Monetary Policy and the Dynamics of the Wealth Distribution

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Abstract

I show that in a quantitative Heterogeneous Agent New Keynesian (HANK) model the combination of high concentration of financial wealth and changes in equity prices shapes the cross-sectional and aggregate consumption response to monetary policy. I find that households at the tails of the wealth distribution account for most of the changes in aggregate consumption. Households in the bottom 50% of the distribution benefit the most from higher labor earnings, households in the top 10% gain the most from higher equity prices. While capital gains increase welfare at the top, low-wealth households' welfare increases the most.

Keywords: Heterogeneous Agents, Wealth Inequality, Consumption, New Keynesian.

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1 Introduction

In view of the high concentration of wealth at the top of the distribution, there is a growing interest in the interactions between wealth inequality and monetary policy. Recent empirical work documents the effects of monetary policy on the balance sheet of households at the top of the income and wealth distribution through asset price channels (Amberg, Jansson, Klein, and Rogantini Picco (2022), Andersen, Johannesen, Jorgensen, and Peydró (2023)). This suggests that high wealth concentration amplifies differences in households' exposure to monetary policy across wealth groups. What are the implications for household consumption and aggregate demand? How is the welfare of different groups affected by a monetary expansion?

I leverage a quantitative HANK model to assess the role of different wealth groups in the transmission mechanism of monetary policy to household consumption and evaluate the welfare implications of interest rate cuts. I focus on the effects of monetary policy across the distribution of financial wealth, following the recent literature on heterogeneous agents models that highlights the importance of liquid asset holdings. I calibrate and validate the model using cross-sectional data from the Survey of Consumer Finances (SCF). This provides comprehensive information on household income and wealth.

This paper presents two main findings. First, in a quantitative HANK model with equity prices, households at the tails of the wealth distribution exhibit the largest consumption responses to monetary policy. Top and bottom groups are the ones that contribute the most to the response of aggregate consumption. I show that the cross-sectional and aggregate effects of monetary policy depend on the dynamics of the wealth distribution. Expansionary monetary policy shocks raise stock prices. As wealth is highly concentrated at the top, movements in asset prices generate substantial capital gains for wealthy households. This leads to higher consumption at the top of the distribution of financial wealth, increasing the response of aggregate consumption. Second, the welfare effects are more nuanced. At the top of the wealth distribution, lower returns outweigh the welfare gains from higher stock prices. As a result, wealthy households can be worse off from monetary expansion despite getting large capital gains and consuming more at impact. Households at the lower end of the distribution are typically the ones who gain the most from an expansionary monetary policy.

These results are important for several reasons. First, they provide new quantitative insights into how different wealth groups contribute to the aggregate effects of monetary policy. Understanding how different groups within the society respond to monetary policy and the macroeconomic implications of such heterogeneity is a key issue. Second, the results provide novel insights into the importance of wealth dynamics for the transmission mechanism of monetary policy to household consumption and aggregate demand. Third, evaluating the welfare gains of different wealth groups is also important to understand the distributional effects of monetary policy. I find that the welfare implications of asset price redistribution are more complicated than one would expect. Fourth, understanding wealth dynamics is important to analyze how long-run trends in wealth inequality shape the effectiveness of monetary policy.

To quantitatively study the macroeconomic implications of wealth inequality, I use the HANK framework.[1] I model investment using Tobin's q theory. This introduces equity prices and capital gains in the model.[2] Specifically, households can trade bonds and accumulate capital through an investment fund. In the baseline model, there is no aggregate risk or liquidity frictions, so the returns on these assets are equalized. For the remaining blocks of the model, I employ the New Keynesian framework with both sticky prices and sticky wages.[3] The baseline model also features extraordinary earning states in the income risk process. This generates exceptionally high earning levels for a few households that accumulate large fortunes, increasing wealth concentration. In an extension of the baseline model, I analyze a two-asset model with liquid bonds and illiquid stocks using convex transaction costs as in Kaplan, Moll, and Violante (2018). This introduces endogenous portfolio choices and allows me to account for the composition of households' financial wealth. This extension also includes fiscal policy to control for the fiscal adjustment to monetary policy innovations. I present the two-asset model in the Online Appendix D and discuss the results from the model in the Online Appendix D.2.

The HANK framework allows for several transmission channels of monetary policy. In particular, all the structural models that I study in this paper feature direct and indirect effects of monetary policy. The direct effects are due to changes in real interest rates that affect household intertemporal consumption-saving decisions, interest rate expenses for borrowers, and interest income for creditors, this is the textbook interest rate channel of monetary policy. The indirect effects are due to changes in macroeconomic variables that indirectly respond to monetary policy innovations and affect household balance sheets. These indirect effects include changes in household labor income and changes in equity prices. The labor market adjustments that affect household earnings consist of changes in real wages and employment levels. These effects reflect a general increase in labor demand after an expansionary monetary policy shock that stimulates economic activity. Finally, the asset price channel consists of an increase in equity prices that generates capital gains, raising households' income or wealth.

I begin by studying a monetary policy shock in the baseline HANK model with capital and equity prices. In particular, I leverage the model to quantify the impact of different wealth groups on the aggregate consumption response and on the transmission mechanism of monetary policy. First, I show that households at both tails of the wealth distribution account for most of the aggregate consumption response to monetary policy.[4] In the baseline model, households at

[1] Households have different income and wealth due to uninsurable idiosyncratic income risk and face a potentially binding borrowing limit depending on the realizations of income shocks (Huggett (1993), Aiyagari (1994)).

[2] Several papers argue that excess returns account for the largest part of the response of asset prices to monetary policy shocks (Bernanke and Kuttner (2005), Hanson and Stein (2015), Gertler and Karadi (2015)). More recently, Nagel and Xu (2024) find that most of the stock market response to monetary policy is due to changes in short-term interest rates rather than changes in the risk premium. In line with this mixed evidence and to generate large fluctuations in asset prices, I also introduce in the model a time-varying excess return.

[3] Firms operate in monopolistic competition and set prices subject to price adjustment costs à la Rotemberg (1982), while unions also have some degree of market power and set wages subject to wage adjustment costs. Finally, the central bank follows a simple Taylor rule.

[4] If households are ranked by financial wealth, the differences in wealth among the bottom 50% are small, and therefore I consider all these households in the same group.

the top 10% have a disproportionate influence on aggregate consumption relative to the middle class from the 50th to the 90th wealth percentile and the bottom 50% of the wealth distribution. The reason for this result is that households at the top substantially benefit from higher equity prices. These households have at least $350,000 in financial assets with a median of around $700,000. On average, around 80% of this wealth is held in the stock market. If a 25-basis-point accommodative policy shock leads to an increase in stock values of 1.25% (Bartscher, Kuhn, Schularick, and Wachtel (2022)), the wealth gain can be as large as their average monthly income. Even if the Marginal Propensity to Consume (MPC) out of capital gains is low and only a small fraction of these capital gains feeds into consumption, their magnitude implies that the effects on household expenditure can be significant. Importantly, households in the top 10% have the largest share of nondurable consumption relative to other wealth deciles. Therefore, the impact of their response on aggregate consumption is amplified. Intuitively, there are two effects of higher asset prices on household consumption: there is an income effect from realized capital gains and an income effect from unrealized capital gains. On one hand, households that sell their assets at a higher price realize a capital gain that partly feeds into consumption as emphasized in Fagereng, Gomez, et al. (2025). On the other hand, those households that hold on to their investments become wealthier, and this increases consumption. In the model, the consumption policy functions are increasing in wealth, and a substantial fraction of households do not adjust asset holdings. As a result, the wealth effects account for most of the effects of equity prices. On the other hand, the consumption response of households at the bottom of the wealth distribution is due to higher earnings and employment levels after an expansionary monetary policy shock since these households have few liquid assets and high MPCs.[5]

Next, I evaluate the welfare effects of an expansionary monetary policy across the distribution of financial wealth. One sometimes hears the argument that monetary policy increases stock valuations and these gains primarily accrue to wealthy households. So the claim is that expansionary policy primarily benefits the wealthy. I evaluate this claim by asking how the welfare of different groups is affected by a monetary expansion. I measure welfare using consumption equivalent variations. This consists in the percentage change in household consumption that will make individuals indifferent between the policy scenario and a case without any policy. This ultimately depends on the difference between the value function with monetary policy and the value function at the steady state. My first result is that the welfare gains are quantitatively small throughout the distribution of financial wealth. This reflects the fact that in the model, the effects of monetary policy are not very persistent and therefore have little impact on lifetime utility. Moreover, the increase in household labor supply partially offset the welfare gains from higher consumption. The second result is that households at the bottom of the wealth distribution gain the most from an expansionary monetary policy through higher labor earnings and consumption. The welfare effects at the top are either very small or even negative. The reason is that there are two opposite forces. Higher equity prices tend to generate large welfare gains

[5] Moreover, in the two-asset model, a large fraction of these households are net borrowers. Hence, lower interest rates directly stimulate consumption at the bottom of the distribution.

at the top. However, lower subsequent asset returns generate substantial welfare losses. These two effects tend to compensate each other, leading to small welfare effects at the top (Fagereng, Gomez, et al. (2025)).

In an extension of the baseline model, I use a two-asset HANK model with liquid assets and illiquid stocks to study the role of wealth composition and endogenous portfolio choices. The model reproduces well the composition of financial wealth in the US, even if this is not explicitly targeted in the calibration. Liquid assets, i.e. bank deposits and bonds, are the main saving devices at the bottom 50% of the distribution. Household portfolios are more balanced between bonds and stocks around the median of the wealth distribution as middle-class households begin to accumulate equity. Households in the top 10% of the distribution tilt their portfolios toward stocks. In the baseline one-asset model, the wealth composition is indeterminate, in this model instead changes in equity prices only affect stock portfolios. This specification also includes fiscal policy to take into account fiscal adjustments to monetary policy and a borrowing wedge in order to match the left tail of the wealth distribution. After an expansionary monetary policy shock, households will rebalance their portfolios away from bonds and toward stocks, increasing their exposure to equity prices and illiquid returns. The overall consumption responses tend to be U-shaped across wealth groups. The welfare gains are also very similar to the baseline model, with the larger gains that accrue to households at the bottom of the wealth distribution through higher labor earnings.

A final point worth discussing is the role of housing and mortgages. This is a potentially important transmission channel of monetary policy because middle-class and wealthy households tend to hold a substantial share of their wealth in home equity, and house prices are also responsive to monetary policy. However, explicitly modeling housing and mortgages is beyond the scope of this paper. Specifically, Bartscher, Kuhn, Schularick, and Wachtel (2022) compare the effects of monetary policy on stock prices and house prices and find a smaller and more delayed increase in house prices. Moreover, the analysis of the effects of monetary policy on house prices is complicated by the fact that house prices tend to have a substantial idiosyncratic component that reflects the location. However, differences in leverage can be important to understand the heterogeneous effects of monetary policy.[6] Adding this extra channel could potentially change the consumption responses across the distribution of liquid wealth. I leave the analysis of the effects of monetary policy in a model with home equity to future research.

In conclusion, while the role of low-wealth households is often emphasized in the literature, in this paper, I study the importance of top wealth groups within the HANK framework. I find that endogenous changes in the right tail of the wealth distribution matter for the distributional and aggregate effects of monetary policy. Wealth inequality amplifies the exposure of households at the top to monetary policy through equity prices and increases the top expenditure share. As a result, the expenditure decisions of wealthy households have a large impact on

[6]The average mortgage at the top 10% is $201,500 and $108,500 for middle-class households. This likely reflects the fact that households in the top 10% also tend to have the largest home equity in absolute value. By looking at leverage, defined as the housing debt to income ratio, I find 3.5 in the middle and 2.8 at the top. Hence, in the SCF data, wealthy households at the top have a lot of housing debt.

aggregate consumption.

Literature. This paper contributes to several strands of the large literature that investigates the relationships between household heterogeneity and the macroeconomy.

The first strand of the literature includes papers that study how household heterogeneity shapes the aggregate effects of monetary policy and fiscal policy and their distributional outcomes with quantitative HANK models (McKay, Nakamura, and Steinsson (2016), Kaplan, Moll, and Violante (2018), Gornemann, Kuester, and Nakajima (2022), Hagedorn, Manovskii, and Mitman (2019), Hagedorn, Luo, Manovski, and Mitman (2019) Laibson, Maxted, and Moll (2021), Wolf (2023), Lee (2021), Broer, Kramer, and Mitman (2023)). These studies emphasize the importance of liquidity constraints and household MPCs. I contribute to this literature by providing a quantification of the impact of different wealth groups on the response of aggregate consumption in a broad class of HANK models. I find a critical role of low-liquidity households, as in previous studies. Moreover, I show that the response of aggregate consumption substantially depends on the consumption response of top wealth groups. I also analyze the transmission channels of monetary policy across the wealth distribution and show that wealthy households at the top increase their consumption because of substantial capital gains due to changes in equity prices. This paper also adds to studies focusing on the relationship between heterogeneity and monetary policy. Some of these papers emphasize the macroeconomic implications of high-income household investment decisions (Luetticke (2021), Bilbiie, Kanzig, and Surico (2022), Melcangi and Sterk (2022)) and redistributive effects among wealth groups (Auclert (2019)). Other papers in this strand of the literature study the role of aggregate investment, risk premium, and liquidity premium as additional demand amplification channels (Auclert, Rognlie, and Straub (2020), Kekre and Lenel (2022), Bayer, Luetticke, Pham-Dao, and Tjaden (2019)). In a similar spirit, Auclert, Rognlie, Straub, and Tapák (2024) investigate the role of portfolio choices and find that endogenous portfolios and exogenous portfolios generate similar responses to monetary policy shocks. Relative to these papers, I highlight the importance of the consumption responses of wealthy households and connect these responses to changes in equity prices and in the wealth distribution. This paper focuses on the positive analysis of the monetary transmission mechanisms. Nevertheless, it is also connected to a strand of the literature that focuses on welfare (del Canto, Grigsby, Qian, and Walsh (2023)) and optimal monetary policy in the HANK framework (McKay and Wolf (2023)). Finally, this paper is related to studies that analyze the interactions between wealth inequality and monetary policy (Fernández-Villaverde, Marbet, Nuño, and Rachedi (2023), Fernández-Villaverde, Hurtado, and Nuño (2023)). The main contribution of the paper to the existing literature is to highlight the importance of household heterogeneity beyond liquidity constraints and MPCs. In the HANK framework, the dynamics of the wealth distribution due to valuation effects from equity prices matter for the effects of monetary policy on aggregate demand.

The paper also relates to the recent empirical literature investigating the heterogeneous effects of monetary policy and the monetary transmission mechanism to household consumption.

