The Marginal Propensity to Consume in Behavioral Macroeconomics[*]

Valerio Pieroni Giovanni L. Violante

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Abstract

We develop a behavioral Heterogeneous Agent New Keynesian (HANK) model with reference dependence to quantify the macroeconomic implications of heterogeneous consumption responses to income changes. In the model, household income provides 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 role of MPC heterogeneity for the response of aggregate demand to monetary policy and stimulus checks.

Keywords: Reference Dependence, Monetary Policy, Fiscal Policy.

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

[*]Pieroni: University of Essex, valerio.pieroni.econ@gmail.com. Violante: Princeton University, CEPR, IFS, IZA and NBER, violante@princeton.edu. We would like to thank Jeanne Commault for comments and discussions, we also thank participants to seminars and conferences for discussions, comments, and suggestions.

1 Introduction

In view of the increasing use of stimulus checks as a policy tool in recent recessions, it 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 with reference-dependent preferences 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 used to smooth consumption. Our behavioral framework assumes that households assess consumption's utility relative to a reference consumption level that varies with their economic conditions. Specifically, we posit that the relevant reference level is proportional to disposable income, implying that the benchmark against which households evaluate their material well-being adjusts with available resources. This reference-dependent formulation places comparatively greater emphasis on contemporaneous income than on measures of permanent income. 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 MPC. Liquid wealth is defined as cash, bank deposits, bonds, and stocks.

This paper presents two main findings. First, we incorporate reference-dependent preferences 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 aggregate demand.

We start our analysis by studying household consumption-saving decisions with reference-dependent preferences in isolation from the rest of the economy. 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 reference point. This generates a group of households that optimally behave as hand-to-mouth consumers regardless of their liquid wealth holdings. 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. 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 interest rate cuts and 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 measured in the microdata by a vast empirical literature. 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 because while liquidity-constrained households play a relatively limited role in aggregate consumption dynamics, wealthy households account for a substantial share of aggregate consumption. When these wealthy households also have relatively high MPCs, income changes to them can generate sizable changes in aggregate demand.

We leverage the behavioral model to analyze the effects of fiscal stimulus during a severe recession. To this end, we introduce a financial shock that generates a demand-driven downturn characterized by a decline in both economic activity and inflation. In the absence of a fiscal policy response, the shock reduces aggregate output by approximately 4 percent on impact, providing a sizable recessionary environment in which to study the effectiveness of alternative stimulus policies. We consider stimulus checks of different sizes and examine how their effects depend on the distribution of MPCs across households. We find that, in the behavioral model, stimulus checks distributed broadly across households are particularly effective at mitigating the decline in aggregate output. The key mechanism is the behavior of wealthy spenders, who account for a substantial fraction of aggregate consumption and respond strongly to the additional resources provided by the transfers. Unlike in models where high-MPC households are primarily liquidity constrained and have relatively limited weight in aggregate consumption, the behavioral model assigns an important role to households with substantial resources and high consumption levels. Consequently, fiscal transfers can generate a sizable increase in aggregate demand even when they are not targeted exclusively toward households with limited liquidity. Importantly, the strong consumption responses at the micro level do not translate into implausibly large aggregate effects. Despite generating relatively high micro-level MPCs, the behavioral model produces fiscal multipliers in the range of 30-40%, broadly consistent with plausible estimates of the aggregate effects of temporary fiscal transfers. Overall, these results imply that fiscal policy is more effective in the behavioral model than in the standard benchmark, highlighting the importance of accounting for heterogeneity in both consumption behavior and the distribution of economic resources when evaluating fiscal interventions.

We next study the implications of the behavioral model for forward guidance and for the effectiveness of monetary policy during episodes in which the policy rate is constrained by the zero lower bound. Forward guidance operates by affecting current economic decisions through announcements about future interest rates, and its effectiveness therefore depends critically on the extent to which households incorporate future income and interest-rate conditions into their current consumption decisions. In the behavioral model, wealthy spenders effectively have a shorter planning horizon because their consumption responds more strongly to current earnings and less strongly to permanent or expected future income than in the standard model. This feature weakens the transmission of information about future monetary policy to current consumption decisions. We show that, as a result, the anticipation effects associated with forward guidance are substantially muted relative to those in the standard HANK model. Announcements of future interest-rate cuts therefore generate a smaller increase in current aggregate demand, making forward guidance less effective as a stabilization tool. We then turn to zero lower bound episodes and introduce a financial shock that pushes the economy into a situation in which the policy rate is constrained at zero for one year. Interestingly, we find that the resulting recession is less severe in the behavioral model than in the standard HANK model. The intuition is that the zero lower bound represents a constraint on the ability of systematic monetary policy to respond to adverse shocks. However, the quantitative importance of this constraint depends on the effectiveness of monetary policy in the first place. Because monetary policy has weaker effects on aggregate demand in the behavioral model, limiting further adjustments in the policy rate generates a smaller additional loss in economic activity. Thus, the same behavioral features that reduce the effectiveness of conventional monetary policy and forward guidance also imply that the economy is less exposed to the costs associated with the zero lower bound.

We also compare the effectiveness of income-targeted stimulus payments with untargeted transfers of the same magnitude. In the targeted program, transfers are concentrated among low-income households and phase out with income, whereas the untargeted program extends the transfer to all households. We find that targeting remains more effective at stimulating aggregate demand in the behavioral model. Although wealthy households have relatively high MPCs and account for a large share of aggregate consumption, the higher MPCs of liquidity-constrained households are sufficiently large that concentrating transfers on these households generates a stronger aggregate response.

Finally, we allow households to differ in their exposure to aggregate income fluctuations. Motivated by evidence that earnings responses to aggregate shocks are particularly strong at the tails of the income distribution, we introduce an incidence function that generates heterogeneous exposure across households. The resulting U-shaped incidence reflects distinct economic mechanisms at the two tails: employment risk is particularly important for low-income households, while performance-based compensation generates greater exposure among high-income households. This extension reveals that unequal incidence interacts importantly with MPC heterogeneity. While the responses of households around the median are broadly similar under equal and unequal incidence, policy exposure and consumption responses diverge substantially at the tails. In particular, monetary policy generates pronounced differences in consumption responses among households in the bottom 25% and top 10% of the income distribution. Because both groups contain households with relatively high MPCs, unequal exposure to aggregate fluctuations can amplify the distributional consequences of macroeconomic policy.

These findings have broader implications for the evaluation of stabilization policy. At the bottom of the distribution, high MPCs are associated primarily with liquidity constraints, while at the top they arise from behavioral features that induce wealthy households to respond strongly to changes in current resources. Consequently, the incidence of aggregate shocks and the distribution of MPCs jointly determine the aggregate transmission of policy. The analysis highlights that understanding macroeconomic policy requires considering where high-MPC households are located in the income and wealth distributions and how strongly they are exposed to aggregate fluctuations.

Overall, we show that reference dependence 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), Mijakovic (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 reference dependence 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 framework featuring reference-dependent preferences. In particular, we examined the predictions of a new behavioral model and find that the model 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 reference dependence. Section 4 explores the policy implications of household consumption behavior in general equilibrium. Section 5 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 reference-dependent preferences. 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 The role of reference dependence for the MPC

In this section, we investigate the implications of reference dependence for the joint distribution of MPCs and wealth. In the canonical HA model, households optimize intertemporally by smoothing consumption based on their permanent income and liquid wealth positions. MPCs are highest among low-wealth households close to the borrowing constraint, as limited liquid assets prevent them from smoothing consumption in response to temporary income shocks. As households accumulate even a modest amount of liquid wealth, their ability to smooth consumption improves, leading to a sharp decline in MPCs. The model therefore generates a strong negative relationship between liquid wealth and MPCs, with the steepest gradient concentrated near the borrowing limit. By contrast, in our behavioral model, current income serves as the reference point for consumption decisions regardless of households' liquid wealth positions, thereby sustaining higher MPCs throughout the wealth distribution. Specifically, our behavioral framework posits that households evaluate their consumption relative to a reference level determined by their economic conditions. We assume that the relevant consumption reference point is proportional to disposable income, so that households' perceptions of well-being adjust as their resources change. This form of reference dependence implies that households place greater weight on current income over permanent income, potentially altering their responses to transitory income shocks. In our model, households do not respond to a temporary income shock only according to its implications for lifetime resources because the shock also shifts the household's reference point, thereby changing the utility associated with a given level of consumption even when the shock has little effect on permanent income. For example, a positive transitory income shock raises the reference level and induces households to increase consumption to maintain their utility relative to the new benchmark. In this sense, households anchor their consumption choices to current income, which functions as a reference point. 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 the heterogeneous agent model with reference-dependent preferences. We can define $y_t = w_t e_t n_t + r_t a_t$ as households' disposable income where w_t is the real wage, e_t idiosyncratic labor-market productivity, n_t labor supply, a_t liquid wealth, and r_t the real interest rate. The novel element of this model is the instantaneous utility function $u(c_t - \varphi y_t)$ in which consumption's utility depends on the distance of expenditures c_t from the consumption reference point φy_t. The behavioral parameter $\varphi \geq 0$ governs the consumption reference point. Households choose consumption and saving by solving the following maximization problem

