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 U.S. consumption during the 1998–2018 boom-bust cycle. The framework's first contribution is to offer 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). Second, 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. Third, 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 prices. 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 assume that agents misperceive aggregate as idiosyncratic asset price movements due to information frictions, 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

[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) show that agents naively extrapolate personal experiences with their own asset returns when forming aggregate expectations.

[2] Conditional on such 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.

calibrated to empirical estimates and the model driven by realized asset prices, it closely tracks U.S. consumption over the 1998–2018 boom-bust 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 actual consumption in "real time" without relying on unobservable demand disturbances (preference/risk-premium shocks), which are effectively residuals. 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 feeds 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 $0.01 - 0.06$, 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 $\hat{P} = 4\% - 9\%$, so the consumption response in percentage is

$$\hat{C} = \frac{\text{MPC}^A}{1 - \text{MPC}^Y} \frac{A}{C} \hat{P} = \frac{0.03}{1 - 0.5} \times 3.5 \times 6\% = 1.26\%. \tag{1}$$

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]

[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 4.2 provides an estimation taking into account housing wealth and household heterogeneity, and the estimated consumption response is 0.97%. For estimates of MPC^A 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), and Paiella and Pistaferri (2017). For MPC^A 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 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), and 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.

The paper's first contribution is to offer a unified mechanism 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 its strength is governed by risk aversion, and house prices influence demand through the substitution between consumption and housing services. Under information frictions, these shocks operate through a unified 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.

Having established the causality betweeen consumption and asset prices, the second contribution is to provide 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, consumption depends explicitly on asset valuations, so policies that move asset prices transmit to spending via wealth effects. The framework replaces the Taylor rule on nominal interest rates with an *Asset-Price Taylor Rule* which links asset prices to macroeconomic conditions and discount rate shocks. Under conventional policy, it is equivalent to a rule targeting long-term real interest rates. Under unconventional policy, it becomes a structural representation of balance-sheet tools.

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 1998–2018 period. The correlation between model-predicted and actual consumption is 0.80 for the 1998–2018 period and 0.51 for the full 1959–2025 sample. 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.

The paper's third 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 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.

[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 model due to Ricardian equivalence. Such shocks are inherently redistributive and transmit via MPC heterogeneity.

[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.

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 evidence on biased 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 (Fagereng et al. 2022), as it operates under complete markets and without reallocation of resources.

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 during 1998–2018.

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 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 standard full-information rational-expectation models do not generate wealth effects from asset price movements. Section 3 develops and evaluates the framework with a representative agent. 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.

[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 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).

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.

Households. The representative agent households solve the following problem:

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

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 $R_t^v \equiv (P_t + D_t)/P_{t-1}$ and $A_{t-1} \equiv P_{t-1} V_{t-1}$. The household budget constraint can also be written as

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

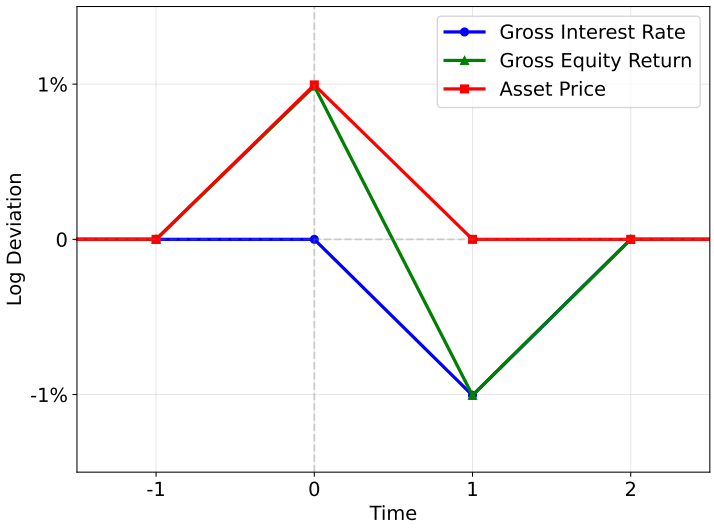
Firms. A competitive final-good firm produces a final good from intermediate goods, indexed by j, according to the production function $Y_t = \left(\int y_{j,t}^{1/\mu^p} dj \right)^{\mu^p}$. The intermediate goods are produced by monopolistic competitive firms using labor as the only input with linear 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

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

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



where π_t is inflation. 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.

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 $V_t = 1$, and the bond market clears with $B_t = 0$. In financial markets, equity is priced by the no-arbitrage condition $\mathbb{E}_t R^v_{t+1} = R_{t+1}$.

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 $\mathbb{E}_0 R^v_1 = (P_* + D_*)/P_0 = R_1 < R_*$. 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 $R^v_0 = (P_0 + D_*)/P_* > R_*$.

Missing Wealth Effects. The one-time asset price shock has three effects: (i) realized income effect, which make households richer in proportion to their equity holdings at the beginning of time 0 due to the higher realized return; (ii) expected income effect, which makes agents poorer overall because the future return on savings falls; 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.[8]

Although there are capital gains at time 0 ($R_0^v > R_*$), the presence of wealth effects is not immediate because the expected return on savings falls ($\mathbb{E}_0 R_1^v = R_1 < R_*$). 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:

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

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

$$P_{j0} = \frac{\mathbb{E}_0 \left[P_{j1} + D_{j1} \right]}{R_1}.$$

[8] 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.

By no-arbitrage, the expected return on any stock or portfolio equals the market return:

$$\mathbb{E}_0 R_{j1}^v \equiv \frac{\mathbb{E}_0\left[P_{j1} + D_{j1}\right]}{P_{j0}} = \mathbb{E}_0 R_1^v = R_1, \quad \forall j.$$

At time $t = 0$, news about future dividends D_{j1} arrives, generating an idiosyncratic shock to the time-0 stock price P_{j0} and the realized return R_{j0}^v. If an agent's portfolio differs from the market portfolio, their time-0 realized return may outperform or underperform the market. Importantly, such a shock does not affect the expected return at time $t = 1$: the market already incorporates the new information so the expected return of any portfolio equals the market return R_1. Thus, both the expected income effect and the intertemporal substitution effect are absent and only the realized income effect remains.

Under market efficiency, idiosyncratic return shocks are unpredictable. The mechanism of realized income effects holds regardless of the shock source. For instance, if the news is about future return volatility of stock j, agents will adjust the portfolio carried forward according to their original risk preferences. But the realized capital gains/losses can not be avoided. The consumption response is driven not by a shock to future return or consumption risks, but by the realized income effect.

The economic interpretation of wealth 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 wealth effects. Consequently, any co-movement of consumption and idiosyncratic asset prices must be driven by income (net of substitution) effects.

I assume market efficiency throughout this paper, which implies constant rather than extrapolative expectations for idiosyncratic returns. This assumption simplifies the dynamic household problem in the next section and facilitates the empirical analysis. I do not need to track the expectation about past returns and distinguish between the MPC out of persistent or transitory idiosyncratic return shocks. Empirically-estimated MPC out of capital gains, identified from cross-sectional return variation, may reflect a mix of forces depending on agents' beliefs about the dynamics of idiosyncratic asset price shocks. For quantitative analysis, I treat this MPC as a sufficient statistic for spending response to perceived wealth shocks. Therefore, the assumption of market efficiency is without loss of generality for the quantitative results.

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 and aggregate dividend shocks.

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.[9]

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. 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 and compares it with the standard New Keynesian model.

3.1 Model Description and Equilibrium Characterization

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

$$\hat{P}_t = \rho\, \hat{P}_{t-1} + \epsilon_t, \text{ with } \epsilon_t \sim \mathcal{N}(0, \sigma_\epsilon^2), \tag{7}$$

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

Within the representative household, there is a continuum of agents $i \in I$ who hold shares v_{it-1} at the beginning of period t, with $\int v_{it-1}\, di = 1$. Agent i observes the value of its (pre-return) wealth $a_{it-1} = P_{t-1} v_{it-1}$, but not the separate components of P_{t-1} and v_{it-1}. Following the realization of asset price shocks, agent i also observes

[9] 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).

its after-return wealth $P_t s_{it} v_{it-1}$. The price of its portfolio is subject to an idiosyncratic asset-price shock s_{it} that is i.i.d. across agents:

$$s_{it} = \frac{e^{\epsilon^s_{it}}}{\int e^{\epsilon^s_{it}} di}, \qquad \epsilon^s_{it} \sim \mathcal{N}(0, \sigma^2_{\epsilon^s}), \qquad \epsilon^s_{it} \perp \epsilon_t \perp v_{it-1}. \tag{8}$$

Since consumption and labor supply are determined by the representative household and are homogeneous across agents (see below), in equilibrium the individual wealth share evolution is exogenous. Defining $v_{it} = s_{it} v_{it-1}$ as the time-t effective share, agent i will carry savings $a_{it} = P_t v_{it}$ into the next period $t+1$.

