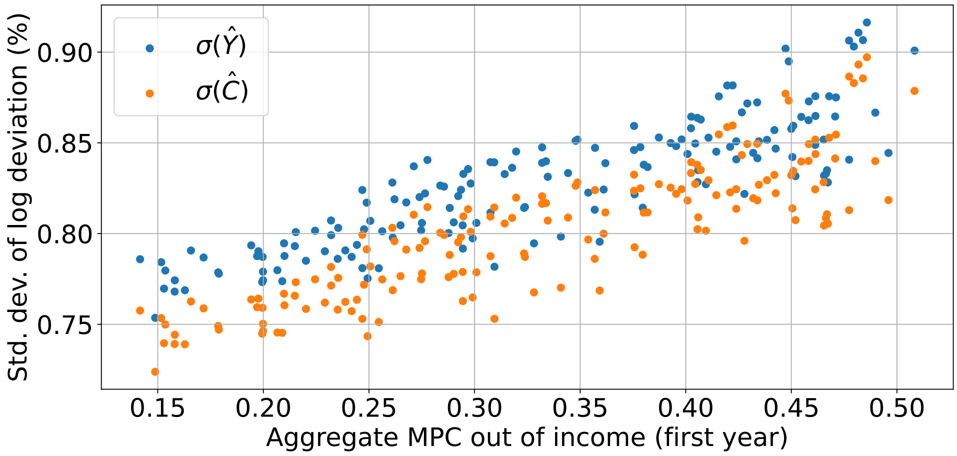
Notes: Each panel displays IRFs of the AP-HANK model to asset-price (ϵ^P), productivity (ϵ^Z), and government-spending (ϵ^G) shocks of one standard deviation. The solid line is the baseline calibration, and the dashed line is the high-liquidity calibration. The baseline calibration features a 0.11 quarterly probability of adjusting illiquid asset holdings, while the high-liquidity scenario has a quarterly adjustment probability $\lambda = 0.999$.

similarly to an expansionary monetary policy shock: it raises asset valuations, stimulates consumption, and lowers the real interest rate.

The productivity shock increases consumption and asset prices and reduces the real interest rate as well. Because the shock is transitory, households would like to save part of the temporary income gain; absent an offsetting force, aggregate demand would be too weak relative to the expansion in supply. In the APNK mechanism, asset prices must rise to generate a perceived wealth increase that lifts consumption demand and restores market clearing. By no-arbitrage, higher asset prices correspond to lower expected real interest rates.

The government-spending shock crowds out private consumption, lowers asset prices, and raises the real interest rate. Households would like to borrow against higher future income to smooth consumption, so asset prices must fall to reduce perceived wealth and bring consumption back in line with available resources; by no-arbitrage,

Figure 7: Volatility of Output and Consumption versus Aggregate MPC out of Income



Notes: Unconditional standard deviations of output and consumption from long simulations for calibrations with different levels of aggregate MPC out of income. MPCs are reached by varying the liquid-asset return, variance of the transitory income shock, and illiquid-asset adjustment probability while re-calibrating the subjective discount factor to clear the market.

this implies higher expected real interest rates.

Relative to the standard New Keynesian model, the qualitative responses are similar, but the mechanism differs: in the standard model, consumption rises because current consumption becomes cheaper relative to future consumption, whereas in the APNK model consumption adjusts because agents feel richer.

Under the high-liquidity calibration, responses remain qualitatively similar but are uniformly smaller, consistent with weaker amplification when aggregate MPCs are lower. The cumulative consumption responses under the baseline versus high-liquidity calibration are 1.58% and 1.22% (asset-price shock), 1.94% and 1.58% (productivity shock), and 0.20% and 0.16% (government-spending shock), respectively. Financial variables (asset prices and interest rates) move more in the high-liquidity scenario to absorb the perturbations when consumption responds less. Overall, the results confirm that higher aggregate MPC^Y amplifies aggregate shock propagation, consistent with Proposition 1.

6.2 Inequality, MPCs, and Macroeconomic Volatility

Policy implications differ across the standard and the AP-HANK environments. In a standard HANK economy, the correlation between individual MPCs and redistribution may amplify or dampen shock transmission, depending on the nature of the shock. This leads to ambiguous effects of inequality on the volatility of output and consumption: smaller heterogeneity across individual MPCs implies that both amplification and dampening are milder. In AP-HANK, by contrast, policies that compress the wealth distribution and reduce aggregate MPCs—for example, a modest wealth tax—directly

Table 2: Wealth inequality and Macroeconomic volatility: Baseline vs Wealth Tax

	Liquid assets		Illiquid assets	
Inequality metrics	Baseline	Wealth tax	Baseline	Wealth tax
Gini	0.88	0.84	0.75	0.72
Mean wealth	1.40	1.72	11.00	10.68
Median wealth	0.04	0.10	2.48	2.90
P90 wealth	2.80	3.96	25.69	26.66
P95 wealth	5.64	7.47	40.39	40.61
P99 wealth	18.65	21.53	94.95	85.09
Top 10% share (%)	79.69	72.48	58.70	53.84
Top 1% share (%)	34.83	25.50	19.12	13.61
Top 0.1% share (%)	13.08	6.55	6.24	2.83
Bottom 50% share (%)	0.31	0.66	2.59	2.97

Unconditional std. dev.	Baseline	Wealth tax
Output (%)	0.83	0.78
Consumption (%)	0.80	0.75
Asset price (%)	2.32	2.42
Inflation (bps)	40	41
Interest rate (bps)	97	100

Notes: Wealth tax is 1% annually on illiquid assets over $3 million. The first panel reports steady-state wealth inequality statistics; the second panel reports unconditional standard deviations of aggregates from long stochastic simulations.

stabilize real activity and can mute peaks and accelerate recovery during crises.

To further shed light on the implications of higher MPC^Y on business-cycle fluctuations, I build a simple "envelope" of aggregate MPCs by adjusting the liquid-asset return, variance of the transitory income shock, and illiquid-asset adjustment probability of the two-asset HANK model. For each parameter combination, I re-calibrate the subjective discount factor. Then I run long stochastic simulations and compute unconditional standard deviations of aggregate variables (in percentage terms).

