# THE MACROECONOMICS OF MENTAL ACCOUNTING: CONSUMPTION AND STABILIZATION POLICY

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## Abstract in English

In this dissertation I study Mental Accounting and how it affects consumption and saving decisions of households.

In the introductory chapter I provide an overview of the research problem and I explain why its study is of scientific interest. I start my analysis in the second chapter, where I revisit the concept of Mental Accounting. Then I show how Mental Accounting can be sensibly expressed as a variant of prospect theory and reference dependence, with loss aversion relative to current income (the reference point). I introduce Mental Accounting into an environment set in partial equilibrium featuring incomplete markets, idiosyncratic income risk, and household heterogeneity. Once I have defined a problem of these characteristics, where the utility function has a non-differentiability point or kink, I explain the basic effects of Mental Accounting on the consumption and policy functions of the household problem in the steady state. In particular, I show how Mental Accounting modifies marginal incentives and, thereby, optimal choices.

Next I analyze how households with Mental Accounting respond to different income and wealth shocks. The fundamental result is that Mental Accounting improves the explanatory power of the model along a number of dimensions. First, I consider marginal propensities to consume (MPC) out of transitory shocks to income and/or wealth, and I compare these against the empirical evidence. Mental Accounting resolves the difficulty of one-asset incomplete-markets models in matching the aggregate MPC, aggregate wealth, and median wealth. In addition, Mental Accounting offers a unified explanation of several MPC anomalies: liquid households have high MPCs and contribute substantially to the aggregate MPC; the MPC distribution is bi-modal, mimicking a spender-saver structure; MPCs are account-specific, with MPCs out of income (dividends) being higher than MPCs out of assets (capital gains); the intertemporal MPC features smaller anticipation and smaller lagged effects, as well as excess sensitivity; MPCs are asymmetric with respect to the size and the sign of the shock.

Second, I consider large and/or permanent shocks to income. I characterize life-cycle choices, and I show that Mental Accounting can rationalize the retirement-consumption puzzle. A recurring theme throughout this chapter is that, with Mental Accounting, savings play a more limited role in smoothing transitory and permanent income shocks than in the rational counterpart models.

The third chapter carries out an analogous analysis to chapter 2 in an environment with two assets with different degrees of liquidity. Many of the properties of Mental Accounting documented for the 1-asset model carry over to the 2-asset model. In addition, Mental Accounting is able to solve specific challenges facing the 2-asset model. In particular, there is no longer a trade-off between a realistic aggregate MPC and a realistic return spread between the assets, while the model remains consistent with the estimated shares of poor hand-to-mouth and wealthy hand-to-mouth. In addition, the realistic return spread also helps deliver a more realistic ratio of aggregate consumption to aggregate household income. I also consider large lottery payments, and I show that size considerations are essential in the comparison between model predictions and empirical evidence.

In the fourth chapter I embed Mental Accounting in an otherwise standard general equilibrium model, namely a Heterogeneous Agent New Keynesian economy. In this environment, I study the transmission of macroeconomic policies to consumption. Here again Mental Accounting is able to explain a number of empirical facts that are at odds with leading models. In particular: (i) monetary policy generates small intertemporal substitution and large general-equilibrium income effects, both among liquid households and in the aggregate; (ii) monetary policy announcements are less powerful than contemporaneous interest rate shocks; (iii) Ricardian Equivalence fails, as the government spending multipliers with balanced budget is substantially smaller than with debt financing; (iv) deficits are not expansionary enough to finance themselves, consistent with evidence on intertemporal MPCs. I compare the findings with a representative-agent and a two-agent New Keynesian environments.

## Resum en Valencià

En aquesta tesi estudie la comptabilitat mental, i com aquesta afecta les decisions de consum i estalvi de les famílies.

En el capítol d'introducció, done una visió general del problema d'investigació i explique per què l'estudi del mateix és d'interés científic. Comence la meua anàlisi en el segon capítol, on revisite el concepte de comptabilitat mental. A continuació, mostre que la comptabilitat mental, com fricció que és, es pot modelar com una variant de *prospect theory* i *reference dependence*, variant en la qual l'individu té aversió a la pèrdua respecte de la seua renda, que constitueix el punt de referència. Introduïsc la comptabilitat mental en un model definit en equilibri parcial amb mercats incomplets, risc idiosincràtic a la renda, i heterogeneïtat en les famílies. Una vegada que he definit un problema d'aquestes característiques, on la funció d'utilitat té un punt que no és diferenciable, explique els efectes fonamentals de la comptabilitat mental sobre les funcions política de consum i estalvi del problema de les famílies en el estat estacionari. En concret, mostre com la comptabilitat mental modifica els incentius marginals i, a través d'ells, les decisions òptimes.

Més endavant analitze com les famílies amb comptabilitat mental responen a diferents xocs a la renda i a la riquesa. El resultat principal d'aquest capítol es que la comptabilitat mental millora el poder explicatiu del model en diverses dimensions. En primer lloc, aborde les propensions marginals a consumir (PMC) de xocs transitoris a la renta i/ó a la riquesa, i les compare amb la evidència empírica. La comptabilitat mental resol la dificultat que tenen els models de un actiu i mercats incomplets a explicar la PMC agregada, la riquesa agregada, i la riquesa mediana. A més a més, la comptabilitat mental proporciona una explicació unificada de anomalies al voltant de les PMCs en els dos models: les famílies amb riquesa líquida tenen PMC elevades i contribueixen de manera substancial a la PMC agregada; la distribució de PMCs es bi-modal, evocant la estructura de gastadors i estalviadors; les PMCs varien en funció de cada compta mental, i la PMC de la renda (o dividends) es més alta que la PMC de la riquesa (o plusvàlues); la PMC inter-temporal té uns efectes de anticipació del xoc i posteriors al xoc més reduïts, i presenta un excés de sensibilitat; les PMCs on asimètriques respecte a la magnitud i al signe del xoc.

En segon lloc, considero xocs grans i/ó permanents a la renda. Analitze les decisions al llarg del cicle vital, i demostre que la comptabilitat mental pot racionalitzar els efectes de la jubilació sobre el consum. Un tema recurrent en aquest capítol es que, en presència de comptabilitat mental, els estalvis tenen un paper més limitat a l'hora de suavitzar els xocs transitoris i permanents, en comparació amb models d'elecció purament racional.

El tercer capítol desenvolupa una anàlisi anàloga a la del capítol 2 en un model amb dos actius que tenen diferent grau de liquiditat. Moltes propietats de la comptabilitat mental documentades en el model de 1 actiu apareixen novament en el model amb 2 actius. A més a més, la comptabilitat mental és capaç de resoldre alguns problemes específics del model de 2 actius. En particular, por explicar la PMC agregada i el diferencial de rendiments entre els 2 actius, mentre seguix sent coherent amb els percentatges estimats de famílies amb poca riquesa líquida (*poor hand-to-mouth* y *wealthy hand-to-mouth*). Amb aquest diferencial de rendiments, també es pot generar una ràtio de consum agregat sobre renda familiar agregada que es més realista. També considere loteries de quantitats significatives, i demostre que és essencial tenir en compte la magnitud del xoc a l'hora de comparar les prediccions del model amb l'evidència empírica.

En el quart capítol, introduïsc la comptabilitat mental en un model d'equilibri general del tipus Neo Keynesià amb Agents Heterogenis. En aquesta economia, estudie la transmissió de polítiques macroeconòmiques al consum. Ací també obtinc el resultat que la comptabilitat mental té la capacitat d'explicar un nombre de fets empírics que estan en contradicció amb altres models. Més concretament: (i) la política monetària genera menys substitució intertemporal i més efectes de equilibri general sobre la renda, tant a les famílies amb riquesa líquida com a nivell agregat; (ii) els anuncis de política monetària tenen un efecte menor que els xocs contemporanis sobre el tipus d'interés; (iii) la Equivalència Ricardiana no es complisc, perquè els multiplicadors fiscals tenen un efecte substancialment menor quan es financen amb equilibri pressupostari que quan es financen amb deute públic; (iv) els dèficits fiscals no son suficientment expansius com per a auto-finançar-se, d'acord amb l'evidència sobre PMC intertemporals. Compare els resultats amb un model Neo Keynesià d'agent representatiu i un altre de dos agents.

## Resumen en Castellano

En esta tesis estudio la contabilidad mental, y cómo ésta afecta a las decisiones de consumo y ahorro de los hogares.

En el capítulo introductorio, proporciono una visión general del problema de investigación y explico por qué el estudio del mismo es de interés científico. Comienzo mi análisis en el segundo capítulo, donde revisito el concepto de contabilidad mental. A continuación, muestro que la contabilidad mental, en cuanto que fricción, se puede modelar como una variante de *prospect theory* y *reference dependence*, variante en la cual el individuo tiene aversión a la pérdida respecto de su propia renta, que constituye el punto de referencia. Introduzco la contabilidad mental en un modelo definidos en equilibrio parcial, con mercados incompletos, riesgo idiosincrático de la renta, y heterogeneidad en los hogares. Una vez definido el problema de estas características, donde la función de utilidad tiene un punto que no es diferenciable, explico los efectos básicos que tiene la contabilidad mental sobre las funciones política de consumo y ahorro del problema de los hogares en el estado estacionario. En concreto, muestro la manera en que la contabilidad mental modifica los incentivos marginales y, a través de ellos, las decisiones óptimas.

Más adelante analizo cómo los hogares con contabilidad mental responden a diferentes shocks a la renta y a la riqueza. El resultado principal de este capítulo es que la contabilidad mental mejora el poder explicativo del modelo en varias dimensiones. En primer lugar, abordo las propensiones marginales a consumir (PMC) de shocks transitorios a la renta y/o a la riqueza, y los comparo con la evidencia empírica. La contabilidad mental resuelve la dificultad que tienen los modelos de un activo y mercados incompletos para explicar la PMC agregada, la riqueza agregada, y la riqueza mediana. Además, la contabilidad mental proporciona una explicación unificada de las anomalías alrededor de las PMC en ambos modelos: los hogares con riqueza líquida tienen PMC elevadas y contribuyen de manera sustancial a la PMC agregada; la distribución de PMCs es bi-modal, evocando la estructura de gastadores y ahorradores; las PMCs varían en función de cada cuenta mental, y la PMC de la renta (o dividendos) es mayor que la PMC de la riqueza (o plusvalías); la PMC inter-temporal tiene unos efectos de anticipación al shock y posteriores al shock más reducidos, y presenta un exceso de sensibilidad; las PMC son asimétricas respecto a la magnitud y al signo del shock.

En segundo lugar, estudio shocks grandes y/o permanentes a la renta. Analizo las decisiones a lo largo del ciclo vital, y demuestro que la contabilidad mental puede racionalizar los efectos de la jubilación sobre el consumo en los dos modelos considerados. Un tema recurrente en este capítulo es que, en presencia de contabilidad mental, los ahorros tienen un papel limitado a la hora de suavizar los shocks transitorios y permanentes, en comparación con modelos de elección puramente racional.

En el tercer capítulo desarrollo un análisis análogo al del capítulo 2, en un modelo con dos activos que tienen diferente grado de liquidez. Muchas de las propiedades de la contabilidad mental documentadas en el modelo de 1 activo aparecen nuevamente en el modelo de 2 activos. Además, la contabilidad mental es capaz de resolver algunos problemas específicos del modelo de 2 activos. En particular, la contabilidad mental es capaz de explicar la PMC agregada y el diferencial de rendimientos entre los 2 activos, mientras sigue siendo coherente con los porcentajes estimados de hogares con poca riqueza líquida (*poor hand-to-mouth* y *wealthy hand-to-mouth*). Con este diferencial de rendimientos, también puede generar una ratio de consumo agregado sobre renta agregada de los hogares que es más realista. También analizo loterías de gran tamaño, y demuestro que es esencial tener en cuenta la magnitud del shock al comparar las predicciones del modelo con la evidencia.

En el cuarto capítulo, introduzco la contabilidad mental en un modelo de equilibrio general del tipo Neo Keynesiano con Agentes Heterogéneos. En esta economía, estudio la transmisión de políticas macroeconómicas al consumo. Aquí también obtengo el resultado de que la contabilidad mental tiene la capacidad de explicar un número de hechos empíricos que están en contradicción con otros modelos. Más concretamente: (i) la política monetaria genera menos sustitución intertemporal y más efectos de equilibrio general sobre la renta, tanto en los hogares con riqueza líquida como a nivel agregado; (ii) los anuncios de política monetaria tienen un efecto menor que los shocks contemporáneos sobre el tipo de interés; (iii) la Equivalencia Ricardiana no se cumple, puesto que los multiplicadores fiscales tienen un efecto sustancialmente menor cuando se financian con equilibrio presupuestario que cuando se financian con deuda pública; (iv) los déficits fiscales no son lo suficientemente expansivos como para auto-financiarse, de acuerdo con la evidencia sobre PMC intertemporales.

# 1. Objetivos, Metodología, y Conclusiones de la Tesis Doctoral

## 1.1 Objetivos

La contabilidad mental es un concepto popularizado por los trabajos de Richard Thaler sobre economía del comportamiento (Shefrin y Thaler, 1988; Thaler, 1990). La contabilidad mental constituye una hipótesis sobre el comportamiento de los individuos y/u hogares, a saber: que éstos separan sus recursos disponibles en distintas cuentas mentales, y que tienen preferencias distintas a consumir los recursos de cada cuenta mental.

Sin embargo, no existe un modelo formal de dicha hipótesis, lo cual genera dos problemas fundamentales. En primer lugar, la hipótesis no se puede someter a examen empírico, puesto que carece de predicciones obtenidas a partir de la solución de un modelo. En segundo lugar, la hipótesis no se puede comparar con otras hipótesis.

Nos encontramos ante un problema de interés científico, que esta tesis doctoral se dispone a abordar. Por tanto, la tesis constituye un estudio de la contabilidad mental, y en particular de cómo ésta afecta a las decisiones de consumo y ahorro de los hogares.

La resolución del problema de investigación se articula en dos objetivos. Primero, analizar en qué manera la contabilidad mental mejora el poder explicativo de los modelos de consumo, tanto el modelo estándar de mercados incompletos de un activo, como el modelo de 2 activos con distinto grado de liquidez. El segundo objetivo es entender qué implicaciones tiene la contabilidad mental para la transmisión de las políticas macroeconómicas al consumo.

## 1.2 Metodología

Para resolver el problema de investigación planteado, la tesis emplea una metodología basada en cuatro principios rectores.

### 1.2.1 Principios Generales

El primer principio consiste en formalizar la contabilidad mental en el marco axiomático dominante dentro de la economía del comportamiento, es decir, utilizando las herramientas de *prospect theory* (Kahneman y Tversky, 1979) y *reference dependence* (Köszegi y Rabin, 2006).

El segundo principio es que, siguiendo la metodología expuesta por Rabin (2002; 2013a), los elementos de psicología y racionalidad limitada se analizan incorporándolos a modelos de optimización como los utilizados en la teoría neoclásica; además, es deseable que estén expresados como extensiones de modelos existentes y que se puedan aplicar en otros contextos (Rabin, 2013b).

El tercer principio consiste en evaluar la aportación de la contabilidad mental y su validez como hipótesis de la siguiente manera: (1) comparando las predicciones del modelo con las de un modelo sin la fricción de contabilidad mental; y (2) comparando las predicciones del modelo con la evidencia empírica disponible. Este planteamiento permite no sólo entender los mecanismos teóricos de la contabilidad mental, sino medir de manera precisa la mejora que supone en el poder explicativo.

El cuarto principio es que utilizo modelos de consumo donde los hogares son heterogéneos en renta y riqueza. Esta clase de modelos presenta tres características fundamentales. Primero, se diferencian de los modelos de agente representativo en que sus predicciones pueden compararse con la evidencia empírica a nivel microeconómico, permitiendo así una valoración mucho más detallada y pormenorizada. Segundo, los modelos de consumidores heterogéneos constituyen el eje central de la nueva generación de modelos macroeconómicos (Kaplan, Moll, y Violante, 2018): su filosofía es que las variables agregadas deben ser el resultado de la agregación de las decisiones a nivel microeconómico, una vez éstas hayan sido validadas empíricamente. Un elemento central que se utiliza tanto para disciplinar empíricamente los modelos de consumo y los modelos macroeconómicos son las propensiones marginales a consumir. Tercero, y relacionado con el anterior, la introducción de elementos de economía del comportamiento tiene el potencial de mejorar las predicciones a nivel microeconómico, y por tanto dichos "modelos macroeconómicos con agentes heterogéneos son la puerta de entrada a la macroeconomía del comportamiento" (Moll, 2020).

Una vez establecidos los principios metodológicos que guían la tesis, expuestos en el capítulo introductorio, paso a detallar el desarrollo y aplicación de los mismos en los capítulos posteriores.

### 1.2.2 Capítulo 2

En el segundo capítulo hago una propuesta de formalización de la contabilidad mental, es decir, la expresión matemática del concepto de manera que se pueda incorporar a un modelo de consumo de los hogares. Esta expresión matemática incorpora los elementos de la psicología que se han relacionado con la contabilidad mental: por un lado, la sensación de satisfacción producida cuando el gasto en consumo se mantiene por debajo de la renta; y, por otro lado, la sensación de culpa cuando el gasto en consumo supera la renta. Dicha psicología encuentra un acomodo natural en las ya mencionadas *prospect theory* y *reference dependence*, ya que estos marcos teóricos proponen una función de utilidad definida en dos partes a cada lado del punto de referencia y con asimetría por aversión a la pérdida. En el caso que nos ocupa, la aversión a la pérdida corresponde al mencionado sentimiento de culpa, y el punto de referencia es la renta disponible, puesto que ésta se considera una de las características más destacadas y sobresalientes de los recursos de los hogares (Mankiw, 2000; Bordalo et al., 2013). De esta manera, los hogares clasifican sus recursos en dos cuentas mentales, una de renta y otra de riqueza, y tienen una preferencia a consumir de la renta pero no de la riqueza.

Una vez definida la función de utilidad, la incorporo a un modelo de equilibrio parcial con mercados incompletos, riesgo idiosincrático de la renta, y agentes heterogéneos (Deaton, 1991; Zeldes, 1989; Carroll, 1997). El problema dinámico que nos ocupa, que cuenta con una distribución endógena de hogares, tiene la dificultad añadida de que la función de utilidad tiene un punto donde no es diferenciable; por ello, debo adaptar el método numérico para que sea capaz de resolver dicho problema correctamente. En concreto, el método debe basarse o bien en la ecuación de Bellman, o bien en la derivada de la función valor, para así sortear los puntos donde la derivada de la función de utilidad no existe.

El mencionado algoritmo permite obtener el estado estacionario del problema de horizonte infinito, como es habitual en macroeconomía; éste consta de las funciones política de los hogares, así como su distribución estacionaria. Para proporcionar una comprensión profunda de la contabilidad mental, utilizo las condiciones de primer orden del problema de optimización para analizar los incentivos marginales a los que se enfrentan los hogares, y cómo dichos incentivos condicionan las decisiones óptimas. Puesto que se trata de un modelo con hogares heterogéneos en renta y riqueza, documento cómo la contabilidad mental afecta de manera diferente a los hogares dependiendo del lugar de la distribución de renta y riqueza en el que se encuentren.

La calibración del modelo persigue dos objetivos concomitantes: generar un nivel de riqueza agregada realista y una propensión marginal al consumo agregada realista (Kaplan y Violante, 2022). Para el primer objetivo, se utiliza el factor de descuento. Para el segundo, el peso de la contabilidad mental sobre la función de utilidad.

Sobre el modelo calibrado, el capítulo 1 realiza un estudio sistemático y pormenorizado de las propensiones marginales a consumir (PMC) que surgen de shocks transitorios a la renta, salvo que se indique lo contrario, y las evalúa contra la evidencia empírica. Las PMC se calculan como el cambio en el consumo, respecto al estado estacionario, que produce la recepción de una transferencia. Para ello, analiza las PMC a nivel individual de cada hogar; la distribución de valores de PMC; las PMC medias a lo largo de la distribución de hogares; la PMC agregada; las PMC que resultan de shocks a la cuenta mental de la renta y de la riqueza, respectivamente; las PMC intertemporales, así como el papel de los ahorros para suavizar los shocks; y las asimetrías de las PMC respecto de la magnitud y el signo de los shocks. Como parte de dicho estudio, se consideran los problemas específicos que presenta el modelo estándar de mercados incompletos que se utiliza como base, tanto aquellos de los que habla la literatura, como algunos nuevos.

El capítulo 1 también documenta la respuesta del consumo frente a shocks de carácter permanente. Para ello, considera el clásico ejercicio de ciclo vital, que es un problema de horizonte finito, y analiza la respuesta del consumo a la jubilación, tanto a nivel agregado como a lo largo de la distribución de hogares, y evalúa el modelo frente a la evidencia empírica.

### 1.2.3 Capítulo 3

En el tercer capítulo introduzco la contabilidad mental en un modelo de agentes heterogéneos en equilibrio parcial con mercados incompletos, riesgo idiosincrático a la renta, y dos activos con distinto grado de liquidez. Utilizo una formulación bastante extendida en la literatura (Auclert et al., 2024; Bayer et al., 2024), según la cual los hogares tienen acceso al activo ilíquido de manera aleatoria y con una frecuencia relativamente baja cada periodo. De esta manera, la mayor parte del tiempo los hogares no tienen acceso al activo ilíquido, que a cambio presenta unos rendimientos superiores al del activo líquido.

La calibración en este caso es más compleja que la del modelo de 1 activo, puesto que tiene que cumplir un mayor número de objetivos. Además del objetivo de riqueza agregada y de PMC agregada, el modelo también debe cumplir los porcentajes estimados de hogares con poca riqueza líquida, tanto si carecen de riqueza ilíquida (*poor hand-to-mouth*) como si disponen de ella (*wealthy hand-to-mouth*). Por último, el diferencial de rendimientos entre los dos activos juega un papel importante, por lo que considero diferentes versiones del modelo con distintos diferenciales de rendimientos.

El análisis de este capítulo sigue una estructura análoga a la del capítulo anterior. Es decir, comienzo exponiendo las propiedades de las funciones política en base a las condiciones de primer orden, y después detallo las PMC de shocks transitorios en sus distintas variantes. En este caso, hago especial énfasis en aquellos problemas específicos del modelo de 2 activos. En particular, considero algunos problemas que ha señalado la literatura, como los efectos derivados de distintos supuestos sobre el diferencial de rendimientos entre los 2 activos; también señalo problemas nuevos, que aparecen de considerar otros elementos del modelo, como es el nivel de consumo agregado respecto al resto de variables. Además, señalo algunos detalles importantes a la hora de evaluar el modelo mediante la evidencia empírica.

Este capítulo también brinda la oportunidad de discutir con mayor detalle los efectos de shocks de distinta magnitud. Para ello, utilizo un caso de loterías de tamaño significativo para evaluar las propiedades del modelo.

### 1.2.4 Capítulo 4

En el cuarto capítulo introduzco la contabilidad mental en un modelo de equilibrio general tipo Neo Keynesiano con Agentes Heterogéneos (HANK, por sus siglas en inglés). Este modelo consta de varios bloques diferenciados. Por un lado, el bloque de los hogares heterogéneos, similar al del capítulo 1, pero donde el salario que reciben es a cambio de un trabajo realizado. El mercado de trabajo se modela de una manera muy estilizada y reducida, donde existe una regla de fijación de salarios de manera que éstos presentan rigidez y responden muy poco a las variaciones en la demanda de trabajo. Por otro lado, el bloque de las empresas, que a cambio de un salario contratan a los trabajadores para producir bienes y servicios, que son vendidos a y consumidos por los hogares y el gobierno / sector público. Además, las empresas operan en competencia monopolística y tienen el poder de fijar precios sobre sus productos diferenciados. Por último, existe un banco central que fija tipos de interés en respuesta a la inflación siguiendo una regla de Taylor, y un gobierno u autoridad fiscal que financia el gasto público recaudando impuestos y emitiendo deuda pública.

En el modelo con agentes heterogéneos documento el impacto de la fricción de contabilidad mental sobre el comportamiento de los consumidores, tanto a nivel agregado, como a lo largo de la distribución de renta y riqueza. Además, y para poner dichos resultados en perspectiva, los comparo con modelos Neo-Keynesiano de agente representativo y de dos agentes (respectivamente, RANK y TANK, por sus siglas en inglés). Ello permite establecer un vínculo con el grueso de la literatura anterior a los modelos HANK, cuya aparición ha sido reciente. En mi análisis, los modelos RANK y TANK se diferencian de los HANK exclusivamente en el bloque de los hogares, mientras que el resto de elementos se mantienen, para facilitar dicha comparación. Más concretamente, el modelo de agente representativo se apoya sobre el supuesto de mercados completos, es decir, que el consumidor tiene a su disposición todo tipo de activos financieros que le permiten mitigar los distintos shocks que pueda recibir. A su vez, el modelo de dos agentes supone que existen dos tipos de consumidores: ahorradores, que consumen y ahorran en base a la solución de un problema de optimización, y gastadores, que no disponen de riqueza alguna y que consumen su renta; el peso relativo de cada tipo de agente se calibra para conseguir la misma PMC agregada que en el modelo de contabilidad mental.