Agents cannot perfectly distinguish whether revaluations of their wealth reflect the aggregate term P_t or the idiosyncratic term s_{it}. They form expectations about P_t based on observables $a_{it-1} = P_{t-1} v_{it-1}$ and $P_t s_{it} v_{it-1}$. Write the state-space system as

$$\hat{P}_t = \rho \, \hat{P}_{t-1} + \epsilon_t, \qquad \text{(transition)} \tag{9}$$

$$x_{it} = \log\left(\frac{P_t s_{it} v_{it-1}}{a_{it-1}}\right) = \hat{P}_t - \hat{P}_{t-1} + \epsilon^s_{it} + \text{Const}, \qquad \text{(observation)} \tag{10}$$

The Kalman filter implies

$$\mathbb{E}^f_{it} \hat{P}_t \equiv \mathbb{E}\left[\hat{P}_t \,\middle|\, x^t_i\right] = \rho \, \mathbb{E}^f_{it-1} \hat{P}_{t-1} + K_t \left(\hat{P}_t - \hat{P}_{t-1} + \epsilon^s_{it} - (\rho - 1) \mathbb{E}^f_{it-1} \hat{P}_{t-1}\right), \tag{11}$$

where $\mathbb{E}^f$ is the expectation operator under information frictions, x^t_i denotes the history of observations, and K_t is the Kalman gain. In the steady state, K_t converges to a constant K, which depends on the steady-state prior and innovation variances determined by the system's Riccati equations. Aggregating expectations across agents yields

$$\mathbb{E}^f_t \hat{P}_t \equiv \int \mathbb{E}^f_{it} \hat{P}_t \, di = \rho \, \mathbb{E}^f_{t-1} \hat{P}_{t-1} + K \left(\hat{P}_t - \hat{P}_{t-1} - (\rho - 1) \mathbb{E}^f_{t-1} \hat{P}_{t-1}\right). \tag{12}$$

When $K = 1$, $\mathbb{E}^f_t \hat{P}_t = \hat{P}_t$ for all t and agents have full information about aggregate asset prices; when $K = 0$, all innovations to aggregate asset prices are perceived as idiosyncratic shocks. The solution to the signal extraction problem implies the forecast error follows an AR(1) process:

$$\hat{P}_t - \mathbb{E}^f_t \hat{P}_t = \lambda (\hat{P}_{t-1} - \mathbb{E}^f_{t-1} \hat{P}_{t-1}) + (1 - K) \epsilon_t, \quad \text{with } \lambda = \rho(1 - K) + K. \tag{13}$$

Household Problem. The representative-agent household first collects expectations about asset prices across agents. Then the continuum of agents pools individual wealth $\int P_t s_{it} v_{it-1} \, di = P_t V_{t-1}$, and the representative household makes consumption-labor-

saving decisions subject to the perceived aggregate budget constraint:

$$C_t + \mathbb{E}_t^f P_t \cdot \mathbb{E}_t^f V_t = \mathbb{E}_t^f P_t \cdot \left(\frac{P_t}{\mathbb{E}_t^f P_t} \frac{V_{t-1}}{\mathbb{E}_t^f V_{t-1}} \right) \cdot \mathbb{E}_t^f V_{t-1} + Y_t. \tag{14}$$

I assume that the household always observes its contemporaneous labor and dividend income $Y_t = D_t V_{t-1} + W_t N_t$.[10] This ensures that the budget constraint is not violated given the observed after-return wealth $P_t V_{t-1}$ and income Y_t. Market clearing implies $C_t = Y_t$ and $\mathbb{E}_t^f P_t \cdot \mathbb{E}_t^f V_t = P_t$. At the end of the period, the household returns wealth $P_t s_{it} v_{it-1} = P_t v_{it}$ to agent i.

The right-hand term in parentheses is the perceived wealth shock at the aggregate level, which can be decomposed as

$$\log \left(\frac{P_t}{\mathbb{E}_t^f P_t} \frac{V_{t-1}}{\mathbb{E}_t^f V_{t-1}} \right) = \left(\hat{P}_t - \mathbb{E}_t^f \hat{P}_t \right) + \left(\mathbb{E}_t^f \hat{P}_{t-1} - \hat{P}_{t-1} \right), \tag{15}$$

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 $\mathbb{E}_t^f \hat{P}_{t-1} - \hat{P}_{t-1}$ by construction offsets the effects of the misperceived aggregate shares $E_t^f V_{t-1} = A_{t-1} / E_t^f P_{t-1}$ on available resources. When the perceived aggregate share is higher than the actual share $E_t^f V_{t-1} > 1$ due to underestimation of the previous price $\mathbb{E}_t^f \hat{P}_{t-1} < \hat{P}_{t-1}$, the realized return is lower than expected, and the household rationalizes the low return with a negative wealth shock $\mathbb{E}_t^f \hat{P}_{t-1} - \hat{P}_{t-1} < 0$.

Below, I simplify the household problem. First, because the idiosyncratic asset price shock is i.i.d., agents' decisions are indifferent to whether the misperception is about prices/returns, which can be persistent, or about existing shares, which affects consumption as a one-time shock. The second term in the perceived wealth shock and the perceived shares can be consolidated into a constant, $V_{t-1} = 1$. The contemporaneous misperception, $\hat{P}_t - \mathbb{E}_t^f \hat{P}_t$, pins down household decisions, and we can use one MPC to characterize the consumption response.

Second, in general, the correctly perceived 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 $\mu \in [0, 1]$, which allows me to derive a simple Euler equation later. This assumption is exact in two limiting cases. First, when the aggregate asset-price process becomes a random walk ($\rho \to 1$), the Kalman filter implies $\lambda \to 1$ and $\mu_t = K$ remains constant. Second, the constant fraction arises in a static signal extraction setup where agents have no memory of past observations. Agents directly observe v_{it-1} and the contemporaneous signal $P_t s_{it}$. In this case, $\mu = \sigma_{\hat{p}}^2 / (\sigma_{\hat{p}}^2 + \sigma_{\epsilon^s}^2)$ by

[10] In principle, the household can also formulate $\mathbb{E}_t^f V_{t-1}$ from the observed dividend income $D_t V_{t-1}$. Inferring from dividends complicates the analysis without adding much insight. I assume that the consumption-labor decision is made after collecting expectations and pooling individual wealth.

standard normal updating where $\sigma_{\hat{p}}^2$ derives from the unconditional prior about $\hat{P}_t$. Away from these limits, a time-varying μ_t simply implies a time-varying decomposition of wealth versus substitution effects.

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 wealth effects (MPC^A). The equilibrium consumption response is the sum of the two parts

$$\hat{C}_t = \hat{C}_t^{subs} + \hat{C}_t^{wealth} = \underbrace{-\sigma \mathbb{E}_t^f \sum_{i=1}^{\infty} \beta^i \hat{R}_{t+i} + \text{MPC}^Y \mathbb{E}_t^f \sum_{i=0}^{\infty} \beta^i \hat{Y}_{t+i}^{subs}}_{= \hat{C}_t^{subs}\text{, intertemporal substitution channel}} \tag{16}$$

$$\underbrace{+ \text{MPC}^A (\hat{P}_t - \mathbb{E}_t^f \hat{P}_t) \frac{A_*}{C_*} + \text{MPC}^Y \hat{Y}_t^{wealth} + \text{MPC}^Y \frac{E_*}{Y_*} \mathbb{E}_t^f \sum_{i=1}^{\infty} \beta^i \hat{E}_{t+i}^{wealth}}_{= \hat{C}_t^{wealth}\text{, wealth channel}}, \tag{17}$$

with $\text{MPC}^Y \equiv 1 - \beta$ and $\mathbb{E}_t = W_t N_t$ denoting labor income (earnings). 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 $\hat{C}_t^{subs}$:

$$\hat{C}_t^{subs} = -\sigma \mathbb{E}_t^f \hat{R}_{t+1} - \sigma \mathbb{E}_t^f \sum_{i=2}^{\infty} \beta^{i-1} \hat{R}_{t+i} + \text{MPC}^Y \mathbb{E}_t^f \sum_{i=1}^{\infty} \beta^{i-1} \hat{Y}_{t+i}^{subs}. \tag{18}$$

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 (18) 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 perceived dividends. However, there are no restrictions on perceived future labor income $\mathbb{E}_t^f \hat{E}_{t+i}^{wealth}$. A natural assumption is that the equilibrium

[11] I allow MPC^A to differ from MPC^Y. With exogenous 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.

response of aggregate labor income $\hat{E}_t^{wealth}$ to the perceived idiosyncratic asset price 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 Introduction, the magnitude of consumption response to monetary policy already fits the data well without income expectation persistences. In this paper, I simply assume this income shock is (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 $\hat{C}_t^{wealth}$:

$$\hat{C}_t^{wealth} = \sigma^{wealth}(\hat{P}_t - \mathbb{E}_t^f \hat{P}_t), \quad \text{with } \sigma^{wealth} = \frac{\text{MPC}^A}{1-\text{MPC}^Y}\frac{A_*}{C_*}. \tag{19}$$

Sum these two parts, the equilibirum consumption response is

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

Asset-Price Euler Equation. To derive the Euler Equation, I impose the approximation $\hat{P}_t = -\hat{R}_{t+1} + \mathbb{E}_t \hat{P}_{t+1}$ 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

$$\hat{C}_t = \left(\mu\sigma + (1-\mu)\sigma^{wealth}\right)\hat{P}_t. \tag{21}$$

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

$$\hat{C}_t - \mathbb{E}_t \hat{C}_{t+1} = -\left(\mu\sigma + (1-\mu)\sigma^{wealth}\right)\hat{R}_{t+1}. \tag{22}$$

We have the Asset-Price Euler Equation.

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

$$\hat{C}_t = -\sigma^{macro}\hat{R}_{t+1} + \mathbb{E}_t \hat{C}_{t+1}, \text{ with } \sigma^{macro} = \mu\sigma + (1-\mu)\sigma^{wealth}. \tag{23}$$

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

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

$$\hat{P}_t = -\hat{R}_{t+1} + \mathbb{E}_t \hat{P}_{t+1}\frac{P_*}{P_*+D_*} + \mathbb{E}_t \hat{D}_{t+1}\frac{D_*}{P_*+D_*} = -\hat{R}_{t+1} + \mathbb{E}_t \hat{P}_{t+1}\frac{1}{R_*} + \mathbb{E}_t \hat{D}_{t+1}(1-\frac{1}{R_*}). \tag{20}$$

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.

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. As shown in the Introduction, set $\mu = 0$ and substitute micro estimates of MPCs, aggregate wealth—consumption ratio, empirical elasticities of asset prices to interest rates, we obtain a plausible macro-level EIS.

3.2 Extensions

This section extends the analysis in two directions: introducing aggregate uncertainty and incorporating housing assets. These extensions demonstrate the framework's flexibility in capturing wealth effects arising from distinct classes of assets and alternative sources of asset price fluctuations.

