A Model of Consumption with Mental Accounting and Heterogeneous Agents*

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Abstract

This paper studies how mental accounting of income and wealth affects consumption decisions in a heterogeneous agent environment with incomplete markets, idiosyncratic risk, and asset illiquidity. Mental accounting is formalized using elements from reference-dependence with loss aversion, and it offers a unified explanation of empirical facts about marginal propensities to consume (MPC) and the household distribution that elude standard models: the existence of poor, wealthy, and liquid hand-to-mouth; a spender-saver MPC distribution; realistic levels of aggregate MPC, wealth, return spread, and consumption; differential MPCs from dividends and capital gains; non-Ricardian intertemporal MPCs; and asymmetric MPCs with respect to different attributes.

JEL codes: D11, D14, D15, D31, D90, E21, E70.

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1. Introduction

A long-standing question in household finance and macroeconomics is: how does household consumption respond to income and wealth shocks? The answers to this question, that is the marginal propensities to consume (MPC), shed light on substantive macroeconomic issues: they help understand the transmission of stabilization policies to consumption (Kaplan, Moll, and Violante, 2018; Auclert, Rognlie, and Straub, 2024), and they inform the monetary policy response to stock market fluctuations (Cieslak and Vissing-Jorgensen, 2021).

To rationalize empirical estimates of MPCs and moments from the wealth distribution, the literature has proposed heterogeneous agent models with liquidity constraints and illiquid assets (e.g. Kaplan and Violante, 2022). The underlying idea is that, by disciplining these models empirically at the microeconomic level, they should produce better macroeconomic predictions. However, these theories are at odds with further facts about MPCs and other distributional moments: across levels of liquid assets; across levels of aggregation; for shocks from different sources; as well as in response to announcements and to past shocks.

In light of these difficulties, this paper asks whether the above facts can be explained by models featuring mental accounting of income and wealth (Shefrin and Thaler, 1988; Thaler, 1990). Under mental accounting, households treat income and assets as non-fungible resources, and they prefer to consume from their income but not from their assets. Using "behavioral models of preferences […] [with] loss aversion and mental accounting" is a legitimate approach to answering questions in household finance (Campbell, 2006). Empirically, this approach is justified also, as the non-fungibility of money is a well-documented phenomenon in household decision-making (Thaler and Imas, 2025). Moreover, behavioral biases add microeconomic discipline to heterogeneous-agent models, which has the potential to improve their aggregate predictions (Moll, 2020).

However, Shefrin and Thaler (1988) and Thaler (1990) rely on verbal descriptions of behavior; and beyond these treatments, mental accounting of income and wealth has received little attention from theorists, generating two limitations. First, mental accounting cannot be subject to proper empirical testing: whether it can actually rationalize empirical facts remains unknown.[1] Second, mental accounting cannot be compared with competing theories.

To overcome these challenges, this paper proposes a quantitative framework with mental accounting and household heterogeneity. Expanding on Thaler (1985; 1999), mental accounting

[1] A similar view is held by Baugh, Ben-David, Park, and Parker (2021): "[in] models of mental accounting […], predictions are generally limited, which has led to limited empirical testing".

is formulated combining the tools of prospect theory, in particular reference dependence and loss aversion (Kahneman and Tversky, 1979; Tversky and Kahneman, 1991; Köszegi and Rabin, 2006), with mental classification rules. The rest of the model is a partial-equilibrium environment with incomplete markets, idiosyncratic income risk, agent heterogeneity, and asset illiquidity that nests the workhorse incomplete-markets model.

In this setup, households partition their liquid resources and classify them into the 'income' or the 'asset' mental accounts, experiencing a psychological cost whenever they consume from their asset account. The main implications are twofold. First, the balances of both mental accounts pin down household choices and are, therefore, the individual state variables. Second, there is a wedge in marginal utility that modifies the standard intertemporal trade-off: the gain from increasing consumption is lower when it implies drawing down assets. Facing these marginal incentives, a non-trivial share of households optimally sets consumption equal to the balance of their income mental account. Intuitively, these hand-to-mouth households arise because they want to avoid dissaving.

By endogenously generating hand-to-mouth behavior, mental accounting provides a micro-foundation for the spender-saver theory (Campbell and Mankiw, 1989). The models generate a bimodal distribution of individual MPCs from an income transfer. In particular, one group of households are hand-to-mouth with an MPC of 100% ('spenders'), and the other group of households smooths consumption with a small MPC that is close to the annuity value of the windfall ('savers').

Across the household distribution, mental accounting induces hand-to-mouth behavior across the entire spectrum of liquid assets and income. This effect is especially noticeable among medium- and high-income households, whose income makes them satiated enough and who, as a result, do not mind foregoing some additional consumption. These households hold sufficient liquid assets, in line with the empirical evidence (see Section 4.1), and are therefore called the "liquid hand-to-mouth". In contrast, for low-income households with little to no liquidity, foregoing extra consumption is a 'luxury' that they cannot afford for long. For some of them mental accounting does amplify the MPC, while others present hand-to-mouth behavior as a result from being at or close to the liquidity constraint. Overall, the fraction of high-MPC households as well as the average MPC across the distribution is consistent with the available evidence (see Sections 4.2 and 4.3).

In the aggregate, mental accounting can solve the difficulties faced by both 1- and 2-asset models to fit with a macro calibration targeting the aggregate MPC and aggregate wealth without distorting the wealth distribution (see Section 4.4). As a result, the 1-asset model with

mental accounting constitutes a parsimonious alternative for macroeconomic analysis. As for the 2-asset model with mental accounting, it can match the shares of poor and wealthy hand-to-mouth, while avoiding an unrealistic return spread and the associated distortion of the aggregate consumption level. Moreover, the aggregate MPC is obtained with sizable contributions from households with both low and high levels of liquid assets, consistent with the microeconomic evidence on MPCs and in proportion to their population share.

While the properties discussed so far refer to shocks to the income account, shocks to the asset account trigger smaller consumption responses: MPCs are account-specific. In particular, the same liquid transfer can generate different MPCs depending on how it is mentally classified. Relatedly, a transfer between mental accounts is not neutral in terms of consumption, as the outflow from one account is not perfectly offset with the inflow into another account. These results break the fungibility and framing irrelevance properties of standard choice models. Moreover, these features in combination offer a rationalization of further empirical facts on MPCs from financial wealth, on intertemporal MPCs, and on MPCs from asymmetric shocks.

In the case of directly held stocks, households classify the capital gains in the asset mental account and the dividends in the income account, following available survey evidence. As a result, the model rationalizes that capital gains and dividends generate differential MPCs at the individual level, across the (liquid) asset distribution, and in the aggregate; as well as different MPC distributions – for dividends, bimodal with a spender-saver pattern, and approximately unimodal for capital gains (see Section 4.5). In addition, when capital gains are realized exogenously, they generate a substantially higher MPC than unrealized gains, in line with the empirical estimates.

As for the intertemporal MPC from a transitory income shock, mental accounting generates excess sensitivity while dampening both anticipation and lagged effects. Liquid assets play a limited role in smoothing consumption around the shock because households – both with low and high liquidity– are less prone to dissave. These predictions are in agreement with a number of empirical studies (see Section 4.6).

Finally, mental accounting modifies the asymmetry properties along several dimensions. The size and sign effects generated by liquidity constraints are dampened. Yet, at the same time, a richer set of shock attributes that are irrelevant through the lens of the standard model can trigger different mental classifications which, in turn, generate differential consumption responses. As a result, mental accounting can reconcile apparently contradictory pieces of evidence on asymmetric MPCs: that increasing the size of the shock reduces the MPC in some cases but not in others; and that negative shocks produce higher MPCs than positive shocks in

some cases but lower MPCs in others (see Section 4.7).

Literature. – This paper relates to several strands of the literature. First, the research on mental accounting studies how violations of the fungibility of money generate departures from standard choice models (Thaler, 1999). Applications include the evaluation of returns and trading in the stock market (Barberis and Huang, 2001; Frydman, Hartzmark, and Solomon, 2018; Hartzmark and Solomon, 2019; Shefrin and Statman, 1985), and the allocation of retirement savings (Choi, Laibson, and Madrian, 2009; Card and Ransom, 2011). In the realm of consumption, non-fungibilities appear in the uses and in the sources of funds. On the uses (Thaler, 1985), there is both empirical[2] and theoretical[3] work. On the sources (Shefrin and Thaler, 1988; Thaler, 1990; Shefrin and Statman, 1984)[4], there is also empirical evidence[5], but a full set of predictions is still missing. This paper attempts to fill part of that gap by solving quantitative models and evaluating them against the available empirical evidence.[6]

Second, since the advent of prospect theory (Kahneman and Tversky, 1979), a vast set of papers have applied reference dependence with loss aversion to understand both risky and riskless choices (Tversky and Kahneman, 1991; Köszegi and Rabin, 2006). These models use reference points that can be endogenous or exogenous, and the applications range from labor

[2] See Hastings and Shapiro (2013; 2018), Abeler and Marklein (2017), Milkman and Beshears (2009), Beatty et al. (2014).

[3] See Lian (2021), Köszegi and Matejka (2020), Galperti (2019), and Farhi and Gabaix (2019).

[4] Shefrin and Thaler's (1988) seminal paper also touches on other biases like self-control and temptation, which have been revisited in later work (Laibson, 1997; Gul and Pesendorfer, 2001; Fudenberg and Levine, 2006). There are two main conceptual differences between them and mental accounting of income and wealth. First, self-control and temptation capture overspending problems, whereas mental accounting is used to keep expenditures in check. Second, mental accounting introduces non-fungibility between liquid resources, a feature that is not present in models of self-control or temptation.

[5] See Baugh et al. (2021), Boehm et al. (2025), Baker et al. (2007), Di Maggio et al. (2020), Bräuer et al. (2022), among others.

[6] A paper by Graham and McDowall (2026) looks at MPCs under mental accounting, and it relates to this paper as follows. First, the formulation of mental accounting in both papers is isomorphic under certain conditions (see Online Appendix D), but here it is rooted in prospect theory and features explicit mental classification rules. Second, they derive an Euler equation which, by their assumption, only holds for choices anywhere but at the kink. (For the limitations that such approach imposes on their analysis, see Gimeno-Ribes, 2025b). In contrast, this paper proposes a characterization of incentives and optimal choices at the kink, it shows that such choices are relevant for quantitative model predictions, and it proposes an algorithm that efficiently handles the kink. Third, they consider a 1-asset model calibrated to liquid wealth; whereas this paper also studies mental accounting in a 2-asset environment, and the calibrations target aggregate wealth to address macroeconomic puzzles. Fourth, both papers focus on liquid households' average MPCs and on intertemporal MPCs, but they remain silent on other results that this paper reports, such as the spender-saver pattern of individual MPCs, the relationship between the aggregate MPC and other distributional moments, the account-specific MPCs and their application to dividends and capital gains, and the MPC asymmetries relating to mental classification.

Two more recent papers deal with mental accounting, but again restricted to a 1-asset environment. Mijakovic (2025) derives an Euler equation for a 2-period problem to gain insights on asymmetric MPCs; this paper differs in the characterization of incentives at the kink, and emphasizes the quantitative importance of mental classification to explain asymmetries. Pieroni and Violante's (2025) results on incentives at the kink, MPCs, and wealth distribution were already available in the first version of this paper, Gimeno-Ribes (2022), which they cite.

supply to asset pricing (for an overview, see O'Donoghue and Sprenger, 2018). Relying on this set of tools, this paper formalizes previous intuitions of mental accounting (Shefrin and Thaler, 1988; Thaler, 1990) and characterizes its effects on consumption and saving decisions.

Third, a growing literature introduces psychological biases in heterogeneous-agent models to study questions in household finance (Beshears et al., 2018) and macroeconomics (Moll, 2020). The closest papers have analyzed the incomplete markets model with a dual-system framework (Ilut and Valchev, 2023), with expectations-based reference dependence (Pagel, 2017), and with finite planning horizons (Boutros, forthcoming); as well as the interaction of illiquid assets with temptation preferences (Attanasio, Kovacs, and Moran, 2024), with present bias (Laibson, Maxted, and Moll, 2025), and with overconfidence (Pfäuti, Seyrich, and Zinman, 2024).[7] This paper takes a similar approach, but focuses on mental accounting.

Fourth, a set of papers use facts on MPCs and the wealth distribution to discriminate between competing heterogeneous-agent models. The closest work includes Kaplan and Violante (2014; 2022), Kaplan, Moll, and Violante (2018), Auclert, Rognlie, and Straub (2024), Campbell and Hercowitz (2019), Ilut and Valchev (2023), Boutros (forthcoming), Attanasio et al. (2024), Laibson et al. (2025), Pfäuti et al. (2024), Andre et al. (2025). This paper follows their lead, but differs from them along several dimensions. First, it focuses on a different friction – mental accounting– and shows that it can solve the known difficulties of the 1- and 2-asset models to match the aggregate MPC without making unrealistic predictions or assumptions about the asset distribution and the return spread, respectively (Kaplan and Violante, 2022). Second, mental accounting can rationalize other puzzles which have not yet been directly confronted with models relating to individual MPCs, the aggregate MPC contribution of liquid households, MPCs from dividends and capital gains among direct stockholders, or the level of consumption.

Outline. – The rest of the paper is organized as follows. Section 2 presents the model. Section 3 characterizes household behavior in the model, as well as its main properties in steady state. Section 4 carries out the quantitative analysis of MPCs and distributional moments in the model, discussing them jointly with the empirical evidence. Section 5 concludes.

2. Model

This section presents the model environment with mental accounting and household heterogeneity.

[7] Relatedly, Lian (2023), and Bianchi, Ilut, and Saijo (2024) introduce behavioral biases into representative-agent setups. Andre et al. (2025) propose a 1-asset model with costly optimization and rules of thumb.

2.1 Household Problem

Households choose consumption and savings to maximize:

$$E_0 \sum_{t=0}^{\infty} \beta^t U_t$$

subject to

$$c_{h,t} + b_{h,t+1} + d_{h,t}\mathbf{1}_{\{adj=A\}} = y_{h,t} + Tr_{h,t} + \left(1 + R_t^b\right)b_{h,t},$$

$$a_{h,t+1} = (1 + R_t^a)a_{h,t} + d_{h,t}\mathbf{1}_{\{adj=A\}},$$

$$a_{h,t+1} \geq 0,\ b_{h,t+1} \geq \underline{b},$$

where $c_{h,t}$ denotes consumption of household h at time t. Households receive transfers $Tr_{h,t}$ and labor earnings $y_{h,t} = (1 - \tau)z_{h,t}$, where z is labor productivity, and τ is the tax rate. Productivity follows a Markov chain whose transition matrix, with probabilities $\Pr(z_{h,t+1}|z_{h,t})$, is constant over time. The initial productivity distribution is set equal to the ergodic distribution of the Markov chain, such that it remains constant over time. The expectations operator E is taken over all possible productivity realizations, using the conditional probabilities above.

Savings can be allocated into two assets: b is liquid, pays net return R_t^b between periods t – 1 and t, and features a borrowing constraint $\underline{b} = 0$; a is illiquid, pays net return R_t^a between periods t – 1 and t, and features a short-sale constraint on it. Asset illiquidity is modelled as in Auclert, Rognlie, and Straub (2024) (for related setups, see Bayer, Born, and Luetticke, 2024; Kaplan and Violante, 2022). In particular, there is a financial friction whereby opportunities to participate in capital markets are random and i.i.d., creating two adjustment types *adj*. Each period, a fraction υ of households (*adj* = *A*, for Adjusters) can access all their asset holdings and can make a deposit $d_{h,t}$ into or out of the illiquid asset; the other fraction 1 – υ of households (*adj* = *NA*, for Non-Adjusters) have access to their liquid assets, but cannot make deposits into or out of the illiquid asset, such that the illiquid returns capitalize.

In the special case where the asset a yields the liquid return ($R_t^a = R_t^b$) and it can be adjusted by all households (υ = 1), the environment simplifies to the incomplete-markets model: households are indifferent between both assets, which can be folded into one liquid asset, b.

2.1.1 Mental Accounting

The idea that people are willing to consume 'within their income' and may even derive a

modest satisfaction from doing so is present in Adam Smith.[8] A complementary approach is taken in Shefrin and Thaler (1988), who assume that a negative feeling like guilt arises when consumption is higher than income.[9] In both of these views, income acts as a reference point, which is reminiscent of Keynes' consumption function. Moreover, in the spender-saver theory spenders are assumed to set consumption equal to income because "current income is the most salient piece of information available" (Mankiw, 2000).[10]

These elements are assembled into the model by means of two features. First, households classify their resources – a process also known as 'hedonic editing'– into two mental accounts with 'income' and 'assets' based on similarity and on how they plan to spend them (Shefrin and Thaler, 1988; Shefrin and Statman, 1984; Evers, Imas, and Kang, 2022). Second, households prefer to consume from their income account and not from their asset account (Shefrin and Thaler, 1988). The utility function, as advocated by Thaler (1999), uses the tools from prospect theory (Kahneman and Tversky, 1979) and reference dependence with loss aversion (Tversky and Kahneman, 1991; Köszegi and Rabin, 2006). I discuss these features next.