Figure 7 plots the unconditional standard deviations against the aggregate MPC^Y, which is a clear, approximately linear relationship: higher aggregate MPC^Y is associated with higher volatility of output and consumption. Intuitively, when MPC^Y is larger, a greater share of income innovations is passed through to contemporaneous spending thus shocks propagate more strongly in general equilibrium through the Keynesian multiplier $1/(1-\text{MPC}^Y)$.

On the other hand, wealth inequality and aggregate MPCs are tightly linked. Carroll, Slacalek and Tokuoka (2014) documents a positive link between wealth inequality and aggregate MPCs out of income. Combined with the above mapping between aggregate MPCs and volatility, the direct implication is that policies that aim at reducing inequality and MPCs are also effective in stabilizing business-cycle fluctuations.

I study a concrete policy that compresses inequality and lowers aggregate MPC^Y of the baseline economy: a modest annual 1% wealth tax on illiquid assets over $3 million. I let the liquid-asset return increases from baseline -1.18% (p.a.) to 1.4% to clear the market. Tables 2 reports steady-state inequality statistics and unconditional volatilities for the baseline and the wealth-tax counterfactual. The tax flattens the liquid-wealth distribution substantially—e.g., the liquid-wealth Gini falls from 0.88 to 0.84 and the top 1% share from 34.83% to 25.50%—while the illiquid distribution also compresses (Gini 0.75 to 0.72; top 1% share 19.12% to 13.61%). Figure 4 shows the first-year intertemporal MPC out of income falls from the baseline $\text{MPC}_0^Y = 0.5$ to $\text{MPC}_0^Y = 0.4$.

In line with the envelope, output and consumption become modestly less volatile (0.83% to 0.78% and 0.80% to 0.75%, respectively). Asset price and policy-rate volatilities tick up slightly, consistent with weaker real fluctuations: given similar shocks, aggregate spending responds less, so stabilizing policy absorbs more of the adjustment and asset valuations fluctuate more.

Taken together, the simulations indicate a robust mapping from inequality to macroeconomic volatility via aggregate MPC^Y. Policies that compress the wealth distribution and reduce aggregate MPCs dampen the volatility of real activities in the AP-HANK environment.

6.3 Application: The Great Recession with Wealth Tax

I re-evaluate the Great Recession in the wealth-tax counterfactual scenario. Figure 5 constrasts the consumption dynamics during the Great Recession under wealth-tax and the baseline. The wealth-tax scenario reveals stabilization effects for the 1998-2019 cycle. Under the 1% wealth tax regime, consumption exhibits more muted dynamics throughout the entire cycle, with the boom-phase peak reaching 3.75% above steady state, lower than the baseline peak (4.13%). More importantly, the consumption recovery following the crisis occurs more rapidly under the wealth tax scenario (trough at -2.19%), while the baseline case remains significantly depressed (trough at -2.75%).

The policy shifts resources toward higher-MPC households, who lead to greater macroeconomic instability during the cycle. The bottom-50% liquid-wealth share (panel iii) avoids hitting the borrowing limits and recovers sooner, indicating that liquidity buffers erode less during the bust. Panel (iv) highlight the milder widening and faster normalization of the consumption dispersion under the tax. Both patterns are consistent with a compression of MPC^Y distribution under the wealth tax, which weakens the general-equilibrium amplification and shortens the duration of the slump.

7 Conclusion

This paper develops an Asset-Price Centric New Keynesian (APNK) model in which wealth effects of asset prices drive aggregate consumption dynamics. The findings advance a unified view: asset-price-driven wealth effects, disciplined by micro MPCs and embedded in an APNK structure, organize both representative-agent dynamics and distributional dynamics in heterogeneous-agent economies. They reconcile micro and macro EIS, explain the timing and magnitude of Great Recession consumption dynamics, link inequality to stabilization, and deliver actionable policy guidance.

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Appendix

A Information Frictions and Model Solution

I formulate another version of the model in which the idiosyncratic shock is a shock to asset-price level rather than the return on savings.

Household Problem. Within the representative household, there is a continuum of agents $i \in I$ who hold shares $s_{it-1} = 1$ of stock at the beginning of period t carried from the last period. The price of its stock satisfies the no-arbitrage condition:

$$\frac{\mathbb{E}_t[P_{it+1} + D_{it+1}]}{P_{it}} = \frac{\mathbb{E}_t[P_{t+1} + D_{t+1}]}{P_t} \equiv \mathbb{E}_t R^A_{t+1}, \tag{80}$$

where P_{it} is the price and D_{it} is the dividend of agent i's stock. I assume that $D_{it} = v_{it} D_t$ in which v_{it} is the idiosyncratic shock to the dividend flow. $\hat{v}_{it} \equiv \log v_{it}$ follows a AR(1) process:

$$\hat{v}_{it+1} = \rho_v \hat{v}_{it} + \epsilon^d_{it}, \qquad \epsilon^d_{it} \sim \mathcal{N}(0, \sigma^2_{\epsilon^d}) \perp \epsilon_t. \tag{81}$$

$\sigma^2_{\epsilon^d}$ is scaled such that $\int v_{it} di = 1$. The news about the innovation ϵ^d_{it} to future dividends realizes at t.

Each agent observes the price and dividend of its own stock and forms an expectation about the aggregate price. The representative household then aggregates these expectations. Given the expectation, the perceived aggregate budget constraint can be writtten as

$$C_t + \mathbb{E}^f_t P_t \frac{P_t}{\mathbb{E}^f_t P_t} S_t = \mathbb{E}^f_t P_t \frac{P_t}{\mathbb{E}^f_t P_t} S_{t-1} + \mathbb{E}^f_t D_t \frac{D_t}{\mathbb{E}^f_t D_t} S_{t-1} + \mathbb{E}^f_t E_t \frac{E_t}{\mathbb{E}^f_t E_t}. \tag{82}$$

which is the budget constraint from the perspective of a household who believes the movement in future dividend payments $D_{t+1}/\mathbb{E}^f_t D_{t+1}$ moves today's asset prices by $P_t/\mathbb{E}^f_t P_t$. Then the household makes consumption-labor-saving decisions subject to the budget constraint. Market clearing implies $C_t = Y_t = D_t + W_t N_t$ and $S_t = 1$. Since consumption and income is homogeneous across agents, the individual wealth evolution is exogenous. At the end of the period, agent i's stock share is given by $s_{it} = s_{it-1} = 1$.