El análisis de estos modelos también requiere la utilización de métodos numéricos adecuados; en este caso, sigo las indicaciones de Boppart et al. (2018) y de McKay et al. (2016). En primer lugar, considero *MIT shocks*, es decir, shocks de carácter exógeno e inesperado y con una probabilidad nula de volverse a repetir. En segundo lugar, resuelvo las funciones de impulso respuesta a dichos shocks como *perfect foresight paths*, es decir, sendas de respuesta agregada cuya dinámica es perfectamente anticipada y sin incertidumbre a nivel agregado. En tercer lugar, las magnitudes agregadas relativas a los hogares se obtienen resolviendo el problema de los hogares hacia atrás en el tiempo y después simulando la distribución de los hogares hacia delante en el tiempo. Cabe resaltar que los modelos RANK y TANK no requieren la simulación de la distribución puesto que ésta es conocida y se ha determinado exógenamente. Por último, el equilibrio general del modelo en cada momento del tiempo se obtiene mediante un proceso iterativo, a partir de una solución inicial que se va mejorando en sucesivas iteraciones hasta que el modelo converge. Esta metodología numérica se emplea para el análisis de los shocks que se detallan a continuación.

En primer lugar, someto los modelos a shocks de política monetaria, y obtengo las respuestas de cantidades, precios, y políticas a nivel agregado. Ello me permite hacer una descomposición de los efectos de cada precio y/o política sobre el consumo en efectos directos e indirectos, siguiendo la literatura (Kaplan, Moll, y Violante, 2018). Cuantifico, por un lado, el canal de sustitución intertemporal y, por otro lado, los efectos de equilibrio general de renta y riqueza sobre el consumo. En este análisis me centro no sólo en los efectos a nivel agregado, sino también en la incidencia de la política monetaria sobre la distribución de hogares. Esto es algo que la literatura ha enfatizado y, además, me permite comparar las predicciones de los modelos entre sí y con la evidencia empírica disponible.

En segundo lugar, estudio los anuncios de política monetaria (*forward guidance*), es decir, los shocks sobre el tipo de interés en el futuro. En este caso sigo una metodología similar al shock anterior, pero con dos variaciones, en línea con la literatura (McKay, Nakamura, y Steinsson, 2016). Primero, prescindo de la regla de Taylor y asumo que el banco central es capaz de mantener un tipo de interés real constante. Segundo, el análisis se centra en los efectos de dicho anuncio desde el presente hasta el momento futuro en el que el shock ocurre.

En tercer lugar, considero un shock al gasto público. Ello me permite hacer el clásico análisis de equivalencia Ricardiana basado en la comparación entre el multiplicador de gasto público de presupuesto equilibrado y el multiplicador financiado con deuda pública, que se repaga en el futuro siguiendo una regla fiscal. Ello me permite documentar una propiedad fundamental de los modelos macroeconómicos, y además me da la oportunidad de evaluar los efectos de distintas reglas fiscales, tanto a nivel agregado como a lo largo de la distribución.

Por último, abordo la pregunta de si los déficits fiscales pueden autofinanciarse, es decir, si tienen un efecto agregado lo suficientemente expansivo como para generar un aumento de la recaudación que devuelva la deuda pública a su nivel inicial sin la necesidad de realizar ningún ajuste fiscal posterior. Para ello, supongo que la autoridad fiscal realiza una transferencia fiscal financiada enteramente con deuda, y que no realiza ningún ajuste fiscal durante un periodo prolongado de tiempo (17,5 años), transcurrido el cual se activa de nuevo una regla fiscal que implementa los ajustes necesarios para devolver a la deuda a su nivel de estado estacionario en caso de que ésta todavía no haya sido repagada. Dicho periodo de tiempo, planteado por Angeletos et al. (2024), es suficiente para identificar si la senda de deuda pública converge hacia el estado estacionario o si, por el contrario, diverge del mismo; por tanto, resulta suficiente para contestar la pregunta planteada.

En este caso, hago una pequeña discusión del trabajo de Angeletos et al. (2024), que aborda la misma cuestión sobre la sostenibilidad fiscal de los déficits. Concretamente, comento la idoneidad de la evidencia empírica que se utiliza para calibrar el bloque de los hogares.

## 1.3 Conclusiones

La conclusión fundamental de la tesis es que la contabilidad mental es una manera sencilla de mejorar el poder explicativo de los modelos de consumo con hogares heterogéneos, tanto si se plantean en equilibrio parcial como si se plantean como parte de modelos de equilibrio general para el análisis de políticas macroeconómicas. A continuación, explico las conclusiones con mayor detalle, organizadas por capítulos.

### 1.3.1 Capítulo 2

La contabilidad mental mejora el poder explicativo del modelo de un activo y mercados incompletos en varias dimensiones, tanto en las propensiones marginales a consumir de shocks transitorios como en la respuesta a shocks grandes y/o permanentes.

La fricción de contabilidad mental, en tanto que punto no diferenciable de la función de utilidad, hace que una parte de los hogares escojan de manera óptima situarse en dicho punto de no diferenciabilidad, siendo su consumo óptimo igual a su renta disponible; por tanto, me refiero a ellos como hogares *hand-to-mouth* (por el término popular en inglés), aunque también podría emplear el término de hogares keynesianos o no Ricardianos. Dicha decisión óptima se puede entender a partir de la condición de primer orden: incrementar el consumo por encima del punto de referencia lleva aparejado un coste de utilidad, y por tanto no compensa la reducción en el valor marginal por tener menos ahorros en el siguiente periodo; y al revés, reducir el consumo por debajo del punto de referencia lleva aparejado una ganancia de utilidad que no compensa el aumento del valor marginal por disponer de menos ahorros en el siguiente periodo. El resto de hogares, que no se encuentran en el punto de no diferenciabilidad, se comportan como en el modelo estándar.

La capacidad del modelo para generar hogares *hand-to-mouth* de manera endógena a partir de la fricción de contabilidad mental supone un resultado importante, puesto que proporciona una micro-fundación de la popular teoría de los ahorradores y gastadores (Campbell y Mankiw, 1989; 1991). Esta predicción está en línea con la evidencia empírica, que ha observado la presencia de dos tipos de hogares diferenciados, con PMC bajas (ahorradores) y altas (gastadores). Además, dicha distribución bi-modal de PMCs se ha utilizado como vara de medir la capacidad explicativa de otros modelos teóricos de consumo (Kaplan y Violante, 2014).

Este mecanismo tiene especial interés porque, a diferencia de modelos de 1 y 2 activos con preferencias estándar, no depende de la cantidad de riqueza (líquida) disponible. Así, los hogares *hand-to-mouth* aparecen repartidos a lo largo de toda la distribución de la riqueza y renta, también en aquellos de riqueza y renta altas. De esta manera, el modelo es capaz de generar una PMC alta en hogares a lo largo de toda la distribución, lo cual es coherente con la evidencia empírica.

Puesto que la distribución tiene un porcentaje alto de hogares con riqueza líquida suficiente, y éstos presentan PMC medias elevadas, resulta de manera lógica que éstos realizan una contribución importante a la PMC agregada. En particular, cuando la fricción de contabilidad mental es lo suficientemente severa, el modelo es capaz de generar una PMC agregada en línea con las estimaciones, al tiempo que genera una riqueza agregada realista, y sin distorsionar la riqueza mediana ni el proceso de acumulación de riqueza. Éste es otro resultado, puesto los modelos de mercados incompletos son incapaces de explicar estos tres hechos empíricos (Kaplan y Violante, 2022).

Intuitivamente, la mayor PMC de la renta se deriva de la preferencia a de la renta y no de la riqueza. La otra cara de la misma moneda es que la PMC de la riqueza es menor que en un modelo con preferencias estándar. Es decir, la PMC es específica para cada cuenta mental de la que se pretenda consumir: la PMC de la renta es casi un orden de magnitud mayor que la PMC de la riqueza; y el mismo resultado es relevante para las diferentes PMCs estimadas en dividendos y en plusvalías de un activo financiero, como las acciones. Además, existen dos resultados empíricos que están en línea con el modelo: por un lado, los hogares admiten en encuestas que clasifican los dividendos como si fuesen renta, mientras que clasifican las plusvalías como si fueran riqueza, lo cual da respalda el supuesto del modelo; por otro lado, la distribución de PMC frente a dividendos es bi-modal, lo cual sugiere que dicha propiedad es un rasgo transversal. Como consecuencia, la contabilidad mental rompe la indiferencia entre dividendos y plusvalías que subyace al resultado de Modigliani y Miller (1965) sobre la irrelevancia de la política de dividendos de una empresa. La respuesta del consumo frente a otros shocks a la riqueza, como puede ser sobre el valor de una vivienda, o el gasto con una cuenta de ahorro destinada a un fin específico como es la matrícula universitaria, tienen un efecto similar y pueden ser racionalizados por el modelo.

Una vez explicada la reacción del consumo a un shock dentro de un mismo periodo, paso a analizar la respuesta dinámica del consumo a lo largo de varios periodos, utilizando para ello el concepto de PMC inter-temporal. Ello permite mostrar que el modelo de contabilidad mental tiene unos efectos de anticipación al shock y posteriores al shock muy reducidos, prácticamente inexistentes. Sin embargo, la reacción contemporánea al shock presenta un exceso de sensibilidad. Estas tres características, que están en línea con la evidencia empírica, constituyen un comportamiento marcadamente no Ricardiano: los hogares hacen un uso muy limitado de los ahorros para suavizar los shocks. La evidencia de la PMC intertemporal arroja otro dato importante: al mismo t

El hecho de tener una PMC específica de cada cuenta mental permite, además, combinarlas, en algunos casos específicos. Por ejemplo, Shefrin y Thaler (1988) propusieron que mientras un shock pequeño se clasifica como renta, un shock grande se clasifica entre la cuenta de renta y la de riqueza. De esta manera, el modelo es capaz de explicar que la PMC se reduce con el tamaño del shock, y más concretamente que la PMC de un shock pequeño es mayor que la de un shock grande. Otro ejemplo ocurre con los shocks de distinto signo, donde en base a la evidencia empírica disponible se puede suponer que shocks con origen o signo distinto se clasifican también en distintas cuentas mentales, dando lugar a una asimetría. Planteo que este supuesto debe ser sometido a examen empírico para disciplinar adecuadamente el modelo.

Por último, abordo los shocks permanentes a la renta en el marco de las decisiones de ciclo vital. En concreto, demuestro que la contabilidad mental puede racionalizar los efectos de la jubilación: cuando el hogar pasa de recibir un salario a una pensión, que es generalmente inferior, el consumo se reduce al mismo tiempo. Esto se debe a que los ahorros en el momento de la jubilación tienen un papel limitado a la hora de suavizar los shocks. Éste es, por tanto, un tema recurrente a lo largo del capítulo y muestra una diferencia fundamental con los modelos de elección puramente racional.

### 1.3.2 Capítulo 3

En el tercer capítulo abordo cuestiones parecidas a las del capítulo 2 en un modelo de dos activos. Cabe destacar que en este modelo existen dos fricciones. Por un lado, una fricción en la psicología humana que dificulta el uso de la riqueza para financiar el gasto en consumo. Por otro lado, una fricción en el mercado de capitales que dificulta el acceso al activo ilíquido: esto supone que los hogares deben tomar la decisión adicional de ahorrar en el activo líquido e ilíquido. El activo líquido ofrece la posibilidad potencial de suavizar el consumo frente a shocks a costa de obtener un menor rendimiento; a su vez, el activo ilíquido ofrece un mayor rendimiento, pero resulta de más difícil acceso en caso de necesidad. Por tanto, el modelo cuenta con dos fricciones que generan hogares *hand-to-mouth* de manera endógena, lo cual debe tenerse en cuenta a la hora de calibrar el modelo.

Muchas de las propiedades de la contabilidad mental documentadas y deseables en el modelo de un activo aparecen nuevamente en el modelo de 2 activos. Entre éstas se encuentran la generación de PMC altas en hogares con riqueza líquida, así como la contribución de dichos hogares a la PMC agregada. También demuestro que el análisis del ciclo vital arroja conclusiones parecidas a las obtenidas en el capítulo anterior: la contabilidad mental permite reconciliar el modelo de 2 activos con los efectos de la jubilación sobre el consumo.

Además, la contabilidad mental es capaz de resolver algunos problemas específicos del modelo de 2 activos. En particular, este modelo no es capaz de generar una PMC agregada y un diferencial de rendimientos realista entre los dos activos (Kaplan y Violante, 2022). La contabilidad mental resuelve este problema, puesto que aporta un mecanismo adicional para generar una PMC agregada. El modelo resultante es coherente con los porcentajes estimados de hogares con poca riqueza líquida (*poor hand-to-mouth* y *wealthy hand-to-mouth*), que constituyen una parte esencial del modelo de 2 activos. Además, con este diferencial de rendimientos, la ratio de consumo agregado sobre renta agregada de los hogares es más realista.

Otro elemento importante son las PMCs específicas de cada activo o de cada cuenta mental. En concreto, la literatura teórica ha comparado las predicciones del modelo de PMC respecto al activo ilíquido con la evidencia empírica de plusvalías de acciones en bolsa. Sin embargo, señalo que dicha evidencia empírica se ha obtenido a partir de acciones a las que los hogares tienen acceso directo, y cuya compra-venta tiene unos costes de transacción asociados poco relevantes; por tanto, dicha evidencia debe compararse con las predicciones del modelo relativas al activo líquido. Y éste es otro caso en donde el modelo de 2 activos no arroja una buena predicción, y debe recurrirse a la contabilidad mental para mejorarla.

También considero la PMC inter-temporal, que en el caso del modelo de 2 activos tiene unos efectos de anticipación al shock y posteriores al shock más elevados de lo observado empíricamente. La fricción de contabilidad mental reduce estos efectos de manera sustancial, aunque el modelo resultante no acaba de estar en perfecta consonancia con la evidencia empírica. También demuestro que estos efectos de anticipación y posteriores al shock son muy sensibles al caso numérico que se considere, puesto que en la frecuencia del modelo y en el riesgo idiosincrático de la renta generan comportamientos diferentes.

Por último, y como parte del análisis dinámico, reviso un estudio empírico que se ha utilizado recientemente para evaluar el modelo de dos activos. Al tratarse de shocks de gran tamaño, señalo que es fundamental tener en cuenta dicha magnitud de los shocks para realizar una adecuada comparación entre las predicciones del modelo y la evidencia empírica; de lo contrario, si se está evaluando un modelo que no responde igual a shocks de distinto tamaño, se extraen conclusiones erróneas. Otro elemento importante, puesto que estamos hablando de modelos con heterogeneidad en los hogares, es la respuesta a lo largo de la distribución. Dicho estudio obtiene que los hogares con abundante liquidez también tienen una PMC elevada, y sólo el modelo de contabilidad mental (de entre los considerados) es capaz de obtener una predicción similar.

### 1.3.3 Capítulo 4

En el cuarto capítulo, estudio las implicaciones de la contabilidad mental para la transmisión de distintas políticas monetaria y fiscal. En este caso, la contabilidad mental también tiene la capacidad de explicar un número de hechos empíricos.

En primer lugar, la política monetaria genera una menor respuesta de sustitución intertemporal y más efectos de equilibrio general sobre la renta, tanto en los hogares con riqueza líquida como a nivel agregado. En segundo lugar, los anuncios de política monetaria tienen un efecto menor que los shocks contemporáneos sobre el tipo de interés. En tercer lugar, la Equivalencia Ricardiana no se cumple, puesto que los multiplicadores fiscales de presupuesto equilibrado tienen un efecto sustancialmente menor que los financiados con déficit. Por último, los déficits fiscales no son lo suficientemente expansivos como para generar un aumento de recaudación que repague el aumento de deuda correspondiente.

Cabe destacar que los resultados, al menos en términos agregados, del modelo con contabilidad mental son similares a los del modelo con dos agentes (TANK). Sin embargo, los resultados no son idénticos en los dos modelos. Por un lado, existen diferencias a nivel agregado, entre ellas que el modelo TANK genera un efecto riqueza nulo, mientras que la evidencia empírica ha estimado sistemáticamente un efecto pequeño pero positivo, que el modelo de contabilidad mental es capaz de generar. Por otro lado, existen diferencias en la incidencia desigual de los shocks sobre la distribución. La evidencia empírica señala que todos los hogares, incluidos aquellos con riqueza líquida suficiente, responden incrementando su consumo frente a los efectos de equilibrio general de la renta tras un shock de política monetaria: este comportamiento sólo es capaz de generarlo el modelo con contabilidad mental, pero no el modelo TANK, que cuenta con una distribución muy sencilla con tan sólo dos hogares. Además, dicha incidencia desigual tiene efectos agregados, puesto que en cada modelo existe una covarianza distinta entre la incidencia y la distribución de PMCs: esto se aprecia en la importancia de la transmisión de efectos de la renta tras un shock de política monetaria, así como de política fiscal.

Para disciplinar estos modelos, la literatura tiene en cuenta la evidencia empírica de PMC inter-temporal. Puesto que estos shocks desplazan a la economía en un entorno cercano del estado estacionario, utilizo varios estudios que cuentan con shocks relativamente pequeños y del mismo orden de magnitud. El modelo de contabilidad mental es coherente con esta evidencia empírica. Pero otros trabajos en la literatura utilizan un único estudio empírico de shocks de un tamaño muy superior al que se pretende analizar. Dicha aproximación puede resultar contradictoria, especialmente si las PMC del modelo varían en función del tamaño del shock.

# 2. Chapter 1. Introduction

This dissertation attempts to answer the following questions: How does household consumption and saving respond to shocks to income and wealth? And how do macroeconomic policies transmit to household consumption? In order to answer these questions, I combine elements from three subfields of economic theory: consumption / household finance, behavioral economics, and heterogeneous-agent macroeconomics. Below I provide a brief overview of relevant developments of each subfield and how I bring them together to answer the questions above.

## 2.1 Consumption / Household Finance

The field of consumption as we know it today naturally starts with Keynes' (1936) consumption function, which posits that households consume their income and have a marginal propensity to consume (MPC) of one. A few decades later, using the utility-maximizing framework, Modigliani and Brumberg (1954) and Friedman (1957) developed, respectively, the Life-Cycle Hypothesis and the Permanent Income Hypothesis, where households consume the annuity value of their wealth and smooth the marginal utility of consumption in response to transitory income shocks.[1]

However, these Hypotheses predicted that households would respond much stronger to interest rate shocks and much weaker to income shocks than was found by the empirical evidence (Hall and Mishkin, 1982; Hall, 1988; Campbell and Mankiw, 1989; 1991). Motivated by this finding, Campbell and Mankiw proposed a sort of synthesis of the two views in the previous paragraph. Namely, that aggregate consumption could be described by a population of two types of households: spenders, i.e. Keynesian consumers, and savers, i.e. consumers à la Modigliani.

The first attempt at explaining this spender-saver dichotomy with household heterogeneity was through the incomplete markets "Buffer-Stock" model. In the presence of income uncertainty, consumers with little wealth (Zeldes, 1989; Carroll, 1997) and

[1] For the sake of completeness, it should be noted that, in his revision of the Permanent Income Hypothesis, Friedman (1963) posited that households have a 33.3% annual MPC out of windfalls – which are different from what Friedman called transitory income shocks. See Chapter 2 for more on this.

arbitrarily close the liquidity constraint (Deaton, 1991) display high MPCs, whereas wealthier consumers behave like savers.

However, this environment cannot produce a realistically high aggregate MPC that matches the estimates of recent transfer stimulus experiments and, at the same time, generate a sufficient level of aggregate wealth. One way to solve this problem is by introducing a capital markets friction, in particular a high-return asset that is costly to liquidate (Kaplan and Violante, 2014; 2022). The trade-off between the consumption-smoothing "insurance" offered by the liquid asset and the higher return offered by the illiquid asset explains the presence of wealthy hand-to-mouth households, which contribute to generate a realistically high aggregate MPC. As a result, the model generates also 'spenders' and 'savers', and the household heterogeneity across different assets also allows to match the model with the microeconomic evidence more accurately.

### 2.2 Behavioral Economics

Although many classic authors in Economics, such as Adam Smith, Irving Fisher, or John Maynard Keynes, address issues of Behavioral Economics in their writings (Thaler, 2015), it was the publication of the paper on Prospect Theory by Kahneman and Tversky (1977) that marked the beginning of the field in its modern form. Kahneman and Tversky argued that insights from psychology were needed to describe risky choices that the neoclassical framework was at odds with. Thaler (1980) followed suit and differentiated between the neoclassical framework as a good prescription of ideal behavior, and the models with psychological elements as a better description of actual behavior.

The growth and dissemination of Behavioral Economics as a field, and its application to a wide array of problems, owes much to the 'Anomalies' column run by Richard Thaler at the *Journal of Economic Perspectives* from the late 80s to the early 2000s. This column and all the surrounding efforts focused on pointing out the empirical shortcomings of the neoclassical paradigm. By doing so, they provided a set of anomalous facts that new theoretical models with behavioral insights might aim to explain.

To provide an organizing framework, behavioral models are set up as optimization problems (Rabin, 2013a) and they can be understood as departures from the neoclassical paradigm along one (or more) of the following three dimensions (Rabin, 2002): the utility function, the discounting of future utility, and the way in which agents form probabilistic beliefs. An example of the first departure can be found in Köszegi and Rabin (2006), an axiomatic formalization of reference dependence and loss aversion, the core elements of Prospect Theory. The second departure is studied, for instance, in Laibson's (1997) model of consumption with hyperbolic discounting and illiquid assets. The third appears in the recent work on diagnostic expectations (Bordalo, Gennaioli, and Shleifer, 2018).

In the realm of consumption theory, important work was done by Thaler and Shefrin (1981) and Shefrin and Thaler (1988). Shefrin and Thaler touch on many central ideas in behavioral consumption, such as self-control problems, temptation, and mental accounting. The most popular of them so far are the self-control problems, which have been addressed in different ways, ranging from dynamic inconsistency (Strotz, 1955; Laibson, 1997), temptation preferences (Gul and Pesendorfer, 2001), and the two-self model (Fudenberg and Levine, 2006). Mental accounting, on the other hand, has received little attention from theorists, despite several further papers dedicated exclusively to it (Thaler, 1985; 1990).[2]

While intended as a behavioral 'fix' of Modigliani's work, the problem with Shefrin and Thaler's (1988) contribution is that it relies solely on the verbal description of behavior, and it does not present the solution of a formal model. While other issues have been addressed, when it comes to mental accounting it remains an open research question whether and to what extent it can improve the explanatory power of consumption models beyond competing theories, a question that I attempt to answer in this dissertation.

This research project, logically, implies the formulation and evaluation of a formal model of mental accounts, by means of modifying the utility function. For the formulation, I express the model as a PEEM (Rabin, 2013b), that is a Portable Extension of an Existing Model: that way, the model can be compared with its counterpart without the behavioral element; and, at the same time, the model can be ported to other environments (e.g. from a partial-equilibrium setting to a general-equilibrium environment with a New Keynesian supply side, in my case). For the evaluation, I obtain precise model predictions that can be falsified, and I check that the model does not generate any new contradictions with respect to standard theories (Tirole, 2002).

[2] That said, mental accounting has been documented in many empirical studies of consumption, for instance in Hastings and Shapiro (2013; 2018), but also in many others – see Chapter 2. Also, mental accounting has been theoretically formalized in other domains, such as stock market evaluation (Barberis and Huang, 2001).

### 2.2.1 Further Methodological Considerations

The behavioral literature has frequently used the term 'anomalies' and neoclassical 'paradigm'. This mere choice of language suggests that the introduction of Behavioral Economics is the start of a paradigm shift, a scientific revolution in Thomas Kuhn's (1960) sense. After all, such transition processes consist of a period where the anomalies of the old paradigm are discovered, followed by a period where new paradigms are formulated. It seems that the paradigm-shifting way of framing the debate probably helped convey the message that Behavioral Economics is a serious pursuit.

Naturally, opposing views have been voiced. There is skepticism as to whether behavioral economics will amount to a paradigm-shifting scientific revolution (Thaler, 2015). Some skeptics have challenged behavioral economics more fundamentally, questioning that psychological biases be incorporated into economic models (Thaler, 2015).

However, even these skeptics embrace the methodological view of Milton Friedman (1953). In his famous essay on methodology echoing falsificationism, Friedman argued that a model should not be judged based on the realism of its assumptions, but solely on the explanatory power of its predictions. In this dissertation I posit a hypothesis of how consumers behave, and I compare it with competing hypotheses in the light of empirical evidence. Therefore, in Friedman's view, it follows that my research question is of scientific interest;[3] regardless of the subjective positions on paradigms and on Behavioral Economics.