Overall, the findings in this paper are broadly consistent with the main results of these studies. In particular, Bartscher, Kuhn, Schularick, and Wachtel (2022) document that in the US, the stock market response to expansionary monetary policy shocks leads to large wealth gains for wealthy households. Chang and Schorfheide (2022) using CE data show that expansionary monetary policy shocks mostly increase consumption at the right tail of the distribution. The results in this paper also complement other quantitative studies that use microdata to analyze the effects of monetary policy (Cantore, Ferroni, Mumtaz, and Theophilopoulou (2023), Cloyne, Ferreira, and Surico (2020), Evans (2020), Coibion, Gorodnichenko, Kueng, and Silvia (2017), Slacaleky, Tristani, and Violante (2020)). Using administrative data from Norway Holm, Paul, and Tischbirek (2021) document U-shaped consumption responses to monetary policy shocks across the distribution of liquid assets. Amberg, Jansson, Klein, and Rogantini Picco (2022) using Swedish administrative data document substantial income gains at the top after interest rate cuts due to higher asset prices. These capital gains substantially outweigh the interest income losses. Andersen, Johannesen, Jorgensen, and Peydró (2023) using administrative data for Denmark also show that monetary policy leads to large income and wealth gains at the top through profits and stock prices. These effects tend to be an order of magnitude larger than the response of earnings and interest income. I find that in HANK models, changes in equity prices in combination with high wealth concentration in the stock market tend to outweigh interest income losses.

Finally, the paper contributes to studies analyzing the role of different elements for the quantitative properties of heterogeneous agent economies (Alves, Kaplan, Moll, and Violante (2020), Krueger, Mitman, and Perri (2016), Auclert, Rognlie, and Straub (2023)). I find that top wealth groups have a disproportionately large influence on aggregate consumption because of changes in households' wealth and equity prices. The importance of such wealth effects on consumption is well established in the literature (Caballero and Simsek (2020), Challe and Giannitsarou (2014)). I show that a large class of quantitative HANK models can capture these effects through endogenous changes in the wealth distribution.[7]

Outline. The remainder of the paper is organized as follows. Section 2 presents the baseline model. Section 3 describes the parametrization, calibration strategy, and validation of the model. Section 4 contains the main quantitative results on the effects of monetary policy and the monetary transmission mechanism across the distribution of financial wealth in the HANK framework. Section 5 concludes.

[7]More broadly, this contributes to theoretical and quantitative work that contrasts quantitative HANK models with more tractable models (Werning (2015), Kaplan and Violante (2018), Bilbiie (2021), Berger, Bocola, and Dovis (2023), Debortoli and Galì (2023)). Similarly, other studies investigate the monetary policy transmission mechanism using models with two agents (Debortoli and Galì (2018)) or the representative agent framework (Rupert and Sustek (2019)).

2 Model

For the analysis, I employ a Heterogeneous Agent New Keynesian model with capital and equity prices. Markets are incomplete. In the model, households are heterogeneous in their income and wealth and subject to a potentially binding borrowing limit. Following the New Keynesian literature, the model features sticky wages and prices due to adjustment costs. The model also features investment adjustment costs and a Tobin's q. The latter element introduces equity prices and capital gains as an additional channel through which monetary policy can affect households' income and wealth. Finally, to match the micro evidence on economic inequality in the US, I augment the model by incorporating idiosyncratic labor income risk with extraordinary states, i.e. realizations with high income levels, to include in the analysis households with top earnings.

2.1 The economy

Consider an economy in continuous time $t \in \mathbb{R}_+$ without aggregate risk. Markets are incomplete, households face idiosyncratic labor income risk e_t and accumulate liquid wealth a_t. Let $M = (X, \mathcal{X})$ be a measurable space where $(a, e) \in X = A \times E \subseteq \mathbb{R}^2$. Moreover, $\psi_t : M \to [0, 1]$ is the probability distribution over idiosyncratic states and f_t the associated density. Despite the absence of aggregate risk, macro variables can change over time due to unexpected monetary policy shocks given by an exogenous and deterministic path for the innovations of the nominal interest rate.

2.2 Households

Given a utility function $u(c_t, n_t)$ separable in consumption c_t and labor supply $n_t \in [0, 1]$, and given real wages w_t, bond returns r_t, stock market dividends d^s_t, and equity price q_t, household earnings $y_t := w_t e_t n_t$, state variables and initial conditions, households decide c_t solving

$$\max_{c_t} \ \mathbb{E}_0 \int_0^\infty e^{-\rho t} u(c_t, n_t) dt, \tag{1}$$

$$\text{s.t. } q_t \dot{k}_t + \dot{b}_t = w_t e_t n_t + d^s_t k_t + r_t b_t - c_t,$$

$$a_t \geq 0.$$

Household total assets $a_t = q_t k_t + b_t$ consist of bonds in positive net supply and equity shares in an investment fund. In equilibrium, because of no-arbitrage conditions, the returns on all the assets in the economy are equalized $r_t = d^s_t / q_t + \dot{q}_t / q_t$. Household balance sheets feature two main income sources. Household labor earnings $w_t e_t n_t$ and total financial income $r_t a_t$ that includes interest payments, dividends, and capital gains. Since household wealth a_t reflects the market value of equity shares, any valuation effect due to changes in the equity price q_t will be captured by changes in the initial wealth distribution.

Following the literature, I introduce labor market unions that intermediate household labor supply. (Auclert, Rognlie, and Straub (2023), Hagedorn, Manovskii, and Mitman (2019)). Unions set nominal wages by maximizing the average welfare of the households, and determine household labor supply, which is assumed to be equal for all households and given by n_t. In particular, a competitive recruiting firm aggregates a continuum of differentiated labor services indexed by $j \in [0, 1]$ by maximizing profits subject to a CES aggregator

$$\max_{N_{jt}} \ W_t N_t - \int_0^1 W_{jt} N_{jt} dj, \tag{2}$$

$$N_t = \left(\int_0^1 N_{jt}^{\frac{\epsilon_w - 1}{\epsilon_w}} dj \right)^{\frac{\epsilon_w}{\epsilon_w - 1}},$$

where W is the nominal wage, N is the aggregate labor demand or hours, and ϵ_w is the elasticity of substitution across differentiated labor inputs. This implies a CES demand for labor services of type j given by

$$N_{jt} = \left(\frac{W_{jt}}{W_t} \right)^{-\epsilon_w} N_t.$$

Households supply a continuum of labor services which are imperfect substitutes, and for each labor input j, a union sets the nominal wage to maximize the average welfare of the union members, taking their marginal utility of consumption u' and the labor disutility v as given. Let C_t be aggregate consumption and p_t the consumer price index, the union solves the problem

$$\max_{\dot{W}_{jt}} \ \int_0^\infty \left[\exp\left(- \int_0^t r_s ds \right) \left(\int_0^1 \frac{W_{jt}}{p_t} N_{jt} - \frac{v(N_{jt})}{u'(C_t)} - \frac{\Psi_w}{2} \left(\frac{\dot{W}_{jt}}{W_{jt}} \right)^2 N_t dj \right) \right] dt \tag{3}$$

$$\text{s.t. } N_{jt} = \left(\frac{W_{jt}}{W_t} \right)^{-\epsilon_w} N_t.$$

Let the wage markup $\mu_w := \epsilon_w / (\epsilon_w - 1)$, in a symmetric equilibrium with $W_{jt} = W_t$ and $N_{jt} = N_t$, we obtain a wage Phillips curve given by

$$\pi_{w,t} \left(r_t - \frac{\dot{N}_t}{N_t} \right) = \dot{\pi}_{w,t} + \frac{\epsilon_w}{\Psi_w} (mrs_t - w_t \mu_w^{-1})$$

This equation connects labor supply decisions to the real wage, the marginal rate of substitution between labor and consumption $mrs_t := v'(N_t)/u'(C_t)$ and wage inflation $\pi_{w,t}$. Introducing labor market unions in the HANK framework implies a clear separation between consumption decisions and labor supply decisions. This simplifies the analysis and allows me to concentrate the complexity of the model on the consumption decisions and on the wealth distribution.[8] For reasons that I will discuss in detail later in this section, assuming sticky wages helps generate a more realistic response of household earnings to monetary policy.

[8]At the same time, removing unions and allowing for direct labor supply decisions by households does not substantially change the main results.

2.3 Firms

A representative firm produces a final good Y_t with price p_t using a Constant Elasticity of Substitution (CES) technology that aggregates a continuum of intermediate inputs Y_{it}, indexed by $i \in [0,1]$, with price p_{it}. The elasticity of substitution of intermediate goods is given by $\epsilon_p > 1$. The representative firm operates in a perfectly competitive market and solves the following profit maximization problem

$$\max_{Y_{it}} \; p_t Y_t - \int_0^1 p_{it} Y_{it} di, \tag{4}$$

$$\text{s.t. } Y_t = \left(\int_0^1 Y_{it}^{\frac{\epsilon_p - 1}{\epsilon_p}} di \right)^{\frac{\epsilon_p}{\epsilon_p - 1}},$$

This problem yields the iso-elastic demand for intermediate good i, $Y_{it} = (p_{it}/p_t)^{-\epsilon_p} Y_t$. together with the price index $p_t = (\int_0^1 p_{it}^{1-\epsilon_p} di)^{\frac{1}{1-\epsilon_p}}$. See the Online Appendix A.1 for the analytical derivations associated to (4). Input producers operate in monopolistic competition. They demand capital K_{it} and labor N_{it} to minimize production costs given real wages, the rental rate of capital r_t^k, and the production function F with constant returns to scale.

$$\min_{K_{it}, N_{it}} w_t N_{it} + r_t^k K_{it}, \tag{5}$$

$$\text{s.t. } Y_{it} = F(K_{it}, N_{it}),$$

This optimization problem implies that all firms operate with the same capital-labor ratio and face the same marginal costs. Firms also set prices to maximize the present value of nominal profits subject to the market demand and a price adjustment cost function. Let m_{it} denote nominal marginal costs and let i_t be the nominal interest rate. Then, intermediate producers solve the following problem

$$\max_{\dot{p}_{it}} \int_0^\infty \left[\exp\left(- \int_0^t i_s ds \right) \left((p_{it} - m_{it}) Y_{it} - \frac{\Psi_p}{2} \left(\frac{\dot{p}_{it}}{p_{it}} \right)^2 p_t Y_t \right) \right] dt \tag{6}$$

$$\text{s.t. } Y_{it} = \left(\frac{p_{it}}{p_t} \right)^{-\epsilon_p} Y_t.$$

From the characterization of the solution to (4), (5), (6) we can derive a price Phillips curve where $\mu_p := \epsilon_p/(\epsilon_p - 1)$ is the price markup. The Online Appendix A.1 contains further details on the analytical derivations.

$$\pi_t \left(r_t - \frac{\dot{Y}_t}{Y_t} \right) = \dot{\pi}_t + \frac{\epsilon_p}{\Psi_p} (mc_t - \mu_p^{-1}).$$

The link between price inflation and wage inflation is given by $\dot{w}_t / w_t = \pi_{w,t} - \pi_t$. So, real wages will adjust following the gap between wage and price inflation.

2.4 Financial sector

In the financial sector, there is an investment fund that collects household savings through equity shares. The fund owns the economy's capital stock K_t. Moreover, the fund rents capital to the intermediate firms and collects $D_t = Y_t – w_t N_t$ including both rental income and firms' profits. The fund also invests in new capital, facing investment adjustment costs χ_t. Let $\iota_t = I_t/K_t$ be the investment rate and $d_t := D_t/K_t$ the dividend rate. The investment fund solves the problem

$$V_0 := \max_{\iota_t} \int_0^\infty \left[\exp\left(-\int_0^t r_s ds \right) \left((d_t - \iota_t - \chi_t(\iota_t))K_t \right) \right] dt \tag{7}$$

$$\text{s.t. } \dot{K}_t = (\iota_t - \delta)K_t.$$

The value of the fund V_t is given by $V_t = q_t K_t$, where q_t is Tobin's q, $q_t K_t$ is the market value of the aggregate stock of capital. The stock market dividends are given by $d_t^s := d_t - \iota_t - \chi_t(\iota_t) + (\iota_t - \delta)q_t$. In equilibrium, a no-arbitrage condition between the return on wealth and the return on capital holds. See the solution to (7) in Online Appendix A.2.

2.5 Monetary policy

The nominal interest rate i_t and the real interest rate r_t are related through a Fisher equation, i.e. $i_t = r_t + \pi_t$, where $\pi_t := \dot{p}_t/p_t$ is the inflation rate. The central bank sets nominal interest rates according to the simple Taylor rule

$$i_t = r + \phi_\pi \pi_t + v_t,$$

where r is the steady state level of the real interest rate and $\{v_t\}_{t\geq 0}$ is an interest rate policy given by $v_t = e^{-\eta t} v_0$. At the steady state $v_0 = 0$. In this paper, I study the response of the economy to unexpected monetary policy innovations v_t.

2.6 Equilibrium

The equilibrium of the economy is given by paths for household decisions $\{c_t, n_t\}_{t\geq 0}$, aggregate variables $\{K_t, N_t, Y_t, I_t, C_t, D_t\}_{t\geq 0}$, prices $\{r_t, q_t, w_t, \pi_t, \pi_{w,t}\}_{t\geq 0}$, and monetary policy $\{v_t\}_{t\geq 0}$ such that in every period: (i) households solve (1), (2), (3) given equilibrium prices, (ii) firms solve (4), (5), (6), (7) given equilibrium prices, (iii) the sequence of density functions $\{f_t\}_{t\geq 0}$ is consistent with the household policy functions and aggregate variables, (iv) monetary policy follows a Taylor rule, and (v) financial and labor markets clear

$$q_t K_t + B = \int_X a_t d\psi_t, \tag{8}$$

$$N_t = \int_X e_t n_t d\psi_t. \tag{9}$$

2.7 Discussion of the model

In this section, I discuss in detail specific aspects of the model and some of the assumptions. Specifically, I begin with the role of equity prices and how asset prices interact with the wealth distribution. Then, I discuss the assumption of sticky wages and the cyclical properties of profits. Finally, I provide an overview of the solution methods and add to the model a time-varying risk premium to match the response of stock prices to monetary policy shocks.

First of all, note that the equilibrium in financial markets connects the supply of savings by households to the demand of savings by firms. Thus, households' wealth held in public equity equals the market value of the capital demand by firms. To see this, note that $K_t = \int_0^1 K_{it} di$ and $V_t = q_t K_t$. It is important to highlight that the presence of q_t in the model has implications for the dynamics of the wealth distribution. Specifically, after a monetary policy shock, q_t changes on impact, while aggregate capital is a predetermined state variable that does not change on impact and slowly adjusts to the shock over time. Thus, from $V_t = q_t K_t$ and Equation (8) we can see that household market wealth a_t has to "jump" as monetary policy induces a valuation effect via q_t. I assume that households hold the same equity-bond portfolio shares as in the aggregate.[9] This implies that the model generates endogenous changes in the wealth distribution due to variations in asset prices q_t after a monetary policy shock. Wealth concentration implies that these capital gains due to changes in equity prices are concentrated at the top. In this paper, I leverage the model to assess the importance of these effects on aggregate demand.

In the baseline version of the model, I also assume nominal wage rigidities and nominal price rigidities. For simplicity, I also assume that wage adjustment costs and price adjustment costs are virtual, namely, these costs only affect optimal decisions but not real resources as in Hagedorn, Manovskii, and Mitman (2019). The assumption of sticky wages implies that profits are procyclical after a monetary policy shock. This is important to generate the right sign in the response of stock prices to monetary policy, as the fundamental value of stocks is given by the discounted stream of dividends.