Information Frictions. At any point in time, agent i observes only the value of its own stock wealth P_{it} and dividends D_{it}, but not the separate aggregate versus idiosyncratic components. Agents cannot perfectly distinguish whether shocks to their stock prices reflect the aggregate term P_t or the idiosyncratic term v_{it+1}. They form expectations about prices based on the history of their own observables. Log-linearizing the non-arbitrage condition around the steady state yields the state-space system

$$\hat{P}_t = \rho \hat{P}_{t-1} + \epsilon_t, \qquad \text{(transition)} \tag{83}$$

$$\hat{v}_{it+1} = \rho_v \hat{v}_{it} + \epsilon^d_{it}, \qquad \text{(transition)} \tag{84}$$

$$\hat{P}_{it} = \hat{P}_t + (1 - \frac{1}{R^A_*})\frac{\hat{v}_{it+1}}{1 - \rho_v / R^A_*}, \qquad \text{(observation)} \tag{85}$$

$$\hat{D}_{it} = \hat{D}_t + \hat{v}_{it} = \eta^D_P \hat{P}_t + \hat{v}_{it}. \qquad \text{(observation)} \tag{86}$$

where I assume in equilibrium the relation $\hat{D}_t = \eta^D_P \hat{P}_t$ holds with η^D_P to be determined. The main condition for the relation to hold is that in equilibrium the correctly-identified fraction of the aggregate price movement is constant $\mu_t = \mathbb{E}^f_t \hat{P}_t / \hat{P}_t = \mu$. I discuss the condition below.

Ccombining the two observations eliminates the persistent idiosyncratic state,

$$\begin{aligned} x_{it} \equiv \hat{P}_{it} - \alpha\rho_v \hat{D}_{it} &= \hat{P}_t + \alpha(\rho_v \hat{v}_{it} + \epsilon^d_{it}) - \alpha\rho_v(\eta^D_P \hat{P}_t + \hat{v}_{it}) \\ &= c\hat{P}_t + \alpha\epsilon^d_{it}, \quad \alpha \equiv \left(1 - \frac{1}{R^A_*}\right)\frac{1}{1 - \rho_v / R^A_*}, \quad c \equiv 1 - \alpha\rho_v\eta^D_P. \end{aligned} \tag{87}$$

When $c \neq 0$, the problem is a scalar signal-extraction problem for the latent aggregate price $\hat{P}_t$. In steady state, the Kalman filter implies

$$\mathbb{E}^f_t \hat{P}_t = \rho(1-K)\mathbb{E}^f_{t-1}\hat{P}_{t-1} + K\hat{P}_t, \qquad K = \frac{c^2\sigma^2_{\hat{P}}}{c^2\sigma^2_{\hat{P}} + \alpha^2\sigma^2_{\epsilon^d}} \in [0,1], \tag{88}$$

where $\sigma^2_{\hat{P}}$ is the steady-state prior variance of $\hat{P}_t$. The forecast error follows the AR(1) process,

$$\hat{P}_t - \mathbb{E}^f_t \hat{P}_t = \rho(1-K)\left(\hat{P}_{t-1} - \mathbb{E}^f_{t-1}\hat{P}_{t-1}\right) + (1-K)\epsilon_t. \tag{89}$$

In the general case $\mu_t \equiv \mathbb{E}^f_t \hat{P}_t / \hat{P}_t$ is history-dependent and need not be constant unless $\rho = 0$, in which case $\mu = K$.

When $\alpha\rho_v = 1/\eta^D_P$ and $c = 0$, contemporaneous observations are singular:

$$\hat{P}_{it} = \hat{P}_t + \alpha\rho_v\hat{v}_{it} + \alpha\epsilon^d_{it} = \frac{1}{\eta^D_P}\hat{D}_{it} + \alpha\epsilon^d_{it}. \tag{90}$$

Thus current observations do not separately identify $\hat{P}_t$. If in addition $\rho_v = \rho$, then $\hat{D}_{it} = \eta^D_P \hat{P}_t + \hat{v}_{it}$ is itself a single AR(1) process with persistence ρ. Agents therefore can only extract $\hat{P}_t$ from the unconditional prior. Aggregating individual posteriors implies the constant share

$$\mathbb{E}_t^f \hat{P}_t = \mu \hat{P}_t, \qquad \mu = \frac{(\eta_P^D)^2 \sigma_\epsilon^2}{(\eta_P^D)^2 \sigma_\epsilon^2 + \sigma_{\epsilon^d}^2}. \tag{91}$$

This is a static-extraction result: the data identify only the composite dividend process. The near-singular case $\rho_v \approx \rho$ is therefore empirically relevant. When the two processes have similar persistence, the history of observations does not contain information, and μ_t is approximately constant over time.

B Model-Fit Details

B.1 Monetary Policy Transmission

This appendix reports the full local-projection estimates underlying Section 4.1. The quarterly baseline estimates a separate regression for each horizon using the high-frequency monetary policy shock, a constant, a linear trend, one lag of the selected controls, and COVID dummy controls for 2020Q1–2021Q2. The quarterly control vector contains output, consumption, investment, the federal funds rate, unemployment, CPI, and the shock. Inference uses 90% Newey–West confidence intervals with bandwidth equal to the horizon. The quarterly sample runs from 1988Q3 to 2023Q4 after lag trimming. All reported responses are normalized so that the maximum consumption response around the medium-run peak equals 1%.

