The Marginal Propensity to Consume in Behavioral Macroeconomics*

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Abstract

We develop a behavioral Heterogeneous Agent New Keynesian (HANK) model with mental accounting to quantify the macroeconomic implications of heterogeneous consumption responses to income changes. In the model, household earnings provide a reference point to finance expenditure decisions. This yields an empirically realistic distribution of liquid wealth and Marginal Propensity to Consume (MPC). We use the model to quantify the importance of MPC heterogeneity for the response of aggregate demand to monetary policy and fiscal stimulus checks.

Keywords: Reference Dependence, Monetary Policy, Fiscal Policy.

JEL Classification: E70, E21, E52, E60, D10

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1 Introduction

In view of the increasing use of stimulus checks as a policy tool in recent recessions, is important to better understand households' consumption behavior. A key statistic is the Marginal Propensity to Consume (MPC) which measures the consumption response to temporary income changes. Heterogeneous Agent (HA) models feature realistic MPCs and replicate several aspects of households' consumption behavior documented with microdata. However, the fact that a group of households shows both high liquid wealth holdings and high MPCs poses a well-known challenge for these models. The reason is that in heterogeneous agent models high-MPC households are liquidity-constrained, but as soon as they move away from the borrowing limit and accumulate some liquid wealth, their MPC sharply declines toward zero. As a result, this is an important limitation for many quantitative applications.

We develop a behavioral Heterogeneous Agent New Keynesian (HANK) model that can match the joint distribution of MPCs and liquid wealth while retaining the tractability of standard heterogeneous agent models. We use this framework to analyze the macroeconomic implications of MPCs heterogeneity. Our behavioral approach focuses on reference dependence. In standard heterogeneous agent models, households pool all available resources together as cash-on-hand including liquid savings. As a result, all these resources are equally fungible to smooth consumption. In practice, however, most consumers rely essentially on their earnings to finance consumption and dislike to dissave and consume out of their assets. Savings can have specific purposes, such as college or pension funds. Therefore, even if these assets are liquid, it does not necessarily mean that households are willing to use them to smooth consumption. If earnings provide the reference point for expenditure decisions, households are more likely to adjust consumption instead of savings in response to income shocks. This endogenously generates a group of households with high MPCs and high liquid wealth. In this paper, we focus on households' total spending and liquid financial wealth. To be precise, spending includes both durables and non-durables. Since our model makes no distinction between durables and non-durables, we simply refer to the marginal propensity to spend as the marginal propensity to consume. Liquid financial wealth is defined as cash, bank deposits, bonds, stocks, and other securities.

This paper presents two main findings. First, we incorporate reference-dependent preferences and mental accounting in a quantitative HANK model. This behavioral model can match the joint distribution of liquid wealth and MPC while retaining the tractability of standard heterogeneous agent models. Second, we show that MPC heterogeneity and the presence of a group of households with high MPCs and liquid wealth can amplify the effects of stimulus checks and mitigate the effects of monetary policy. Micro MPC heterogeneity matters significantly for the response of aggregate demand to stabilization policies.

We start our analysis by studying household consumption-saving decisions with reference-dependent preferences in isolation from the rest of the economy. We begin with the mental accounting framework. This theory restricts the income sources that households consider fungible given their system of "mental accounts". The key assumption is that households use their earnings as a reference point for their spending decisions. In this model, the utility function features a point of non-differentiability. This generates inaction regions where households optimally behave as hand-to-mouth consumers. This preference structure endogenously gives rise to a group of wealthy spenders with MPC equal to 1, consistent with the empirical evidence. Importantly, these households are present throughout the wealth distribution. As a result the average MPC slowly declines with liquid wealth and remains at a level well above zero even at the very top of the distribution. Therefore, the behavioral model can match key features of the joint distribution of wealth and MPC observed in the microdata.

Then, we move to general equilibrium analysis augmenting an otherwise off-the-shelf HANK model with reference-dependent preferences in the form of mental accounting. The model is rich enough to capture key elements of household balance sheets. Moreover, we introduce in this model monetary policy and fiscal policy in the form of stimulus checks. Importantly, the model nests a standard HANK model allowing for a natural comparison that isolates the role of MPC heterogeneity driven by households' behavioral bias. We calibrate the behavioral preferences to match the average MPC and the share of hand-to-mouth households in the microdata. We begin the analysis by studying the impulse response functions of key macroeconomic variables to stimulus checks and interest rate cuts in the behavioral model. Having established that the model can match key features of household consumption behavior and generate realistic macroeconomic responses to stabilization policies, we turn to the question of what is the role of MPC heterogeneity. Using counterfactual policy experiments, we show that the presence of wealthy households with high MPC substantially amplifies the response of aggregate consumption to stimulus transfers. On the other hand, however the presence of these households mitigates the response of aggregate consumption to interest rate cuts. These results have a common root. For wealthy households income effects become more important relative to substitution effects. The balance sheet channels gain importance relative to substitution effects. As a result, in the behavioral model the consumption response to interest-rate changes is attenuated, while the response to changes in household earnings is strengthened. This implies that for fiscal policy both the direct effect of the fiscal transfer and the indirect effects operating through labor income are amplified, whereas for monetary policy the direct effect transmitted through interest rates is dampened and the indirect effects through labor income are enhanced. Therefore, heterogeneity in MPCs is consequential not only for the overall magnitude of the aggregate demand response, but also for shaping the specific channels through which stabilization policies operate. The distribution of MPCs matters beyond the average level.

We leverage the behavioral model to analyze the effects of stimulus checks during a severe recession. To this end, we incorporate in the model a financial shock that generates a demand-driven recession with a fall in economic activity and inflation. Absent a fiscal policy intervention, this shock reduces aggregate output on impact by around 4%. In this enviroment, we study the macroeconomic effects of stimulus checks of different sizes. We show that in the behavioral model stimulus checks distributed to all households are particularly effective at reducing the output loss and closing the output gap. This result is driven by the group of wealthy spenders who mostly consume out of the fiscal transfers. This stands in contrast with the standard model, which would predict more stimulative effects from targeting low-wealth households. Importantly, in the behavioral model the share of wealthy spenders declines with the size of stimulus payments. As checks become larger households optimally decide to start smoothing consumption and saving a larger fraction of the transfer. This generate a substantial size-dependence in the spending response to stimulus checks. Overall, untargeted fiscal packages are more effective in the behavioral model.

We study the implications of the behavioral model for forward guidance, i.e. announcements of future interest rate cuts, and zero lower bound episodes. Wealthy spenders effectively have a short planning horizon as their consumption decisions mostly depend on current earnings. We show that this implies that the anticipation effects of forward guidance are mitigated. As a result, forward guidance is less effective at stimulating aggregate demand than in the standard HANK model. Regarding zero lower bound episodes, we feed into the model a financial shock such that the zero lower bound is binding for one year. We find that the recession during the zero lower bound is less severe in the behavioral model than in the standard model. The reason is that the zero lower bound is an effective constraint on systematic monetary policy. However, since monetary policy is less effective in the behavioral model than in the standard model, the consequences of this constraint are less severe.

There are also other additional results that are worth discussing. Mental accounting generates a meaningful distinction between MPC out of earnings and MPC out of wealth. In standard heterogeneous agent models all income sources are equally fungible and therefore there is no distinction between the two concepts. This distinction is empirically relevant as existing evidence suggests that MPCs out of wealth tend to be substantially lower than MPCs out of income (Chodorow-Reich, Plamen, and Simsek (2021)). Therefore, this property of the mental accounting theory moves the model towards the data. In the behavioral the MPCs out of wealth of wealthy spenders are exactly equal to zero. We show that this implies a substantial mitigation of the equity price channel of monetary policy. However, dividend income and realized capital gains are likely perceived by households as "income". Therefore, introducing realized capital gains in the reference point could partially offset the mitigation of the equity price channel of monetary policy. We leave the quantification of these effects to future research.

We also investigate the business cycle properties of the behavioral model. We begin by examining how a demand-driven recession affects the cross-sectional responses of household earnings and consumption. Relative to the baseline model, we incorporate heterogeneous exposure of household earnings to business-cycle fluctuations. Households at the tails of the income distribution are most affected by fluctuations in GDP. In particular, this applies to households in the bottom 50% and the top 10% of the distribution. We calibrate the demand shocks such that the earnings response in the behavioral model matches that in the standard model. Despite exhibiting identical earnings responses, the two models generate markedly different consumption responses. The behavioral model features a sharper decline in consumption both at the bottom and at the top of the income distribution. Because consumption in the behavioral framework more closely tracks contemporaneous income, the unequal exposure to business-cycle fluctuations amplifies aggregate demand fluctuations relative to the standard model.

We also examine the business-cycle implications of the behavioral model by simulating time-series data for inflation and output driven by both demand and supply shocks. In finite samples, we find that the behavioral model exhibits greater volatility in output and inflation than the standard model. This arises because aggregate consumption is more sensitive to current income and exhibits less smoothing over time. Notably, the behavioral model also generates a stronger positive correlation between output and inflation relative to the standard model, indicating that aggregate demand shocks play a disproportionately larger role in driving economic fluctuations compared with supply shocks.

Finally, we conduct a case study of the 2008 tax rebates implemented in the early phase of the Great Recession. During the second and third quarters of 2008, most U.S. households received approximately \$1,000 in stimulus payments in the form of tax rebates. We use the behavioral model to construct counterfactual trajectories for U.S. GDP and inflation in the absence of these fiscal transfers, thereby quantifying the macroeconomic impact of the 2008 stimulus package. We consider two specifications of the behavioral framework: a baseline version without household debt and an extension that incorporates debt repayment behavior, reflecting evidence that many households used a substantial share of the rebate to reduce outstanding liabilities at the onset of the recession. Across these counterfactual simulations, we estimate cumulative fiscal multipliers in the range of 30-40 percent, indicating that the 2008 stimulus measures played a meaningful role in mitigating the decline in GDP during the Great Recession. We view these estimates as an upper bound on the likely effects of the stimulus package, because transfers in the model are untargeted, whereas the actual payments were phased out with income. Unlike the standard model, in which untargeted transfers are less effective, the behavioral framework predicts substantially greater effectiveness for targeted transfers. Overall, these magnitudes align closely with the effects associated with standard stimulus-payment interventions as generated by HANK models.

Overall, we show that mental accounting can be easily incorporated into quantitative HANK models. Importantly, the proposed mechanism generates a realistic MPC heterogeneity and wealth distribution. In the model, households optimally choose to behave hand-to-mouth regardless of the amount of liquid assets, breaking the trade-off between wealth accumulation and MPC. We find that carefully accounting for a group of households with high wealth holdings and MPC turns out to matter significantly for macroeconomic policy.

Literature. This paper contributes to several strands of the behavioral macro literature. Farhi and Werning (2019), Kaplan and Violante (2021) study the predictions of heterogeneous agents models combining incomplete markets and behavioral frictions on expectations or preferences. A set of papers studies specific behavioral factors such as mental accounting (Shefrin and Thaler (1988), Thaler (1990), Gimeno-Ribes (2023), Graham and McDowall (2025)), temptation and self-control (Gul and Pesendorfer (2001), Attanasio, Kovacs, and Moran (2021)), inattention (Sims (2003)), imperfect problem solving (Ilut and Valchev (2023)), finite planning horizon (Boutros (2025)), financial stress, (Sergeyev, Lian, and Gorodnichenko (2023)), and overconfidence (Pfäuti, Seyrich, and Zinman (2023)).[1] Building on this literature, we examine the macroeconomic implications of reference-dependent preferences.

This paper is also closely connected to a recent and growing literature that emphasizes the importance of behavioral factors to understand the consumption response to fiscal policy and monetary policy using HANK models.[2] Auclert, Rognlie, and Straub (2020) develop a HANK model with sticky information to generate hump-shaped responses of macroeconomic variables to aggregate shocks. Laibson, Maxted, and Moll (2021) analyze the implications of present bias for monetary policy and fiscal policy in partial equlibrium. Pfäuti and Seyrich (2022) focus on the role of expectations with cognitive discounting for the effects of monetary policy. Our main contribution to this literature is to use a behavioral HANK model with mental accounting to quantitatively illustrate the macroeconomic implications of MPCs heterogeneity. This also adds to the literature on the effects of fiscal policy and monetary policy with heterogeneous agents (Auclert, Rognlie, and Straub (2025), Kaplan and Violante (2018)).[3] In this literature, Bayer, Born, and Luetticke (2024) study the distributional effects of aggregate shocks. Kaplan, Nikolakoudis, and Violante (2023) analyze the effects of fiscal and monetary policy on inflation. Kaplan, Moll, and Violante (2018) study the transmission of monetary policy in the presence of "wealthy hand-to-mouth" households. Our contribution is to show the role of a group of wealthy spenders for the amplification or mitigation of macroeconomic policy effects.

[1] In general, Lian (2023) shows how some of the different behaviorial biases can be captured by adding wedges to the first order conditions of standard models.

[2] Woodford (2013), Gabaix (2020) also study similar questions using the representative agent framework.

[3] While we focus on a positive analysis several papers also investigate optimal policy Bhandari, Evans, Golosov, and Sargent (2021), McKay and Wolf (2022).

Our results also contribute to the literature analyzing household consumption-saving behavior more broadly. Traditionally, the literature has emphasized the importance of liquid wealth (Aiyagari (1994), Huggett (1993)).[4] A typical approach for better reconciling the predictions of the models with the data is to introduce a second illiquid asset adjusted only infrequently (Kaplan and Violante (2014), Bayer, Luetticke, Pham-Dao, and Tjaden (2019)).[5] Recently, the literature has explored alternative factors behind household consumption-saving behavior that are not related to liquidity. Aguiar, Bils, and Boar (2021) analyze the role of heterogeneous preferences and find that these differences can rationalize several empirical facts about the behavior of hand-to-mouth households. Commault (2024) shows the importance of the persistent component of households' earnings for MPCs. Our paper follows this approach emphasizing the role of behavioral factors beyond liquidity.

This paper is also related to recent empirical and quantitative work on the distribution of MPCs. Jappelli and Pistaferri (2014), Fuster, Kaplan, and Zafar (2021), Kosar, Melcangi, Pilossoph, and Wiczer (2023) provide stylized facts on the cross-sectional distribution of MPCs for Italy and the US using survey data. These studies find that around 15% of households have an MPC equal to one or even above unity. Moreover, Lewis, Melcangi, and Pilossoph (2024) find that unobserved heterogeneity explains most of the variation in MPCs across households. Importantly, many recent empirical studies find large MPCs even for households with high liquid wealth (Fagereng, Holm, and Natvik (2021), Baugh, Ben-David, Park, and Parker (2021), Boehm, Fize, and Jaravel (2025), Chan and Kan (2023), Ganong and Noel (2019), Olafsson and Pagel (2018)). To summarize, this literature established three stylized facts. First, the extent to which liquid wealth reduces the MPC is relatively modest. Second, the explanatory power of liquid wealth for MPC heterogeneity is weak. Third, there is a group of wealthy spenders with high liquid wealth and MPC. All this evidence is consistent with a mental accounting framework. In particular, we examined the predictions of a set of behavioral models and find that models with mental accounting can explain the empirical findings.

Outline. The remainder of the paper is organized as follows. Section 2 studies how behavioral preferences shape the joint distribution of MPCs and liquid wealth. In this section we focus on the household consumption-saving decisions in isolation from the rest of the economy. Section 3 presents a behavioral HANK model with mental accounting. Section 4 explores the policy implications of household consumption behavior in general equilibrium. Section 5 investigates the business cycle properties of the behavioral model. Section 6 concludes.

[4]More recently, Auclert, Rognlie, and Straub (2024) analyze the importance of intertemporal MPCs for fiscal policy. Along these lines, Cantore and Freund (2021) develop a two-agent New Keynesian model with liquidity frictions to match the empirical evidence on intertemporal MPCs and study the implications for fiscal policy.

[5]In a similar spirit, Berger and Vavra (2015), McKay and Wieland (2021), Laibson, Maxted, and Moll (2022), Beraja and Zorzi (2023) study households' marginal propensity to spend on durables and the importance of the differences between consumption and spending that arise in the presence of durable goods.

2 Model with Reference Dependence

In this section we study a behavioral extension of the standard Heterogeneous Agent (HA) model with incomplete markets. Specifically, we analyze a model with mental accounting, which introduces reference-dependent preferences in an otherwise standard HA model. In this class of behavioral models individuals evaluate outcomes relative to a reference point. The aim of this section is to compare the joint distribution of MPCs and wealth in the behavioral model with the standard HA model. We begin our analysis focusing on the household problem in isolation from the rest of the economy to highlight the properties of the behavioral model, later on in the paper we investigate general equilibrium effects and policy implications.

2.1 Mental accounting

In this section we revisit the implications of mental accounting for the joint distribution of MPCs and wealth. Specifically, we consider the continuous time version of the mental accounting model proposed by Gimeno-Ribes (2023), Graham and McDowall (2025). In this model, current income provides the reference point for consumption decisions. In the canonical HA model, households aggregate all sources of income—including labor earnings, interest and dividend payments, rental income, and realized capital gains—along with their liquid savings into a single resource measure used to guide consumption–saving decisions. From this perspective, all components of income and wealth are fully fungible: a dollar received as wage income is treated identically to a dollar obtained from asset returns. Households thus optimize intertemporally by smoothing consumption based on their total disposable income and current cash-on-hand positions. By contrast, the mental-accounting framework posits that households do not treat all resources equivalently. Instead, they anchor their consumption–saving choices primarily on current earnings, which function as a reference point. Consuming more than one's contemporaneous earnings incurs a psychological or utility cost, reflecting the discomfort of drawing down assets for routine expenditures. Consequently, households exhibit a preference for preserving accumulated wealth. In this setting, assets are not perfectly fungible with income, they are mentally categorized as long-term savings rather than spendable resources. In this mental accounting framework the utility function features a point of non-differentiability or kink that generates inaction regions in the state-space where households optimally choose to behave hand-to-mouth. The Online Appendix A.2 contains further details on this model including the consumption and saving policy functions. Because households in the mental-accounting paradigm are reluctant to finance consumption from wealth, their consumption responds more strongly to changes in labor income than to equivalent changes in wealth. This key divergence from the standard HA model has substantive implications for consumption dynamics and the distribution of MPCs in the economy.