Classification. – Resources are classified into mental accounts as per the following rules:

$$y_m = y + div^y + Tr^y, \qquad y_m > 0$$

$$b_m = (1 + R^b)b - div^y + Tr^b, \qquad b_m \geq 0$$

$$Tr^y = f(Tr; attributes),$$

$$Tr^b = Tr - Tr^y.$$

The income account (y_m) includes labor earnings and dividends from directly held stocks, consistent with the fact that most stockholders view dividends as similar to salary or windfall income, as documented in Bräuer et al. (2022). The asset account (b_m) contains the holdings of (liquid) assets and the capital gains earned on them net of dividends. This mental classification

[8] In the *Wealth of Nations*, Smith (1776) makes a revealed preference argument: "Among our feudal ancestors, the long time during which estates used to continue in the same family sufficiently demonstrates the general disposition of people to live within their income." In the *Theory of Moral Sentiments* (Smith, 1790): "The methods of improving our fortune, which [Prudence] principally recommends to us, are […] frugality, and even some degree of parsimony, in all our expences. […] The man who lives within his income is naturally contented with his situation, which, by continual, though small accumulations, is growing better and better every day."

[9] Reasons for the adoption of mental accounts include the management of self-control problems (Shefrin and Thaler, 1988), social norms (Akerlof, 2007), choice simplification (Zhang and Sussman, 2018), and popular investment advice (Daniel et al., 2021). While delving deeper into the motives for using mental accounts is a line of research worth pursuing, it is beyond the scope of this paper.

[10] Income appears as a reference point in other contexts also. In job search decisions, DellaVigna et al. (2017) argue that "psychologically, recent paychecks are a plausibly salient comparison point". In labor supply decisions, Crawford and Meng (2011) find that individuals use their expectation of daily income as a reference point.

is consistent with further evidence that investors separate dividends and capital gains into different mental accounts (Hartzmark and Solomon, 2019; Daniel et al., 2021). In turn, transfers present different attributes, whose similarity to income or assets determines the share accruing to either account (Tr^y and Tr^b, respectively), as discussed further in Section 4.

Utility Function. – Utility in period *t* is:

$$U(c_t|r_t) = \begin{cases} u(c_t) + \eta[u(r_t) - u(c_t)] & \text{if} \quad c_t \leq r_t \\ u(c_t) + \eta\lambda[u(r_t) - u(c_t)] & \text{if} \quad c_t > r_t \end{cases},$$

where c_t and r_t denote, respectively, the consumption and the reference point of household h in period t (the sub index h is dropped to ease notation). Utility consists of the "intrinsic" consumption utility $u(c_t)$, and gain-loss utility $u(r_t) - u(c_t)$, where $u(\cdot)$ is an increasing and concave function with constant relative risk aversion. If consumption is below or at the reference point ($c_t \leq r_t$), the household derives gain utility $u(r_t) - u(c_t) > 0$ with weight η, where $0 \leq \eta < \frac{1}{\lambda}$. If consumption is above the reference point ($c_t > r_t$), the household derives loss utility $u(r_t) - u(c_t) < 0$ with weight $\eta\lambda$, where $\lambda > 1$ is the loss aversion parameter.

The reference point is household-specific, i.e. heterogeneous, and equal to the balance of the 'income' mental account, $r_t = y_{m,t}$. This balance is salient as it defines the budget for consumption that households would like to stay within. Intuitively, households experience contentment when they consume 'within their income'; and they experience a relatively larger guilt when they dissave. At $c = y_m$, the utility has a non-differentiability point, or kink:

$$\lim_{c \to y_m^-} \frac{\partial U(c|r)}{\partial c} = (y_m)^{-\gamma} * (1 - \eta) \qquad \text{and} \qquad \lim_{c \to y_m^+} \frac{\partial U(c|r)}{\partial c} = (y_m)^{-\gamma} * (1 - \eta\lambda),$$

with a downward jump in marginal utility of size $\frac{1-\eta\lambda}{1-\eta}$, which governs the strength of mental accounting. The standard model is nested as a special case when $\eta = 0$ (see Figure 1).[11]

2.2 Calibration

The calibration is summarized in Table 1. The model period is one quarter. Idiosyncratic income follows an AR(1) process, with an autoregressive coefficient of 0.9657 for log wage risk and an unconditional standard deviation of 0.92 (Auclert et al., 2024), discretized on a Markov chain with 21 states. The income tax rate is 33% and steady-state transfers are zero.

[11] The reference point is an indicator of "the decision maker's current position" and the loss domain is defined when assets decrease, which are consistent with reference dependence (Tversky and Kahneman, 1991).

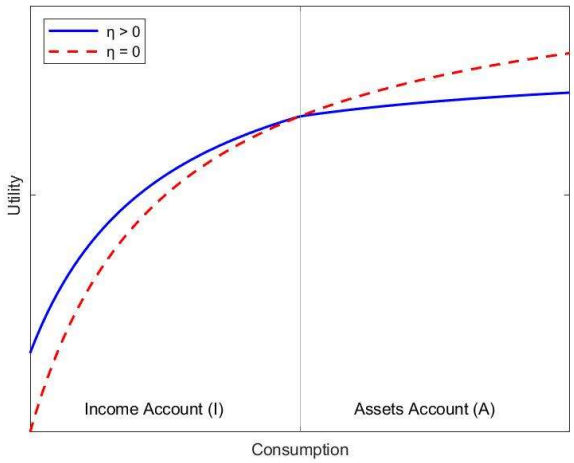


Figure 1. Utility function with mental accounting ($\eta > 0$) and with standard form ($\eta = 0$).

As for the returns on wealth, in the 1-asset model the (annual) real interest rate is 1.7%. In turn, in the 2-asset environment the (annual) interest rate on the liquid asset is –2%; and three different return spreads are considered. First, 8.2%, as proposed in Kaplan and Violante (2022), despite being admittedly too high, to match the aggregate MPC. Second, 3.8%, as estimated in Kaplan and Violante (2014). However, in that estimation the majority of the housing return comes from imputed rents, whereas an alternative view argues that housing yields meager returns (Shiller, 2015) and that the 2-asset model should reflect that (see, for instance, Alan Blinder's comments in Kaplan, Violante, and Weidner, 2014). Thus, in the third case, housing offers a 1% excess return over liquid wealth, which using the portfolio composition from Kaplan and Violante (2014, Table III) gives a return spread of 2.25%. In both environments, dividends are zero in steady state.

In the 2-asset environment, the probability of portfolio adjustment is 9% to generate realistic shares of poor and wealthy hand-to-mouth.

Preferences are calibrated as follows. The risk aversion coefficient is set to 1. The discount factor is calibrated to match a ratio of total assets to annual pre-tax income of 4.1 (Kaplan and Violante, 2022). As is standard in the reference-dependence literature, the loss aversion parameter λ is set to 2.5; whereas the weight of the gain-loss utility η, and thereby the mental accounting friction, is calibrated to match an aggregate MPC of 25%.

2.3 Implications for Recursive Problem

The timeline within a model period is as follows. First, households receive resources in the form of a shock to idiosyncratic income, returns on assets, dividends, and transfers. Second, households classify these resources into the mental accounts according the rules discussed above. Third, households make the decisions to consume and save.

Table 1. Calibration

Frequency	Quarter		Quarter				
Preferences							
η (gain-loss utility)	0	0.1497	0	0	0	0.0769	0.0996
λ (loss aversion)	2.5				2.5		
β (discount factor)	0.9904	0.9917	0.9803	0.9911	0.9949	0.9916	0.9956
γ (risk aversion)	1				1		
Financial Markets							
number of assets	1				2		
υ (probability of adj.)	-				9%		
R^b (liquid rate of return)	1.70%[b]				- 2.00%[a]		
R^a (illiquid rate of return)	-		6.20%[a]	1.80%[b]	0.25%	1.80%	0.25%
Income Process							
ρ (persistence)	0.9656				0.9656		
σ (std. dev.)	0.92				0.92[c]		
τ (income tax rate)	0.33				0.33		
Wealth Target							
Assets / ann. income	4.10				4.10[a]		

[a]Kaplan and Violante (2022).
[b]Kaplan and Violante (2014).
[c]Auclert, Rognlie, and Straub (2024).

Households face a liquid return and a borrowing constraint expressed in terms of liquid wealth b because these are features of the liquid saving technology. That information is subsumed into the mental liquid balance b_m, as it is a deterministic function of the "physical" balance b. Household choices depend on how liquid resources are mentally classified, hence the balances of mental accounts (y_m, b_m) are state variables of the individual problem.

The recursive problem with the optimality conditions, as well as the algorithms to solve the household problems, are in Online Appendices A and B, respectively.

3. Optimal Behavior and the Steady State

This section starts by characterizing optimal behavior in the model and then it discusses the effects of mental accounting on consumption and wealth accumulation in steady state.

3.1 Optimal Behavior with Mental Accounting

An organizing framework is provided by the first-order condition (FOC):

$$\frac{\partial}{\partial c}U(c|r) = \mu + \beta E\left[\frac{\partial}{\partial b}V(y'_m, b'_m, a', adj')\right] \text{ for } adj = NA, A, \ \forall\, c \neq y_m, \ \nexists \frac{\partial}{\partial c}U(y_m|r),$$

where V is the value function, the prime characterizes next-period variables, and μ is the Lagrange Multiplier associated with the liquidity constraint.

Based on this FOC, three main types of households emerge. First, those who trade off the marginal utility of current consumption with the marginal value of future liquid asset holdings. Second, households for whom the liquidity constraint binds ($\mu > 0$). Third, households who optimally consume their mental income balance.

In the latter case, the intertemporal tradeoff is modified by a wedge between the marginal utilities of increasing and decreasing consumption, making utility non-differentiable. The absence of a one-to-one mapping between marginal utility and consumption implies that the standard FOC cannot pin down current consumption.[12] Instead, to understand marginal incentives and choices, one requires the generalized derivative of utility, which includes the derivatives from the right and from the left, as follows.

PROPOSITION 1. *Mental accounting induces hand-to-mouth behavior ($c^* = y_m$) if the following condition holds:*

$$\lim_{c \to y_m^-} \frac{\partial U(c|r)}{\partial c} > \beta \frac{\partial}{\partial b} E[V(y'_m, b'_m, a', adj')] > \lim_{c \to y_m^+} \frac{\partial U(c|r)}{\partial c}, \quad \text{for } adj = NA, A.$$

Proof. Assume $c = y_m$. Consider a positive and infinitesimal deviation in consumption. As per the second inequality, the marginal utility of increasing consumption is smaller than the corresponding marginal cost of decreasing next period's liquid assets. Now consider a negative and infinitesimal deviation in consumption. As per the first inequality, the marginal disutility of decreasing consumption is larger than the marginal benefit of increasing next period's liquid assets. Neither deviation makes the household better off, hence it is optimal to set consumption equal to the balance of the income mental account. Q.E.D.

3.2 Mental Accounting in Steady State

Consumption. – The marginal incentives faced by households and the consumption choices that result, $C(y_{m,i}, b_{m,i})$, are shown in Figure 2 for the 1-asset case, which is discussed first for expositional clarity. For many households the FOC applies and, for a given level of income, consumption increases with liquid assets. But when Proposition 1 holds, the wedge in marginal

[12] A standard Euler equation of the form $U_c(c_t|r) = \beta E_t[U_c(c_{t+1}|r)]$ is not appropriate either, as $c = y_m$ corresponds to two values of U_c (where U_c denotes $\partial U(c|r)/\partial c$).

utilities creates a departure from consumption smoothing: a flat region where consumption is equal to income and any interest on assets is saved, as long as asset holdings remain within that region. Intuitively, when these households are about to increase consumption above income, mental accounting reins in their desire to do so: they are better off foregoing the extra consumption than suffering the psychological cost of dipping into the asset account.

Such hand-to-mouth behavior appears across the state space: a higher (lower) income is associated with a pair of lower (higher) marginal utilities that intercept a flatter (steeper) value function, which corresponds to more (less) liquid resources. However, this effect on choices is more pronounced among households in the upper half of the income distribution and with high liquidity (Panels A and B), and less so among households in the lower half of the income distribution and low liquidity (Panels C and D). Intuitively, the former are more satiated and thus more willing to keep consumption within their income. Yet, for the latter, 'living within their income' is a luxury that they cannot afford for long, as it would leave them non-satiated; hence, they start consuming their assets after they hold just some.

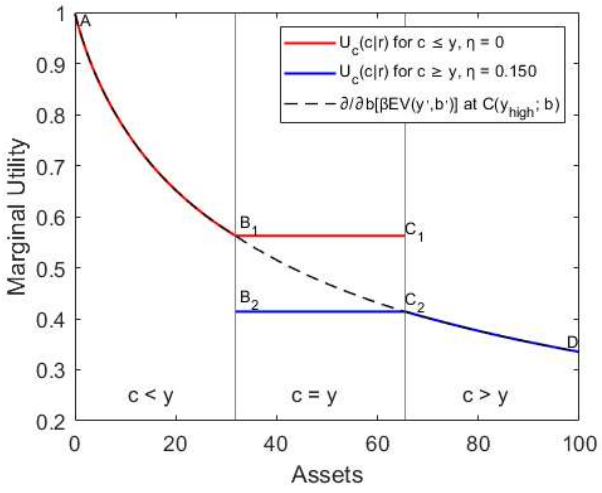
That being said, not all medium-to-low income, low-liquidity households are hand-to-mouth *because* of mental accounting. If Proposition 1 does not hold, their consumption choices can be driven by the liquidity constraint instead. Thus, two different mechanisms for hand-to-mouth behavior coexist in the model.

These properties carry over to the 2-asset environment (see Online Appendix C), especially to the household decisions about accessible resources. The relationship is most clearly visible in the Non-Adjuster type, who solves a 1-asset problem with an inaccessible illiquid asset; but it is also noticeable in the Adjuster problem, where all assets become temporarily accessible.[13]

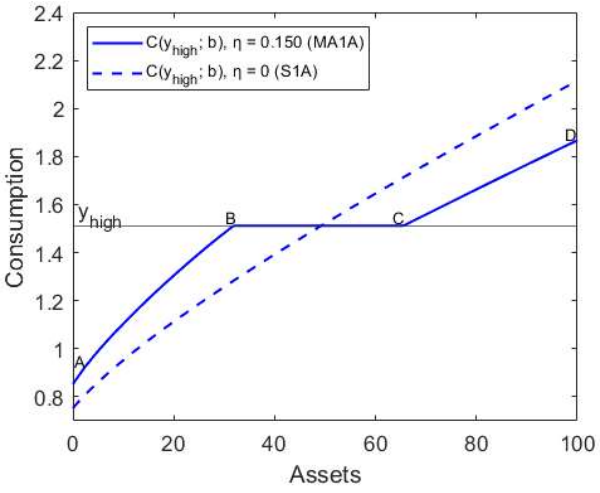
Here again, low-liquidity households, either with zero or with positive illiquid holdings, behave in a hand-to-mouth way due to different mechanisms: for some, mental accounting dominates; for others, a (likely to be) binding constraint operates instead. Moreover, the effect of mental accounting depends on the level of illiquid assets, as per Proposition 1: households with higher (lower) illiquid wealth are more (less) satiated, their value functions are flatter (steeper) and hand-to-mouth behavior arises at lower (higher) liquid assets.[14]

[13] While both assets become accessible for the Adjuster in the current period, the two assets still have different liquidity properties in future periods. To avoid confusion with the term 'liquid', 'accessible' is used instead.

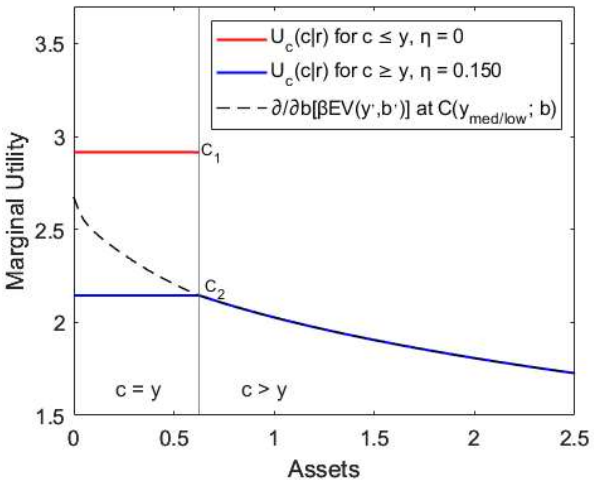
[14] Note the parallels between the mental accounting and the asset illiquidity friction. Each of these frictions restrict the otherwise free access to resources held, respectively, in the asset mental account and in the illiquid asset. Hand-to-mouth behavior arises when households are "up against" each friction, which in both cases occurs mostly among medium to high income households who are satiated enough to be willing to set consumption equal to income. However, their available liquid assets may differ: with mental accounting, hand-to-mouth households have consumed their income; whereas with asset illiquidity, the hand-to-mouth household has to, in addition, have depleted its liquid assets in a previous period, either by consuming them or by investing them in the illiquid asset.