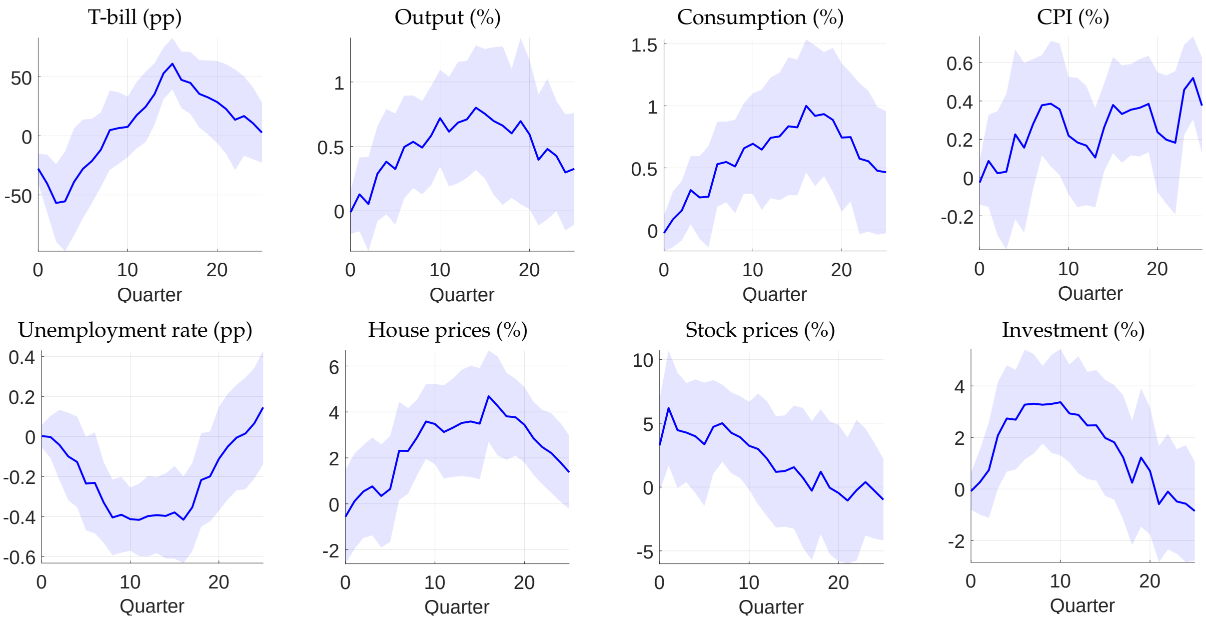
As a robustness exercise, I also estimate a monthly local projection. The monthly specification is analogous, and uses three lags of the controls. The monthly control vector contains industrial production, consumption, the federal funds rate, unemployment, CPI, and the shock itself. The monthly sample runs from 1988M05 to 2023M12 and excludes the Covid-19 period 2020M01-2021M06.

I use quarter-end wealth and asset prices to interpolate between-quarter quantities. The monthly wealth is then constructed from the monthly quantity and asset prices. The sample-average monthly stock- and housing-wealth–consumption ratios are 14.86 and 26.03.

B.2 Business cycles

Figure 11 decomposes the benchmark 1998Q1–2019Q4 APNK prediction from Figure 3 into stock and housing components. Measured by the sum of absolute contributions over time, housing contributes slightly more to total model movement over the sample, while the two components contribute nearly equally at the trough of the Great Recession.

Figure 8: Quarterly Local-Projection Responses to Monetary Policy

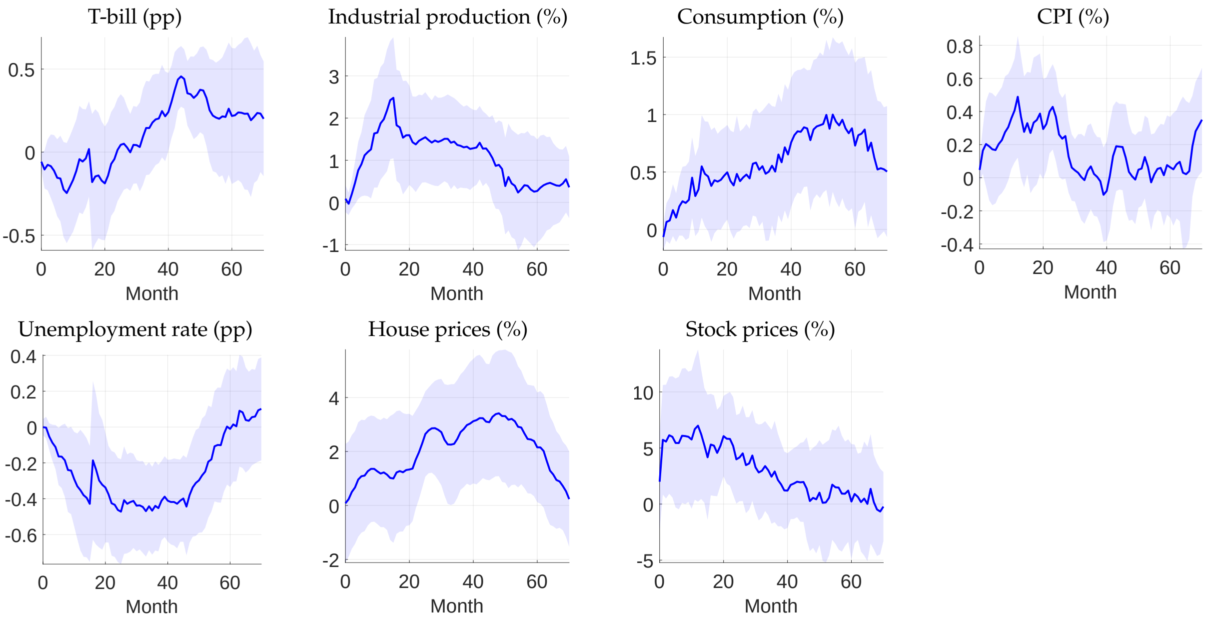


Notes: Quarterly local-projection estimates for 1988Q3–2023Q4. Shaded regions are 90% Newey–West confidence bands. All responses are normalized so that the maximum consumption response over horizons 13–17 quarters equals 1%.

Figure 12 reports robustness exercises: 12-month growth over the 1998-2019 window, 4-quarter growth over the longer sample 1954-2025, 12-month growth for the post-Covid period, and business cycle fluctuations measured by the log deviation from trend.[19] Figure 13 reports the standard Euler equation fit for the 1998-2019 cycle using the Wu–Xia (2016) shadow rate and the 3-Month Treasury bill as measures of the real interest rate. Table 3 reports the correlation and RMSE of all exercises. Table 4 reports summary statistics for the asset-price, consumption, and wealth–consumption-ratio series entering these exercises.