## 2.3 Heterogeneous-Agent Macroeconomics

Macroeconomic models of business cycles have come in many varieties over the last 100 years or so. While this introduction does not attempt to provide an exhaustive overview, I should mention the few models that serve as a benchmark for comparison with later theories, starting with the static Keynesian IS-LM. After a detour with econometric policy models and the Lucas' critique, the real business cycle (Kydland and Prescott, 1982) and the New Keynesian (see Galí, 2015, for a treatise) models with a representative agent

[3] A similar, yet more general, argument has been made by Richard Thaler (2010). The emphasis on evaluating behavioral models based on their predictions has been made explicitly by behavioral theorists (Tirole, 2002; Rabin, 2013b).

appeared. These environments are absent any household heterogeneity and are a model of intertemporal substitution in consumption and sticky prices (and wages) (Cochrane, 2018). In order to improve its consumption properties and restore insights from the Keynesian IS-LM, spenders were introduced in the environment, resulting in the Two-Agent New Keynesian model (Galí, López-Salido, and Vallés, 2007).

In parallel, the first models with household heterogeneity featuring idiosyncratic income risk and incomplete markets were developed (Bewley, 1986; Aiyagari, 1994; Huggett, 1993; Den Haan 1996; 1997; Krusell and Smith, 1998). These can be thought of as the heterogeneous-agent equivalent of the real business cycle model (although in some cases they are just endowment economies), i.e. without nominal rigidities; alternatively, they can be understood as the Buffer-Stock model of consumption in a general equilibrium setting, where the interest rate is determined endogenously to clear the asset market. An important result is that, in contrast to the representative agent model where the asset supply is infinitely elastic when the discount factor equals the inverse of the interest rate, in the incomplete markets economy asset supply increases as the discount factor approaches the inverse of the interest rate from below (Aiyagari, 1994).[4] However, for some time, perhaps the most influential result was that "approximate aggregation" holds in incomplete markets economies (Krusell and Smith, 1998), which the profession most generally took to mean that household heterogeneity does not matter much for aggregate outcomes (Lucas, 2003; Kaplan and Violante, 2018).[5]

The fusion of the incomplete markets and the New Keynesian strands of the literature was triggered most likely by the Financial Crisis of 2008, together with an increasing availability of microeconomic data on MPCs. The idea was to take the insight from the Buffer-Stock literature that low-liquidity households have high MPCs, and incorporate it into a model with nominal rigidities. A stream of papers has used such a framework to evaluate the aggregate effects of transfer stimulus programs (Oh and Reis, 2011), tightening credit conditions (Guerrieri and Lorenzoni, 2017), and forward guidance programs (McKay, Nakamura, and Steinsson, 2016), among others.

[4] Achdou et al. (2022) revisit this result in a continuous time environment and show that the result holds in most applications, but not necessarily when the Intertemporal Elasticity of Substitution is greater than one.
[5] Although, at the time, there were already some examples indicating that the distribution does matter for aggregate outcomes (Galor and Zeira, 1993).

The problem with these models is the one Kaplan and Violante (2014) pointed out: they cannot generate a realistic aggregate MPC and a realistic aggregate wealth at the same time. In order to circumvent this issue, the papers in the previous paragraph calibrated their models to some broad measure of liquid wealth, which generated just enough poor or liquidity-constrained households who behave in a hand-to-mouth way. But, as Kaplan, Moll, and Violante (2018) argued, a general-equilibrium model for business-cycle analysis requires an accurate representation of total aggregate wealth, and not just some portion of it. They resolved this problem by introducing a high-return illiquid asset into the incomplete markets New Keynesian framework already developed. The more realistic asset structure generates a share of wealthy hand-to-mouth households who contribute substantially towards the aggregate MPC, thereby reintroducing the Keynesian properties of consumption into the New Keynesian model (Kaplan and Violante, 2018). This setup allows to quantify the importance of the different channels of transmission of aggregate shocks. While this is a similarity point with the Two-Agent New Keynesian model, the two environments differ in that the heterogeneous-agent counterpart allows to study the incidence of macroeconomic policies across the household distribution, and the effects on macroeconomic variables that result from aggregating heterogeneous individual behaviors.

## 2.4 Bringing It All Together

The first part of my dissertation is concerned about solving the mental accounting model of consumption and evaluating its performance against the empirical evidence. I obtain model predictions in an incomplete markets setting and in a 2-asset environment (Chapters 2 and 3, respectively). Because these environments feature a continuum of households with heterogeneous income and wealth, I can evaluate whether mental accounting improves the explanatory power of the model at the individual household level as well as at different levels of aggregation.

Comparing the model against not only macroeconomic evidence but also microeconomic evidence makes sense because the latter has become increasingly available over the recent years. But also because heterogeneous-agent models for business-cycle analysis are calibrated to match microeconomic moments of consumption as a way of ensuring the accuracy of aggregate variables, which are computed by aggregation of individual decisions. To the extent that mental accounting does improve the explanatory power of such models at the individual level, it has the potential to generate more accurate predictions, both in terms of the distributional impact of macroeconomic policies and in the aggregate. I document these changes in a heterogeneous-agent New Keynesian with mental accounting in Chapter 4.[6]

[6] This idea has been enunciated in more general terms in Benjamin Moll's (2020) research agenda under the section "heterogeneous-agent macro as a gateway to behavioral macro".

# 3. Chapter 2. A Model of Consumption with Mental Accounting and Incomplete Markets

## 3.1 Introduction

How do households make spending and saving decisions as they receive shocks to income and wealth? One legitimate approach to answering this central question in household finance is to consider "behavioral models of preferences that incorporate phenomena such as loss aversion and mental accounting" (Campbell, 2006). In fact, the empirical literature has attributed a number of consumption anomalies[7] to Mental Accounting of income and wealth (Shefrin and Thaler, 1988). Under this behavioral bias (i) households treat income and assets as non-fungible resources, and (ii) they prefer to consume out of their income rather than out of their assets.[8]

However, the absence of a fully specified model of Mental Accounting leaves two open questions. First, the model cannot be subject to empirical testing:[9] it remains unknown whether Mental Accounting can rationalize any empirical facts, including the aforementioned anomalies. Second, the model cannot be compared with competing theories.

This paper attempts to make progress on these issues. In order to do so, I produce a set of new quantitative predictions for a Mental Accounting model and I evaluate them against the available empirical evidence. To do so, I make two adjustments to the original model in Shefrin and Thaler (1988) while retaining the essence of Mental Accounting.[10]

[7] These anomalies include: the retirement-consumption puzzle (Bernheim, Skinner, and Weinberg, 2001); high marginal propensities to consume (MPC) among liquid, high-income households (Kueng, 2018); no spending in anticipation of known future income gains, even among liquid households (Kueng, 2018; Baugh, Ben-David, Park, and Parker, 2021); and differential MPCs out of dividends and capital gains (Baker, Nagel, and Wurgler, 2007; Di Maggio, Kermani, and Majlesi, 2020; Bräuer, Hackethal, and Hanspal, 2022).
[8] While Shefrin and Thaler (1988) consider a third mental account with 'future income', here I abstract from it for simplicity. Note that 'mental accounting' has also been used in the literature, albeit less frequently, to denote the non-fungibility of resources devoted to different spending categories (Thaler, 1985); however, in this paper I use the meaning in the body of the text.
[9] A similar view is held by empirical researchers, e.g. Baugh et al. (2021): "[in] models of mental accounting […], [the] predictions are generally limited, which has led to limited empirical testing".
[10] For related publications on Mental Accounting, see Shefrin and Statman (1984); Thaler (1985; 1990; 1994; 1999; 2015; 2018); Thaler and Shefrin (1981).

First, I replace their utility function, which produces unrealistic MPCs, with a variant of reference-dependent utility (Köszegi and Rabin, 2006) where loss aversion is defined with respect to consumption above current income (the reference point). Second, I substitute the representative-agent environment with an incomplete-markets environment with idiosyncratic risk and agent heterogeneity set in partial equilibrium. This choice is appropriate for several reasons: (i) it features a continuous household distribution that can be confronted by the microeconomic evidence; (ii) the approach is similar to related work on consumption[11]; (iii) it is considered to be the workhorse in modern macroeconomics (Achdou et al., 2020); (iv) it speaks to a current debate on one-asset models (Kaplan and Violante, 2022); (v) it allows for a transparent characterization of Mental Accounting, in the absence of other frictions.

In this framework, which I call the Mental Accounting Incomplete Markets model of consumption, I characterize optimal behavior and I derive predictions at the individual, semi-aggregate, and aggregate levels. I find that Mental Accounting adds substantial explanatory power to the standard model: not only does Mental Accounting rationalize the consumption anomalies initially attributed to it, but it also explains a set of additional empirical facts, some of which are at odds with leading models of consumption.

The first result of the paper is that Mental Accounting generates hand-to-mouth behavior across the entire asset spectrum. The hand-to-mouth's optimal choice is to set consumption equal to income in order to avoid the psychological cost of consuming more than income. For positive asset holdings, hand-to-mouth behavior arises in households with medium to high incomes: the "unconstrained hand-to-mouth". This prediction is consistent with empirical evidence finding high marginal propensities to consume (MPC)[12] in households with: medium and high incomes; positive holdings of liquid wealth; and positive net worth (see Section 4.1 for the empirical evidence). In turn, for low asset levels at the constraint or close to it, Mental Accounting amplifies hand-to-mouth behavior in households with low incomes and low liquidity. Overall, hand-to-mouth households are distributed such that the average MPC is decreasing in assets.

[11] See Straub (2019); Ilut and Valchev (forthcoming); Pagel (2017); Achdou, Han, Lasry, Lions, and Moll (2022); Fuster, Kaplan, and Zafar (2021).

[12] The empirical literature cited in this paper has used either elasticities or MPCs to measure consumption responses to income and wealth shocks. Because my analysis focuses on MPCs, I refer to all empirical estimates as MPCs, with a slight abuse of terminology.

Since hand-to-mouth behavior arises endogenously, Mental Accounting provides a micro-foundation for the spender-saver theory of Campbell and Mankiw (1989, 1991) and the MPC distribution is bi-modal. One group is made of hand-to-mouth households ('spenders'), which represent 20% of the population (Misra and Surico, 2014; 2011) and have an MPC close to 100% (Misra and Surico, 2014; Kueng, 2018). The rest is made of Life-Cycle Hypothesis (LCH) households ('savers') with a small MPC close to the annuity value of the windfall.

The model matches the aggregate MPC, the total-wealth-to-GDP ratio, and a plausible level of median wealth. Mental Accounting resolves an important difficulty of one-asset models in matching the two aggregate moments[13] while avoiding the 'missing middle' problem, that is without distorting the asset distribution (Kaplan and Violante, 2022). Hence, the Mental Accounting consumption model can be used for general-equilibrium macroeconomic analysis.

The two channels through which Mental Accounting generates a realistic aggregate MPC are: by generating unconstrained hand-to-mouth households, and by amplifying the MPC at the constraint. The unconstrained hand-to-mouth contribute substantially more to the aggregate MPC, resolving an unstudied puzzle that combines two facts: (i) households with positive (liquid) assets have high MPCs; and (ii) they represent a majority of the household population (Kaplan and Violante, 2014). The share of low-liquidity households is also realistic (i.e. small) because the discount factor is calibrated to match aggregate wealth.

The non-fungibility assumption generates account-specific MPCs, that is different MPCs depending on whether the windfall is *framed* as income or as (liquid) wealth. This result breaks the framing irrelevance property of standard choice theory (Kahneman and Tversky, 1984; Tversky and Kahneman, 1981). As a result, stock market investors are not indifferent (have different MPCs) between dividends and unrealized capital gains, which violates the "rational behavior" assumption underlying the Miller-Modigliani (1961) dividend-irrelevance result.

The account-specific MPCs predicted by the model are in agreement with several empirical facts. First, most households frame dividends as income (Bräuer et al., 2022).

[13] This difficulty of 1-asset models has motivated the use of 2-asset models (Kaplan and Violante, 2014; Kaplan, Moll, and Violante, 2018).

Second, the MPC out of dividends is substantially higher when households frame them as income than when they frame them as assets (Bräuer et al., 2022). Third, the MPCs out of dividends[14] and out of realized capital gains (Meyer, Pagel, and Previtero, 2020) are close to the MPCs out of labor income and one order of magnitude higher than the MPCs out of unrealized capital gains (Di Maggio et al., 2020; Baker et al., 2007), both across the wealth distribution and in the aggregate. Fourth, the portfolio rebalancing response to dividend receipt is bi-modal, with a group that saves and another group that consumes the dividend (Daniel, Garlappi, and Xiao, 2021; Baker et al., 2007). Fifth, the MPCs out of housing wealth are of the same order of magnitude than the MPCs out of unrealized capital gains (see Section 4.5.2 for empirical evidence). Sixth, college tuition payments have a relatively small impact on consumption (Souleles, 2000).

The Mental Accounting friction also generates non-Ricardian intertemporal behavior. The unconstrained hand-to-mouth have an MPC out of assets of 0%, which explains the empirically observed reluctance of unconstrained households to dissave in order to substitute consumption across periods. The aggregate intertemporal consumption response to a small, expected transitory income shock is non-anticipatory, excessively sensitive, and without lagged effects, consistently with a body of empirical evidence (see Section 4.6 for a discussion of the empirical literature). Savings play a smaller role in smoothing transitory income shocks among unconstrained households than under standard preferences.

The model is consistent with further empirical findings on the size and sign effects of MPCs. First, because households classify small windfalls as income, but they classify larger windfalls partly as income and partly as assets (Shefrin and Thaler, 1988), the MPCs decrease with the size of the windfall (Misra and Surico, 2014; Olafsson and Pagel, 2018; Kueng, 2018; Christelis et al., 2019). Second, by virtue of its framing properties, the model is able to reconcile evidence on the sign effects of MPCs out of tax refunds and payments (Baugh et al., 2021) with evidence on MPCs out of income losses and gains (Fuster et al., 2021; Christelis et al., 2019).

Over the life-cycle, Mental Accounting rationalizes the "retirement-consumption" puzzle, the consumption drop observed at retirement[15]. This result indicates that

[14] See Bräuer et al. (2022); Di Maggio et al. (2020); Kueng (2018); Baker et al. (2007).
[15] See Banks, Blundell, and Tanner (1998); Bernheim, Skinner, and Weinberg (2001); Haider and Stephens (2007).

consumption responds to anticipated (Ameriks, Caplin, and Leahy, 2007) permanent income changes, yet by less than to transitory changes. The unconstrained hand-to-mouth households are instrumental to explain related facts. First, the model generates a sizable, anticipated consumption drop among households with positive wealth (Ameriks et al., 2007) because households are reluctant to dissave in order to smooth consumption around the shock. Second, the model predicts a negative correlation between the consumption drop and wealth at retirement (Bernheim et al., 2001). Third, because households anticipate the lower need for savings to smooth consumption (Bernheim et al., 2001), they accumulate less wealth for retirement.

### 3.1.1 Literature

This paper relates to several strands of the literature. The first strand of the literature uses the following empirical regularities of MPCs and of the wealth distribution to discriminate between competing models of consumption[16]: high MPCs in unconstrained (liquid) households (Campbell and Hercowitz, 2019; Ilut and Valchev, forthcoming; Lian, forthcoming; Bianchi, Ilut, and Saijo, forthcoming; Boutros, 2022)[17]; a bi-modal distribution of MPCs with 'spenders' and 'savers' (Kaplan and Violante, 2014); a realistic aggregate MPC together with a realistic aggregate wealth-to-GDP ratio (Kaplan et al., 2018; Kaplan and Violante, 2014); an asset distribution with a realistic median wealth level and with a realistic share of poor hand-to-mouth households (Kaplan and Violante, 2022); a "tent-shaped" intertemporal MPC (Auclert et al., 2018; Wolf, 2021; Kaplan and Violante, 2022); size effects of MPCs (Kaplan and Violante, 2014; Boutros, 2022); and sign effects of MPCs (Kaplan and Violante, 2022).

My paper follows their lead and makes five contributions. First, I argue that the unconstrained households, as a group, contribute substantially to the *aggregate* MPC, which is a new empirical puzzle for all leading consumption models that generate MPCs only via liquidity constraints.[18] Second, I review empirical studies documenting account-specific MPCs out of dividends and out of (un)realized capital gains, findings that

[16] Nakamura and Steinsson (2018) refer to the MPC regularities as "identified moments".
[17] In Reis (2006), inattentive savers (who never plan) live hand-to-mouth due to a mechanism different than liquidity constraints; but these agents save less and end up at the lower end of the wealth distribution.
[18] In Ilut and Valchev's (forthcoming) model, the contribution of the unconstrained households to the aggregate MPC, although not negligible, is small.

constitute a further empirical puzzle for all leading consumption models.[19] Third, in contrast to previous theoretical papers on intertemporal MPCs, I discuss in detail an expanded body of empirical evidence that systematically finds a reluctance to dissave in anticipation, excess sensitivity, and no lagged effects for anticipated shocks, both among unconstrained households and in the aggregate; this body of research includes Fagereng et al. (2021), for which I offer an alternative, more nuanced interpretation. Fourth, having established the above set of empirical facts on MPCs and wealth distribution, I show that a Mental Accounting model with incomplete markets can provide, to the best of my knowledge, the first unified explanation of all these facts. Finally, I show that, in contrast to previous conclusions (Kaplan and Violante, 2022), the Mental Accounting one-asset model is indeed appropriate for use in general-equilibrium macroeconomic analysis.

The second strand of the literature has proposed different ways to rationalize empirical life-cycle facts (for an overview, see Pagel, 2017). The closest papers propose life-cycle models with non-standard preferences, such as present bias (Angeletos et al., 2001) and expectations-based reference dependence (Pagel, 2017). This paper proposes a Mental Accounting friction to rationalize the retirement-consumption puzzle, as well as a set of related consumption facts across the wealth distribution at retirement.[20]

Third, since the advent of prospect theory (Kahneman and Tversky, 1979), a group of papers have developed reference-dependent preferences with loss aversion (Tversky and Kahneman, 1991; Köszegi and Rabin, 2006) and have applied them to a variety of problems.[21] My paper builds on this literature, but differs from it in three aspects. First, I propose a plausible reference point that is exogenous as in Della Vigna et al. (2017), but equal to current income instead of past income. Second, whereas usually loss utility is assumed when consumption is below the reference point, I assume that loss is experienced

[19] Previous papers have focused on different concepts of asset-specific MPCs. In Laibson (1997) and in Kaplan and Violante (2022), the models predict differential MPCs out of liquid and illiquid assets. In Pagel (2018), the model predicts an MPC out of unexpected shocks to the checking account that is higher than to the brokerage account, although the prediction is reversed for expected shocks. In Mullainathan (2002), the different MPCs arise based on the memory evocativeness of different 'income streams'.

[20] According to Kaplan and Violante (2014, Figure 4.(a)), the 2-asset model does not seem to rationalize the retirement-consumption puzzle.

[21] Including purchasing behavior (Köszegi and Rabin, 2006), labor supply (Köszegi and Rabin, 2006; Crawford and Meng, 2011), attitudes towards risk (Köszegi and Rabin, 2007), asset pricing (Pagel, 2016), consumption (Köszegi and Rabin, 2009; Pagel, 2017), job search (Della Vigna et al., 2017), and portfolio choice (Pagel, 2018).

when consumption is above the reference point (income) to capture the Mental Accounting friction.

The fourth strand of the literature consists of a recent set of papers that study consumption models with incomplete markets and behavioral biases.[22] I focus on a Mental Accounting friction with a kink in the utility function, similarly to Graham and McDowall (2022). My paper differs from theirs in several aspects. First, they remain silent on the majority of the questions I address. Second, they characterize individual behavior with the first-order condition based on the assumption that household choices are always at the "interior of the kink", and they employ the right-hand derivative of utility. Obviously, this is wrong because, in a non-differentiability, one needs the general derivative[23] with both right-hand side and left-hand side derivatives. Probably due to this mathematical error, they miss arguably the most important property of the model: that it provides a micro-foundation for the spender-saver theory.

Fifth, this paper relates to other instances where Mental Accounting biases are able to explain behavior. In the domain of investment performance, Barberis and Huang (2001) show that investors mentally evaluate individual stocks returns separately. In the consumption domain, Hastings and Shapiro (2013; 2018) show that households have separate mental budgets for different spending categories. My variant of Mental Accounting is orthogonal to theirs: I assume that stocks (and other investments) are evaluated jointly, and that consumers buy one bundle of goods, but their resources are separated into different mental accounts.

## 3.2 A Model of Consumption with Mental Accounting

This section presents a partial equilibrium model of consumption with idiosyncratic income risk and incomplete markets (Deaton, 1991; Carroll, 1997; Zeldes, 1989), modified with a new specification of Mental Accounting.

### 3.2.1 Household Problem

Households choose consumption to maximize:

[22] These include present bias (Angeletos et al., 2001; Laibson, Maxted, and Moll, 2021), expectations-based reference dependence (Pagel, 2017), imperfect problem solving (Ilut and Valchev, forthcoming), temptation (Attanasio, Kovacs, and Moran, 2021), and finite planning horizons (Boutros, 2022).

[23] I thank Vincent Crawford for reminding me of this term.

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

subject to

$$c_{h,t} + \frac{a_{h,t+1}}{1+R_t} = a_{h,t} + y_{h,t} + T_{h,t}$$

and

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

where $c_{h,t}$ denotes consumption of household $h$ at time *t*. The utility function incorporates a Mental Accounting friction, as detailed in Section 2.2. Labor supply is inelastic and labor earnings, $y_{h,t} = \chi_t e_{h,t}$, can be decomposed into an idiosyncratic stochastic component, $e_{h,t}$, and a deterministic component that only varies with time, $\chi_t$. The stochastic component of earnings follows a Markov chain whose transition probabilities are $\Pr(e_{h,t+1}|e_{h,t})$. The transition matrix of the Markov chain is constant over time and the initial cross-sectional distribution of stochastic earnings $e_{h,t}$ is set equal to the ergodic distribution of the Markov chain, such that their distribution is constant over time. $\mu_t(a, y)$ denotes the distribution of households over their individual state variables, namely earnings and asset holdings, at date *t*. There is no market for contingent claims: households can save in a risk-free asset that is perfectly liquid and does not carry any transaction costs. The risk-free asset pays the constant real interest rate $R_t$ between periods *t* and *t* + 1, and households cannot borrow because of the borrowing constraint.

As in Carroll (1997), I consider two versions of the model. In Sections 3 and 4 I consider an infinite-horizon environment with $T = \infty$ and $\chi_t = 1$. In Section 5 I study a life-cycle problem with finite horizon, where the subscript $t$ denotes the age of the household, and where $\chi_t$ captures the deterministic variation in earnings over the working life and during retirement.

### 3.2.2 Mental Accounting

The Mental Accounting friction proposed in this paper has two main characteristics. First, households partition their wealth into two non-fungible accounts, one with ‘income’ and one with ‘assets’. Second, households have a preference for financing consumption with income rather than with assets.

#### 3.2.2.1 Foundations

These key elements of Mental Accounting go back at least to Adam Smith, yet this relationship has remained unknown in the literature (Shefrin and Thaler, 1988; Ashraf et al., 2005). In his *Theory of Moral Sentiments*, Adam Smith (1790) characterizes the "prudent man" as a person who, in the context of consumption and saving decisions, keeps expenses 'frugal' and contained 'within his income':

> 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."

Moreover, in his *Wealth of Nations*, Adam Smith (1776) makes a revealed preference argument to show that households actually have a preference for 'living within their income':

> "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."

Hence, Adam Smith's (1790) concept of "prudent man"[24] introduces the two main characteristics above. Moreover, it considers that individuals take income as a reference point for their consumption and saving decisions.

In turn, Shefrin and Thaler (1988) take a complementary approach. They assume that households experience a utility penalty when they consume more than their income, capturing the associated psychological feeling of guilt (see Shefrin and Thaler for its relationship with the psychological literature).

There is, however, one problem with the fixed cost penalty specification in Shefrin and Thaler (1988, Figure 1): it generates counterfactual predictions both at the individual level and in the aggregate. According to Tirole (2002), hedonic components added to the utility function should not generate new contradictions with respect to existing standard theories. Therefore, I propose a new utility function that overcomes this problem.

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[24] This differs from other meanings of prudence used in economics: in Kimball (1990), prudence refers to the properties of the utility function that generate precautionary savings.