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

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

$$a_t \geq -\phi.$$

The income process is given by

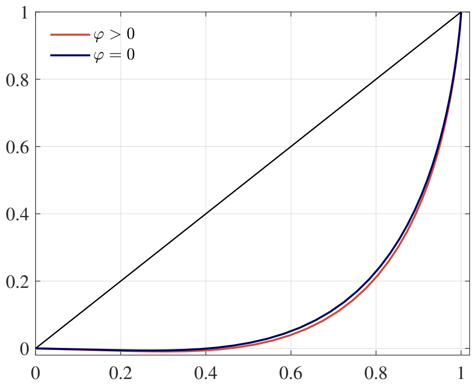
$$d \ln e_t = \nu_e (\mu_e - \ln e_t) dt + \sigma_e d\hat{w}_t,$$

where $d\hat{w}_t \sim N(0, dt)$ is a standard Brownian motion. For simplicity we assume that labor supply n_t is inelastic and homogeneous across households. Relaxing these assumptions to allow for endogenous and heterogeneous labor supply is straightforward. 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 $\psi_t(a_t, e_t)$. Let $v_t(a_t, e_t)$ be the value function of the household problem. In this model, disposable income serves as the reference point governing expenditure decisions. This interpretation is made explicit by expressing the consumption policy function as

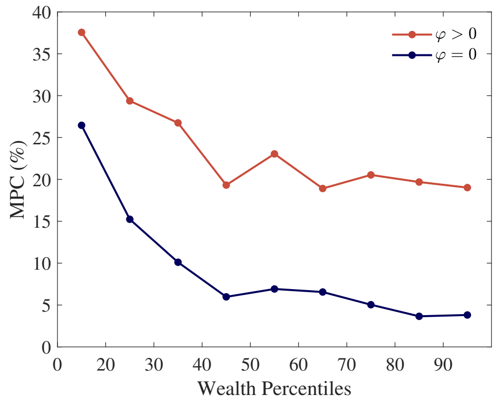
$$c_t = \varphi y_t + (u')^{-1}(\partial v_t / \partial a_t)$$

In this model, consumption tracks the reference point, generating excess sensitivity of consumption to current income. The first term captures the component of consumption that moves directly with the household's current disposable income. In this sense, changes in y_t shift the reference point against which consumption decisions are evaluated and therefore induce a contemporaneous adjustment in expenditure. The second term reflects the standard intertemporal component of consumption, governed by the marginal value of wealth. It captures the household's incentive to smooth consumption by adjusting saving. Thus, reference-dependent expenditure decisions provide a mechanism through which current income affects consumption beyond its effect on lifetime wealth.

In our baseline parametrization we choose a CRAA utility function with parameter $\gamma = 1$ so that $u(x_t) = \ln x_t$. We allow for some borrowing and set the limit $\phi = 0.5$.[6] The real wage $w = 2$ and $r = 2\%$ per year. The parameter ρ is calibrated to 7% annually. These are all typical values in the literature. In the behavioral model φ is internally calibrated to match the average quarterly MPC. To compute the MPCs we simulate the model equivalent of a \$500 transfer. The empirical benchmark in the literature for the average MPC at the quarterly level for this transfer is between 23% and 37% (Borusyak, Jaravel, and Spiess (2024), Boehm, Fize, and Jaravel (2025)). We do not make an explicit distinction between durables and non-durables, we interpret our results in terms of aggregate spending. The average MPC in the behavioral model is approximately 20%, at the lower end of the range of empirical estimates, yet remains twice as large as the 10% MPC implied by the canonical HA model. The behavioral model can easily generate empirically realistic average MPC because a group of wealthy households with high MPCs emerge endogenously in this model. These predictions are consistent with empirical evidence documenting the presence of households with high MPCs and liquid assets (Misra and Surico (2014), Kueng (2018), Lewis, Melcangi, and Pilossoph (2024)).



(a)



(b)

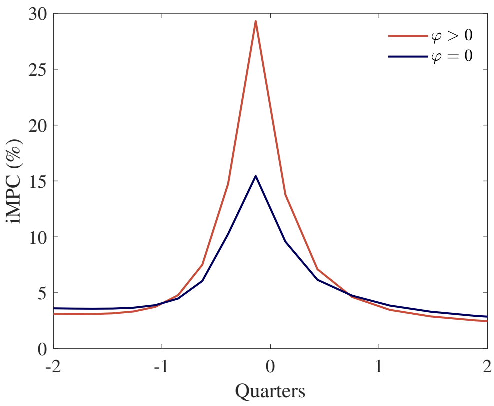
Figure 1: The distribution of liquid wealth and MPC.

Note: Panel (a) shows the distribution of liquid wealth in the behavioral model ($\varphi > 0$) and in the standard model ($\varphi = 0$). Panel (b) shows the quarterly spending responses to \$500 stimulus checks across the distribution of liquid wealth in the behavioral model ($\varphi > 0$) and in the standard model ($\varphi = 0$).

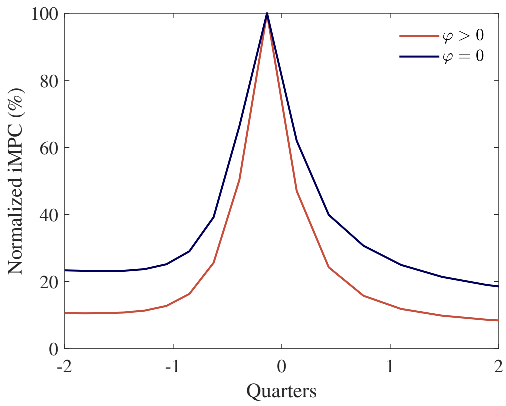
Figure 1 shows the distribution of liquid wealth and MPC in the behavioral model ($\varphi > 0$) and in the standard HA model ($\varphi = 0$). The two models generate essentially identical wealth distributions, yet imply substantially different consumption behavior. In the behavioral model, households exhibit high MPCs regardless of their liquid wealth holdings.

[6] 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 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 features 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. Panel (b) in Figure 1 illustrates this point. In the canonical HA model the MPCs quickly decline with liquid wealth. In the behavioral model the MPCs do decline with liquid wealth but remain substantially high throughout the wealth distribution.



(a)



(b)

Figure 2: Intertemporal MPCs.

Note: Panel (a) shows the intertemporal MPCs in the behavioral model ($\varphi > 0$) and in the standard model ($\varphi = 0$). Panel (b) shows the intertemporal MPCs normalized to the peak response in the behavioral model ($\varphi > 0$) and in the standard model ($\varphi = 0$). Quarters from the peak of the shock on the x-axis.

Figure 2 reports the intertemporal MPCs in the model to a \$500 dollars stimulus check. Panel (a) shows that the behavioral model generates a substantially stronger consumption response on impact, with the initial response approximately twice as large as in the standard model. Panel (b) compares the intertemporal MPCs after normalizing the peak response to unity and highlights the dynamic implications of reference dependence. The intertemporal MPCs decay considerably faster in the behavioral model, implying that consumption responds more tightly to the timing of income changes, while both anticipation and delayed consumption responses are muted. This pattern arises because reference-dependent households consume a larger share of the transfer upon receipt, leaving fewer resources for consumption in subsequent periods. As a result, households engage in less intertemporal consumption smoothing, generating a more front-loaded consumption response and a faster decay of intertemporal MPCs.

Overall, the behavioral model is straightforward to implement and helps resolve the counterfactually strong trade-off between MPCs and wealth accumulation by generating a group of relatively wealthy households with high MPCs.

3 A Behavioral HANK Model

In this section, we introduce a quantitative HANK model with reference-dependent preferences using our behavioral 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.[7] Therefore, households solve

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

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

$$a_t \geq 0.$$

where the instantaneous utility function $u(x_t) := x_t^{1-\gamma}/(1-\gamma)$ and $u(x_t) = \ln x_t$ 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. 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.

[7] Since labor income constitutes the primary source of income for most households, we focus on labor income as the relevant reference point. The model can readily be extended to define the reference point based on total disposable income, without affecting the main results.

3.2 Wage and price setting

In this section, we describe the wage setting and price setting decisions in the economy.[8] 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 $n_t = N_t/(\int_X e_t d\psi_t)$.[9] 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.

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

[9]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 Online Appendix C.

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 consumption decisions $\{c_t\}$, 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 a debt-to-output ratio of 100%, the discount rate ρ to match the interest rate around 1%, and government transfers τ_x to represent a 6% share of income (Alves and Violante (2023)). We set ω so that household wealth is approximately 2.5 times household income, consistent with the data. The behavioral parameter φ is internally calibrated to match an average MPC of about 20%. Table 1 shows the calibrated parameters.

Table 1: 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	0.2	Internally calibrated
B	Net asset supply	3.5	Internally calibrated
ρ	Discount rate (p.a.)	0.07	Internally calibrated
ω	Business income share	0.75	Internally calibrated
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	0.17	Internally calibrated

Table 2 reports targeted and untargeted statistics. Overall, the model provides a reasonable fit of all the targeted statistics. In our baseline calibration, aggregate wealth relative to annual income is around 2.5, the transfer to income ratio is 6%, the real interest rate is around 1%, the debt-to-output ratio is 100%, and the average MPC is 20% in the behavioral model and 10% in the standard HA model. 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 23%. In the behavioral HANK model our calibration strategy delivers $\varphi = 0.2$. Table 2 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. This explains the difference in the average MPC. In the standard HANK model around 13% of the households are liquidity constrained. In the model with reference dependence around 13% of the population is liquidity constrained.