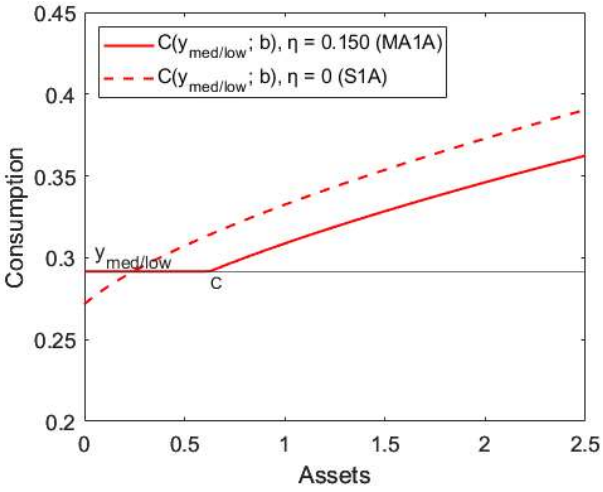
Panel A: Marginal incentives, 'high' income.



Panel B: Policy function, 'high' income.



Panel C: Marginal incentives, medium/low income.



Panel D: Detail of pol. fun., medium/low income.

Figure 2. Effect of mental accounting across levels of income: 'high' and 'medium-low' income states correspond to the 87-94th and to the 25-41st percentiles of the income distribution.

Wealth Accumulation. – With mental accounting households have a preference against dissaving and they draw down their liquid savings less to smooth consumption around shocks. But because of rational expectations, households anticipate the lower need of savings in the future and hence accumulate less liquid wealth. Intuitively, mental accounting reduces the role of liquid savings as insurance against idiosyncratic income fluctuations that is present in the standard 1-asset model, thereby requiring a slightly higher discount factor to match the same wealth target (see Table 1). Similarly, in a 2-asset environment mental accounting reduces the insurance value of the liquid asset, tilting the portfolio towards the illiquid asset.

These properties are more marked the higher the strength of mental accounting, up to a limit: when $\eta = 1/\lambda$. In this case, utility is flat for $c > y_m$ such that households have no incentive to consume more than income. Hence, households save all returns on wealth in the 1-asset model;

as a result, the wealth distribution is unbounded and aggregate wealth goes to infinity, so a fixed point of the problem does not exist. In the 2-asset case, because households never consume more than their income, the liquid asset is never used to smooth consumption and loses all its consumption insurance value; as a result, households invest all their savings in the illiquid asset, the wealth distribution is unbounded, and a fixed point of the problem does not exist. Hence, $\eta = 1/\lambda$ is excluded from the admissible range of values of η.

4. Marginal Propensities to Consume

Having discussed the main steady state properties, this section presents the model MPCs from various transitory shocks together with other distributional moments, and evaluates them against the empirical evidence. A summary is provided in Table 2. The MPC is computed as the consumption change from a windfall T with respect to the steady state. Unless stated otherwise, the transfer is distributed uniformly to all households, it is unexpected, it is labeled as 'income', and it is worth \$500. For household h, the MPC is:

$$MPC_h^y = \frac{C(y_m + T, b_m, a, adj) - C(y_m, b_m, a, adj)}{T}.$$

4.1 Hand-to-Mouth Households

This section considers various definitions of hand-to-mouth households (HtM) to capture the different mechanisms operating in the model.

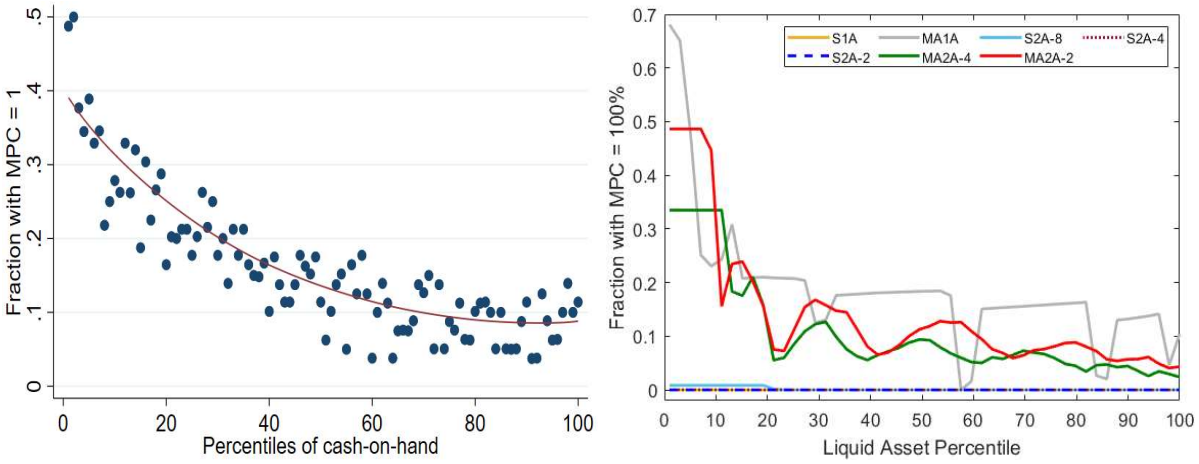
Poor and Wealthy Hand-to-Mouth. – Following Kaplan and Violante (2014; 2022), the poor HtM are the households whose liquid assets are equal to or less than half their pay-period earnings and who hold no illiquid assets; in turn, the wealthy HtM are the households who satisfy the same condition for liquid assets as the poor HtM and hold positive illiquid assets. The corresponding estimates, based on data from the Survey of Consumer Finances (SCF), are that: (i) the sum of poor and wealthy HtM represent a share of 17.5-35% of all households and (ii) 7-26% of households are wealthy HtM; in a later wave of the SCF, the estimate is a 14% share of poor HtM and a 27% share of wealthy HtM. Note that these shares of poor and wealthy HtM are robust across many countries (Kaplan, Violante, and Weidner, 2014). In turn, in the 1-asset model, the poor HtM are households whose wealth is equal to or less than half their pay-period earnings, and the corresponding estimate is a 4-14% share of poor HtM in terms of net worth, which is the empirical counterpart of wealth in the 1-asset model.

Table 2. Empirical Facts vs. Model Predictions – Summary

Empirical Fact		**Model Prediction**						
Name	*Value*	*S1A*	*MA1A*	*S2A-8*	*S2A-4*	*S2A-2*	*MA2A-4*	*MA2A-2*
Share of poor HtM	4-14 / 3.5-21%[1]	6.1%	6.8%	10.3%	8.2%	8.7%	9.2%	9.2%
Share of wealthy HtM	NA / 7-28%[1]	N/A	N/A	30.7%	15.8%	8.7%	17.9%	11.4%
Liquid HtM (existence)	Y	N	Y	N	N	N	Y	Y
Share of individual MPC = 100%	8-16%	0%	18.7%	0.2%	0%	0%	10.6%	14.0%
Spender-saver (Yes/No: MPC in %)	Y: ~0/100	N	Y: ~0/100	Y: ~0/50	N	N	Y: ~0/100	Y: ~0/100
High MPCs across liquid deciles	Y	N	Y	N	N	N	Y	Y
High-income HHs: high avg. MPCs	Y	N	Y	Y/N	N	N	Y	Y
Liquid HHs: contrib. aggr. MPC	14.5-20.7pp	2.4pp	19.8pp	4.5pp	3.7pp	3.1pp	10.0pp	12.9pp
Aggregate MPC	25%	3.7%	25.0%	17.9%	9.6%	6.9%	25.0%	25.0%
Total wealth / income	4.10	4.10	4.10	4.10	4.10	4.10	4.10	4.10
Return Spread (liquid vs. Illiquid)	3.8-2.25%	(3.8%)	(3.8%)	8.2%	3.8%	2.25%	3.8%	2.25%
Median net worth / mean income	1.56	2.09	2.15	1.15	1.55	1.65	1.53	1.65
Mean liquid wealth / income	0.56	N/A	N/A	0.73	0.81	0.93	0.74	0.83
Mean consumption / income	0.79-1.02	1.10	1.10	1.27	1.06	0.98	1.07	0.99
Dividends: aggr. MPC	24.6%	0%	21.3%	0%	0%	0%	10.7%	13.1%
Dividends: bimodal MPC	Y: ~0/100	N: 0/0	Y: ~0/100	N: 0/0	N: 0/0	N: 0/0	Y: ~0/100	Y: ~0/100
Div.: avg. MPC at liquid quintiles	10.6-25.3%	0%	18-29%	0%	0%	0%	7-15%	9-18%
Cap. gains (fin.): agg. MPC (ann.)	12.9%	9.1%	7.4%	30.7%	17.4%	12.9%	16.1%	11.6%
Cap. gains (fin.): unimodal MPC	~Y	~Y	~Y	~Y	~Y	~Y	~Y	~Y
Real. cap. gains (fin.): agg. MPC	10.6%	0%	18.6%	0%	0%	0%	7.4%	9.0%
Housing cap. gains: agg. MPC (ann.)	3-7%	10.9%	8.5%	7.9%	7.0%	6.8%	6.3%	5.8%
iMPC: anticipation effects	0-2%	2.8%	1.8%	7.7%	5.4%	4.2%	4.2%	3.1%
iMPC: impact effects	15-35%	3.5%	25.0%	16.7%	9.0%	6.5%	24.6%	24.8%
iMPC: lagged effects	0-3%	3.2%	1.7%	10.8%	6.8%	5.3%	4.2%	3.0%
Agg. MPC 1T / 9T	25% / 24%	3.7 / 3.1%	25 / 25%	18 / 11%	10 / 6%	7 / 5%	25 / 17%	25 / 19%
Agg. MPC 1mth inc: windfall / bonus	19.6 / ~0%	3.6 / 3.6%	25 / 2.7%	15 / 15%	9 / 9%	7 / 7%	22 / 8%	23 / 6%
Agg. MPC 1mth inc: gain / loss	19.6 / 23.8%	3.6 / 6.6%	25 / 21%	15 / 33%	9 / 19%	7 / 14%	22 / 27%	23 / 25%
Agg. MPC tax: refund / payment	13.3 / -0.7%	3.8 / 6.1%	25 / 6%	17 / 30%	10 / 16%	7 / 12%	25 / 18%	25 / 13%

[1]The two ranges correspond to the 1- and 2-asset models, respectively. In the latter environment, the sum of poor and wealthy HtM is estimated between 17.5% and 41%.

Note. The supporting evidence is cited in the text. Model names contain return spreads rounded to the nearest unit.



Panel A. Evidence (Jappelli and Pistaferri, 2020). Panel B. Model predictions.

Figure 3. Fraction of households with MPC=100% across liquid assets: estimates vs. model predictions.

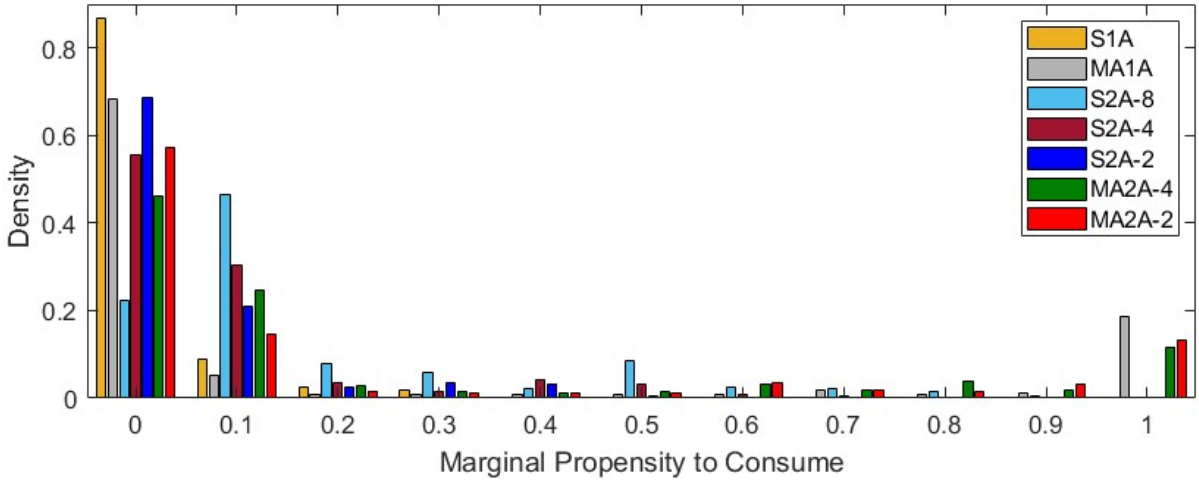


Figure 4. Histogram of MPCs from income.

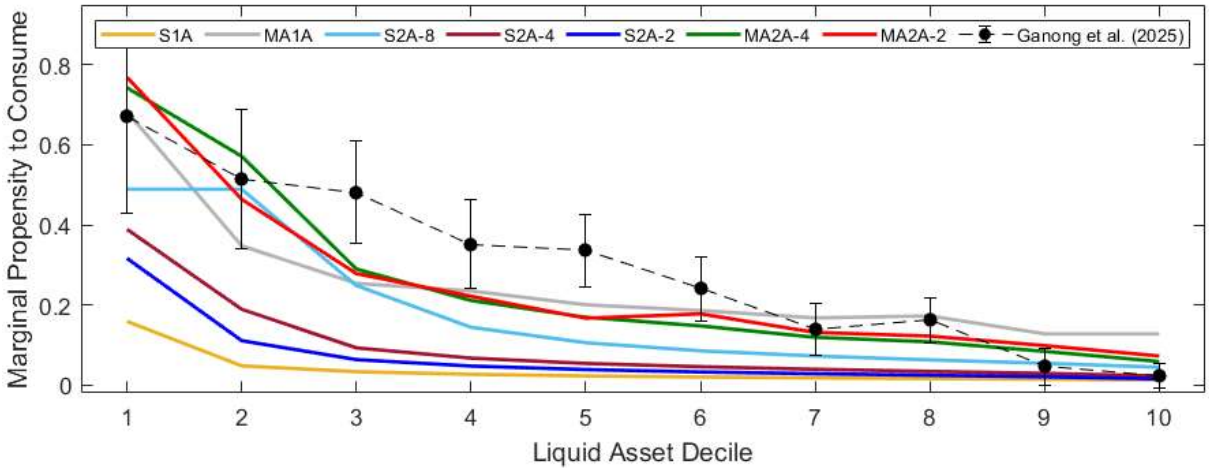


Figure 5. MPC averages across liquid asset deciles: estimates vs. model predictions.

These shares are matched by the 2-asset model with all three return spreads. In the mental accounting models with a 3.8% (MA2A-4) and with a 2.25% (MA2A-2) spread, the shares are within the empirical range. In turn, in the 1-asset model with both preference specifications (S1A, MA1A) the share of poor HtM is also consistent with the estimates.

Liquid Hand-to-Mouth. – The liquid HtM are the households whose liquid assets are more than half of their pay-period earnings, and who display an MPC that is above the annuity value of the windfall. The empirical literature has documented high MPCs among households with positive holdings of liquid wealth[15] as well as with medium to high income levels[16].

These estimates are a challenge for standard models, where hand-to-mouth behavior arises for low levels of liquid holdings: in the 1-asset case, coinciding with low income; and in the 2-asset case, either with low income for the poor HtM or with medium income for the wealthy HtM. With mental accounting, liquid HtM households do arise across levels of income and liquid assets; but they coexist with non-HtM households with similar levels of income and assets, in line with the evidence in Misra and Surico (2014).

Because evidence on the liquid HtM exists at different levels of aggregation, individual-level estimates are discussed here whereas later sections address (sub-)sample estimates.

Individual MPC^y of 100%. – Finally, I consider households with an individual MPC of 100%. Kueng (2018) measures an average MPC close to 100% in a 12% share of the population (his Table V). Andre et al. (2024) find an MPC of 100% in 14% of the households for a $500 transfer. Misra and Surico (2014) obtain MPC point estimates that are not statistically different from 100% for 16% of households (their Figure 1). Boehm et al. (2025) report a positive share of households with an MPC of 100% across different experiments.

Such high individual MPCs elude the standard 1- and 2-asset models entirely (Table 2). The closest is the 2-asset model, which generates MPCs of around 50% in roughly 10% of the households. In contrast, mental accounting generates individual MPCs of 100% when Proposition 1 holds before and after receiving the transfer. In particular, the models produce such prediction for 8-20% of households, broadly consistent with the reported estimates.