3.2.1 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 housing services H_t:

$$\max_{\{C_t, H_t, B_t\}_{t\geq 0}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-1/\sigma}}{1-1/\sigma} + \psi \frac{H_t^{1-1/\eta}}{1-1/\eta} \right], \tag{24}$$

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

$$C_t + P_t^H H_t + B_t = R_t B_{t-1} + P_t^H H_{t-1} + Y_t, \tag{25}$$

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:

$$P_t^H C_t^{-1/\sigma} = \psi H_t^{-1/\eta} + \beta \mathbb{E}_t \left[P_{t+1}^H C_{t+1}^{-1/\sigma} \right] = \psi H_t^{-1/\eta} + \mathbb{E}_t \sum_{i=1}^{\infty} \beta^i \left[\psi H_{t+i}^{-1/\eta} \right]. \tag{26}$$

The right-hand side is the present value of the flow of housing services provided by one unit of housing. In addition to the intertemporal substitution channel (housing

as a saving device), house prices also affect consumption through the intratemporal substitution between housing services and non-durable consumption. Combining the housing FOC with the Euler equation for bonds,

$$P_t^H = \underbrace{\frac{\psi H_t^{-1/\eta}}{C_t^{-1/\sigma}}}_{\equiv \text{rent}_t} + \frac{\mathbb{E}_t P_{t+1}^H}{R_{t+1}} = \frac{\psi H_t^{-1/\eta} / \beta \mathbb{E}_t[C_{t+1}^{-1/\sigma}]}{R_{t+1}} + \frac{\mathbb{E}_t P_{t+1}^H}{R_{t+1}}. \tag{27}$$

That is, today's house price equals the current implicit rent plus the discounted expected house price tomorrow. A one-time unexpected interest rate shock that lowers R_1 and raises P_0^H creates no net wealth. This shock (i) raises the implicit rents today and (ii) lowers the expected return on housing wealth $E_0 P_1^H / P_0^H = P_*^H / P_0^H$, together offsetting the higher revaluation $dP_0^H H_{-1}$.[13] The original allocation $\{C_*, H_*\}$ satisfies the budget constraint exactly under the new price.

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

$$C_t + \mathbb{E}_t^f P_t^H \cdot \mathbb{E}_t^f H_t + B_t = R_t B_{t-1} + \mathbb{E}_t^f P_t^H \frac{P_t^H}{\mathbb{E}_t^f P_t^H} H_{t-1} + Y_t. \tag{28}$$

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 (26) gives $\hat{C}_t = \sigma \hat{P}_t^H$, thus

$$\hat{C}_t^{\text{subs}} = \sigma \mathbb{E}_t^f \hat{P}_t^H = \mu\sigma \hat{P}_t^H, \tag{29}$$

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

$$\hat{C}_t^{\text{wealth}} = \sigma_H^{wealth}\left(\hat{P}_t^H - \mathbb{E}_t^f \hat{P}_t^H\right) = (1-\mu)\sigma_H^{wealth} \hat{P}_t^H, \quad \sigma_H^{wealth} = \frac{\text{MPC}^H}{1 - \text{MPC}^Y} \frac{A_*^H}{C_*}. \tag{30}$$

Adding both components, equilibrium consumption is

$$\hat{C}_t = \left(\mu\sigma + (1-\mu)\sigma_H^{wealth}\right) \hat{P}_t^H. \tag{31}$$

[13] For a permanent house price shock, as considered in Berger et al. (2018), only the channel of higher rental cost operates.

3.2.2 Aggregate Uncertainty

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

$$\hat{C}_t = \mathbb{E}_t \hat{C}_{t+1} - \frac{1}{\gamma}\hat{R}_{t+1} - \frac{\gamma}{2}\operatorname{Var}_t(\Delta\hat{C}_{t+1}). \tag{32}$$

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,

$$1 = \mathbb{E}_t\left[M_{t+1}R^v_{t+1}\right], \qquad M_{t+1} = \beta\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}, \tag{33}$$

implies, under the same log-normal approximation,

$$\mathbb{E}_t\hat{R}^v_{t+1} - \hat{R}_{t+1} = -\operatorname{Cov}_t(\hat{M}_{t+1}, \hat{R}^v_{t+1}) = \gamma\operatorname{Cov}_t(\Delta\hat{C}_{t+1}, \hat{R}^v_{t+1}), \tag{34}$$

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:

$$\sigma^2_{\epsilon^R,t} - \sigma^2_{\epsilon^R,*} = \epsilon^{\text{risk}}_t, \tag{35}$$

and there is a one-to-one pass-through from fundamental interest-rate volatility to the variance of $t+1$ consumption. Below, I impose $\hat{R}_{t+1} = 0$ 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

$$\hat{C}_t = -\frac{\gamma}{2}\left(\sigma^2_{\epsilon^R,t} - \sigma^2_{\epsilon^R,*}\right). \tag{36}$$

Let $\mathcal{R}^v_C = \operatorname{Cov}_t(\Delta\hat{C}_{t+1}, \hat{R}^v_{t+1})/\operatorname{Var}_t(\Delta\hat{C}_{t+1})$ denote the exposure of equity returns to consumption (the quantity of risk) at $t+1$.[14] With $\hat{R}_{t+1} = 0$,

$$\mathbb{E}_t\hat{R}^v_{t+1} = \gamma\mathcal{R}^v_C\left(\sigma^2_{\epsilon^R,t} - \sigma^2_{\epsilon^R,*}\right), \quad \hat{P}_t = -\mathbb{E}_t\hat{R}^v_{t+1} = -\gamma\mathcal{R}^v_C\left(\sigma^2_{\epsilon^R,t} - \sigma^2_{\epsilon^R,*}\right). \tag{37}$$

[14] 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 $\mathcal{R}^v_C = 1/\sigma^{macro}$.

So an increase in uncertainty lowers both current consumption, through precautionary saving, and equity valuations, through higher required risk premia. The co-movement of asset prices and consumption is not casual, as they are both the outcome of the risk shock. 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 wealth shock. The consumption response is the sum of the standard precautionary savings effect and the wealth effect:

$$\hat{C}_t = \hat{C}_t^{risk} + \hat{C}_t^{wealth} = \frac{\mathbb{E}_t^f \hat{P}_t}{2\mathcal{R}_C^v} + \frac{\text{MPC}^A}{1-\text{MPC}^Y}\frac{A_*}{C_*}(\hat{P}_t - \mathbb{E}_t^f \hat{P}_t). \tag{38}$$

$$= \left(\mu\frac{1}{2\mathcal{R}_C^v} + (1-\mu)\sigma^{wealth}\right)\hat{P}_t. \tag{39}$$

To obtain $\hat{C}_t^{risk}$ from equation (36), I use the asset price response (37) to substitute the unobservable risk shock with the observable price. 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 Asset-Price Euler Equation:

$$\hat{C}_t = \mathbb{E}_t\hat{C}_{t+1} - \frac{\gamma^{macro}}{2}(\sigma^2_{\epsilon^R,t} - \sigma^2_{\epsilon^R,*}), \quad \gamma^{macro} = \mu\gamma + 2(1-\mu)\gamma\mathcal{R}_C^v\sigma^{wealth}. \tag{40}$$

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

3.3 Four-Equation New Keynesian Model

In the presence of information frictions, the policy and shock's transmission to consumption relates to how much they move equilibrium asset prices. Therefore, I explicitly incorporate asset prices into the system. I abstract from preference shocks.

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

$$\hat{C}_t = \sigma^{wealth}\hat{P}_t \tag{41}$$

$$\pi_t = \kappa(mc_t - 1/\mu^p) + \beta\mathbb{E}_t\pi_{t+1} \tag{42}$$

$$\hat{P}_t = -\hat{R}_{t+1} + \mathbb{E}_t\hat{P}_{t+1} + v_t^P \tag{43}$$

$$i_t = i_* + \phi_\pi^i\pi_t + v_t^i \tag{44}$$

The disturbance v_t^P captures discount-rate shocks other than interest rates and maps to the shock to equity premia $\mathbb{E}_t\hat{R}_{t+1}^v - \hat{R}_{t+1}$. News about future fundamentals (levels,

volatility), or sentiment, can be easily incorporated into the model as components of v_t^P. The disturbance v_t^i is the standard monetary policy shock. Different from the standard model, the realized asset price is a sufficient statistic for all shocks regardless of their sources.

For balance-sheet policies, the central bank directly intervenes in financial markets, making the asset-price a more relevant policy variable. We can replace equation (43) and (44) with an *Asset-Price Taylor rule*

$$\hat{P}_t = \phi_\pi^P \pi_t + v_t^P. \tag{45}$$

The interpretation is direct: quantitative easing/tightening moves asset valuations in response to macro conditions (π_t). The central bank has imperfect control over asset prices due to financial market volatility embeded in v_t^P.

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 $\mathbb{E}_t^f R_{t+1}^v \neq \mathbb{E}_t R_{t+1}^v$). Consequently, one must solve for the perceived SDF and asset prices jointly. Combining the Euler equation with the budget constraint under information frictions:

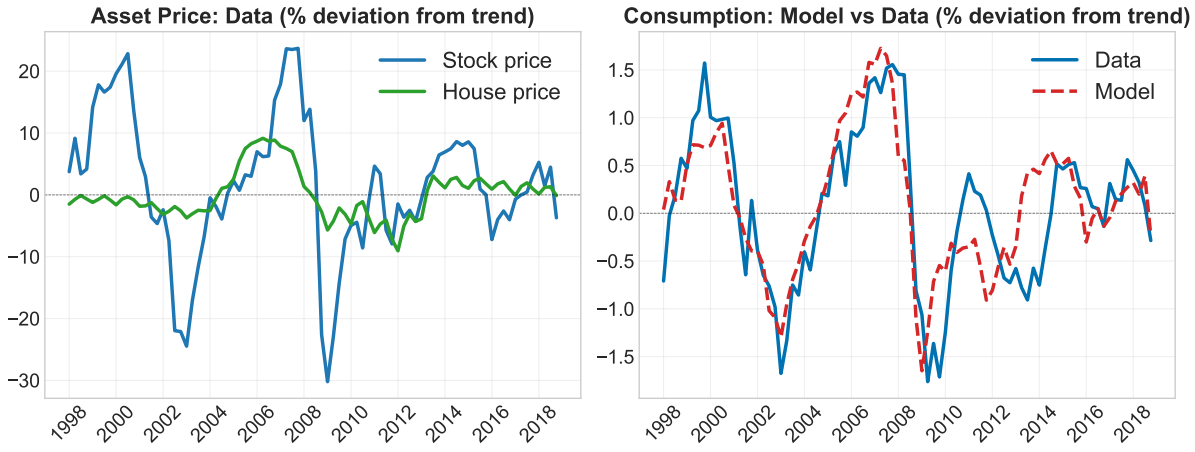
$$\mathbb{E}_t^f [M_{t+1} R_{t+1}^v] = 1, \text{ with } M_{t+1} = \beta \left(\frac{C_{t+1}}{C_t} \right)^{-1/\sigma} \tag{46}$$

$$C_t + \mathbb{E}_t^f P_t \cdot \mathbb{E}_t^f V_t = \mathbb{E}_t^f P_t \, \frac{P_t}{\mathbb{E}_t^f P_t} \, V_{t-1} + Y_t, \tag{47}$$

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. Here, agents are insensitive to changes in interest rates, and 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 anticipated future consumption such that the perceived marginal rate of substitution aligns with return expectations.