Table 2: Statistics across models

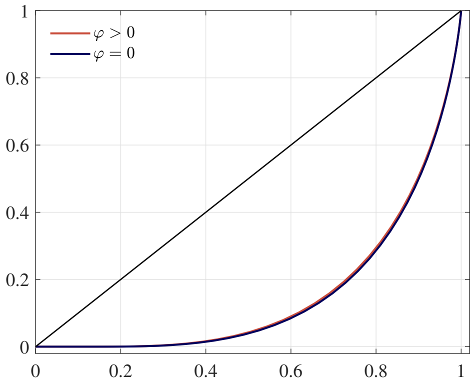
Description	$\varphi = 0$	$\varphi > 0$		$\varphi = 0$	$\varphi > 0$
Transfer-income ratio	6%	6%	Quarterly MPC	10%	20%
Debt-output ratio	100%	100%	Annual MPC	20%	30%
Real rate (p.a.)	1%	1%	Share at $a = 0$	13%	13%

Note: All targeted and untargeted statistics are shown as percentages and computed at the stationary equilibrium. MPCs are computed out of a small transfer ($500).

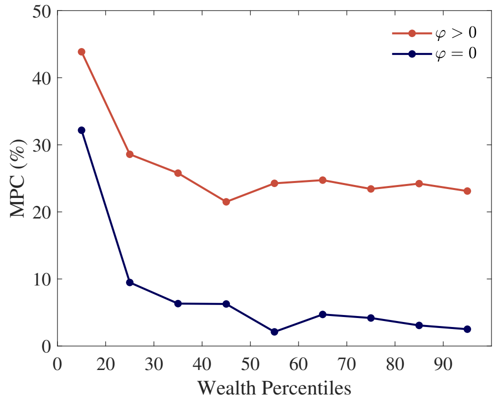
This calibration allows us to study the role of MPC heterogeneity. In the standard model and in the behavioral model the share of liquidity constrained households is similar. The main difference is given by the share of wealthy households with high MPCs. By comparing the two versions of the model we can isolate the role of the consumption behavior of these households for the aggregate consumption response to monetary policy and fiscal stimulus checks. This comparison therefore allows us to quantify the extent to which MPC heterogeneity among households shapes the transmission of these policies to aggregate demand.

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, panel (b) in Figure 3 shows the distribution of MPC across wealth groups in the behavioral HANK model with $\varphi > 0$ and in the HANK model with $\varphi = 0$.



(a)



(b)

Figure 3: The distribution of liquid wealth and MPC in HANK.

Note: Panel (a) shows the distribution of liquid wealth in the behavioral model ($\varphi > 0$) and in the standard model ($\varphi = 0$). Panel (b) shows the quarterly spending responses to \$500 stimulus checks across the distribution of liquid wealth in the behavioral model ($\varphi > 0$) and in the standard model ($\varphi = 0$).

As expected, in the behavioral model, the MPC is large even for wealthy households with a lot of liquid assets, implying that even households with considerable saving buffers respond strongly to transitory changes in income. This feature is central to the behavioral model, as it allows households with high levels of wealth to contribute substantially to aggregate consumption responses despite being far from the liquidity constraint. Note that the MPC is above 20% throughout the wealth distribution.[10] Panel (a) in Figure 3 shows the wealth distribution across model specifications. 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 suggesting that the behavioral mechanism does not come at the expense of matching an important dimension of the household-level data. The combination of a similar wealth distribution and markedly different MPCs provides a useful basis for isolating the role of consumption behavior in shaping aggregate responses to macroeconomic policy. In the following analysis, we therefore exploit this model to assess how the higher MPCs of wealthy households affect the transmission of monetary policy and fiscal stimulus to aggregate consumption.

[10]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.[11] Figure 4 shows the responses of the main macroeconomic variables in the HANK model to stimulus checks.

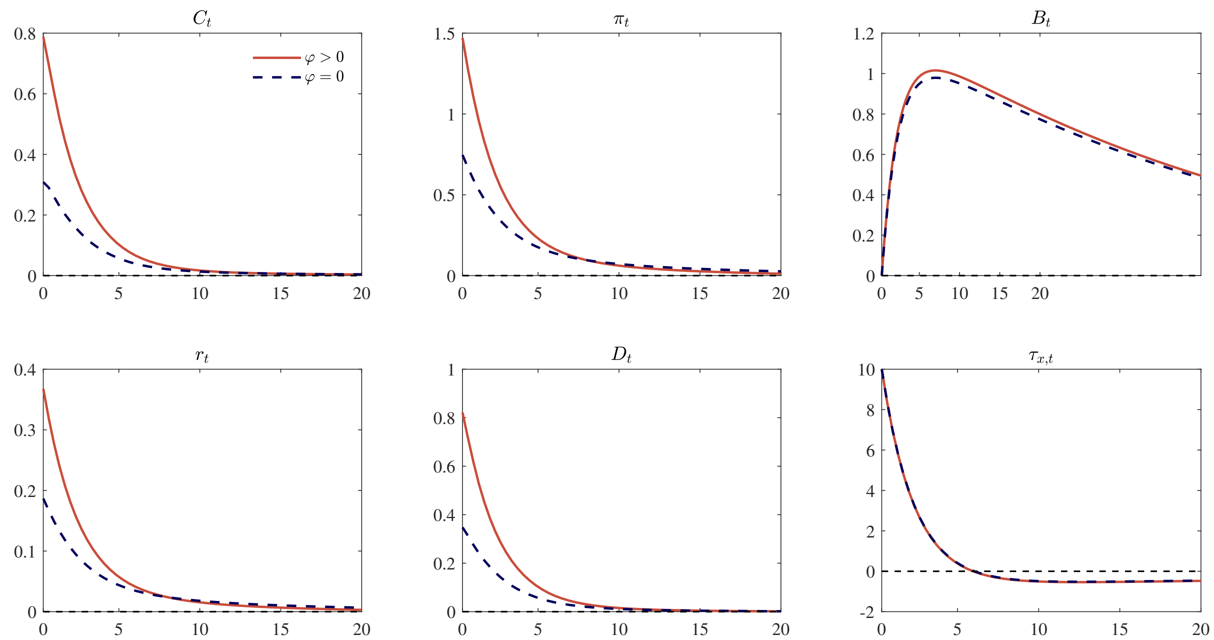


Figure 4: Impulse responses to stimulus checks.

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.

[11] We set the persistence so that the stimulus program lasts for one year. The fiscal policy shock is given by $u_t = u_0 e^{-\rho_u t}$ with $u_0 = 0.1\tau_x$ and $\rho_u = 0.5$.

This policy increases consumption by 0.8%. 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.

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. The presence of wealthy spenders amplifies the response of aggregate consumption to stimulus checks by 0.5 percentage points or by almost two times.

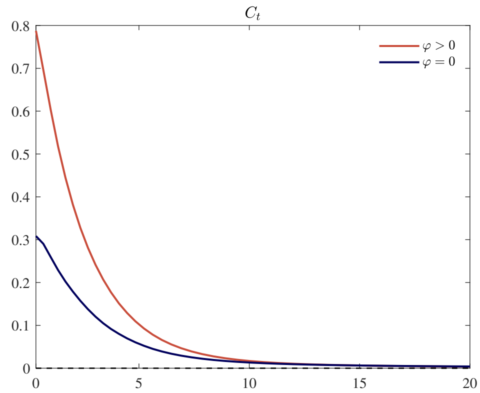


Figure 5: Consumption response to stimulus checks.

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.[12] Figure 6 shows the impulse response functions in the HANK model to a 25 basis points reduction in the nominal interest rate.

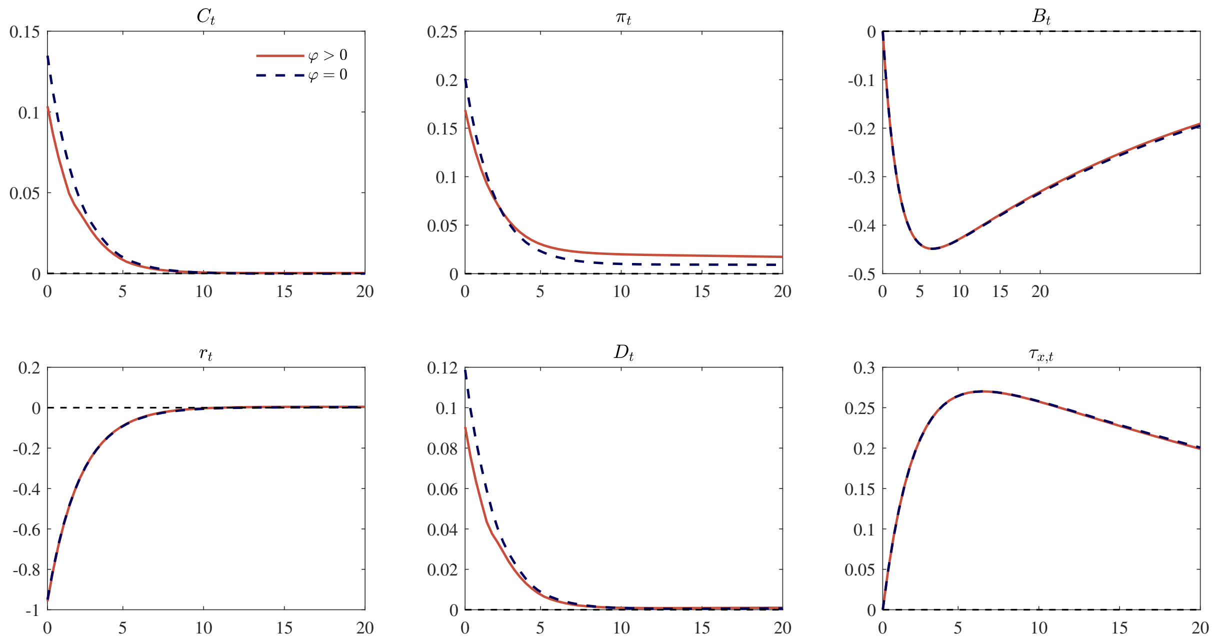


Figure 6: Impulse responses to monetary policy.