Joint evidence of individual MPCs of 100% and of liquid hand-to-mouth (from Jappelli and Pistaferri, 2020) is reproduced in Figure 3 Panel A. In particular, the fraction of households with an MPC of 100% is positive across the spectrum of liquid assets and, despite the scatter,

[15] See Bräuer et al. (2022); Baugh et al. (2021); Kueng (2018); Olafsson and Pagel (2018); Misra and Surico (2014); Fagereng, Holm, and Natvik (2021); Jappelli and Pistaferri (2020); Debortoli and Galí (2025).
[16] See Bräuer et al. (2022); Kueng (2018); Olafsson and Pagel (2018); Misra and Surico (2014); Sahm, Shapiro and Slemrod (2010); Shapiro and Slemrod (2003).

it presents a declining trend. Such a pattern only obtains in models with mental accounting (see Panel B), with the MA2A-2 and MA2A-4 performing best among them.

In this and in coming empirical evaluations of the model, the evidence based on measures of liquid wealth is more directly comparable with the 2-asset model; but it also speaks to the model mechanisms in the 1-asset environment because the savings vehicle is liquid. Alternatively, the MA1A can be interpreted as generating high MPCs for positive levels of net worth, consistent with the evidence of high MPCs among homeowners without mortgage debt (Misra and Surico, 2014) and among the wealthy HtM (Kaplan, Violante, and Weidner, 2014); however, such comparison can mask the role of low liquidity in generating high MPCs.

4.2 MPC Bimodality and the Spender-Saver Theory

Besides the households who consume a large portion of the transfer, empirical studies have found that another fraction of households consume very little from it, if at all – a pattern conceptualized as the spender-saver theory (Campbell and Mankiw, 1989). In recent work, Misra and Surico (2014) find a "bimodal" MPC distribution, where about half of the households have an MPC close to zero, whereas a substantial share of households has an MPC over 50%; Coibion, Gorodnichenko, and Weber (2020) and Andre et al. (2025) find that many households bunch at MPCs of 0% and 100%; Boehm et al. (2024) find sizable shares of households with 0% and 100%, albeit also at intermediate values.

A histogram of individual MPCs across models is shown in Figure 4. The standard 2-asset model generates a bimodal distribution, although with MPCs of 50% as already noted, and only for an 8.2% spread. For more realistic spreads, the distribution is no longer bimodal; and neither is it in the standard 1-asset model. In contrast, with mental accounting the MPC distribution becomes markedly bimodal both in the 1- and in the 2-asset environments. Most households behave dichotomously as either Keynesian hand-to-mouth consumers with an MPC of 100% – 8-20% of households, depending on the model–, or savers, whose MPC is approximately equal to the annuity value of the windfall (see also Table 2).[17] There is also a small share of households spread out around intermediate values of MPCs. Because such bimodal distribution arises endogenously in the model, mental accounting offers a micro-foundation for the spender-saver theory.

[17] The literature sometimes refers to these 'saver' households as 'PIH consumers'. However, in the revision of his Permanent Income Hypothesis, Friedman (1963) explicitly stated that households discount 'windfalls' over a horizon of three years with a "subjective rate" of one third, which corresponds to a first-year MPC of around 33%. Hence, and to avoid confusion, I use the term 'saver'. For more on this topic, see Carroll (2001) and Thaler (2015).

4.3 Average MPCs Across the Distribution

Looking at the next level of aggregation, Figure 5 compares the average MPC obtained at liquid asset deciles in the models with the evidence on 3-month MPCs in Ganong et al. (2025). Standard models with more realistic returns on wealth (S2A-4, S2A-2, S1A) are inconsistent with the evidence except in deciles 9-10, where the estimates are low and do not discriminate between models. In turn, S2A-8 generates higher MPCs up to decile 4 because the combined shares of poor and wealthy HtM amount to 43.4%; beyond decile 5, the MPC is still higher than in other standard models because the MPC is approximately the annuity value of the windfall, which is higher due to the unrealistic higher returns on wealth.

In comparison, mental accounting pushes the MPC up across levels of liquid assets, owing to the presence of high-MPC households documented in Section 4.1. As a result, all three mental accounting models perform significantly better than their standard counterparts: they are not only consistent with the declining trend of MPCs, but they are also quantitatively much closer to the empirical estimates from Ganong et al. (2025) – albeit somewhat lower, since the point estimates at liquid deciles sum to an MPC of 29.7% whereas the model is calibrated to 25%.

4.4 Aggregate MPC and Distributional Moments

This section turns to the next level of aggregation and evaluates the models based on the empirical facts on the aggregate MPC and on other moments from the household distribution.

4.4.1 Challenges of the 1-asset Model

The standard 1-asset model has a known difficulty in matching simultaneously the aggregate MPC, the aggregate wealth-to-income ratio, and the median level of wealth (Kaplan and Violante, 2022), thereby compromising its suitability for macroeconomic analysis. When the discount factor is calibrated to match the aggregate wealth, the model predicts a small aggregate MPC (Table 2); conversely, when the discount factor is calibrated to match a realistic aggregate MPC, the model only matches the liquid wealth in the economy, abstracting from 92-98% of total wealth. The literature has proposed to overcome this challenge by adding discount factor heterogeneity, but this produces a polarized asset distribution with a "missing middle" problem: the model severely understates, by at least one order of magnitude, the amount of wealth held by the median household.

Mental accounting generates a high enough share of hand-to-mouth households to match an aggregate MPC of 25% (see Figure 6 Panel A). At the same time, the discount factor is an

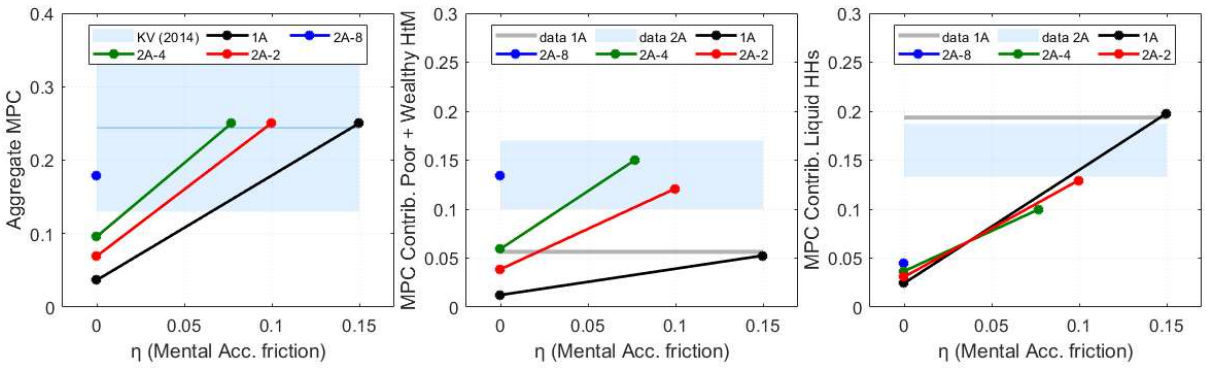
additional degree of freedom that is calibrated to match the aggregate wealth-to-income ratio of 4.1. Moreover, mental accounting does not distort the wealth distribution and does not suffer from the missing middle problem (Figure 7 Panels C and D). In particular, the ratio of median wealth to annual earnings is 2.09 in S1A and 2.15 in MA1A, compared to the data point of 1.56 (Kaplan and Violante, 2022): this difference reveals a moderate overstatement of median wealth, as opposed to the severe understatement that characterizes the 'missing middle problem'.

Moreover, the aggregate MPC should be consistent with the evidence at lower levels of aggregation. The contribution to the aggregate MPC of low-liquidity vs. high-liquidity households is given by the respective average MPC times the population share of each group. In the 1-asset case, it is approximately the case that the lowest decile of the wealth distribution can be classified as poor HtM, whereas the other deciles are not. Using the MPCs estimates across liquid asset deciles from Ganong et al. (2025), and scaling them such that the sum amounts to 25%, the contribution of the poor HtM (approximately the first decile), is 5.6pp and that of the liquid households is 19.4pp. Alternatively, one could use MPC estimates in terms of net worth obtained for poor HtM and for wealthy households (Kaplan, Violante, and Weidner, 2014). After scaling them up to 25% (the sum of the estimates is 20.5%), the contribution of the poor HtM is 3.8pp and that of the wealthy households is 21.2pp – which are very similar to the estimates based on liquid assets. These contributions cannot be matched by the S1A, but they are consistent with the MA1A model (Figure 6 Panel C).

4.4.2 Challenges of the 2-asset Model

Although it was proposed to overcome the aforementioned shortcomings of the standard 1-asset model (Kaplan and Violante, 2014; 2022), the 2-asset model faces some challenges of its own.

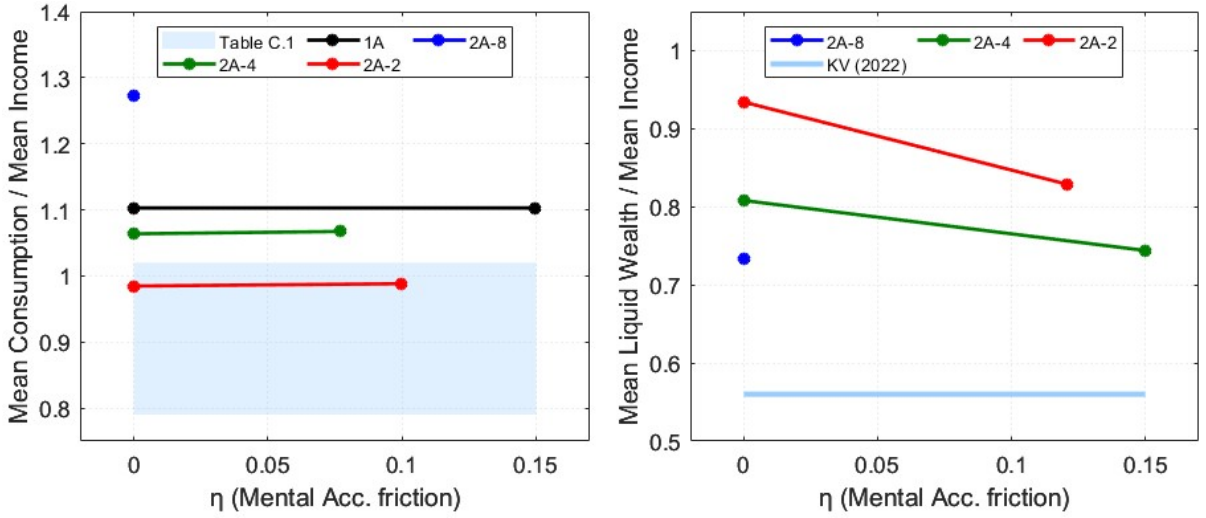
The 2-asset model calibrated to match the aggregate wealth has a difficulty in generating a realistic aggregate MPC and a realistic return spread. Kaplan and Violante (2022) propose an 8.2% spread, although it is unrealistically high, to generate a large enough MPC (17.9%). Otherwise, with lower spreads of 3.8% and 2.25% spread, the aggregate MPC goes down respectively to 9.6% and 6.9% (see Table 2), both of which are below the 'minimum' acceptable threshold of 15% and even further below the 25% benchmark (Kaplan and Violante, 2022; 2014).



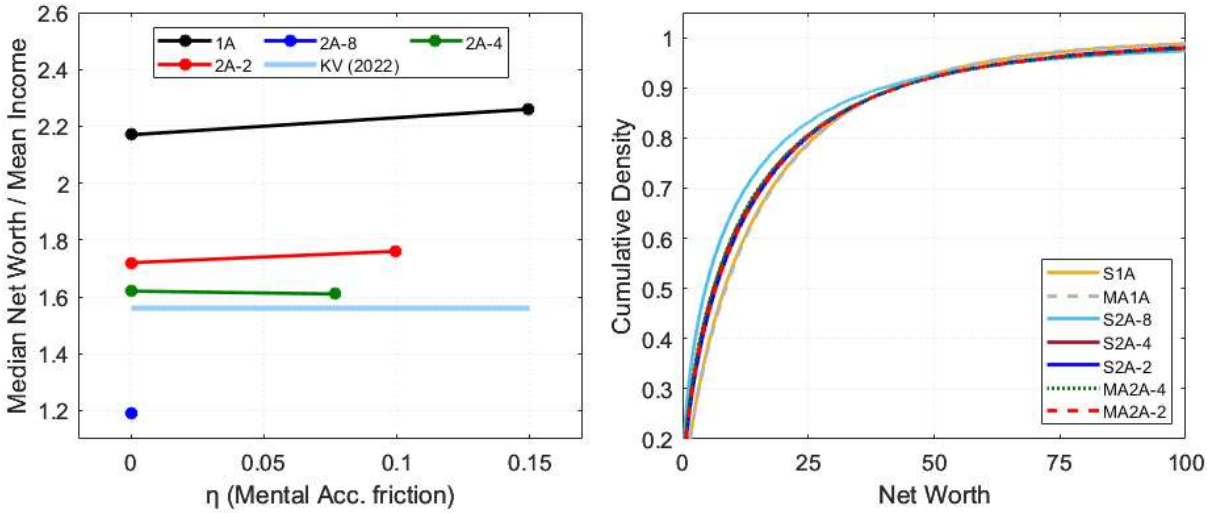
Panel A: Aggregate MPC. Panel B: Poor & Wealthy HtM. Panel C: Liquid households.

Figure 6. Aggregate MPC and contributions from households with low and sufficient liquidity across models.

Note: KV (2014) stands for Kaplan and Violante's (2014) preferred estimate. The data in Panels B and C are based on the author's calculations: for more details, see text.



Panel A: Consumption-income ratio. Panel B: Liquid wealth-income ratio.



Panel C: Median Net Worth. Panel D: Net Worth Distribution.

Figure 7. Distributional moments across model environments.

Note: KV (2022) stands for Kaplan and Violante (2022); for more details, see text.

The 8.2% return spread has an additional problem: it generates an unrealistically high level of aggregate (mean) consumption (see Figure 7 Panel A). In particular, a given wealth-to-income calibration target entails that the higher returns on wealth have to be consumed in order to make the budget constraint hold in steady state; hence, the lower discount factor (see Table 1). Quantitatively, the consumption-to-(after-tax)-income ratio is 1.27, well above the empirical estimates between 0.79 and 1.02 (see Online Appendix C); in turn, with a 3.8% spread the ratio is still too high (1.06), and it only comes down to a plausible level with a 2.25% spread (0.98). However, a high return spread was assumed in the first place to match the aggregate MPC and thus to improve the accuracy of aggregate consumption responses to shocks. But if the model overstates the steady state level of consumption, then it will likely generate counterfactual consumption fluctuations resulting from shocks, thereby potentially limiting the model's ability to be used for macroeconomic analysis.

Moreover, the estimates from Ganong et al. (2025) imply that high liquidity households contribute substantially to the aggregate MPC in the 2-asset case. In particular, the sum of poor and wealthy HtM is within the range 20-40% and therefore corresponds to the first two to four deciles of the liquid wealth distribution; whereas the liquid households take up the resting six to eight deciles. After scaling the estimates down to sum 25%, households with low liquidity contribute 13.3-18.7pp of the aggregate MPC, whereas high-liquidity contribute 10.0-17.0pp. These group contributions to the aggregate MPC are also at odds with the standard versions of the 2-asset environment.

Mental accounting offers a way to resolve the aforementioned challenges. In particular, mental accounting brings to the table a source of hand-to-mouth behavior that complements the asset illiquidity along a number of dimensions. The model matches the shares of poor and wealthy HtM households, as well as their contribution to the aggregate MPC (Figure 6 Panel B). At the same time, mental accounting raises the aggregate MPC contribution of liquid households to a more realistic level (Figure 6 Panel C). As a result, the model matches the aggregate wealth and the aggregate MPC without assuming an unrealistic return spread, and thus it can generate a realistic consumption-income ratio (Figure 7 Panel A).

The model with mental accounting also matches additional moments from the wealth distribution. One is the ratio of median net worth to mean income (Figure 7 Panel C), mentioned in the context of the 1-asset model. While in S2A-8 the ratio is on the low side, with more realistic return spreads, the ratio is close to the estimate, proving that mental accounting does not distort the wealth distribution in the 2-asset model either (Figure 7 Panel D).