#### 3.2.2.2 Utility Function

The utility function uses ideas from reference-dependence with loss aversion (Köszegi and Rabin, 2006). In particular, the gain-loss asymmetry is well-suited for Mental Accounting: households experience pleasure when they consume less than their income, capturing the feeling of contentment in Adam Smith (1790); and they experience a relatively larger pain when they consume more than their income, capturing the aforementioned feeling of guilt.[25]

Formally, household utility $U$ is defined as follows:

$$U(c_{h,t}|r_{h,t}) = \begin{cases} u(c_{h,t}) - \eta[u(c_{h,t}) - u(r_{h,t})] & \text{if} \quad c_{h,t} \leq r_{h,t} \\ u(c_{h,t}) - \eta\lambda[u(c_{h,t}) - u(r_{h,t})] & \text{if} \quad c_{h,t} > r_{h,t} \end{cases},$$

where $r_{h,t}$ denotes the reference point of household $h$ in period $t$. Utility consists of the "intrinsic" consumption utility $u(c_{h,t})$, and gain-loss utility $u(r_{h,t}) - u(c_{h,t})$, where $u(\cdot)$ is an increasing and concave function with constant relative risk aversion (CRRA). When consumption is below or at the reference point ($c_{h,t} \leq r_{h,t}$), the household derives gain utility $u(r_{h,t}) - u(c_{h,t}) > 0$ with weight $\eta$. Conversely, when consumption is above the reference point ($c_t > r_t$), the household derives loss utility $u(r_{h,t}) - u(c_{h,t}) < 0$ with weight $\eta\lambda$, where $\lambda > 1$ is the loss-aversion parameter. The model nests the standard model as a special case when $\eta = 0$ (see Figure 3.1).

The reference point is equal to income because income is a salient feature in the household finances.[26] The idea that households take income as a reference point when making consumption-saving decisions has been present in theoretical work. In addition to Adam Smith's writings (see Section 2.2.1) and Shefrin and Thaler (1988), it appears in Keynes' (1936) consumption function. More recently, in the spender-saver theory (Mankiw, 2000), spenders set consumption equal to income because "current income is the most salient piece of information available".[27] Hence,

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[25] The idea that emotions causing pleasure and pain are part of utility goes back to Jeremy Bentham (1789). Tirole (2002) argues that positive and negative emotions can be incorporated via "hedonic components" into the utility function. Gary Becker (1996, Appendix 7B) gives an example where happiness and guilt are modelled as a utility benefit and cost, respectively.

[26] Salient stimuli automatically draw attention mainly because they are contrasting, surprising, or prominent (Bordalo, Gennaioli, and Shleifer, 2022).

[27] Income appears as a reference point in other contexts, as well. In labor supply decisions, Crawford and Meng (2011) find that individuals use their expectation of daily income as a reference point. In job search

$$r = I$$

where $I$ denotes household income, or more precisely all the resources that the household classifies in the 'income mental account' (see Section 2.2.3).

At $c = I$, the utility function has a point of non-differentiability, or kink:

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

i.e. there is a downward jump in marginal utility of $\frac{1-\eta\lambda}{1-\eta}$ (Figure 3.1).

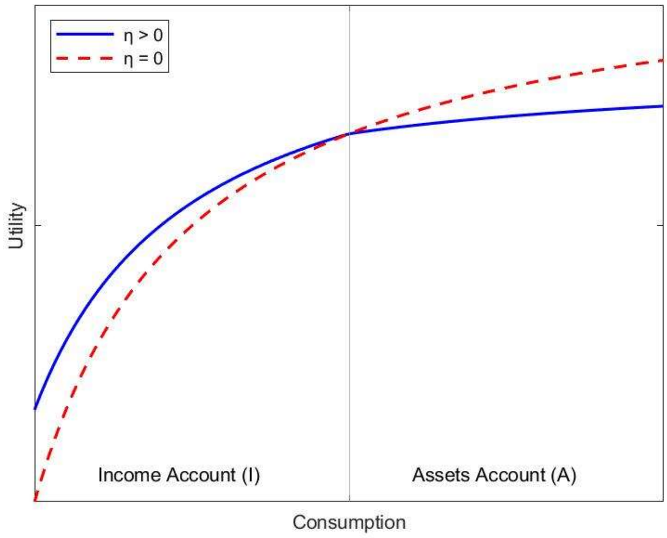



Figure 3.1. Utility function with Mental Accounting ($\eta > 0$) and with standard form ($\eta = 0$).

This utility function differs from the prospect theory utility (Kahneman and Tversky, 1979) in several aspects. First, as in many recent reference-dependent models, it does not include probability weighting or diminishing sensitivity, for simplicity. Second, loss utility is experienced when consumption is above the reference point (income). While the latter assumption is uncommon in the reference-dependent consumption literature, and it violates assumption A4 in Köszegi and Rabin (2006), it serves to articulate Mental Accounting in a way that relates to reference-dependence while retaining its core idea of introducing a jump in the marginal utility.

decisions, Della Vigna et al. (2017) argue that the average of past income realizations is a plausible reference point given the salience of "recent paychecks".

#### 3.2.2.3 Non-Fungibility of Income and Assets

The household classifies into the income mental account all the resources that it wishes to consume; and classifies into the asset mental account all the resources that it wishes to save. Hence, the household treats resources labeled 'income' and resources labeled 'assets' as *non-fungible*. The theory (Shefrin and Thaler, 1988; Shefrin and Statman, 1984; Thaler, 1990) posits that labor earnings, cash dividends, and realized capital gains are labeled as 'income' upon their receipt, whereas wealth and unrealized capital gains are labeled as 'assets'.

The empirical evidence supports the theory. Bräuer et al. (2022) find that many investors view dividends as another source of income similar to their salary. The literature also reports that MPCs out labor earnings (Olafsson and Pagel, 2018), dividends (Bräuer et al., 2022; Di Maggio et al., 2020; Kueng, 2018; Baker et al., 2007), and realized capital gains (Meyer, Pagel, and Previtero, 2020) have a similar magnitude, whereas the MPCs out of unrealized capital gains are one order of magnitude smaller (Di Maggio et al., 2020; Baker et al., 2007).

In terms of the model, I assume $I = y$, that is households label their labor earnings as 'income', and $A = a$, i.e. the asset holdings plus the interest or capital income earned on them are labeled as 'assets'. Whatever income is left unspent in one period is classified into the asset account for the next period.

### 3.2.3 Recursive Problem

Because the household needs to be aware of the balances in the income (I) and asset (A) accounts, I choose income and assets as the two state variables of the recursive problem, instead of the more usual choice of 'cash-on-hand' in standard models (Deaton, 1991). The following Bellman Equation characterizes optimal behavior:

$$V(a_h, y_h) = \max_{c_h} U(c_h|r_h) + \beta E[V(a_h', y_h')],$$

subject to

$$c_h + \frac{a_h'}{1+R} = a_h + y_h$$

and

$$a_h' \geq 0 \ ,$$

where $V(a_h, y_h)$ denotes the value function for household $h$ in the current period, $a_h'$ and $y_h'$ are next-period variables, and the rest of the notation is as introduced in Sections 2.1 and 2.2. The expectations operator $E$ is taken over the different possible realizations of the stochastic earnings process, using the conditional probabilities $\Pr(y_h'|y_h)$.

The First-Order Condition (FOC) associated with the household problem is:

$$U_c(c_h|r_h) = \beta \frac{\partial}{\partial a} E[V(a_h', y_h')] \qquad \forall\, c_h \neq y_h\,, \quad \nexists U_c(y_h|r_h).$$

Note that the marginal utility does not exist at the non-differentiability point of the utility function ($c = y$). For this reason, the FOC does not fully characterize the household problem, and neither does the standard Euler Equation.

### 3.2.4 Calibration

The calibration is summarized in Table 3.1. I set the real interest rate at 0.5% quarterly (2% annually) and I set the coefficient of relative risk aversion to 2. The idiosyncratic income process matches the persistent component of the wage risk in Floden and Lindé (2001).

In the infinite-horizon version, the model period is one quarter and the stochastic income process is rewritten at quarterly frequency, as in McKay, Nakamura, and Steinsson (2016). The resulting AR(1) process, with an autoregressive coefficient of 0.9657 and an innovation variance of 0.17, is discretized on a Markov chain using the Rouwenhorst (1995) method, following Kopecky and Suen (2010). I discretize the income process with 24 states in order to allow a smooth interaction between household heterogeneity and Mental Accounting across the distribution of income and assets. The discount factor is calibrated to match a ratio of total assets to annual output of 3.18 following Kaplan, Moll, and Violante (2018). In the Mental Accounting case, the parameter $\eta$ is calibrated to generate an aggregate MPC out of income of 25%, based on Kaplan and Violante's (2014) summary of the empirical MPC estimates. With standard preferences, as well as in alternative calibrations of the Mental Accounting preferences with different values of the parameter $\eta$, the total wealth-to-GDP ratio is the only calibration target. The loss aversion parameter $\lambda$ is set to 2.5, which is within the range considered in the literature[28]. The MPC is obtained out of a windfall transfer T which I calibrate to match the size of the fiscal stimulus checks relative to output of 0.4 – 0.7% from the 2001-2008 episodes (Shapiro and Slemrod, 2003a; Kaplan and Violante, 2014).

Table 3.1. Baseline Calibration

| *Model Version* | Infinite Horizon | | Life-Cycle | |
|---|---|---|---|---|
| *Preferences* | Mental Acc. | Standard | Mental Acc. | Standard |
| ***Model Frequency*** | Quarter | Quarter | Year | Year |
| ***Parameters*** | | | | |
| $\eta$ (Gain-Loss utility weight) | 0.1542 | 0 | 0.289 | 0 |
| $\lambda$ (Loss Aversion parameter) | 2.5 | – | 2.5 | – |
| $\beta$ (Discount Factor) | 0.9894 | 0.9878 | 0.9795 | 0.9533 |
| $\gamma$ (Risk Aversion) | 2 | 2 | 2 | 2 |
| $R$ (Real interest rate) | 0.50% | 0.50% | 2.00% | 2.00% |
| ***Targets*** | | | | |
| Total assets / annual GDP | 3.18[a] | 3.18[a] | – | – |
| Median assets / annual income | – | – | 1.56[c] | 1.56[c] |
| Aggr. MPC out of income | 25.0%[b] | – | 48.0%[d] | – |

[a]Kaplan, Moll and Violante (2018).
[b]Kaplan and Violante (2014) and references therein.
[c]Kaplan and Violante (2022).
[d]Auclert, Rognlie, and Straub (2018).

In the life-cycle version, the model period is one year. For the income process, the estimates from Floden and Lindé (2001) – a yearly autoregressive coefficient (0.9136) and the innovation variance (0.0426) – are discretized on a Markov chain, as above. Households enter the workforce at age 22, they retire at age 65, and they die deterministically at age 85. The deterministic component of income during working life is hump-shaped, and the retirement pension is equal to 70% of the pre-retirement income, as in Carroll (1997). The weight on gain-loss utility $\eta$ is calibrated to match an aggregate annual MPC of 48%, a similar target as in Auclert et al. (2018), out of a windfall transfer T recalibrated as indicated above. The discount factor is calibrated to match the ratio of median net wealth to annual earnings of 1.56 (Kaplan and Violante, 2022), following the strategy in Kaplan and Violante (2014).

[28] Tversky and Kahneman (1992) estimate a value of 2.25 for risky choices, while Pagel (2017) estimates a value of 3.11 in a model with expectations-based reference-dependence.

### 3.2.5 Computation

The household problem is solved using Value Function Iteration (VFI) with grid search. This method is preferable to others (i.e. the Endogenous Grid Method in Carroll, 2004) because it avoids using the marginal utility of consumption, which is not defined at the non-differentiability point of the utility function. Following the standard VFI algorithm (Aruoba and Fernández-Villaverde, 2015a; 2015b; Aruoba, Fernández-Villaverde, and Rubio-Ramírez, 2006), I take advantage of the monotonicity of the savings decision rule and of the concavity of the value function to make the algorithm more efficient. However, because the utility function is defined piece-wise, I embed the VFI algorithm into a guess-and-verify routine to find the optimum in the relevant region.

The Impulse Response Functions of consumption to an expected income shock are computed as perfect foresight transition paths of the economy in response to an MIT shock, following Boppart, Krusell, and Mitman (2018). I proceed in two steps: first, I solve the dynamic problem backwards using the Bellman Equation, and then I simulate the household distribution forward and compute the aggregate consumption as

$$C_t \equiv \int c_t(a_h, y_h) d\mu_t(a_h, y_h)$$

where the distribution evolves according to the following law of motion:

$$\mu_{t+1}(A, y') = \int_{\{(a,y): a'(a,y) \in A\}} \Pr(y'|y) d\mu_t(a, y) \qquad \text{for all sets } A \subset \mathbb{R}.$$

## 3.3 Consumption and Saving in the Stationary Equilibrium

This section presents the consumption and saving policy functions in the infinite-horizon Mental Accounting Incomplete Markets (MAIM) model in comparison to the Standard Incomplete Markets (SIM) model, as well as the conditions under which hand-to-mouth behavior arises with Mental Accounting.

### 3.3.1 Consumption Policy Functions

The key property of the Mental Accounting (MA) friction arises from the kink in the utility function, which has a differential impact on behavior depending on the household levels of income and assets. In order to showcase these differences, I discuss the consumption policy function for two levels of income: one in the 80-90th and another one in the 10-20th percentiles of the income distribution, which are representative of household behavior with medium to high income, and low income, respectively (Figure 3.2).

#### 3.3.1.1 Medium and High Income Households

Figure 3.2 Panel A shows the policy function broken down into three segments – AB, BC, and CD–, depending on whether the consumption choice is lower than, equal to, or higher than income, respectively. The policy function is not strictly concave with respect to assets, in contrast to the standard model[29]: with MA, the policy function is locally convex around point C. In segment AB ($c_{h,t} < y_{h,t}$) and in segment CD ($c_{h,t} > y_{h,t}$), the optimal choice is characterized by the usual tradeoff captured by the FOC: the marginal utility of increasing (decreasing) consumption in period *t* with respect to the optimal choice is compensated by the discounted expected marginal value function of having lower (higher) assets in period *t + 1*. Figure 3.3 provides a graphic representation of the marginal incentives governing behavior, where the segments AB, BC, and CD correspond to those in Figure 3.2 Panel A.

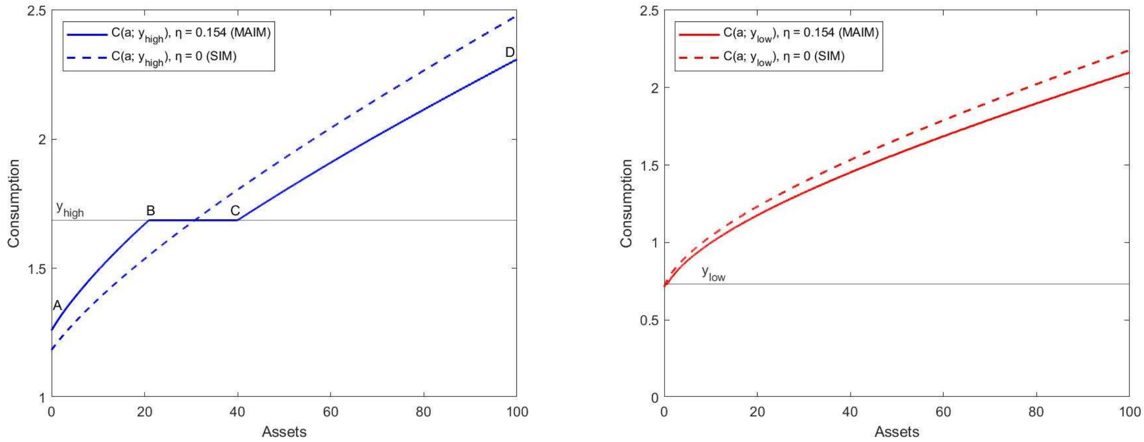
##### 3.3.1.1.1 Optimal Choice at the Kink: The Unconstrained Hand-to-Mouth

In segment BC of Figure 3.3, where $c_{h,t} = y_{h,t}$ and the household is at the kink, the FOC does not hold. However, the FOC provides a useful basis for understanding the marginal incentives that govern optimal behavior. The household now faces a different tradeoff than in the other segments: MA creates a wedge between the marginal utility of increasing consumption in period *t* and the marginal utility of decreasing consumption in period *t*, where the former is $\frac{1-\eta\lambda}{1-\eta}$ times (smaller) than the latter. Note that it is the gain-loss asymmetry (λ) what creates the wedge. The discounted expected marginal value function is in between these two marginal utilities. These relationships are shown graphically in Figure 3.3 and are summarized by the following inequalities:

[29] The concavity of the consumption policy function in the standard model is due to the presence of liquidity constraints (Helpman, 1981; Carroll, Holm, and Kimball, 2021) and of income risk (Carroll and Kimball, 1996).

$$U_c(y_h - \varepsilon | r_h) > \beta \frac{\partial}{\partial a} E_t[V(a'_h, y'_h)] > U_c(y_h + \varepsilon | r_h)$$

where $\quad U_c(y_h + \varepsilon | r_h) \cong (\frac{1-\eta\lambda}{1-\eta}) U_c(y_h - \varepsilon | r_h), \quad$ for $\varepsilon$ arbitrarily small.




Panel A: Medium to high incomes. Panel B: Low incomes.

Figure 3.2. Consumption Policy Function $C(a_h, y_h)$ in the Mental Accounting (MAIM) and in the Standard (SIM) models.

The optimal choice follows logically. As per the second inequality, it is not optimal to increase consumption above income because the associated marginal utility gain (segment $B_2C_2$) is smaller than the associated marginal value loss from having lower asset holdings next period (segment $B_1C_2$). This inequality illustrates how the MA friction reins in the household's desire to increase consumption above their income. In turn, as per the first inequality, it is not optimal to decrease consumption below income because the associated marginal utility loss (segment $B_1C_1$ in Figure 3.3) is larger than the associated marginal value gain from having higher asset holdings next period (segment $B_1C_2$). Hence, the optimal choice at the kink is to set consumption equal to income (segment BC in Figure 3.2 Panel A).

Intuitively, the household is better off foregoing the extra consumption than suffering the psychological cost. Unlike the unconstrained households in the standard/LCH model, who smooth the marginal utility of consumption, MA prevents households at the kink from smoothing consumption. In particular, they consume in a purely Keynesian way and I refer to them as the "unconstrained hand-to-mouth". They save the interest income and/or capital gains on their assets, hence hand-to-mouth households do not modify consumption in response to a change in assets, as long as their asset holdings do not jump to the right of point C or to the left of point B in the asset space.

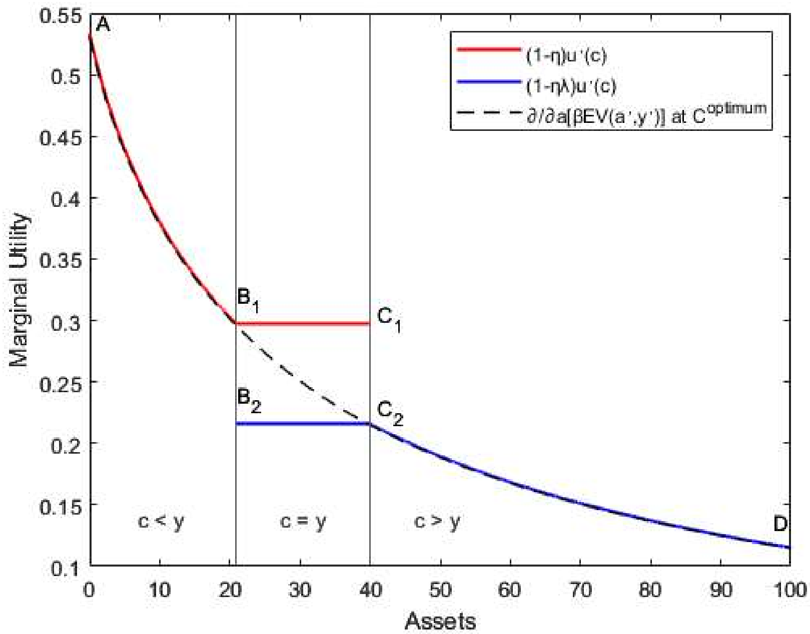



Figure 3.3. Marginal incentives for medium/high income households in the Mental Accounting model.
Note: In segment $B_1C_1$, $(1-\eta)u'(c)$ refers to $U_c\ (y_h-\varepsilon|r_h)$; in segment $B_2C_2$, $(1-\eta\lambda)u'(c)$ refers to $U_c\ (y_h+\varepsilon|r_h)$, for $\varepsilon$ arbitrarily small in both cases.

#### 3.3.1.1.2 Hand-to-Mouth Behavior Across Assets

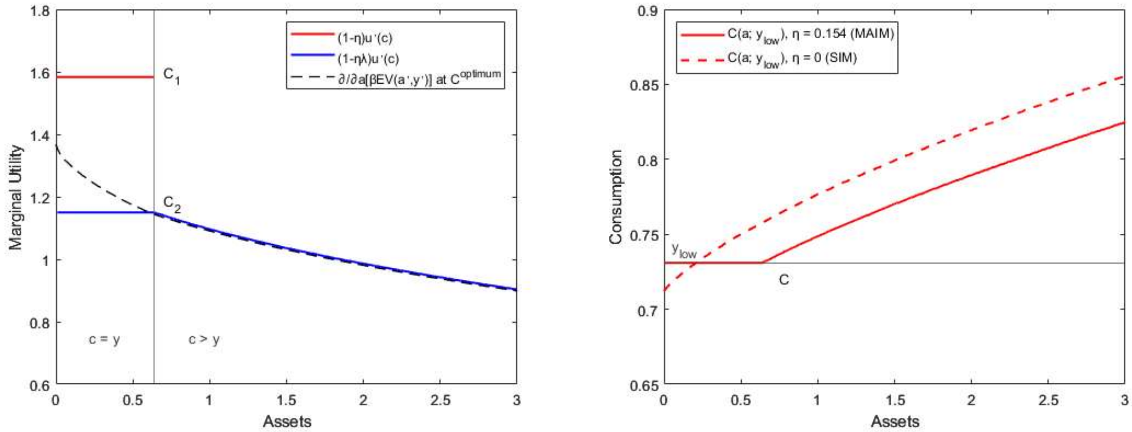
As an approximation, hand-to-mouth behavior arises when consumption in the standard model is close to income (segment BC in Figure 3.2 Panel A), i.e. when the household is close to its buffer-stock *target* wealth level. The standard model predicts that target wealth levels rise with the level of income. This provides an intuition for two predictions of the Mental Accounting model: (i) higher income households become hand-to-mouth at higher asset levels, as can be seen schematically in Figure 3.2; and (ii) hand-to-mouth behavior arises across the entire (liquid) asset distribution in a way that is independent from the level of available liquid resources. As a result, MA also generates hand-to-mouth behavior for low-income households at the liquidity constraint.

### 3.3.1.2 Low Income Households

The policy function of the low income household is shown in Figure 3.2 Panel B. These households only consume their income when they are at or close to the constraint.

For positive asset levels, they consume more than income, because consuming just their low incomes would leave them non-satiated. Intuitively, 'living within their income' is a luxury that these households cannot afford.

The policy function is below than and has a smaller slope than in the standard model because the MA penalty increases in the difference between consumption and income. MA makes the policy function more concave through a clockwise rotation with respect to point C in Figure 3.4 Panel B. This property is reminiscent of the "concavification" result in Carroll, Holm, and Kimball (2021), who show that liquidity constraints and income uncertainty are the two sources of concavity of the consumption policy function in the standard model.



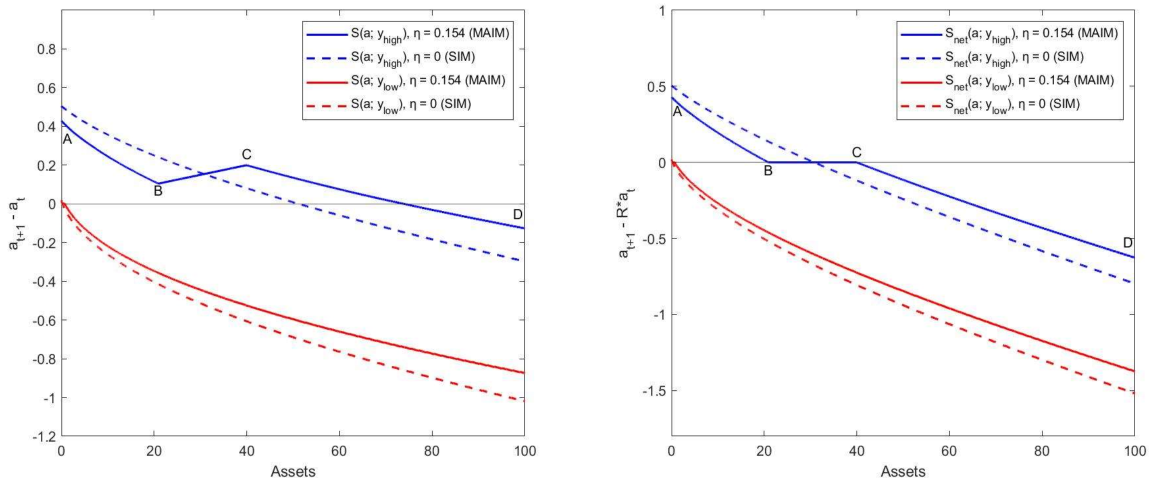

Panel A: Marginal incentives in MA model. Panel B: Detail of policy functions.