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 increases employment and firms' profits, and stimulates household consumption. On impact, monetary policy raises household expenditure by 0.14% 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 guar-

[12] The monetary policy shock is given by $v_t = v_0 e^{-\rho_v t}$ with $v_0 = -0.0025$ and $\rho_v = 0.5$.

antee 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 0.14% increase in consumption on impact. The behavioral model features an initial increase of aggregate consumption of 0.1%. Therefore, reference dependence mitigates the response of aggregate consumption to monetary policy by almost 0.04 percentage points or by 28%.

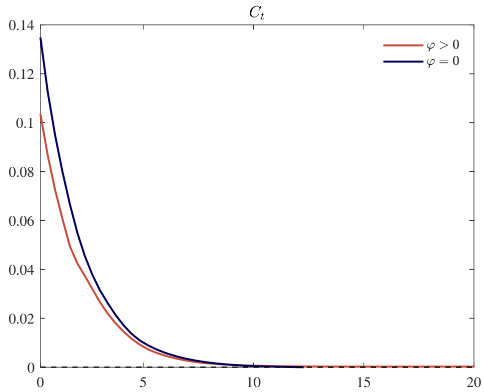


Figure 7: Consumption response to monetary policy.

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 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 for a smaller share 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

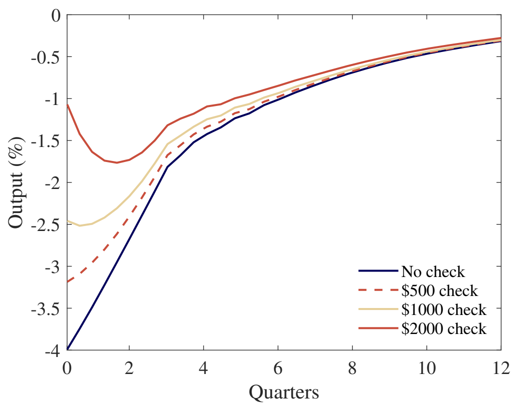
Bringing all these results together, we establish that reference dependence can have first-order implications for the transmission of macroeconomic stabilization policy and the response of aggregate demand. Importantly, the direction and magnitude of these aggregate effects depend on the nature of the policy intervention. The behavioral model changes individual consumption responses substantially and the resulting differences in aggregate dynamics are driven primarily by the heterogeneous-agent block of the model. In contrast, equilibrium paths for other endogenous prices and aggregate variables remain remarkably similar across the counterfactual economies. This finding suggests that the macroeconomic consequences of reference-dependent preferences operate less through broad changes in equilibrium prices or quantities and more through the composition and distribution of households' MPCs.

A central result is that the same behavioral forces that increase the responsiveness of consumption to direct transfers can attenuate the response to monetary policy. Economies characterized by higher average MPCs exhibit a stronger aggregate response to stimulus checks, consistent with the conventional income-channel mechanism: a larger fraction of each additional dollar of disposable resources is immediately translated into consumption. The aggregate demand effects of fiscal transfers are therefore amplified when households are more responsive to changes in current resources. The implications are markedly different for monetary policy. Higher MPCs need not imply stronger aggregate consumption responses to an interest-rate intervention. Instead, greater responsiveness of consumption to current resources is accompanied by a weaker intertemporal substitution margin. When households place greater weight on their current consumption relative to future consumption, changes in the real interest rate generate smaller movements in the desired allocation of consumption across time. Consequently, an economy with higher MPCs may respond more strongly to fiscal transfers while responding less strongly to monetary policy.

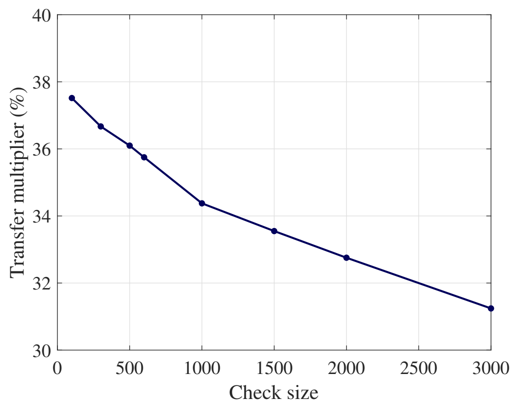
The presence of a distinct group of wealthy spenders shapes aggregate consumption dynamics and the propagation of policy shocks. Because of their greater wealth holdings, these households exert a disproportionately large influence on aggregate demand. In this sense, the MPC heterogeneity across the distribution of liquid wealth matters. The broader implication is that behavioral preferences can alter the quantitative effectiveness of stabilization policy even when they leave much of the aggregate equilibrium essentially unchanged. In particular, fiscal and monetary interventions may generate substantially different aggregate effects in economies with otherwise comparable macroeconomic fundamentals simply because households differ in their MPCs. 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.



(a)



(b)

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

Note: Panel (a) plots the response of aggregate output in percentage deviation from steady-state and reports the size of the transfer at impact when the recession hits the economy. Panel (b) shows the fiscal multipliers at impact, i.e. the response of aggregate output relative to the size of the transfer for different check size.

Panel (a) in Figure 8 shows the response of aggregate output to stimulus checks for various sizes of stimulus checks. Panel (b) in Figure 8 shows the implied fiscal multiplier at impact for checks of different size. Without any stimulus program, aggregate output falls by 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 0.8%. A stimulus check of \$1000 reduces the output loss by around 1.5 percentage points. A larger check of \$2000 is required to almost 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.

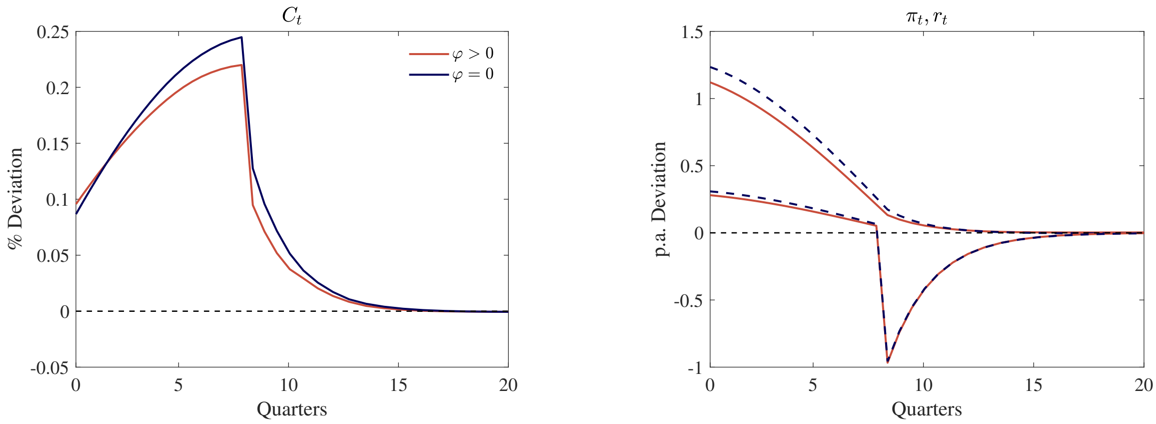
Panel (b) of Figure 8 shows that extrapolating the effects of large stimulus checks from the responses to small transfers can be misleading. In particular, the decline in the fiscal multiplier as the size of the stimulus check increases indicates that the aggregate consumption response is not proportional to the size of the transfer. The model therefore exhibits a quantitatively important degree of size dependence: larger transfers continue to stimulate aggregate demand and remain effective in mitigating the recession, but each additional dollar of transfers generates a progressively smaller increase in aggregate demand. This nonlinearity implies that evaluating the effectiveness of large-scale fiscal interventions using multipliers estimated from small transfers may substantially overstate their aggregate effects. Panel (b) quantifies the transfer multipliers implied by the response of aggregate output. Across the range of transfer sizes considered, the multiplier lies between approximately 40% and 30% and declines monotonically with the size of the stimulus. Thus, while the fiscal intervention remains expansionary throughout, its effectiveness diminishes at larger scales. This pattern arises endogenously from the heterogeneous-agent structure of the model. As the size of the transfer increases, the MPC among recipient households becomes smaller, limiting the additional increase in aggregate demand generated by progressively larger transfers. The resulting size dependence provides an important qualification to the interpretation of transfer multipliers and highlights that their magnitude cannot generally be treated as invariant to the scale of the fiscal intervention.