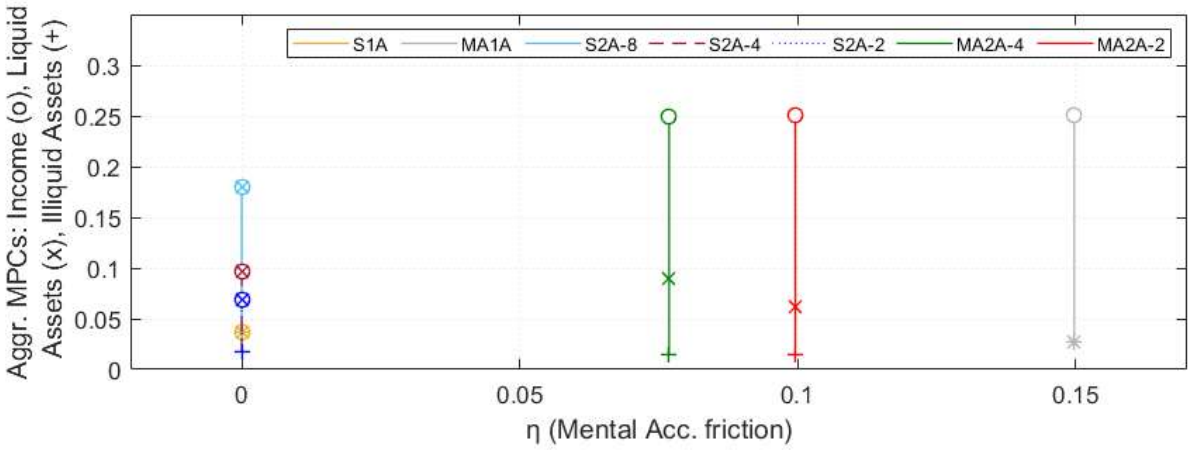


Figure 8. Account-specific aggregate MPCs (income, liquid assets, and illiquid assets) across models.

Another moment is the ratio of mean liquid wealth to mean annual income, estimated at 0.56 (Kaplan and Violante, 2022). With standard preferences, bringing the return spread down to more realistic levels makes the liquid asset relatively more attractive, increasing the mean liquid wealth from 0.77 to 0.93 (Figure 7 Panel B). When mental accounting is added, the portfolio is tilted towards the illiquid asset with ratios of 0.76 and 0.83 which are closer to the data.

4.5 Account-specific MPCs: Income vs. Asset Shocks

While the previous sections have considered shocks to the income account, this section considers the MPCs from shocks to different accounts and/or assets. First it presents the properties of mental accounting: non-fungibility and framing. Then it discusses how the model can rationalize available evidence on MPCs from different types of shocks. The MPC of household h from a shock T_h to the liquid assets, b_m, is given by:

$$MPC_h^b = \frac{C(y_m, b_m + T_h, a, adj) - C(y_m, b_m, a, adj)}{T},$$

and the MPC of household h from a shock T_h to illiquid assets, a, is given by:

$$MPC_h^a = \frac{C(y_m, b_m, a + T_h, adj) - C(y_m, b_m, a, adj)}{T}.$$

4.5.1 Non-Fungibility and Framing

While standard models assume the fungibility of income and liquid assets, these become non-fungible once mental accounting is introduced. A shock to the income mental account produces no longer the same MPC as a shock to the liquid asset account. Hence, how a liquid transfer is mentally classified becomes relevant with mental accounting. Relatedly, a transfer

between mental accounts is no longer neutral in terms of consumption, as the outflow from one mental account is not perfectly offset by the inflow into the other. These properties explain (i) why mental account balances are the relevant state variables of the problem, and (ii) why the slope of the consumption policy function (e.g. in Figure 2) with respect to liquid assets corresponds only to the MPC from liquid assets, but not to the MPC from income anymore.

Quantitatively, Figure 8 compares the MPCs from a uniform transfer T to different accounts and assets. Consider first the households for which Proposition 1 holds before and after the shock. For them, a transfer to the liquid asset account does not modify the balance of the income account. But their consumption is equal to their income balance, hence consumption does not react at all to the shock and the corresponding MPC is 0%. Again, this result holds even for low-liquidity households as long as Proposition 1 holds, as in Figure 2 Panel D. At the same time, whenever Proposition 1 holds, the individual MPC from an income shock is 100%. As a result, the aggregate MPC from income is 10 and 5 times higher than the MPC from liquid assets in the 1-asset and 2-asset environments, respectively. In addition, the MPC from income is above and the MPC from liquid assets is below the respective predictions of the standard models across the household distribution.

Note that these mental account-specific MPCs are an example of 'framing': a deviation from standard choice theory where the same decision problem generates different outcomes depending on the way it is framed (Kahneman and Tversky, 1984; Tversky and Kahneman, 1981). In this sense, shock attributes that are irrelevant through the lens of the standard model (Thaler, 2015) can trigger differential mental classification of resources and, as a result, differential MPCs. Examples of those attributes are discussed in the next sections.

Analogous to the wedge created by mental accounting between the MPCs from income and liquid assets, the 2-asset environment introduces a wedge between the MPCs from liquid and illiquid assets (Figure 8) – which goes as high as one order of magnitude in the S2A-8 model. Adding mental accounting reduces the MPC from an illiquid shock, but such effect is barely visible as the MPC is already small in the standard model.

4.5.2 MPCs from Financial Wealth

These principles can be applied to rationalize MPCs from financial wealth. Regarding the comparison between model and evidence, two comments are in order. First, the empirical estimates cited in this section (DiMaggio et al., 2020; Baker et al., 2007; Daniel et al., 2021; Braeuer et al., 2022; Meyer et al., 2020) were all obtained for directly held stocks, bonds, and

mutual funds. These assets are not tied in an illiquid vehicle subject to withdrawal penalties, nor do households incur in significant costs for trading them, hence they are part of the household's liquid wealth.[18] As a result, the MPC estimates are compared with model MPCs from a shock to liquid resources; this distinction matters given that, in comparison, an illiquid transfer generates a lower MPC, as already discussed. Second, the shock is only received by direct stockholders, whose distribution across income levels in the model matches the 2022 SCF (see Online Appendix C); model predictions are referred to this subset of the distribution.

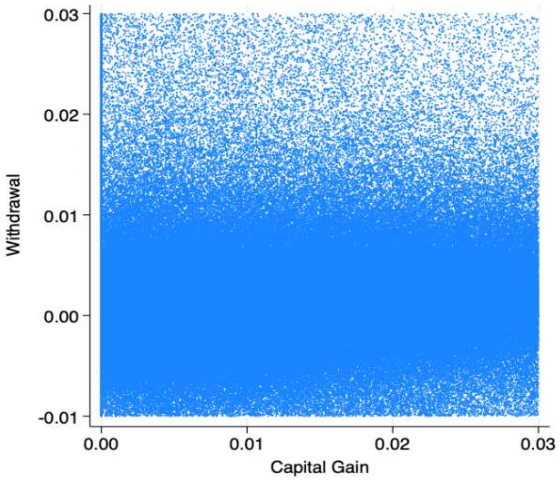
Capital Gains. – DiMaggio et al.'s (2020, Table III) MPC estimate from capital gains is 12.9% annually. Moreover, Daniel et al. (2021) find that many investors withdraw a small fraction of their capital gains and reinvest the rest (see Figure 9 Panel A).

The standard model predicts that the aggregate MPC from capital gains on liquid assets is the same as the MPC from income because of the fungibility property. As a result, in S1A the MPC from capital gains cumulated to one year is in line with the evidence only because the MPC from income is unrealistically low; a similar comment applies to S2A-4 and S2A-2, but in S2A-8 the one-year cumulated MPC is unrealistically high (see Figure 9 Panel C). As for the distribution, most MPCs bunch at low values in line with the evidence, although S2A-8 also presents some intermediate values.

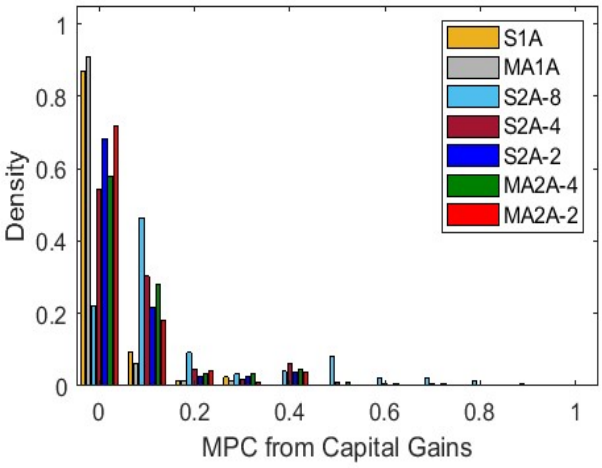
In turn, with mental accounting capital gains are classified into the asset mental account, which has a smaller MPC than that of income. As a result, both in the 1- and the 2-asset environments can match the evidence on the aggregate MPC and on its distribution.

Dividends. – The empirical literature has documented several facts about dividends. Braeuer et al. (2022) find high MPCs from dividends across levels of liquid assets (Figure 9 Panel G), as well as an aggregate MPC from dividends of 24.6% (Figure 9 Panel H), both after 5 weeks (DiMaggio et al., 2020, find an aggregate MPC from dividends that is about 4 times larger than the MPC estimate from capital gains; Baker et al., 2007, also obtain high MPC estimates from dividends). In addition, Daniel et al. (2021, Figure 1 Panel A) document a bimodal portfolio rebalancing response to stock dividends and bond coupon payments (Figure 9 Panel E), whereas Baker et al. (2007, Figure 3 Panel 2) find a very similar bimodal response to mutual fund dividends: in both samples, one group of investors reinvests the dividend into their portfolio ('non-withdrawers'), and another group withdraws the entire dividend, which the respective authors have interpreted as two groups that save and consume the dividend, respectively.

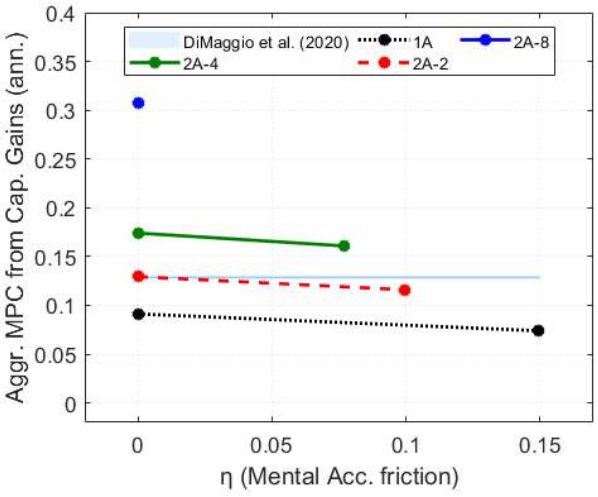
[18] This interpretation is consistent with Kaplan and Violante's (2014) decomposition of household portfolio data (their Table III), where directly held stocks, bonds, and mutual funds are counted as liquid assets.



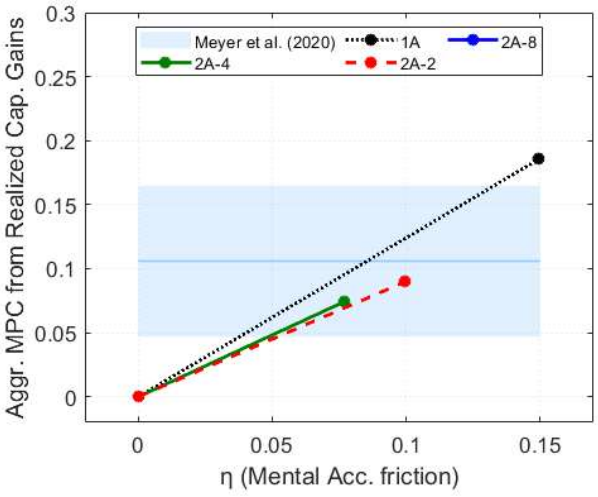
Panel A. Evidence from cap. gains (Daniel et al., 2021).



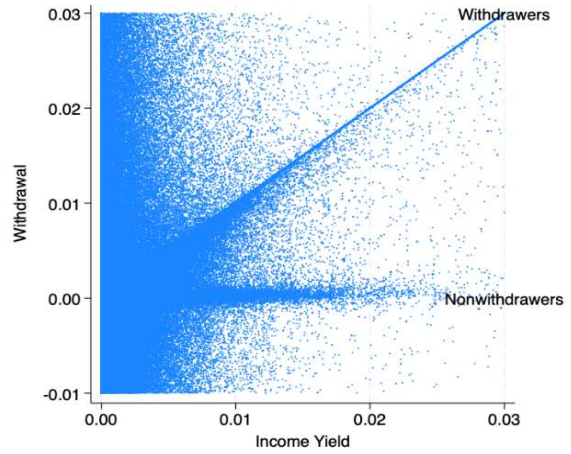
Panel B. Model MPCs from cap. gains: histogram.



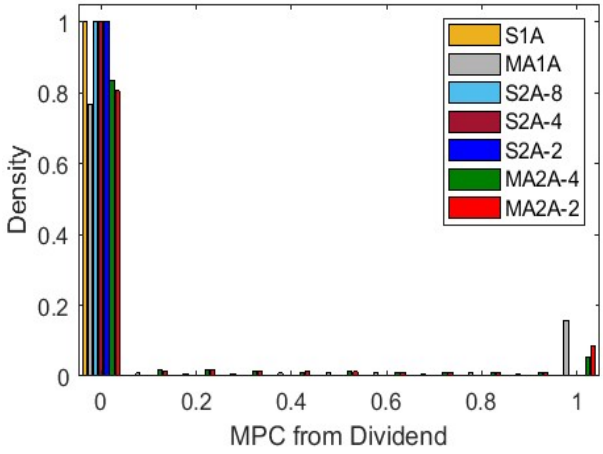
Panel C. Aggr. MPC (ann.) from capital gains.



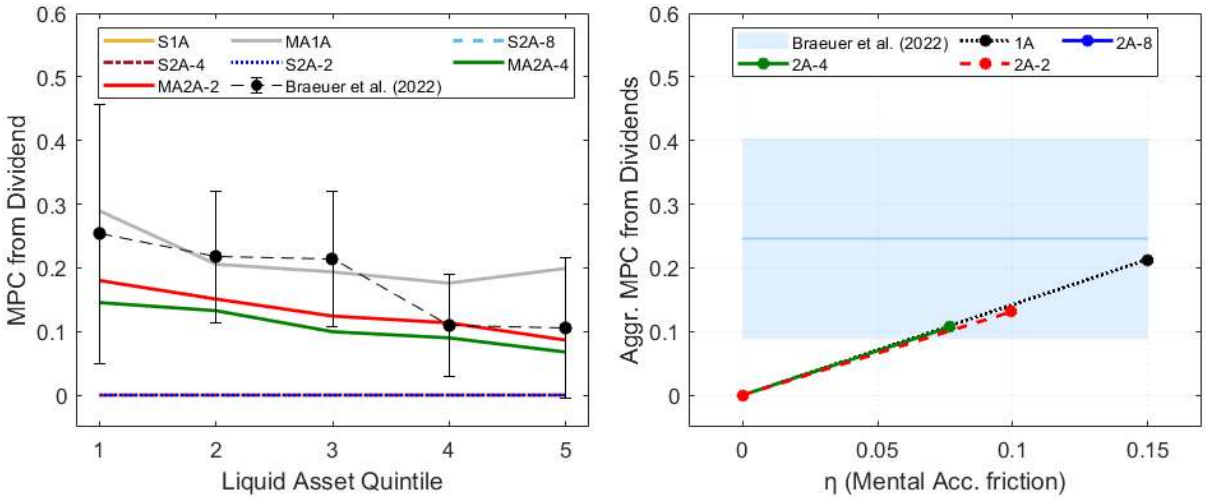
Panel D. Aggr. MPC from exo. realized cap. gains.



Panel E. Evidence from dividends (Daniel et al., 2021).



Panel F. Model MPCs from dividends: histogram.



Panel G. Avg. MPCs from dividends across liquid assets. Panel H: Aggregate MPC from dividends.

Figure 9. MPCs from financial wealth (capital gains, dividends and realized capital gains): model vs. evidence.

Turning to the model, note that although financial markets are not formalized explicitly, they are assumed to operate as in standard finance theory. Hence, a dividend payment (or bond coupon) generates an equally large decrease in the price of the asset, such that the net change in wealth is zero. Framing the cash payout as income and the associated capital loss as liquid assets, the MPC from a dividend T_h is:

$$MPC_h^{Div} = MPC_h^{RCG} = \frac{C(y_m + T_h, b_m - T_h, a, adj) - C(y_m, b_m, a, adj)}{T},$$

i.e. a dividend is essentially a transfer from the liquid asset account to the income account.

In the standard environment with both 1 and 2 assets, by virtue of the fungibility property the positive effect from the cash payout and the negative effect from the capital loss perfectly offset each other, yielding a total MPC of 0% which is at odds with the evidence. Note that, although the value of the MPC from income and from liquid assets varies across model specifications, it is irrelevant what those values are in each case; what matters is that they are equal, such that one offsets the other.

In contrast, the mental accounting models do predict that dividends generate positive consumption responses. By virtue of non-fungibility, the negative effect from the capital loss is more than compensated by the positive effect from the cash payout, producing an overall positive MPC. In particular, among the households for whom Proposition 1 holds before and after the shock, the MPC from the capital loss is 0% whereas the MPC from the cash payment is 100%. As a result, mental accounting can explain the evidence, both in the 1- and 2-asset environments (Figure 9). First, the aggregate MPC from dividends is close to the empirical

estimate (Panel H), and substantially higher than the MPC from capital gains. Second, the MPCs are high even among liquid households (Panel G). Third, the distribution of MPCs from dividends is bimodal, with a group of households who save the majority of the dividend and another group of households who consume the entire dividend (Panel F).