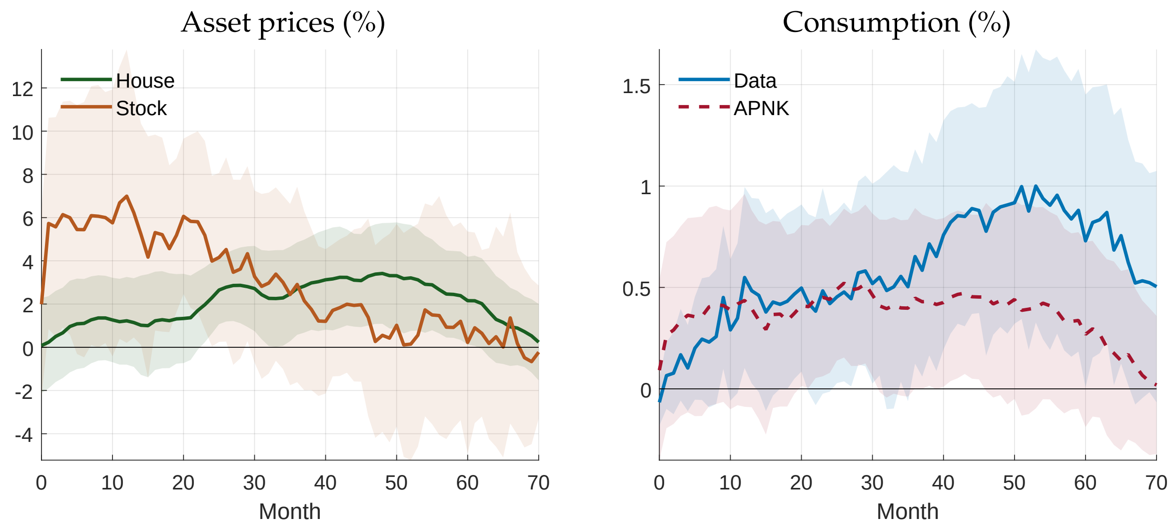
[19]The trend for consumption, stock prices, house prices, stock wealth, and housing wealth is obtained by applying an HP filter with $\lambda = 1600$ to each series in log levels. The wealth–consumption ratios are constructed from the corresponding trend levels, $A_t^{S,\text{trend}}/C_t^{\text{trend}}$ and $A_t^{H,\text{trend}}/C_t^{\text{trend}}$.

Figure 9: Monthly Local-Projection Responses to Monetary Policy



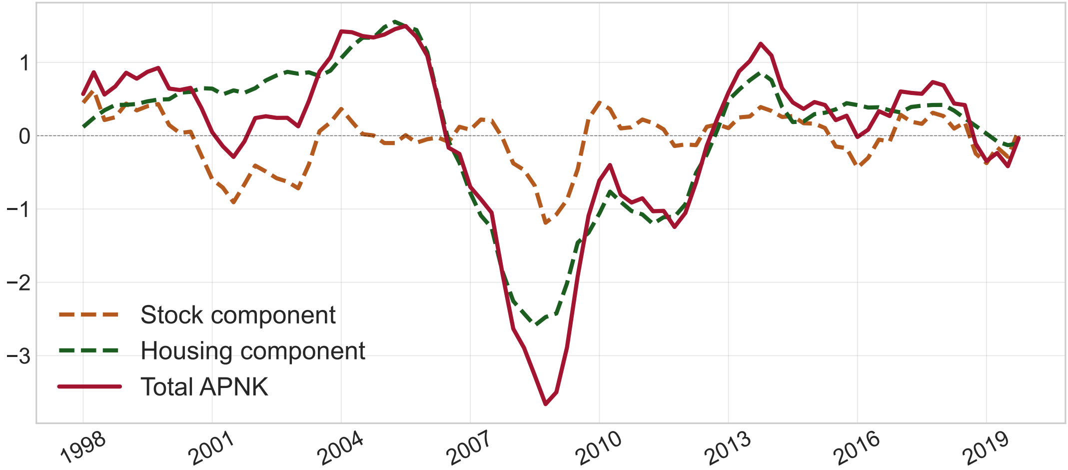
Notes: Monthly local-projection estimates for 1988M05–2023M12 after lag trimming. Shaded regions are 90% Newey–West confidence bands. All responses are normalized so that the maximum absolute consumption response over horizons 44–56 months equals 1%.

Figure 10: Monetary Policy Transmission Through Asset Prices, Monthly



Notes: The left panel shows the estimated monthly responses of stock prices and house prices to the identified monetary policy shock. The right panel compares the estimated consumption response with the APNK prediction.

Figure 11: Decomposition of the Consumption-growth Fit, 1998Q1–2019Q4



Notes: This figure decomposes the APNK consumption-growth prediction in Figure 3 into the stock-price component, the housing-price component, and their sum. Over 1998Q1–2019Q4, the shares of the sum of absolute contributions over time are 41.59% for the stock component and 58.41% for the housing component. At the peak model contraction in 2008Q4, the corresponding shares are 48.35% and 51.65%.