We begin by introducing a heterogeneous agent model with mental accounting. Let $y_t = w_t e_t n_t$ denote households' earnings or nonfinancial income, and define $1_{[c_t > y_t]}$ as an indicator function equal to one if $c_t > y_t$ and zero otherwise. The novel element of this model is the instantaneous utility function $u(c_t) - \varphi(u(c_t) - u(y_t))1_{[c_t > y_t]}$. The behavioral parameter $\varphi \geq 0$ governs households' preferences for living within their earnings. There is a utility loss whenever $c_t > y_t$ and households prefer to set $c_t < y_t$. Note that the utility cost is asymmetric, this introduces a kink in the utility function that is critical to generate inaction regions in the state-space where households optimally set $c_t = y_t$ and have a MPC equal to one. Households choose consumption and saving by solving the following maximization problem

$$\max_{c_t} \quad \mathbb{E}_0 \int_0^{\infty} e^{-\rho t} \big(u(c_t) - \varphi(u(c_t) - u(y_t)) 1_{[c_t > y_t]} \big) dt,$$

$$\text{s.t.} \;\; da_t = (w_t e_t n_t + r_t a_t - c_t) dt,$$

$$a_t \geq -\phi.$$

The income process is again given by

$$d \ln e_t = \nu_e(\mu_e - \ln e_t) dt + \sigma_e d\hat{w}_t,$$

where $d\hat{w}_t \sim N(0, dt)$ is a standard Brownian motion. For the moment the labor supply $n_t = \mathbb{E}(e_t)$ is inelastic and homogeneous across households. Later on in the paper, we will relax these assumptions, allowing for endogenous and heterogeneous labor supply. There are two state variables in this model, households assets a_t and income risk e_t. We solve the model numerically using a finite difference approximation to the Hamilton-Jacobi-Bellman (HJB) equation and the Kolmogorov Forward (KF) equation that describes the dynamics of the distribution of idiosyncratic states $\psi_t(a_t, e_t)$.[6]

In our baseline parametrization we choose a CRAA utility function with parameter $\gamma = 1$ so that $u(c_t) = \ln c_t$. We allow for some borrowing and set the limit $\phi = 0.5$.[7] The real wage $w = 2$ and $r = 2\%$ per year. The parameter ρ is internally calibrated to match the wealth-income ratio. In the behavioral model φ is internally calibrated to match the average MPC. To compute the MPCs we simulate the model equivalent of a \$500 transfer. The empirical benchmark for the average MPC at the quarterly level for this transfer is between 25% and 37% (Borusyak, Jaravel, and Spiess (2024)). We do not make an explicit distinction between durables and non-durables, we interpret our results in terms of aggregate spending.

[6] The Online Appendix A.2 contains further results and details on the model.

[7] The income process is calibrated to be consistent with typical estimates from PSID (Heathcote, Perri, and Violante (2010)). In particular, we set the standard deviation of the log-income innovations $\sigma_e = 0.2$ so that the variance is 0.04, and $\nu_e = 0.0263$ so that the annual autocorrelation of log-income shocks is 0.9. We set the log-mean $\mu_e = -0.32$ so that the mean of the income shocks $\mathbb{E}(e_t)$ is about one.

In the model with mental accounting the distinction between MPCs out of earnings and MPCs out of assets becomes important. The behavioral model can easily generate wealthy households with very large MPCs out of income, these households optimally choose to consume out of their earnings so they have MPCs equal to 1. On the other hand, these households have lower MPCs out of wealth. It is important to make this distinction explicit. The marginal propensity to consume out of wealth and income are defined respectively as

$$MPC^{a}_{\tau,h}(a,y,e) := \frac{C_h(a+\tau,y,e)-C_h(a,y,e)}{\tau},$$
$$MPC^{y}_{\tau,h}(a,y,e) := \frac{C_h(a,y+\tau,e)-C_h(a,y,e)}{\tau},$$

where τ is a one-time windfall and C_h is the total consumption flows over the period $[0,h]$ of an household with initial states a,e and earnings y.[8] In the canonical HA model $MPC^{a}_{\tau,h} = MPC^{y}_{\tau,h}$. Table 1 shows the implications of mental accounting for MPCs and wealth.

Table 1: MPC and wealth statistics across models

Description	$\varphi = 0$	$\varphi > 0$	Description	$\varphi = 0$	$\varphi > 0$
Wealth-income ratio	2.5	2.5	MPC^y bottom 50	16	32
Avg. quarterly MPC (%)	10	24	MPC^y next 40	3	17
Avg. annual MPC (%)	37	40	MPC^y top 10	3	14
Share with $a = \underline{a}$ (%)	10	10	Gini wealth	0.71	0.71
Description	$\varphi = 0$	$\varphi > 0$	**Description**	$\varphi = 0$	$\varphi > 0$
Median wealth	0.7	0.7	MPC^a bottom 50	16	10
P50$-$P10 ratio	12	12	MPC^a next 40	3	3
P90$-$P50 ratio	10	10	MPC^a top 10	3	3

Note: Wealth mean and percentiles are reported relative to households' average annual earnings. The upper panel reports average quarterly MPCs out of earnings (500 dollars) across wealth groups. The lower panel reports average quarterly MPCs out of assets (500 dollars) across wealth groups. Liquidity constraint $\underline{a} := -\phi$.

[8] These MPCs are comparable to empirical estimates (Parker, Souleles, Johnson, and McClelland (2013), Broda and Parker (2014), Guren, McKay, Nakamura, and Steinsson (2021), Di Maggio, Kermani, and Majlesi (2020)).

The average MPC in the behavioral model is around 25%, an order of magnitude larger than in the canonical HA model. However, note that the share of low-liquidity households and the average wealth is similar between the two models. The behavioral model can easily generate empirically realistic average MPC because a group of wealthy households with high MPCs emerge endogenously in this model. In our calibration about 15% of households belong to this group. These predictions are consistent with empirical evidence documenting the presence of high-income households with high MPCs and liquid assets (Misra and Surico (2014), Kueng (2018), Lewis, Melcangi, and Pilossoph (2024)). The upper panel in Table 1 also reports average MPCs across broad wealth groups. We can observe that in the behavioral model MPCs decline with liquid assets but remain high for all wealth groups, in contrast the canonical HA model generates MPCs that sharply decline with liquid assets. The lower panel in Table 1 shows the MPCs out of wealth gains across wealth groups. These MPCs are small and of the same order of magnitude than the MPCs of the standard HA model.

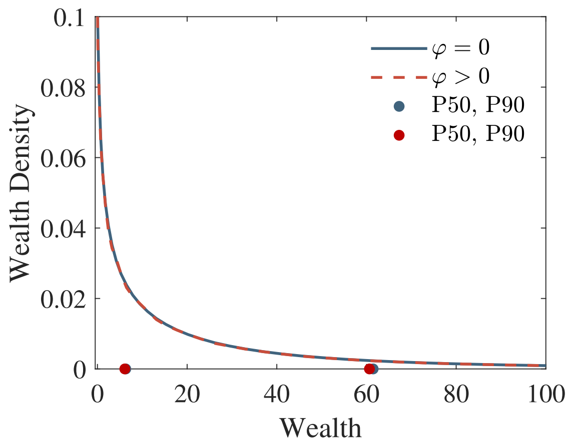

Figure 1: The wealth distribution.

Note: The 50th percentile and the 90th percentile are reported for $\varphi = 0$ (blue dots) and $\varphi > 0$ (red dots).

The economy with behavioral preferences is slightly more unequal than the economy of the canonical HA model despite a similar average wealth and share of liquidity constrained households. Inequality is lower at the left tail of the wealth distribution, but it increases at the rigth tail. Figure 1 shows the wealth distribution in the behavioral model ($\varphi > 0$) and in the canonical HA model ($\varphi = 0$). The two density functions are very similar and there are no noticeable differences. The behavioral parameter φ induces a consumption wedge. However, since preferences are asymmetric relative to the kink, there is a lower saving incentive when $c_t < y_t$ and an additional saving motive if $c_t > y_t$. In the aggregate, this generates a lower asset accumulation and an increase in wealth inequality.

In the standard HA model high MPCs are tightly related to liquidity constraints, as soon as households move away from the borrowing limit and accumulate enough liquid wealth to smooth income shocks their MPC falls. As a results the model feature a stark trade-off between MPCs and wealth. In contrast, in the behavioral model high-income spenders are present throughout the wealth distribution relaxing the trade-off between MPCs and liquid wealth accumulation. The left panel in Figure 2 illustrates this point. In the canonical HA model ($\varphi = 0$) the MPCs quickly decline with liquid wealth. In the behavioral model ($\varphi > 0$) the MPCs do decline with liquid wealth but remain substantially high throughout the wealth distribution.

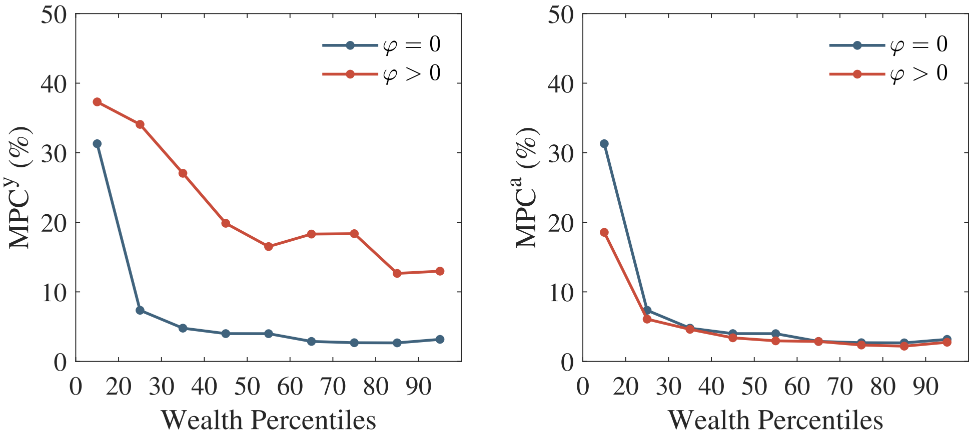

Figure 2: MPCs across the wealth distribution.

Note: The left panel shows MPCs out of earnings, the right panel shows MPCs out of assets.

The right panel in Figure 2 shows the MPCs out of wealth across the wealth distribution. In the behavioral model the average quarterly MPC out of assets is 6% and 25% yearly. These statistics are respectively 9% and 37% in the standard model. There are two main factors contributing to this. First, with $\varphi > 0$ the consumption wedge reduces MPCs if $c_t > y_t$. Second, in the inaction region $c_t = y_t$ MPCs out of assets are zero. The latter effect substantially reduces the MPCs of low-wealth households that are very close to the borrowing limit. This explains why the MPCs out of assets are particularly low at the bottom of the wealth distribution. Another important implication of the mental accounting framework is that MPCs out of income gains can be non-monotonic in wealth. Note that the kink of the utility function implies higher MPCs (100%) than those implied by the borrowing limit especially for liquidity-constrained households with high-income. If $\varphi > 0$ these households set $c_t < y_t$ to have positive saving and move away from the borrowing limit. As they become unconstrained the kink of the utility function is more likely to be binding.

3 A Behavioral HANK Model

In this section we introduce a quantitative HANK model with reference-dependent preferences using the mental accounting framework. We leverage the model to study the macroeconomic implications of household consumption behavior at the micro-level.

3.1 Households

In the economy markets are incomplete, time is continuous, and the horizon is infinite. The economy is populated by a unit mass of households that can invest in assets a_t, but cannot insure against their idiosyncratic income risk e_t. Let w_t be the real wage, n_t households' labor supply, and $\tau_{y,t}$ the marginal income tax rate. We define household earnings after taxes $y_t := (1-\tau_{y,t})w_t e_t n_t + b_t + \tau_{x,t}$ as the sum of net labor income $(1-\tau_{y,t})w_t e_t n_t$, business income b_t, and government transfers $\tau_{x,t}$. The level of earnings is the households' reference point to finance their consumption expenditures. Therefore, households solve

$$\max_{c_t} \ \mathbb{E}_0 \int_0^{\infty} e^{-\rho t}\big(u(c_t) - v(n_t) - \varphi(u(c_t) - u(y_t))1_{[c_t > y_t]}\big)dt,$$

$$\text{s.t. } da_t = ((1-\tau_{y,t})w_t e_t n_t + b_t + r_t a_t + \tau_{x,t} - c_t)dt,$$

$$a_t \geq 0.$$

where the istantaneous utility function $u(c_t) := c_t^{1-\gamma}/(1-\gamma)$ and $u(c_t) = \ln c_t$ when $\gamma = 1$, while $v(n_t) := n_t^{1+\nu}/(1+\nu)$. The parameter $\gamma > 0$ is the inverse of the intertemporal elasticity of substitution, and $\nu > 0$ is the inverse of the Frisch elasticity of labor supply. The income process is given by the Ornstein–Uhlenbeck process

$$d\ln e_t = \nu_e(\mu_e - \ln e_t)dt + \sigma_e d\hat{w}_t,$$

where $d\hat{w}_t \sim N(0, dt)$ is a standard Brownian motion. Households' disposable income consists of earnings component $(1-\tau_{y,t})w_t e_t n_t + b_t$ subject to one proportional tax rate $\tau_{y,t}$, capital income $r_t a_t$, and government lump-sum transfers $\tau_{x,t}$. For simplicity at the current stage we abstract from progressive tax-transfer system and business income taxes. For business income we assume that a fraction $\omega \in (0,1)$ of firms' profits D_t are distributed across households lump-sum according to the following rule $b_t = (e_t / \int_X e_t d\psi_t)\omega D_t$ where ψ_t is the distribution of idiosyncratic states $(a_t, e_t) \in X \subset \mathbb{R}^2$. This rule satisfies aggregate consistency as household business income b_t adds up to ωD_t. According to this rule high-earners have a larger share of business income. If $\varphi = 0$ we recover the canonical HA model.

3.2 Wage and price setting

In this section we describe the wage setting and price setting decisions in the economy.[9] Given that the main focus of this paper is on the demand side of the economy we keep the supply block as simple as possible. We use nominal wage rigidities to derive the Phillips curve of our model. Specifically, households supply a continuum of labor services indexed by $j \in [0,1]$ that are imperfect substitutes. Unions determine the household labor supply and set nominal wages subject to virtual wage adjustment costs by maximizing the average welfare of the union members. Following the literature, we assume that these costs do not cause a real waste of resources and only affects optimal decisions. This delivers the wage Phillips Curve

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

where $\pi_{w,t}$ is the inflation rate of nominal wages, N_t aggregate empoyment, C_t aggregate consumption, mrs_t the marginal rate of substitution between labor services and consumption, and $\mu_w := \epsilon_w/(\epsilon_w - 1)$ the wage markup. For simplicity we assume that labor supply is the same across households, in particular $n_t = N_t/(\int_X e_t d\psi_t)$.[10] The parameters ϵ_w, θ_w are respectively the elasticity of substitution between labor inputs, and the wage adjustment cost parameter.

On the firms side, we assume that a competitive firm aggregates a continuum of intermediate inputs indexed by $i \in [0,1]$ to produce a final consumption good. Intermediate input producers operate under monopolistic competition using a linear production technology

$$Y_t = N_t.$$

Marginal pricing implies that $w_t = mc_t$ since the marginal product of labor is constant and equal to one. Moreover, intermediate producers set prices to maximize profits. We assume a symmetric equilibrium and fully flexible nominal prices. As a result, real marginal costs are constant and equal to the inverse of the price markup $mc_t = \mu_p^{-1}$. This implies that real wages in this model are constant and labor income only responds to changes in employment levels. The main advantage of this specification is that it generates procyclical business profits. This is also broadly in line with the empirical evidence that suggests a larger adjustment of labor supply realtive to real wages in response to monetary policy shocks. The firms pricing decisions also implies the profit function $D_t = (1 - mc_t)Y_t$. Note that the assumptions of fully flexible prices implies that profits are procyclical since by construction real marginal costs are constant and $\mu_p > 1$. Since w_t is constant $\pi_{w,t} = \pi_t$, where π_t is the inflation rate of nominal prices.

[9] For further details on the model see the Online Appendix B.

[10] This can be relaxed by introducing more complicated distribution rules for agrgegate employment that depend on both household wealth and income risk.

3.3 Investment fund

Household assets a_t are invested in bonds and stocks. A mutual fund collects all household savings a_t and invests in government bonds B_t and in the stock market buying shares X_t of the intermediate firms. Specifically, the fund solve the following problem

$$\max_{x} \int_0^{\infty} \exp\Big(-\int_0^t r_s ds\Big)\Big((1-\omega)D_t X_t - q_t \dot{X}_t\Big)dt,$$

$$\text{s.t. } \dot{X}_t = x$$

Profit maximization implies the following no-arbitrage condition

$$r_t = \frac{(1-\omega)D_t}{q_t} + \frac{\dot{q}_t}{q_t}$$

Solving forward the no-arbitrage condition we obtain $q_t = \int_t^{\infty}(\exp(-\int_t^{\tau} r_s ds))(1-\omega)D_\tau d\tau$. So the fundamental value of the shares is given by the dividends cash flow. We normalize the total number of shares to one $X_t = 1$.