Finally, note that this section speaks to the dividend irrelevance result in Miller and Modigliani (1961), which rests on the assumption that households are indifferent between the stock market wealth being in the form of share value or in the form of cash dividends. In the standard model, the MPC from dividends is zero precisely because households are indifferent between both forms, and therefore the irrelevance result would hold. With mental accounting, however, the MPC from dividends is positive because households are no longer indifferent, which would break the irrelevance result. That said, the implications for the valuation of assets with different dividend properties is outside of the scope of this paper.

Exogenously Realized Capital Gains. – Meyer et al. (2020) analyze exogenous mutual fund closures, the proceeds of which are received in cash by the households; their finding is that the corresponding MPC is 10.6%. In this case, the capital gains have accrued in advance, hence the shock does not imply a change in wealth, but only a transfer from the liquid asset account to the income account. As a result, the MPC is computed exactly as the MPC from dividends. Again, standard models predict, by fungibility, a zero MPC from realized capital gains; but mental accounting models can rationalize this estimate (Figure 9 Panel D).

Note the differences with the previous exercise on capital gains, where households receive a shock to wealth, hence classified into the asset account, and they make the (endogenous) decision whether or not to consume from it – which would imply selling the corresponding securities. Here, the already known gains are converted into cash by an exogenous event, and being in cash they are perceived as more similar to the income mental account. Finally, perhaps it is worth mentioning two related cases that imply a conversion of shares into cash, corporate acquisitions and share repurchases, which are left for future research.

4.5.3 MPCs from Housing Wealth

Turning to housing wealth, the empirical literature (Mian, Rao, and Sufi, 2013; Aladangady, 2017; Guren et al., 2021; Paiella and Pistaferri, 2017) finds that MPCs from housing capital gains are in the range 3-7% annually. Consuming from these gains entails making transactions in the real estate and/or mortgage markets, which in some cases carries a cost. Hence, the MPC estimates from housing gains are compared with the model MPC from a transfer to the illiquid

asset and to net worth for the 2- and 1-asset models, respectively. The transfer is received by homeowners, which in the model are distributed across income levels according to the 2022 SCF (see Online Appendix C); model predictions are referred to this subset of the distribution.

Table 2 shows model MPCs cumulated to one year. The standard 2-asset models are consistent with the evidence due to the illiquidity friction; but in the 1-asset case the MPC is too high, because of fungibility. In turn, the mental accounting versions of the model generate similar, albeit lower values: with 2 assets the MPC is mainly driven by the illiquidity friction; with 1 asset, the predictions are closer to the evidence.

4.6 Intertemporal MPCs

This section considers the dynamic consumption response to a transitory income shock, or intertemporal MPC, and evaluates the models against three empirical facts (see Figures 10-11).

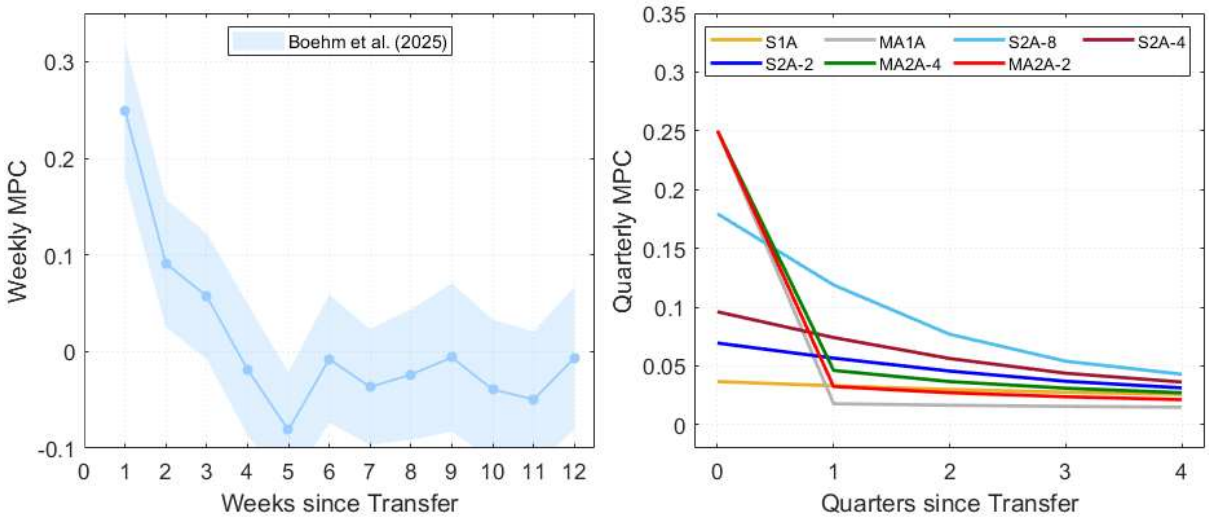
First, the anticipation effects to an expected shock are small to non-existent. Baugh et al. (2021) find that the MPC accumulated during one month before the shock is less than 0.5%; Braeuer et al. (2022) estimate an MPC from income accumulated during the 5 weeks prior to the shock to be about 2% – in both cases with a very narrow confidence interval.[19]

Second, the response features excess sensitivity – a fact that appears in both unexpected shocks and expected ones. On the former, Boehm et al. (2025) estimate an MPC of 24.9% in the first week after the shock. On the latter, Braeuer et al. (2022) find an MPC of 22.3% in the first 5; and Baugh et al. (2021), an MPC of 13% in the first quarter.

Third, the lagged effects are also small to non-existent: the consumption response is front-loaded and dies out relatively quickly. Boehm et al. (2025) estimate positive MPCs only in the first 3 weeks after the shock, and MPCs indistinguishable from zero for the remaining 9 weeks of the quarter. In Baugh et al. (2021), the cumulative MPC reaches 18% after 5 months and remains virtually flat thereafter for the rest of the estimation horizon, which is 2.76 years. In the surveys by Shapiro and Slemrod (2003b) and Sahm et al. (2010), respondents who did not spend the rebate at impact did not plan to make any other adjustments to their saving plan in the year following the shock.[20]

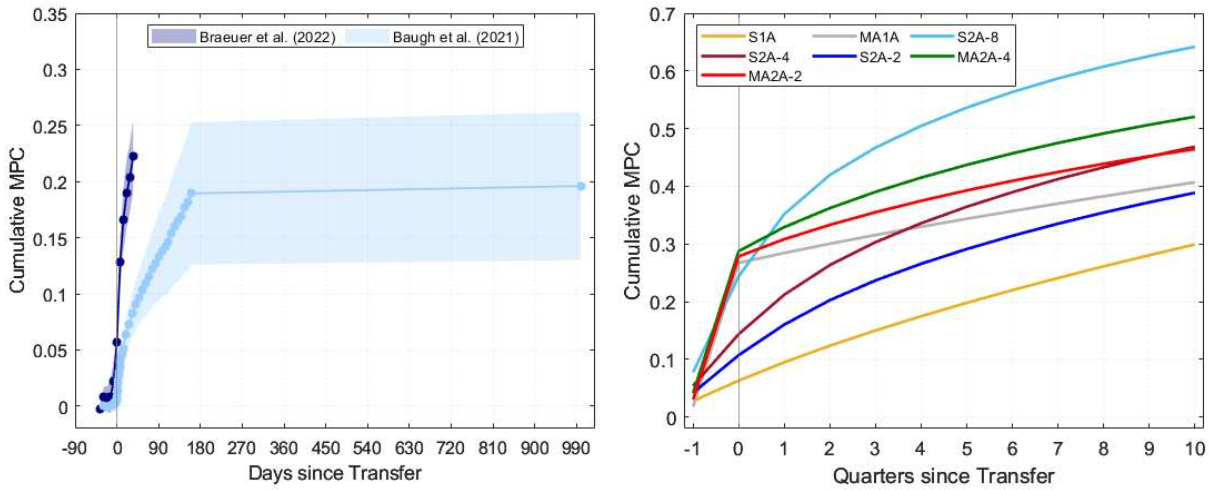
[19] For additional evidence on non-anticipation, see Olafsson and Pagel (2018); and Kueng (2018).

[20] Further estimates of intertemporal consumption responses are provided in Fagereng et al. (2021). They find a fully front-loaded response in their subsample of small lotteries worth $1100-2070, i.e. the closest to the $500 transfer considered here. At the same time, they find evidence of lagged effects in their full sample with lotteries worth up to $150,000, but the average prize there is about 34 times the $500 transfer. While the estimates are more accurate in the full sample, the estimates also put higher weight on large-prize winners, more frequent in the full sample. For further discussion in a business cycle context, see Gimeno-Ribes (2023).



Panel A: Evidence (Boehm et al., 2025). Panel B: Intertemporal MPC across models.

Figure 10. Intertemporal MPC from an unexpected income shock.



Panel A: Evidence (Baugh et al., 2021). Panel B: Intertemporal MPC across models.

Figure 11. Intertemporal MPC from an expected income shock: model vs. evidence.

Turning to the models, the S1A predicts a nearly flat iMPC in the vicinity of 3% across all periods, which is close to the estimated small anticipation and lagged effects, but it misses the excess sensitivity entirely. Introducing illiquid assets raises the MPC across periods, but with several problems. On one hand, when the shock is unexpected, the MPCs at impact are in line with the estimates, at least for the S2A-8 which is 17.9%; however, for S2A-4 (9.6%) and for S2A-2 (6.9%) they are arguably too low. On the other hand, when the shock is expected, the MPCs one quarter in advance are unrealistically high, especially for higher return spreads – 7.7% for the S2A-8–, and they get closer to the evidence as the return spread goes down: 5.4% for the S2A-4, and 4.2% for the S2A-2. Here, the fungibility property is at work: in anticipation, high-MPC households draw down the available liquid assets and consume them as if they were

income. Such a high anticipatory response reduces the MPCs at impact, an effect that becomes especially visible when the shock is anticipated many periods in advance.

After the shock, again by fungibility, high-MPC households consume the fraction of the transfer that is left unspent and which has become part of their liquid assets. Lagged effects appear, in addition, through another mechanism: with the news and/or the receipt of the shock, households invest a fraction of the transfer in the illiquid high-return asset over a longer period of time, thereby multiplying their investment, which they liquidate and consume later on. As a result, the lagged effects are too large in the period after the shock and keep growing at long horizons, especially in models with higher return spreads: in S2A-8, the MPC one quarter after the shock is 10.8%, and the cumulative MPC 2.75 years after the shock is 64% – predictions that are at odds with the evidence. In turn, in S2A-4 and S2A-2 the cumulative MPC a couple of quarters after the shock may look more in line with the data, but this prediction only obtains because the high anticipation and/or lagged effects counteract the low MPC at impact.

With mental accounting, households avoid dissaving and make a limited use of their liquid assets to smooth consumption around the shock because of non-fungibility. At impact, the transfer is classified in the income mental account, and thus generates a high MPC of around 25% across models, even when the shock was expected. When the shock is anticipated, households increase spending very little in advance, between 1.8–4.2% depending on the model. In turn, after the shock, the portion of the transfer that is left unspent is automatically saved into the liquid asset account, from which households have a lower MPC, thereby reducing the lagged effects: the MPC one quarter after the shock are between 1.7–4.2% depending on the model. Finally, at the 2.75-year horizons, the cumulative MPCs climb up to 40.7–52%, which is closer to but still above the estimate. Yet, qualitatively, the shape of the intertemporal MPC with mental accounting is more in line with the data.

4.7 MPC Asymmetries

This section considers asymmetric responses to shocks in the evidence and in the models.

4.7.1 Size

Figure 12 plots the evidence on MPCs in four different cases. Panel A shows that larger payments generate virtually the same aggregate MPCs as smaller shocks: the 2001 stimulus checks, 80% of which were the maximum amount of $600, generate an MPC of 24.4% (Kaplan and Violante, 2014); and the Alaska permanent fund payment averaging $4,600 per household

elicit an MPC of 24% (Kueng, 2018). In turn, Panel B shows that larger payments have lower MPCs, even in samples with liquid households, but with substantial variation: one extra month of labor income (on average about $3,734) produces an MPC of 19.6% (Christelis et al., 2019); and an expected bonus payment worth one month of labor income generates an undistinguishable consumption response (Browning and Collado, 2001), i.e. an MPC of 0%.

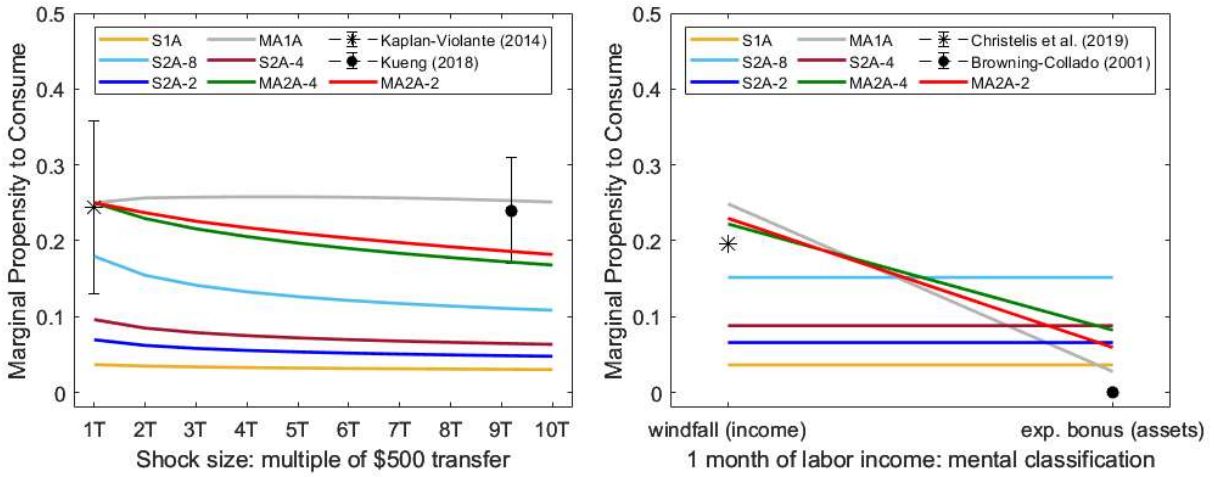
In the standard model, low-liquidity households use a larger shock to save themselves out of the liquidity constraint, thereby producing a lower MPC than smaller shocks. In this way, the S2A-8 can rationalize a high aggregate MPC from a stimulus check, but generates too low an MPC (11%) from the large fund payments; as for the receipt of one month of labor income, it predicts an MPC of 15% regardless of whether the shock is perceived as a windfall or as a bonus payment, a prediction that is only consistent with the windfall estimate.

In turn, in mental accounting models, the larger the shock size, the larger the adjustment in the income mental account and in the marginal incentives at the kink. Consider the low-to-medium-income, low-liquidity households who set consumption equal to income in steady state for a very short segment in their policy function: intuitively, with a larger income they are more satiated, they are willing to forego extra consumption for larger values of assets. However, these effects are quantitatively small for the range of shock sizes considered, a property that becomes apparent from Figure 12 Panel A, in model MA1A; of course, this model also features low-liquidity households, but their size effects are virtually absent, as in S1A.

In contrast, MA2A-4 and MA2A-2 feature higher shares of low-liquidity households and thus predict that the aggregate MPC declines modestly with transfer size. In all cases, the mental accounting models can match the high MPC both from the smaller stimulus checks and from the larger fund payments. Note that in this exercise households view the fund payments as part of their regular income, an assumption that is consistent with Kueng's (2018) evidence that households pay attention to the announcement of and to the application to the fund payments.

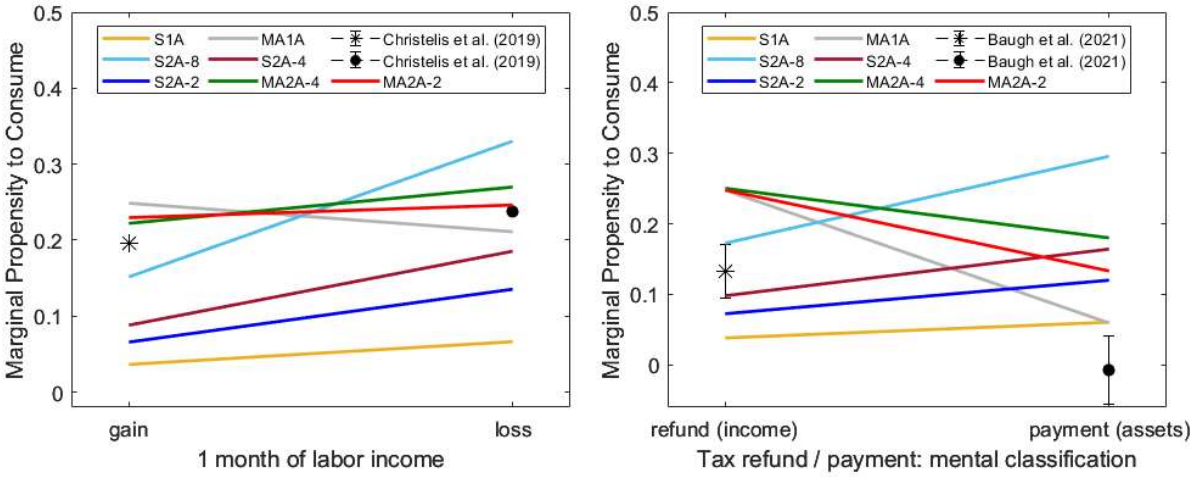
Naturally, classifying shocks into the asset account can generate different consumption responses (see Figure 12 Panel B). If the extra month of labor income is perceived as a windfall and classified into the income mental account, the MPC is broadly consistent with the estimate. But if, on the contrary, the extra month is perceived as an infrequent bonus payment from which the household does not intend to spend, it is classified into the asset mental account and the resulting MPC is substantially lower, consistent with the estimate.[21]

[21] The model also offers the possibility that shocks are classified partly in both mental accounts; yet, more evidence would be needed to discipline such assumption.