An important implication of these results is that matching the high micro-level MPCs documented in the empirical literature does not necessarily imply implausibly large aggregate fiscal multipliers. HANK models calibrated to reproduce substantial household-level MPC heterogeneity can generate transfer multipliers that are quantitatively consistent with empirical estimates, while simultaneously producing well-behaved aggregate responses to large fiscal interventions. In particular, the model does not generate extreme macroeconomic counterfactuals despite assigning relatively high MPCs to a substantial fraction of households.

Overall, the quantitative experiments in this section demonstrate that the distribution of MPCs is central to understanding the aggregate effects of fiscal policy during recessions. In particular, the presence of wealthy spenders and the resulting heterogeneity in consumption responses shape the size of the fiscal multiplier. Large micro-level MPCs are consistent with reasonable aggregate responses. Moreover, the model also has implications for the targeting of fiscal stimulus. The model challenges the conventional case for targeting fiscal transfers toward low-income households. While these households tend to have high MPCs, wealthy households can also exhibit substantial MPCs and therefore contribute importantly to aggregate demand.

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 effectiveness 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. In particular, it reduces both anticipation effects and lagged effects as discussed in Section 2.1. This has potential implications for the effectiveness of forward guidance policies.



(a) (b)

Figure 9: Forward guidance in HANK.

Note: Panel (a) plots the consumption response in percentage deviation from steady state across HANK models. Panel (b) plots the response of inflation and real interest rate.

Figure 9 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 mostly 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 ξ_t^d such that the ZLB binds for one year after the shock. 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.

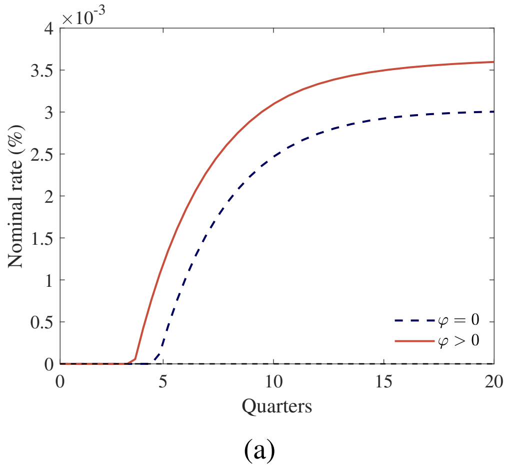


Figure 10: Zero lower bound in HANK.

Note: Panel (a) plots the response of the nominal interest rate to the aggregate demand shock expressed in levels. Panel (b) plots the response of output to the aggregate demand shock as percentage deviation from steady state.

Figure 10 shows the responses of the nominal interest rate and aggregate output 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 as much as in the standard model in response to changes in the interest rates. These households respond mostly to changes in their labor earnings. Overall, with these experiments we highlight the importance of indirect income effects for the transmission of monetary policy.

4.6 Fiscal policy design

In practice, most fiscal stimulus programs incorporate some form of income-based phase-out and are explicitly designed to direct a larger share of transfers toward low-income households. This design reflects the conventional view that the MPC is systematically higher among households with limited liquid wealth and constrained access to credit, which are disproportionately concentrated at the lower end of the income distribution. Targeting transfers toward these households can therefore increase the aggregate consumption response generated by a given fiscal cost. However, the effectiveness of such targeting is not immediate in an environment with substantial heterogeneity in household MPCs. In particular, the presence of high-income households with relatively high MPCs raises the question of whether income-based targeting necessarily delivers a larger aggregate demand response than an otherwise comparable untargeted program. Although liquidity-constrained households tend to exhibit higher MPCs on average, the aggregate consumption response depends not only on the MPC of the recipient but also on their share in aggregate income and consumption. Consequently, a policy that excludes high-income households may forgo transfers to a group whose individual MPC is sufficiently large, and whose relatively large economic weight could generate a sizable contribution to aggregate demand.

In this section, we study the design of stimulus programs and quantify the aggregate effects of targeted interventions relative to untargeted transfers. We consider two alternative stimulus packages that are identical in terms of the transfer amount allocated to households. Under the first program, transfers are targeted to low-income households, with the transfer schedule designed to phase out with income. Under the second program, the transfer is extended to all households, so that every household receives a transfer equal to the average transfer received by households under the targeted program. This comparison isolates the role of targeting by holding fixed the transfer size relevant for the targeted population while allowing us to assess the additional aggregate consumption generated by expanding eligibility to households further up the income distribution. The comparison is particularly informative because the two programs need not rank identically in terms of their aggregate consumption effects. The targeted program places greater resources on households with, on average, higher MPCs, thereby maximizing the consumption response per unit of transfer among eligible households. The untargeted program, by contrast, spreads transfers across a larger set of households and consequently allocates resources to households with lower average MPCs. Nevertheless, because higher-income households command a disproportionately large share of aggregate resources, their inclusion may generate a quantitatively important consumption response even when their MPC is lower than that of low-income households. The relative effectiveness of the two policies therefore depends on the joint distribution of income, consumption, and MPCs rather than on the income-MPC relationship alone.

In the first package, the maximum amount of the stimulus payments received by the poorest households in the economy is around \$500. This transfer scheme is highly targeted toward the bottom of the income distribution. Households in the bottom 25% receive the bulk of the transfers, while payments are gradually phased out for households in the next 25% of the distribution and are reduced to zero for households in the top half of the income distribution. To formalize this comparison, let households' budget constraint be given by

$$da_t = ((1 - \tau_{y,t})w_t e_t n_t + b_t + r_t a_t + \mathcal{T}_t(y_t) - c_t)dt,$$

where $\mathcal{T}_t(y_t)$ denotes the fiscal transfer received by the household depending on labor income y_t. In the first package $\mathcal{T}_t$ depends on income y_t while in the second package $\mathcal{T}_t = \tau_{x,t}$ and stimulus checks are paid through lump-sum transfers $\tau_{x,t}$. The two stimulus programs differ only in the mapping from household income to $\mathcal{T}_t$. This formulation allows us to characterize the aggregate consumption response to each policy and to quantify the extent to which targeting improves or reduces the effectiveness of fiscal stimulus checks.

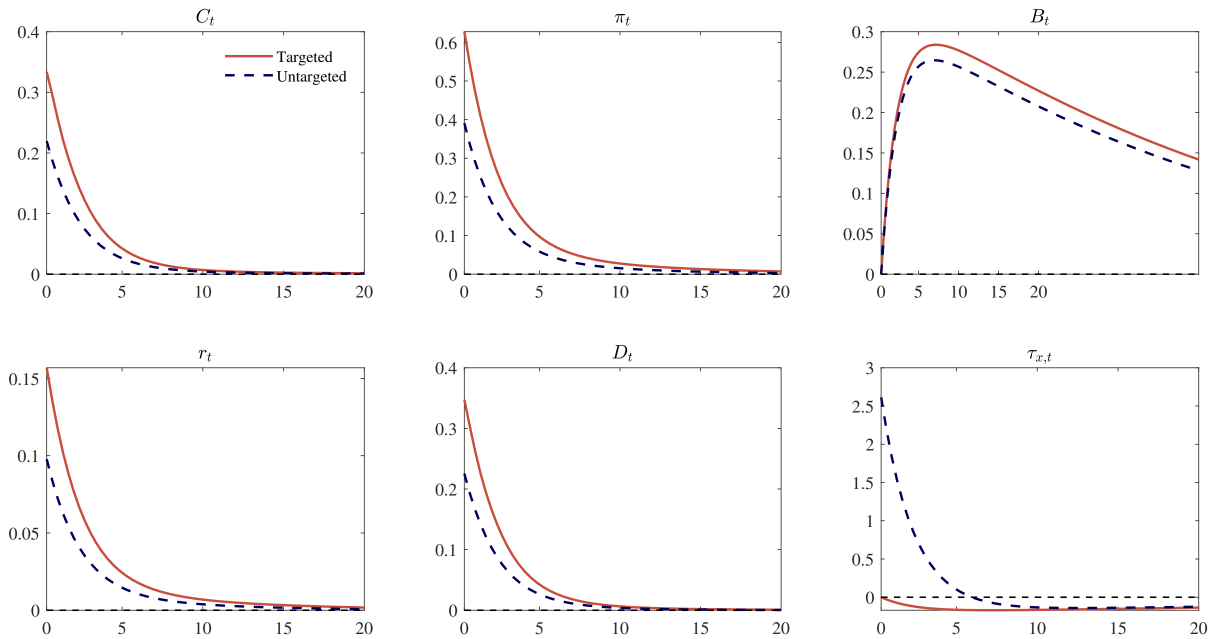


Figure 11: Impulse responses to targeted and untargeted stimulus checks.