Figure 3.4. Behavior of low income household. Detail of marginal incentives in the Mental Accounting model. Detail of consumption policy function close to the constraint, in the Mental Accounting (MAIM) and in the Standard (SIM) model.

Note: In segment $B_1C_1$, $(1-\eta)u'(c)$ refers to $U_c\ (y_h - \varepsilon|r_h)$; in segment $B_2C_2$, $(1-\eta\lambda)u'(c)$ refers to $U_c\ (y_h + \varepsilon|r_h)$, for $\varepsilon$ arbitrarily small in both cases.

### 3.3.1.2.1 Mental Accounting at Low Liquidity

The liquidity constraint has the usual effect on low-income households: it prevents them from achieving their optimal consumption. However, when liquidity-constrained households find it optimal to stay at the kink, the effect of the kink dominates their behavior. As shown in Figure 3.4 Panel A, these households consume hand-to-mouth because they have the marginal incentives to do so. These choices are shown in Figure 3.4 Panel B in a detail of the policy function that is not visible in Figure 3.2 Panel B.[30]




Panel A: Gross saving.

Panel B: Saving net of interest income.

Figure 3.5. Saving Policy Functions for a medium/high and a low income type in the Mental Accounting (MAIM) model and in the Standard (SIM) model.

### 3.3.2 Saving Policy Functions

Reassuringly, the saving policy functions (Figure 3.5) are the mirror image of the consumption policy functions. Low-income households have negative saving rates once they get out of the liquidity constraint, but higher saving rates than in the standard model. In turn, medium and high income households are affected the most by MA. For low levels of assets, MA works against the precautionary savings motive and pushes consumption closer to income (segment AB in Figure 3.5 Panel A). Starting from point B to the right, MA provides an additional saving motive. In segment BC, these households are unconstrained hand-to-mouth and save the interest income earned on their assets. Hence, the gross saving policy function has a positive slope (Panel A), where gross saving is defined as the change in wealth, while the saving net of interest earned on their assets is zero (Panel B). For a high enough level of assets, these households start consuming more than income and they dissave at a slower pace than in the standard model. As a result, they have a higher asset *target* than predicted by buffer-stock considerations: when the

[30] Hand-to-mouth behavior is an optimal choice in the MA model. Hence, it does not qualify as 'near rationality' in the sense of Akerlof and Yellen (1985), Cochrane (1989), and Browning and Crossley (2001).

precautionary motives caused by income risk and by the liquidity constraint have faded, MA provides an additional saving motive.

### 3.3.3 Wealth Distribution and Inequality

Aggregate asset accumulation in the MA model is lower than in the standard model, as evidenced by the higher discount factor needed to match the same level of aggregate wealth (Table 3.1). With the same wealth-to-output ratio, both models generate a similar asset distribution – the two lines in Figure 3.6 are close, but not identical. Hence, the MA model has the same difficulty in matching top wealth inequality moments as the standard model (Carroll, 2000; De Nardi and Fella, 2017). The models also generate a similar share of poor hand-to-mouth households (see Section 4.1 for further details).

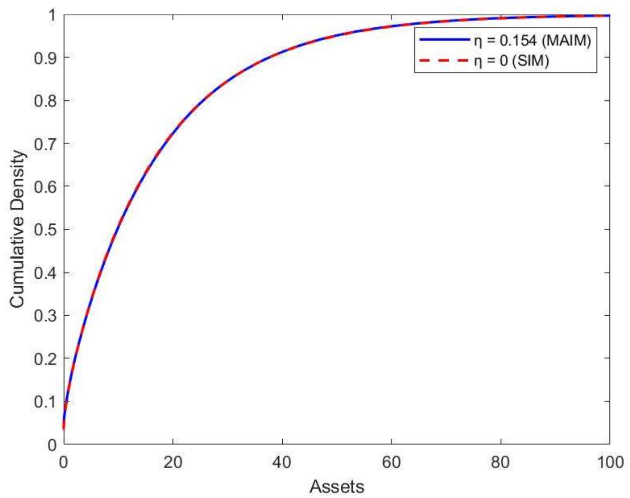



Figure 3.6. Cumulative Distribution Function for Assets: Mental Accounting (MAIM) vs. Standard (SIM) model.

## 3.4 Marginal Propensities to Consume

This section presents the MPCs in the infinite-horizon model out of transitory shocks at the individual level, across the household distribution, and in the aggregate, and evaluates them against the empirical evidence. The MPC is computed as the consumption change with respect to the stationary equilibrium of the model out of a windfall T, that is distributed to all households. Unless stated otherwise, this transfer is unexpected and labeled as 'income'. For household $h$, the MPC out of income is:

$$MPC_h^y = \frac{C(a_h, y_h + T) - C(a_h, y_h)}{T}$$

where $C(a_h, y_h)$ is the optimal consumption choice for a household with assets $a_h$ and income $y_h$, given by the policy function computed in Section 3.[31] The aggregate MPC out of income is computed as the sum of the consumption responses across households weighted by the probability density function of the stationary household distribution $\mu_\infty$:

$$MPC_{aggr}^y \equiv \int MPC_h^y(a_h, y_h) d\mu_\infty(a_h, y_h)$$

### 3.4.1 Hand-to-Mouth Households

Table 3.2 summarizes the share and the average MPC of the types of hand-to-mouth (HtM) households in the MA model, using alternative definitions. First, I consider hand-to-mouth households with low levels of assets. The Zero-Liquidity (ZL) households are those with zero assets, while the poor HtM are those with asset holdings lower or equal than half of their pay-period earnings (following Kaplan and Violante, 2014). The two models generate similar shares of these households, consistently with the microeconomic data (Kaplan and Violante, 2014, estimate the poor HtM share to be in the range 4% – 14%). However, the MA model substantially amplifies the MPC at the constraint and close to it because the kink dominates behavior in that region (see Section 3.1.2).

Second, I look at unconstrained HtM households with asset holdings above half of their pay-period earnings. I use two definitions of HtM behavior: (1) an optimal choice of consumption equal to income, and (2) an MPC of 100%; the share in (2) is smaller because the definition is more restrictive. The bulk of the unconstrained HtM have an MPC of 100%. This result also holds when I pool together all HtM households across asset levels ('total HtM'): 20% of the household population in the model has an MPC of 100%.

[31] Because income and assets are non-fungible, the slope of the policy function in Figure 2 with respect to assets (right axis) corresponds only to the MPC out *assets* (see Section 4.5), and not to the MPC out of income, as would be the case in standard models.

Table 3.2. Type, Share, and MPC$^y$ of Hand-to-Mouth Households

| ***Household Type*** | ***Magnitude*** | Mental Accounting | Standard |
|---|---|---|---|
| Zero Liquidity<br>(Assets = 0) | Share (%)<br>MPC$^y$ (%) | 3.8<br>97.2 | 3.4<br>47.6 |
| Poor HtM<br>($a \leq y/2$) | Share (%)<br>MPC$^y$ (%) | 9.0<br>71.3 | 8.4<br>26.2 |
| Unconstr. HtM 1<br>($c^* = y$; $a > y/2$) | Share (%)<br>MPC$^y$ (%) | 16.0<br>94.5 | 0<br>- |
| Unconstr. HtM 2<br>(MPC$^y$ = 1; $a > y/2$) | Share (%)<br>MPC$^y$ (%) | 14.5<br>100 | 0<br>- |
| Total HtM 1<br>($c^* = y$; $\forall a$) | Share (%)<br>MPC$^y$ (%) | 21.9<br>94.8 | 3.3<br>49.7 |
| Total HtM 2<br>(MPC$^y$ = 1; $\forall a$) | Share (%)<br>MPC$^y$ (%) | 19.9<br>100.0 | 0<br>- |

#### 3.4.1.1 High MPCs in Liquid Households

These predictions of high MPCs in unconstrained households are consistent with empirical evidence of high MPCs in households with medium and high incomes[32], with positive liquid wealth[33,34], and with positive net worth[35]. Although the model asset represents net worth (liquid and illiquid wealth), I also evaluate the model predictions with evidence using liquid wealth data, for two reasons. First, because it speaks to the

[32] For studies using nondurable consumption (NDC), see Bräuer et al. (2022); Kueng (2018); Olafsson and Pagel (2018); Misra and Surico (2014; 2011); Parker (1999). For studies using total consumption (TC), see Sahm, Shapiro and Slemrod (2010); Shapiro and Slemrod (2009; 2003a; 2003b; 1995). While the model is calibrated to the nondurable MPC, throughout the paper I assume that the evidence on total consumption, while not as directly relevant as the evidence on nondurable consumption, is still informative about the response of nondurables.

[33] For studies with NDC, see Bräuer et al. (2022); Baugh et al. (2021); Kueng (2018); Olafsson and Pagel (2018); Misra and Surico (2014; 2011); Souleles (2002). For studies with TC, see Fagereng, Holm, and Natvik (2021); Jappelli and Pistaferri (2020; 2014).

[34] These predictions are also not inconsistent with previous empirical work. Parker et al. (2013) find that the NDC responses to tax rebates are not statistically significantly different across households with different levels of liquidity. In turn, Johnson, Parker, and Souleles (2006) find high NDC responses to tax rebates among households with both low and high liquid assets.

[35] Misra and Surico (2014) find high MPCs out of tax rebates in homeowners without mortgage debt (positive net worth), both in 2001 and 2008. Kaplan, Violante, and Weidner (2014) find high MPCs in households with positive net worth (the so-called 'wealthy hand-to-mouth' have, by definition, positive illiquid net wealth and hence positive net worth). Bräuer et al. (2022) find high MPCs in stockowners, most of which have positive net worth given the observed rates of stock market participation (Campbell, 2018, Ch. 10). These three papers estimate NDC MPCs, whereas Di Maggio et al. (2020), Sahm et al. (2010), and Shapiro and Slemrod (2003a) estimate high TC MPCs in stockowners.

model *mechanisms* that generate high MPCs in unconstrained households. And second, because it can be taken as evidence of high MPCs in households with positive net worth with a small error, given that households with negative illiquid wealth appear very infrequently in the data (Kaplan et al., 2014). The MPC estimates above are typically (sub-)sample *averages*, which should be compared with the average MPCs reported in Section 4.3.

#### 3.4.1.2 Individual $MPC^y$ = 100%

The individual predictions of an MPC of 100% (Table 3.2) are numerically comparable with studies that explicitly address MPC heterogeneity. Misra and Surico (2014) obtain, for the 2001 tax rebate, MPC point estimates equal to or larger than 100% for 10% of households; and they find MPCs not statistically different from 100% for 16% of households – these estimates correspond to their Figure 1.[36] Kueng (2018) measures an average MPC close to 100% in three of the sixteen subsamples in his Table V. Relatedly, Jappelli and Pistaferri (2014, Figure 4) document that a sizable share of households report a numerical MPC of 100% in the Italian Survey of Household Income and Wealth; in turn, Daniel et al. (2021) find an 'assumed' MPC of 100% out of dividends in a substantial fraction of their sample. Note, however, that the last two studies only measure total consumption responses.

### 3.4.2 MPC Bi-modality and the Spender-Saver Theory

Figure 3.7 shows a histogram with the bi-modal distribution of MPCs. Households behave dichotomously as either Keynesian hand-to-mouth consumers (20% of the population) or LCH[37] consumers (75%), with the remaining 5% having MPCs somewhere in between. Because hand-to-mouth behavior arises endogenously, the MA incomplete

[36] These details have been kindly shared by Paolo Surico.

[37] These consumers behave as do unconstrained households in the standard model, and I refer to them as LCH consumers in order to stress that they use a long horizon to spread their consumption response to the windfall, and hence their MPC is equal to the annuity value of the shock. The literature has sometimes referred to these as PIH consumers (for Permanent Income Hypothesis). However, in the revision of his PIH, 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%. This interpretation of the PIH is consistent with Carroll (1997; 2001) and with Thaler (2015, Ch. 11). See Carroll (2001) for a reconciliation between Friedman's (1963) prediction regarding the MPC out of windfalls and Friedman's (1957) popular prediction of a nearly-zero MPC out of 'transitory income shocks'.

markets model offers a micro-foundation for the spender-saver theory of Campbell and Mankiw (1989, 1991). Moreover, and as discussed in Kaplan and Violante (2014), the MPC bi-modality is found in the empirical evidence: a fraction of households consumes most of the transfer/rebate, while the rest do not consume from it at all (Misra and Surico, 2014; Bunn et al., 2018).

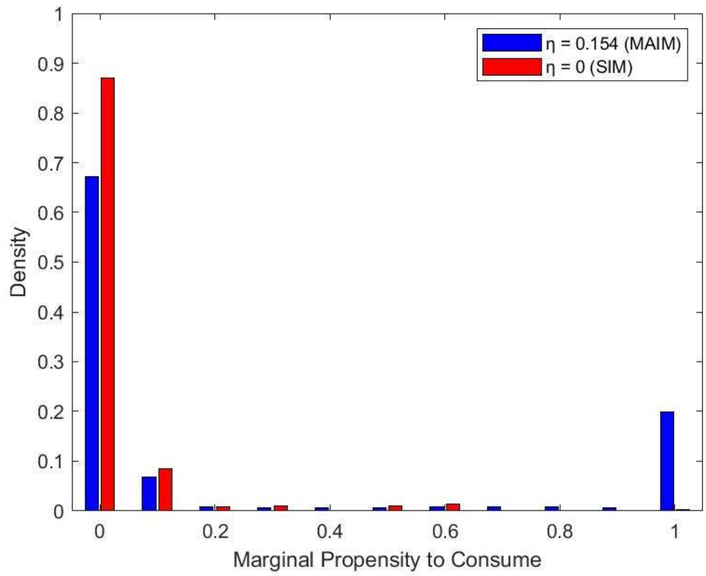
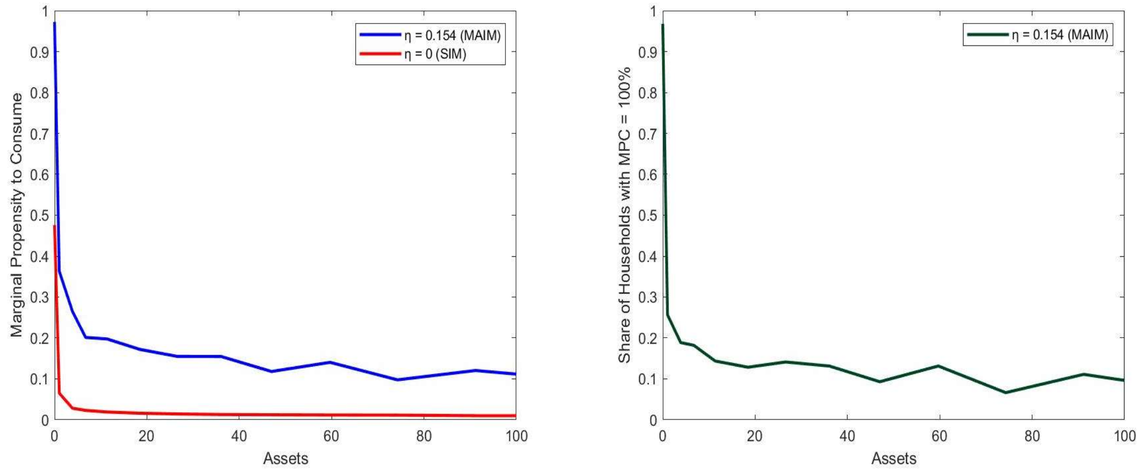



Figure 3.7. MPC Histogram: Mental Accounting (MAIM) vs. Standard (SIM) model.

### 3.4.3 MPCs across the Asset Distribution

Figure 3.8 Panel A shows the average of the individual MPCs over income levels across the asset spectrum. As should be expected from the MPC bi-modality, the average MPC is driven almost entirely by the share of hand-to-mouth households (Figure 3.8 Panel B). The ZL and poor HtM drive the average MPC close to 100% near the constraint, well above the standard model. For positive asset holdings, the model generates an average MPC of 35% – 10% that is also well above the standard model. Overall, the average MPC and the share of hand-to-mouth households with an MPC of 100% decline with wealth.[38] This prediction is consistent with much of the evidence discussed in Section 4.1, which finds that the average MPC declines with different measures of wealth and/or cash-on-hand.

[38] The idea goes back to Keynes (1936): "the marginal propensity to consume [is] weaker in a wealthy community".




Panel A: MPC average over incomes. Panel B: Share of HHs with MPC = 1.

Figure 3.8. MPC out of income and hand-to-mouth households across the asset distribution: Mental Accounting (MAIM) vs. Standard (SIM) model.

### 3.4.4 Aggregate MPC (Contributors), Aggregate Wealth, and Median Wealth

In this section I consider the challenges of the 1-asset model regarding aggregate moments and how Mental Accounting can resolve them.

#### 3.4.4.1 Challenges of One-Asset Models

The standard one-asset model has a well-known difficulty in matching simultaneously the aggregate MPC and the aggregate wealth-to-GDP ratio. When the discount factor is calibrated to match the aggregate wealth, standard models typically predict a small share of ZL / poor HtM households (Table 3.2) and, as a result, an aggregate MPC around 4%, well below the empirical evidence. Conversely, if the discount factor is calibrated to match only the liquid wealth in the economy (Carroll et al., 2017), the share of poor HtM households is large enough to generate a realistic aggregate MPC, but at the cost of abstracting from 92-98% of aggregate wealth. This limits the model's use for macroeconomic analysis in general equilibrium, where it is important to represent total wealth, and not just a minor fraction of it (Kaplan, Moll, and Violante, 2018; Kaplan and Violante, 2022). Since both the aggregate MPC and the aggregate wealth depend on the discount factor, the standard model cannot match the two aggregate moments simultaneously, but only one of them.

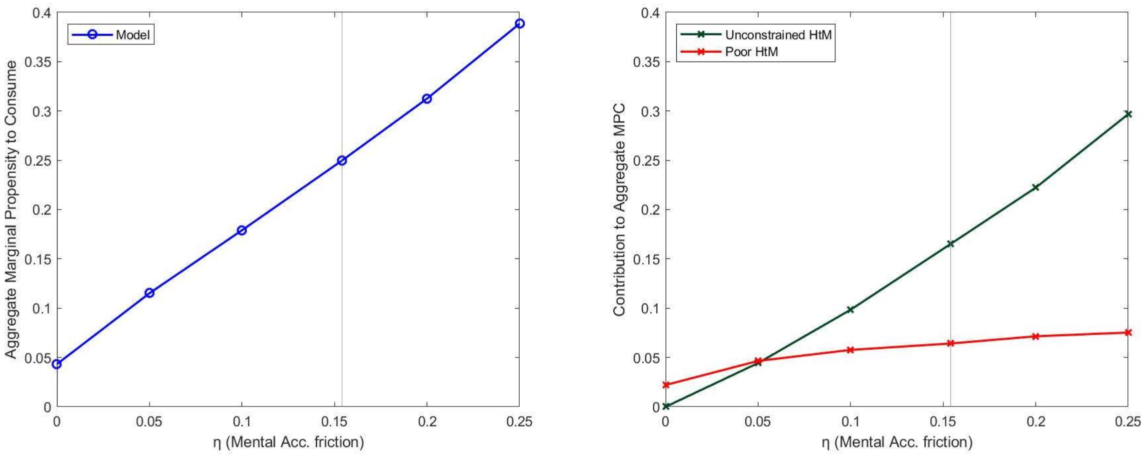
The literature has proposed to overcome this challenge by adding features to the one-asset model (Kaplan and Violante, 2022). While these features resolve the challenge, they generate a very polarized asset distribution: an unrealistically large mass of households with little wealth and high MPC serves to match the aggregate MPC, while another large mass of wealthy households with low MPC serves to match the aggregate wealth. As a result, these models understate the amount of wealth held by the median household: Kaplan and Violante (2022) call this the 'missing middle' problem.

Moreover, there is an unstudied puzzle about the *contributors* to the aggregate MPC. Because unconstrained households have high MPCs (see evidence in Section 4.1) and they represent a majority of the population (Kaplan and Violante, 2014), they contribute substantially to the aggregate MPC. This empirical fact challenges any model that relies only or mainly on liquidity constraints to generate hand-to-mouth behavior.

#### 3.4.4.2 Mental Accounting: A Solution

In the MA model, the discount factor is calibrated to match an aggregate wealth-to-output ratio of 3.18 from Kaplan et al. (2018). This calibration generates a realistic share of ZL and poor HtM (Table 3.2), but those shares are insufficient to match the aggregate MPC when $\eta = 0$ (see Figure 3.9 Panels A and B). Crucially, the model has now an additional degree of freedom (parameter $\eta$) that decouples the calibration of the aggregate MPC and the calibration of aggregate wealth. By increasing the value of $\eta$, the model increases the aggregate MPC to a realistic level of 25% via two channels (Figure 3.9 Panels A and B): generating a sizable share of unconstrained HtM households, and amplifying the MPC at the constraint. Hence, the MA model is consistent with the empirical evidence on the determinants of the aggregate MPC and it resolves the known difficulty of one-asset models, thereby showing that the model is fit for use in general equilibrium applications.

Moreover, the ratio of median wealth to annual earnings is 2.17 in the MA model (2.15 in the standard case). This ratio is above but within a reasonable range of the empirical moment of 1.56 (Kaplan and Violante, 2022, based on the 2019 Survey of Consumer Finances). It indicates a slight overstatement of the wealth held in the middle of the distribution, as opposed to the understatement that characterizes the 'missing middle' problem. However, this difference is not due to the MA friction, but it is a result of the assumed income process and hence can be easily resolved.[39] Importantly, the asset distribution is not polarized (Figure 3.6). Hence, the model resolves the aforementioned puzzles without running into the 'missing middle' problem.




Panel A: Aggregate MPC. Panel B: Aggr. MPC decomposition.

Figure 3.9. Aggregate MPC and contributions of the poor and unconstrained hand-to-mouth to the aggregate MPC, for different calibrations of the MAIM model varying $\eta$.

Note: The baseline calibration of the $\eta$ parameter is indicated by the vertical grey line.

### 3.4.5 Asset-specific MPCs: Income vs. Asset Shocks

The MPC out of an unexpected windfall of size T that the household $h$ labels as 'assets' is given by:

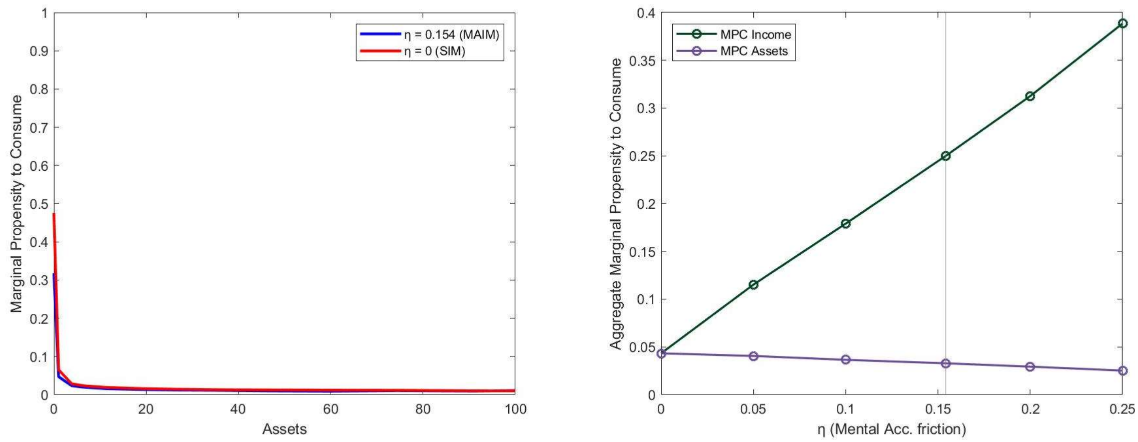
$$MPC_h^a = \frac{C(a_h + T, y_h) - C(a_h, y_h)}{T}$$

where the notation is the same as above. For unconstrained HtM the MPC out of income is 100% and the MPC out of assets is 0% (Table 3.3). This asset-specific MPC is a manifestation of the non-fungibility between income and assets and indicates aversion to dissaving. ZL and poor HtM are responsive to asset shocks, but they have a substantially lower MPC out of assets than in the standard model. In turn, all unconstrained non-HtM households have an MPC out of assets that is close to the standard model.

[39] Kaplan and Violante (2022, Table 1) use a different income process and obtain a median wealth-to-earnings ratio of 1.3 in their "baseline" standard one-asset model.

Table 3.3. Heterogeneity in MPCs out of Assets

| ***Household Type*** | ***Magnitude*** | Mental Acc. | Standard |
|---|---|---|---|
| Zero Liquidity | Share (%) | 3.8 | 3.4 |
| (Assets = 0) | MPC$^a$ (%) | 31.8 | 47.6 |
| Poor HtM | Share (%) | 9.0 | 8.4 |
| (Assets ≤ Income/2) | MPC$^a$ (%) | 17.6 | 26.2 |
| Unconstrained HtM | Share (%) | 17.5 | 0 |
| (MPC$^y$ > 40%) | MPC$^a$ (%) | 0.4 | – |
| Unconstrained HHs with $c^* \neq y$ | Share (%) | 75 | 91.6 |
| (Assets > Income/2) | MPC$^a$ (%) | 2.3 | 1.3 |
| Total HtM | Share (%) | 24.0 | 2.4 |
| (MPC$^y$ > 40%) | MPC$^a$ (%) | 5.9 | 57.0 |




Panel A: Average MPC assets.