Panel A: Shock of varying size (income). Panel B: 1 extra month of labor income (inc./asset).

Figure 12. Size-related asymmetries.



Panel A: 1 extra / less month of labor income (income). Panel B: Tax refund (income) / payment (asset).

Figure 13. Sign-related asymmetries.

4.7.2 Sign

Figure 13 plots the evidence on MPCs of two different sign asymmetries. Panel A shows evidence that the loss of one month of labor income generates a larger MPC (23.8%) than the corresponding gain (19.6%) (Christelis et al., 2019; see also Bunn et al., 2014). In turn, Panel B shows what appears to be the opposite: that tax refunds worth $2,121 on average generate a larger MPC (13.3%) than a tax payment worth $1,574 on average (-0.7%) (Baugh et al., 2021).

In standard models, a negative shock pushes more households towards the liquidity constraint, thereby generating a higher MPC than a same-sized positive income shock. In the aggregate, these effects are most visible in the 2-asset model. While the S2A-8 can explain the gain-loss asymmetry for income (Panel A) at least qualitatively, it is at odds with the tax refund-payment asymmetry (Panel B) both qualitatively and quantitatively.

In models with mental accounting, there is again a readjustment of incentives: for low-to-medium-income, low-liquidity households who lose some of their income it is no longer optimal to be at the kink and they start dissaving sooner; hence, their MPC becomes smaller. In MA2A-4 and MA2A-2 the higher MPC for the negative income shock reveals that the liquidity-constrained households dominate; as a result, both models are consistent with the gain-loss asymmetry in Panel A. In turn, in MA1A mental accounting dominates over the effect of low-liquidity households, hence the slightly smaller MPC in the negative case; while these predictions are quantitatively in line with the estimates in Panel A, they do not match the higher MPC in the negative case. However, this problem could be solved if further evidence found that, in some cases, part of the positive shock is classified into the asset account.

In the case of tax refunds and payments, Baugh et al. (2021) document that the tax payments are made from different physical – albeit perfectly liquid– accounts than the ones used to finance expenditures after the tax refunds are received. Baugh et al. (2021) suggest that households in their sample are using different mental accounts to receive refunds and to make payments. Panel B shows the model predictions when the tax refund is classified into the income mental account, yet the tax payment is made from the asset mental account: in all three models, the MPC from the refund is substantially higher than from the payment, which is qualitatively consistent with the estimates.[22]

5. Conclusion

Introducing mental accounting of income and wealth into a heterogeneous household environment rationalizes a set of empirical facts about consumption and wealth that elude standard models. These facts concern the MPCs across different regions of the household distribution, across different levels of aggregation, from different types of shocks, and in response to announcements and to past shocks.

One lesson worth pointing out is that mental accounting can help match a macroeconomic calibration that targets the aggregate MPC and aggregate wealth, while avoiding problems in the distribution of wealth and consumption. While the 1-asset model with mental accounting constitutes a parsimonious alternative for quantitative macroeconomic analysis, mental accounting also improves the suitability of the 2-asset model for the same purpose.

[22] A related payment that generates apparently small consumption effects is the college tuition (Souleles, 2000): the results suggest at least qualitatively that households make these payments from their asset mental account, although the presence of simultaneous nonseparable expenditures may difficult the quantitative comparison.

These results open up a related research question on how mental accounting shapes the macroeconomic policy transmission to consumption. The model of mental accounts is conveniently set up as a PEEM, i.e. a portable extension of an existing model (Rabin, 2013). Therefore, it can be easily introduced into a general-equilibrium environment with nominal rigidities for business-cycle analysis: a "mental accounting HANK" (Gimeno-Ribes, 2023).

Moreover, the model of mental accounts offers implications for the design of fiscal stimulus policies. In particular, when stimulus transfers are perceived to be more similar to the income mental account, the associated MPC is higher and the stimulus is more effective per dollar spent. However, the evidence on mental classification, and in particular the reasons or triggers that lead households to partition and spend their resources in a particular way, remains scarce. Obtaining more evidence on these mental processes could both bring additional discipline to the model and help design more budget-efficient stimulus policies.

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A Model of Consumption with Mental Accounting and Heterogeneous Agents

Online Appendix

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A Recursive Problems

This section presents the recursive formulation of the household problem in the 1-asset and 2-asset environments, respectively.

A.1 Recursive Problem of 1-asset Model

The recursive problem is:

$$V(y_m, b_m) = \max_{c,b'} U(c|r) + \beta E[V(y'_m, b'_m)],$$

subject to

$$c + b' = (1 + R^b)b + y$$

and

$$b' \geq 0\ ,$$

where $V(a, y_m)$ denotes the value function for the household in the current period; y', b', y'_m, and b'_m are next-period variables; after-tax income and mental account balances are computed following the classification rules in Section 2; and the rest of the notation is as in the main text. The expectations operator E is taken over the different possible realizations of the stochastic earnings process, using the conditional probabilities $\Pr(z'|z)$.

The First-Order Condition (FOC) and Envelope Condition (EC) are:

$$\frac{\partial}{\partial c}U(c|r) = \mu + \beta E\left[\frac{\partial}{\partial b}V(y'_m, b'_m)\right] \qquad \forall\, c \neq y_m\ , \quad \nexists \frac{\partial}{\partial c}U(y_m|r)$$

$$\frac{\partial}{\partial b}V(y_m, b_m) = (1 + R^b)\frac{\partial}{\partial c}U(c|r) \qquad \forall\, c \neq y_m\ , \quad \nexists \frac{\partial}{\partial c}U(y_m|r),$$

where the marginal utility does not exist at the non-differentiability point ($c = y_m$).

The law of motion for the distribution is:

$\Gamma_{t+1}(y'_m, b'_m) = \int_{\{(y_m,b_m):b'\in A\}} \Pr(z'|z)d\Gamma_t(y_m, b_m)$, for all $A \subset \mathbb{R}$,

and aggregate consumption and wealth are computed as:

$$C_t \equiv \int c_t(y_m, b_m)d\Gamma_t(y_m, b_m),$$

$$B_t \equiv \int b'_t(y_m, b_m)d\Gamma_t(y_m, b_m).$$

A.2 Recursive Problem of 2-asset Model

The opportunities of portfolio adjustment are i.i.d., producing two types of households: Adjusters and Non-Adjusters. Each solves a different problem, as below.

The problem of the Non-Adjusters:

$$V(y_m, b_m, a, NA) = \max_{c,b'} U(c|r) + \beta E[V(y'_m, b'_m, a', adj')],$$

subject to

$$c + b' = (1 + R^b)b + y$$

and

$$a' = (1 + R^a)a,$$
$$b' \geq \underline{b}.$$

In turn, the problem of the Adjusters:

$$V(y_m, b_m, a, A) = \max_{c,b',a'} U(c|r) + \beta E[V(y'_m, b'_m, a', adj')],$$

subject to

$$c + b' + a' = (1 + R^b)b + (1 + R^a)a + y$$

and

$$a' \geq 0\ ,$$
$$b' \geq \underline{b}.$$

For both problems above, after-tax income and mental account balances are defined as in section 2.

The saving decisions are liquid savings for Non-Adjusters, and liquid and illiquid savings for Adjusters. Variables with a prime denote next-period variables. The expectations operator E is taken over the different adjustment types using their respective weights and over all the possible realizations of the stochastic income process using the conditional probabilities $\Pr(z'|z)$.

The First-Order Conditions (FOC) of the household problem are:

$$\frac{\partial}{\partial c} U(c|r) = \mu + \beta E\left[\frac{\partial}{\partial b} V(y'_m, b'_m, a', adj')\right], \text{ for } adj = NA, A$$

$$\frac{\partial}{\partial c} U(c|r) = \theta + \beta E\left[\frac{\partial}{\partial a} V(y'_m, b'_m, a', adj')\right], \text{ for } adj = A,$$

and the Envelope Conditions (EC) are given by:

$$\frac{\partial}{\partial b}V(y_m, b_m, a, adj) = (1 + R^b)\frac{\partial}{\partial c}U(c|r)\ , \text{ for } adj = NA, A$$

$$\frac{\partial}{\partial a}V(y_m, b_m, a, A) = (1 + R^a)\ \frac{\partial}{\partial c}U(c|r)$$

$$\frac{\partial}{\partial a}V(y_m, b_m, a, NA) = \beta(1 + R^a)E\left[\frac{\partial}{\partial a}V(y'_m, b'_m, a', adj')\right],$$

where $\forall\ c \neq y_m,\ \ \nexists \frac{\partial}{\partial c}U(y_m|r)$ applies to all the FOCs and ECs above. In addition, in the first two equations the multipliers are zero except for when $b = 0$ and $a = 0$, respectively. And the interior solutions of the Adjuster portfolio problem can be characterized by the following indifference condition:

$$E\left[\frac{\partial}{\partial b}V(y'_m, b'_m, a', adj')\right] = E\left[\frac{\partial}{\partial a}V(y'_m, b'_m, a', adj')\right]. \text{ for } adj' = A$$

The law of motion for the distribution is:

$\Gamma_{t+1}(y'_m, b'_m, a', adj') = \int_{\{(y_m, b_m, a, adj):a', b' \in A\}} \Pr(z'|z)d\Gamma_t(y_m, b_m, a, adj)$, for all $A \subset \mathbb{R}$.

In turn, aggregate consumption, liquid and illiquid wealth are, respectively:

$$C_t \equiv \int c_t(y_m, b_m, a, adj)d\Gamma_t(y_m, b_m, a, adj),$$

$$B_t \equiv \int b'_t(y_m, b_m, a, adj)d\Gamma_t(y_m, b_m, a, adj),$$

$$A_t \equiv \int a'_t(y_m, b_m, a, adj)d\Gamma_t(y_m, b_m, a, adj).$$

B Algorithms

This section contains the algorithms used to solve the 1- and 2-asset models, respectively.

B.1 Algorithm for 1-asset Model

The algorithm presented here is an extension of the Endogenous Grid Method (EGM) (Carroll, 2004; see also Aruoba et al., 2006) that accommodates the presence of mental accounting. The routine uses the insights from the optimal choice analysis in the main text to avoid the marginal utility of consumption at the point of non-differentiability.

The algorithm starts with a guess of the derivative of the value function with respect to liquid assets and iterates backwards until convergence. The steps are as follows:

Step 0. Make initial guess of $\frac{\partial}{\partial b}V(y'_m, b'_m)$.

Step 1. Given $\frac{\partial}{\partial b}V(y'_m, b'_m)$, use the transition probability matrix to compute the expectations with respect to income and obtain the derivative of next-period's expected discounted value function, W, referenced to the current-period income grid: $\frac{\partial}{\partial b}W(y_m, b'_m) = \beta E\left[\frac{\partial}{\partial b}V(y'_m, b'_m)\right]$. Then consumption falls under one of two cases:

a. If the Proposition on choices at the kink holds:

$$(1-\eta)u'(y_m) > \frac{\partial}{\partial b}W(y_m, b'_m) > (1-\eta\lambda)u'(y_m),$$

then $c = y_m$.

b. In contrast, if the Proposition does not hold, then obtain consumption from the First-Order Condition applied to either side of the kink:

$$\frac{\partial U(c|r)}{\partial c} = \frac{\partial W(y_m, b'_m)}{\partial b}.$$

Step 2. Interpolate the policy function $c(y_m, b'_m)$ from the endogenous asset grid to the current-period exogenous asset grid to obtain $c(y_m, b_m)$. Back out the saving policy function, $b(y_m, b_m)$, from budget constraint.

Step 3. Enforce liquidity constraint on policy functions.

Step 4. Update guess of $\frac{\partial V}{\partial b}$. There are two distinct cases:

a. Households for whom the liquidity constraint is not binding, i.e. the Lagrange Multiplier is zero ($\mu = 0$). Substitute the FOC into the Envelope Condition (EC) and interpolate

$\frac{\partial W}{\partial b}$ with the future mental asset balance:

$$\frac{\partial}{\partial b}V(y_m, b_m) = (1+R)\frac{\partial}{\partial b}W(y_m, b'_m(y_m, b_m)).$$

This case includes: (a.1) households on the FOC with $\mu = 0$; (a.2) households for whom Proposition 1 holds.[1] For households in group (a.2), the use of $\frac{\partial}{\partial b}W$ conveniently avoids the marginal utility and translates the marginal incentives associated with the continuous saving choices into the next guess of $\frac{\partial}{\partial b}V$.

b. Households on the FOC with a binding liquidity constraint and a positive Lagrange Multiplier ($\mu > 0$). In the EC use the right-hand side (RHS) marginal utility:

$$\frac{\partial}{\partial b}V(y_m, b_m) = (1+R)(1-\eta\lambda)u'(c).$$

This case includes: (b.1) households with $c > y_m$; (b.2) households with $c = y_m$. For group (b.1), consumption is to the right of the non-differentiability point, hence the use of the RHS marginal utility. For group (b.2), $c = y_m$ is not an optimal choice, but it is due to a binding liquidity constraint – actual consumption is below optimal consumption–; necessarily, their asset holdings equal zero. Recall that the envelope condition captures the intra-temporal effect on welfare of a change in liquid assets. A decrease in liquid assets is not feasible, because the liquidity constraint does not allow households to hold a negative amount of liquid assets. Hence, the only feasible change for group (b.2) is an increase in liquid assets. Such change induces an increase in consumption above income, as indicated by the positive Lagrange Multiplier; and the associated marginal effect on welfare is captured by the RHS marginal utility.

Once the guess is updated, go back to step 1 and repeat until convergence.

B.2 Algorithm for 2-asset Model

This section discusses the algorithm used to solve the 2-asset model: it is a version of Bayer et al. (2019) that accommodates for the presence of mental accounting. The 2-asset model can be decomposed into two 1-asset problems – one where only liquid assets are adjusted (Non-Adjusters), and one where all assets can be adjusted (Adjusters) –. Hence, the strategy for

[1] Note that in group (a.2) households may have any level of liquid assets. Consider a household with zero liquid assets where consumption is equal to income. The important distinction here is that this is an optimal choice given preferences; this is different from a choice resulting from a binding liquidity constraint, as in group (b.2).

dealing with mental accounting in the 1-asset environment can be applied to both problems here.

The algorithm starts with a guess of the derivatives of the value function with respect to liquid and illiquid assets and iterates backwards until convergence. The steps are as follows:

Step 0. Make initial guesses of $\frac{\partial}{\partial b}V(y'_m, b'_m, a', adj')$ and $\frac{\partial}{\partial a}V(y'_m, b'_m, a', adj')$.

Step 1. Apply 1-asset EGM to Non-Adjusters: (i) compute expectations with respect to income; (ii) use the FOC with respect to liquid assets to obtain the consumption and liquid saving policy functions; (iii) interpolate the policy functions back to the exogenous liquid asset grid and enforce liquidity constraint; and (iv) obtain $\frac{\partial}{\partial b}V$, $\frac{\partial}{\partial a}V$ for $adj = NA$ with the EC's, accounting for illiquid capital gains.

Step 2. Use the portfolio indifference condition between liquid and illiquid assets to obtain the optimal portfolio combinations of liquid and illiquid savings for Adjusters.

Step 3. Apply 'enlarged' 1-asset EGM to Adjusters: (i) compute expectations with respect to income; (ii) use the FOC with respect to liquid assets to obtain the consumption policy function; (iii) exploit results from Step 2 to determine liquid and illiquid saving policy functions; (iv) interpolate policy functions back to exogenous asset grids and enforce the liquidity and short-selling constraints; (v) obtain $\frac{\partial}{\partial b}V$, $\frac{\partial}{\partial a}V$ for $adj = A$ with the EC's.