The recursive formulation of the household optimization problem and the law of motion of the density f_t are given by Hamilton-Jacobi-Bellman (HJB) and Kolmogorov forward (KF) equations, see the Online Appendix B. These are two partial differential equations, and their exact formulation depends on the parametrization of the stochastic process for earnings e_t presented in Section 3. In this paper, I analyze the steady state and dynamics of the fully nonlinear model using global methods. The algorithms share the same basic structure: an inner loop solves the HJB and KF equations using finite difference methods as in Achdou, Han, Lasry, Lions, and Moll (2022), and an outer loop implements a continuous time version of the sequence-space method from Auclert, Bardóczy, Rognlie, and Straub (2021). The HJB and KF solution method leverages the sparsity of the matrices used to approximate these equations. Since I rely on a flexible continuous-time Markov process for income risk e_t, the HJB and KF equations

[9] One could allow for more realistic portfolios by taking those positions directly from the data. However, I found small differences relative to the baseline. For the role of portfolio choices, see the results from a two-asset model in the Online Appendix D.

feature expected values. However, even though the presence of integrals in the HJB and KF equations increases the computational burden, the algorithms to solve these equations remain efficient. The Online Appendix C contains further details on the numerical solutions.

I also augment the model with a time-varying excess bond premium or excess return r^x_t in order to generate large fluctuations in stock prices.[10] This variable is an exogenous wedge in the no-arbitrage condition of the investment fund.[11] Specifically, I assume that

$$r_t + r^x_t = \frac{\dot{q}_t}{q_t} + (\iota_t - \delta) + \frac{d_t - \iota_t - \chi_t(\iota_t)}{q_t}$$

Here, a drop in r^x_t raises stock prices as it decreases the discount rate of dividends. This is equivalent to a risk-premium shock. To see this point, one can solve forward the no-arbitrage condition above to obtain the fundamental value of stock prices in the model

$$q_t = \int_t^\infty \exp\Big(-\int_t^\tau (r_s + r^x_s - \iota_s + \delta)ds\Big)\Big(d_\tau - \iota_\tau - \chi_\tau(\iota_\tau)\Big)d\tau,$$

In line with the empirical literature, I assume that after an expansionary monetary policy shock that reduces the short-term interest rate r_t, there is also a drop in the excess return r^x_t. The combination of these effects raises the discount factor and stock prices. The fall in the bond premium is calibrated to match the response of the bond premium to a 1% interest rate cut observed in the data.[12] This specification implies that most of the changes in stock prices are driven by changes in discount rates. However, exactly disentangling the source of variation of stock prices between short-term interest rates, excess returns, or dividends goes beyond the scope of this paper. Large asset price movements are hard to generate in a basic Tobin's q model. To deliver large or volatile asset price movements, the model needs additional mechanisms that amplify shocks. For example, adding financial constraints can make asset prices more sensitive to shocks. When firms or households borrow against collateral, which depends on asset prices, a small decline in asset prices tightens borrowing constraints, reducing investment and output, and this further lowers asset prices. Alternatively, asset prices depend on discounted future returns, if expectations of future profitability or capital gains change suddenly with monetary policy, stock prices can move a lot. Analyzing the implications of different mechanisms is a promising avenue for future research. The primary focus of this paper remains on understanding the impact on consumption and welfare of realistic changes in asset prices and in the distribution of liquid wealth following a monetary policy shock.

[10]Define the short-term policy interest rate as r_t, the return on corporate bonds as $r^b_t := r_t + r^x_t$, and the return on equity shares as r^e_t. The excess return $r^x_t = r^e_t - r_t = r^b_t - r_t$ can be interpreted as an excess bond premium or as an excess equity premium, given that in the model the returns between bonds and stocks are equalized.

[11]For simplicity, I further assume that this premium is zero at the steady state. Outside of the steady state, the overall return on households' savings is given by $r_t + r^x_t$.

[12]This implies a fall at impact of roughly 30 basis points in the excess premium. The estimates in Gertler and Karadi (2015), Bauer and Swanson (2023) imply a reduction at impact in the excess bond premium of around 30-40 basis points for a 1% interest rate cut. I assume that r^x_t has the same persistence of the monetary policy shock with a quarterly autocorrelation of 0.61.

3 Parametrization

In this section, I outline the parametrization of the model, the calibration strategy, and assess the model's empirical performance. I quantify the parameters of the model with two goals. The model should reproduce the US wealth and earnings distributions.

3.1 Functional forms and stochastic processes

I parametrize preferences and production technology using standard functional forms. In particular, for the instantaneous utility I use a CRRA function given by

$$u(c_t, n_t) = \frac{c_t^{1-\gamma}}{1-\gamma} - \frac{n_t^{1+\nu}}{1+\nu},$$

with $\gamma \geq 0, \nu \geq 0$, where $1/\gamma$ is the elasticity of intertemporal substitution and $1/\nu$ is the Firsch elasticity of labor supply. The production technology is Cobb-Douglas,

$$Y_{it} = K_{it}^{\theta} N_{it}^{1-\theta},$$

and the investment adjustment costs are quadratic,

$$\chi_t = \frac{\kappa}{2}(\iota_t - \delta)^2.$$

Labor income risk follows a continuous-time Markov process. I specify this process following the approach of Castañeda, Díaz-Giménez, and Ríos-Rull (2003), Poschke, Kaymak, and Leung (2022) that combines normal states with extraordinarily high states. In particular, the idiosyncratic component of labor income follows a Poisson process. The process jumps from normal states to extraordinary earning states with arrival rate λ_1, and switches back from top states to any of the normal states with arrival rate λ_2. There are two extraordinary earning states e_1, e_2 with transition probabilities θ_1, θ_2 such that $\theta_1 + \theta_2 = 1$. The new income realization is drawn from the distribution Φ_e with probability function ϕ_e. Moreover, households transit between normal states at the rate λ_e according to the conditional distribution F_e characterized by a stochastic matrix. I obtain these transition probabilities between normal states from a discrete-state approximation to an AR(1) process for $\ln e_t$ obtained from a finite difference approximation to a continuous-time Ornstein–Uhlenbeck process for $\ln e_t$. The process is parametrized by an autoregressive coefficient equal to $1 - \nu_e$ and a standard deviation rate σ_e of quarterly shocks $\hat{w}_{e,t} \sim N(0, \sigma_e^2 \Delta t)$. This substantially reduces the number of parameters that characterize F_e. Given the transition probabilities, I compute the stationary probabilities over the normal states ϕ_e from which households that leave the top states draw their new normal income state. These objects fully characterize the continuous-time Markov process for labor income risk that I use in the model.

3.2 Calibration

The model is calibrated at a quarterly time frequency to US microdata in 2004, before the Great Recession. The main data source for the joint distribution of income and wealth is the Survey of Consumer Finances (SCF).[13] I focus on liquid financial wealth, and I define wealth as the difference between assets and liabilities, excluding home equity, privately held business, and mortgages. Specifically, assets are given by bank deposits, corporate and government bonds, and stocks. Liabilities are given by consumer credit. Earnings are given by wages, salaries, and business income. Market income is the sum of earnings, financial income, and capital gains or losses. I first chose the values of a set of parameters following the literature. Then, I jointly calibrate the remaining parameters describing earning dynamics to reproduce key features of the distributions of earnings and wealth in the US. Table 1 reports the parameters' values.

I set the preference parameters γ, ν, the borrowing limit ϕ, depreciation rate δ, and the Taylor coefficient ϕ_π to values common in the literature. In the data, we observe that the mode of the wealth distribution is close to zero. Models with a potentially binding borrowing limit generate a mass of households at the constraint. The value for ϕ implies that the wealth distribution has a point mass of households at zero, as in the data. Following the New Keynesian literature, I set the intermediate goods elasticity ϵ_p to match a steady state markup equal to 11%, and the price adjustment cost parameter Ψ_p to match a slope of the price Phillips curve ϵ_p/Ψ_p of 0.1. Following the literature, I use the same value of ϵ_p for the labor elasticity ϵ_w and assume that wages are more sticky than prices ($\Psi_w = 300$). I set the Poisson arrival rate $\lambda_e = 1$ so that shocks arrive on average once in each quarter and the persistence of income risk is fully determined by its transition probabilities. The values for ν_e, σ_e imply an annual autocorrelation for $\ln e_t$ equal to 0.9 and a standard deviation rate of innovations equal to 0.2. These values are consistent with typical estimates of AR(1) models at annual frequency.[14]

I choose the discount rate ρ, the parameters describing the income process $e_1, e_2, \lambda_1, \lambda_2, \theta_1$, the capital elasticity θ, and the bond net supply B, to jointly match statistics characterizing wealth and income inequality. In particular, aggregate wealth-income ratio, bonds-income ratio, public equity-income ratio, the gini coefficients of earnings and wealth, the earning shares of the top 0.1%,1%, the fraction of low-wealth households, and the 30% probability of leaving the top 1% of the earnings distribution after 1 year (Kopczuk, Saez, and Song (2010)).[15] Finally, I choose κ to match investment volatility relative to output. I target a ratio between the peaks of the investment and output response to interest rate cuts of 2 (Christiano, Eichenbaum, and Evans (2005), Christiano, Eichenbaum, and Trabandt (2016)).

[13] In particular, I use the extract from the SCF by Kaplan, Moll, and Violante (2018). This dataset is based on the data constructed in Weidner, Kaplan, and Violante (2014). The sample restricts individuals' age to 22-79.

[14] As in Guvenen, Kambourov, Kuruscu, Ocampo, and Chen (2023), Krueger, Mitman, and Perri (2016). In particular, the autocorrelation's value is on the lower bound of empirical estimates since I do not separately model transitory shocks. Moreover, as the main purpose of the labor income shocks is to produce sufficient dispersion in earnings, I assume that the variance of innovations at the quarterly frequency is the same at the annual frequency.

[15] I compute this moment in the model using transition rates across the stationary earnings distribution.

Table 1: Model parameters

Parameter	Description	Value	Source
Households			
γ	CRRA/Inverse IES	1	External
ν	Inverse Frisch elasticity	1	External
ϕ	Borrowing limit	0	External
B	Bond supply	1.8	Internally calibrated
ρ	Individual discount rate (p.a.)	0.09	Internally calibrated
Income process			
λ_e	Arrival rate normal states	1	External
ν_e	Mean reversion coeff.	0.0263	External
σ_e	S. d. of innovations	0.2	External
θ_1	Transition probability to e_1	0.6	Internally calibrated
λ_1	Arrival rate top states	0.00028	Internally calibrated
λ_2	Arrival rate leave top states	0.1	Internally calibrated
e_1, e_2	Top earnings states	20, 70	Internally calibrated
Firms and policy			
Ψ_p, Ψ_w	Adjustment costs	100, 300	External
ϵ_p, ϵ_w	Elasticities of substitution	10, 10	External
δ	Depreciation rate (p.a.)	0.07	External
θ	Capital elasticity	0.1	Internally calibrated
κ	Investment adjustment cost	25	Internally calibrated
ϕ_π	Taylor coeff.	1.25	External

Aguiar, Bils, and Boar (2021) using PSID data find that around 40% of US households are liquidity constrained, Weidner, Kaplan, and Violante (2014) find a value around 30%. I target a fraction of constrained households of 30%, at the lower bound of empirical estimates.[16] This choice has advantages and limitations. On one hand, it allows the model to match the overall fraction of constrained households in the economy, and this delivers a realistic average marginal propensity to consume. On the other hand, the joint distribution of MPCs and liquid wealth features MPCs that sharply decline with liquid wealth.

[16] In the Online Appendix E.2 I provide further details on the identification of low-liquidity households and their distribution across wealth deciles in the US.

Although the parameters affect all moments, the discount rate is more important for the wealth-output ratio and the share of liquidity-constrained households. The parameters related to income risk are more important for the Gini coefficients and earnings shares. Bond supply and capital elasticity are important to match the composition of financial wealth. The arrival rate at which households leave top-earning states is key to matching the persistence of top earnings. The calibration strategy delivers a total of 9 parameters and 10 targeted statistics.

3.3 Model performance and validation

Overall, the model captures the targeted statistics quite well. Table 2 shows that the aggregate amount of liquid financial wealth relative to annual income, the Gini coefficients of earnings and wealth, and the fraction of low-liquidity households in the model are close to their data counterparts. The model also matches the composition of the average financial wealth between bonds and public equity. The top earning states e_1, e_2 are respectively 16, 56 times the average of the income process, and only 0.16%, 0.1% of households enjoy these states. The aggregate return to liquid wealth is around 4%. In the remainder of this section, I discuss how the model fits untargeted statistics that are relevant to my analysis: wealth shares, including the very top of the distribution, the income distribution, and the MPCs across the wealth distribution.

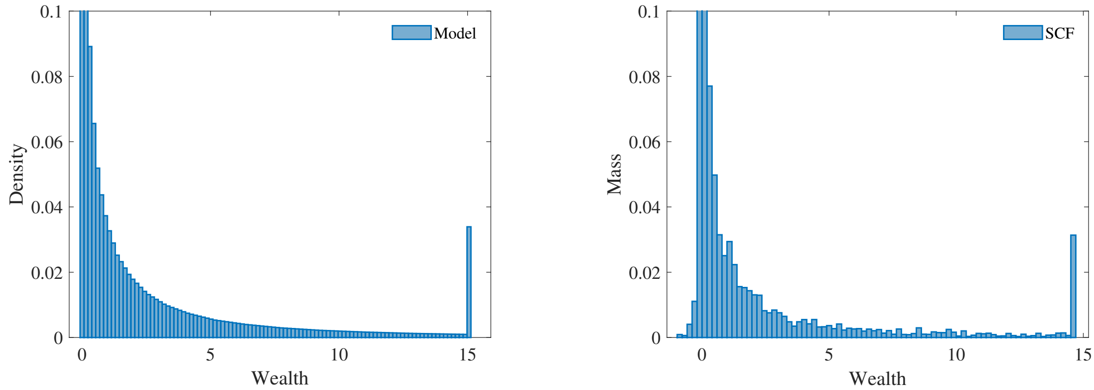
Table 2: Targeted statistics

Targeted Statistics	Data	Model	Targeted Statistics	Data	Model
Wealth-income ratio	2.5	2.5	Gini wealth	0.87	0.84
Bonds-income ratio	0.5	0.5	Gini earnings	0.59	0.53
Equity-income ratio	2	2	Top 0.1% earnings share	6	6
Fraction with $a = 0$	0.3	0.3	Top 1% earnings share	16	14

Note: data source: SCF 2004 and Weidner, Kaplan, and Violante (2014). Income corresponds to $68,000 of average annual earnings.

The model generates realistic wealth shares up to the top 1% of the distribution. The wealth share at the top 1% is 35% in the data and 25% in the model, while for the top 10% it is 77% in the data and 74% in the model. This is despite the fact that I calibrate the income process to generate a realistic income distribution rather than use it to match top wealth shares. This success mostly reflects the choice to only target financial wealth, excluding housing and business income from the definition of wealth. Overall, the model can generate high levels of wealth inequality. Therefore, I keep this calibration as the baseline.

Wealth distribution. I begin analyzing the wealth distribution in the model and in the SCF. Figure 1 shows, on panel (a), the wealth histogram in the model and on panel (b) the wealth histogram in the SCF. In both cases, wealth is measured relative to mean annual earnings. In the SCF sample, the average annual earnings are around \$68,000. In the panels, all wealth values above 1 million or around 15 times the average income are top-coded and reported as a fraction of the total population. The model successfully reproduces the right tail of the wealth distribution and the point mass of households with almost zero wealth.