3.4 Monetary policy and fiscal policy

Monetary policy is given by a sequence of innovations to the nominal interest rate, while fiscal policy sets taxes and transfers and issues short-term government bonds $B_t > 0$. The central bank sets nominal interest rates according to a Taylor rule

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

where v_t are the monetary policy innovations. The Fisher equation $r_t = i_t - \pi_t$ holds at every t. The government collects income taxes and pays lump-sum transfers. The primary deficit is $d_t := \tau_{x,t} - \tau_{y,t} \int_X w_t e_t n_t d\psi_t$ and the flow government budget is given by

$$dB_t = \Big(r_t B_t + \tau_{x,t} - \tau_{y,t} \int_X w_t e_t n_t d\psi_t\Big)dt.$$

Given a slow adjustmnet of inflation, we can see from the government budget constraint that an expansionary monetary policy reduces real interest rates and the government's borrowing expenditures. The fiscal instrument that adjusts to balance the budget can be either transfers $\tau_{x,t}$ or income taxes $\tau_{y,t}$. At the steady state we calibrate τ_x and adjust τ_y. Outside the steady state we assume that government adjusts the transfers $\tau_{x,t}$ according to $\tau_{x,t} = \tau_x (B_t/B)^{-\gamma_B}$.

3.5 Aggregate shocks

We introduce unexpected aggregate demand shocks ξ_t^d and aggregate supply shocks ξ_t^s in the economy. We will use these shocks for the experiments in Section 4 and Section 5.

The shock ξ_t^d introduces a wedge in the investment fund first-order condition, in the household optimization problem, as well as in the government budget constraint. This wedge is equivalent to an excess bond premium as the return on bonds is given by $r_t + \xi_t^d$. An increase in ξ_t^d reduces stock prices as it increases the discount rate and the overall return on household savings. This is equivalent to a risk-premium shock as an increase in ξ_t^d widens the gap between the return on stocks and bonds. As a result, households reduce consumption causing a fall in labor demand and a recession. In turn, this reduces nominal wages and inflation. We label this shock a demand shock since it generates a positive correlation between inflation and output and originates in the household block of the model. The shock ξ_t^s is a wedge in the wage Phillips curve. This wedge is equivalent to a cost push shock as it increases the households' marginal rate of substitution $mrs_t + \xi_t^s$. This induces firms to raise nominal wages and production costs. In turn, this increases inflation and causes a fall in labor demand and a recession. We label this shock a supply shock since it generates a negative correlation between inflation and output.

3.6 Equilibrium

The equilibrium of the economy is given by paths for household decisions $\{c_t, n_t\}$, aggregate variables $\{C_t, Y_t, N_t, D_t, B_t\}$, prices $\{q_t, i_t, w_t, r_t, \pi_t\}$, monetary policy $\{v_t\}$, and fiscal policy $\{\tau_{x,t}, \tau_{y,t}\}$ such that in every period: (i) households solve the utility maximization problem given equilibrium prices, (ii) unions maximize households' utility, and firms maximize profits and minize costs given equilibrium prices, (iii) the sequence of density functions $\{f_t\}$ over idiosyncratic states is consistent with the household saving decisions and income risk, (iv) monetary policy follows a Taylor rule and the government budget constraint holds, and (v) financial markets and labor markets clear

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

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

We use the HJB and KF equations to represent the household block of the model recursively as in Achdou, Han, Lasry, Lions, and Moll (2022). We solve these partial differential equations using finite differences. We solve for the dynamics of the fully nonlinear model globally using the sequence space Jacobians of the model as in Auclert, Bardóczy, Rognlie, and Straub (2021).

3.7 Parametrization

In this section we present our baseline calibration. We calibrate the model to the US economy. The parameters γ, ν are calibrated externally using standard values in the literature. Specifically, we set the risk aversion parameter $\gamma = 2$, the Frisch elasticity $\nu^{-1} = 1$. The income process is calibrated as discussed in Section 2.1. Following the literature we set the price markups to match a profit share of 10% of output, the labor supply elasticity is equal to the intermediate inputs elasticity implying a wage markup of 11%. The wage adjustment cost coefficient θ_w is set to match a slope of the wage Phillips curve of 0.1.We set the steady-state net supply of public debt B to match the average labor income tax rate, the discount rate ρ to match the interest rate around 2%, and government transfers τ_x to represent a 6% share of income (Alves and Violante (2023)). The behavioral parameter φ is internally calibrated to match an average MPC of 25%. Table 2 shows the calibrated parameters.

Table 2: Model parameters

Parameter	Description	Value	Source
Households			
γ	CRRA/Inverse IES	2	External
ν	Frisch elasticity of labor supply	1	External
ν_e	Mean reversion coeff.	0.0263	External
σ_e	S. d. of innovations	0.2	External
φ	Behavioral parameter	0.27	Internally calibrated
B	Net asset supply	2	Internally calibrated
ρ	Discount rate (p.a.)	0.079	Internally calibrated
ω	Business income share	0.5	External
Firms and policy			
θ_w	Wage adjustment cost	100	Internally calibrated
ϵ_p	Intermediate goods elasticity	10	Internally calibrated
ϵ_w	Labor inputs elasticity	10	External
ϕ_π	Taylor coeff.	1.25	External
τ_x	Government transfers	0.18	Internally calibrated

Table 3 reports targeted and untargeted statistics. In our baseline calibration, aggregate wealth relative to annual income is around 2.5 and the transfer to income ratio is 7%. In all cases the tax rate τ_y at the steady state is determined by government budget balance. This yields values of τ_y around 25%. In the behavioral HANK model our calibration strategy delivers $\varphi = 0.27$. Table 3 shows that the canonical HANK model ($\varphi = 0$) and the behavioral HANK model ($\varphi > 0$) both generate sizable MPCs. The economy with $\varphi > 0$ is as wealthy as in the case with $\varphi = 0$. The overall wealth distribution is similar across the two model specifications. The fiscal variables are also undistinguishable across the two economies. The key difference between the two models is given by the joint distribution of MPCs and wealth, for this reason we take this calibration as our baseline. In particular, the MPCs across the wealth distribution are very different because the behavioral model features a group of wealthy spenders. In the standard HANK model around 14% of the households are liquidity constrained. In the model with mental accounting around 33% of the population behaves hand-to-mouth, around half of these households (19%) are liquidity constrained, the other half (14%) consists of households with large liquid asset holdings and MPCs.

Table 3: Statistics across models

Description	$\varphi = 0$	$\varphi > 0$		$\varphi = 0$	$\varphi > 0$
Real rate	2.3	2.6	Quarterly MPC^{y}	12	25
Share at $a = \underline{a}$	14	19	Quarterly MPC^{a}	12	11
Share of spenders	0	14	Annual MPC^{y}	50	60

Note: All targeted and untargeted statistics are shown as percentages and computed at the stationary equilibrium. Spenders are defined as wealthy unconstrained households that optimally choose $c_t = y_t$. MPCs are computed out of a small transfer ($500). Liquidity constraint $\underline{a} := -\phi$

This calibration allows us to study the role of MPC heterogeneity. In the standard model and in the behavioral model the share of liquidity constrained households is relatively similar. The main difference is given by the share of wealthy unconstrained households with high MPCs. By comparing the two versions of the model we can isolate the role of this group of households for the aggregate consumption response to monetary policy and fiscal stimulus checks. In the Online Appendix B.4 we study additional simulations in which the share of liquidity constrained households is the same in the behavioral model and in the standard model and find quantitatively similar results as in our benchmark calibration.

3.8 Household consumption behavior

In this section, we report the distribution of quarterly MPCs out of a $500 transfer across HANK models. In particular, Figure 3 shows the distribution of MPC across wealth groups in the behavioral HANK model with $\varphi > 0$ and in the HANK model with $\varphi = 0$.

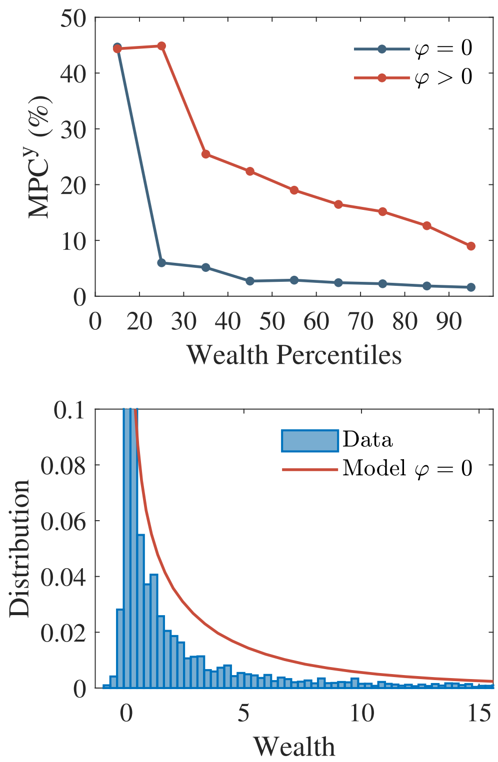

Figure 3: MPC and wealth across HANK models.

The two upper panels in Figure 3 show household consumption behavior across the wealth distribution. As expected, the MPC out of income is large even for wealthy households with a lot of liquid assets, while the MPC out of wealth is low even among liquidity constrained households at the bottom of the wealth distribution. Note that the MPC out of income is above 10% throughout the wealth distribution.[11] The two bottom panels in Figure 3 show the wealth distribution across model specifications and in the data. We can see that despite the substantial differences in the household consumption response to income shocks, the wealth distribution is almost the same across models. Moreover, both models deliver a realistic wealth distribution. Finally, note that the MPC in the model tend to be slightly non-monotonic in wealth as households at the borrowing limit have a lower average MPC than households in the next group.

[11] Quantitatively, this is broadly in line with the empirical evidence on MPC heterogeneity. Jappelli and Pistaferri (2014), Commault (2024) report annual MPCs around 0.3-0.4 at the top of the distribution of liquid wealth. Kueng (2018) estimates a quarterly MPC of nondurables around 0.2-0.3 for wealthy households.

4 Macroeconomic Policy

In this section, we quantitatively illustrate the implications of reference-dependent preferences for a set of macroeconomic stabilization policies. In particular, we study how the joint distribution of MPC and wealth that arise in general equilibrium affects the response of household consumption to fiscal policy and monetary policy. We start with fiscal policy and analyze the effects of fiscal stimulus checks. Next we study the impact of an expansionary monetary policy. For each stabilization policy we study the role of MPC heterogeneity for the response of aggregate consumption and for the policy transmission channels.

4.1 Fiscal policy

The fiscal stimulus checks consist of a 10% increase in government transfers to households. This captures stimulus checks of about $500 on impact followed by smaller payments in subsequent rounds. Since we focus on the macroeconomic responses on impact the assumptions regarding the timing of the fiscal shock are not critical. We set the persistence so that the stimulus program lasts for one year. In particular, we feed into the model an exponential path for policy innovations. The fiscal policy shock is given by $u_t = u_0 e^{-\rho_u t}$ with $u_0 = 0.1\tau_x$ and $\rho_u = 0.5$. The government resorts to public debt to finance the stimulus checks and will gradually adjust transfers over the years to balance its budget. Figure 4 shows the responses of the main macroeconomic variables in the behavioral HANK model to stimulus checks.

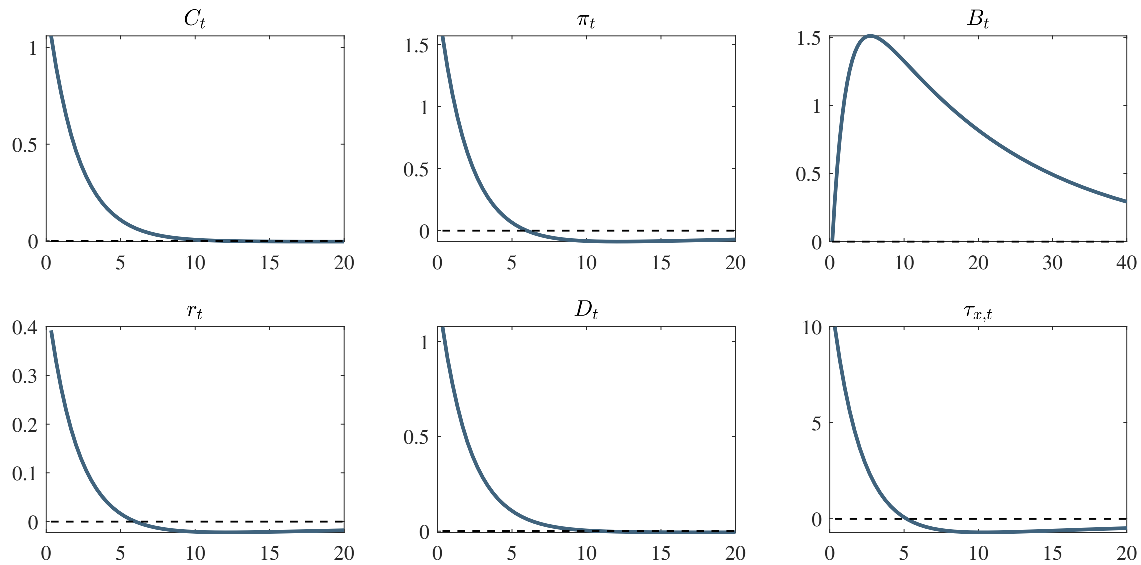

Figure 4: Impulse responses to stimulus checks.

Note: All the responses are in percentage deviation from steady-state values. Only the interest rate r_t and inflation π_t are reported in annual percentage points deviation from steady state. Quarters on the x-axis.

This policy increases consumption by 1%. The increase in aggregate demand leads to higher production, profits, and inflation. As unions demand higher nominal wages firms raise prices and the inflation rate increases. The central bank responds to the fiscal stimulus by increasing the short-term interest rates. After the first year, the program ends and the fiscal authority reduces fiscal transfers to stabilize public debt which is fully repaid after 25 years.

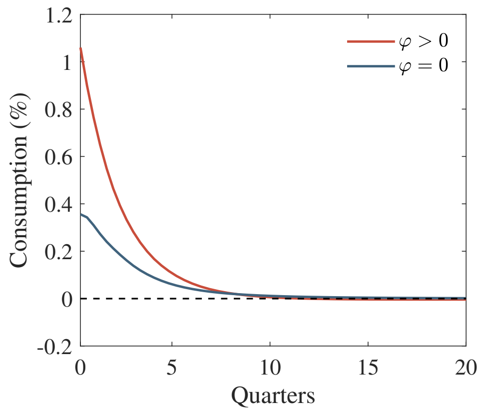

Figure 5: Consumption response to stimulus checks.

Does the presence of wealthy households with high MPCs matter for aggregate consumption? We answer this question by comparing the consumption responses to stimulus checks in the behavioral HANK model ($\varphi > 0$) and in the standard HANK model ($\varphi = 0$). Figure 5 shows that the response of aggregate consumption to fiscal stimulus is higher in the behavioral model than in the standard model. In this case, the presence of wealthy spenders amplifies the response of aggregate consumption to stimulus checks by 0.65 percentage points or by almost two times. We can decompose the consumption response into four main channels reflecting the main components of household balance sheets. A direct interest rate channel which depends on the decisions of the central bank as well as household saving decisions and an indirect asset price channel that depends on the stock market prices. A direct channel given by government transfers and an indirect channel given by household earnings, i.e. the sum of labor income and business income, that depends on general equilibrium effects. Specifically, as stimulus checks increase aggregate demand they raise labor demand and employment levels as well as the level of economic activity and business profits. All these effects impact household earnings.

First of all, note that systematic monetary policy reduces the aggregate demand stimulus by raising the interest rate because inflation is higher. This implies a negative effect from the interest rate channel. On the other hand, however, lower interest rates and higher firms' profits also increase stock market prices and the value of household wealth increasing household consumption. The net effect is positive. Also the earnings channel increases consumption. However, the main driving force of the consumption response in Figure 5 is the direct effect of stimulus checks.

4.2 Monetary policy

The monetary policy shock consists of an interest rate cut of 25 basis points with a quarterly autocorrelation of 0.6, a value consistent with the empirical estimates of monetary policy shocks.The monetary policy shock is given by $v_t = v_0 e^{-\rho_v t}$ with $v_0 = -0.0025$ and $\rho_v = 0.5$. Figure 6 shows the impulse response functions in the behavioral HANK model to a 25 basis points reduction in the nominal interest rate.

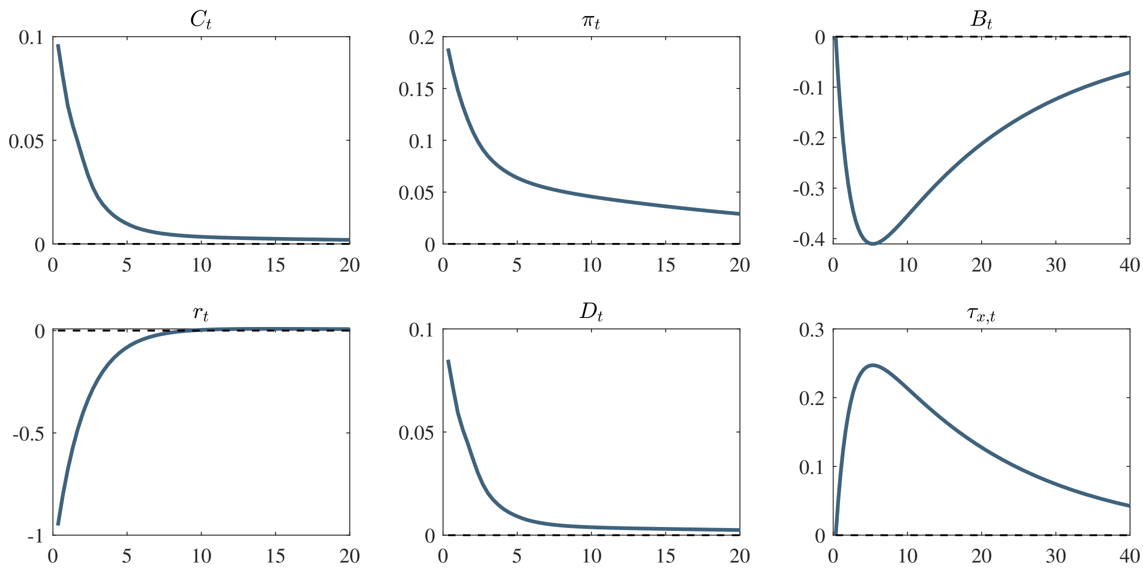

Figure 6: Impulse responses to monetary policy.