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 11 shows the impulse responses of the main macro variables to each policy. The targeted intervention generates a substantially larger aggregate demand response than the untargeted transfer program. Thus, when comparing stimulus packages of equal size but with different distributional incidence, the gains from concentrating transfers on households with higher MPCs more than offset the potential contribution of high-income households to aggregate demand. In particular, the presence of wealthy households with relatively high MPCs does not overturn the case for targeting. Rather, the results indicate that the effectiveness of fiscal stimulus depends critically on the interaction between household MPCs and their position in the income distribution, with targeted transfers remaining the more effective instrument for stimulating aggregate demand in our setting.

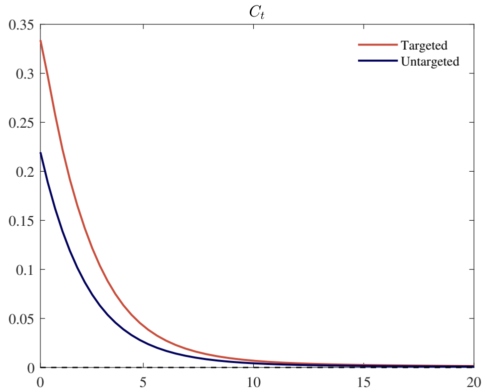


Figure 12: Consumption response to targeted and untargeted stimulus checks.

Note: All the responses are in percentage deviation from steady-state values. Quarters on the x-axis.

Figure 12 shows the response of aggregate demand across the two fiscal packages. Targeted transfers increase the aggregate demand response by approximately 0.15 percentage points relative to the untargeted policy. This difference is quantitatively substantial and reflects the higher MPCs of liquidity-constrained households, which amplify the aggregate demand response to targeted transfers. By targeting households with high MPCs, the government can generate a larger spending response per dollar of transfers. Although these households account for only a relatively small share of aggregate consumption, the dispersion in MPCs is sufficiently large that the resulting increase in spending more than offsets their smaller consumption share.

Overall, our findings challenge the conventional view that the presence of high-MPC households at the top of the income distribution, by itself, provides a reason to reduce the degree of income targeting in stimulus programs. While wealthy households with relatively high MPCs can contribute meaningfully to aggregate demand, their inclusion does not necessarily make untargeted transfers more effective. More broadly, our results highlight that the degree of targeting cannot be inferred from the presence of high-MPC households alone. Instead, it depends on the joint distribution of MPCs, income, and consumption across households. From this perspective, the relevant policy margin is not simply whether high-income households respond to transfers, but whether extending transfers to them generates a sufficiently large additional spending response.

4.7 Unequal incidence

So far, we have assumed that economic fluctuations have an equal incidence on households' earnings. However, 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 and Broer, Kramer, and Mitman (2025) find similar results for monetary policy shocks. Motivated by this evidence, we revisit the transmission of fiscal policy and monetary policy to aggregate demand in a version of the model with heterogeneous exposure to income shocks across the earnings distribution.

To capture the unequal exposure 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, let $Y_t^\ell = w_t N_t$ we assume that household earnings y_t^ℓ are given by

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

where Y_t^ℓ is aggregate labor income, Y^ℓ is aggregate labor income at the steady state, and $\gamma(e_t)$ is the elasticity of earnings to aggregate labor income. 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.

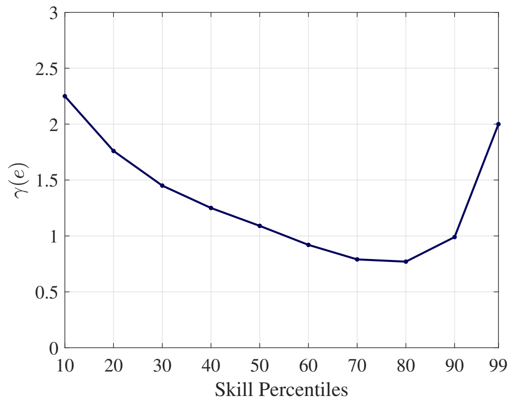
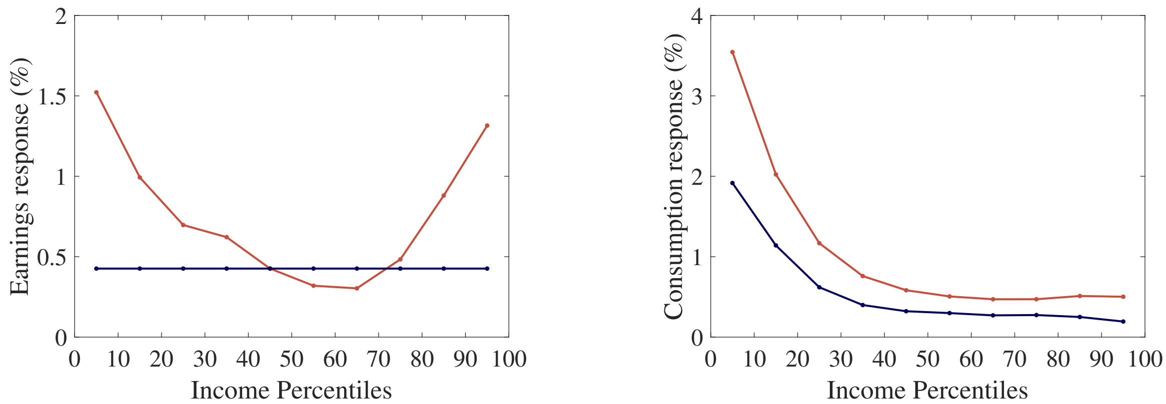


Figure 13: Unequal incidence of output in HANK.

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 macroeconomic implications of the unequal exposure to output fluctuations for fiscal policy and monetary policy, we consider the same shocks of the previous sections. Specifically, we separately feed into the model a \$500 stimulus payments and a 25 basis points interest rate cut and compare the response of aggregate demand to each shock with the response of demand under equal incidence and with the size of each policy shock recalibrated so that the response of earnings of all households in the case with equal incidence is the same as the response of the median in the case of unequal incidence. This comparison allows us to quantify the role of higher exposure to policy shocks at the tails of the earnings distribution.

Panel (a) of Figure 14 presents the response of earnings to stimulus checks across the distribution of labor income, while panel (b) reports the corresponding response of consumption to the same policy intervention. Around the median of the income distribution, the responses are remarkably similar across the two economies, suggesting that the incidence of the policy and its transmission into household economic outcomes are broadly comparable for households in the middle of the distribution. However, the responses diverge systematically among households at the lower and upper ends of the earnings distribution due to the unequal incidence fo the labor income response to economic fluctuations.



(a)

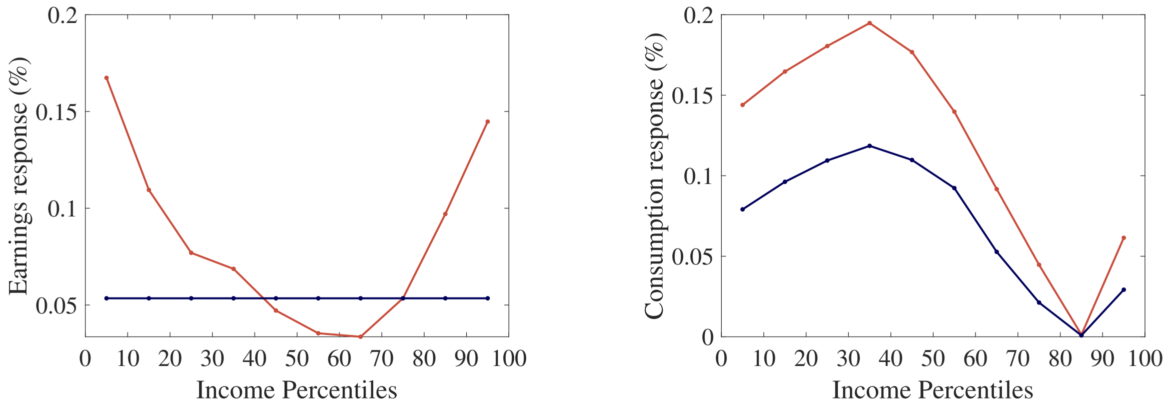
(b)

Figure 14: Cross-sectional responses to stimulus checks.

Note: Panel (a) plots the responses of labor earnings in percentage deviation from steady state across the distribution of labor income. Panel (b) plots the response of consumption in percentage deviation from steady state across the distribution of labor income. Unequal incidence (red line) equal incidence (blue line).

The comparison across panels further suggests that heterogeneity in households' exposure to the policy plays an important role in shaping the consumption response. Specifically, the differences between the two economies in policy exposure are associated with substantially larger differences in consumption responses at the tails of the earnings distribution than around the median. This pattern is consistent with a mechanism in which differences in the incidence of stimulus payments are amplified through household-level responses, generating pronounced heterogeneity in consumption effects among households with relatively low or high earnings. Taken together, the results underscore the importance of accounting for distributional heterogeneity in both policy exposure and behavioral responses when evaluating the aggregate effects of fiscal transfers. This suggests that the aggregate effectiveness of fiscal stimulus depends critically on the alignment between the distribution of policy exposure and households' MPCs.