(a) (b)

Figure 1: Wealth histograms

Note: Wealth values $\hat{a}$ are in terms of average annual income. The wealth distribution in the model is on panel (a), the wealth distribution in the SCF on panel (b). Fraction of households in different wealth bins: $P(\hat{a} \leq 0.1) \approx .3$ in the data and in the model, $P(\hat{a} \geq 14.5) \approx .03$ in the data and in the model.

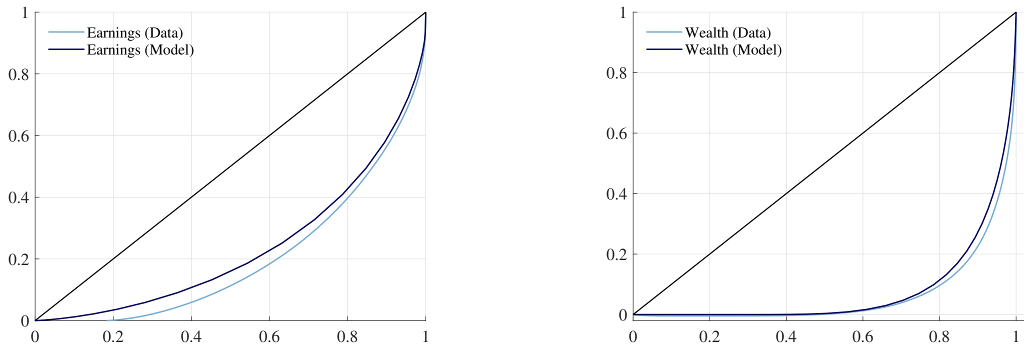
Table 3 reports additional wealth statistics. The model generates realistic wealth holdings for the median households, and the top percentiles are also close to their data counterparts.

Table 3: Wealth percentiles

Wealth statistics	Data	Model	Wealth statistics	Data	Model
Mean wealth	2.5	2.5	90th percentile	5	5
Median wealth	0.17	0.11	95th percentile	10	10
75th percentile	1.3	1.4	99th percentile	34	34

Note: Wealth values are in terms of average annual income.

Income and wealth. Figure 2 shows that the model broadly matches the distributions of earnings and wealth. Panel (a) shows the Lorenz curve for earnings in the SCF and in the model. Panel (b) shows the Lorenz curve for wealth. Each figure reports the share of total earnings or wealth on the y-axis and the population percentiles on the x-axis. Panel (a) in Figure 2 shows that in the model, the quintiles of earnings are close to the empirical quintiles. These estimates are less precise at the bottom of the earnings distribution. This is due to the fact that in the data, the bottom 20% of the distribution has almost zero market income and mostly relies on public transfers. On the other hand, the model captures almost exactly the earning shares of top percentiles, including those not targeted in the calibration. Panel (b) in Figure 2 shows that the wealth quintiles in the model also replicate well the empirical quintiles. In particular, the model generates sizable wealth shares of the top percentiles.



(a) (b)

Figure 2: Lorenz curves

The nature of the income process can generate a high concentration of earnings, leading to a high concentration of wealth since earnings and wealth are positively correlated: households with persistently high-income realizations accumulate large fortunes.

Consumption and wealth. In the model, as in the data, households at the top 10% of the wealth distribution have the largest consumption share relative to other wealth deciles. Regarding the MPCs, the literature considers 15-25 percent as the empirical benchmark for the average quarterly MPC out of a $500 transfer (Broda and Parker (2014), Parker, Souleles, Johnson, and McClelland (2013), Fagereng, Holm, and Natvik (2021)). In the model, the quarterly average MPC is 14% and the MPC of the top 10% of the wealth distribution is 3%.[17]

[17] Di Maggio, Kermani, and Majlesi (2020), Chodorow-Reich, Nenov, and Simsek (2021) study the MPC out of stock market wealth gains and find an average annual MPC around 3%. However, despite these quantitative differences, the model generates relatively low MPCs at the top of the wealth distribution.

4 Quantitative Analysis

This section contains the main quantitative results of the paper. As discussed, the model is consistent with key aspects of the distribution of consumption, income, and wealth in the US. I now use the model to map this micro evidence into consumption responses to monetary policy. This allows me to quantify the relative importance of different wealth groups for the response of aggregate consumption to monetary policy and to analyze the role of wealth concentration for the transmission mechanisms of monetary policy. Throughout this section, I study the impulse responses to an unexpected monetary policy shock. The policy shock is a 25 basis point reduction in the nominal interest rate or a 1% annualized cut in the nominal interest rate. The corresponding quarterly innovation at $t = 0$ is given by $v_0 = -0.0025$. The shock mean-reverts at rate $\eta = 0.5$ so that the quarterly autocorrelation $e^{-\eta} = 0.61$, as in the empirical estimates (Christiano, Eichenbaum, and Evans (2005), Gertler and Karadi (2015)). This section of the paper is organized as follows. First, I present the impulse responses of aggregate variables to monetary policy with a particular focus on the response of aggregate consumption, and on the response of the variables that primarily affect households' balance sheets, such as interest rates, equity prices, and earnings. Then, I study the cross-sectional consumption responses of the model and how wealth concentration shapes the transmission channels of monetary policy to aggregate consumption. I conclude by studying the welfare effects of monetary policy shocks.

4.1 Aggregate responses

I begin by analyzing the response of aggregate variables to the expansionary monetary policy shock. After a nominal interest rate cut, the real interest rate falls, which stimulates consumption and investment. In response to an increase in aggregate demand, firms raise prices and increase production because of nominal price rigidities. As firms increase production, the demand for capital and labor inputs increases, and this leads to higher income for households that further stimulates investments and consumption.

In the model, the rise in firms' labor demand leads to higher employment levels, while real wages respond little due to sticky nominal wages and prices. Therefore, employment is the most important component driving the increase in household earnings. On the financial side, lower interest rates benefit net borrowers and reduce the interest income of wealthy households. This is in line with the empirical evidence on the effects of monetary policy shocks. Importantly, the equity price q_t increases by 1% on impact, and because wealth is highly concentrated, these capital gains mostly benefit households at the top 10% of the wealth distribution. Bernanke and Kuttner (2005), Bartscher, Kuhn, Schularick, and Wachtel (2022) estimate that a 100 basis points reduction in the policy rate on average increases the stock market index by 4-5% and around 1% at the lower bound of the 90% confidence interval. So, my calibration is conservative because the model understates the magnitude of changes in stock prices. However, it still produces an empirically realistic stock market response to monetary policy.

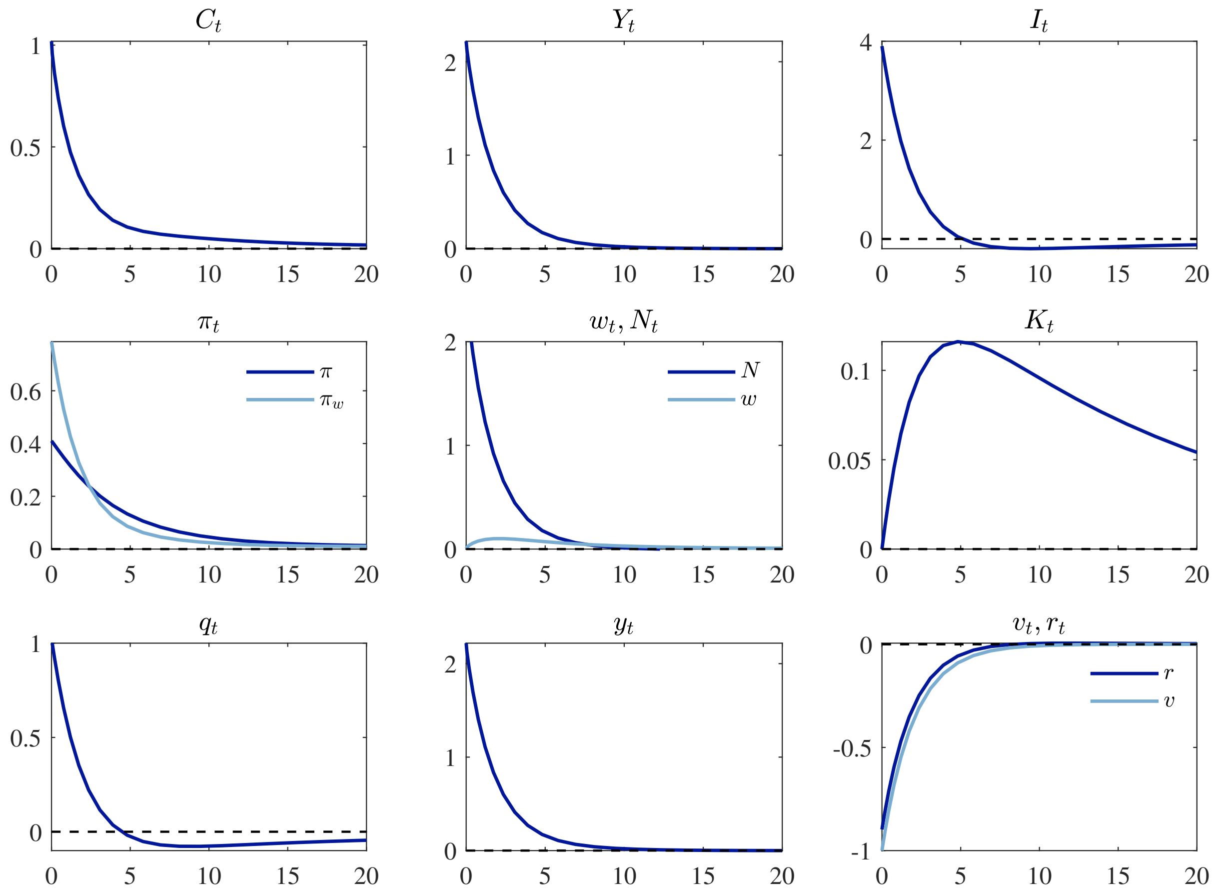


Figure 3: Impulse responses to a 1% reduction in the nominal interest rate.

Note: The figure shows the responses of output, consumption, investment, price inflation, wage inflation, real wages, employment, aggregate capital, equity prices, household earnings, the real interest rate (p.a.) and the monetary policy shock (p.a.) over quarters and in % deviation from steady state.

Figure 3 shows the responses of prices and aggregate demand components to the expansionary monetary policy shock. Investment responds more than output, which responds more than consumption. This is qualitatively in line with the empirical evidence. Quantitatively, these responses are also realistic and broadly consistent with the range of empirical estimates.[18] Specifically, the model quantitatively reproduces strong aggregate demand effects. Moreover, monetary policy has a significant impact on equity prices. The remainder of this section studies the cross-sectional responses and how wealth concentration shapes the distributional and aggregate effects of monetary policy in the HANK framework.

[18] Christiano, Eichenbaum, and Evans (2005) find that the average magnitude of the responses' peaks for consumption, output, and investment is approximately about 0.2%, 0.5%, and 1%. Coibion, Gorodnichenko, Kueng, and Silvia (2017) find that the average responses of consumption and output are around 1% and 1.5% at the upper bound of the empirical estimates. For Norway, Holm, Paul, and Tischbirek (2021) find that the responses for consumption, output, and investment are about 1%, 2%, and 4% after a year.

4.2 Consumption responses

In this section, I explore households' consumption responses to monetary policy and illustrate their macroeconomic implications. Specifically, I decompose the contributions of different wealth groups to the response of aggregate consumption. The analysis is based on a definition of wealth groups that is independent from monetary policy. In particular, wealth groups are defined at the steady state using the stationary distribution of financial wealth, before the monetary policy shock. Then, for each wealth group, I follow the same households over time and record their consumption. This yields a consumption panel for all households in the economy, and aggregating these consumption paths, I obtain the total consumption response of each wealth group.[19] Moreover, in this paper, I study the consumption response of each group as a fraction of steady state aggregate consumption. These consumption responses measure the contribution of each wealth group to the aggregate consumption response. To see this, note that the response of aggregate consumption is a weighted average of consumption changes of different wealth groups with weights given by the steady-state consumption shares of each wealth group.

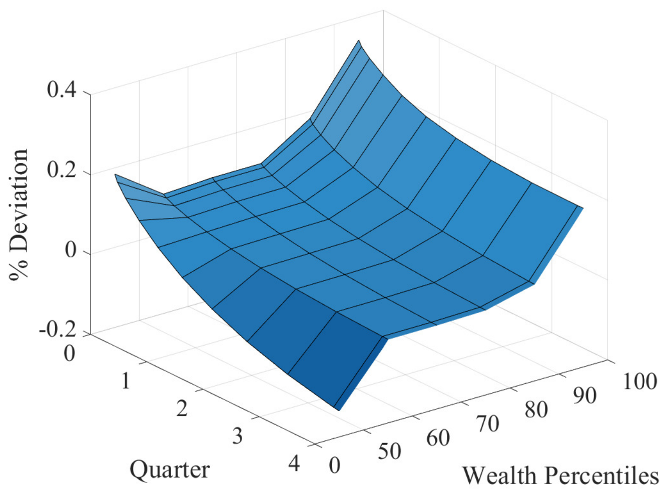


Figure 4: Consumption responses to a 1% reduction in the nominal interest rate.

Note: The figure shows the consumption responses across the wealth distribution in percentage deviation from steady-state aggregate consumption.

Figure 4 shows the consumption responses across wealth groups at different time horizons after the monetary policy shock.[20] Households at the tails of the wealth distribution display large responses. High-wealth households and low-wealth households account for most of the increase

[19]Note that these computations require iterating forward in time the conditional distribution of each group because household wealth and income states change over time and the panel responses should account for these dynamics. For example, households that in the third quarter are in the fourth wealth decile are households that were in the fourth wealth decile at impact. Hence, their wealth in quarter three can be below the 40th percentile or above the 50th percentile of household wealth in the third quarter.

[20]Given that there is very little heterogeneity in terms of wealth holdings at the bottom 50% of the distribution, I consider all these households in the same group.

in aggregate consumption. This is a common prediction of HANK models on the cross-sectional effects of monetary policy when we include equity prices in the analysis. Here, I leverage the model to isolate the key mechanisms that generate U-shaped consumption responses to monetary policy. There are several factors contributing to this result. In particular, these responses show that HANK models endogenously generate three broad types of households.

First, there are households at the bottom 50% of the wealth distribution who are the most responsive to monetary shocks. All these households have a high marginal propensity to consume. This is due to the fact that they are either liquidity-constrained or unconstrained but with high MPCs because they are close to the constraint and anticipate the possibility of hitting the borrowing limit in the future. As a result, for these households, temporary income changes feed into consumption. Specifically, these households rely primarily on labor earnings. Thus, the increase in household earnings is critical for the consumption response of this group. Within the bottom half of the wealth distribution, low-liquidity households at the bottom 30% have the highest MPCs and show the largest response. The second group consists of middle-class households in the next 40% of the wealth distribution, from the 50th to the 90th wealth percentile. These households are relatively less exposed to monetary policy shocks. Here, income gains from higher labor earnings and income losses from financial assets tend to offset each other. So, the net effect of monetary policy on consumption is negligible for this group. Moreover, most of these households have a substantial precautionary saving motive and are accumulating wealth to move away from the borrowing limit. As a result, these households have low MPCs and are less responsive to monetary policy. These households mostly respond to monetary policy through the conventional intertemporal substitution mechanism. The third group consists of households at the top 10% of the wealth distribution. These households show a much smoother consumption response relative to other households. The consumption response at the top is more persistent. Importantly, high-wealth households substantially gain from the increase in asset values and equity prices. Only a small fraction of these income and wealth gains feed into consumption. Nevertheless, households in the top 10% have a substantial impact on aggregate consumption. There are two factors contributing to this result. First, among all wealth groups, households in the top 10% have the largest consumption share. This amplifies the impact of their consumption response on aggregate consumption. Second, the size of the capital gains from higher equity prices can be substantial for the top 10%. It is important to highlight that the high exposure at the top is due to the size of households' wealth holdings. This establishes an important link between wealth concentration and the effects of monetary policy in the HANK framework. These households mostly respond to monetary policy through income effects due to equity price changes.