Note: All the responses are in percentage deviation from steady-state values. Only the interest rate r_t and inflation π_t are reported in annual percentage points deviation from steady state. Quarters on the x-axis.

The reduction in the policy rate reduces borrowing costs, increases employment and firms' profits, and stimulates household consumption. On impact, monetary policy raises household expenditure by 0.1% and annual inflation by 0.2%. Overall, these responses are broadly in line with the empirical evidence on the effects of expansionary monetary policy shocks of 25 basis points. The monetary policy shock has also fiscal consequences. In the presence of nominal rigidities, the monetary shock lowers the real interest rate reducing the government borrowing expenses. By reducing the government borrowing costs it generates fiscal space to reduce public debt and increase government transfers. In the baseline experiment, we assume that fiscal policy lets public debt adjust to the shock. The fiscal authority will gradually adjust transfers over the years to guarantee intertemporal budget balance. Despite these interactions most of the stimulus effects on aggregate consumption are due to monetary policy rather than fiscal policy.

Figure 7 shows that the response of aggregate consumption to monetary policy is smaller in the behavioral model ($\varphi > 0$) than in the standard model ($\varphi = 0$). The standard model features a 0.12% increase in consumption on impact. The behavioral model features an initial increase of aggregate consumption of 0.1%. Therefore, mental accounting mitigates the response of aggregate consumption to monetary policy by 0.02 percentage points or by 20%.

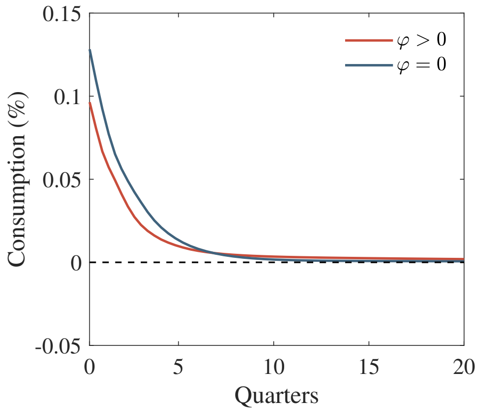

Figure 7: Consumption response to monetary policy.

In order to understand these responses we need to analyze the transmission channels of monetary policy. As before, we can decompose the general equilibrium response of aggregate consumption into four main channels reflecting the composition of household balance sheets. There is a direct effect of monetary policy on household budgets through the conventional interest rate channel and an indirect effect through the asset price channel. Moreover, the policy increases aggregate demand leading to higher profits and labor earnings. Finally, there is an indirect channel due to the response of fiscal policy and government transfers to the monetary innovations. All these effects are positive and contribute to the response of aggregate consumption. Here, the interest rate channel and the asset price channel play the main role followed by government transfers and labor earnings. In particular, for the standard HANK model the interest rate channel and the fiscal response account for most of the changes in aggregate consumption. In the behavioral HANK model, on the other hand, the presence of wealthy households with high MPCs amplifies the indirect effects. The interest rate channel accounts only for 20% of the total consumption response. This reflects the fact that for these wealthy households the income effects dominate over substitution effects leading to a weaker response to changes in the interest rates. This weaker response dampens the response of consumption to monetary policy. Therefore, as in the case of fiscal policy, the main message is that with a group of wealthy spenders income effects are amplified while substitution effects are dampened. This results in an amplification of the effects of stimulus checks and a mitigation of the effects of monetary policy.

4.3 Taking stock

Bringing all these results together, the magnitude of these effects show that reference dependence in the form of mental accounting has a first-order impact on the response of aggregate consumption to macroeconomic stabilization policy. The aggregate demand amplification or mitigation depends on the specific policy. The differences introduced by behavioral preferences are substantial and mostly depend on the heterogeneous agent block of the model since the equilibrium paths of the other prices and variables are similar across all counterfactuals. Notably, the presence of a group of wealthy spenders shapes the response of aggregate consumption and the propagation mechanisms of macroeconomic policy. More broadly, this shows that MPC heterogeneity is important for the macroeconomic effects of stabilization policy.

4.4 Stimulus checks in recession

So far, we have analyzed the effects of monetary policy shocks and fiscal policy shocks at the steady state. In practice, however, stimulus checks are implemented during economic downturns. In this section we focus on fiscal policy and study the effects of stimulus checks during a recession in the behavioral HANK model. The economy experiences a demand-driven recession due to financial shocks $\{\xi_t^d\}$. We engineer these shocks so that aggregate output falls by 4% on impact, and then recovers over the next three years. The fiscal shock is the same as in the previous sections of the paper, the government sends a stimulus check to all households. We set the persistence of government transfers so that the program ends after one year and experiment with checks of different sizes. This allows us to compare the effects of fiscal shocks when the economy is not at the steady state with the effects of fiscal shocks at the steady state.

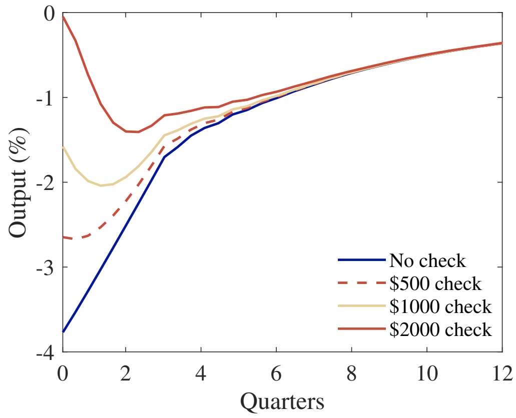

Figure 8: Aggregate output response to fiscal policy during recession.

Note: All the responses are in percentage deviation from steady-state values. The figure reports the size of the transfer at impact when the recession hits the economy.

Figure 8 shows the response of aggregate output to stimulus checks for various sizes of stimulus checks. Without any stimulus program, aggregate output falls by almost 4%. A stimulus check of \$500 reduces the output loss by around 1 percentage point on impact which is quantitatively in line with our main finding that such fiscal stimulus check increases aggregate consumption by 1%. A stimulus check of \$1000 reduces the output loss by around 2 percentage points. A larger check of \$2000 is required to close the output gap. In the standard HANK model with $\varphi = 0$ all responses imply an output loss between 4% and 3% even for large stimulus programs. This shows that the MPC heterogeneity due to reference points is key to capture the effects of stimulus checks. In particular, the group of wealthy spenders drives the results in Figure 8. The key role of this group of households also suggests that the effectiveness of targeted transfer to low-income households is overstated in standard HANK models because the relationship between MPCs and income is much weaker in our behavioral HANK model.

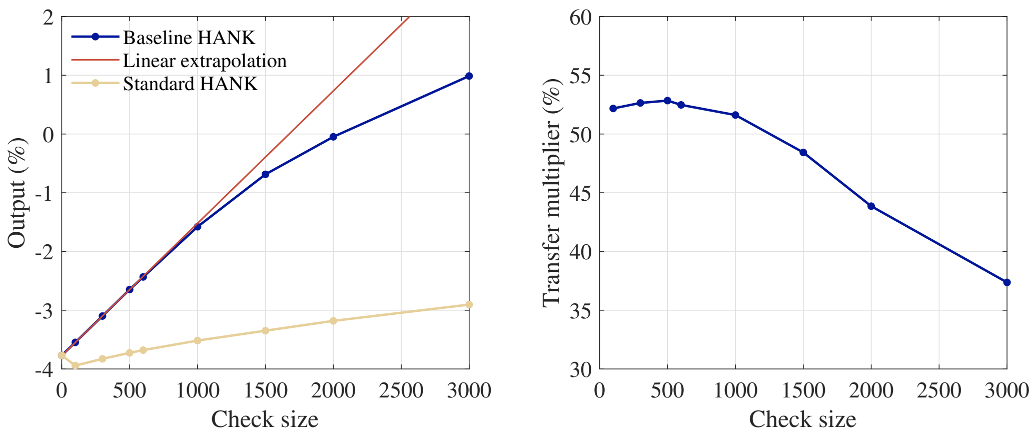

Figure 9: Fiscal policy during recession.

Note: The left plots the response of aggregate output in percentage deviation from steady state at impact. The figure also plots the linear extrapolation from a \$300 check. The right panel plots the response of aggregate output relative to the size of the transfer at impact. The x-axis in both panels report the size of the transfer at impact.

Figure 9 plots the output loss and the transfer multipliers for different sizes of stimulus checks on impact. The left panel shows that extrapolating the effects of large stimulus checks from small transfers can be misleading. The concavity in the response of aggregate output shows that the model features size dependence even though large checks remain effective against the recession. The right panel quantifies the transfer multipliers implied by the responses of aggregate output. The multipliers are between 55% and 35% and decline with the size of the stimulus transfers. Therefore, HANK models calibrated to match high micro MPCs tend to generate empirically realistic transfer multipliers. Overall, the quantitative experiments in this section highlight how important is MPC heterogeneity and the presence of wealthy spenders to understand the effects of fiscal policy during recessions.

4.5 Forward guidance and ZLB

In recent years, the growing reliance on unconventional monetary policy tools has brought forward guidance to the forefront as a key instrument for policymakers. Forward guidance involves the central bank communicating its anticipated path for future interest rate changes to the public. McKay, Nakamura, and Steinsson (2016) show how HANK models do not feature a forward guidance puzzle and more generally that the effectivness of forward guidance is much lower than in representative agent models. In our behavioral framework, the presence of a reference point given by current income effectively shortens the planning horizon of wealthy spenders. This has potential implications for the effectivness of forward guidance policies.

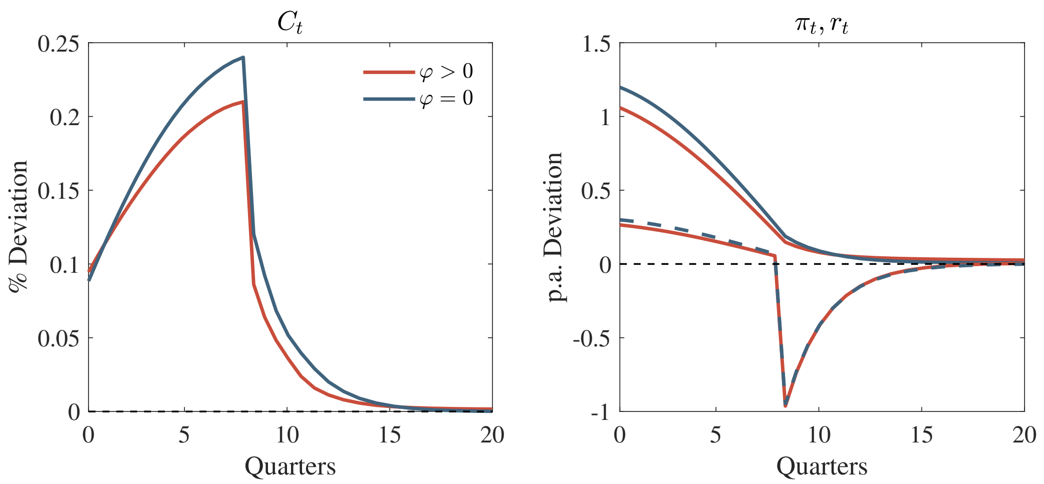

Figure 10: Forward guidance in HANK.

Note: The left panel plots the consumption response in percentage deviation from steady state across HANK models. The right panel plot the response of inflation and real interest rate when $\varphi = 0$ (lower blue dashed line) and when $\varphi > 0$ (lower red solid line).

Figure 10 plots the consumption and inflation response to a forward guidance shock. In this experiment, the central bank announces that the interest rate will be cut in 2 years from the announcement. We can observe that in a model with wealthy spenders forward guidance is less powerful as a substantial fraction of agents only cares about current earnings for expenditure decisions. The anticipation effects are much weaker around the policy date. On impact, we observe similar responses. This is due to general equilibrium effects. Unconstrained households anticipate the future policy by increasing current consumption this increases household earnings at impact and leads to higher consumption also from wealthy spenders. The net effect of these opposite mechanisms is again a mitigation of the effects of monetary policy on household spending. Therefore, in the behavioral model forward guidance policies are less effective than in the standard model.

The main reason for the incresing use of unconventional monetary policy tools is the presence of the Zero Lower Bound (ZLB) on the nominal policy rates. This constraint prevents interest rate cuts during a recession, restricting the central bank's capacity to conduct countercyclical monetary policy. Given that in the behavioral model monetary policy is much less powerful we expect the ZLB to be less costly in the behavioral framework relative to the standard case. To make this point, we extend the Taylor rule to include a ZLB constraint. The modified Taylor rule is given by $i_t = \max(r + \phi_\pi \pi_t + v_t, 0)$. We consider a demand-driven recession and engineer a financial shock ζ_t^d such that the ZLB binds for one year after the shock.[12] Then, we compare the effects of the recession when monetary policy is constrained by the ZLB in the standard HANK model and in the behavioral HANK model.

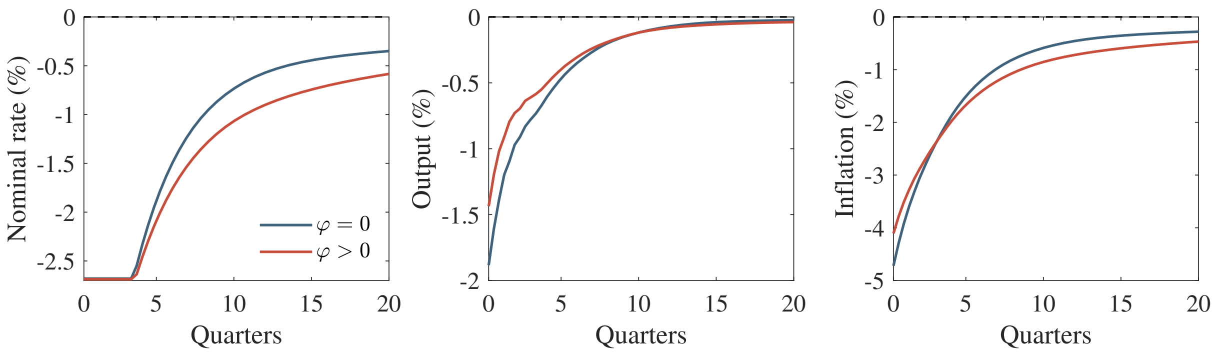

Figure 11: Zero lower bound in HANK.

Note: The figure plots the response of nominal interest rates, aggregate output, and inflation in percentage deviation from steady state across HANK models.

Figure 11 shows the responses of the nominal interest rate, aggregate output, and inflation to a large demand-shock that triggers the ZLB for one year. Aggregate output and annual inflation fall by around 0.5 percentage point less in the behavioral model relative to the standard model. The ZLB is substantially less costly in the behavioral model because systematic monetary policy is less effective as discussed in Section 4.2. In the representative agent framework the output losses are unbounded and substantially increase with the duration of the ZLB. The behavioral HANK framework is less subject to this problem because the severity of the ZLB is much weaker. All these results are driven by the fact that wealthy spenders do not adjust consumption in response to changes in the interest rates. These households respond only to changes in their labor earnings. Overall, with these experiments we highlight the importance of indirect income effects for the transmission of monetary policy.

[12] In order to induce the same path of nominal interest rates at the ZLB we also recalibrate the discount factor in the standard model to match the same steady-state real interest rate of the behavioral model.

4.6 Asset prices and capital gains

The stock market response to interest rate cuts play an important role in the transmission mechanism of monetary policy to aggregate demand. The distiction of MPCs out of earnings and MPCs out of wealth of our behavioral model aligns well with the empirical evidence that document small MPCs out of stock market gains (Chodorow-Reich, Plamen, and Simsek (2021)). In the behavioral model wealthy spenders with an MPC out of earnings equal to one have an MPC out of wealth equal to zero, namely all capital gains are saved. In the standard model, there are no inaction regions, and the consumption policy functions are always increasing in wealth, and some of these capital gains lead to higher consumption even if the MPCs are close to but different from zero. This implies that in the behavioral model there is a mitigation of the income effects from higher equity prices which contributes to the overall dampening of the effects of monetary policy.

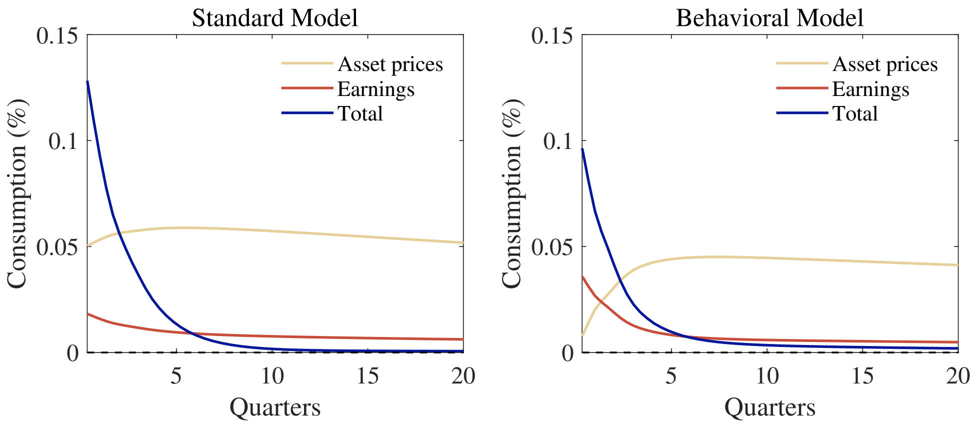

Figure 12: Asset prices in HANK.

Note: The figure plots the partial equilibrium decomposition of the response of aggregate consumption between asset prices and labor earnings in percentage deviation from steady state across HANK models.

Figure 12 plots a decomposition of the transmission of monetary policy through equity prices and labor earnings in the standard model and in the behavioral model. We can observe an amplification of the consumption response to changes in labor income. Parallel to this, there is also a mitigation of the consumption response to equity prices as wealthy spenders have MPCs out of wealth exactly equal to zero. Together with a mitigation of intertemporal substitution, i.e. the standard interest rate channel, the weaker equity price channel contributes to the mitigation of the effects of monetary policy. Our view is that the assumption of zero MPCs out of wealth for wealthy spenders is somewhat extreme as dividend income and realized capital gains are more likely to be perceived as income. We leave these extensions to future research.