Figure 12: Additional Model-Fit Exercises

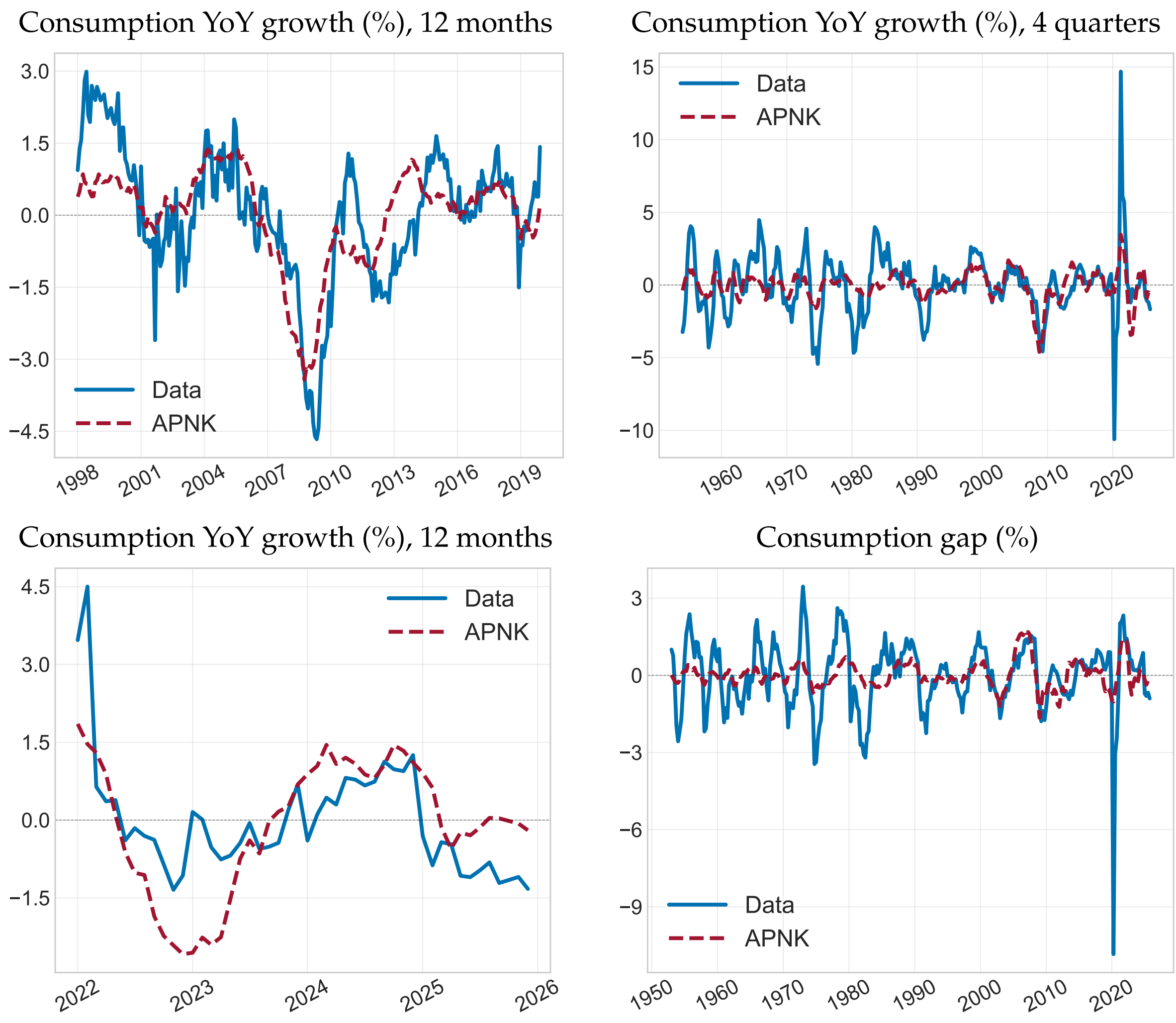
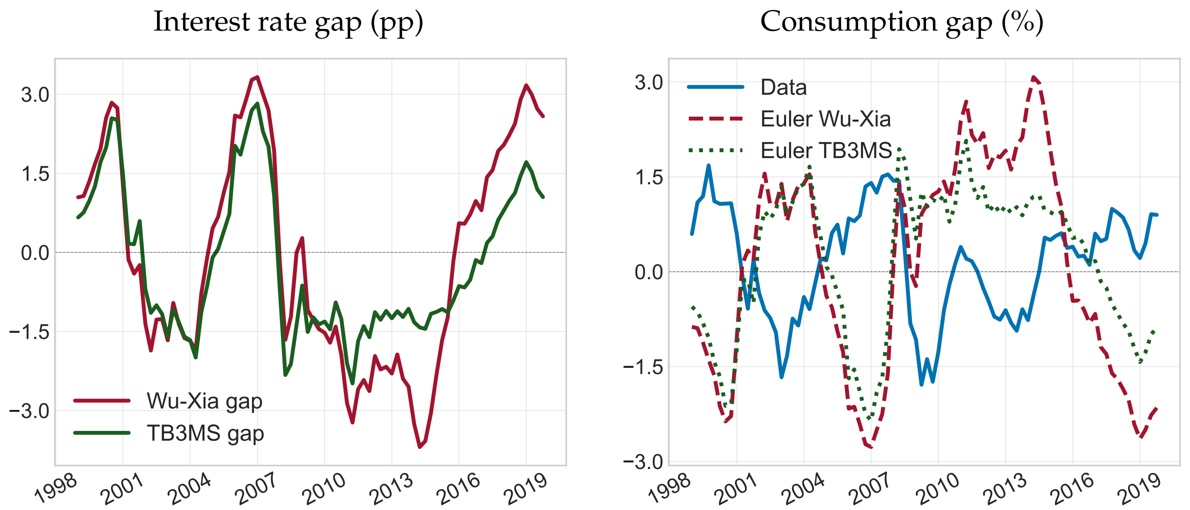


Figure 13: Euler Equation Fit, the 1998-2019 Cycle.



Notes: Left panel: real interest rate deviations from sample means using the Wu–Xia (2016) shadow rate and the 3-Month Treasury bill (TB3MS), both deflated by Michigan Survey inflation expectations. Right panel: actual consumption gap against the Euler predictions $\hat{C}_t = -\sigma \hat{R}_{t+1}/(1-\rho)$, with EIS $\sigma = 1$ and persistence $\rho = 0.7$. Model frequency is quarterly.

Table 3: Model-fit Statistics

Fig.	Exercise	Window	Correlation	Normalized RMSE
2	MP quarterly	1988Q3–2023Q4	0.762	0.843
2	MP quarterly, Euler	1988Q3–2023Q4	-0.907	2.984
2	MP quarterly, Euler habit	1988Q3–2023Q4	-0.542	2.534
10	MP monthly	1988M5–2023M12	0.170	1.334
3	Growth	1998Q1–2019Q4	0.779	0.652
12	Growth	1998M01–2019M12	0.761	0.655
12	Growth	2022M01–2025M12	0.579	0.987
12	Growth	1954Q1–2025Q4	0.547	0.840
12	Gap	1953Q1–2025Q4	0.511	0.859
13	Gap, Euler (Wu-Xia)	1999Q1–2019Q4	-0.645	2.742
13	Gap, Euler (TB3MS)	1999Q1–2019Q4	-0.665	2.158

Notes: The table summarizes how closely the model or benchmark series tracks observed consumption in each exercise. Correlation is the Pearson correlation between the data and model consumption series. Normalized RMSE is $\sqrt{\sum_t (y_t^{data} - y_t^{model})^2/N}/\sigma(y_t^{data})$, where $\sigma(y_t^{data})$ is the sample standard deviation. The quarterly aggregate MPCs used in the APNK mapping are 0.03/4 for stock wealth, 0.05/4 for housing wealth, and 0.2 for income. The monthly aggregate MPCs are 0.03/12 for stock wealth, 0.05/12 for housing wealth, and 0.1 for income.