Overall, these results show that HANK models feature relatively larger consumption responses to monetary policy shocks at the tails of the wealth distribution. These findings are robust to different model specifications. In particular, I will consider in the Online Appendix D.2 the role of endogenous portfolio choices and wealth composition in a two-asset model.

4.3 Wealth dynamics

Here, I study the role of the wealth distribution and equity prices in the HANK framework. Specifically, I show that in HANK models, changes in the wealth distribution shape the cross-sectional and aggregate consumption responses to monetary policy. In order to understand the transmission mechanisms of monetary policy, I use the decomposition from Kaplan, Moll, and Violante (2018). Let f_t be the density function over the space X of individual states x_t, and c_t the household consumption decisions, q_0 the equity price at $t = 0$, and $\{r_s, y_s\}_{s=0}^{\infty}$ the path of interest rates and earnings. Aggregate consumption is

$$C_t(\{r_s, y_s\}, q_0) = \int_X f(x_t; \{r_s, y_s\}_{s\leq t}, q_0) c(x_t; \{r_s, y_s\}_{s\geq t}) dx_t.$$

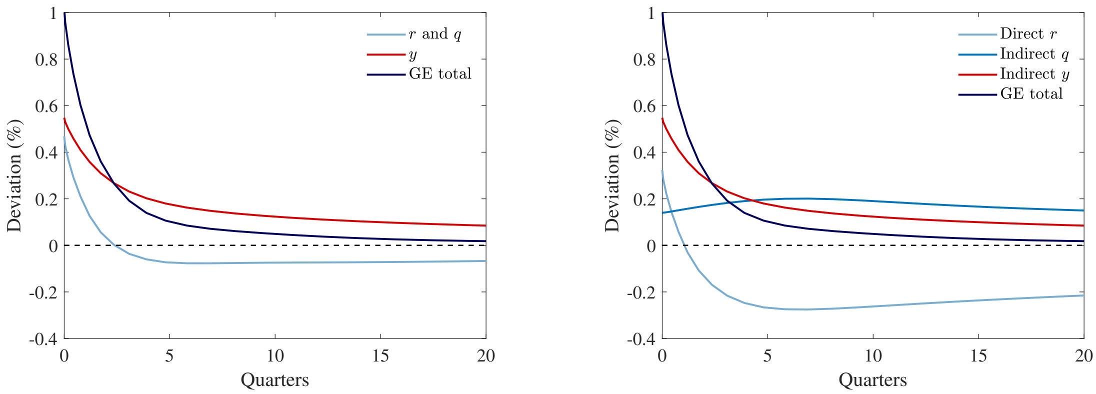
Totally differentiating delivers

$$dC_t = \int_0^{\infty} \frac{\partial C_t}{\partial r_s} dr_s ds + \int_0^{\infty} \frac{\partial C_t}{\partial y_s} dy_s ds + \frac{\partial C_t}{\partial q_0} dq_0.$$

The partial derivatives give the partial equilibrium response of consumption to a change in the equilibrium path of each variable. Specifically, this equation provides a partial equilibrium decomposition of the aggregate consumption response in a direct effect in the first integral, i.e. the standard interest rate channel of monetary policy, and indirect effects due to changes in household earnings and from capital gains. The last term captures the effects of the wealth distribution and equity prices. To see this note that aggregate consumption depends on equity prices only through the density function $f(x_0; \{r_s, y_s\}_{s\leq 0}, q_0)$ and note that

$$\frac{\partial C_t}{\partial q_0} = \frac{\partial C_t}{\partial f} \frac{\partial f}{\partial q_0}.$$

After a monetary policy shock in $t = 0$, changes in the wealth distribution due to changes in equity prices can have first-order implications for the response of aggregate consumption dC_t. If $dq_0 = 0$, i.e. when households' initial wealth remains constant on impact, then f_0 is the stationary density function. If $dq_0 > 0$, the density f_0 is the density with capital gains. Note that this is a different problem from analyzing the macroeconomic role of investment adjustment costs that only affect the size of dq_0. A counterfactual obtained by varying the adjustment costs will change the response of equity prices and aggregate investment. Therefore, it cannot be used to identify the role of initial conditions, i.e. the initial distribution of wealth, for the path of aggregate consumption, which is the problem studied in this paper. To quantitatively illustrate the importance of these wealth dynamics for aggregate consumption, I compute the consumption response to asset revaluation, i.e. $\{\partial C_t/\partial q_0\}$ and compare this response with the standard interest rate channel, i.e. $\{\partial C_t/\partial r_s\}$. To identify the first effect, i.e. the asset price channel of monetary policy, I change the value of households' assets, keeping the real interest rate and earnings constant at the steady state level. To identify the second effect, i.e. the interest rate channel, I feed into the household consumption problem the equilibrium path of the real interest rate, keeping households' wealth constant at the steady state. Figure 5 shows the macroeconomic implications of changes in the initial asset positions a_0. This figure plots the decomposition of the response of aggregate consumption to monetary policy in direct and indirect effects. The panel (a) plots the decomposition without separating the effect of equity prices and interest rates. The panel (b) shows that a substantial fraction of the effects that would be normally attributed to the interest rate channel are actually due to indirect general equilibrium changes in equity prices. When interest rates decrease and profits increase, stock market valuations tend to rise. This surge in stock values has a considerable impact on the financial positions of affluent households, particularly those with large investments in the stock market. The rise in their asset values leads to significant income effects on their balance sheets. As a result, these households experience increased purchasing power and financial security, influencing their consumption patterns.



(a) (b)

Figure 5: Consumption and stock prices.

Note: The figure plots the consumption responses to monetary policy on impact $(t = 0)$ relative to steady-state aggregate consumption due to capital gains (green line), real interest rates (light blue line), household labor earnings (red line). The total general equilibrium effect is given by the dark blue line. Panel (a) plots the decomposition without separating the effect of equity prices and interest rates. Panel (b) separately shows the effects of the interest rate channel and of the equity price channel.

The panel (a) shows that on impact, the response of aggregate consumption is almost equally split between direct and indirect effects. However, once we take into account the effect of equity prices, this picture changes substantially. The equity price channel of monetary policy increases aggregate consumption by 0.13 percentage points or by 13%. This changes the transmission mechanism of monetary policy as indirect effects now explain more than two-thirds of the consumption response to monetary policy. Importantly, the effects tend to be persistent over time. While lower interest rates reduce future consumption, the wealth gains from the initial valuation effects increase future consumption.

To better understand the transmission channels of monetary policy and their macroeconomic implications, I analyze the cross-sectional consumption responses of each wealth group. Figure 6 shows the transmission channels of monetary policy across the wealth distribution at impact in the baseline HANK model. From this figure, we observe that the response of households at the bottom of the wealth distribution is driven by employment and labor market outcomes as well as lower interest rates, while consumption adjustments at the top 10% are due to capital gains from changes in equity prices. The consumption responses to real interest rate changes are small, and if anything, decline with wealth as negative income effects due to lower financial income scale-up. These results show that an endogenous wealth distribution and the stock market response to monetary policy shape cross-sectional and aggregate consumption.

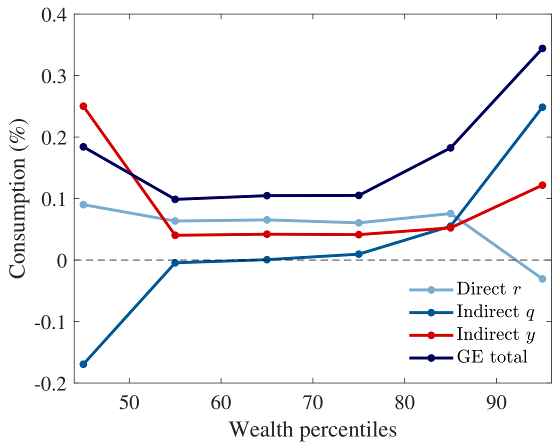


Figure 6: Consumption and stock prices across the wealth distribution.

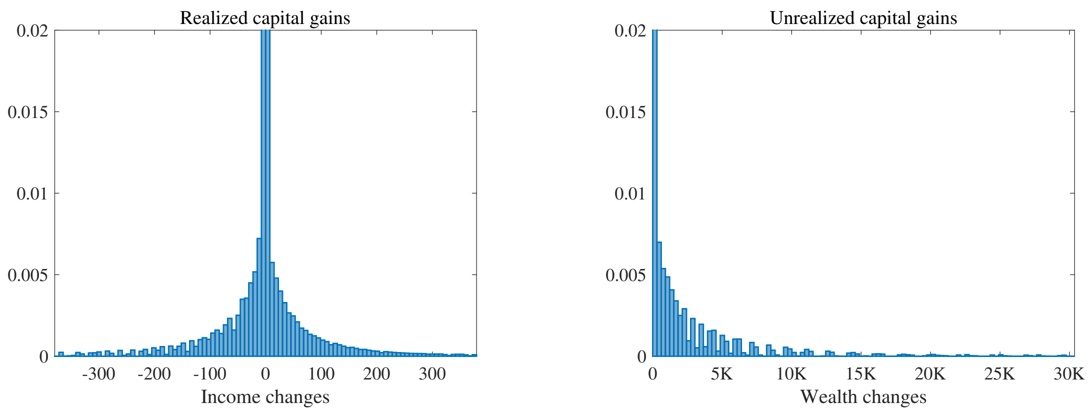
Note: The figure plots the consumption responses to monetary policy on impact ($t = 0$) relative to steady-state aggregate consumption due to capital gains (green line), real interest rates (light blue line), and household labor earnings (red line) across the wealth distribution.

The consumption responses are also heterogeneous within the top 10%. Consumption increases by less at the very top because these households also face the largest decline in financial income. As a result, the negative income effect of interest rate changes increases relative to the substitution effect. Therefore, the response of wealthy households at the top 10% does not reflect a disproportionately high response of the top 1%. Notice that equity prices not only raise consumption at the top but also reduce consumption at the bottom of the distribution. This is due to the fact that most of these households are accumulating wealth, and higher equity prices make it more costly for them to build that wealth.

Overall, existing studies often emphasize the role of constrained households and bottom wealth groups more broadly for the amplification of aggregate shocks (Krueger, Mitman, and Perri (2016)). The cross-sectional patterns in Figure 6 confirm this prediction. However, the wealth dynamics highlighted here show that income and wealth effects at the right tail of the wealth distribution are important for the aggregate effects of monetary policy.

4.4 Asset price redistribution

Asset price changes redistribute income and wealth across wealth groups. Specifically, asset price changes benefit households at the top 10% of the wealth distribution, but reduce income for the bottom 50%. Intuitively, note that asset price changes affect consumption either through realized capital gains or through unrealized capital gains. In the former case, there is an income effect on consumption because households sell assets at a higher value, in the latter case, there is a wealth effect on consumption due to the fact that household consumption increases as wealth increases.[21] The former income effect is purely redistributive, the latter income effect increases aggregate consumption. The asset price redistribution is the result of households' trade and the wealth accumulation process implied by the policy functions of the model. Households at the top of the wealth distribution sell assets at a higher price while households at the bottom 50% accumulate wealth and buy equity at a higher price.[22] The net effect on aggregate income from realized capital gains is zero. Panel (a) in Figure 7 plots the distribution of realized capital gains. Changes in asset prices create winners and losers, depending on whether households are building wealth or liquidating their investments. Panel (b) in Figure 7 plots the distribution of unrealized capital gains.



(a) (b)

Figure 7: Asset price redistribution in HANK.

Note: The figure plots realized and unrealized capital gains in dollar amounts.

Overall, the total magnitude of the asset price redistribution is modest relative to unrealized capital gains that can be as large as one-third of the average annual earnings. Therefore, a key finding in this section is that income effects from asset holdings are an order of magnitude larger than income effects from sales and purchases. To fully understand the distributional implications of changes in asset prices on consumption and welfare, it is quantitatively important to consider both realized and unrealized capital gains.

[21] The consumption policy functions are increasing in wealth.

[22] Households at the top of the distribution have large asset holdings relative to their wealth targets, while households in the bottom 50% tend to have asset holdings below their wealth targets and plan to accumulate wealth.

4.5 Welfare effects

In this section, I study the welfare implications of monetary policy shocks to understand which wealth groups benefit the most from an expansionary monetary policy. I use the Consumption Equivalent Variation (CEV) as a welfare measure. This is essentially given by a monotone transformation of the difference between the value function with the policy at impact $v_0(a, e)$ and the value function at the steady-state $v(a, e)$, absent any policy intervention.[23] Figure 8 shows the welfare gains across the distribution of financial wealth. Households at the bottom 50% gain the most from an expansionary monetary policy because the policy increases employment and wages. The welfare gains at the bottom are entirely explained by the response of household earnings. Households in the top 10% of the distribution of liquid wealth, i.e. those with wealth holdings above 5, experience a welfare loss. The reason is that there are two opposite effects as emphasized by Fagereng, Gomez, et al. (2025). First, an interest rate cut increases stock market valuations and household wealth, increasing welfare. Second, the shock leads to lower asset returns, which reduces welfare. These effects tend to outweigh each other, leading to only small changes in lifetime utility at the top, despite substantial gains in consumption on impact. Quantitatively, in the model, the second effect slightly prevails.

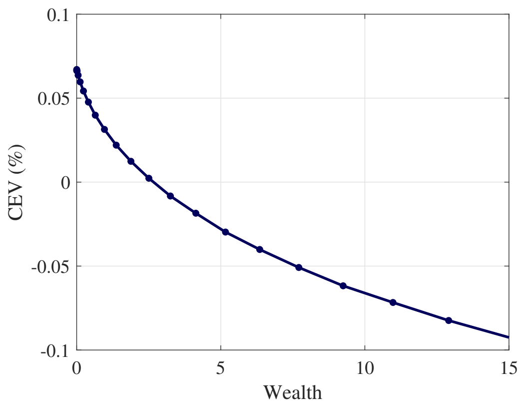


Figure 8: Welfare effects of expansionary monetary policy.

Note: The figure plots the welfare gains across the steady-state distribution of liquid wealth. Wealth levels are in terms of average annual earnings. Households in the top 10% of the distribution of liquid wealth are above 5, households in the bottom 50% of the distribution are close to zero, while households in the middle-class or next 40% are in between 0 and 5.

An important takeaway from these results is that, although wealthy households primarily benefit from the stock market's reaction to an expansionary monetary policy through higher asset valuations, they also lose from lower subsequent asset returns, and the welfare gains are generally larger for those at the bottom because of higher labor earnings due to improved labor market outcomes.