Panel B: Aggr. MPCs income vs. assets.

Figure 3.10. Distribution of MPCs out of assets and aggregate MPC out of income and out of assets in the Mental Accounting (MAIM) vs. the Standard (SIM) model.

Note: The baseline calibration of the $\eta$ parameter is indicated by the vertical grey line.

Table 3.4. Asset-specific Aggregate MPCs

| ***Model version*** | Mental Accounting | Standard |
|---|---|---|
| Aggr. MPC out of income | 25.0% | 4.3% |
| Aggr. MPC out of assets | 3.3% | 4.3% |

Figure 3.10 Panel A plots the MPC out of assets averaged over income levels, across the asset distribution. Reassuringly, the standard model predicts the same MPC distribution out of assets and out of income (Figure 3.8 Panel A), because it assumes perfect fungibility of income and assets. In contrast, the MA model predicts a distribution

of MPCs out of assets substantially below that of income (Figure 3.8 Panel A); and also below the MPCs out of assets in the standard model. These differences manifest themselves in the aggregate MPCs, as summarized in Table 3.4 and in Figure 3.10 Panel B. The MA model generates an aggregate MPC out of income that is one order of magnitude (almost 10 times) higher than the aggregate MPC out of assets. The aggregate MPCs out of income and out of assets drift apart as the MA friction ($\eta$) becomes more severe.

Asset-specific MPCs are an example of *framing* in the sense of Kahneman and Tversky (1984), Tversky and Kahneman (1981): a model property by which the same decision problem formulated or framed in two different ways generates two different outcomes. This property can explain a number of empirical facts.

#### 3.4.5.1 Stock Market Wealth[40]

I compare the model MPCs out of assets to the estimated MPCs out of unrealized capital gains, and the MPCs out of income with the estimated MPCs out of cash dividends and realized capital gains. I rely on the model MPCs for the entire household distribution, although stock market participation is not universal (Campbell, 2018, Ch. 10). Unrealized capital gains represent a change in wealth, hence the comparison is consistent with standard finance theory. In turn, dividends and realized capital gains do not constitute a change in wealth, but only a reallocation thereof, hence their comparison deviates from standard theory. However, Hartzmark and Solomon (2019) find that investors behave and analysts formulate forecasts as if dividends had no effect on stock prices, a mistake called the "free dividend fallacy". In light of this, I assume that households perceive the dividend payments and realized capital gains (for ease of comparison) as windfalls that do not diminish their wealth. In any case, the difference between the two approaches is conceptual, rather than quantitative.[41]

[40] The MPCs out of assets are informative about the stock market wealth effects on consumption, which are reportedly an important driver of the U.S. monetary policy response to stock market fluctuations (Cieslak and Vissing-Jorgensen, 2021).

[41] Following standard finance theory, dividends and realized capital gains generate a transfer from stock market wealth to liquid wealth. In the standard model this transfer generates an MPC of 0% because of fungibility. Conversely, in the MA model, there is a transfer of resources from the asset account to the income account, and the MPCs are defined correspondingly as follows:

$$MPC^{Div} = MPC^{RCG} = \frac{C(a_h - T, y_h + T) - C(a_h, y_h)}{T}$$

#### 3.4.5.1.1 Miller and Modigliani (1961)

The different MPCs out of dividends and out of unrealized capital gains imply that households are *not* indifferent between a change in the market value of their stock holdings and a change in dividend cash payments. Hence, MA violates the "rational behavior" assumption underlying the Miller-Modigliani dividend irrelevance result.

#### 3.4.5.1.2 Dividends and Capital Gains

The predictions of the MA model are consistent with the following empirical findings. First, Bräuer et al. (2022) report that: (i) most (over 60%) of the investors in their sample view dividends as a source of regular income; and (ii) the investors who view dividends as a source of income respond to their receipt with a much higher MPC than the investors who view dividends as "negligible payments". Second, the MPC out of dividends is: (i) high and in the same order of magnitude than the MPC out of labor income, including households with positive liquid wealth (Bräuer et al., 2022; Kueng, 2018; Baker et al., 2007); and (ii) one order of magnitude higher than the MPC out of unrealized capital gains, both across the wealth distribution (Di Maggio et al., 2020) and in the aggregate (Di Maggio et al., 2020; Baker et al., 2007).[42] Third, Meyer et al. (2020) estimate an aggregate MPC for total consumption out of realized capital gains that is in the same order of magnitude as previous estimates of the MPC out of dividends, and substantially larger than for unrealized capital gains.[43]

#### 3.4.5.1.3 Bi-modality Again: Portfolio Rebalancing

Finally, the MA model is consistent with further empirical findings on portfolio rebalancing behavior. Daniel et al. (2021, Figure 1 Panel A) document a bi-modal portfolio rebalancing response to stock dividends and bond coupon payments, while

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where the notation is the same as before. Note that I divide by the size of the transfer T in order to normalize the consumption response, although there is no change in wealth. The resulting MPC in the MA model is 23.1%, as opposed to the 25% of the MPC out of windfall income.

[42] Di Maggio et al. (2020) and Baker et al. (2007) use an imputed measure of TC, while all the other studies analyze the responses of NDC.

[43] Kaldor (1955) argued that realized capital gains and unrealized capital gains are different concepts of income with respect to their implications for expenditure: "For in so far as capital gain is realized and spent, […] the benefit derived from the gain is equivalent to that of any other casual profit. If however it is not so realized, there is clearly only a smaller benefit – even though, […] a rise in capital values […] is of some advantage to the holder."

Baker et al. (2007, Figure 3 Panel 2) find a bi-modal response to mutual fund dividends: in both samples, one group of investors reinvests (i.e. saves) the entire dividend into their portfolio (MPC of 0%), and another group withdraws (i.e. consumes) the entire dividend (MPC of 100%). Regarding capital gains, in contrast, Daniel et al. (2021, Figure 1 Panel B) find a *uni*-modal portfolio rebalancing response, where many investors withdraw a very small fraction and reinvest the rest (positive, but small MPC), although with more scatter. Note, however, that both studies use transaction, not consumption, data.

#### 3.4.5.2 Housing Wealth

The MPCs out of assets are also quantitatively consistent with MPC estimates out of housing wealth across the distribution and in the aggregate, a comparison that is more exact given that households participate more in housing markets (Campbell, 2018, Ch. 10). Estimates of the aggregate MPC lie within the range 2% to 7%, including in some cases MPCs that decrease with household wealth (Mian, Rao, and Sufi, 2013; Aladangady, 2017; Guren et al., 2021; Paiella and Pistaferri, 2017; Andersen and Leth-Petersen, 2021; Christelis et al., 2021; Jappelli and Pistaferri, 2017, Ch. 9 for an overview of the earlier literature). Note, however, that all studies use total consumption, except for Paiella and Pistaferri (2017), who use nondurables.

#### 3.4.5.3 College Tuition Payments

Shefrin and Statman (1984) argue that households adopt MA rules to ensure that they will be able to meet important future expenses, such as their children's college tuition. Souleles (2000) finds that college tuition payments have little effect on nondurable consumption. The MA model can rationalize this finding by assuming that tuition is paid from the asset account, generating a small MPC.

### 3.4.6 Intertemporal MPCs and the Role of Savings

In this section I compute the perfect-foresight transition path of aggregate consumption in response to an *anticipated* windfall of the same size T of previous experiments. This object has been called the 'intertemporal MPC' (Auclert et al., forthcoming). The aggregate consumption path is shown in Figure 3.11.

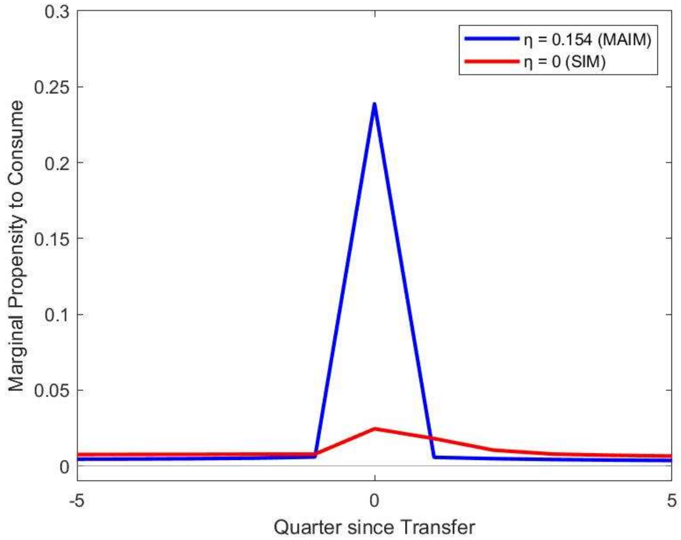



Figure 3.11. Intertemporal MPC out of anticipated shocks: Mental Accounting (MAIM) vs. Standard (SIM) model.

Table 3.5. MPCs out of Unexpected vs. Anticipated Windfalls

| ***Model version*** | Mental Acc. | Standard |
|---|---|---|
| MPC out of Unexpected Windfall | 25.0% | 4.3% |
| MPC out of Anticipated Transfer | 23.9% | 2.5% |
| MPC out of Future Income | 0.6% | 0.8% |

#### 3.4.6.1 Non-Anticipation, Excess Sensitivity, and No Lagged Effects

Four patterns appear systematically in empirical studies of intertemporal consumption behavior in response to anticipated, transitory income shocks. First, consumption does not react to the news about future income gains.[44] Second, consumption is excessively sensitive to the receipt of the anticipated income gains.[45] Third, the consumption response dies out approximately one quarter after the shock.[46] Fourth, these patterns are visible in samples of households with enough liquid assets (footnote 43 and Souleles, 2002), with high incomes (Parker, 1999), with large stock holdings (Shapiro and Slemrod, 2003a; Sahm et al., 2010), as well as in the aggregate.[47] Being aware of the future shock, the lack of dissaving in liquid households is not only evidence of non-smoothing behavior, but it

[44] See Baugh et al. (2021); Kueng (2018); Olafsson and Pagel (2018); Braüer et al. (2022).
[45] See Baugh et al. (2021); Kueng (2018); Olafsson and Pagel (2018); Braüer et al. (2022); Souleles (2002); Parker (1999); Shapiro and Slemrod (2003a); Sahm et al. (2010).
[46] See Baugh et al. (2021); Kueng (2018); Olafsson and Pagel (2018); Braüer et al. (2022); Shapiro and Slemrod (2003b); Sahm et al. (2010).
[47] The papers use NDC, except for Shapiro and Slemrod (2003a; 2003b) and Sahm et al. (2010).

also reveals a preference for *not* using liquid assets to smooth consumption around shocks.

Mental Accounting is able to match this evidence. MA generates a substantial share of unconstrained HtM, apart from poor HtM, households, who have an MPC out of income of 100% and an MPC out of assets of 0%. In anticipation, HtM dissave little, if at all, in response to the news about future income, hence the aggregate MPC is 0.6% in the period just before the income gain is realized (Table 3.5). Only upon receipt of the shock do households classify it as income. Because there is little spending in anticipation, the aggregate MPC out of the anticipated shock is 23.9%, very close to that of an unanticipated shock (25%), driven by the response of HtM households. In the period after the shock, HtM households are back in the initial situation before the transfer was announced because they have consumed all of it. Non-HtM households smooth consumption: in anticipation of the shock they consume little; upon receipt they consume little and save the rest into the asset account; and afterwards they consume little because of a low MPC out of assets.

#### 3.4.6.2 The Role of Savings

The intertemporal behavior of the HtM households reveals that savings play a smaller role in the reallocation of resources over time than in models with standard preferences. Households prefer not to dissave in order to smooth consumption around shocks. The non-Ricardian intertemporal behavior manifests itself also in the aggregate, explaining a number of empirical facts.

### 3.4.7 Asymmetric MPCs

In the MA model, liquidity constraints are no longer a source of size and sign MPC asymmetries, as in the standard model, because the kink dominates behavior at the constraint. However, asymmetries arise through the framing of different shocks as either income or assets.

#### 3.4.7.1 Size Asymmetries

A number of empirical studies have documented that the MPC declines with the size of the windfall (Misra and Surico, 2014; Kueng, 2018; Olafsson and Pagel, 2018;

Christelis et al., 2019; Baker et al., 2007), in samples with liquid households. The numerical exercise in Table 3.6 shows how the MA model can rationalize this finding: by making the additional assumption that households classify small windfalls (size T) as income and larger windfalls (2T) partly as income (50%) and partly as assets (50%). Hence, the MPC of HtM households is 100% for half of the windfall, and 0% for the other half, i.e. 50% overall. The model implications for the design of fiscal stimulus transfers are that the stimulus of small transfers is more efficient because a higher fraction is spent.

#### 3.4.7.2 Sign Asymmetries

The evidence on MPCs out of windfalls with different sign is seemingly contradictory. On one hand, Baugh et al. (2021) find that tax refunds generate excessively sensitive consumption responses, whereas tax payments do not. As Baugh et al. (2021) suggest, this finding can be rationalized in the MA model by assuming that tax refunds are classified as income, whereas tax payments are paid from the asset account. On the other hand, empirical work documents that income losses generate bigger consumption adjustments than income gains (Fuster et al., 2021; Christelis et al., 2019). This fact can be rationalized by assuming that gains are classified partly as assets whereas losses are all classified as income. While this section schematically shows the model properties, more evidence is needed to generate accurate predictions.

Table 3.6. Size Effects of MPCs

| | Mental Accounting | Standard |
|---|---|---|
| MPC income (T) | 25.0% | 4.3% |
| MPC income (2T) | 13.4% | 3.9% |

## 3.5 Consumption and Saving over the Life-Cycle

In this section I present the predictions of the life-cycle model and evaluate these against the empirical evidence.

### 3.5.1 The Retirement-Consumption Puzzle and Related Facts

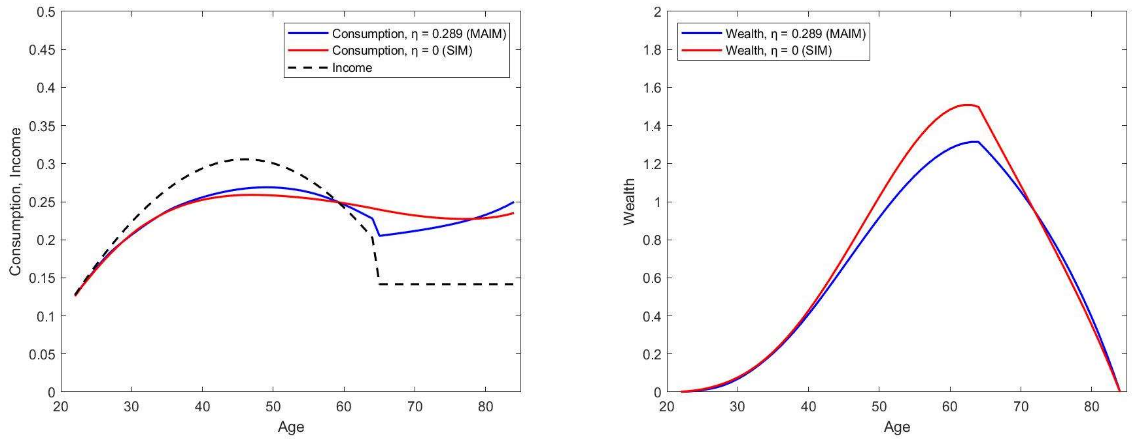
The transition from working life to retirement implies an anticipated permanent income change (Haider and Stephens, 2007, find that subjective expectations of retirement are a good predictor of retirement). Empirical work (Banks, Blundell, and

Tanner, 1998; Bernheim, Skinner, and Weinberg, 2001; Haider and Stephens, 2007) has found a sizable non-durable consumption drop at retirement. This drop is substantial even after considering work-related expenses (Banks et al., 1998; Bernheim et al., 2001). The empirical estimates of the consumption decrease at retirement are a median drop of 14% in Bernheim et al. (2001), a cumulated 10% drop over the retirement years in Banks et al. (1998), and a 7-11% drop at the expected retirement date in Haider and Stephens (2007). Other papers (Angeletos et al., 2001; Pagel, 2017) find similar consumption drops. Because such decrease in consumption is larger than the prediction of the standard model (0.8%), the discrepancy has been called the 'retirement-consumption puzzle'.[48] Moreover, Bernheim et al. (2001) observe consumption drops across different wealth and income levels, and find a negative correlation between retirement wealth and the consumption drop. In addition, Ameriks, Caplin, and Leahy (2007) find that relatively wealthy households expect consumption to drop, revealing a preference for not using savings to smooth consumption.

#### 3.5.1.1 Excess Sensitivity and the Role of Savings

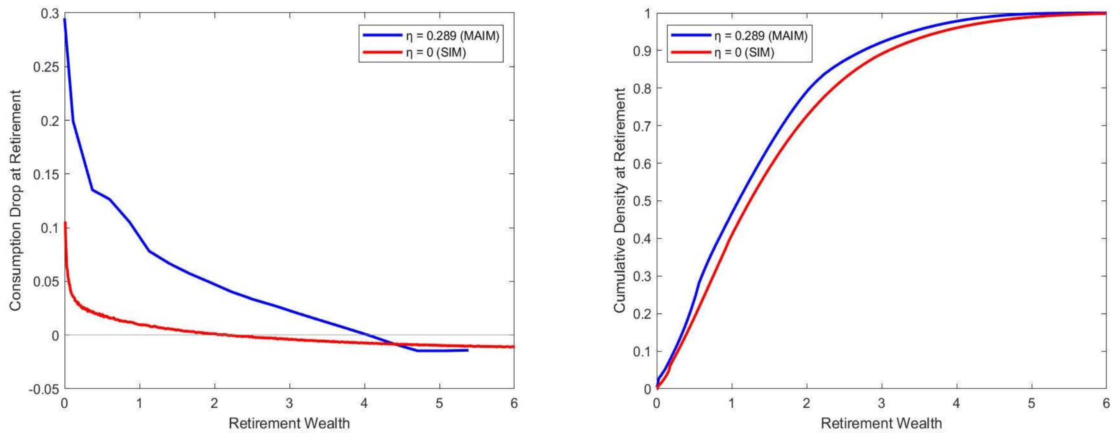
MA offers a rationalization of the retirement-consumption puzzle by generating a 10.0% consumption drop at retirement (Figure 3.12 Panel A). Consumption is excessively sensitive to the anticipated permanent income shock. Consistent with the evidence, households do not reallocate their savings across time periods to smooth consumption around the shock. In addition, the unconstrained HtM households are spread across the wealth distribution in a way that the consumption drop is negatively correlated with retirement wealth (Figure 3.13 Panel A). Conversely, in the standard model most households use savings to smooth the shock and only liquidity-constrained households respond to the shock. In both models there is a small counteracting consumption increase due to the reduction of income uncertainty at retirement.

[48] This view is not undisputed. A line of criticism argues that household expenditure data do not necessarily reflect household consumption, which is the argument of the utility function. Aguiar and Hurst (2005) estimate that the observed drop in expenditure (i) does not reflect a decrease in quality nor quantity of nutrient intake when entering retirement, and (ii) can be rationalized by an increase in shopping time and in home production. However, Stephens and Toohey (2021) revisit this question and find that nutrient intake does decrease at retirement.




Panel A: Consumption and income paths. Panel B: Wealth path.

Figure 3.12. Life-cycle paths: Mental Accounting (MAIM) vs. Standard (SIM) model.




Panel A: Consumption drop. Panel B: Cum. Distr. Func. of wealth.

Figure 3.13. Consumption drop at retirement averaged over income levels across retirement wealth: Mental Accounting (MAIM) vs. Standard (SIM) model.

### 3.5.2 Retirement Wealth

Households with MA accumulate less wealth for retirement than in the standard model (Figure 3.12 Panel B) because they anticipate the consumption drop at retirement and the lower need for savings to smooth consumption. The model captures the fact that households are forward-looking about their retirement (Haider and Stephens, 2007) and that preferences generate, at the same time, a consumption discontinuity at retirement and a lower level of retirement wealth (Bernheim et al., 2001, Figures 2A and 2B). Intuitively, households anticipate their preference to live off their pension/retirement income once they retire.

#### 3.5.2.1 Do Households Save Enough for Retirement?

The above discussion can shed some light on this question. Shefrin and Thaler (1988), extending an idea present in Thaler (1980) and in Kahneman and Tversky (1979), argue that the LCH can be thought of as a model of how people should behave (i.e. a "normative theory"), as opposed to the Mental Accounting model, which is a model of how people actually behave (a "positive/descriptive theory"). Following this argument, the gap in retirement wealth between the standard and the MA models (Figure 3.12 Panel B) can be interpreted as the gap between the ideal and the actual levels of retirement wealth, which indicates that households save "too little" for retirement because they anticipate their preference to live off their pension.

## 3.6 Conclusion

In this paper I show that the Mental Accounting incomplete markets model explains a large set of empirical facts about consumption at the individual level, across the household distribution, and in the aggregate, within and across time periods, as well as over the life-cycle. There are several avenues for future research. In the realm of consumption theory, potential model extensions include additional frictions, such as durable goods, multiple mental accounts (e.g. for debt), or illiquid assets. In the area of general equilibrium analysis, a natural question is how Mental Accounting affects the transmission of macroeconomic policies. On the empirical side, more evidence is needed on the behavioral aspects of household finances.

# 4. Chapter 3. Consumption with Mental Accounting in a Two-Asset Environment

## 4.1 Introduction

The idea that households have a preference for "living within their income" goes back at least to Adam Smith (1790; 1776). About 200 years later, Shefrin and Thaler (1988) proposed that a psychological bias called Mental Accounting, which includes a related idea, should be a sensible enrichment of standard models of consumption and saving. Recent research (previous Chapter) has shown that this bias does increase the explanatory power of consumption models, in particular by explaining a number of anomalies that eluded previous theories.

The recent work on Mental Accounting has rationalized facts about behavior heterogeneity at the household level, facts which are now at the center of macroeconomic research (Kaplan and Violante, 2014; Kaplan, Moll, and Violante, 2018). However, this same research has argued that capital market frictions, in particular asset illiquidity, are necessary to understand consumption behavior. Therefore, it remains to be understood whether Mental Accounting can improve the explanatory power of models in the presence of this other type of frictions.

The present paper attempts to make progress on these issues. For this purpose, I embed a Mental Accounting friction (as in the previous Chapter) into an otherwise standard heterogeneous-agent environment with income risk and two assets of different liquidity, set in partial equilibrium. I obtain and discuss the model predictions, with an emphasis on Marginal Propensities to Consume (MPC), and I evaluate them against the empirical evidence.

The main result of this paper is that Mental Accounting does improve the explanatory power of the 2-asset model, as well. Reassuringly, many of the Mental Accounting properties obtained in the 1-asset incomplete markets model (see previous Chapter) carry over to the 2-asset model. In addition, Mental Accounting is able to solve an empirical puzzle that is specific to the 2-asset model.

In a nutshell, Mental Accounting induces people to behave in a hand-to-mouth way: they consume their income, and have high MPCs. When the Mental Accounting friction is severe enough, by virtue of the household heterogeneity in the model, the share of such hand-to-mouth households increases. This model property allows to solve empirical puzzles at different levels of aggregation, ranging from individual behavior, to averages across the household distribution, to aggregates.

One long-standing puzzle is that unconstrained consumers with enough liquid assets and different levels of income display hand-to-mouth behavior. However, the 2-asset model predicts that hand-to-mouth behavior only arises in households with low levels of liquidity, either the poor hand-to-mouth with low income, or the wealthy hand-to-mouth at the medium income range. This puzzle can be resolved with Mental Accounting: the friction is independent of liquidity levels, generating "liquid hand-to-mouth" households (Olafsson and Pagel, 2018) across the spectrum of liquid wealth (see Section 4.1 and 4.3 for more evidence).

Such liquid hand-to-mouth behavior is pervasive enough that it makes a large contribution to the aggregate MPC. While the standard 2-asset model is totally unable to match this contribution, it does generate an aggregate MPC that is in the lower range of plausible values. Thereby leaving enough space for the Mental Accounting friction to generate a share of liquid hand-to-mouth households that make a difference in the aggregate MPC (see Section 4.4).

The empirical literature has also measured the individual MPC values: they are distributed bi-modally, mimicking a spender-saver structure, and they go up to 100%. The standard 2-asset model does feature this difference between spenders and savers. However, Mental Accounting generates a more marked contrast between these two groups of households, and generates a sizable share of households with an MPC of 100% (Misra and Surico, 2014; Boehm et al., 2024).