Figure 2: APNK Model Fit 1998Q1–2018Q4



Notes: Correlation between data and model-predicted consumption: 0.802. Left: S&P 500 and Case-Shiller U.S. National Home Price Index. Right: Actual consumption (solid blue) and APNK model prediction (dashed red) using equation (48). Data sources: Shiller (stock/housing prices); FRED (PCEC, HNOCEA, BOGZ1LM653064155Q, HNOREMV). All series are converted to per capita real terms.

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 proposed mechanism only pins down asset prices, not interest rates, with consumption. 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.

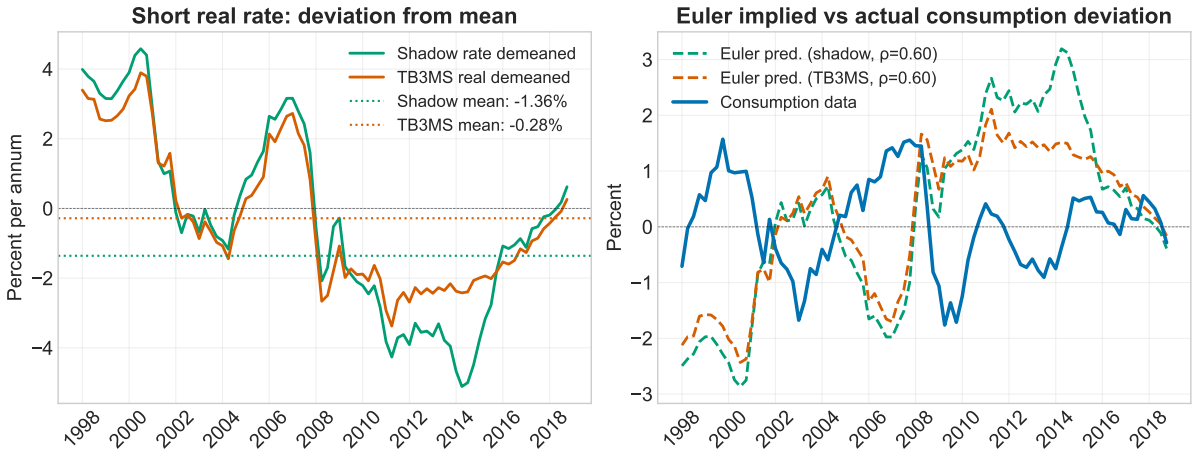
4 Model Validation

This section validates the proposed mechanism with data. Section 4.1 applies the model to the 1998–2018 boom-bust cycle. Section 4.2 discusses the implications of wealth effects on heterogeneous consumption responses to monetary policy.

4.1 The 1998–2018 Boom-Bust Cycle

I apply the model to the period of 1998–2018 and show that it delivers a tight empirical fit. To focus on the proposed mechanism, I set $\mu = 0$ throughout this paper. From the above extensions we can see that, under $\mu = 0$ and driven by realized asset prices, the consumption dynamics reflect all shocks moving equilibrium asset prices

Figure 3: Simple Euler Equation Prediction



Notes: *Left panel:* Real interest rate deviations from sample means, using the Wu–Xia (2016) shadow rate and 3-month Treasury bill (TB3MS) deflated by Michigan Survey inflation expectations. *Right panel:* Actual consumption gap vs. standard Euler equation prediction $\hat{C}_t = -\sigma \hat{R}_t/(1-\rho)$, with persistence $\rho = 0.6$ and $\sigma = 1$.

(except shocks to preferences), not only interest rates.

I distinguish between stock wealth (S) and housing wealth (H). The equilibrium consumption is given by

$$\hat{C}_t = \frac{\text{MPC}^S}{1-\text{MPC}^Y}\frac{A^S_*}{C_*}\hat{P}^S_t + \frac{\text{MPC}^H}{1-\text{MPC}^Y}\frac{A^H_*}{C_*}\hat{P}^H_t. \tag{48}$$

I get the trends and deviations of asset prices $\hat{P}^S$, $\hat{P}^H$ from the aggregate time series. The wealth-consumption ratios A^S_*/C_* and A^H_*/C_* are set to the respective trends. The annual aggregate MPCs are set as $\text{MPC}^S = 0.026$, $\text{MPC}^H = 0.037$, and $\text{MPC}^Y = 0.5$, respectively. These values are computed from the estimates of Di Maggio, Kermani and Majlesi (2020), Aladangady (2017), and Fagereng, Holm and Natvik (2021) by weighting their estimates of group MPCs by the group's asset and labor-income shares estimated from SCF 2004 (see Section 4.2 for details). I convert the MPC^S and MPC^H to quarterly by dividing the yearly values by 4, and the quarterly MPC^Y is set to 0.2.

Figure 2 shows the actual consumption and the predicted consumption of the APNK model from 1998Q1 to 2018Q4. The model fits the data remarkably well. The cycle starts in the late 1990s with the dot-com boom and recessions. Starting from 2004, stock and housing prices continue to increase, stimulating aggregate consumption. The Great Recession follows with a significant drop in asset prices and consumption. The APNK model captures the timing and magnitude of consumption dynamics accurately. The model's success in fitting the data suggests that wealth effects from asset prices play a crucial role in consumption dynamics during this period. The appendix shows the model's predictions for other sample periods.

Figure 3 evaluates the standard Euler equation over the same period. Conditional only on observed real interest rates, the standard model predicts consumption dynamics that are largely opposite to the data (right panel). This discrepancy arises because policy rates are endogenous and typically "lean against the wind".[15] Consequently, standard models must rely on unobservable preference or risk shocks to match the data. By contrast, the APNK model relies on asset prices, which naturally capitalize aggregate information about the macroeconomic environment, allowing it to track actual consumption without latent disturbances.

4.2 Heterogeneous Consumption Responses to Monetary Policy

There is large heterogeneity in MPCs, income, and asset positions. According to Aladangady (2017)'s estimates on US households, the MPC out of housing capital gains $\text{MPC}^H = 0.074$ for homeowners with mortgages, and is statistically insignificant for homeowners without mortgages and renters. Di Maggio, Kermani and Majlesi (2020) use Swedish data on households' stock holdings and estimate MPC out of stock capital gains $\text{MPC}^S = 0.23$ for the bottom 50% of the wealth distribution and about 0.03 for the top 30% of the wealth distribution.

On the macro side, Cloyne, Ferreira and Surico (2020) documents that, for the US and UK, households with mortgages (M) show stronger consumption adjustments following a monetary policy shock compared to renters (R) and outright homeowners (O): $\hat{C}_M > \hat{C}_R > \hat{C}_O$. They also show that the heterogeneous responses are not due to redistribution.

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

$$dC_i = \text{MPC}_i^S dA_i^S + \text{MPC}_i^H dA_i^H + \text{MPC}_i^Y dY_i, \quad \forall i \in \{M, R, O\} \tag{49}$$

$$\hat{C}_i = \underbrace{\text{MPC}_i^S \frac{A_i^S}{C_i} \hat{P}^S + \text{MPC}_i^H \frac{A_i^H}{C_i} \hat{P}^H}_{\text{wealth channel}} + \underbrace{\text{MPC}_i^Y \frac{Y_i}{C_i} \hat{Y}}_{\text{income channel}} . \tag{50}$$

I distinguish between stock wealth and housing wealth as their distributions among households are quite different. The consumption response of a group depends on the group-level MPCs and asset (income) positions, which are treated as parameters and estimated below.

In Table 1, I list the estimates of the parameters in equation (50). To estimate MPC^S

[15] For illustrative purposes, the prediction assumes a simple exogenous AR(1) interest rate process with a conservative persistence of $\rho = 0.6$. Higher, more realistic persistence values would generate an even larger discrepancy between actual and Euler-implied consumption.

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	0.63%	0.63%	1.26%
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	0.3%	0.3%	0.6%

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

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). Since renters have negligible wealth compared to the other two groups, their wealth-consumption ratios are set to zero.

The estimates of MPC^H are from Aladangady (2017). The MPC^H of outright homeowners is not statistically different from zero, and the point estimate is close to zero. The estimates of MPC^Y are 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 an interest rate cut of 100bps and assume that $\hat{P}^S = 6\%$, $\hat{P}^H = 2\%$ and $\hat{Y} = 1\%$, The model-implied consumption response for each group is shown in the last column of Table 1. Mortgagors' consumption is more responsive than the other two groups. The wealth channel, due to capital gains, and the income channel, due to the general equilibrium output boom, contribute equally to their expenditure increase. Renters only benefit from the income increase. Outright homeowners also benefit from capital gains but have smaller MPCs; thus, they adjust their spending less than mortgagors. The heterogeneous consumption responses align with the findings in Cloyne, Ferreira and Surico (2020).

The standard full-information model struggles to replicate these heterogeneous responses. In the absence of wealth effects, the transmission operates through intertem-

poral substitution. Decomposing the consumption response into direct substitution and indirect income effects yields:

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

Assuming log utility ($\sigma = 1$) and the calibration from Table 1, the implied 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 assuming proportional income rises. However, these distributional 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:

$$\max_{\{c,n,a^{liq},a^{illiq}\}} E\left[\sum_{t=0}^{\infty}\beta^t u(c_{it},n_{it})\right]; \tag{51}$$

$$\text{s.t. } c_{it}+a_{it}^{liq}+a_{it}^{illiq}=R_t^{liq}a_{it-1}^{liq}+R_t^{illiq}a_{it-1}^{illiq}+z_tW_tn_{it}; \tag{52}$$

$$a_{it}^{liq}\geq 0;\quad a_{it}^{illiq}\geq 0, \tag{53}$$

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:

$$a_{it}^{illiq}=R_t^{illiq}a_{it-1}^{illiq},\text{ if } s_t=0. \tag{54}$$

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 $R_t^v=(D_t+P_t)/P_{t-1}$ thus $R_t^{illiq}=R_t^v$ and $R_t^{liq}=\xi R_t^v$. The amount of equity held by households is given by $v_{it-1}^{liq}=a_{it-1}^{liq}/P_{t-1}$ and $v_{it-1}^{illiq}=a_{it-1}^{illiq}/P_{t-1}$.