[23]Specifically, from the condition $\mathbb{E}_0 \int_0^\infty e^{-\rho t}(\ln((1+g)c_t) - n_t^{1+\nu}/(1+\nu))dt = v_0(a_t, e_t)$ we can derive the steady-state consumption growth $g(a_t, e_t) = \exp(\rho(v_0(a_t, e_t) - v(a_t, e_t))) - 1$. Finally, I aggregate the consumption equivalent variation $g(a_t, e_t)$ using the stationary distribution.

To better understand these results, it is instructive to study the welfare gains on impact at $t = 0$. So, instead of measuring welfare in terms of lifetime utility, we can compute CEVs by comparing the utility gains at impact with the policy $u(c_0, n_0)$ against the steady-state instantaneous utility $u(c, n)$. In this case, it is particularly easy to decompose the relative role of consumption and labor supply for welfare. Specifically, Figure 9 plots the CEV at impact while fixing the labor supply decisions at the steady-state.[24] All wealth groups gain from an expansionary monetary policy shock. However, households in the bottom 50% have larger welfare gains relative to the middle-class and households at the top. This implies that while the level of the CEV is determined by labor supply decisions, the shape of the CEV depends on consumption decisions. This clarifies that the welfare losses in Figure 8 are driven by disutility from labor supply, while the relative welfare gains at the bottom and at the top are due to the consumption variations and the differential effects of labor earnings, interest rate income, and capital gains on consumption across the distribution of liquid wealth.

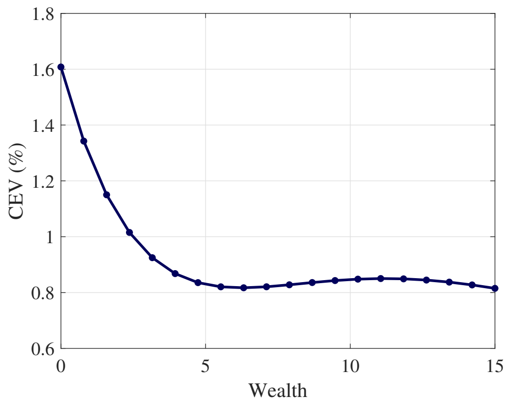


Figure 9: Welfare effects of expansionary monetary policy at impact.

Note: The figure plots the welfare gains across the steady-state distribution of liquid wealth fixing labor supply at the steady state. Wealth levels are in terms of average annual earnings. Households in the top 10% of the distribution of liquid wealth are above 5, households in the bottom 50% of the distribution are close to zero, while households in the middle-class or next 40% are in between 0 and 5.

How much do higher equity prices increase welfare at the top 10% of the distribution of liquid wealth? The impact CEV at the top 10% of the distribution is 0.3 percentage points higher because of the valuation effects from higher equity prices. The lifetime CEV at the top 10% of the distribution is roughly 0.2 percentage points higher. Hence, the effects of equity prices on welfare are quantitatively large.

Overall, welfare increases the most at the bottom 50% of the distribution of liquid wealth despite the fact that an expansionary monetary policy leads to large capital gains and to an increase in consumption at the top. However, changes in equity prices in isolation significantly raise welfare at the top 10% of the distribution of liquid wealth.

[24]The CEV is given by $g(a, e) = \exp((u(c_0, n) - u(c, n))) - 1$ where n is the steady-state labor supply.

5 Conclusion

In this paper, I analyze a structural macroeconomic model encompassing a broad class of quantitative HANK models to study the consumption responses of different wealth groups to monetary policy and to assess the macroeconomic implications of wealth concentration at the top for the transmission channels of monetary policy. I show that the structural models reproduce key features of the distributions of consumption, income, and financial wealth in the US and the estimates of MPCs from external studies. Overall, policy experiments show that the consumption responses are U-shaped across the distribution of financial wealth in a broad class of HANK models. After an expansionary monetary policy shock, households at the bottom mostly respond to changes in labor income while wealthy households at the top receive substantial capital gains from rising stock values. On the other hand, the welfare effects are more nuanced as lower stock returns outweigh the welfare gains from higher stock values. As a result, households at the bottom of the wealth distribution tend to be the ones who benefit the most from an expansionary monetary policy.

In my quantitative analysis, I find that the dynamics of the wealth distribution can have a substantial impact on the aggregate consumption path. In particular, I show that households at both tails of the wealth distribution display the largest responses and account for most of the aggregate effects of monetary policy, leading to U-shaped consumption responses across the wealth distribution. In the model, wealthy households in the top 10% have a substantial impact on aggregate consumption because of their high exposure to changes in equity prices and sizable consumption shares. These results demonstrate that the combination of wealth concentration at the top of the distribution and changes in equity prices can shape the cross-sectional and aggregate effects of monetary policy. In this paper, I show that even if the MPCs out of wealth gains in the stock market are small, the size of the capital gains for households at the top 10% of the wealth distribution can be substantial. Moreover, high consumption shares amplify the impact of households at the top on the aggregate. Therefore, even if a small fraction of these wealth gains actually feed into consumption, the macroeconomic effects can still be significant. These results provide new quantitative insights into the role of household heterogeneity and changes in the wealth distribution for the aggregate and cross-sectional effects of monetary policy.

In conclusion, I show that high wealth concentration and capital gains imply that top wealth groups have an important role in the transmission mechanism of monetary policy to aggregate demand. However, our models struggle to generate large stock price movements. Future research can quantitatively assess the consumption responses and welfare gains by matching the movements in stock prices observed in the data. Moreover, the U-shaped responses suggest analyzing also other transmission channels that are particularly relevant for middle-class households, such as mortgages and home equity. On the other hand, the results on the consumption responses at the bottom of the distribution point toward a more detailed analysis of labor market outcomes. Future research can investigate these important dimensions.

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For Online Publication

Online Appendix for "Monetary Policy and the Dynamics of the Wealth Distribution"

Valerio Pieroni

A Analytical Derivations

In this section I characterize the solution to (4), (5), (6), (7) under the parametrization presented in Section 3, i.e. a Cobb-Douglas production technology $Y_{it} = K_{it}^{\theta} N_{it}^{1-\theta}$, quadratic price adjust costs $\Phi_t = \frac{\Psi_p}{2}(\pi_{it})^2 p_t Y_t$, and investment adjustment costs $\chi_t = \frac{\kappa}{2}(\iota_t - \delta)^2 K_t$. I conclude this section with a list of the resulting equilibrium conditions.

A.1 Phillips curve

Final good firm. The first order condition of (4) is $p_t(\int_0^1 Y_{it}^{1-\epsilon_p^{-1}} di)^{\frac{1}{(\epsilon_p - 1)}} Y_{it}^{-\epsilon_p^{-1}} - p_{it} = 0$. Dividing the first order condition of two intermediate goods i and j yields

$$p_{jt} = \left(\frac{Y_{it}}{Y_{jt}}\right)^{\frac{1}{\epsilon_p}} p_{it}.$$

Rewriting $p_{jt} Y_{jt} = p_{it} Y_{it}^{\epsilon_p^{-1}} Y_{jt}^{1-\epsilon_p^{-1}}$ and integrating over j we have $p_t Y_t = p_{it} Y_{it}^{\epsilon_p^{-1}} \int_0^1 Y_{jt}^{1-\epsilon_p^{-1}} dj$ from the zero profit condition $p_t Y_t = \int_0^1 p_{jt} Y_{jt} dj$. Substituting for Y_t from the CES technology and solving for Y_{it} yields the optimal demand of intermediate inputs

$$Y_{it} = \left(\frac{p_{it}}{p_t}\right)^{-\epsilon_p} Y_t,$$

which together with the zero profit condition implies

$$p_t = \left(\int_0^1 p_{it}^{1-\epsilon_p} di\right)^{\frac{1}{1-\epsilon_p}}.$$

Intermediate producers. The first order condition of problem (5) are

$$r_t^k = mc_{it} \theta K_{it}^{\theta-1} N_{it}^{1-\theta},$$

$$w_t = mc_{it}(1-\theta) K_{it}^{\theta} N_{it}^{-\theta}.$$

The Lagrange multiplier is the marginal cost $mc_t = \frac{d}{dY_{it}}(w_t N_{it} + r_t^k K_{it})$. Combining the first order conditions yields $K_{it}/N_{it} = \theta(1-\theta)^{-1}(w_t/r_t^k)$. Therefore, all firms choose the same capital-labor ratio and have the same real marginal costs $mc_{it} = mc_t$.

The production technology implies the factor demands

$$K_{it} = Y_{it}\left(\frac{\theta}{1-\theta}\frac{w_t}{r_t^k}\right)^{1-\theta},$$

$$N_{it} = Y_{it}\left(\frac{\theta}{1-\theta}\frac{w_t}{r_t^k}\right)^{-\theta}.$$

Substituting the demands in the cost function and differentiating with respect to Y_{it} yields

$$mc_t = \left(\frac{w_t}{1-\theta}\right)^{1-\theta}\left(\frac{r_t^k}{\theta}\right)^{\theta}.$$

Finally, intermediate producers set prices in monopolistic competition subject to price adjustment costs to maximize discounted profits. Define $m_{it} := p_{it}mc_{it}$. The Hamiltonian associated to (6) with control $\dot{p}_{it}$ and state p_{it} taking Y_t, p_t, i_t as given is

$$\begin{aligned} H_t(\dot{p}_{it}, p_{it}, \mu_t) &= \exp\left(-\int_0^t i_s ds\right)\left((p_{it} - m_{it})\left(\frac{p_{it}}{p_t}\right)^{-\epsilon_p} Y_t - \frac{\Psi_p}{2}\left(\frac{\dot{p}_{it}}{p_{it}}\right)^2 p_t Y_t\right) + \lambda_t \dot{p}_{it} \\ &= \exp\left(-\int_0^t i_s ds\right)\left((p_{it} - m_{it})\left(\frac{p_{it}}{p_t}\right)^{-\epsilon_p} Y_t - \frac{\Psi_p}{2}\left(\frac{\dot{p}_{it}}{p_{it}}\right)^2 p_t Y_t + \mu_t \dot{p}_{it}\right). \end{aligned}$$

In the second line I used $\mu_t := \lambda_t \exp(\int_0^t i_s ds)$. The first order conditions are given by

$$H_{\dot{p}_{it}} = -\Psi_p\left(\frac{\dot{p}_{it}}{p_{it}}\right)\frac{p_t}{p_{it}} Y_t + \mu_t = 0,$$

$$H_{p_{it}} = \left(1 - \epsilon_p + \epsilon_p mc_t\right)\left(\frac{p_{it}}{p_t}\right)^{-\epsilon_p} Y_t + \Psi_p\left(\frac{\dot{p}_{it}}{p_{it}}\right)^2 \frac{p_t}{p_{it}} Y_t = i_t\mu_t - \dot{\mu}_t,$$

$$H_\mu = \dot{p}_{it}.$$

In equilibrium, all the firms charge the same price equal to p_t and produce the same output. Then, solving for μ_t we derive a New Keynesian Phillips curve and firms' profits

$$\pi_t\left(r_t - \frac{\dot{Y}_t}{Y_t}\right) = \dot{\pi}_t + \frac{\epsilon_p}{\Psi_p}(mc_t - \mu_p^{-1}),$$

$$D_t := Y_t - w_t N_t,$$

where $\mu_p = \epsilon_p/(\epsilon_p - 1)$. The Phillips curve connects the real side of the economy, namely w_t, r_t to inflation and other nominal variables. The cyclical behavior of profits net of rental income $r_t^k K_t$ with respect to output Y_t crucially depends on the term $(1 - mc_t)Y_t$ where the markup, $(1 - mc_t)$, is countercyclical. In standard calibrations with flexible wages the change in markups is larger than the variation of aggregate output leading to countercyclical profits.

A.2 Investment

The Hamiltonian associated to (7) with control ι_t and state K_t is

$$H_t(\iota_t, K_t, q_t) = \exp\Big(-\int_0^t r_s ds\Big)\Big((d_t - \iota_t - \chi_t(\iota_t))K_t + q_t(\iota_t - \delta)K_t\Big).$$

The first order-conditions are given by

$$r_t = \frac{\dot{q}_t}{q_t} + (\iota_t - \delta) + \frac{d_t - \iota_t - \chi_t(\iota_t)}{q_t},$$

$$q_t = 1 + \chi_t'(\iota_t).$$

Together with a transversality condition $\lim_{t\to\infty} e^{-\int_0^t r_s ds} q_t K_t = 0$. The Tobin's q is the shadow price of capital $q_t = dV_t/dK_t$. The discount rate r_t is the sum of two components: the capital gains due to market valuations $\dot{q}_t/q_t$ and firm's growth $\dot{K}_t/K_t$, and the yield to price ratio $(d_t - \iota_t - \chi_t(\iota_t))/q_t$. Solving forward the no-arbitrage condition

$$q_t = \int_t^\infty \exp\Big(-\int_t^\tau (r_s - \iota_s + \delta)ds\Big)\Big(d_\tau - \iota_\tau - \chi_\tau(\iota_\tau)\Big)d\tau,$$

and $K_\tau = K_t \exp(-\int_t^\tau (\iota_s - \delta)ds)$. Hence, $V_t = q_t K_t$.

A.3 Equilibrium conditions

To summarize, the equilibrium conditions that characterize the solution to (4), (5), (6), (7) are given by the following equations.

$$r_t^k = \theta mc_t K_t^{\theta-1} N^{1-\theta},$$

$$w_t = (1-\theta) mc_t K_t^{\theta} N^{-\theta},$$

$$Y_t = K_t^\theta N_t^{1-\theta},$$

$$\pi_t(r_t - \dot{Y}_t/Y_t) = \dot{\pi}_t + (\epsilon_p/\Psi_p)(mc_t - \mu_p^{-1}),$$

$$D_t = Y_t - w_t N_t,$$

$$r_t = \dot{q}_t/q_t + (d_t - \iota_t - \chi_t(\iota_t) + (\iota_t - \delta)q_t)/q_t,$$

$$q_t = 1 + \chi_t'(\iota_t).$$

The remaining variables in the system are determined in other blocks of the model.