5 Business Cycle

In this section, we study the business cycle properties of the behavioral HANK model. We start with the effects of a demand-driven recession when the earnings of households at the tails of the income distribution are more exposed to output fluctuations. Next, we quantify the effects of the behavioral bias on business cycle statistics. Finally, we conclude this section by studying the effects of the 2008 stimulus payments.

5.1 Unequal incidence

So far, we have assumed that economic fluctuations have an equal incidence on households' earnings. Guvenen, Schulhofer-Wohl, Song, and Yogo (2017) show that households at the tails of the earnings distribution are more exposed to fluctuations in output than other households. To capture this unequal exposure to the business cycle we use an incidence function, i.e. a rule for the distribution of an aggregate variable in the cross-section, as in (Alves, Kaplan, Moll, and Violante (2020)). Specifically, we assume that household earnings are given by $y_t^\ell = w_t \hat{e}_t N_t$ where the log of the output-adjusted labor productivity is given by

$$\ln \hat{e}_t = \ln e_t + \gamma(e_t) \ln(Y_t/Y) - \ln\left(\int_X e_t (Y_t/Y)^{\gamma(e_t)} d\psi_t\right)$$

where Y_t is aggregate output, Y is aggregate output at the steady state, and $\gamma(e_t)$ is the elasticity of the idiosyncratic component of earnings to aggregate output. This formulation ensures that $\int_X y_t^\ell d\psi_t = w_t N_t$. Figure 13 shows these elasticities in the model that we take from the empirical literature.

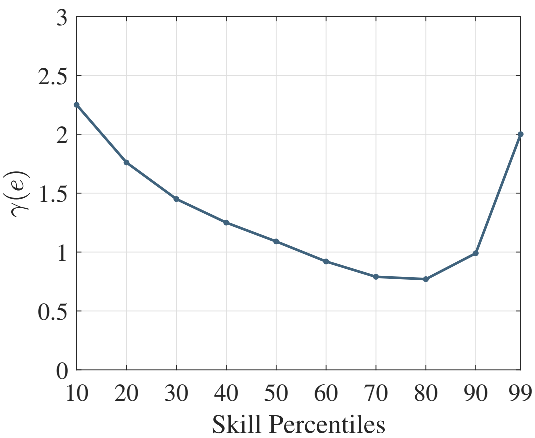

Figure 13: Unequal incidence of output in HANK.

Note: The figure plots the workers' betas, i.e. the systematic exposure to output, from Guvenen, Schulhofer-Wohl, Song, and Yogo (2017) for male workers with age between 36 and 45.

To study the distributional implications of the unequal exposure to output fluctuations, we feed into the model a demand-driven recession. The upper panels in Figure 14 plot the cross-sectional responses of household earnings and consumption in the standard model, while the bottom panels in Figure 14 plot the same responses in the behavioral model. The size of the aggregate demand shock is calibrated to generate the same response in earnings across the two models. Given the same response of earnings to the recession, we observe substantial differences in the consumption response. In the behavioral model, the higher exposure of household earnings to output fluctuations generates a more pronounced response of consumption to the business cycle at the bottom 50% and at the top 10% of the income distribution relative to the standard model. In the behavioral model, consumption is more sensitive to unequal exposure.

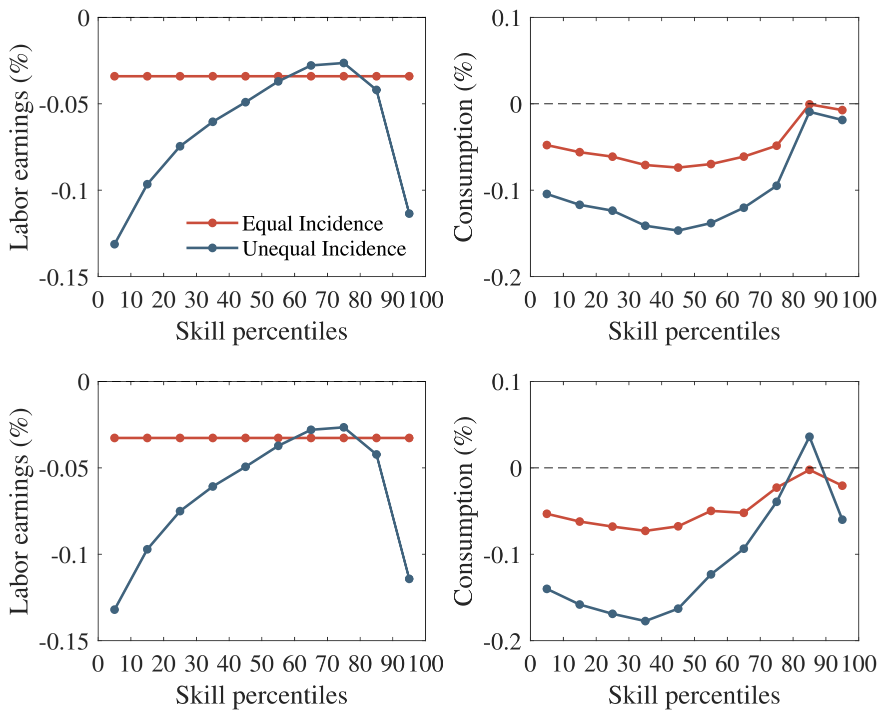

Figure 14: Unequal incidence of recessions in HANK.

Note: The figure plots the cross-sectional responses of labor earnings and consumption to a demand-driven recession in HANK. The upper panels plot the responses in the standard model ($\varphi = 0$), while the bottom panels plot the responses in the behavioral model ($\varphi > 0$).

The results for the bottom income groups are, to some extent, driven by the high MPCs of liquidity-constrained households. However, the magnitude of this decline is much larger in the behavioral model than in the standard model, indicating an important role also for unconstrained households with high MPCs. The decline in consumption that we observe for the top 10% is only present in the behavioral model, which suggests an important role for wealthy spenders. Overall, in the behavioral model, unequal exposure generates a higher cost of recessions.

5.2 Aggregate fluctuations

Economic fluctuations are an inherent feature of modern economies. In this section, we examine how heterogeneity in marginal propensities to consume (MPCs), along with reference-dependent preferences, shapes the dynamics of business cycle fluctuations. Specifically, we explore the extent to which these behavioral differences influence the economy's response to aggregate shocks. Therefore, in addition to aggregate demand shocks now we also introduce aggregate supply shocks. The Online Appendix B.5 describes the parametrization and calibration of these shocks and the simulation procedure that we use.

We consider the following experiment. We take the same aggregate demand and aggregate supply shocks and compute the paths of output and inflation across models. Table 4 shows the results. We can observe that in finite samples the behavioral model tend to generate a larger output and inflation volatility than the standard model. Moreover, in the behavioral model the correlation between output and inflation is much larger. This implies that in the behavioral model aggregate demand shocks have a more prominent role in driving business cycle fluctuations than supply shocks. The reason is that, within the behavioral model, households with high MPC respond more strongly to changes in income. Because these households adjust their spending so sharply, their behavior amplifies movements in aggregate demand, leading to more pronounced fluctuations in overall economic activity and inflation.

Table 4: Business cycle statistics across models

Description	Model $\varphi > 0$	Model $\varphi = 0$
Std. Deviation output	0.023	0.018
Std. Deviation inflation	0.051	0.045
Corr. output and inflation	0.42	0.22

Note: The standard deviations and the correlation between output and inflation are computed under the same demand and supply shocks. We consider a sample of 1,000 quarters.

Overall, these findings demonstrate that heterogeneity in MPCs plays a crucial role not only in shaping the effectiveness of macroeconomic stabilization policies, but also in determining how output and inflation respond to aggregate shocks. In this way, MPC heterogeneity becomes an important factor influencing the underlying forces that drive business cycle fluctuations.

5.3 Great Recession

In February 2008, the US Congress and Administration approved a stimulus package of $100 billion in rebates. The average amount of the rebate received by a household was $1,000. Most of the stimulus payments were distributed from April through July 2008. More than two-thirds of the total amount was distributed in the second quarter of 2008 alone, with the remaining rebates distributed in July (Shapiro and Slemrod (2009)). The evolution of real disposable personal income and real personal consumption expenditures over 2008 reveals a distinct surge in disposable income, attributable to the mechanical boost provided by the 2008 tax rebates. By comparison, the reaction of real consumption is more muted, displaying only a modest and short-lived increase. These divergent patterns in the aggregate time series have been interpreted as evidence of a limited macroeconomic effect of the rebates (Taylor (2009)).

How would the US GDP and inflation have looked like during the Great Recession absent the 2008 stimulus package? We leverage our model to generate this counterfactual. Specifically, we combine the model's impulse responses together with data on GDP and inflation from 1989Q1 to 2019Q1 to filter the sequence of demand and supply innovations that exactly replicate the observed data.[13] The Online Appendix B.5 presents the filtering algorithm that we use and shows the results of the procedure. Because the model replicates a realistic distribution of MPCs, it offers a natural setting in which to conduct this experiment. By capturing the presence of households with MPCs around one and substantial concavity in the spending response to income changes, the framework provides a credible environment in which to simulate the aggregate dynamics that would have prevailed without the fiscal transfers. This allows us to isolate the contribution of the 2008 stimulus to economic activity and inflation during the downturn. The magnitude of the rebate disbursed to each household was determined by tax-filing status and the number of dependents. The structure of the policy incorporated an income-based phase-out, whereby the value of the rebate declined progressively with income, eliminating eligibility for higher-income groups. As a result, roughly 85% of all households received a rebate payment, making the program broadly accessible. For simplicity, we do not model the income phase-out given that in our model high income households in the top 10% of the income distribution have relatively low MPCs. Instead, we compute the impulse responses to a transfer of $1,000 given to all households as in Orchard, Ramey, and Wieland (2025). Accordingly, we interpret our results as providing an upper bound on the macroeconomic impact of the stimulus payments. As a robustness check for our quantitative exercise, we also consider a version of the model with debt allowing households to use the fiscal transfer to deleverage and reduce their debt levels. This allows us to capture an important feature of the US economy during the Great Recession.

[13] In order to construct the counterfactual path of GDP and inflation without any policy we also introduce fiscal shocks and use data on total rebates in combination with data on inflation and output to compute the innovations that match the size and timing of the actual rebates.

Figure 15 shows the response of output and inflation, in the behavioral model, with and without the stimulus package. The effects are visible in the second and third quarter of 2008 when households received the rebates. Absent these payments, inflation would have stayed below 4% and the GDP would have been as much as 0.25 percentage points further below the trend level. The implied cumulative multiplier for the stimulus payments is around 45%. Hence, according to our counterfactual, the fiscal multiplier of the 2008 rebates is similar in size to the multipliers of typical stimulus check packages obtained in HANK models. While modest compared to multipliers associated with large-scale government spending programs, this magnitude is significant given the one-off nature of the rebates.[14]

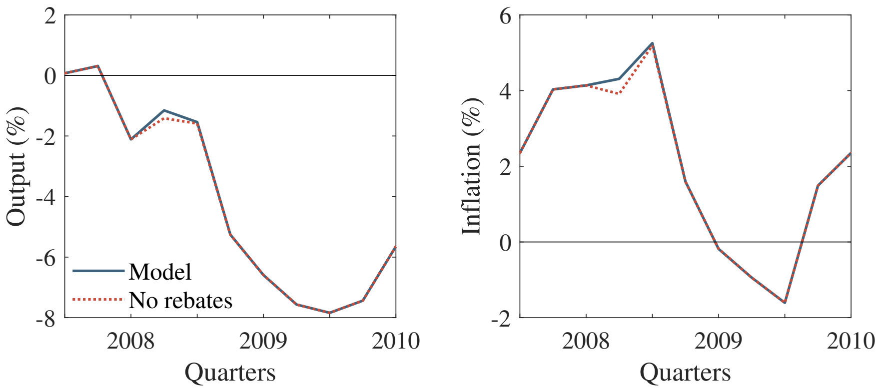

Figure 15: The 2008 stimulus payments in HANK.

Note: The figure plots the path of output and inflation in the behavioral HANK with the 2008 fiscal stimulus (solid blue line) and without the stimulus payments (dotted red line).

During the onset of the Great Recession, households were confronted with elevated debt levels and sharp declines in housing wealth. Under these conditions, it is plausible that they allocated the rebate toward strengthening their balance sheets rather than increasing consumption. The Online Appendix B.2 presents a version of the behavioral model in which net borrowers primarily use any additional income to deleverage. Under this specification, inflation would have stayed below 4% as in the baseline counterfactual. However, GDP would have been as much as 0.18 percentage points further below the trend level. The cumulative multiplier in this case is 33%. This counterfactual analysis suggests that elevated household debt levels may have attenuated the effectiveness of the stimulus rebates.

Overall, we obtain fiscal multipliers for the 2008 rebates that are broadly consistent with those reported in Section 4 and are within the range of credible empirical estimates, reinforcing the conclusion that lump-sum stimulus payments constitute an effective instrument for supporting economic activity during periods of economic contraction.

[14] Ferriere and Navarro (2025) compare transfer multipliers and public spending multipliers.

6 Conclusions

This paper develops and evaluates a behavioral HANK model that incorporates reference-dependent preferences and mental accounting in order to better match the joint distribution of MPCs and liquid wealth observed in microdata. The analysis is motivated by a key empirical challenge for standard heterogeneous agent models: while such models typically associate high MPCs with households close to borrowing constraints, the data reveal a substantial group of households who simultaneously hold significant liquid wealth and display high MPCs. Standard frameworks struggle to account for this pattern because, once households accumulate even modest liquid balances, their MPCs tend to fall sharply. Embedding behavioral features grounded in mental accounting provides a tractable resolution to this tension.

Embedding these behavioral preferences in general equilibrium shows that MPC heterogeneity has first-order macroeconomic implications. Relative to a standard HANK model, the presence of wealthy high-MPC households amplifies the aggregate consumption response to stimulus transfers and attenuates the effects of monetary policy. Because income effects dominate substitution effects for wealthy spenders, aggregate demand reacts strongly to fiscal transfers but more weakly to interest rate cuts. Both direct and indirect channels of fiscal policy gain importance, whereas the interest rate channel of monetary transmission is muted. These findings underscore that the full distribution-not merely the average- of MPCs shapes the effectiveness of stabilization policies. The model also provides new insights into recession dynamics and the role of policy interventions. During a demand-driven downturn, stimulus checks are especially effective because wealthy spenders consume a large share of the transfers. Their prevalence, however, decreases as stimulus sizes grow, implying strong size-dependence in fiscal multipliers. The behavioral model additionally predicts diminished forward-guidance effects and mitigated severity of zero lower bound episodes. Business-cycle simulations further reveal larger macroeconomic volatility and a stronger co-movement between output and inflation than in standard HANK models, highlighting the heightened sensitivity of aggregate consumption to contemporaneous income fluctuations. A case study of the 2008 U.S. tax rebates illustrates the empirical relevance of these mechanisms. Counterfactual simulations suggest that the stimulus payments played a meaningful role in stabilizing GDP during the Great Recession, generating cumulative fiscal multipliers in the range of 30-40 percent.

Taken together, the results show that incorporating mental accounting into quantitative HANK models offers a promising and tractable way to generate realistic MPC heterogeneity and wealth distributions. By allowing households with substantial liquid assets to nonetheless behave as hand-to-mouth consumers, the model breaks the standard trade-off between wealth accumulation and high MPCs. More broadly, the analysis demonstrates that the presence of wealthy high-MPC households shapes the effectiveness of fiscal and monetary policy.

References

Achdou, Yves, Jiequn Han, Jean-Michel Lasry, Pierre-Louis Lions, and Benjamin Moll (2022). "Income and Wealth Distribution in Macroeconomics: A Continuous-Time Approach". In: *Review of Economic Studies* 89, pp. 45–86.

Aguiar, Mark, Mark Bils, and Corina Boar (2021). "Who Are the Hand-to-Mouth?" Working Paper.

Aiyagari, Rao (1994). "Uninsured Idiosyncratic Risk and Aggregate Savings". In: *The Quarterly Journal of Economics* 109 (3), pp. 659–684.

Alves, Felipe, Greg Kaplan, Benjamin Moll, and Giovanni L. Violante (2020). "A further look at the propagation of monetary policy shocks in HANK". In: *Journal of Money, Credit and Banking* 52 (S2), pp. 521–559.

Alves, Felipe and Giovanni L. Violante (2023). "Some Like It Hot: Monetary Policy Under Okun's Hypothesis". Working Paper.

Attanasio, Orazio, Agnes Kovacs, and Patrick Moran (2021). "Temptation and Incentives to Wealth Accumulation". National Bureau of Economic Research. Working Paper 28938.

Auclert, Adrien, Bence Bardóczy, Matthew Rognlie, and Ludwig Straub (2021). "Using the Sequence-Space Jacobian to Solve and Estimate Heterogeneous-Agent Models". In: *Econometrica* 89 (5), pp. 2375–2408.

Auclert, Adrien, Matthew Rognlie, and Ludwig Straub (2020). "Micro Jumps, Macro Humps: Monetary Policy and Business Cycles in an Estimated HANK Model". Working Paper.

— (2024). "The Intertemporal Keynesian Cross". In: *Journal of Political Economy* 132 (12), pp. 4068–4121.

— (2025). "Fiscal and Monetary Policy with Heterogeneous Agents". Working Paper.

Baugh, Brian, Itzhak Ben-David, Hoonsuk Park, and Jonathan Parker (2021). "Asymmetric Consumption Smoothing". In: *American Economic Review* 111 (1), pp. 192–230.

Bayer, Christian, Benjamin Born, and Ralph Luetticke (2024). "Shocks, Frictions, and Inequality in US Business Cycles". In: *American Economic Review* 114 (5), pp. 1211–1247.