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 $n(z^t)=N_t$ to firms, and the aggregate labor supply follows the wage schedule,

$$W_t=W_*\left(\frac{N_t}{N_*}\right)^{\epsilon_W}. \tag{55}$$

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 $\Phi_t(a_{t-1}^{liq},a_{t-1}^{illiq},z_t,s_t)$ 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 (55) 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:

$$N_t = L_t; \tag{56}$$

$$C_t = Y_t, \ where \ C_t = \int c_{it} di; \tag{57}$$

$$A_t = P_t, \ where \ A_t = \int (a_{it}^{liq} + a_{it}^{illiq}) di. \tag{58}$$

5.2 Model Solution

State Space Formation. It is helpful to firstly formulate the problem in the state space. With information frictions, the individual solves the following Bellman equation:

$$\begin{aligned} V^f(a_{it-1}, h_{it}; X_t) &= \max_{c_{it}, a_{it}} u(c_{it}) + \beta \mathbb{E}_{h,X}[V^f(a_{it}, h_{it+1}; X_{t+1}) | R_t^v a_{it-1}, y_{it}^l, h_{it}], \\ \text{s.t. } c_{it} + a_{it} &= R_t^v a_{it-1} + y_{it}^l; \end{aligned}$$

I omit the difference between liquid and illiquid assets and the respective constraints for simplicity, and use $h_{it} = (z_{it}, s_{it})$ to denote exogenous individual states and $X_t \equiv \{P_t, \Phi_t\}$ for aggregate states. Given observed individual after-return wealth $R_t^v a_{it-1}$, labor income y_{it}^l, and the persistent component of labor income state z_{it}, the expectation is taken with respect to future individual state h_{it+1} and contemporaneous aggregate states X_t. Given the expectation about X_t, the expectation about time $t+1$ asset price and distribution derive from the exogenous asset price process and the equilibrium law of motion $\Phi_{t+1} = \Phi(P_t, \Phi_t)$, respectively.

The assumption of infinite-noisy signals simplifies the problem: all observed movements in aggregate equity return and labor income are attributed to i.i.d idiosyncratic asset price and transitory labor income shocks. The expectation about $X_t = \{P_t, \Phi_t\}$

and their time $t+1$ counterparts are fixed at the steady-state values.[16] The expected value function degenerates to the steady-state value function and the expectation is only taken with respect to individual state h_{it+1}:

$$V^f(a_{it-1}, h_{it}; X_t) = \max_{c_{it}, a_{it}} u(c_{it}) + \beta \mathbb{E}_h[V(a_{it}, h_{it+1}; X_*)|h_{it}].$$

Consequently, the expectation about the endogenous $t+1$ equity return $R^v_{t+1} = (P_{t+1} + D_{t+1})/P_t$ and aggregate labor income Y^l_{t+1} are also fixed at their steady-state values.

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. Given the perceived path of aggregate labor income $\mathbf{Y}_l = \{Y^l_t\}^\infty_{t=0}$ and equity return $\mathbf{R}_v = \{R^v_t\}^\infty_{t=0}$, the aggregate consumption $\mathbf{C} = \{C_t\}^\infty_{t=0}$ is given by the consumption policy function

$$\mathbf{C} = \mathcal{C}(\mathbf{Y}_l, \mathbf{R}_v). \tag{59}$$

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

$$\mathbf{M}^{Y_l} \equiv \frac{\partial \mathcal{C}}{\partial \mathbf{Y}_l}; \quad \mathbf{M}^{R_v} \equiv \frac{\partial \mathcal{C}}{\partial \mathbf{R}_v}, \tag{60}$$

with the derivative evaluated at the deterministic steady state. For example, the ts entry of $\mathbf{M}^{Y_l}$, $M^{Y_l}_{ts} = \partial \mathcal{C}_t / \partial Y^l_s$, gives the first-order response of time-t consumption to an aggregate shock to labor income at time s, and the ts entry of $\mathbf{M}^{R_v}$, $M^{R_v}_{ts} = \partial \mathcal{C}_t / \partial R^v_s$, 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 $\mathbf{M}^{FI}$. The Jacobian for myopic agents is given by

$$\mathbf{M}^{MYOPIC} = \begin{pmatrix} M^{FI}_{00} & 0 & 0 & \cdots \\ M^{FI}_{10} & M^{FI}_{00} & 0 & \cdots \\ M^{FI}_{20} & M^{FI}_{10} & M^{FI}_{00} & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{pmatrix}.$$

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

[16] Any perceived law of motion admitting the full-information deterministic steady state as a fixed point $\Phi^{perceived}(P_*, \Phi_*) = \Phi_*$ serves our purpose, including the equilibrium one.

aggregates act as a sequence of time-0 unexpected shocks.

Information frictions affect the expected path of aggregate labor income and equity return. With signal extraction, the Jacobian is a weighted average of the myopic and the full-information Jacobian

$$\mathbf{M}^f = \mu \mathbf{M}^{FI} + (1-\mu)\mathbf{M}^{MYOPIC}. \tag{61}$$

With the Jacobian built, we can solve the model as in Auclert, Rognlie and Straub (2024). The path of aggregate consumption is

$$\begin{aligned} d\mathbf{C} =& \mathbf{M}^{R_v} d\mathbf{R}_v + \mathbf{M}^{Y_l} d\mathbf{Y}_l = \mathbf{M}^{R_v} \frac{\partial \mathbf{R}_v}{\partial \mathbf{P}} d\mathbf{P} + \mathbf{M}^{R_v} \frac{\partial \mathbf{R}_v}{\partial \mathbf{D}} \frac{\partial \mathbf{D}}{\partial \mathbf{Y}} d\mathbf{Y} + \mathbf{M}^{Y_l} \frac{\partial \mathbf{Y}_l}{\partial \mathbf{Y}} d\mathbf{Y} && (62) \\ =& \mathbf{M}^{R_v} \frac{\partial \mathbf{R}_v}{\partial \mathbf{P}} d\mathbf{P} + \left(\mathbf{M}^{R_v} \frac{1}{P_*} \frac{\partial \mathbf{D}}{\partial \mathbf{Y}} + \mathbf{M}^{Y_l} \frac{\partial \mathbf{Y}_l}{\partial \mathbf{Y}} \right) d\mathbf{Y}. && (63) \end{aligned}$$

The jacobian of aggregate MPC out of income $\mathbf{M}^Y$ and asset price $\mathbf{M}^P$ are given by[17]

$$\mathbf{M}^P \equiv \mathbf{M}^{R_v} \frac{\partial \mathbf{R}_v}{\partial \mathbf{P}}; \quad \mathbf{M}^Y \equiv \mathbf{M}^{R_v} \frac{1}{P_*} \frac{\partial \mathbf{D}}{\partial \mathbf{Y}} + \mathbf{M}^{Y_l} \frac{\partial \mathbf{Y}_l}{\partial \mathbf{Y}}. \tag{64}$$

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

$$d\mathbf{C} = \mathbf{M}^P d\mathbf{P} + \mathbf{M}^Y d\mathbf{Y} \tag{65}$$

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

$$\begin{aligned} V_t^f(a_{it-1}, h_{it}) &= \max_{c_{it}, a_{it}} u(c_{it}) + \beta \mathbb{E}_h[V_*(a_{it}, h_{it+1}) | h_{it}], \\ \text{s.t. } c_{it} + a_{it} &= R_t^v a_{it-1} + y_{it}^l. \end{aligned}$$

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

[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.

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:

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

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 (65) implies that, to first order, the time-0 consumption response to an unexpected asset price shock is

$$\begin{aligned} dC_0 &= \mathbf{M}_{00}^{R_v} \frac{\partial R_v}{\partial P_0} dP_0 + \text{MPC}_0^Y dY_0 = \text{MPC}_0^A A_* \hat{P}_0 + \text{MPC}_0^Y dY_0, \\ \hat{C}_0 &= \frac{\text{MPC}_0^A}{1 - \text{MPC}_0^Y} \frac{A_*}{C_*} \hat{P}_0. \end{aligned}$$

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.

[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.

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).

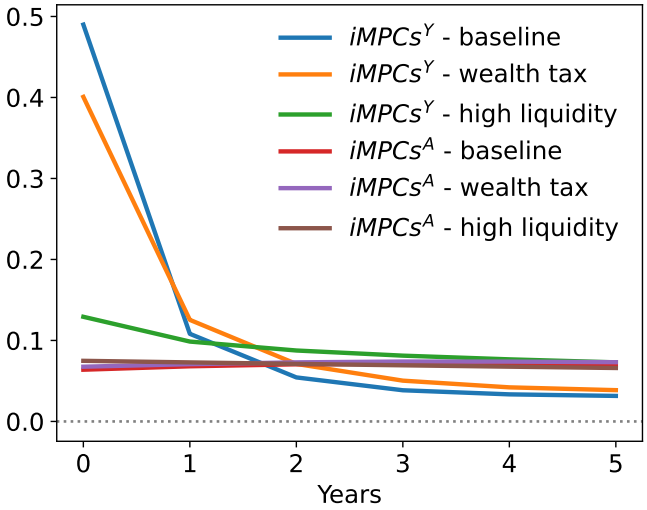
Aggregate MPCs. We first define individual MPCs. Writing individual budget constraints as follows:

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

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

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

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.