B HJB and KF Equations

Here I present the households' HJB equation and the KF equation. Define the indicator function $1_Q : E \to \{0, 1\}$ for any $Q \subseteq E$, let $e_2 > e_1$, $N = \{e : e < e_1\}, S_j = \{e_j\}, \forall j = 1, 2$. Let v_t denote the value function, f_t the density function, and y_t household market income. The Hamilton-Jacobi-Bellman equation is

$$\rho v_t(a, e) = \max_{c_t} \Bigg\{u(c_t, n_t) + \frac{\partial v_t}{\partial a}(y_t - c_t) + \frac{\partial v_t}{\partial t} + 1_N \lambda_1 \sum_{j=1}^{2} \theta_j (v(a, e_j) - v(a, e))$$
$$+ \sum_{j=1}^{2} 1_{S_j} \lambda_2 \int (v(a, e') - v(a, e_j)) d\Phi_e(e') + 1_N \lambda_e \int (v(a, e') - v(a, e)) dF_e(e'|e)\Bigg\},$$

where Φ_e is the distribution associated to ϕ_e and $e' \in N$. Let $P_t(e'|e) := P(e_{t+s} = e'|e_s = e), \forall s \geq 0, \forall t \geq 0$ be the probability function associated to $F_e(e'|e)$, the dynamics of the cross-sectional distribution are given by the Kolmogorov forward equation

$$\frac{\partial f_t}{\partial t} = -\frac{\partial}{\partial a}(f_t(y_t - c_t)) + \sum_{j=1}^{2} 1_{S_j} \Bigg(\lambda_1 \theta_j \sum_{e'} f_t(a, e') - \lambda_2 f_t(a, e_j)\Bigg)$$
$$+ 1_N \Bigg(\lambda_e \sum_{e'} f_t(a, e') P_t(e|e') - \lambda_e f_t(a, e) + \lambda_2 \sum_{j=1}^{2} \phi_e(e) f_t(a, e_j) - \lambda_1 f_t(a, e)\Bigg).$$

C Numerical Solution

This section contains further details on the numerical methods used to solve the model. In particular, here I discuss the solution of the HJB and KF equations. Throughout the paper I use a power grid to increase the accuracy of the solutions in the low-wealth regions of the state space where the policy functions display the largest nonlinearities. The model's solution methods are based on the finite difference approach developed in Achdou, Han, Lasry, Lions, and Moll (2022) to solve HJB and KF equations. I consider a non-uniform grid for each state and index with $i = 1, ..., I, j = 1, ..., J$ the grid points for respectively a, e. Moreover, I use the index n for the iteration scheme. I'll focus on the stationary version of the HJB and KF equations. The state constraint $a \geq -\underline{a}$ gives rise to the boundary condition

$$\partial v(\underline{a}, e)/\partial a := v_a(\underline{a}, e) \geq u'(wen + r\underline{a} + d).$$

Note that since $u'(c) = v_a(a, e)$ the condition above implies that savings $s(a, e) := wen + ra + d - c \geq 0$ at $a = \underline{a}$ and the constraint is never violated.

To solve the HJB equation I use an implicit upwind scheme. Let $(x)^+ := \max(x,0)$, $(x)^- := \min(x,0)$, $p_{j',j}$ the transition probabilities associated to F_e, p_j the probabilities associated to ϕ_e. The discretized version of the HJB equation is given by

$$\begin{aligned}\frac{v_{ij}^{n+1}-v_{ij}^{n}}{\Delta}+\rho v_{ij}^{n+1} = u(c_{ij}^n) + \frac{v_{i+1j}^{n+1}-v_{ij}^{n+1}}{\Delta a_i}(s_{ij,F}^n)^+ + \frac{v_{ij}^{n+1}-v_{i-1j}^{n+1}}{\Delta a_i}(s_{ij,B}^n)^- \\ + 1_N\left(\lambda_e\sum_{j'=1}^{J-2} v_{ij'}^{n+1}p_{j'j} - \lambda_e v_{ij}^{n+1} + \lambda_1\theta_1(v_{iJ-1}^{n+1}-v_{ij}^{n+1}) + \lambda_1\theta_2(v_{iJ}^{n+1}-v_{ij}^{n+1})\right) \\ + 1_{S_1}\left(\lambda_2\sum_{j'=1}^{J-2} v_{ij'}^{n+1}p_{j'} - \lambda_2 v_{iJ-1}^{n+1}\right) + 1_{S_2}\left(\lambda_2\sum_{j'=1}^{J-2} v_{ij'}^{n+1}p_{j'} - \lambda_2 v_{iJ}^{n+1}\right),\end{aligned}$$

where $c_{ij}^n = (u')^{-1}(v_{a,ij}^n)$. We can update the value function by solving a system of $I \times J$ linear equations in $I \times J$ unknowns v_{ij}^{n+1}. Let $v^{n+1} := (v_{11}^{n+1}, v_{21}, ..., v_{I1}, v_{12}, v_{22}, ..., v_{IJ})'$. The system can be written in matrix notation as

$$\frac{1}{\Delta}(v^{n+1}-v^n) + \rho v^{n+1} = u^n + A^n v^{n+1},$$

where $u^n = (u(c_{ij}^n)), v^n = (v_{ij}^n)$ are vectors of dimension $IJ \times 1$ and $A^n = T + B$ is a matrix with dimension $IJ \times IJ$. The matrix T has the standard structure given by a central diagonal $(y_{11}, ..., y_{I1}, y_{12}, ..., y_{I2}, ..., y_{1J}, ..., y_{IJ})$ with the coefficients of v_{ij}^{n+1}, a lower diagonal $(x_{21}, ..., x_{I1}, 0, x_{22}, ..., x_{I2}, 0, ..., x_{2J}, ..., x_{IJ})$ with the coefficients of the backward terms v_{i-1j}^{n+1}, and an upper diagonal $(z_{11}, ..., z_{I-11}, 0, z_{12}, ..., z_{I-12}, 0, ..., z_{1J}, ..., z_{I-1J})$ with the coefficients of v_{i+1j}^{n+1}, and zero elsewhere. We impose $x_{1j} = z_{Ij} = 0, \forall j$ so that v_{0j}, v_{I+1j} are never used. The matrix B has the following block structure

$$B = \begin{bmatrix} B^N_{I(J-2)\times I(J-2)} & 0_{I(J-2)\times 2I} \\ 0_{2I\times I(J-2)} & 0_{2I\times 2I}\end{bmatrix} + \begin{bmatrix} B^1_{I(J-2)\times I(J-2)} & B^2_{I(J-2)\times 2I} \\ B^3_{2I\times I(J-2)} & B^4_{2I\times 2I}\end{bmatrix}.$$

Let P be the transition matrix associated to F_e. $B^N = \lambda_e P_{(J-2)\times(J-2)} \otimes I_{I\times I} - \lambda_e I_{I(J-2)\times I(J-2)}$ gives the transitions between normal states. The second matrix in the sum gives the transition between normal and extraordinary states. Let ι be a column vector with 1 in each row. Then, the remaining blocks are given by $B^1 = -\lambda_1 I_{I(J-2)\times I(J-2)}$, $B^2 = \iota_{J-2} \otimes [\lambda_1\theta_1 I_{I\times I} \quad \lambda_1\theta_2 I_{I\times I}]$, $B^3 = \iota_2 \otimes [\lambda_2 p_1 I_{I\times I} \quad ... \quad \lambda_2 p_{J-2} I_{I\times I}]$, $B^4 = -\lambda_2 I_{2I\times 2I}$.

Let A^n be the matrix obtained from the last HJB iteration, f a $IJ \times 1$ density vector. From the discretized KF equation we see that the density can be obtained by solving

$$(A^n)'f = 0,$$

$$\sum_{i=1}^{I}\sum_{j=1}^{J} f_{ij}\Delta a_i = 1.$$

D Two-asset HANK

In this section, I present the two-asset extension of the baseline one-asset HANK model. There are three main features of the two-asset model. First, the main difference is given by the heterogeneous agent block of the model as now I allow for a portfolio choice between liquid and illiquid assets subject to convex portfolio adjustment costs. Second, the supply block of the model features both sticky prices and sticky wages. Third, the policy block allows for both monetary and fiscal policy.

D.1 Model

Households. Households can save using fully liquid assets b_t and illiquid assets a_t. Idiosyncratic income risk e_t follows a continuous-time Markov process. As in the one-asset model, household income is given by labor income $w_t e_t n_t$ and financial income $r_t^b(b_t)b_t + r_t^a(a_t)a_t$. Households choose the amount to deposit in the illiquid account d_t^a and consumption c_t solving the following problem

$$\max_{(c_t, d_t^a)} \quad \mathbb{E}_0 \int_0^\infty e^{-(\rho+\eta)t} u(c_t, n_t) dt,$$

$$\text{s.t.} \quad \dot{b}_t = (1-\tau)(1-\omega) w_t e_t n_t + r_t^b(b_t) b_t - d_t^a - \chi(d_t^a, a_t) - c_t,$$

$$\dot{a}_t = (1-\tau)\omega w_t e_t n_t + r_t^a(a_t) a_t + d_t^a,$$

$$b_t \geq -\phi, \quad a_t \geq 0.$$

A small fraction ω of labor income is automatically deposited in the illiquid account. The convex deposit adjustment cost is given by

$$\chi(d_t^a, a_t) := \chi_0 |d_t^a| + \frac{\chi_1}{2} \left| \frac{d_t^a}{a_t} \right|^{\chi_2} a_t.$$

With a slight abuse of notation I denote the return schedule of the liquid asset as $r_t^b(b_t)$ and the return schedule of the illiquid investment asset as $r_t^a(a_t)$. Specifically, the return schedule of the liquid asset is given by $r_t^b(b_t) = r_t^b$ if $b_t \geq 0$ and $r_t^b(b_t) = r_t^b + \kappa_b$ if $b_t < 0$ where $\kappa_b > 0$ is a borrowing wedge. A well-known feature of the two-asset model is that it generates a liquidity premium, i.e. $r_t^a > r_t^b$. To prevent some households from accumulating infinite equity I introduce survival risk. At each point in time a fraction $\eta > 0$ of households leave the economy and η new households are formed. The expected lifespan of a household is $1/\eta$ and the cross-sectional distribution of age is exponential. Households can perfectly insure in annuity markets. They receive $r_t^b + \eta, r_t^a + \eta$ if they survive the next dt periods and if they leave the economy the insurance intermediaries receive all their assets. Finally, τ denotes a constant income tax rate decided by the government. I assume that stocks are subject to transaction costs so $q_t K_t = \int_X a_t d\psi_t$ while bonds are fully liquid $B_t = \int_X b_t d\psi_t$.

Households' labor supply decisions are intermediated by unions. Relative to the baseline specification I now introduce income taxes. Moreover, the discount rate now includes the probability of leaving the economy. Therefore, the dynamic program of the unions is given by

$$\max_{\dot{W}_{jt}} \int_0^\infty \left[\exp\left(-\int_0^t (\rho+\eta)ds\right)\left(\int_0^1 (1-\tau)\frac{W_{jt}}{p_t}N_{jt} - \frac{v(N_{jt})}{u'(C_t)} - \frac{\Psi_w}{2}\left(\frac{\dot{W}_{jt}}{W_{jt}}\right)^2 N_t dj\right)\right]dt$$

$$\text{s.t. } N_{jt} = \left(\frac{W_{jt}}{W_t}\right)^{-\epsilon_w} N_t.$$

Let the wage markup $\mu_w := \epsilon_w/(\epsilon_w - 1)$, in a symmetric equilibrium with $W_{jt} = W_t$ and $N_{jt} = N_t$, we obtain a wage Phillips curve given by

$$\pi_{w,t}\left(\rho + \eta - \frac{\dot{N}_t}{N_t}\right) = \dot{\pi}_{w,t} + \frac{\epsilon_w}{\Psi_w}(mrs_t - (1-\tau)w_t\mu_w^{-1})$$

where $mrs_t := v'(N_t)/u'(C_t)$ is the marginal rate of substitution between consumption and labor supply. The choice of the discount rate in the wage Phillips curve does not change the results. Alternatively, one could also use the real rates r_t^b, r_t^a. Finally, price and wage inflation are related through the equation $\dot{w}_t/w_t = \pi_{w,t} - \pi_t$.

Firms The production block of the model is the same as in the one-asset model. Thus, the input pricing conditions hold: $r_t^k = \theta mc_t K_t^{\theta-1}N^{1-\theta}, w_t = (1-\theta)mc_t K_t^{\theta}N^{-\theta}, Y_t = K_t^{\theta}N_t^{1-\theta}$. The price Phillips curve is given by

$$\pi_t\left(r_t^b - \frac{\dot{Y}_t}{Y_t}\right) = \dot{\pi}_t + \frac{\epsilon_p}{\Psi_p}(mc_t - \mu_p^{-1}).$$

Since in equilibrium the returns r_t^b, r_t^a follow similar paths conditional on a monetary policy shock the choice of the discount rate in the price Phillips curve does not change the results. Finally, profits are given by $D_t = Y_t - w_tN_t$.

Financial sector. For the finance block of the model I follow the approach of Auclert, Bardóczy, Rognlie, and Straub (2021). Liquid and illiquid household savings can be invested in government bonds B_t and firm equity V_t and therefore both the liquid and illiquid returns follow the economy-wide real return r_t under a constant liquidity premium which is endogenously determined at the steady state of the model. Moreover, I assume that all capital gains due to changes in equity prices q_t accrue to the illiquid return, i.e. the investment fund discount profits using the illiquid return. Therefore,

$$r_t^a = \frac{\dot{q}_t}{q_t} + \frac{d_t - \iota_t - \chi_t(\iota_t) + (\iota_t - \delta)q_t}{q_t}.$$

Monetary and fiscal policy. Monetary policy sets the short-term nominal interest rate and is again characterized by a simple interest rate rule

$$i_t = r^b + \phi_\pi \pi_t + v_t.$$

Fiscal policy sets government spending G_t and issues public debt B_t. In particular, the flow government budget constraint is given by

$$dB_t = \left(r_t^b B_t + G_t - \tau \int_X w_t e_t n_t d\psi_t \right) dt.$$

A monetary policy shock impacts the government budget through changes in the borrowing cost r_t^b. I assume that fiscal policy responds to these changes by adjusting the level of debt and only over time slowly adjusts government spending to stabilize the debt at the steady state level.

$$G_t = G \left(\frac{B_t}{B} \right)^{-\gamma_B}$$

The parameter γ_B governs the speed at which the fiscal authority stabilizes public debt relative to the steady state. I choose the value of γ_B to generate a very small and persistent spending adjustment. Therefore, in this specification after an expansionary monetary policy shock the government debt absorbs the reduced interest payments and the aggregate demand stimulus is mostly due to monetary policy.

Equilibrium. To close the model in general equilibrium I specify below the market clearing conditions for the labor market and the financial market. The definition of equilibrium and solution method are similar to the baseline model.

$$q_t K_t + B_t = \int_X a_t d\psi_t + \int_X b_t d\psi_t,$$

$$N_t = \int_X e_t n_t d\psi_t.$$

Calibration. Table A.1 reports the main parameters of the two-asset model.[25] First, I calibrate a set of parameters externally. In particular, I calibrate η so that the average lifespan is 45 years. I set the liquid return in the steady state with zero inflation r^b to 2% and the automatic deposit ω to a small fraction of income. The parameters that characterize preferences, the borrowing constraint, production technology, capital depreciation, elasticities of substitution, adjustment costs, and policy are calibrated as in the baseline HANK model. I adopt quadratic adjustment costs also for households' portfolio choices so that $\chi_2 = 2$. These choices correspond to standard values in the literature. The remaining parameters $\rho, \kappa_b, \chi_0, \chi_1, \theta$ are internally calibrated

[25] In order to focus the complexity of the model on household wealth I use a two-state Poisson process for income risk e_t. So the model features two broad income groups: low-income households and high-income households. The liquidity premium is sufficiently large to generate realistic wealth inequality even with a simple income process.

to match the a wealth-to-income ratio of 2.5, the share of net borrowers of 15%, a fraction of poor low-liquidity households of 10%, a fraction of wealthy low-liquidity households of 20%, and an illiquid retunr around 6%. I choose the value for γ_B such that government debt is back at the steady state level after 15 years.