The 2-asset model also faces aggregate empirical challenges. As Kaplan and Violante (2022) have argued, the model has a difficulty in matching a realistic aggregate MPC and a realistic return spread between the liquid and the illiquid asset. Kaplan and Violante (2022) propose a return spread of 8.2% to match a reasonable aggregate MPC, although they had estimated a spread of 3.7% before (Kaplan and Violante, 2014). Apart from the asset return in itself being too large, this generates an additional, yet unstudied, problem that the ratio of aggregate consumption to aggregate income is also unrealistically high, about 25p.p. higher than what the evidence has measured. Mental Accounting provides a solution to the MPC puzzle as it generates an aggregate MPC of 25% (Kaplan and Violante, 2014) with a spread of 4%. However, the model calibration that can solve the two aforementioned issues has a lower return spread of 2.5%, consistent with the widespread view (Shiller, 2015) that housing offers meager returns. Despite the introduction of Mental Accounting, the resulting environment retains the essence of the 2-asset model, as it predicts realistic shares of poor hand-to-mouth and wealthy hand-to-mouth households (Kaplan and Violante, 2014; 2022).

The Mental Accounting friction and the capital market friction have something deep in common: both violate the assumption that all resources are fungible[49]. They do so in different and complementary ways. While the illiquidity friction separates illiquid assets and all other liquid resources into different *physical* accounts, the behavioral friction classifies income and all assets into different *mental* accounts. As a result, the model generates three different, account-specific MPCs: the MPC out of income is higher than the MPC out of liquid assets, which in turn is higher than the MPC out of illiquid assets.

These properties are useful in explaining a set of empirical facts that elude the standard 2-asset model. One set of facts concerns the differential MPCs out of dividends and capital gains, ranging from the individual households up to the aggregate responses (see Section 4.5 for evidence). Another set of facts revolves around the intertemporal MPC (iMPC) out of anticipated income shocks. While the 2-asset model features sizable anticipation and lagged effects, many recent empirical studies have found that those effects do not exist (see Section 4.6 for evidence). Mental Accounting, with the non-fungibility between income and liquid assets, implies that households do not use their liquid wealth to smooth income shocks, thereby dampening the anticipation and lagged effects and bringing them closer to the data. Here the Mental Accounting friction adds a layer of Ricardian Non-Equivalence on top of the layer corresponding to the capital markets friction, thereby reflecting the two instances of non-fungibility.

Relatedly, I revisit the evidence in Fagereng et al. (2021) through the lens of the 2-asset model. Crucially, my analysis incorporates the size effects in MPCs, i.e. the model prediction that larger shocks produce smaller MPCs (Kaplan and Violante, 2022; 2014).

[49] This assumption is implicit in the Life-Cycle Hypothesis. See, for instance, Shefrin and Thaler (1988).

I find that the model-implied iMPC out of the average lottery in Fagereng et al. ($25,700) does *not* match, by a substantial amount, the iMPC empirical estimate in Fagereng et al. This finding is consistent with Fagereng et al. (2021), who report that their 2-asset model is inconsistent with their empirical estimates. These size considerations and, as a result, this conclusion, are at odds with Auclert, Rognlie, and Straub (forthcoming).

### 4.1.1 Literature

This paper relates to several strands of the literature. First, there is a literature on Mental Accounting, initiated by the work of Shefrin and Thaler (1988), Thaler (1990), and Thaler (1985). Applications of this framework have touched on different aspects, including stock performance evaluation (Barberis and Huang, 2001), retirement saving rules (Choi, Laibson, and Madrian, 2009), budgeting of different spending categories (Hastings and Shapiro, 2013; 2018), and consumption out of income and wealth (previous chapter). This paper presents a contribution by extending my previous study of Mental Accounting to an environment with capital market frictions.

Second, a recent literature is combining incomplete markets models and behavioral biases to explain consumption facts. These include papers on the dual-system framework (Ilut and Valchev, 2023), expectations-based reference-dependence (Pagel, 2017), and finite planning horizons (Boutros, 2022). The closest ones study the interaction of asset illiquidity with, respectively, temptation (Attanasio, Kovacs, and Moran, 2021), and present bias (Laibson, Maxted, and Moll, 2022). This paper takes a similar approach, but documents the properties of a different bias, namely Mental Accounting.

Third, a subset of the consumption literature has focused on the 2-asset model and its MPC predictions. Previous work includes Kaplan and Violante (2014; 2022), Kaplan, Moll, and Violante (2018), and Auclert, Rognlie, and Straub (forthcoming). This paper differs from these by showing that Mental Accounting can explain a number of empirical challenges affecting the 2-asset model.

## 4.2 A Two-Asset Model of Consumption with Mental Accounting

This section presents a partial equilibrium model of consumption with idiosyncratic income risk, liquid and illiquid assets, as well as Mental Accounts for income and wealth.

### 4.2.1 Household Problem

Households choose consumption (and savings) to maximize:

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

subject to

$$c_{h,t} + b_{h,t+1} + a_{h,t+1} = (1 + R_t^b) b_{h,t} + (1 + R_t^a) a_{h,t} + y_{h,t}$$

and

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

where $c_{h,t}$ denotes consumption of household $h$ at time *t*. The utility function incorporates a Mental Accounting friction, as detailed below. Labor supply is inelastic, pre-tax income is labor productivity $z$, and taxes are progressive with the following schedule: $y_{h,t} = (1 - \tau) z_{h,t}$. Labor productivity follows a Markov chain whose transition probabilities are $\Pr(z_{h,t+1} | z_{h,t})$. The transition matrix of the Markov chain is constant over time and the initial cross-sectional distribution of labor productivity $z_{h,t}$ is set equal to the ergodic distribution of the Markov chain, such that the distribution is constant over time.

#### 4.2.1.1 Two-Asset Structure

The two assets have different degrees of liquidity (Auclert, Rognlie and Straub, forthcoming(a); for similar setups, see also Bayer, Born, and Luetticke, 2024; Kaplan and Violante, 2022). There is no market for contingent claims and households allocate their savings into a portfolio of two assets: $b$ is perfectly liquid, pays net return $R_t^b$ between period $t - 1$ and $t$, and households face a borrowing constraint $\underline{b} = 0$; $a$ is illiquid, pays net return $R_t^a$ between period $t - 1$ and $t$, and households face a short-sale constraint on it. Asset illiquidity is due to a financial friction whereby opportunities to participate in capital markets are random and i.i.d. As a result, each period only a fraction $\upsilon$ of households is allowed to adjust their holdings of asset $a$, the other households see how their illiquid returns capitalize and they can only adjust their liquid asset position. The individual state variables are liquid assets, illiquid assets, income, and the adjustment type; the distribution at time $t$ is $\Gamma_t(a, b, y, adj)$.

#### 4.2.1.2 Mental Accounting

Household preferences include a mental accounting friction, with two main features. First, households partition their wealth into two non-fungible accounts, one with 'income' and one with 'assets'. Second, households have a preference for financing consumption with income rather than with assets. This friction follows the conceptual framework developed in Shefrin and Thaler (1988), and is modelled using the tools of prospect theory (Kahneman and Tversky, 1977) and reference-dependence (Köszegi and Rabin, 2006).

Formally, household utility $U$ is defined as follows:

$$U(c_{h,t}|r_{h,t}) = \begin{cases} u(c_{h,t}) + \eta[u(r_{h,t}) - u(c_{h,t})] & \text{if} \quad c_{h,t} \le r_{h,t} \\ u(c_{h,t}) + \eta\lambda[u(r_{h,t}) - u(c_{h,t})] & \text{if} \quad c_{h,t} > r_{h,t} \end{cases},$$

where $r_{h,t}$ denotes the reference point of household $h$ in period *t*. Utility consists of the "intrinsic" consumption utility $u(c_{h,t})$, and gain-loss utility $u(r_{h,t}) - u(c_{h,t})$, where $u(\cdot)$ is an increasing and concave function with constant relative risk aversion (CRRA). When consumption is below or at the reference point ($c_{h,t} \le r_{h,t}$), the household derives gain utility $u(r_{h,t}) - u(c_{h,t}) > 0$ with weight $\eta$. Conversely, when consumption is above the reference point ($c_t > r_t$), the household derives loss utility $u(r_{h,t}) - u(c_{h,t}) < 0$ with weight $\eta\lambda$, where $\lambda > 1$ is the loss-aversion parameter. The reference point is equal to after-tax labor income. The model nests the standard model as a special case when $\eta = 0$.[50]

Finally, note that this model incorporates two sources of non-fungibility. The mental accounting friction introduces non-fungibility between income and all assets. In tur, the capital markets friction generates non-fungibility between liquid and non-liquid resources.

### 4.2.2 Recursive Problem

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:

[50] For more on the utility function and its properties, see Chapter 2.

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

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:

$$V_{Ad}(b,a,y) = \max_{c,b'_{Ad},a'_{Ad}} U(c|r) + \beta E[V(b'_{Ad}, a'_{Ad}, y')],$$

subject to

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

and

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

And the continuation value $V$ is defined as follows:

$$V(b', a', y') = \upsilon\, V_{Ad}(b', a', y') + (1 - \upsilon)V_{NA}(b', a', y').$$

The saving decisions are $(b'_{NA})$ for Non-Adjusters and $(b'_{Ad}, a'_{Ad})$ for Adjusters. $V_{Ad}$ and $V_{NA}$ denote the value function for the Adjusters and for the Non-Adjusters in the current period, and $V$ is the continuation value over both. Variables with a prime denote next-period variables. The expectations operator $E$ is taken over all the possible realizations of the stochastic income process, using the conditional probabilities $\Pr(y'|y)$.

The First-Order and Envelope Conditions associated with the household problem are:

$$\frac{\partial}{\partial c} U(c|r) \geq \beta E\left[\frac{\partial}{\partial b} V(b_i', a_i', y')\right] \text{ , for } i = NA, Ad$$

$$\frac{\partial}{\partial c} U(c|r) \geq \beta E\left[\frac{\partial}{\partial a} V(b_{Ad}', a_{Ad}', y')\right]$$

$$\frac{\partial}{\partial b} V_i(b,a,y) = (1 + R^b)\ \frac{\partial}{\partial c} U(c|r) \text{ , for } i = NA, Ad$$

$$\frac{\partial}{\partial a}V_{Ad}(b,a,y) = (1+R^a)\ \frac{\partial}{\partial c}U(c|r)$$

$$\frac{\partial}{\partial a}V_{NA}(b,a,y) = \beta(1+R^a)E\left[\frac{\partial}{\partial a}V({b_{NA}}',{a_{NA}}',y')\right]$$

Where the subscripts denote the adjustment type. The first two equations hold with equality except for when $b = 0$ and $a = 0$, respectively.

In the equations above the marginal utility does not exist at the non-differentiability point of the utility function, i.e. when consumption equals income: $\nexists U_c(y|r)$. For this reason, the standard Euler Equation cannot be used to characterize the household problem, and a combination of FOCs and Envelope Conditions is required instead in order to circumvent the use of marginal utility at non-differentiability points and use the marginal value function instead.

### 4.2.3 Calibration

The calibration is summarized in Table 4.1. I set the real interest rate of the liquid asset at -0.5% quarterly (-2% annually) and the coefficient of relative risk aversion to 1. I consider three return spreads: 8%, 4%, and 2.5% (all annual), as explained in Section 3.2. Given the liquid rate, these spreads imply the three following illiquid rates: 1.5% quarterly (6% annually), 0.5% quarterly (2% annually), and 0.125% (0.5% annually).

Idiosyncratic income follows an AR(1) process, with an autoregressive coefficient of 0.9657 quarterly (0.91 annually) for log wage risk from Floden and Lindé (2001); and an unconditional standard deviation of 0.92 from Song et al. (2019), as in Auclert et al. (forthcoming). The process is discretized on a Markov chain with 10 income states using the Rouwenhorst (1995) method, following Kopecky and Suen (2010). The average income tax rate is 33% (DeLong and Summers, 2012).

The discount factor is calibrated to match a ratio of total assets to annual pre-tax income of 4.1 (Kaplan and Violante, 2022). In the Mental Accounting versions of the model, the parameter $\eta$ is calibrated to generate a realistic aggregate MPC out of income (Kaplan and Violante, 2014); whereas the loss aversion parameter $\lambda$ is set to 2.5, a plausible value in the literature that captures how agents weigh losses more than gains.

I consider two model frequencies. In the quarterly model, the probability of portfolio adjustment is 6% (Bayer, Born, and Luetticke, 2024), such that the different model versions are consistent with the estimated shares of poor and wealthy hand-to-mouth households (Kaplan and Violante, 2022; 2014). In turn, the annual model's probability of adjustment is set to 15%, to match the annual MPC target in Auclert et al. (forthcoming).

Table 4.1. Calibration

| ***Model Frequency*** | | | Quarter | | | Year | |
|---|---|---|---|---|---|---|---|
| ***Preferences*** | | | | | | | |
| $\eta$ (gain-loss utility) | 0 | 0 | 0 | 0.083 | 0.106 | 0 | 0.195 |
| $\lambda$ (loss aversion) | | | 2.5 | | | 2.5 | |
| $\beta$ (discount factor) | 0.9805 | 0.9906 | 0.9944 | 0.9912 | 0.9952 | 0.9271 | 0.9858 |
| $\gamma$ (risk aversion) | | | 1 | | | 1 | |
| ***Financial Markets*** | | | | | | | |
| $\upsilon$ (probability of adj.) | | | 6%[a] | | | 15% | |
| $R^b$ (liquid int. rate) | | | - 2.00%[b] | | | - 2.00% | |
| $R^a$ (illiquid int. rate) | 6.00%[b] | 2.00%[c] | 0.50% | 2.00% | 0.50% | 6.00% | 0.50% |
| ***Income Process*** | | | | | | | |
| $\rho$ (persistence) | | | 0.9656 | | | 0.91 | |
| $\sigma$ (std. dev.) | | | 0.92[d] | | | 0.92 | |
| $\tau$ (income tax rate) | | | 0.33[e] | | | 0.33 | |
| ***Wealth Target*** | | | | | | | |
| Assets / ann. income | | | 4.1[b] | | | 4.1 | |

[a]Bayer, Born, and Luetticke (2024).
[b]Kaplan and Violante (2022).
[c]Kaplan and Violante (2014).
[d]Auclert, Rognlie, and Straub (forthcoming).
[e]DeLong and Summers (2012).

### 4.2.4 Computation

The solution of the household problem relies on the algorithm in Bayer, Born and Luetticke (2024) and in Bayer et al. (2019), adjusted to accommodate the Mental Accounting friction. The Impulse Response Functions of consumption to an expected income shock are computed as perfect foresight transition paths of the economy in response to an MIT shock, following Boppart, Krusell, and Mitman (2018). The aggregate consumption is

$$C_t \equiv \int c_t(b_h, a_h, y_h, adj_h) d\Gamma_t(b_h, a_h, y_h, adj_h)$$

where other aggregate quantities, notably wealth, are computed analogously. The distribution evolves according to the following law of motion:

$$\Gamma_{t+1}(b', a', y', adj') = \int_{\{(b,a,y): a'(b,a,y), b\prime(b,a,y) \in A\}} \Pr(y'|y) d\Gamma_t(b, a, y, adj) \,,$$

for all sets $A \subset \mathbb{R}$.

### 4.3 Consumption and Saving in the Steady State

This section presents the effect of Mental Accounting on the consumption and saving decisions in the quarterly model. I compare the 2-asset model with Mental Accounting (MA2A) and with standard utility (S2A). Unless stated otherwise, and for expositional clarity, in this Section the two models feature a 2.5% spread, as in this calibration the Mental Accounting friction is in clearest display.

#### 4.3.1 Consumption Policy Functions: Mental Accounting Across the State Space

In this section I discuss how Mental Accounting modifies the consumption policy functions in the 2-asset environment across its four-dimensional state space. It is useful to think about consumption choices in terms of the FOC with respect to liquid assets in Section 2.2 above. This FOC holds generally everywhere in the state space except for two cases. One case is when liquidity constraints bind, that is when the Lagrange Multiplier is positive, indicating that optimal consumption is larger than the maximum feasible consumption allocation as per the household budget constraint.

The other case is when the unconstrained household chooses to set optimal consumption, given the Mental Accounting preferences, equal to income. The household is at the Mental Accounting kink and the following inequality holds:

$$\frac{\partial}{\partial c} U(y - \varepsilon | r) > \beta \frac{\partial}{\partial b} E_t[V(b_i', a_i', y')] > \frac{\partial}{\partial c} U(y + \varepsilon | r), \quad \text{for } i = NA, Ad$$

where $\quad \frac{\partial}{\partial c} U(y + \varepsilon | r) \cong (\frac{1-\eta\lambda}{1-\eta}) \frac{\partial}{\partial c} U(y - \varepsilon | r), \quad$ for $\varepsilon$ arbitrarily small.

Mathematically, households choose to be at the kink when the slope of the expected discounted value function is in between the right-hand-side and the left-hand-side values of marginal utility. Intuitively, that inequality means that the marginal utility of increasing consumption infinitesimally is lower than the corresponding marginal cost of decreasing next period's liquid assets; and that the marginal disutility of decreasing consumption infinitesimally is higher than the marginal benefit of increasing next period's liquid assets. As a result, setting consumption equal to income is optimal, given the preferences.

I now discuss Non-Adjusters and Adjusters separately, as they face different problems. I start with the Non-Adjusters, who represent a much larger share of the population (see calibration).

#### 4.3.1.1 Non-Adjusters

For the Non-Adjusters, consumption is pinned down by the FOC with respect to liquid assets, and the liquid saving choice can then be obtained from the budget constraint. By virtue of the capital markets friction, the illiquid return capitalizes into next period.

Figure 4.1 plots the policy function of consumption against liquid assets for different levels of income and illiquid assets on the left panels, as well as the corresponding marginal incentives faced by the household on the right panels.

The shape of the consumption policy function against liquid assets in its most general form is depicted in blue in Panel E of Figure 4.1: consumption increases monotonically starting at levels below income, then consumption stays equal to income with the policy function being horizontal for growing liquid assets, and finally consumption starts growing monotonically again above income. Perhaps the most defining feature of the Mental Accounting friction is the horizontal segment B'B where consumption equals income and households behave hand-to-mouth. This segment appears when the above inequality is met, that is when the marginal value function with respect to liquid assets is between the right-hand-side and left-hand-side derivatives of the utility function at the kink, as shown in Panel F of Figure 4.1.

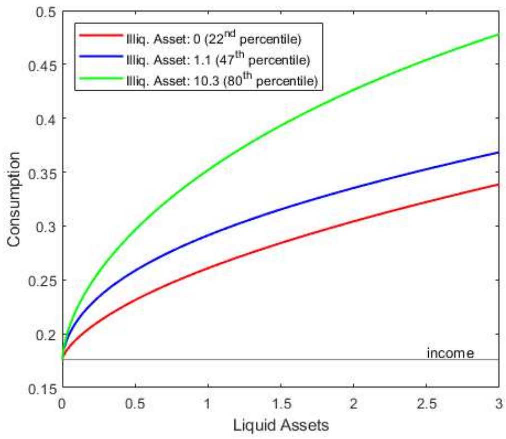
Note that this policy function is conditional on a given level of income and a given level of illiquid assets. Any changes in those variables alter the marginal value function as well as the derivatives of the utility function. Hence, the inequality holds (and hand-to-mouth behavior arises) in a different region of the state space. I discuss how changing these variables modifies consumption choices, one variable at a time.

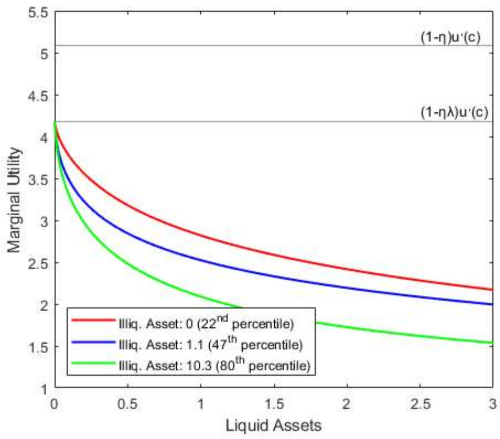
In terms of income, Mental Accounting has a very heterogeneous impact across the distribution. Varying income implies a different marginal value function and different derivatives of the utility function at the kink. For very low levels of income, the policy function is always monotonically increasing above income: the marginal utility of increasing consumption above the kink (lower grey line) is bigger than the marginal cost of dissaving (colored line). Intuitively, households are highly non-satiated and they want to increase consumption despite the associated psychological cost. For higher incomes, because of satiation the marginal value functions are lower, but so are the derivatives of the utility function at the kink. As can be seen in Figure 4.1, the policy function starts below income and is increasing. When it reaches the level of income, their policy function displays a horizontal segment for a positive amount of liquid assets. The higher the income, the flatter the marginal value function is, the higher the amount of liquid wealth at which the horizontal segment starts, and the bigger the range of liquid assets for which the hand-to-mouth behavior arises. This effect manifests across levels of illiquid assets.

In turn, the illiquid asset holdings also matter for the incidence of Mental Accounting. Increasing (decreasing) the amount of illiquid assets shifts down (up) the marginal value function, but without altering the derivatives of utility at the kink. Intuitively, for the same level of income, a higher mount of illiquid assets implies that households have more resources and that their consumption is higher. Hence, the horizontal segment appears for lower values of liquid assets, compared to households with lower illiquid holdings.

##### 4.3.1.1.1 The Poor and the Wealthy Hand-to-Mouth with Mental Accounting

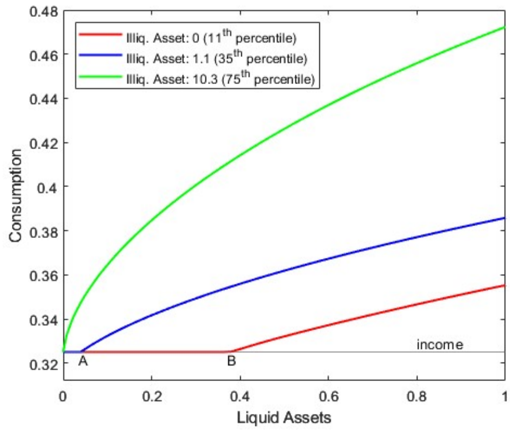
Inspection of the policy functions of Figure 4.1 reveals that Mental Accounting generates hand-to-mouth behavior across the entire spectrum of liquid assets. The poor and the wealthy hand-to-mouth are defined as households that hold liquid assets in an amount lower than half their pay-period earnings and, respectively, hold zero and positive illiquid assets (Kaplan and Violante, 2014). In this environment, because of the illiquidity friction, the wealthy hand-to-mouth households have no access to the illiquid asset.

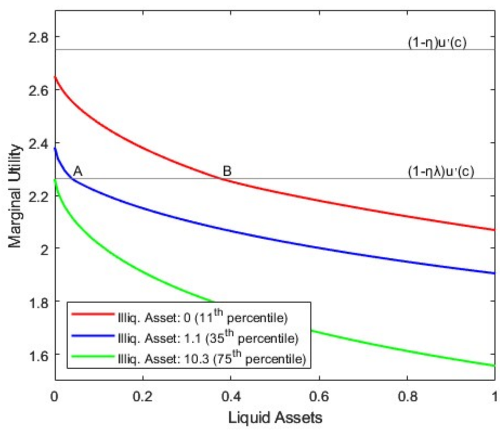



Panel A: Cons. pol. func., 25th perc. income.

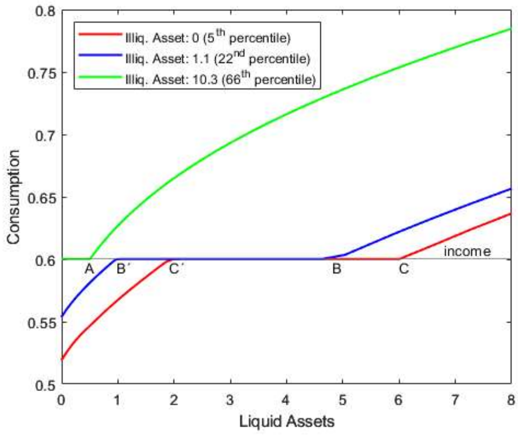
Panel B: Dis. ex. Marg. VF, 25th perc. inc.

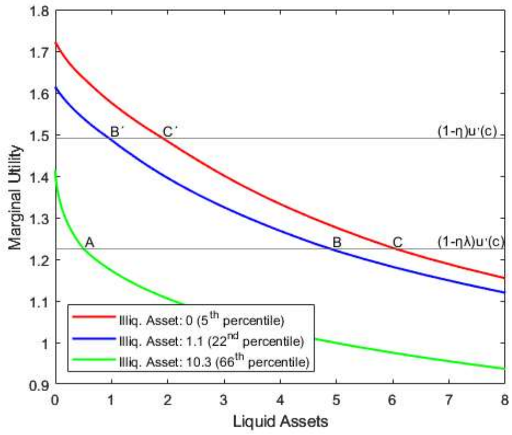



Panel C: Cons. pol. func., 50th perc. income.