Table 4: Summary Statistics for the Business-Cycle Model-fit Exercises

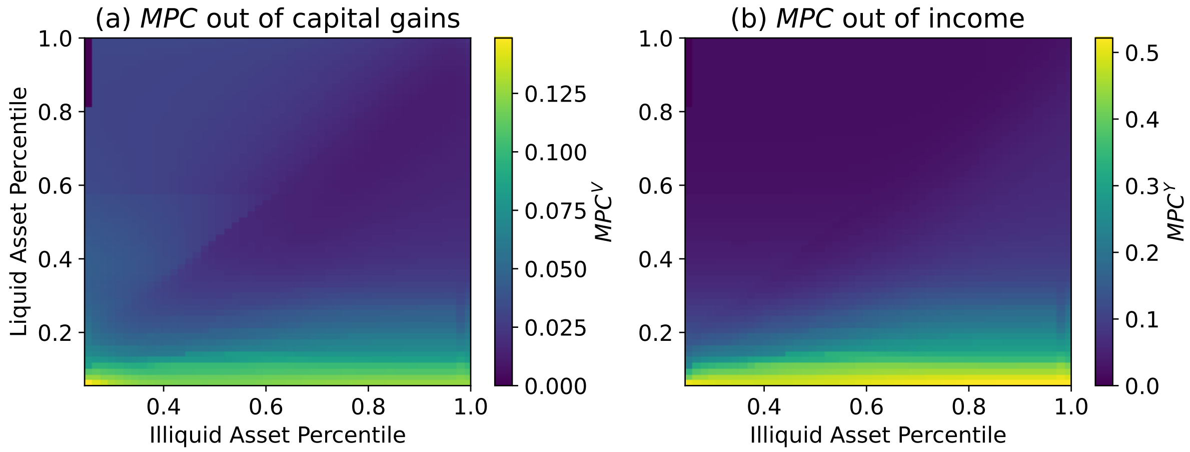
Series	Window	Mean	Standard deviation
Stock price YoY growth 4Q	1998Q1–2019Q4	4.19	15.19
Stock price YoY growth 12M	1998M01–2019M12	4.26	15.57
Stock price YoY growth 12M	2022M01–2025M12	12.19	12.07
Stock price YoY growth 4Q	1954Q1–2025Q4	5.71	15.40
Stock price gap	1953Q1–2025Q4	0.00	9.75
House price YoY growth 4Q	1998Q1–2019Q4	2.44	6.18
House price YoY growth 12M	1998M01–2019M12	2.44	6.17
House price YoY growth 12M	2022M01–2025M12	0.28	2.35
House price YoY growth 4Q	1954Q1–2025Q4	1.40	4.49
House price gap	1953Q1–2025Q4	0.00	2.81
Consumption YoY growth 4Q	1998Q1–2019Q4	1.39	1.37
Consumption YoY growth 12M	1998M01–2019M12	1.39	1.40
Consumption YoY growth 12M	2022M01–2025M12	1.54	0.75
Consumption YoY growth 4Q	1954Q1–2025Q4	1.92	2.17
Consumption gap	1953Q1–2025Q4	0.00	1.35
Stock wealth / consumption	1998Q1–2019Q4	1.28	0.26
Stock wealth / consumption	1998M01–2019M12	1.28	0.26
Stock wealth / consumption	2022M01–2025M12	2.17	0.23
Stock wealth / consumption	1954Q1–2025Q4	1.06	0.48
Stock wealth / consumption	1953Q1–2025Q4	1.07	0.48
Housing wealth / consumption	1998Q1–2019Q4	2.19	0.30
Housing wealth / consumption	1998M01–2019M12	2.18	0.30
Housing wealth / consumption	2022M01–2025M12	2.57	0.08
Housing wealth / consumption	1954Q1–2025Q4	1.94	0.35
Housing wealth / consumption	1953Q1–2025Q4	1.94	0.34

Notes: Each row reports the mean and standard deviation for one series over the indicated sample window. Growth rows are non-demeaned year-over-year growth rates in percent. Gap rows are measured as $100 \times (\log x_t - \log x_t^{\text{trend}})$, where x_t^{trend} is the HP-filter trend from the log level series with $\lambda = 1600$. Wealth-consumption ratios are reported in annualized levels, i.e. wealth relative to annual consumption.

C Details for AP-HANK and Volatility Analysis

This appendix documents quantitative details underlying Section 5 (the AP-HANK model) and Section 6 (the role of MPCs for volatility).

Figure 14: Household's Marginal Propensity to Consume

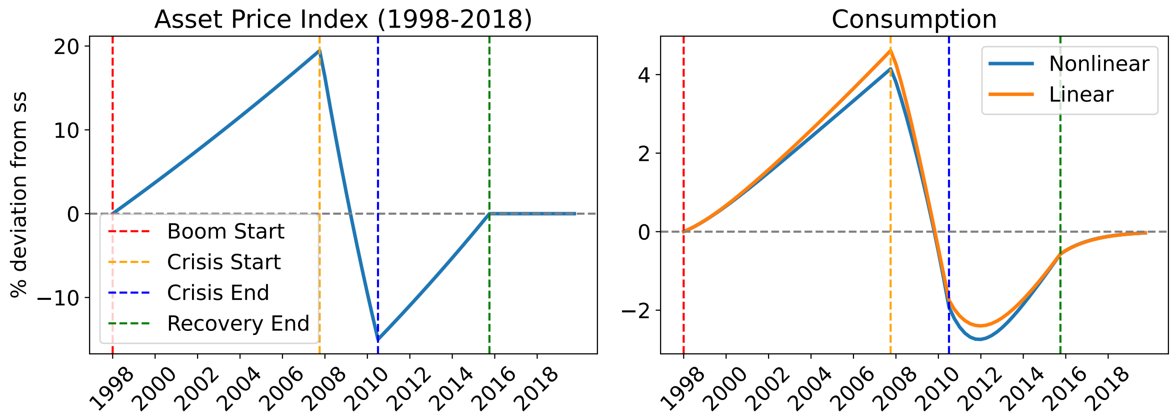


Notes: Household's consumption response to one-unit of unexpected capital gains and windfall income averaged across income states in the AP-HANK model.