Bayer, Christian, Ralph Luetticke, Lien Pham-Dao, and Volker Tjaden (2019). "Precautionary savings, illiquid assets, and the aggregate consequences of shocks to household income risk". In: *Econometrica* 87, pp. 255–290.

Beraja, Martin and Nathan Zorzi (2023). “Durables and Size-Dependence in the Marginal Propensity to Spend”. Working Paper.

Berger, David and Joseph Vavra (2015). “Consumption Dynamics During Recessions”. In: *Econometrica* 83 (1), pp. 101–154.

Bhandari, Anmol, David Evans, Mikhail Golosov, and Thomas J. Sargent (2021). “Inequality, Business Cycles, and Monetary-Fiscal Policy”. In: *Econometrica* 89 (6), pp. 2559–2599.

Boehm, Johannes, Etienne Fize, and Xavier Jaravel (2025). “Five Facts about MPCs: Evidence from a Randomized Experiment”. In: *American Economic Review* 115 (1), pp. 1–42.

Borusyak, Kirill, Xavier Jaravel, and Jann Spiess (2024). “Revisiting Event-Study Designs: Robust and Efficient Estimation”. In: *Review of Economic Studies* 91, pp. 3253–3285.

Boutros, Michael (2025). “Windfall Income Shocks with Finite Planning Horizons”. Working Paper.

Broda, Christian and Jonathan Parker (2014). “The Economic Stimulus Payments of 2008 and the Aggregate Demand for Consumption.” In: *Journal of Monetary Economics* 68 (S), S20–S36.

Cantore, Cristiano and Lukas B. Freund (2021). “Workers, Capitalists, and the Government: Fiscal Policy and Income (Re)Distribution”. In: *Journal of Monetary Economics* 119, pp. 58–74.

Chan, Marc and Kamhon Kan (2023). “Connsumers’ Response to Stimulus Payments with a Co-payment Design”. Working Paper.

Chodorow-Reich, Gabriel, Nenov Plamen, and Alp Simsek (2021). “Stock Market Wealth and the Real Economy: A Local Labor Market Approach”. In: *American Economic Review* 111 (5), pp. 1613–57.

Commault, Jeanne (2024). “Heterogeneity in MPC Beyond Liquidity Constraints: The Role of Permanent Earnings”. Working Paper.

Di Maggio, Marco, Amir Kermani, and Kaveh Majlesi (2020). “Stock Market Returns and Consumption”. In: *The Journal of Finance* 75 (6), pp. 3175–3219.

Fagereng, Andreas, Martin B. Holm, and Gisle Natvik (2021). “MPC Heterogeneity and Household Balance Sheets”. In: *American Economic Journal: Macroeconomics* 13 (4), pp. 1–54.

Farhi, Emmanuel and Ivan Werning (2019). “Monetary policy, bounded rationality, and incomplete markets”. In: *American Economic Review* 109, pp. 3887–3928.

Ferriere, Axelle and Gaston Navarro (2025). “Fiscal Management of Aggregate Demand: The Effectiveness of Labor Tax Credits”. Working Paper.

Fuster, Andreas, Greg Kaplan, and Basit Zafar (2021). “What Would You Do With $500? Evidence from Gains, Losses, News And Loans”. In: *Review of Economic Studies* 88 (4), pp. 1760–1795.

Gabaix, Xavier (2020). “A behavioral New Keynesian model”. In: *American Economic Review* 110, pp. 2271–2327.

Ganong, Peter and Pascal Noel (2019). “Consumer spending during unemployment: positive and normative implications”. In: *American Economic Review* 109 (7), pp. 2383–2424.

Gimeno-Ribes, Jaime (2023). “A Model of Consumption with Mental Accounting and Incomplete Markets”. Working Paper.

Graham, James and Robert McDowall (2025). “Mental Accounts and Consumption Sensitivity across the Distribution of Liquid Assets”. Working Paper.

Gul, Faruk and Wolfgang Pesendorfer (2001). “Temptation and Self-control”. In: *Econometrica* 69 (6), pp. 1403–1435.

Guren, Adam M., Alisdair McKay, Emi Nakamura, and Jón Steinsson (2021). “Housing Wealth Effects: The Long View”. In: *The Review of Economic Studies* 88 (2), pp. 669–707.

Guvenen, Fatih, Sam Schulhofer-Wohl, Jae Song, and Motohiro Yogo (2017). “Worker Betas: Five Facts about Systematic Earnings Risk”. In: *American Economic Review* 107 (5), pp. 398–403.

Heathcote, Jonathan, Fabrizio Perri, and Giovanni L. Violante (2010). “Unequal We Stand: An Empirical Analysis of Economic Inequality in the United States, 1967–2006”. In: *Review of Economic Dynamics* 13 (1), pp. 15–51.

Huggett, Mark (1993). “The risk-free rate in heterogeneous-agent incomplete-insurance economies”. In: *Journal of Economic Dynamics and Control* 17 (5), pp. 953–969.

Ilut, Cosmin and Rosen Valchev (2023). “Economic Agents as Imperfect Problem Solvers”. Working Paper.

Jappelli, Tullio and Luigi Pistaferri (2014). “Fiscal Policy and MPC Heterogeneity”. In: *American Economic Journal: Macroeconomics* 6 (4), pp. 107–136.

Kaplan, Greg, Benjamin Moll, and Giovanni L. Violante (2018). “Monetary Policy According to HANK”. In: *American Economic Review* 108 (5), pp. 697–743.

Kaplan, Greg, Georgios Nikolakoudis, and Giovanni L. Violante (2023). “Price Level and Inflation Dynamics in Heterogeneous Agent Economies”. Working Paper.

Kaplan, Greg and Giovanni L. Violante (2014). “A model of the consumption response to fiscal stimulus payments”. In: *Econometrica* 82, pp. 1199–1239.

— (2018). “Microeconomic Heterogeneity and Macroeconomic Shocks”. In: *Journal of Economic Perspectives* 32 (3), pp. 167–194.

— (2021). “The Marginal Propensity to Consume in Heterogeneous Agent Models”. Working Paper.

Kosar, Gizem, Davide Melcangi, Laura Pilossoph, and David Wiczer (2023). “Stimulus through Insurance: the Marginal Propensity to Repay Debt”. Working Paper.

Kueng, Lorenz (2018). “Excess Sensitivity of High-Income Consumers”. In: *The Quarterly Journal of Economics* (4), pp. 1693–1751.

Laibson, David, Peter Maxted, and Benjamin Moll (2021). “Present Bias Amplifies the Household Balance-Sheet Channels of Macroeconomic Policy”. Working Paper.

— (2022). “A Simple Mapping from MPCs to MPXs”. Working Paper.

Lewis, Daniel, Davide Melcangi, and Laura Pilossoph (2024). “Latent Heterogeneity in the Marginal Propensity to Consume”. Working Paper.

Lian, Chen (2023). “Mistakes in Future Consumption, High MPCs Now”. In: *American Economic Review: Insights* 5 (4), pp. 563–581.

McKay, Alisdair, Emi Nakamura, and Jón Steinsson (2016). “The Power of Forward Guidance Revisited”. In: *American Economic Review* 106 (10), pp. 3133–58.

McKay, Alisdair and Johannes Wieland (2021). “Lumpy durable consumption demand and the limited ammunition of monetary policy”. In: *Econometrica* 89 (6), pp. 2717–2749.

McKay, Alisdair and Christian K. Wolf (2022). “Optimal Policy Rules in HANK”. Working Paper.

Misra, Kanishka and Paolo Surico (2014). “Consumption, Income Changes and Heterogeneity: Evidence from Two Fiscal Stimulus Programs”. In: *American Economic Journal: Macroeconomics* 6 (4), pp. 84–106.

Olafsson, Arna and Michaela Pagel (2018). “The Liquid Hand-to-Mouth: Evidence from Personal Finance Management Software”. In: *Review of Financial Studies* 31 (11), pp. 4398–4446.

Orchard, Jacob, Valerie Ramey, and Johannes Wieland (2025). "Micro MPCs and Macro Counterfactuals: The Case of the 2008 Rebates". In: *The Quarterly Journal of Economics* 140 (3), pp. 2001–2052.

Parker, Jonathan, Nicholas Souleles, David Johnson, and Robert McClelland (2013). "Consumer Spending and the Economic Stimulus Payments of 2008." In: *American Economic Review* 103 (6), pp. 2530–53.

Pfäuti, Oliver and Fabian Seyrich (2022). "A Behavioral Heterogeneous Agent New Keynesian Model". Working Paper.

Pfäuti, Oliver, Fabian Seyrich, and Jonathan Zinman (2023). "Heterogeneity in what? Cognitive Skills, Beliefs and the Liquid Wealth Distribution". Working Paper.

Sergeyev, Dmitriy, Chen Lian, and Yuriy Gorodnichenko (2023). "The Economics of Financial Stress". Working Paper.

Shapiro, Matthew and Joel Slemrod (2009). "Did the 2008 tax rebates stimulate spending?" In: *American Economic Review* 99 (2), pp. 374–379.

Shefrin, Hersh and Richard Thaler (1988). "The Behavioral Life-Cycle Hypothesis". In: *Economic Inquiry* 26 (4), pp. 609–643.

Sims, Christopher (2003). "Implications of rational inattention". In: *Journal of Monetary Economics* 50 (3), pp. 665–690.

Taylor, John (2009). "The lack of an empirical rationale for a revival of discretionary fiscal policy". In: *American Economic Review* 99 (2), pp. 550–55.

Thaler, Richard (1990). "Anomalies: Saving, fungibility, and mental accounts". In: *Journal of Economic Perspectives* 4 (1), pp. 193–205.

Woodford, Michael (2013). "Macroeconomic analysis without the rational expectations hypothesis". In: *Annu. Rev. Econ.* 5, pp. 303–346.

Online Appendix for "The Marginal Propensity to Consume in Behavioral Macroeconomics"

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A Details on Reference Dependence

Here, we provide further details and additional results on behavioral models with reference-dependent preferences. In this class of models individuals evaluate outcomes relative to a reference point. We focus on two different cases self-control and mental accounting.

Consider the instantaneous utility function

$$u(c_t) - \varphi(u(c_t) - u(y_t)).$$

This specification nests several behavioral models. There are two possible interpretations for the second term in this utility function. If $\varphi < 0$ we have a self-control problem. There is a utility loss whenever $c_t < y_t$ so that households are tempted to set $c_t > y_t$. If $\varphi > 0$ households have a preference for "living within their income". There is a utility loss whenever $c_t > y_t$ and households prefer to set $c_t < y_t$. These formulations are isomorphic and have opposite implications. In the self-control model we have that $\varphi < 0$ and we define the reference point as household disposable income including capital income, i.e. $y_t = w_t e_t n_t + r_t a_t$. As we will show below, the inclusion of wealth in the reference point generates a wedge in the Euler equation that increases the MPCs at the bottom of the wealth distribution. In the mental accounting model we have that $\varphi > 0$, an asymmetric utility cost, and and we define the reference point as household labor income $y_t = w_t e_t n_t$. Within the mental accounting framework, households conceptually divide their financial resources into two distinct mental accounts: an income account and a savings account. Current labor earnings flow into the income account and are treated as the primary source of day-to-day consumption. In contrast, capital income is assigned to the savings account. These resources are mentally categorized as long-term wealth rather than spendable income. This framework thus implies that households display a strong preference for preserving accumulated wealth. Drawing on the savings account to finance ordinary consumption is perceived as psychologically costly, leading to under-consumption out of wealth and heightened sensitivity to fluctuations in labor income.

A.1 Self-control

In this section we revisit the implications of self-control for the joint distribution of MPCs and wealth. We begin with a simple HA model with behavioral preferences where $y_t = w_t e_t n_t + r_t a_t$ denotes households' disposable income, $\phi \geq 0$ is the borrowing limit and $\varphi \in [0, 1)$.

$$\max_{c_t} \ \mathbb{E}_0 \int_0^\infty e^{-\rho t} \big(u(c_t) + \varphi(u(c_t) - u(y_t))\big) dt,$$

$$\text{s.t. } da_t = (w_t e_t n_t + r_t a_t - c_t) dt,$$

$$a_t \geq -\phi.$$

The income process is given by

$$d \ln e_t = \nu_e(\mu_e - \ln e_t) dt + \sigma_e d\hat{w}_t,$$

where $d\hat{w}_t \sim N(0, dt)$ is a standard Brownian motion. The labor supply $n_t = \mathbb{E}(e_t)$ is inelastic. There are two state variables in this model, households assets a_t and income risk e_t.

To build up intuition for the quantitative results we consider first the case of an unconstrained household so that $a_t > -\phi$. The first order conditions for the control c_t and state a_t are

$$(1 + \varphi) u'(c_t) = \mu_t,$$

$$\rho \mu_t dt - \mathbb{E}_t(d\mu_t) = \mu_t r_t dt - \varphi u'(y_t) r_t dt.$$

Substituting and rearranging terms yields

$$\frac{\mathbb{E}_t(du'(c_t))}{u'(c_t)} = (r_t - \rho) dt - \frac{\varphi}{1 + \varphi} \frac{u'(y_t)}{u'(c_t)} r_t dt. \tag{A1}$$

Equation (A1) shows that temptation and self-control introduce a wedge in the Euler equation, the second term on the right hand side. All else equal, higher φ implies that households face a larger utility gain from "living beyond their income" decreasing the marginal benefit of saving and wealth accumulation. This effect interact with ratio of marginal utilities $u'(y_t)/u'(c_t)$. Thus, the behavioral wedge is larger whenever households finance consumption with their wealth or by borrowing. Therefore, low-wealth households close to the borrowing limit tend to have a larger consumption wedge. To see this point more clearly define the consumption rate or the average propensity to consume as $c_t(a_t, e_t)/y_t$. An average propensity to consume greater than one signal that households are net borrowers or dissaving, while an average propensity to consume below one means that households are accumulating wealth. In the standard HA model with $\varphi = 0$, wealthy households have on average a consumption rate close to one as they have reached their target level of wealth and no longer save. On the other hand, low-wealth unconstrained households typically have consumption rates above one as they have low-income states. For these reasons the wedge in the Euler equation is mostly active at the bottom of the wealth distribution leading to larger MPCs among low-liquidity households. As a result, this model is not well suited for relaxing the trade-off between the average MPC and wealth holdings. In this section we consider a numerical example to show this point.

The self-control model as the standard model struggle to generate large MPCs and liquid wealth holdings. The calibration yields a behavioral parameter $\varphi = 0.9$ and an average MPC below the lower bound of the empirical estimates. Table A.1 shows more in detail the implications of reference-dependent utility for wealth and MPCs.

Table A.1: MPC and wealth statistics across models

Description	$\varphi = 0$	$\varphi > 0$	Description	$\varphi = 0$	$\varphi > 0$
Wealth-income ratio	2	1.3	MPC bottom 50	20	25
Avg. quarterly MPC (%)	11	15	MPC next 40	4	5
Avg. annual MPC (%)	45	60	MPC top 10	3	4
Share with $a = \underline{a}$ (%)	14	18	Gini wealth	74	79
Description	$\varphi = 0$	$\varphi > 0$	**Description**	$\varphi = 0$	$\varphi > 0$
Share $a \leq \$5000$ (%)	34	41	90th percentile	5	4
Median wealth	0.4	0.2	95th percentile	9	6
75th percentile	2	1.2	99th percentile	17	13

Note: Wealth mean and percentiles are reported relative to households' average annual earnings (68,000 dollars per year). The upper panel reports average quarterly MPCs out of a 500 dollars transfer across wealth groups. Liquidity constraint $\underline{a} := -\phi$. Data source: SCF 2004 from Weidner, Kaplan, and Violante (2014).

The behavioral model can generate an higher average MPC than the canonical HA model. The quarterly average MPC out of 500\$ is 11% in the standard HA model and 15% in the behavioral model. In the economy with behavioral preferences there is more inequality and lower aggregate wealth. The self-control bias leads to a fall in median wealth increasing wealth inequality. As more households are close to the liquidity constraint the average MPC increases.

Figure A.1 shows the joint distribution of MPCs and wealth. In particular, there is clearly an asymmetry in the impact of φ on households' MPCs. The behavioral model features higher marginal propensities to consume for low-wealth households. The reason is that wealthy households tend to have a lower consumption rate c_t/y_t. Since the consumption wedge depends on the ratio of marginal utilities this amplifies the effects at the bottom of the distribution. The right panel in Figure A.1 displays the wealth density in the standard HA model and in the behavioral model. In the model with self-control, the wealth distribution has a lower fraction of households in the middle section and a higher mass at the bottom.

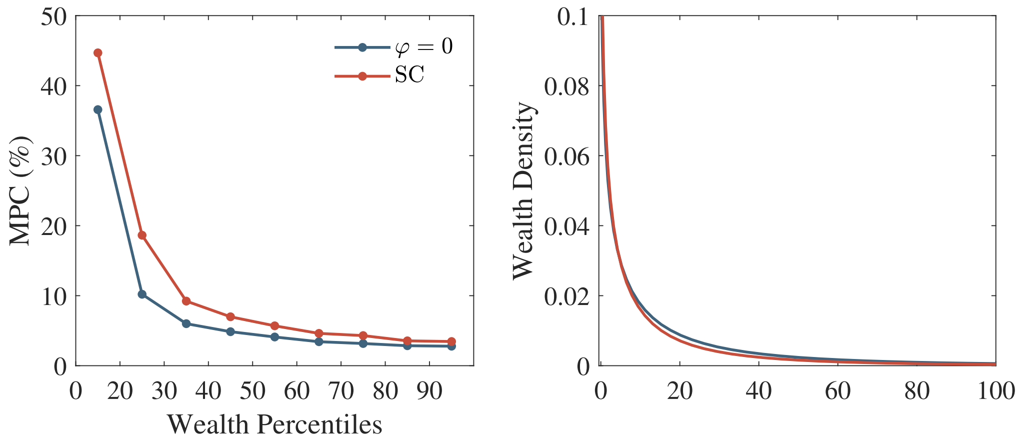

Figure A.1: Joint distribution of wealth and MPCs.