Panel (a) of Figure 15 presents the response of earnings to interest rate cuts across the distribution of labor income, while panel (b) shows the response of consumption to the same policy. As in the previous analysis, the two economies exhibit broadly similar responses around the median of the income distribution, indicating comparable policy incidence and transmission among households in the middle of the distribution. In contrast, the responses differ markedly at both tails of the earnings distribution, consistent with differences in the distributional incidence of labor-income responses to economic fluctuations.



(a) (b)

Figure 15: Cross-sectional responses to interest rate cuts.

Note: Panel (a) plots the responses of labor earnings in percentage deviation from steady state across the distribution of labor income. Panel (b) plots the response of consumption in percentage deviation from steady state across the distribution of labor income. Unequal incidence (red line) equal incidence (blue line).

For monetary policy, differences in consumption responses are particularly pronounced among households in the bottom 25% and the top 10% of the income distribution. This pattern highlights the importance of distributional effects in the transmission of monetary policy: differences in the exposure of households to labor-income fluctuations become especially consequential at the tails, where the incidence of income changes interacts with heterogeneous MPCs. The U-shaped income response reflects employment channel at the bottom of the distribution and performance-based compensations of managers and entrepreneurs at the top.

The presence of households with high MPCs at both the bottom and the top of the distribution implies that the U-shaped incidence of labor income is consequential for both liquidity-constrained and wealthy households. At the bottom, high MPCs likely reflect binding liquidity constraints, so transfers generate large consumption responses. At the top, sizable MPCs due to the behavioral bias indicate that substantial responses are not confined to liquidity-constrained households. Thus, the interaction between the U-shaped incidence of labor income fluctuations and the distribution of MPCs amplifies consumption responses at both tails, making the distribution of policy exposure central to understanding the aggregate effects of macro policy.

5 Conclusions

This paper develops and evaluates a behavioral HANK model that incorporates reference-dependent preferences 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 reference dependence 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 of MPCs shapes the effectiveness of stabilization policies. The model also provides new insights into the implications of income dynamics for the cross-sectional effects of policy interventions. During a demand-driven downturn, stimulus checks are especially effective because wealthy spenders consume a large share of the transfers. Counterfactual simulations suggest that stimulus payments play a meaningful role in stabilizing GDP during recessions, generating fiscal multipliers in the range of 30-40 percent. The behavioral model additionally predicts diminished forward-guidance effects and mitigated severity of zero lower bound episodes.

Taken together, the results show that incorporating reference dependence 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.

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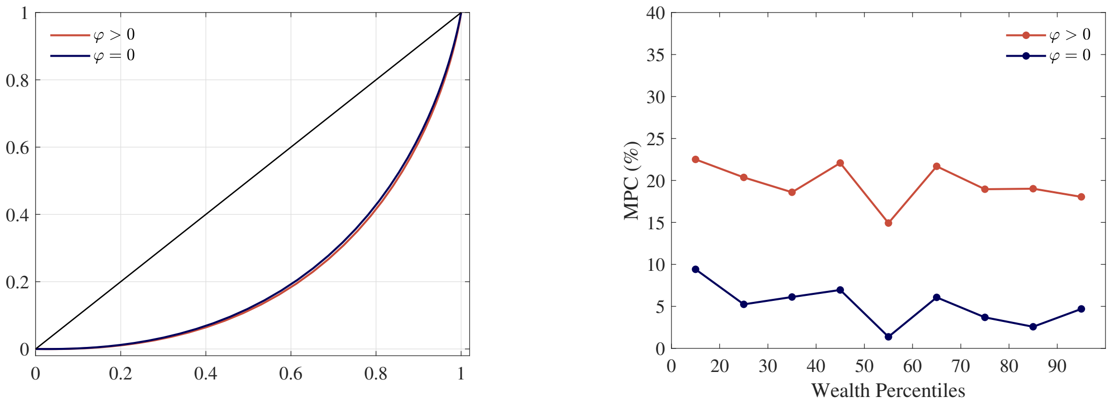
Online Appendix for "The Marginal Propensity to Consume in Behavioral Macroeconomics"

Valerio Pieroni Giovanni L. Violante

A More on MPCs and wealth

In this section, we consider for completeness an alternative calibration with $\gamma = 2$, all the other parameters are the same as in the baseline case. Panel (a) in Figure A.1 reports the distribution of wealth in the behavioral model and in the standard model. Panel (b) in Figure A.1 shows the MPCs across the wealth distribution. In this specification, greater risk aversion strengthens households' precautionary saving motive, leading them to accumulate more assets. The resulting increase in asset holdings substantially reduces the fraction of households that are liquidity constrained at the borrowing limit and generates a more dispersed wealth distribution. Importantly, MPCs remain relatively high despite the greater dispersion in wealth holdings. This result suggests that the model can generate high MPCs even when calibrated to match the distribution of net worth, rather than liquid wealth.



(a) (b)

Figure A.1: The distribution of liquid wealth and MPC.

Note: Panel (a) shows the distribution of liquid wealth in the behavioral model ($\varphi > 0$) and in the standard model ($\varphi = 0$). Panel (b) shows the quarterly spending responses to \$500 stimulus checks across the distribution of liquid wealth in the behavioral model ($\varphi > 0$) and in the standard model ($\varphi = 0$).

Overall, these results suggest that the preference specification is also suitable for applications in which the primary wealth target is the distribution of net worth.

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 $\mu_p := \epsilon_p / (\epsilon_p - 1)$.

C Additional results

In this section, we study additional results of our behavioral HANK model. In particular, we focus on the effects of fiscal policy and monetary policy when the earnings of households at the tails of the income distribution are more exposed to economic fluctuations. Second, we explore the implications of the behavioral bias for the business cycle properties of the model. Finally, we construct a counterfactual for the Great Recession to quantify the multiplier of the 2008 stimulus checks through the lens of the behavioral model.

C.1 Unequal incidence

Figure A.2 presents the responses of the main macroeconomic variables to stimulus checks in an economy characterized by unequal incidence of labor income and in an economy with equal incidence. The responses are substantially more pronounced in the economy with unequal incidence, with larger fluctuations across the main macroeconomic aggregates. This result indicates that heterogeneity in the incidence of labor-income fluctuations amplifies the transmission of stimulus checks, as the same policy intervention generates markedly different responses when income changes are distributed unevenly across households. As discussed in Section 4.7.

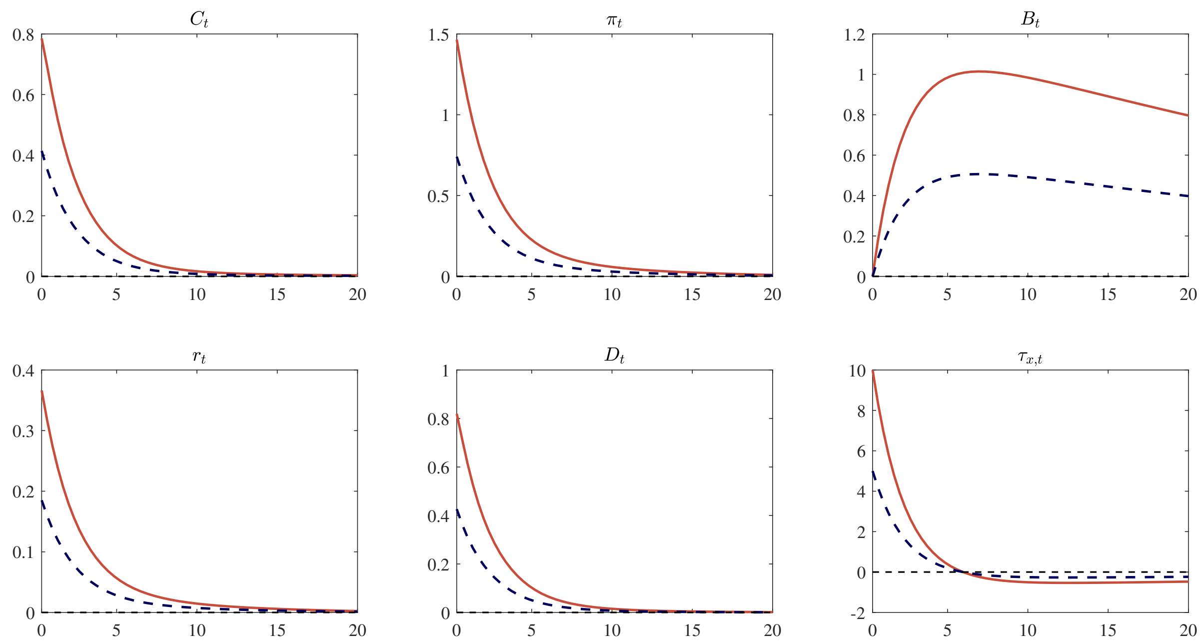


Figure A.2: Impulse responses to stimulus checks.

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. Unequal incidence (red line) equal incidence (blue line).

Of course, part of the differences in the aggregate responses can also be attributed to differences in the magnitude of the policy shock itself. Since the stimulus checks generate different changes in aggregate disposable income across the two economies, a larger response partly reflects a larger underlying transfer rather than differences in the transmission mechanism. These effects are particularly evident in the cross-sectional responses presented in Section 4.7. Focusing on the middle of the income distribution, where changes in labor income are comparable across the two economies, provides a useful benchmark for assessing the extent to which differences in the magnitude of the policy shock account for differences in aggregate responses. Given that the main focus of Section 4.7 is on the distributional implications of unequal incidence, these confounding effects do not pose a concern for our main analysis. Our main objective is not to isolate the contribution of shock magnitude to aggregate fluctuations, but rather to characterize how the distribution of income responses shapes the transmission of policy across households.