Step 4. Obtain the continuation values:

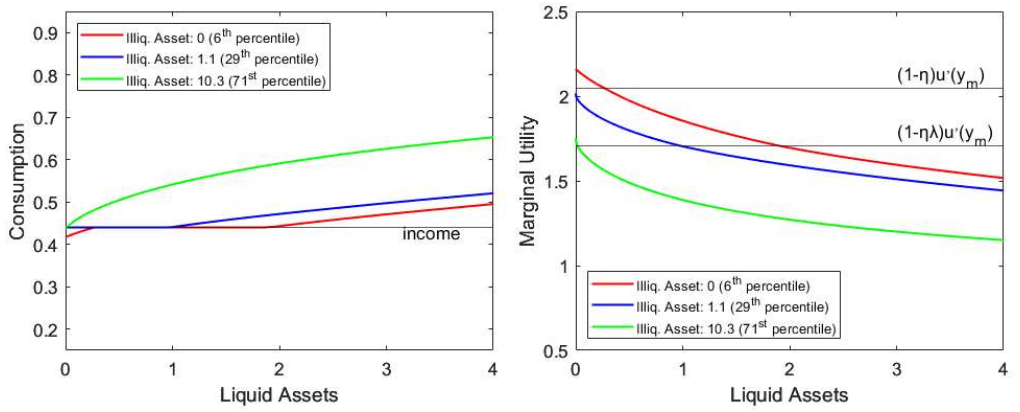
$$\frac{\partial V}{\partial x} = \upsilon \frac{\partial V(y_m, b_m, a, A)}{\partial x} + (1-\upsilon)\frac{\partial V(y_m, b_m, a, NA)}{\partial x} \quad for\ x = a,\ b$$

Once the guesses are updated, go back to step 1 and repeat until convergence.

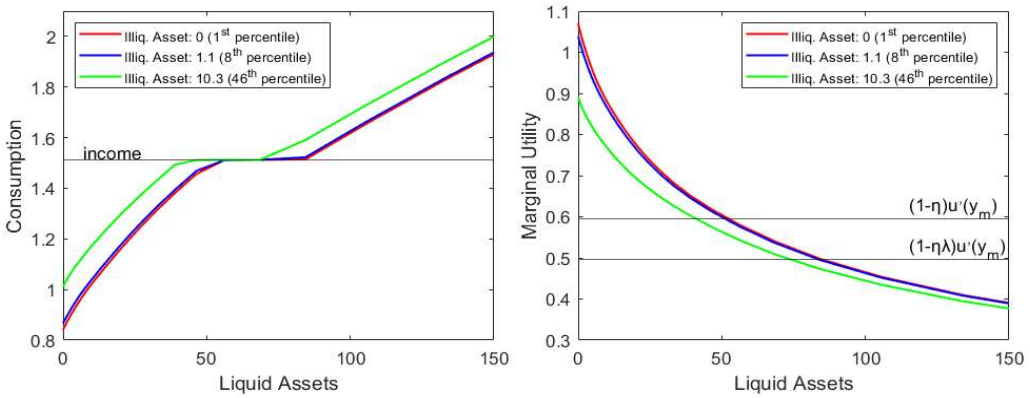
C Additional Figures and Tables

C.1 Policy Functions and Marginal Incentives in 2-asset Model

Analogous to section 3.2 of the paper, this section shows the graphic relationship between marginal incentives and consumption choices in a 2-asset model with 2.25% return spread across different levels of income, liquid wealth, and illiquid wealth. I consider the income states corresponding to percentiles 41-59th and 87-94th of the distribution, where the mental accounting properties appear clearly. Figure C.1 considers Non-Adjuster households, whereas Figure C.2 considers Adjuster households. In particular, whenever Proposition 1 holds, that is the derivative of the value function is inside the wedge of marginal utilities at the kink, it is optimal for households to set consumption equal to income. The policy functions are more linear among Adjusters than among Non-Adjusters because the former have access to both the liquid and illiquid assets; however, the effect of mental accounting is similar in both cases.

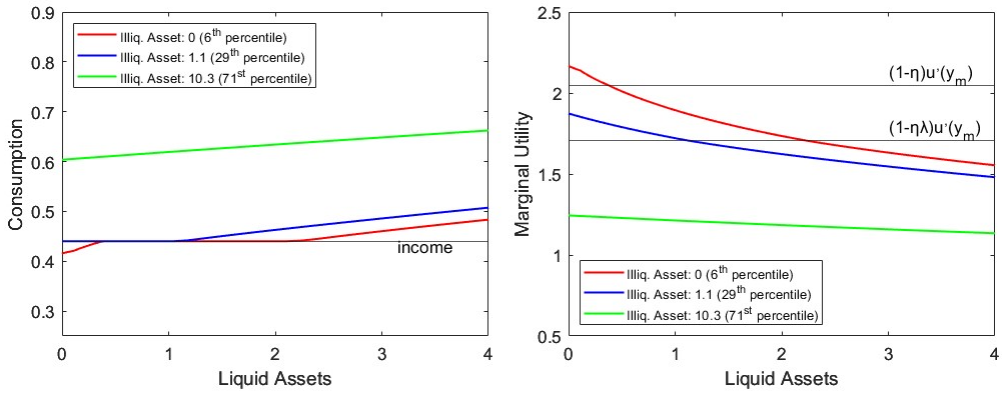


Panel A: Cons. pol. func., 41-59th perc. income. Panel B: Dis. ex. Marg. VF, 41-59th perc. inc.

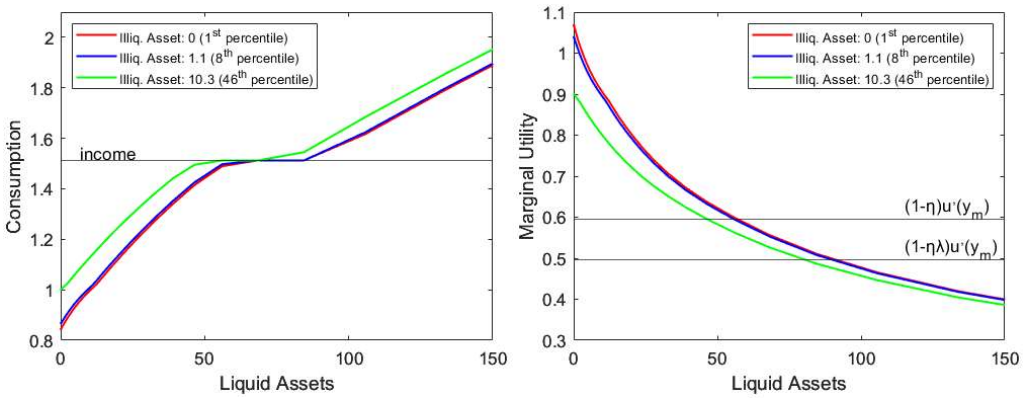


Panel C: Cons. pol. func., 87-94th perc. income. Panel D: Dis. ex. Marg. VF, 87-94th perc. inc.

Figure C.1. Choices and marginal incentives for Non-Adjusters in the MA2A-2 model across the spectrum of liquid assets, for specific levels of income and illiquid wealth. The left panels show the consumption policy function, $C(y_m, b_m, a, NA)$; the right panels show $\beta \frac{\partial}{\partial b} E[V(y'_m, b'_m, a', adj')]$.



Panel A: Cons. pol. func., 41-59th perc. income. Panel B: Dis. ex. Marg. VF, 41-59th perc. inc.



Panel C: Cons. pol. func., 87-94th perc. income. Panel D: Dis. ex. Marg. VF, 87-94th perc. inc.

Figure C.2. Choices and marginal incentives for Adjusters in the MA2A-2 model across the spectrum of liquid assets, for specific levels of income and illiquid wealth. The left panels show the consumption policy function, $C(y_m, b_m, a, A)$; the right panels show $\beta \frac{\partial}{\partial b} E[V(y'_m, b'_m, a', adj')]$.

C.2 Data on the Consumption-Income Ratio

Table C.1 includes the estimates of mean consumption-income ratio obtained from empirical studies. The ratio is computed by dividing the mean expenditure by the mean earnings reported in the summary statistics. The samples are mostly representative and from different countries.

Table C.1. Ratio of Mean Consumption to Mean After-tax Income in Data

Data			
Ratio	*Study*	*Country / Source*	*Sample*
[0.81, 1.02]	Boehm et al. (2024)	France	Representative
1.02	Bräuer et al. (2022)	Germany	Stockholders
0.86	Fagereng et al. (2021)	Norway	Representative
[0.87, 0.99]	Kueng (2018)	USA / CEX	Representative
0.79	Krueger et al. (2016)	USA / PSID	Representative
[0.79, 1.02]	Overall Range		

C.3 Data on Participation Rates: Survey of Consumer Finances 2022

Table C.2 includes data on direct stock holdings and primary residence holdings from the Survey of Consumer Finances 2022 across the income distribution. The table reports the percentage of households who directly held stock and who own a primary residence in each percentile range.[2]

Table C.2. Participation Rates across the Household Distribution in the SCF 2022

Percentile of Income Distribution	*Percent of Direct Stock Holders (%)*	*Percent of Primary Residence Owners (%)*
90-100	56.3	90.3
80-89.9	40.1	88.5
60-79.9	21.5	80.7
40-59.9	17.0	69.4
20-39.9	11.0	49.0
< 20	7.0	41.7

[2] The data have been retrieved from:
https://www.federalreserve.gov/econres/scf/dataviz/scf/table/#series:Directly_Held_Stocks;demographic:inccat;population:all;units:have
and from:
https://www.federalreserve.gov/econres/scf/dataviz/scf/table/#series:Primary_Residence;demographic:inccat;population:all;units:have.

D An Isomorphic Specification of Mental Accounting

This section considers the mental accounting utility function in Graham and McDowall (2026)[3] and shows that, after adding mental classification rules and treating mental account balances as state variables, the model of mental accounts is isomorphic to the one proposed in this paper.

D.1 Household Problem

Consider again the same environment where households maximize:

$$E_0 \sum_{t=0}^{\infty} \beta^t U_t$$

subject to

$$c_{h,t} + b_{h,t+1} = y_{h,t} + Tr_{h,t} + \left(1 + R_t^b\right) b_{h,t},$$

$$b_{h,t+1} \geq \underline{b},$$

where the variables behave exactly as in the paper, except for utility in period *t*, which now is:

$$U\left(c_t \middle| c_t^d\right) = \begin{cases} u(c_t) & \text{if} \quad c_t \leq c_t^d \\ u(c_t) + \psi\left[u\left(c_t^d\right) - u(c_t)\right] & \text{if} \quad c_t > c_t^d \end{cases},$$

where $u(.)$ is as in the main text, $0 \leq \psi < 1$ is the mental accounting parameter, and the threshold value of consumption, c_t^d, is equal to the current income:

$$c_t^d = y_t.$$

D.2 Adding Mental Classification Rules: Mental Account Balances as State Variables

Incentives and optimal choices at the kink can be characterized analogously as in this paper.[4] In particular, since the utility function is non-differentiable at $c = c^d = y$ and features a downward jump in marginal utility of size $1 - \psi$, households find it optimal to set consumption equal to income when the inequalities below hold:

$$\lim_{c \to y^-} \frac{\partial U(c|r)}{\partial c} > \beta \frac{\partial}{\partial b} E[V(y', b')] > \lim_{c \to y^+} \frac{\partial U(c|r)}{\partial c}.$$

[3] This utility function was also used in the first version of this paper, Gimeno-Ribes (2022), which contains the main results reproduced here.

[4] Recall that Graham and McDowall's Euler equation, by assumption, only applies to choices anywhere but at the kink.

However, this specification assumes that the consumption threshold value is always equal to income. If there are additional shocks or transfers that may be classified as either income or assets and generate a different consumption response, then a more general formulation is required. That can be accommodated by adding mental classification rules (as in the paper), together with the consideration of the mental account balances as state variables of the household problem. In the environment that results, the condition for optimal behavior at the kink becomes:

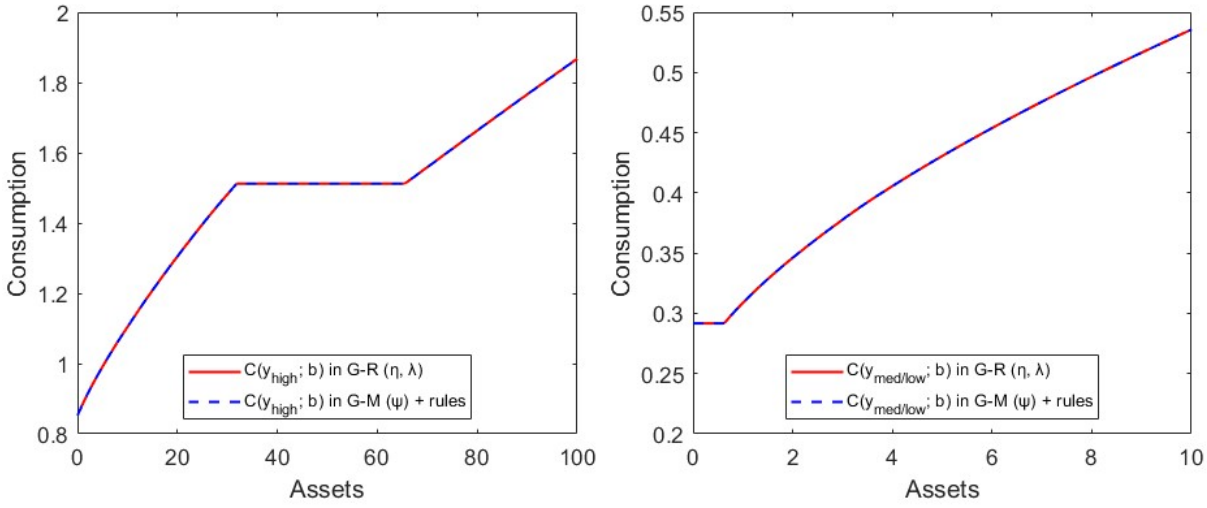
$$\lim_{c \to y_m^-} \frac{\partial U(c|r)}{\partial c} > \beta \frac{\partial}{\partial b} E[V(y'_m, b'_m)] > \lim_{c \to y_m^+} \frac{\partial U(c|r)}{\partial c}.$$

Note an additional difference with respect to Graham and McDowall: here the case $\psi = 1$ is excluded. Again, by analogy, when $\psi = 1$ utility is flat for $c > y$, there is no fixed point of the problem.

D.3 Isomorphism and Model Predictions

Note that the above condition for hand-to-mouth behavior does not depend on the specific mathematical form of the utility function, but on the property that there is a downward jump in the marginal utility. For that reason, the condition looks identical to the one derived in the main text of the paper – the 1-asset version of it–. As long as the jump in the marginal utility is of the same sign and size, namely when $1 - \psi = \frac{1-\eta\lambda}{1-\eta}$, the same wedge appears in marginal incentives at the kink, leading to the same choices. Facing the same type of marginal incentives, the household problem can be solved with an algorithm following the same structure as in Online Appendix A, but adjusting for the specific utility function used in this case. The rest of the model is analogous: households on the First-Order Condition either smooth consumption or are liquidity constrained.

The specification is isomorphic to the one presented in this paper. In particular, the consumption policy functions are identical between specifications (see Figure D.1), and so are the predictions in terms of MPCs and wealth accumulation (a selection thereof is available in Table D.1). Table D.1 also shows that the isomorphism holds in a 2-asset environment as in the main text.



Panel A: Policy function, high income. Panel B: Detail of pol. fun., medium/low income.

Figure D.1. Consumption policy functions across liquid assets for different levels of income in the Graham-McDowall (G-M) model after adding mental classification rules and in the Gimeno-Ribes model (G-R).

Table D.1 Isomorphism in mental accounting formulation: Graham-McDowall (G-M), Gimeno-Ribes (G-R)

Model	MA1A		MA4A		MA2A	
Mental acc. Specification	G-M + rules	G-R	G-M + rules	G-R	G-M + rules	G-R
Preference parameters						
β (discount factor)	0.9917	0.9917	0.9916	0.9916	0.9956	0.9956
η (gain-loss utility)	-	0.1497	-	0.0769	-	0.0996
λ (loss aversion)	-	2.5	-	2.5	-	2.5
ψ (GM parameter)	0.2641	-	0.1249	-	0.1658	-
Downward jump in U_c	0.7359	0.7359	0.8751	0.8751	0.8342	0.8342
Main Predictions						
Assets / ann. income	4.10	4.10	4.10	4.10	4.10	4.10
Liquid assets / ann. income	-	-	0.744	0.744	0.829	0.829
Illiq. assets / ann. income	-	-	3.356	3.356	3.271	3.271
Aggr. MPC (income)	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%
Share of MPC(y) = 100%	18.7%	18.7%	10.6%	10.6%	14.0%	14.0%
Aggr. MPC (liq. assets)	2.74%	2.74%	8.89%	8.89%	6.19%	6.19%
Aggr. MPC (ill. assets)	2.74%	2.74%	1.49%	1.49%	1.44%	1.44%

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