Table A.1: Model parameters

Parameter	Description	Value	Source
Households			
γ	CRRA/Inverse IES	2	External
ν	Inverse Frisch elasticity	1	External
ϕ	Borrowing limit	1	External
η	Exit rate	0.0056	External
ω	Illiquid deposit	0.02	External
r_b	Liquid return (p.a.)	0.02	External
κ_b	Borrowing wedge (p.a.)	0.18	Internally calibrated
ρ	Individual discount rate (p.a.)	0.05	Internally calibrated
χ_0, χ_1	Portfolio adjustment cost	0.05,2	Internally calibrated
Firms and policy			
θ	Capital elasticity	0.15	Internally calibrated
δ	Depreciation rate (p.a.)	5%	External
Ψ_p, Ψ_w	Adjustment costs	100	External
ϵ_p, ϵ_w	Elasticities of substitution	10	External
κ	Investment adjustment cost	25	Internally calibrated
ϕ_π	Taylor coeff.	1.25	External
τ	Income tax rate	0.3	External
γ_B	Spending adjustment coeff.	0.5	Internally calibrated

The model fits the targeted statistics quite well. In the two-asset HANK model the wealth-to-output ratio is around 2.2. Most of this wealth consists of illiquid capital. The share of net borrowers is 18%. The share of liquidity constrained households with $a_t = 0$ is 15% and the share of wealthy households with b_t around zero is around 24%. So, more than one-third of the population is liquidity-constrained as in the data. The equilibrium return on the stock market r_t^a is 6.5%. The model also generates realistic wealth inequality. In the model the Gini coefficient of the wealth distribution is 0.7. The average quarterly MPC is 10%.

Figure A.1 shows the main features of the two-asset HANK model. The left panel shows the MPCs across the distribution of financial wealth. The MPCs are extremely high for liquidity constrained households at the bottom of the wealth distribution. The presence of wealthy households with few liquid assets implies that the MPCs remain sizable throughout the wealth distribution. On average households in the top 10% have an MPC of 7%, this is an order of magnitude higher than the MPC implied by the baseline one-asset model. The right panel in Figure A.1 shows households' portfolio choices and the composition of financial wealth. Households in the first two deciles tend to be net borrowers with the value of their debt exceeding the value of their assets. At the bottom half of the wealth distribution most households accumulate wealth in the form of liquid assets. In the next 40% households start investing in stocks that is the dominant asset of the wealthy at the top 10% of the distribution. These cross-sectional patterns match quite well those documented in the SCF microdata. See the Online Appendix E.1.

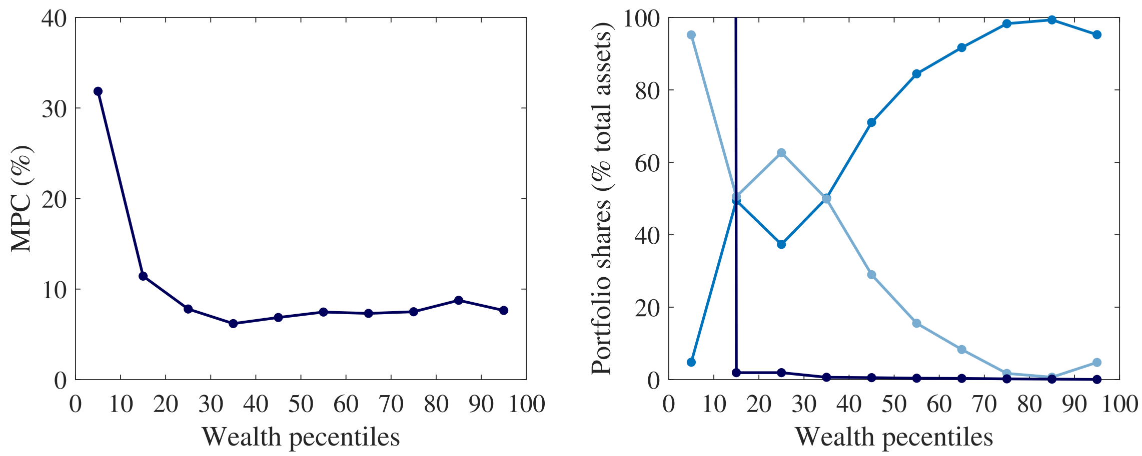

Figure A.1: MPCs and portfolio shares across the wealth distribution.

Note: The left panel shows the marginal propensities to consume out of 500 dollars across the distribution of financial wealth. The right panel shows the portfolio shares of the liquid consumption asset (light blue line), the illiquid investment asset (blue line), and short-term debt (dark blue line) as a share of total financial assets.

Overall, analyzing the consumption responses to monetary policy in the two-asset model calibrated to match the distribution and composition of financial wealth allows me to control for the role of households' MPCs and portfolio choices relative to the baseline one-asset model. The former element is important for the households' response to capital gains and changes in earnings. The latter element introduces in the model a portfolio rebalancing channel and a distinction between capital gains on bonds and stocks in response to monetary policy shocks.

D.2 Quantitative analysis

In this section, I analyze the equity price channel of monetary policy in a two-asset HANK model. This serves two main purposes. First, not all financial assets have the same degree of liquidity. In particular, stocks tend to be more illiquid than bonds. Therefore, I introduce in the model an illiquid asset. Second, this allows me to show that the main results on the monetary transmision mechanism from the baseline model are robust to the specification of household balance sheets and the inclusion of portfolio choices.

I begin with a discussion of the key elements of the two-asset model. In the baseline model, I treat the composition of financial wealth and portfolio choices as given. In the two-asset model of this section, households can save using liquid assets and illiquid assets subject to convex portfolio adjustment costs. The model generates high wealth concentration by introducing a liquidity premium on equity. Intuitively, households trade off consumption smoothing with better investment opportunities in the stock market. Importantly, the model reproduces well the portfolio composition of US households between liquid assets, i.e. bank deposits and bonds, and illiquid stocks across the distribution of financial wealth. Specifically, liquid assets are the main saving device at the bottom 50% of the distribution. The portfolio shares of liquid assets and stocks switch around the median as middle-class households start accumulating equity. Finally, households in the top 10% of the distribution tilt their portfolios toward stocks, which in the data account for more than 80% of the total financial wealth of this group. In this model changes in equity prices only affect the value of stocks. Therefore, households' exposure to capital gains depends on households' wealth composition at the steady state. Portfolio choices also matter beyond steady-state wealth composition. After an expansionary monetary policy shock households will rebalance their portfolios. In particular, in the baseline monetary policy experiment households reduce bond holdings to invest in stocks. Therefore, endogenous portfolio choices affect the transmission channels of monetary policy. In particular, increasing households' exposure to equity prices and to changes in the illiquid return. Beyond these effects, I leave a further investigation of portfolio rebalancing to future research. Differently from the baseline model I now introduce fiscal policy. In particular, in the main policy experiment I assume that after an expansionary monetary policy shock the government will let debt adjust to the lower interest rate expenses and over the years slowly raises public spending bringing public debt back at the steady state level.[26] This specification ensures that most of the aggregate demand stimulus is still due to monetary policy.

The macro responses to an interest rate cut of 25 basis points in the two-asset model are similar to those of the baseline model. The shock has an expansionary effect on economic activity and inflation. Quantitatively these responses are consistent with empirical evidence. Importantly, the stock market response to monetary policy measured by the change in equity prices is 0.3% on impact. The cross-sectional consumption responses and welfare effects by wealth

[26] In this model the central bank follows a simple Taylor rule and can change the short-term nominal interest rates on liquid assets. As before, systematic monetary policy responds only to the inflation rate.

groups reported respectively in Figure A.2 and Figure A.3 are qualitatively similar to those of the baseline model. However, because of the two asset structure household consumption-saving behavior and the transmission channels of monetary policy to household expenditure are different.

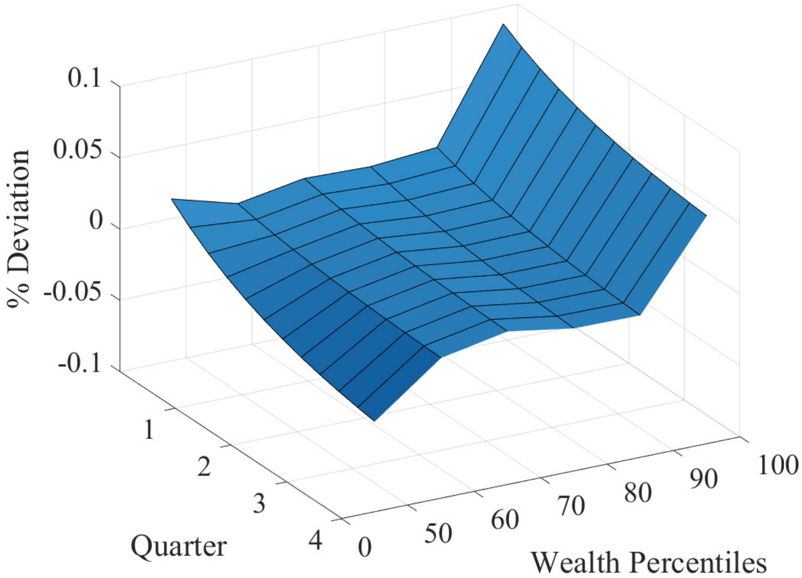

Figure A.2: Consumption responses in the two-asset HANK model.

Note: The figure shows the consumption responses to a 25 bp interest rate cut across the wealth distribution in percentage deviation from steady-state aggregate consumption.

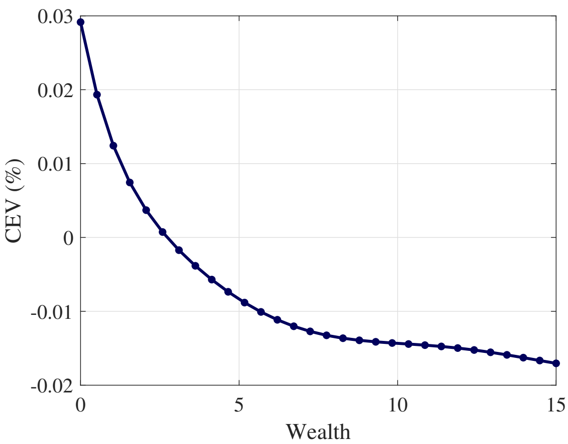

Figure A.3: Welfare effects in the two-asset HANK model.

Note: The figure plots the welfare gains across the distribution of financial wealth at the steady state. Wealth levels are in terms of average annual earnings.

E Further Results

E.1 Wealth composition

In this section, I study household portfolio composition across the distribution of financial wealth in the SCF and discuss how this relates to the main quantitative results of this paper.

Figure A.4 shows the composition of households' wealth across ventiles of the wealth distribution. In this paper, I define wealth as financial wealth. Thus, I first compute the average portfolio shares of three broad asset classes relative to total financial assets. The first class is given by liquid assets and consists of cash holdings, deposits, and bonds. The other classes are given by stocks and revolving debts. Households at the bottom 20% have negative wealth as the value of debt exceeds the value of all the financial assets. Liquid assets dominate household portfolios at the bottom 50%. The portfolio share of public equity increases across the wealth distribution and reaches its peak at the top of the distribution. The financial wealth of wealthy households consists of public equity that represents more than 80% of their total assets. The effects of the equity price in the models studied in this paper are broadly consistent with the cross-sectional composition of wealth as wealthy households benefit the most from higher equity prices while middle-class households face higher prices to accumulate equities. In particular, the two-asset model captures very well household wealth composition. As emphasized by Kuhn, Schularick, and Steins (2020) the total capital gain in a portfolio with multiple asset categories is a weighted average of price changes on each asset category with weights given by the portfolio share of each asset class. Figure A.4 shows that at the top 10% the portfolio share of equity is close to one. In the baseline model and in the two-asset model wealth is highly concentrated at the top of the distribution. Hence, changes in equity prices have a large effect on households' wealth only at the top 10%.

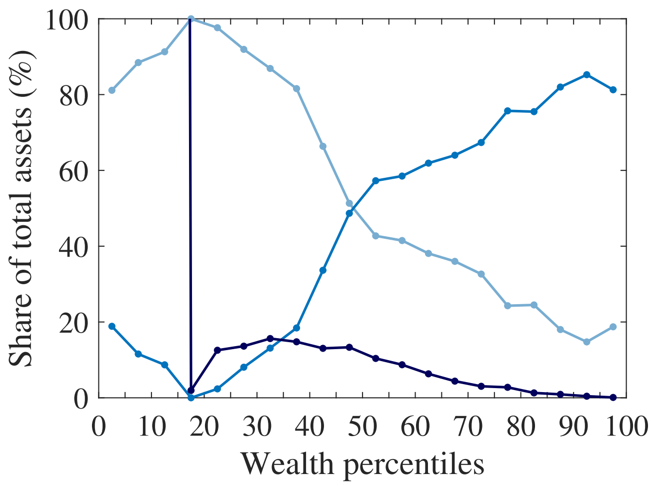

Figure A.4: Wealth composition in the SCF.

Note: The figure shows the average portfolio shares of liquid assets (light blue line), public equity (blue line), and short term debt (dark blue line) relative to the total financial assets across the wealth distribution.

In summary, the evidence from the SCF on systematic differences in households' portfolio choices across the wealth distribution confirms that the composition of households' wealth can be quantitatively important for the heterogeneous effects of monetary policy on household consumption expenditure. However, the main focus of this paper is to study the implications of wealth concentration at the top of the distribution for the equity price channel of monetary policy and households at the top 10% tilt their portfolios toward stocks.

E.2 Low-liquidity households across the wealth distribution

This section provides additional empirical evidence on the distribution of low-liquidity households across wealth groups. Throughout this section, I use the SCF data. This empirical analysis provides supporting evidence for the calibration of low-liquidity households in the model.

To measure low-liquidity households, i.e. households that have low liquid wealth within a pay period, I follow the definition of Weidner, Kaplan, and Violante (2014). Let b be household liquid wealth, y monthly income. I assume that the borrowing limit ϕ_b is 1 month of income. A household is classified as a low-liquidity household if one of the following conditions holds

$$b \geq 0 \quad \text{and} \quad b \leq y/2,$$

$$b < 0 \quad \text{and} \quad b \leq y/2 - \phi_b = -y/2.$$

This measure aims to capture two kinks in households' budgets either at zero liquid wealth, due to differences in saving and borrowing rates, or at the borrowing limit. The cut-off $1/2$ is due to the assumption that all resources are consumed at a constant rate. So, average balances over the pay period are equal to half of income. As noted by Weidner, Kaplan, and Violante (2014) using income before taxes can overstate the fraction of low-liquidity households by increasing the threshold. On the other hand, if a household starts the period with some positive savings and ends the period with zero liquid wealth its average balance would be above half earnings and the measure will miss these low-liquidity households. Liquid wealth is given by cash holding, deposits, government and corporate bonds, and stocks net of credit card debt. I exclude from the sample households with zero or negative earnings and compute monthly earnings by dividing annual before-tax wages and self-employment income by 12. According to this definition, the share of constrained households in the US economy is around 35%. More than 50% of all low-liquidity households in the US economy are at the bottom 30% of the distribution of financial wealth. 21% of all low-liquidity households are in the middle class from the 50th to the 90th wealth percentiles. Similarly, the share of constrained households within each wealth group substantially declines with financial wealth. Low-liquidity households are the vast majority at the bottom 30% of the wealth distribution. The within shares are above 80% in the first three deciles, 34% in the fifth decile, 20% in the seventh decile, and 11% in the ninth decile. These results are consistent with the calibration of the baseline model.

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