Individual MPCs Households' MPCs (averaged across income states) are shown in Figure 14. Households with low liquid wealth and high illiquid wealth (the "wealthy hand-to-mouth") have the highest MPC^Y. They have high MPCs because they hold little liquid wealth to buffer income shocks, while significant illiquid wealth encourages them to shift future consumption to the present. Households with both low liquid and low illiquid wealth also have high MPC^Y; they have limited resources to smooth negative income shocks but expect strong income growth. Households with high liquid wealth and low illiquid wealth have the lowest MPC^Y, as they can smooth consumption using liquid assets. For MPC^A, the relationship with illiquid wealth is reversed: households with low illiquid wealth have higher MPC^A, since capital gains on liquid assets are immediately available for spending, while gains on illiquid assets are less accessible. Overall, the model generates a realistic pattern of heterogeneous MPCs across household types, consistent with the empirical evidence.

Wealth taxation Figure 16 plots optimal next-period liquid (blue) and illiquid (orange) assets against cash on hand for low, median, and high income groups: baseline (no tax), 1% tax rate on illiquid wealth above \$3 million, and 2% tax rate (same \$3 million threshold). Taxing illiquid assets weakens the motive to lock wealth in illiquid form. Households respond by raising liquid savings and scaling back illiquid accumulation. The reallocation is largest for low and median income households, consistent with a

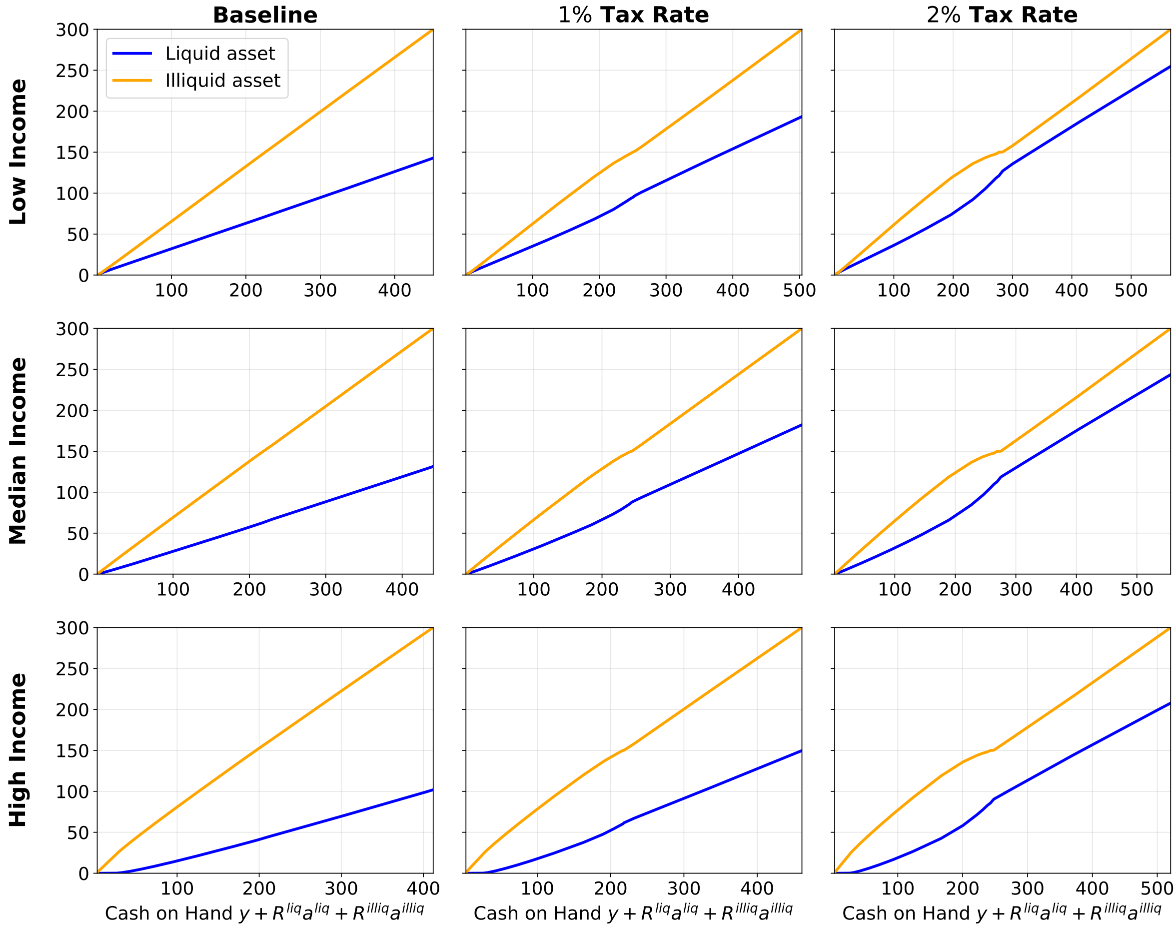
Figure 15: Linear vs Nonlinear Responses to the Great-Recession Asset-Price Shock



Notes: Comparison of linearized and nonlinear model responses to the Great-Recession Asset-Price Shock. The model is solved linearly with sequence-space jacobian and nonlinearly by policy function iteration.

higher marginal value of liquidity under tighter constraints. Increasing the tax rate amplifies these effects. The high tax-rate regime (last column) reveals clear concavity in the illiquid policy function around where taxable illiquid wealth is reached. Below this threshold, the illiquid schedule is relatively flat and locally inactive: households keep illiquid holdings near the maximum and adjust savings primarily through the liquid asset. Once cash on hand is high enough to cross the tax threshold, the slope of the illiquid policy increases but remains below the Baseline slope, due to the after-tax return wedge. The liquid policy correspondingly steepens around the threshold as households substitute toward liquidity when the illiquid tax bites.

Figure 16: Policy function under Wealth Tax vs Baseline



Notes: Policy functions under the wealth tax versus baseline. There is no wealth tax in the baseline. The tax rate of the wealth tax in the main text (second column) is 1% annually on illiquid wealth over $3 million. The third column shows a high tax-rate scenario, where the tax rate is 2% annually.