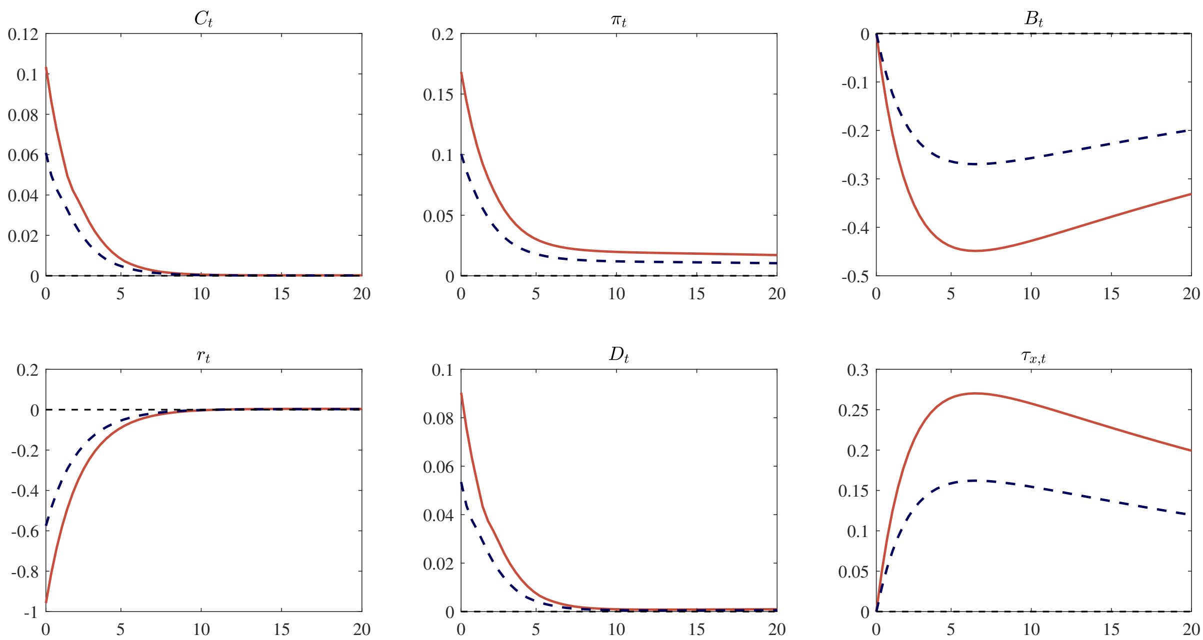


Figure A.3: Cross-sectional responses to interest rate cut.

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. Unequal incidence (red line) equal incidence (blue line).

For completeness, Figure A.3 reports the same responses also for monetary policy. As for fiscal policy, we can observe that there is a significant difference in the aggregate responses. As discussed above, part of this difference is due to the magnitude of the policy shock and part to the unequal exposure to income changes across households.

C.2 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

$$d\xi_{k,t} = -\nu_k \xi_{k,t} dt + \sigma_k d\hat{w}_{k,t} \tag{C1}$$

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 (C1) 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

$$d\hat{x}_t = \sum_{k=d,s} \sum_{j=0}^{T-1} dx_{k,j} \epsilon_{k,t-j}. \tag{C2}$$

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.4 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.

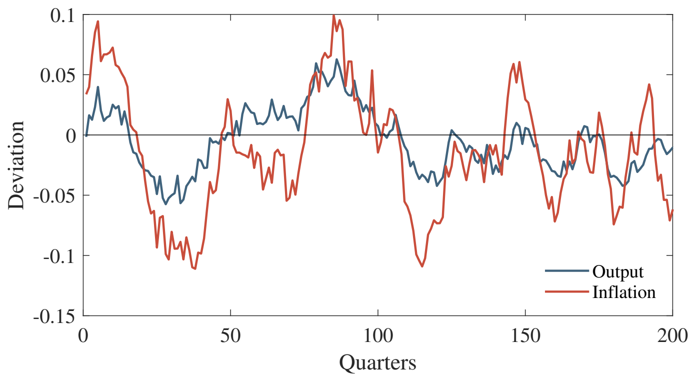


Figure A.4: Simulated data from the model.

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, 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 (C2). 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 (C2) 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 (C2).

Figure A.5 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.

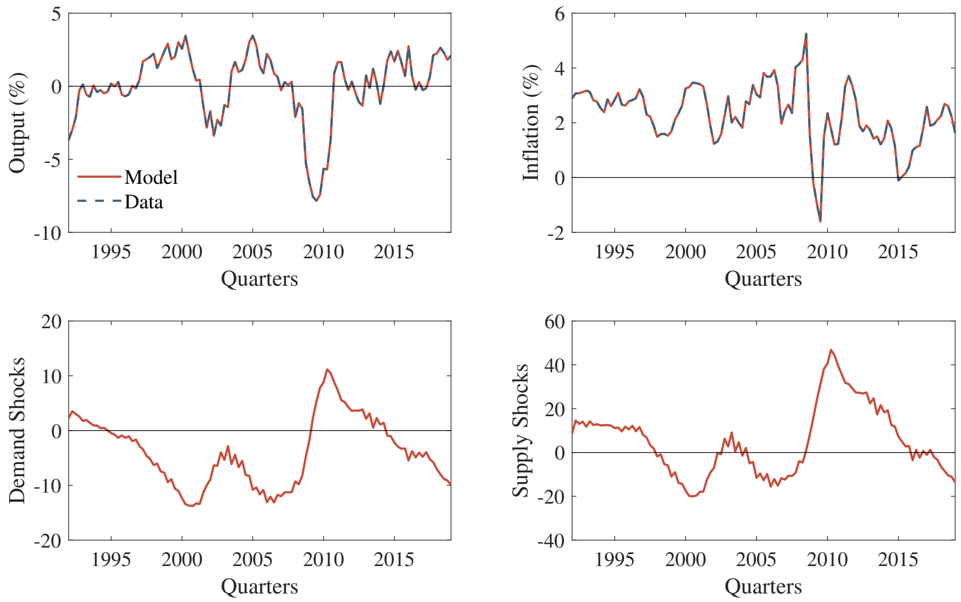


Figure A.5: Great Recession.

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 $\{\xi_t^d, \xi_t^s\}$.

Business cycles. 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.

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 A.1 shows the results. We can observe that in finite samples the behavioral model tend to generate similar output and inflation volatility relative to the standard model. However, 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 A.1: Business cycle statistics across models

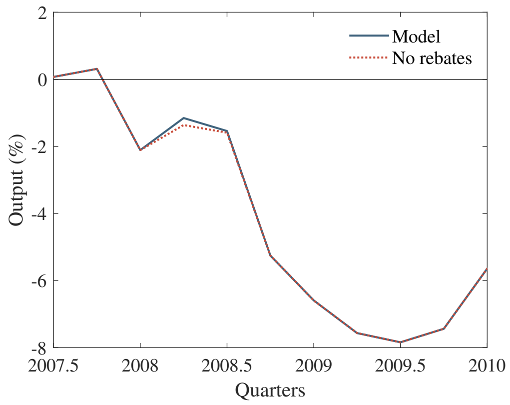
Description	Model $\varphi > 0$	Model $\varphi = 0$
Std. Deviation output	0.023	0.024
Std. Deviation inflation	0.05	0.04
Corr. output and inflation	0.39	0.18

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.

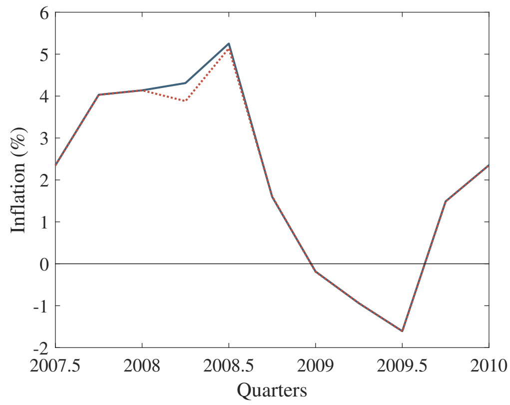
Overall, these findings demonstrate that heterogeneity in MPCs plays a crucial role not only in shaping the effectiveness of macroeconomic stabilization policies, but also in determining how output and inflation respond to aggregate shocks. In this way, MPC heterogeneity becomes an important factor influencing the underlying forces that drive business cycle fluctuations. When preferences are reference-dependent, households' consumption responses can become more sensitive to changes in their economic conditions, further amplifying the role of aggregate demand shocks in driving business cycle fluctuations.

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] Figure A.6 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. The implied cumulative multiplier for the stimulus payments is around 40%. Hence, according to our counterfactual, the fiscal multiplier of the 2008 rebates is similar in size to the multipliers of stimulus check packages in HANK models. This magnitude is significant given the one-off nature of the rebates.[14]



(a)



(b)

Figure A.6: 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).

[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.

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

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