And aggregate MPCs are computed as

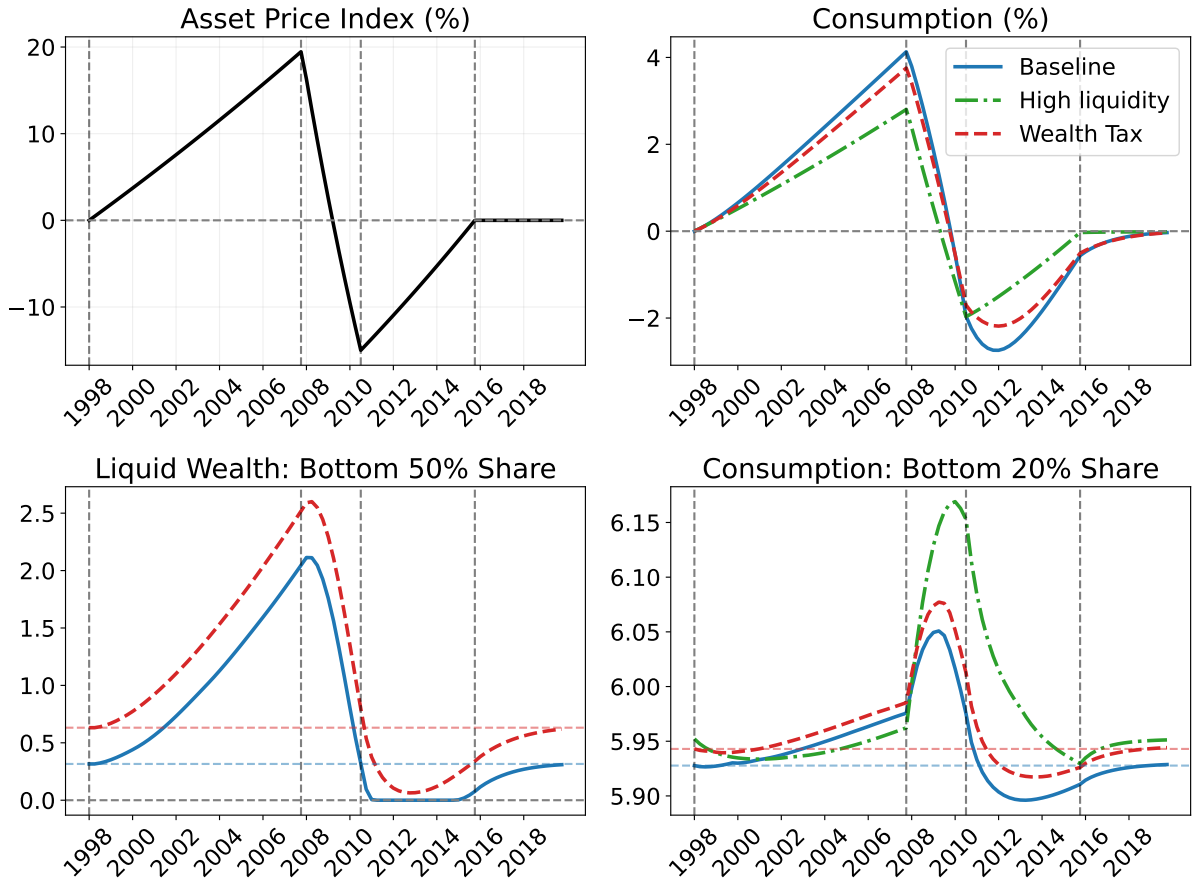
$$\begin{aligned} \text{MPC}^Y &= \frac{\partial D}{\partial Y}\left(\int \text{MPC}_i^{d,liq} v_i^{liq} di + \int \text{MPC}_i^{d,illiq} v_i^{illiq} di\right) + \frac{\partial Y^l}{\partial Y}\int \text{MPC}_i^l z_i di, \\ \text{MPC}^A &= \int \text{MPC}_i^{a,liq} v_i^{liq} di + \int \text{MPC}_i^{a,illiq} v_i^{illiq} di. \end{aligned} \tag{66}$$

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, v_i^{liq}, v_i^{illiq}). This measure is more informative for the model solution (65), as goods market clearing 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.

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.

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

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 boom-bust 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 $\tau_{it} = z_t T_t^L$ to the government where T_t^L is the aggregate labor income tax. The household budget constraint

is given by

$$c_{it} + a_{it}^{liq} + a_{it}^{illiq} = R_t^{liq} a_{it-1}^{liq} + R_t^{illiq} a_{it-1} + z_t W_t n_{it} - \tau_{it}. \tag{67}$$

Both liquid and illiquid assets can be invested in firm equity with real gross return R_t^v 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 $R_t^v = R_t, \forall t \geq 1$. 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

$$R_t^{illiq} = R_t^v \frac{P_{t-1}}{P_{t-1} + B} + R_t \frac{B}{P_{t-1} + B}. \tag{68}$$

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

$$\log(1 + \pi_t) = \kappa \left(\frac{W_t}{Z_t} - \frac{1}{\mu^p} \right) + \frac{1}{R_{t+1}} \frac{Y_{t+1}}{Y_t} \log(1 + \pi_{t+1}). \tag{69}$$

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:

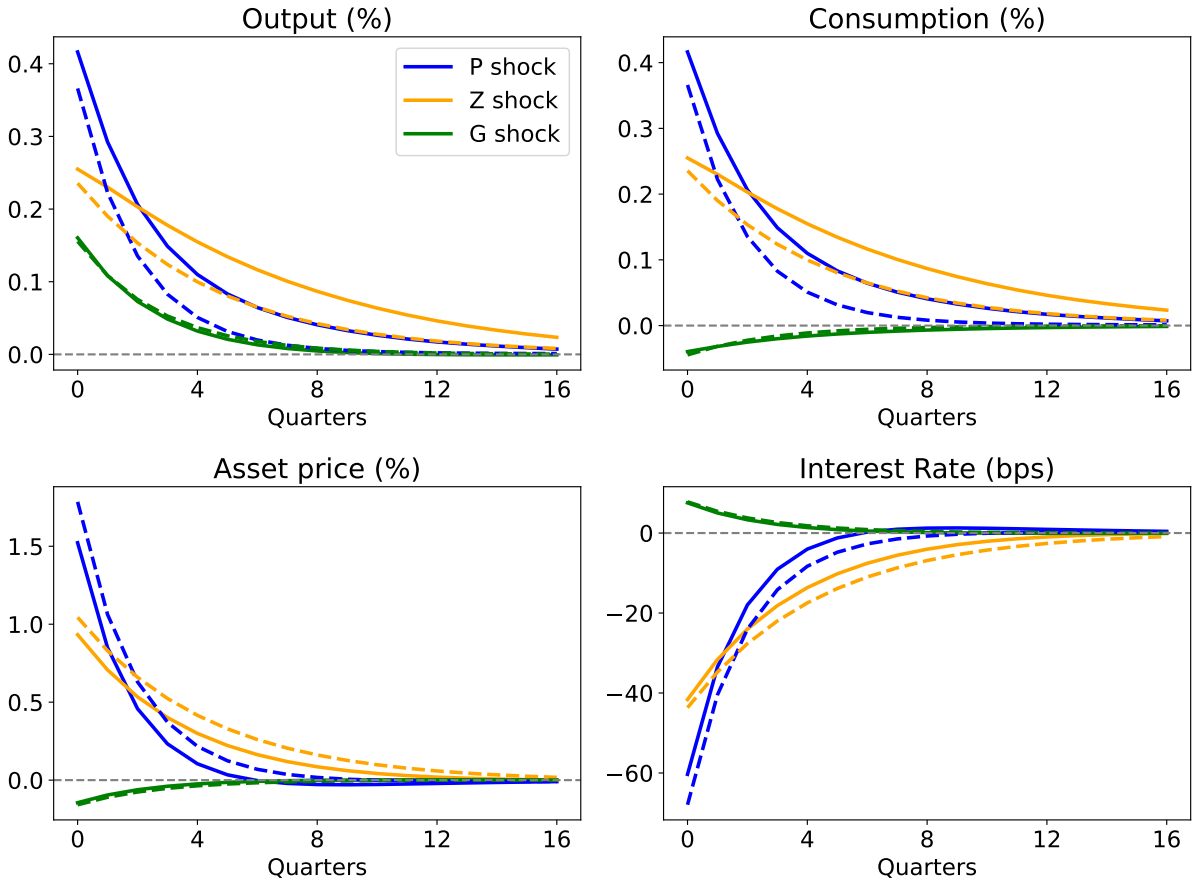
$$D_t = Y_t^{GDP} - W_t N_t - T_t^F = \alpha Y_t^{GDP} - T_t^F.$$

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

$$T_t = G_t. \tag{70}$$

Taxes T_t apply proportionally to gross labor and firm profits with $T_t^L = (1 - \alpha) T_t$ 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

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^v), 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 $\lambda = 0.999$.

spending G_t is exogenous and follows

$$dG_t = \rho_G dG_{t-1} + \epsilon_t^G, \quad \epsilon_t^G \sim \mathcal{N}(0, \sigma^2_{\epsilon^G}), \tag{71}$$

where ρ_G is the shock persistence.

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

$$\hat{P}_t = \phi_\pi^P \pi_t + v_t, \text{ where } v_t = \rho_v v_{t-1} + \epsilon_t^v \text{ and } \epsilon_t^v \sim \mathcal{N}(0, \sigma^2_{\epsilon^v}), \tag{72}$$

with $v_t = 0$ in the steady state. The innovation ϵ_t^v 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 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, this implies higher expected real interest rates.

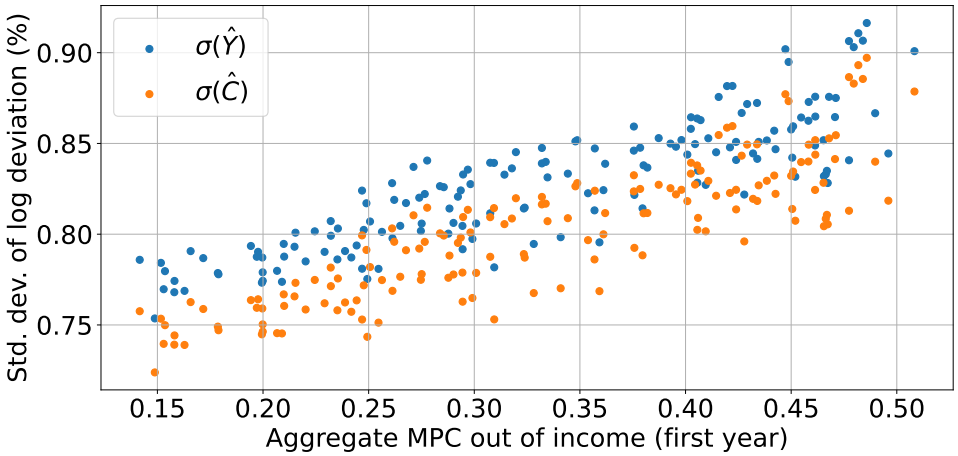
Relative to the standard New Keynesian model, the qualitative responses are similar, but the mechanism differs: in the standard model, consumption rises because current consumption becomes cheaper relative to future consumption, whereas in the APNK model consumption adjusts because agents feel richer.

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

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.

distribution and reduce aggregate MPCs—for example, a modest wealth tax—directly 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

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.