This example shows that self-control bias ($\varphi > 0$) increases the average MPC, but reduces households' wealth. On the other hand, when households prefer to live within their income ($\varphi < 0$) the opposite result holds. The economy has more wealth because of the behavioral saving motive of low-wealth households. As a result the average MPC is lower. These models also have opposite implications for wealth inequality. Overall, in the model with self-control it is still difficult to relax the trade-off between MPCs and aggregate wealth of the canonical model. The quarterly average MPC out of \$500 is around 10% in the standard HA model and 15% in the model with self-control. However, the economy has lower savings and wealth. The reason is that the behavioral wedge is mostly active at the bottom of the wealth distribution and its impact on the average MPC crucially depends on the share of low-wealth households in the economy. For this reason the implications of the self-control model on wealth-MPC trade-off are limited. In the next section, we study how reference-dependent preferences can endogenously generate a group of wealthy households with high MPCs while at the same time retaining the tractability of the standard HA model.

A.2 Mental accounting

In this section, we provide further details on the model with mental accounting. Figure A.2 shows the utility function $u(c_t) - \varphi(u(c_t) - u(y_t))1_{[c_t > y_t]}$. The presence of the kink in the utility function is the critical element of this model: it generates inaction regions where households optimally set $c_t = y_t$. Intuitively, households want to live by their earnings. So, unless they face large enough income shocks they do not consume their assets.

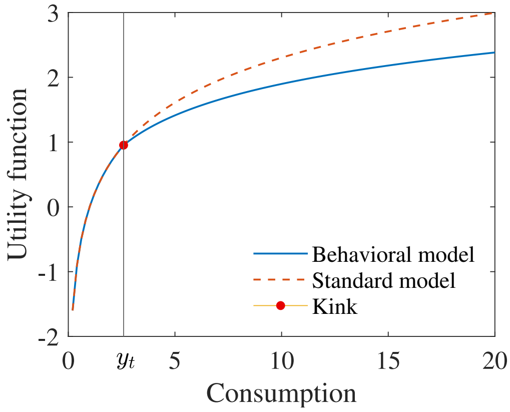

Figure A.2: Utility function with mental accounting ($\varphi = 0.3$).

Figure A.3 shows on the left panel households' consumption policy functions $c_t(a_t, e_t)$ throughout the wealth distribution, and on the right panel households' saving policy functions $s_t(a_t, e_t)$. In the inaction regions where the policy functions become flat households consume their earnings y_t and save from the asset account $r_t a_t$. At the kink $u'_-(y_t) > v_a > u'_+(y_t)$. Intuitively, in these regions the utility cost φ reduces (increases) the marginal utility benefit (loss) relative to the marginal value of assets preventing households from consuming more (less).

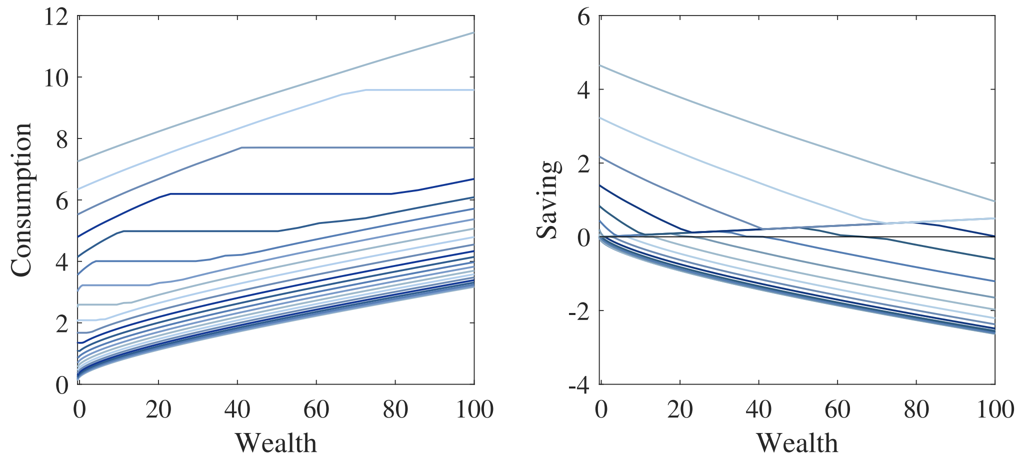

Figure A.3: Policy functions with mental accounting ($\varphi = 0.3$).

Figure A.4 illustrates the share of spenders across both the liquid-wealth distribution and the total-income distribution. Notably, spenders appear throughout the liquid-wealth distribution except at the bottom 10% where the borrowing limit is active. This pattern stands in sharp contrast to liquidity-constrained households, who appear exclusively at the bottom of the liquid-wealth distribution. Moreover, these households tend to occupy higher positions in the income distribution. More than two-thirds of these households have a total income above the median level. All of this indicates that high earnings, high liquid-asset holdings, and high MPCs can coexist among spender-type households.

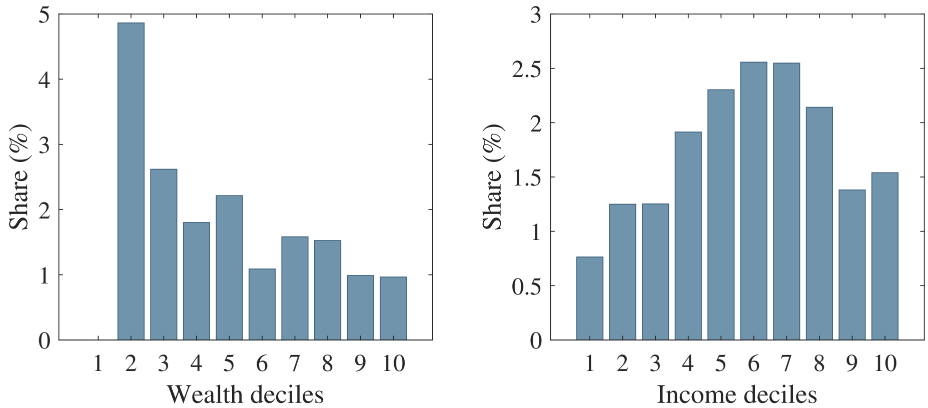

Figure A.4: Share of spenders by liquid wealth and total income.

The cross-sectional relationship between APC and wealth is first increasing and then decreasing. This reflects two opposite effects. On one hand, the APC is increasing in wealth conditional on income. On the other hand, the APC decreases with labor income. Since wealthy households are those with high labor earnings, the correlation between income and wealth generates the decreasing section of the APC. The cross-sectional relationship between MPC and wealth is instead monotonically decreasing in wealth. This implies that the unconditional correlation between MPC and APC is ambiguous in HA models. The standard HA model generates a negative correlation between MPCs and APCs conditional on labor income. While the MPC falls with liquid wealth, the APC increases for any given labor income state. The wealthy spenders in our model have both a high MPC and a high APC. Since these households primarily finance their consumption from current labor earnings while allocating most of their capital income to savings, their APC falls below unity, although it remains very close to one. This pattern reflects the fact that only a small fraction of total income is saved, leaving overall consumption levels nearly proportional to current income. However, it is important to note that, within the model, these households are not those exhibiting the highest APCs. The highest APCs arise instead among wealthy households that experience a temporary decline in labor income.

In the discussion of the basic model in Section 2.1 we focus on the steady state MPC. In this case households' consumption policy functions do not change after an income gain or loss.[15] In general, we are interested in evaluating the macroeconomic effects of a certain policy or income fluctuations when the economy is not at the steady state. For this reason, we consider also the consumption responses to a one-time \$500 income gain in $t = 0$ and assess the MPCs of the model at impact. Figure A.5 shows these MPCs across the stationary wealth distribution.

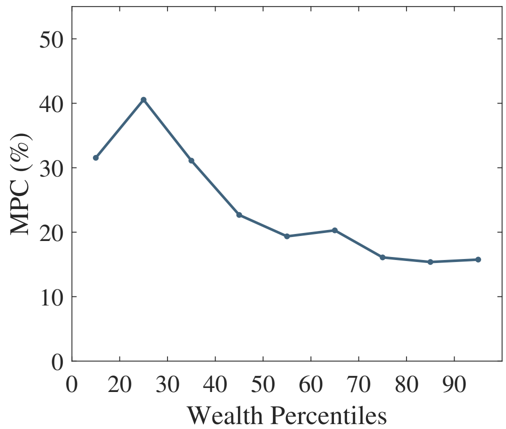

Figure A.5: Impact MPCs out of \$500 income gain.

The impact MPCs are similar to the steady state counterparts.[16] The main difference is that by allowing for time-varying policy functions households' reference earnings change while at the steady state these are predetermined. Similarly to the MPCs reported in Figure 2 the MPCs reach a peak of about 40% at the second decile of the distribution of liquid wealth, then decline to values between 30% and 20% in the middle section of the distribution, and remain above 10% for households with high liquid wealth holdings at the top. By using this approach the average MPC tend to be somewhat larger than the steady-state average MPC. However, the differences are relatively contained and for simplicity we choose the steady-state MPCs as benchmark. Overall, this example shows that the steady-state MPCs provide a reasonable approximation of the consumption response to income fluctuations. Finally, so far we focused on the response to a transitory income shock. However, most of the policy effects studied in this paper tend to be persistent. Therefore, we also analyzed the consumption response out of persistent rather than one-time income changes and find similar results with consumption paths that reflect the income persistence more than in the standard HA model.

[15]By definition the effects of these income changes are evaluated using the stationary consumption decisions and the stationary distribution of idiosyncratic states.

[16]In the basic model the intertemporal MPCs are quite low. Therefore, the impact MPCs capture almost the entire quarterly response and are broadly comparable to quarterly estimates. This is consistent with studies that find little evidence of anticipation and lagged effects (Kueng (2018), Boehm, Fize, and Jaravel (2025)).

We also find that reference-dependent preferences generate size-dependence in the consumption response to stimulus payments. The first panel in Figure A.6 shows the average MPC at impact for checks of different sizes. The MPC declines with the size of the stimulus payment.

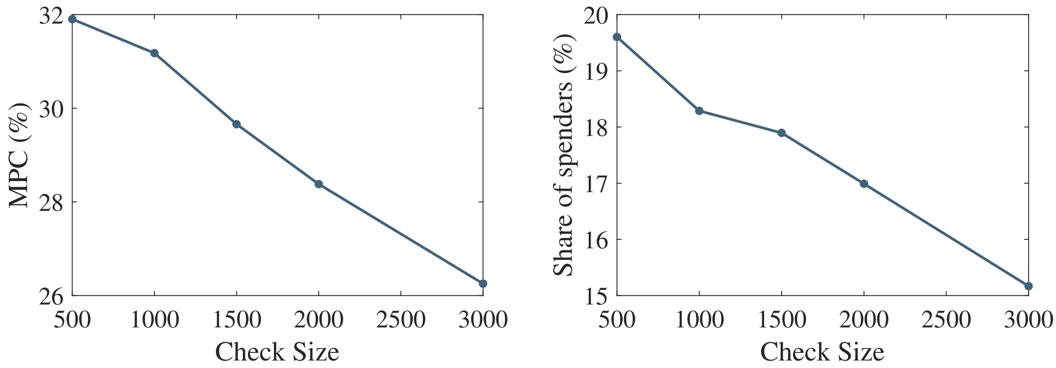

Figure A.6: Size-dependence in the MPC.

The behavioral model generates this size-dependence through two channels. First, there is the standard channel that operates through a relaxation of the borrowing limit. As the size of the stimulus check becomes larger constrained households use the funds to save and move away from the borrowing limit. The concavity of the consumption policy function implies that checks of smaller sizes generate a stronger consumption response. Second, there is a new channel due to the behavioral bias. As the size of the stimulus check becomes larger the utility cost of not smoothing consumption becomes larger than the behavioral bias induced by the reference point causing some wealthy spenders to start smoothing consumption and reducing the inaction regions of the state space. The second panel in Figure A.6 shows exactly this point. From this panel we can observe that the share of spenders with MPCs equal to 1 decreases as the check size increases. This substantially reduces the average MPC in the economy. Figure A.7 shows that the behavioral model generates a substantial concavity in the spending response.

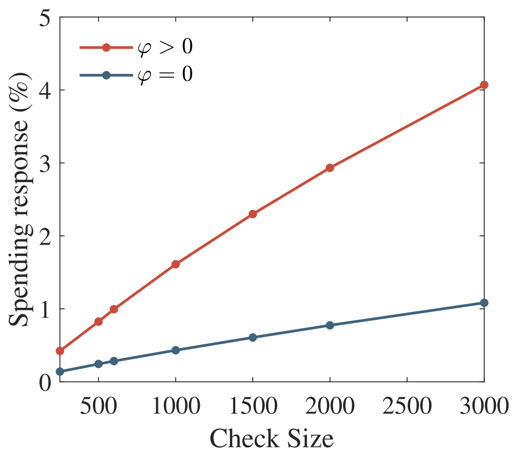

Figure A.7: Size-dependence in the spending response.

B Details on the HANK Model

B.1 Wage and price setting

Here, we provide a description of the main supply blocks of the HANK model. Since these are standard in the literature we omit the derivations. We begin with the wage Phillips curve. A competitive recruiting firm aggregates a continuum of differentiated labor services indexed by $j \in [0, 1]$ by maximizing profits

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

where W is the nominal wage N is the aggregate labor demand or hours, and $\epsilon_w > 1$ is the elasticity of substitution across differentiated labor inputs. This implies a standard CES demand function for labor services of type j given by $N_{jt} = (W_{jt}/W_t)^{-\epsilon_w} N_t$. Define the nominal wage of type j after taxes as $W_{jt}^{\tau} := (1 - \tau_{y,t}) W_{jt}$ and P_t as the consumer price index. Unions set wages to maximize the average welfare of its members subject to wage adjustment costs

$$\max_{\dot{W}_{jt}} \; \int_0^\infty \left[\exp\left(- \int_0^t r_s ds \right) \left(\int_0^1 \frac{W_{jt}^{\tau}}{P_t} N_{jt} - \frac{v(N_{jt})}{u'(C_t)} - \frac{\theta_w}{2} \left(\frac{\dot{W}_{jt}}{W_{jt}} \right)^2 N_t dj \right) \right] dt$$
$$\text{s.t. } N_{jt} = \left(\frac{W_{jt}}{W_t} \right)^{-\epsilon_w} N_t.$$

From the first order conditions of this problem in a symmetric equilibrium with $W_{jt} = W_t$ and $N_{jt} = N_t$, we obtain the wage Phillips curve reported in Section 3. On the firms' side, a representative firm produces the final good using a CES technology with elasticity of substitution $\epsilon_p > 1$. The representative firm operates in a perfectly competitive market and solves

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

This problem yields the demand for intermediate good i, $Y_{it} = (P_{it}/P_t)^{-\epsilon_p} Y_t$. Intermediate firms operate in monopolistic competition and set prices to maximize nominal profits. Let MC_{it} denote nominal marginal costs. Then, intermediate producers choose P_{it} to maximize nominal profits $(P_{it} - MC_{it}) Y_{it}$ with $P_{it} = P_t$, this yields $P_t = \mu_p MC_t$ where $\mu_p := \epsilon_p / (\epsilon_p - 1)$.

B.2 HANK model with debt

Here, we introduce an extension of the behavioral HANK model used in Section 5.3. Specifically, we introduce a wedge between borrowing and saving rates so that borrowers face higher interest rates than savers and remove equity prices from the model ($\omega = 1$). The literature has extensively studied such return schedule in the context of a standard HA model. For example, Achdou, Han, Lasry, Lions, and Moll (2022), introduce a similar interest rate schedule in a standard HA model, Lee, Luetticke, and Ravn (2021) provide a microfoundation through financial frictions using an explicit model of financial intermediation. The full interest rate schedule $r_t^a(a_t)$ is given by a borrowing rate $r_t^- := r_t + \kappa$ if $a_t < 0$ and a saving rate $r_t^+ = r_t$ if $a_t \geq 0$, where $\kappa > 0$ is the wedge between asset returns. Models with a strict borrowing limit ϕ close to zero liquid wealth feature a point mass of households at $\underline{a} = -\phi$. Empirically wealth distributions feature a spike at close to zero wealth and also a left tail made by net borrowers, i.e. households with negative wealth. A model with $\kappa > 0$ can generate both features of the data. Intuitively the presence of a borrowing wedge prevents some households from borrowing by generating a kink in the household budget constraint at zero net wealth. We relax the borrowing limit and calibrate κ to match the share of households with almost zero liquid wealth. Figure A.8 shows the wealth distribution implied by this model. The model generates a spike around zero wealth and a left tail of net borrowers with negative wealth holdings.

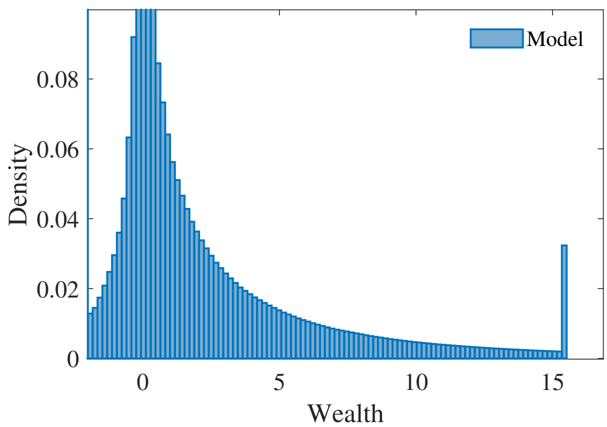

Figure A.8: The wealth distribution with $\kappa > 0$.

Note: Wealth levels are reported relative to average annual earnings.

Table A.2 reports some key steady-state statics for the behavioral HANK model with debt $\kappa > 0$. The model with borrowing wedge can jointly match a mass of households with zero net wealth and the share of net borrowers. In the SCF data the fraction of households with close to zero liquid wealth is between 20% and 30%, in the model is around 27%. In the data the net borrowers are 15% while in the model they are 17%. As Table A.2 shows all the average MPCs are lower when $\kappa > 0$. The reason is that in this model liquidity constrained households primarily use any additional income to reduce debt rather than consuming it.