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 boom-bust 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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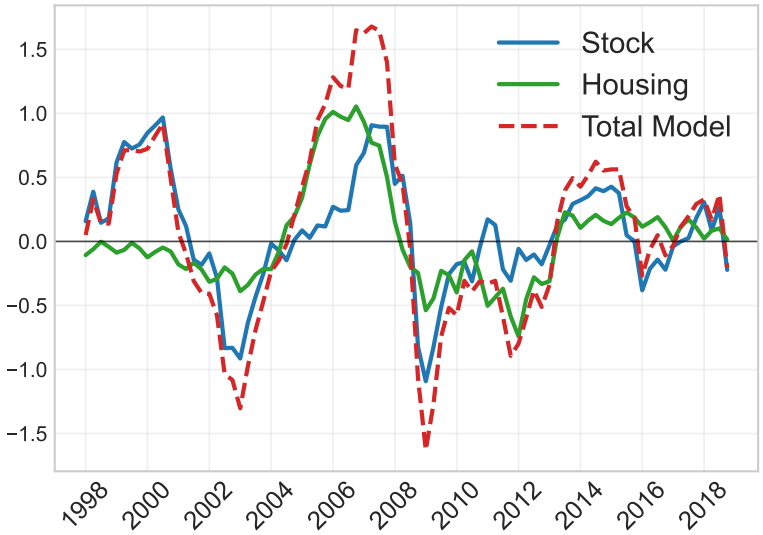
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Figure 8: Consumption Gap: Model Components 1998Q1–2018Q4



Notes: Decomposition of model-predicted consumption gap (quarterly) into components attributed to stock and house price shocks.

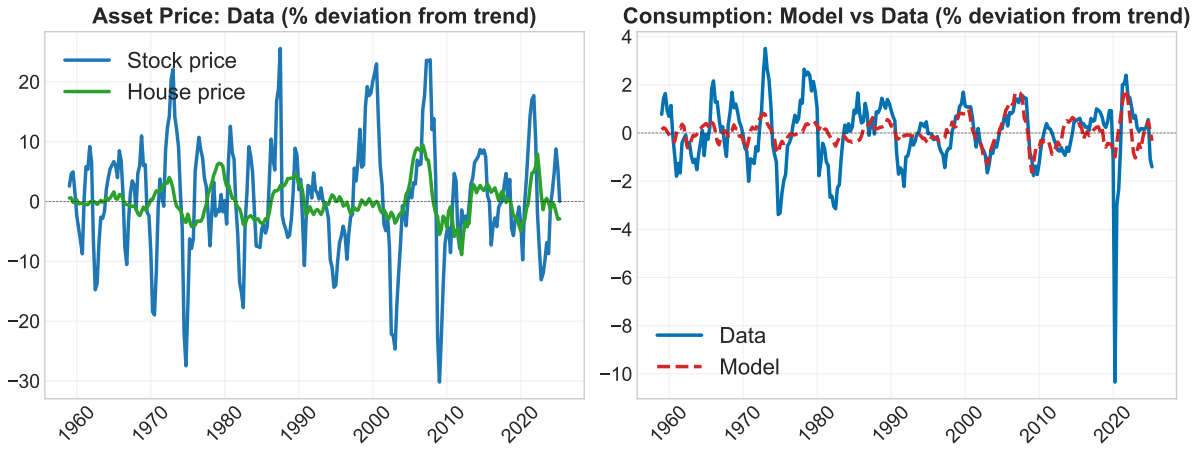
Appendix

A APNK Model Fit to Data

Figure 8 presents a decomposition of the model-implied consumption gap (1998Q1–2018Q4) into the parts driven by stock-price and house-price movements. The panel highlights three main phases: (i) the late-1990s/early-2000s expansion where stock-price gains dominate the consumption upswing; (ii) the mid-2000s housing boom where house-price appreciations make a first-order contribution; and (iii) the 2007–2009 bust and subsequent recovery, in which simultaneous declines in both asset classes generate the sharp consumption contraction and the slow, asymmetric rebound. The figure shows that neither asset class alone accounts for the entire cycle: stock-price movements drive much of the early-cycle volatility while housing is relatively more important for triggering the boom starting from 2004 and the protracted recovery after 2010, and their joint dynamics produce the close fit to observed consumption.

Figure 9 plots the model-implied consumption gap against the data for 1959Q1-2025Q2, highlighting the long-run co-movement between aggregate asset valuations and consumption. Note that the calibration of aggregate MPCs relies on cross-sectional MPCs estimates as well as income and wealth distributions. Currently, I use the distributions from SCF 2004 to estimate aggregate MPCs. Since both individual MPCs and the distribution of income, stock and housing wealth evolve over the entire sample, the fit is necessarily approximate. Consequently, the figure before 2000 is best interpreted as showing comovement, with the correlation providing a more reliable summary of fit

Figure 9: APNK Model Fit 1959Q1–2025Q2



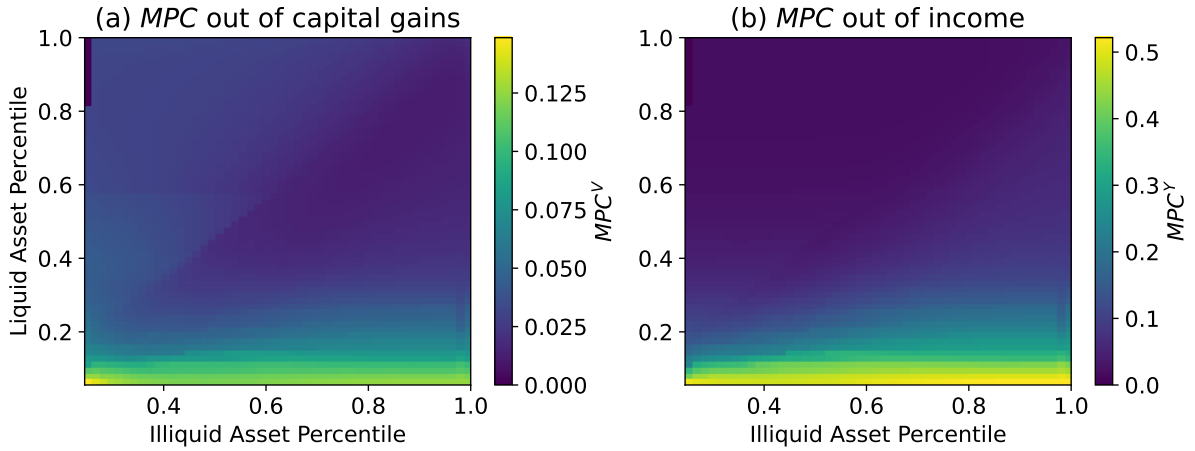
Notes: Right panel: model-predicted vs actual consumption gap (quarterly). Correlation: 0.51.

than pointwise magnitudes.

B 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 10: Household's Marginal Propensity to Consume

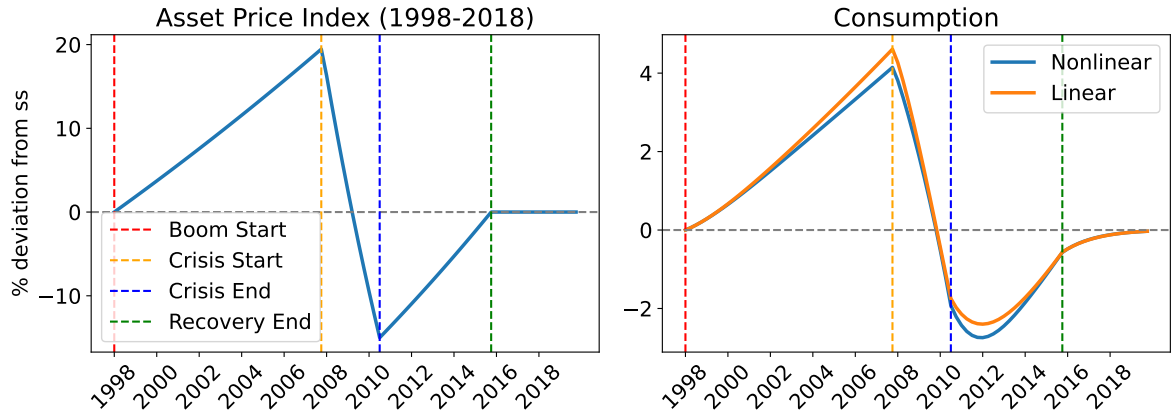


Notes: Household's consumption response to one-unit of unexpected capital gains and windfall income averaged across income states in the AP-HANK model.

Individual MPCs Households' MPCs (averaged across income states) are shown in Figure 10. 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.

Figure 11: Linear vs Nonlinear Responses to the Great-Recession Asset-Price Shock

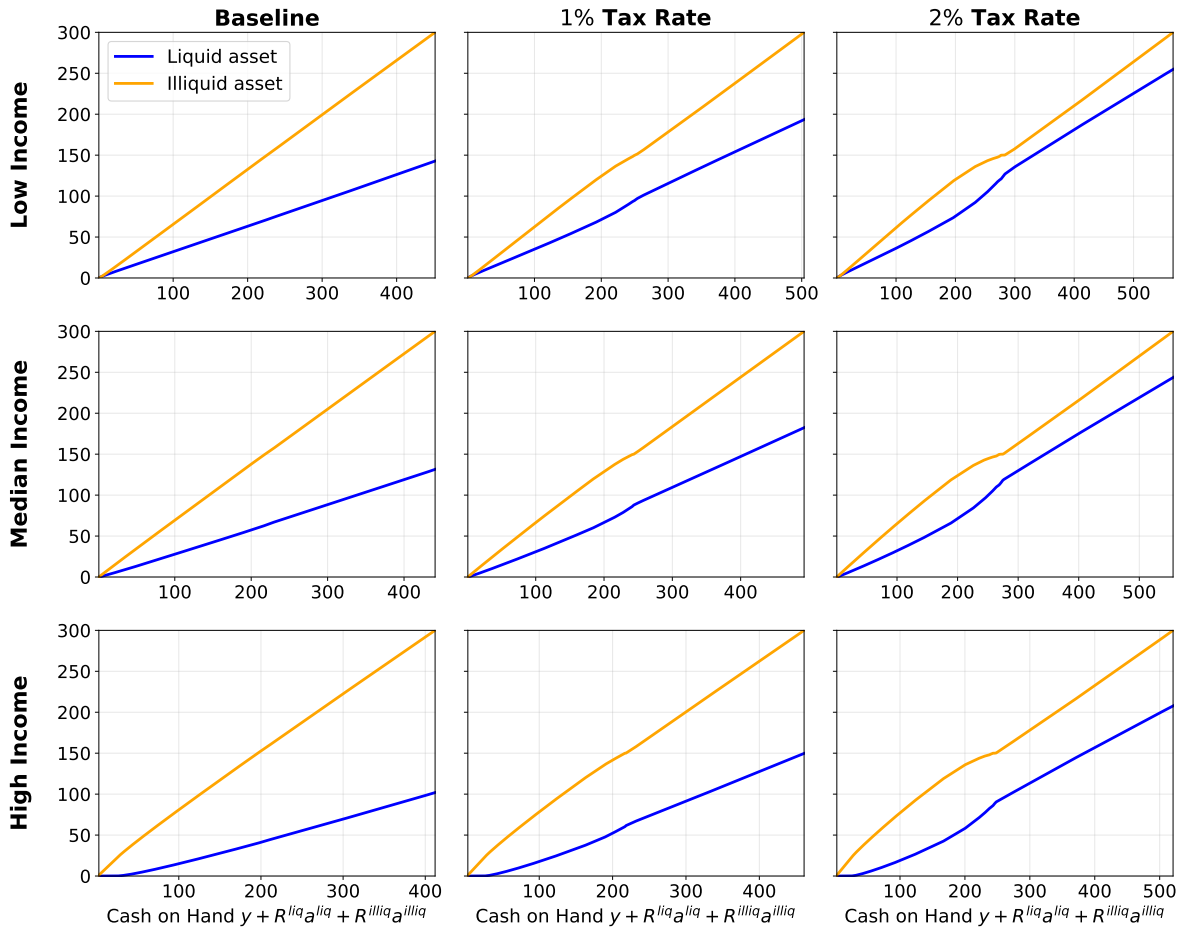


Notes: Comparison of linearized and nonlinear model responses to the Great-Recession Asset-Price Shock. The model is solved linearly with sequence-space jacobian and nonlinearly by policy function iteration.

Wealth taxation Figure 12 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 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 12: 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.

C Asset-Price Responses to Monetary Policy Shock

This appendix details the VAR model specification, identification strategy, and impulse response estimation for the effects of monetary policy shocks on asset prices.

C.1 VAR Model Specification

We estimate a monthly VAR model using external instruments for monetary policy shocks following the approach of Bauer and Swanson (2023) and Gertler and Karadi (2015).

VAR Specification The monthly VAR includes four variables in the following order:

$$\mathbf{Y}_t = \begin{bmatrix} \text{IP}_t \\ \text{LCPI}_t \\ \text{SP500}_t \\ \text{TwoY_T}_t \end{bmatrix} \tag{73}$$

where TwoY_T_t is the 2-year Treasury rate, SP500_t is the S&P 500 index, LCPI_t is the Consumer Price Index, and IP_t is industrial production. When estimating the response of housing prices, we replace stock price index with housing price index LHPRICE_t and put LHPRICE_t after IP_t. Asset price, consumption and output variables are constructed as $100 \times \log(\text{level})$. The reduced-form VAR is estimated as:

$$\mathbf{Y}_t = \mathbf{c} + \sum_{j=1}^{p} \mathbf{A}_j \mathbf{Y}_{t-j} + \mathbf{u}_t \tag{74}$$

where $\mathbf{c}$ is a vector of deterministic variables, $\mathbf{A}_j$ are coefficient matrices, $p = 12$ is the lag length (one year), and $\mathbf{u}_t$ is the vector of reduced-form residuals with covariance matrix $\mathbf{\Sigma}_u$. All impulse response functions are normalized such that the impact response of the 2-year Treasury rate equals 25 basis points.

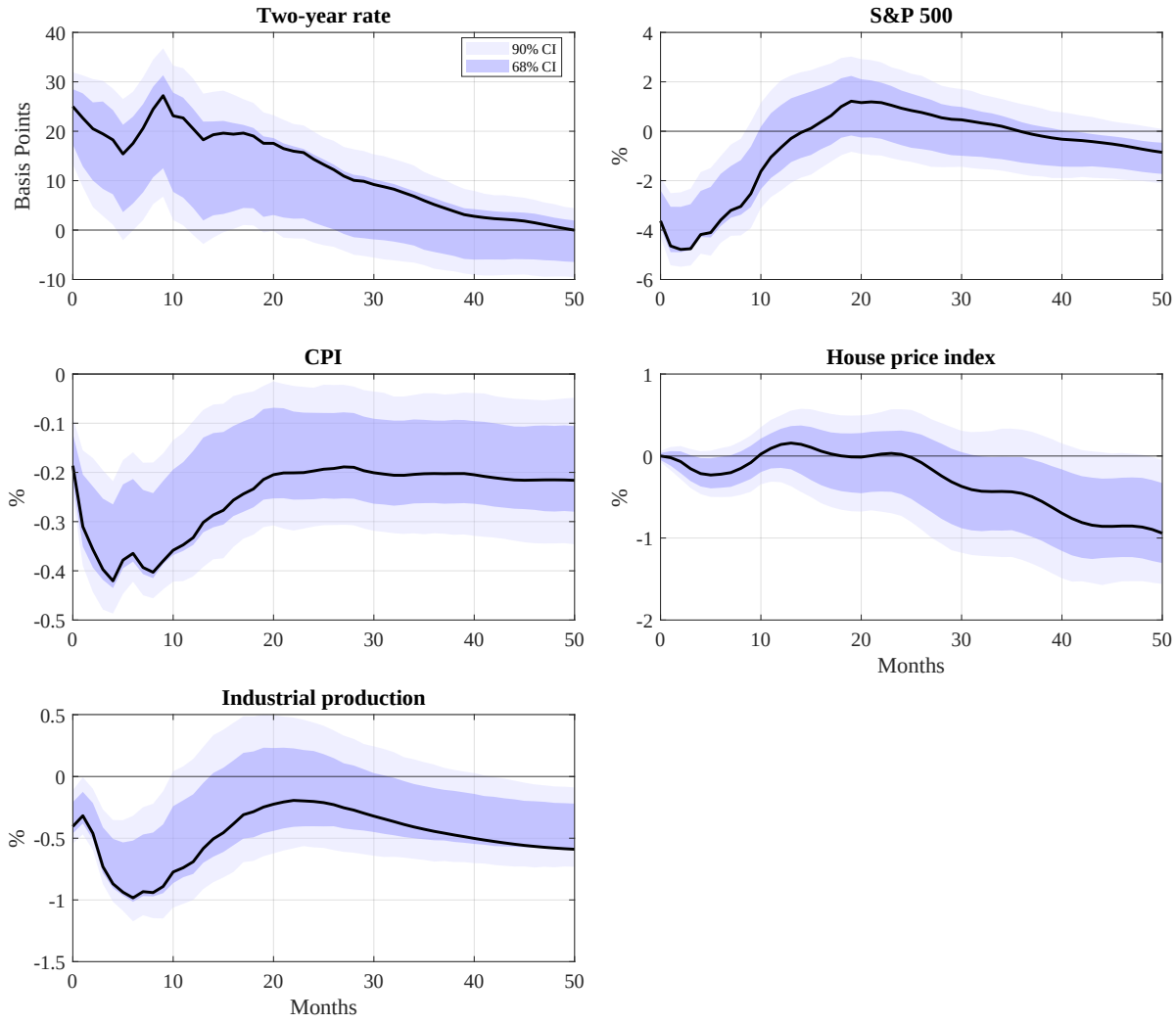
Monthly External Instrument For the monthly VAR, we employ MPS_ORT as the external instrument, which represents orthogonalized monetary policy surprises. This instrument is constructed to be orthogonal to other information available at the time of monetary policy decisions, following standard high-frequency identification approaches (Kuttner, 2001; Gürkaynak, Sack and Swanson, 2005). As in Bauer and Swanson (2023), we work under the assumption that the VAR is invertible so that we can write the innovations u_t as linear combinations of the structural shocks v_t, i.e. primitive driving forces of the economy:

$$u_t = Sv_t \tag{75}$$

Already by definition, the structural shocks are mutually uncorrelated, and as in Bauer and Swanson (2023) the variance is normalized to unity, i.e. $Var(v_t) = I$. Also, from the invertibility condition above, we get the standard covariance restrictions $\Sigma = SS'$. The monetary shock is denoted as the first shock in the VAR, $\varepsilon_{1,t}$. The instrument satisfies the relevance condition:

$$E[m_t \varepsilon_{1,t}] \neq 0 \tag{76}$$

Figure 13: Estimated IRFs to monetary policy shock



Notes: The figure shows the impulse responses to a 25 basis points expansionary monetary policy shock. The responses are estimated from a VAR using the purified high-frequency monetary surprises in Bauer and Swanson (2023) as an instrument. The solid line is the point estimate, and the dark and light shaded areas are 68 and 90 percent confidence bands, respectively.

and the exogeneity condition:

$$E[m_t \varepsilon_{-1,t}] = 0 \tag{77}$$

where m_t is the external instrument (MPS_ORT), $\varepsilon_{1,t}$ are the reduced-form VAR residuals and $\varepsilon_{-1,t}$ is a vector made of the other structural shocks. The structural monetary policy shock is recovered using the external instrument approach. For a given external instrument m_t, the structural shock is identified as:

$$\varepsilon_{mp,t} = \frac{E[m_t \varepsilon_{1,t}]}{E[m_t^2]} m_t + \text{orthogonal component} \tag{78}$$

This approach allows us to trace out the dynamic effects of exogenous monetary policy innovations on all variables in the system.

C.2 Variable Definitions and Data Sources

Table 3 provides detailed definitions for all variables used in the analysis, along with their transformations and data sources.

Table 3: Variable Definitions and Data Sources

Variable	Description	Transformation	Source
TwoY_T	2-Year Treasury Constant Maturity Rate	Level (percentage point)	Bauer and Swanson (2023)
SP500	S&P 500 Stock Price Index	$100 \times \log(\text{level})$	Bauer and Swanson (2023)
LCPI	Consumer Price Index for All Urban Consumers: All Items	$100 \times \log(\text{level})$	Bauer and Swanson (2023)
LHPRICE	House Price Index	$100 \times \log(\text{level})$	Bauer and Swanson (2023)
RPCE	Real Personal Consumption Expenditures	$100 \times \log(\text{level})$	FRED
MPS_ORT	Orthogonalized Monetary Policy Surprises	Level (percentage point)	Bauer and Swanson (2023)

Notes: Sample period: 1987:1 to 2020:2 (398 monthly observations after lags). All price and quantity variables are transformed as $100 \times \log(\text{level})$. The 2-year Treasury rate is in percentage points.

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