Table A.2: Statistics in the behavioral HANK model with debt

Description	$\kappa = 0$	Description	$\kappa = 0$
Wealth-income ratio	1.8	Quarterly MPC$^{\text{y}}$ (%)	18
Gini wealth	0.83	Annual MPC$^{\text{y}}$ (%)	28
Share at $a = 0$ (%)	27	Quarterly MPC$^{\text{a}}$ (%)	3
Share with $a < 0$ (%)	17	Annual MPC$^{\text{a}}$ (%)	15
Return on wealth (%)	3	Borrowing rate (%)	11

Note: MPCs out of assets (MPC$^{\text{a}}$). MPCs out of income (MPC$^{\text{y}}$).

Figure A.9 shows the MPCs along the wealth distribution. At the bottom 40% of the distribution MPCs are increasing in liquid wealth. This happens because the consumption policy functions are convex in this region. At the left tail even low-wealth households save to accumulate enough wealth. Moreover, households with zero liquid wealth do not face a strict borrowing limit and this further reduces their MPCs. The differences in the MPCs at the bottom 40% of the wealth distribution are quantitatively large. As a result the averge MPCs are lower with a nonlinear interest rate schedule.

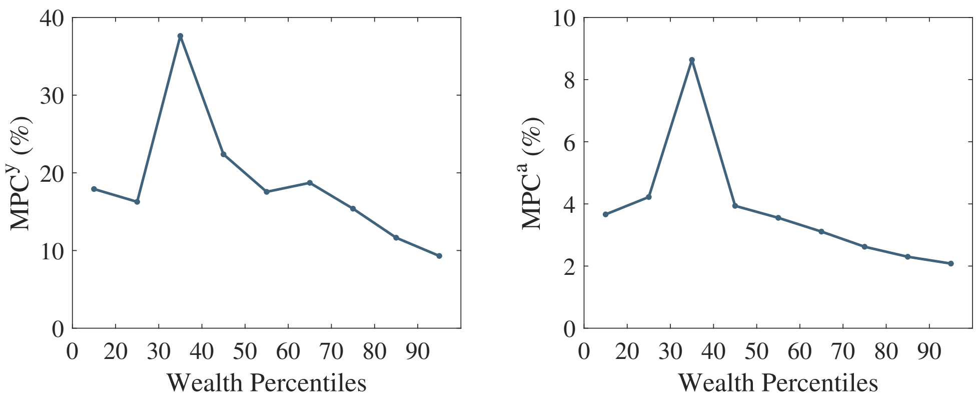

Figure A.9: MPCs across the wealth distribution with $\kappa > 0$.

B.3 Impulse responses in general equilibrium

This section reports the macroeconomic effects of monetary policy and fiscal policy in the behavioral HANK model ($\varphi > 0$) and in the standard HANK model ($\varphi = 0$).

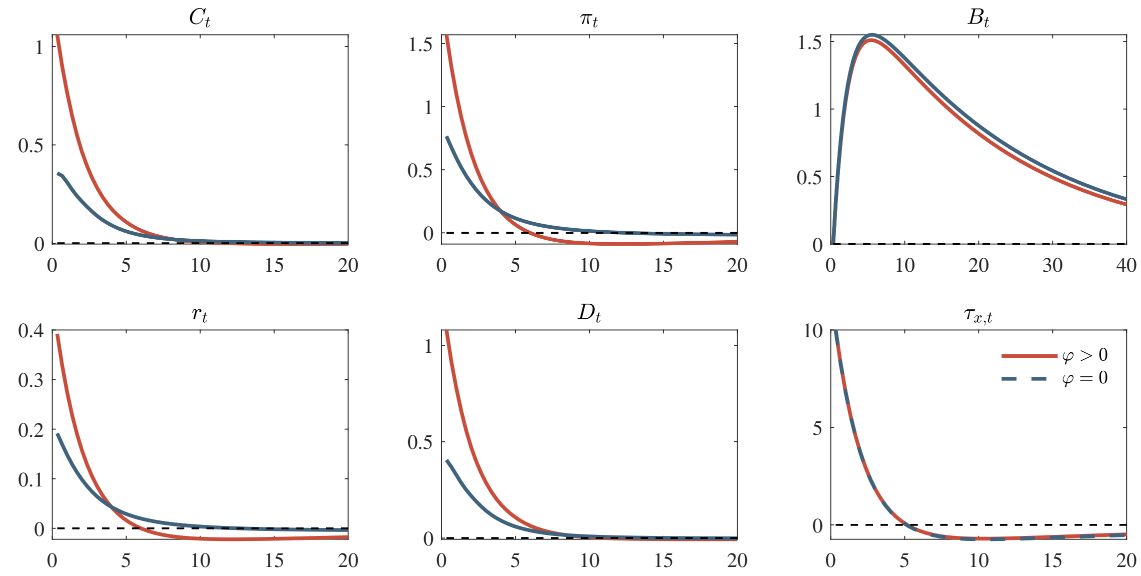

Figure A.10: Impulse responses to stimulus checks.

Note: All the responses are in percentage deviation from steady-state values. Only the interest rate r_t and inflation π_t are reported in annual percentage points deviation from steady state. Quarters on the x-axis.

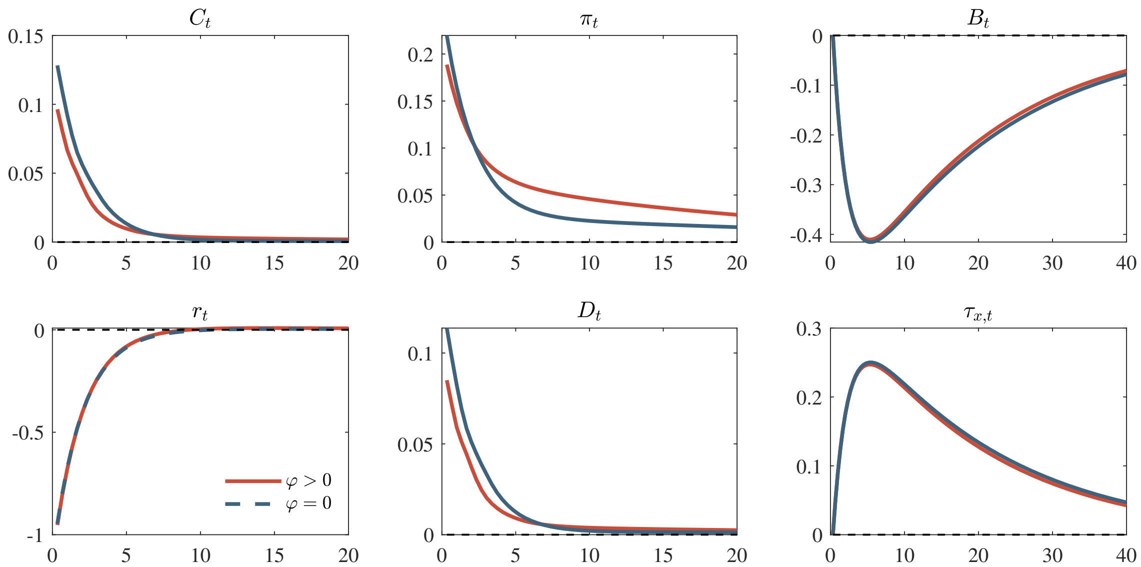

Figure A.11: Impulse responses to monetary policy.

Note: All the responses are in percentage deviation from steady-state values. Only the interest rate r_t and inflation π_t are reported in annual percentage points deviation from steady state. Quarters on the x-axis.

B.4 Additional results

In this section we report the main results for a HANK model without equity prices. Therefore, we set $\omega = 1$ and all household assets are given by bonds. In this version of the model we allow for some borrowing by setting the borrowing limit $\underline{a} = -\phi$ with $\phi > 0$. The calibration strategy is the same as in Section 3.7. Importantly, the share of liquidity constrained households is essentially the same across counterfactuals. Figure A.12 shows the consumption responses to stimulus checks (left panel) in the behavioral model $(\varphi > 0)$ and in the standard model $(\varphi = 0)$ and the consumption response to a 25 basis points interest rate cut (right panel) in the behavioral model and in the standard model.

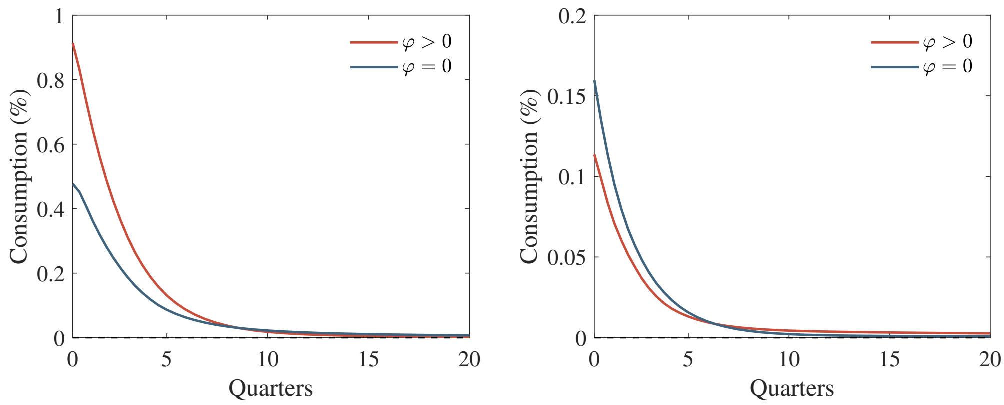

Figure A.12: Consumption response to fiscal policy and monetary policy.

Note: All the responses are in percentage deviation from steady-state values. Fiscal stimulus checks on the left panel. Interest rate cut on the right panel.

As in the baseline version of the model fiscal stimulus checks mostly work directly through government transfers and indirectly through labor market effects. The behavioral model amplifies the indirect labor market effects and mitigates the interest rate channel. On the other hand, monetary policy mostly work directly through the interest rate channel and indirectly through labor market effects and the government response to lower borrowing costs. As for fiscal policy, the behavioral model amplifies the indirect effects and mitigates the direct interest rate channel. Therefore, the results for this version of the model are qualitatively and quantitatively similar to those reported in Section 4 of the paper. This also allows us to show that the results that we find in the paper are not driven by differences in the share of liquidity-constrained households, but rather are due to the share of wealthy spenders that endogenously emerge in the behavioral model, and it is not present in the standard model.

B.5 Business cycle simulations

To simulate the economy we adopt the procedure described in Auclert, Bardóczy, Rognlie, and Straub (2021). We assume that the demand and supply shocks $\xi_{d,t}, \xi_{s,t}$ follow an Ornstein–Uhlenbeck diffusion process

$$\xi_{k,t} = -\nu_k \xi_{k,t} dt + \sigma_k d\hat{w}_{k,t} \tag{B1}$$

where $d\hat{w}_{k,t} \sim N(0, dt)$ is a standard Brownian motion. For both shocks we set ν_k to 0.02 corresponding to a quarterly persistence of 0.98. The standard deviation rates σ_d, σ_s are set to match the standard deviation of aggregate output and the correlation between output and inflation in the data. We discretize the time dimension with a quarterly grid with T_s quarters. A finite difference approximation of Equation (B1) delivers an autoregressive process of order one with autoregressive coefficient $(1 - \nu_k)$. First, we draw a sequence of innovations $\{\epsilon_{k,s}\}$ where $\epsilon_{k,t} \sim N(0, \sigma_k^2)$. Second, we compute the IRFs to both supply and demand shocks $dx_{k,h}$ for each variable of interest x at horizon h. Then, we evaluate the moving-average (MA) process

$$d\hat{x}_t = \sum_{k=d,s} \sum_{j=0}^{T-1} dx_{k,j} \epsilon_{k,t-j}. \tag{B2}$$

This procedure generates a random sample path $d\hat{x}_t$ which we use to compute business cycle statistics such as second order moments and correlations.

Figure A.13 plots the sample paths of inflation and output obtained through the simulation procedure described above and used to compute the business cycle moments in the model.

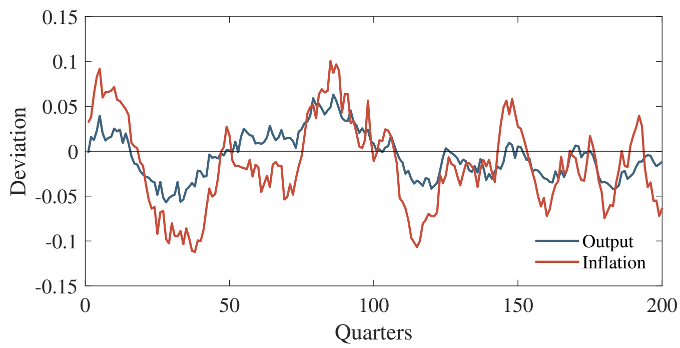

Figure A.13: Simulated data from the model.

Note: The figure plots random sample paths for output and inflation from the behavioral model in deviation from the steady state. We simulate the model for one million of quarters.

For the Great Recession experiments, in Section 5.3, we need to compute the sequence of innovations that generates in our model the output and inflation time series observed for the US. To this end, we use the filtering procedure of McKay and Wieland (2021). This approach allows us to recover the innovations using data on outcome variables and the impulse response functions of the model from Equation (B2). To illustrate the procedure, consider that the researcher has data on output and inflation we can collect these time series in the 2×1 vector X_t and the innovations in the 2×1 vector ϵ_t. Let R_0 be a 2×2 matrix of impulse responses at impact for output and inflation. Define R_t as a vector containing the sum of all remaining terms in the moving-average representation, namely in the ith row we have the element $R_{i,t} = \sum_k \sum_{j=1}^{T-1} dx_{k,i,t+j} \epsilon_{k,i,t-j}$. We can rewrite Equation (B2) as

$$dX_t = R_0 \epsilon_t + R_t,$$

solving for the innovations we have

$$\epsilon_t = R_0^{-1}(dX_t - R_t).$$

We can use this result and proceed recursively. Once we recover the innovations $\{\epsilon_{d,t}, \epsilon_{s,t}\}$ we can compute the paths of any outcome interest as well as conterfactuals $d\hat{x}_t$ from Equation (B2).

Figure A.14 plots output and inflation in the model together with the aggregate demand and supply shocks ξ_t^d, ξ_t^s with innovations filtered to match the actual output and inflation dynamics.

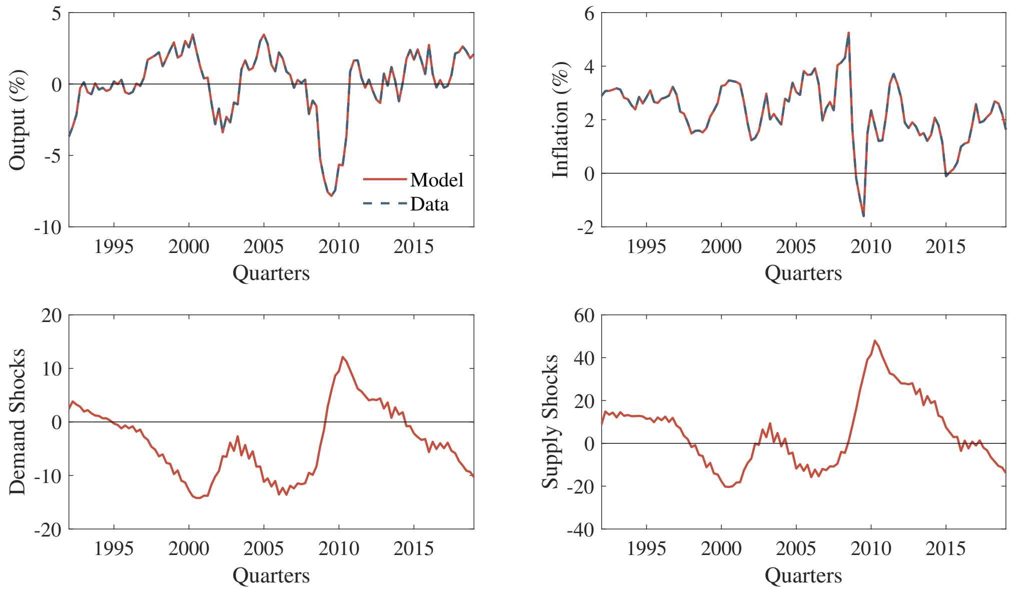

Figure A.14: Great Recession.

Note: The upper panels in the figure plot sample paths for output and inflation from the model and in the data. Output is measured in deviation from the trend as percentage of GDP in 2007Q1. The lower panels plot $\{\xi_t^d, \xi_t^s\}$.

References

Achdou, Yves, Jiequn Han, Jean-Michel Lasry, Pierre-Louis Lions, and Benjamin Moll (2022). "Income and Wealth Distribution in Macroeconomics: A Continuous-Time Approach". In: *Review of Economic Studies* 89, pp. 45–86.

Auclert, Adrien, Bence Bardóczy, Matthew Rognlie, and Ludwig Straub (2021). "Using the Sequence-Space Jacobian to Solve and Estimate Heterogeneous-Agent Models". In: *Econometrica* 89 (5), pp. 2375–2408.

Boehm, Johannes, Etienne Fize, and Xavier Jaravel (2025). "Five Facts about MPCs: Evidence from a Randomized Experiment". In: *American Economic Review* 115 (1), pp. 1–42.

Kueng, Lorenz (2018). "Excess Sensitivity of High-Income Consumers". In: *The Quarterly Journal of Economics* (4), pp. 1693–1751.

Lee, Seungcheol, Ralph Luetticke, and Morten Ravn (2021). "Financial Frictions: Macro vs Micro Volatility". Working Paper.

McKay, Alisdair and Johannes Wieland (2021). "Lumpy durable consumption demand and the limited ammunition of monetary policy". In: *Econometrica* 89 (6), pp. 2717–2749.

Weidner, Justin, Greg Kaplan, and Gianluca Violante (2014). "The Wealthy-Hand-to-Mouth". In: *Brookings Papers on Economic Activity* 45 (1), pp. 77–153.