Panel D: Dis. ex. Marg. VF, 50th perc. inc.




Panel E: Cons. pol. func., 75th perc. income.

Panel F: Dis. ex. Marg. VF, 75th perc. inc.

Figure 4.1. Consumption Policy Function, $C_{NA}(b, a, y)$, and discounted expected derivative of value function with respect to liquid assets, $\beta \frac{\partial}{\partial b} E_t[V(b'_{NA}, a'_{NA}, y')]$, of the Non-Adjusters, across the spectrum of liquid assets, for different levels of illiquid assets and different levels of income, in the Mental Accounting model. Note that each graph has a different scale to allow a clearer inspection.

Note: In Panels A, C, and E, the horizontal grey line represents the income level. In Panels B, D, and F, the horizontal grey lines represent the left-hand-side and right-hand-side utility derivatives at the kink.

An example of poor hand-to-mouth households appears in Panel C of Figure 4.1, at the red horizontal segment covering from zero liquid assets to half of income, where they hold zero illiquid assets; in turn, an example of wealthy hand-to-mouth households is in the partially overlapping blue horizontal segment, where they hold positive illiquid assets. In both cases, it is not the portfolio holdings of little liquid wealth and large illiquid wealth what ultimately causes the hand-to-mouth behavior; rather, it is the Mental Accounting preferences, as can be identified by the horizontal segment in the consumption policy function. In this sense, and consistent with Section 4, Mental Accounting reinforces the Keynesian behavior among the poor and the wealthy hand-to-mouth.

This result does not imply that Mental Accounting modifies the behavior of all the poor and the wealthy hand-to-mouth households. In fact, Panel A in Figure 4.1 contains examples where it does not: the red and green lines are, respectively, populated by poor and wealthy hand-to-mouth households for the range of small liquid asset values that are below half their income. These households' behavior is not influenced – at least not directly– by Mental Accounting. Moreover, when liquid assets are very low, these households have a positive Lagrange multiplier on the FOC with respect to liquid assets: their optimal consumption is unfeasible due to insufficient available resources, hence their actual consumption is below the optimum, and that drives their high MPCs.

Finally, and to fix ideas, note how this mechanism for hand-to-mouth behavior differs conceptually from the one discussed above where Mental Accounting dominates choices. In the latter case, setting consumption equal to income is an optimal choice, and therefore the Lagrange multiplier associated with the FOC is zero, even when the holdings of liquid assets are zero: such example appears in Panels E (green line) and C (blue line) for the wealthy hand-to-mouth, and in Panel C (red line) for the poor hand-to-mouth. Hence, the concepts of 'poor hand-to-mouth' and 'wealthy hand-to-mouth' classify households according to their wealth, but mask heterogeneous behaviors among them.

#### 4.3.1.2 Adjusters

For the Adjusters, consumption is also pinned down by the FOC with respect to liquid assets, only that now both $b$ and $a$ are liquid. In addition, households solve a portfolio allocation problem between the liquid asset and the illiquid asset (even if both assets are accessible to the Adjuster household in a given period, on average they are not). Equating the FOCs with respect to liquid assets and illiquid assets yields the following equality:

$$E\left[\frac{\partial}{\partial b}V(b_{Ad}{}', a_{Ad}{}', y')\right] = E\left[\frac{\partial}{\partial a}V(b_{Ad}{}', a_{Ad}{}', y')\right]$$

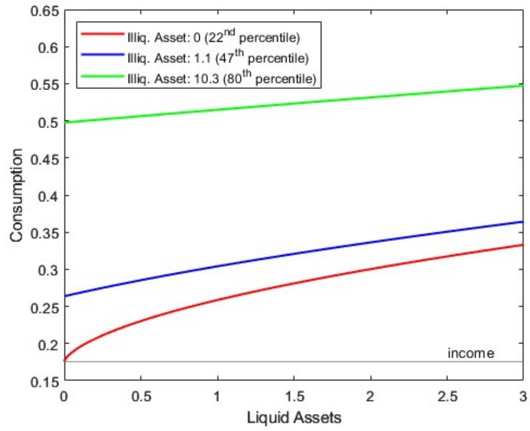
which governs the interior solutions of the portfolio problem. This indifference condition establishes that the optimal portfolio allocation obtains when the household is indifferent between the marginal benefits offered by either asset. This portfolio problem is well-specified because the two assets have different degrees of liquidity, an information that is contained in the marginal value functions, along with the different returns.

Figure 4.2 plots the consumption policy functions, as well as the marginal incentives facing the households at the kink, for the same representative selection of income and illiquid asset levels.

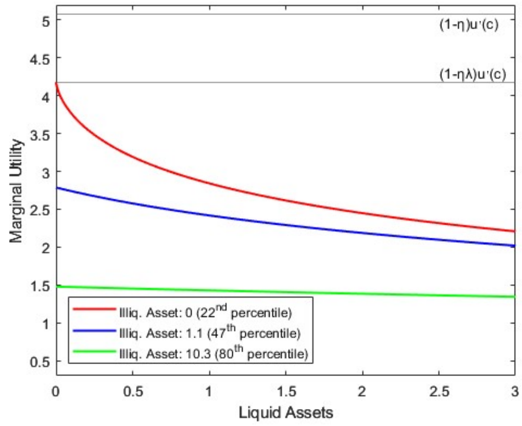
The effect of Mental Accounting on the policy functions is quite similar. Consumption is still monotonically increasing with liquid assets, but displays a horizontal segment whenever the household consumes its income. Again, this only applies when the inequality relationship holds between the marginal value function and the derivatives of utility at the kink.

However, there are some important differences. First, and unlike the Non-Adjusters, the Adjusters do have access to illiquid assets. As a result, those households with positive values of illiquid assets (green line in Panels A and C of Figure 4.2) have a monotonically increasing and linear policy function, whereas for the Non-Adjusters it would be concave. The linearity of the policy function indicates that the household has enough resources available to smooth consumption.

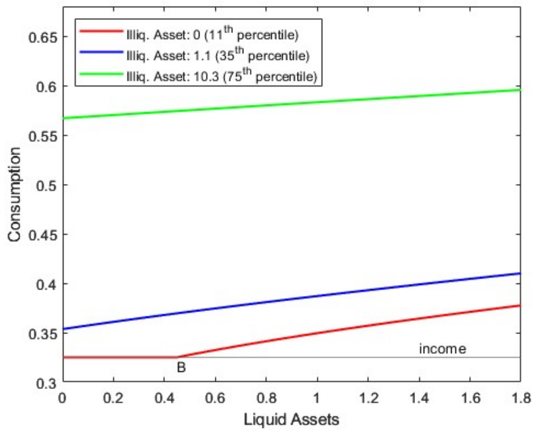
A second difference worth noting is that, in the case of Adjusters, there are only poor hand-to-mouth and no wealthy hand-to-mouth by construction, as all the assets are accessible and, therefore, liquid. A household classified as wealthy hand-to-mouth does not behave in that way because having plenty of illiquid assets compensates for the small amount of liquid assets, as the Adjusters can use the illiquid assets to smooth consumption. In any case, this difference is not important in the aggregate because the Adjusters are a relatively small share of the population.



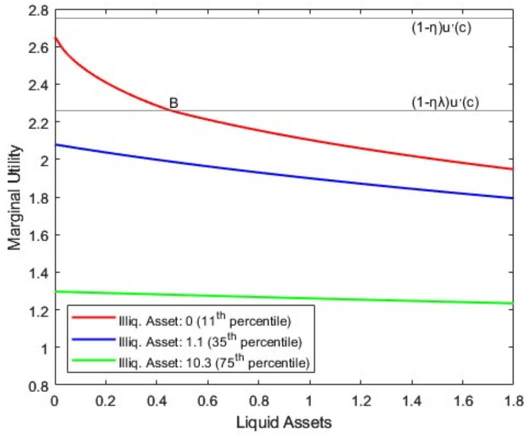

Panel A: Cons. pol. func., 25th perc. income.



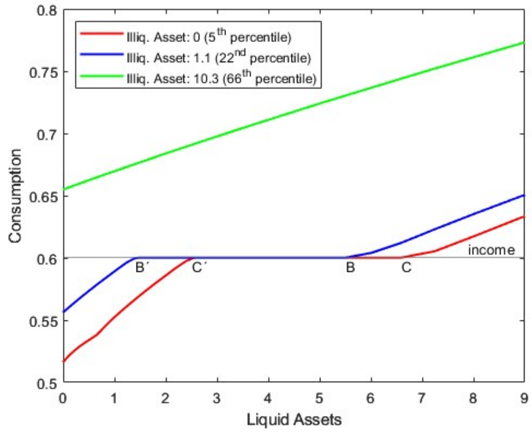

Panel B: Dis. ex. Marg. VF, 25th perc. inc.



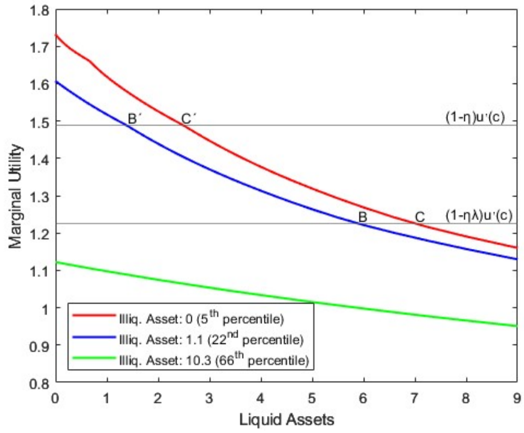

Panel C: Cons. pol. func., 50th perc. income.




Panel D: Dis. ex. Marg. VF, 50th perc. inc.



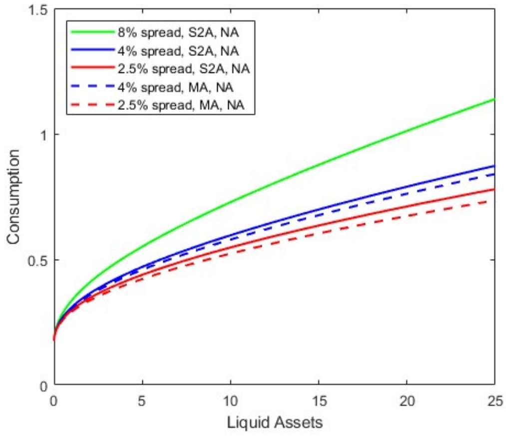

Panel E: Cons. pol. func., 75th perc. income.

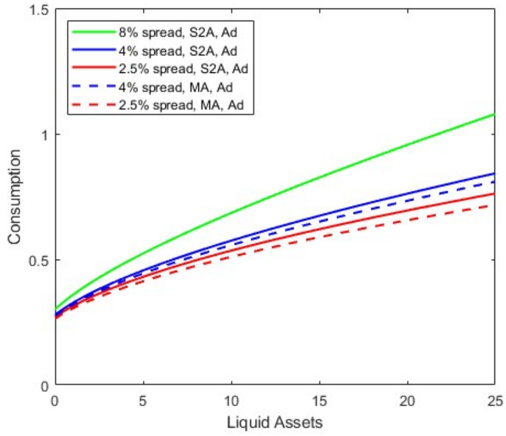



Panel F: Dis. ex. Marg. VF, 75th perc. inc.

Figure 4.2. Consumption Policy Function, $C_{Ad}(b, a, y)$, and discounted expected derivative of value function with respect to liquid assets, $\beta \frac{\partial}{\partial b} E_t[V(b'_{Ad}, a'_{Ad}, y')]$, of the Adjusters, across the spectrum of liquid assets, for different levels of illiquid assets and different levels of income, in the Mental Accounting model. Note that each graph has a different scale to allow a clearer inspection.

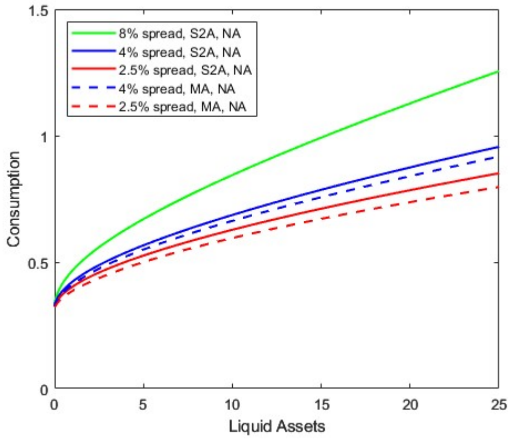
Note: In Panels A, C, and E, the horizontal grey line represents the income level. In Panels B, D, and F, the horizontal grey lines represent the left-hand-side and right-hand-side utility derivatives at the kink.

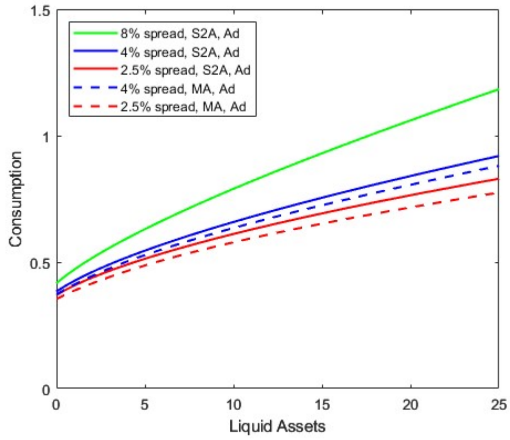



Panel A: CPF, NA, 25th perc. income.

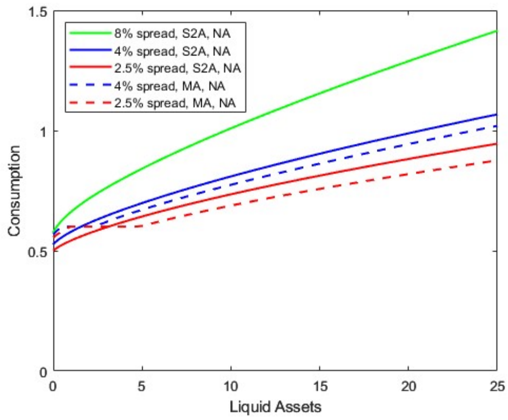
Panel B: CPF, Ad, 25th perc. income.

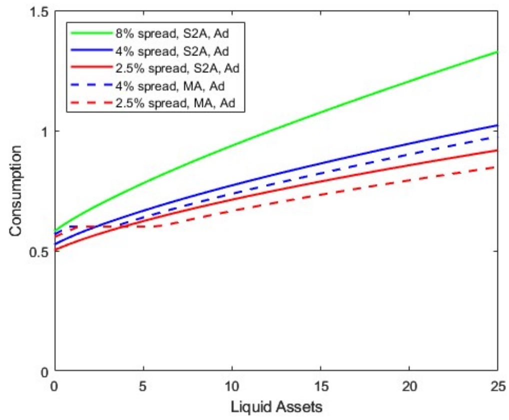



Panel C: CPF, NA, 50th perc. income.

Panel D: CPF, Ad, 50th perc. income.




Panel E: CPF, NA, 75th perc. income.

Panel F: CPF, Ad, 75th perc. income.

Figure 4.3. Consumption Policy Functions of Non-Adjusters and Adjusters, across the spectrum of liquid assets, for different return spreads between assets, for both sets of preferences, for different levels of income, and for a level of illiquid assets that is representative (in Panels A-B it is the 11th percentile, in Panels C-D it is the 35th percentile, and in Panels D-F it is the 75th percentile). Note that each graph has a different scale.

Note: Appendix 4.A contains the plots with the other two levels of illiquid assets of Figures 4.1 and 4.2.

### 4.3.2 The Return Spread and Consumption

In this section I discuss the sensitivity of consumption to different assumptions about the return spreads between liquid and illiquid assets.

#### 4.3.2.1 The Return Spread

I consider three (annual) return spreads: 8%, 4%, and 2.5%. The 8% spread is proposed by Kaplan and Violante (2022) in order to match the aggregate MPC, while they admit that it is unrealistically high. In turn, the 4% spread is estimated in Kaplan and Violante (2014). In this estimation, the most important illiquid asset is housing, and its returns include both capital gains and imputed rents, with the imputed rents contributing the majority of the return (Kaplan, Violante, and Weidner, 2014), in line with other recent empirical estimates (Jordà et al., 2019; Attanasio et al., 2024).

However, an alternative view argues that housing yields significantly lower returns (Shiller, 2015) and that the 2-asset model should reflect that (e.g. see Alan Blinder's comments in Kaplan, Violante, and Weidner, 2014). For this reason, I consider a third case where housing offers a 1% excess return over liquid wealth. I do a back-of-the-envelope calculation using the portfolio composition and all the other returns as in Kaplan and Violante (2014, Table III), and I obtain a return spread of 2.5%.

#### 4.3.2.2 The Effect of the Return Spread on Consumption

Figure 4.3 plots the consumption policy functions across different levels of income, liquid assets, preferences, and return spreads, for Non-Adjusters and Adjusters; and Appendix 4.A contains sensitivities for different values of illiquid assets. The finding that emerges systematically and robustly across preference specifications is that higher return spreads generate, ceteris paribus, substantially higher consumption choices. Naturally, as returns on wealth increase, and the same wealth-to-income ratio remains as calibration target, households need to consume a larger fraction of their total resources in order to make the budget constraint hold, and they achieve that by means of a lower discount factor (see Table 4.1).

These differences among policy functions in Figure 4.3 translate to the aggregate. Table 4.2 presents the ratios of aggregate or mean consumption to after-tax income across model variants with different return spreads (but with the same after-tax income). Aggregate consumption predicted for an 8% spread is a 25% higher than for a 2.5% return spread.

This discrepancy is quite large and raises the question of what the evidence says on this matter. Therefore, Table 4.2 also reports several point estimates of the consumption-income ratio for different countries and samples. The model with the 8% spread generates an unrealistically high aggregate (or mean) consumption. As the return spread declines, the predicted consumption-to-income ratio comes closer to the empirical estimates. The only ratio that is within a plausible range is for the 2.5% spread.

Table 4.2. Ratio of Mean Consumption to Mean After-tax Income in Model and 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 | | |
| **Model** | | | |
| *Ratio* | *Spread* | *Preferences* | |
| 1.27 | 8% | Standard | |
| 1.08 | 4% | Standard | |
| 1.00 | 2.5% | Standard | |
| 1.08 | 4% | Mental Accounting | |
| 1.00 | 2.5% | Mental Accounting | |

### 4.3.2.3 Implications for General-Equilibrium Models

A model used for business-cycle analysis should attempt to match the deviations of aggregate variables from steady state in response to exogenous shock. But if that model overstates the level of steady-state aggregate consumption, then it will overstate the fluctuations in aggregate consumption, as well. Therefore, the 8% spread is an undesirable feature in such an environment, especially if it attempts to study the transmission of shocks to aggregate consumption.

## 4.4 Marginal Propensities to Consume from Transitory Shocks

This section presents the MPCs in the infinite-horizon models out of transitory shocks. MPCs are reported at different levels of aggregation: individual, averages across income and assets, and in the aggregate. MPCs are also evaluated against the empirical evidence.

The MPC is computed as the consumption change with respect to the steady state of the model out of a windfall T that is distributed to all households. Unless stated otherwise, this transfer is unexpected and labeled as 'income'. For household $h$, the MPC out of income is:

$$MPC_h^y = \frac{C_i(b_h, a_h, y_h + T) - C_i(b_h, a_h, y_h)}{T}$$

where $C_i(b_h, a_h, y_h)$ is the optimal consumption choice for a household with assets $(b_h, a_h)$, income $y_h$, and adjustment type $i$. The aggregate MPC out of income is computed as the sum of the consumption responses across households weighted by the probability density function of the stationary household distribution $\Gamma_\infty$:

$$MPC_{aggr}^y \equiv \int MPC_h^y(b_h, a_h, y_h, adj_h) d\Gamma_\infty(b_h, a_h, y_h, adj_h).$$

### 4.4.1 Hand-to-Mouth Households

Table 4.3 summarizes the share and the average MPC of the different types of hand-to-mouth (HtM) households across the models considered. As already argued in Section 3, poor and wealthy hand-to-mouth households are classifications according to wealth: they associate the hand-to-mouth status with a low level of liquid assets below half their pay-period earnings, combined with zero and positive illiquid assets, respectively. While this classification may be suitable for the S2A, where high MPCs do appear in households with low liquid wealth, it does not quite fit the mold of the Mental Accounting model, where hand-to-mouth behavior is not necessarily correlated with liquid wealth. Therefore, I also consider liquid hand-to-mouth households – a term borrowed from Olafsson and Pagel (2018)–, which have liquid assets above half their pay-period earnings.

Table 4.3. Type, Share, and MPC$^y$ of Hand-to-Mouth Households

| *Preferences* | | Standard | Standard | Standard | MA | MA |
|---|---|---|---|---|---|---|
| *Return Spread (Ann.)* | | 8% | 4% | 2.5% | 4% | 2.5% |
| ***Household Type*** | ***Magnitude*** | | | | | |
| Average | MPC$^y$ (%) | 17.8 | 10.1 | 7.4 | 25.0 | 25.0 |
| Adjusters | MPC$^y$ (%) | 7.3 | 5.6 | 4.9 | 17.8 | 20.9 |
| Non-Adjusters | MPC$^y$ (%) | 18.8 | 10.5 | 7.7 | 25.7 | 25.4 |
| Poor HtM | Share (%) | 11.7 | 8.7 | 8.7 | 10.4 | 10.1 |
| $(b \leq \frac{y}{2},\ a = 0)$ | MPC$^y$ (%) | 37.3 | 32.3 | 28.9 | 72.8 | 74.7 |
| Wealthy HtM | Share (%) | 26.6 | 14.9 | 9.2 | 16.5 | 10.2 |
| $(b \leq \frac{y}{2},\ a > 0)$ | MPC$^y$ (%) | 33.1 | 23.3 | 18.8 | 48.8 | 47.9 |
| Liquid HHs | Share (%) | 62.2 | 76.4 | 82.1 | 73.2 | 79.9 |
| $(b > \frac{y}{2},\ \forall b)$ | MPC$^y$ (%) | 7.5 | 4.9 | 3.9 | 13.3 | 15.8 |
| Poor ZL | Share (%) | 9.8 | 6.1 | 5.7 | 8.7 | 8.4 |
| $(b = 0,\ a = 0)$ | MPC$^y$ (%) | 42.1 | 40.2 | 37.2 | 79.0 | 80.4 |
| Wealthy ZL | Share (%) | 10.5 | 4.4 | 2.5 | 5.1 | 3.0 |
| $(b = 0,\ a > 0)$ | MPC$^y$ (%) | 55.7 | 44.3 | 37.0 | 74.9 | 68.1 |
| Liquid HtM 1 | Share (%) | 0 | 0 | 0 | 5.0 | 7.3 |
| $(c^* = y,\ b > \frac{y}{2})$ | MPC$^y$ (%) | - | - | - | 90.4 | 92.1 |
| Liquid HtM 2 | Share (%) | 0 | 0 | 0 | 4.2 | 6.8 |
| $(MPC^y = 1,\ b > \frac{y}{2})$ | MPC$^y$ (%) | - | - | - | 99.9 | 99.8 |
| Total HtM 1 | Share (%) | 18.6 | 8.8 | 6.9 | 18.9 | 19.2 |
| $(c^* = y,\ \forall b)$ | MPC$^y$ (%) | 52.8 | 48.2 | 42.6 | 87.3 | 88.6 |
| Total HtM 2 | Share (%) | 0.2 | 0 | 0 | 11.7 | 13.0 |
| $(MPC^y = 1,\ \forall b)$ | MPC$^y$ (%) | 98.3 | - | - | 99.9 | 99.9 |

#### 4.4.1.1 The Poor and the Wealthy Hand-to-Mouth

Kaplan and Violante (2014) estimate based on data from the Survey of Consumer Finances (SCF) that: (i) the sum of poor and wealthy HtM is 17.5 - 35% of all households; and (ii) 7 - 26% of households are wealthy HtM. In a later study based on a different wave of the SCF, Kaplan and Violante (2022) estimate a 14% share of poor HtM and a 27% share of wealthy HtM.

These estimated shares are matched by the S2A models with 8% and 4% spread, but not with the 2.5% spread. When adding Mental Accounting, both models considered are within these ranges. In addition, Mental Accounting amplifies the MPCs of poor and wealthy HtM for the reasons described in Section 3.

#### 4.4.1.2 Individual MPCs Across Liquid Assets

The empirical literature has found substantial shares (up to 16%) of households with an MPC close to 100%, and who not tied to a specific level of liquid wealth (Boehm et al., 2024; Misra and Surico, 2014; Kueng, 2018; Jappelli and Pistaferri, 2014; Daniel et al., 2021).

The S2A model has difficulty matching these estimates: the households with zero liquid wealth (the 'ZL' in Table 4.3) display somewhat higher MPCs, but neither their share nor their MPC is high enough, especially for realistic return spreads. Conversely, the MA model generates MPCs of 100% across the liquid distribution for a share of households consistent with the evidence above (the 'Liquid HtM' in Table 4.3).

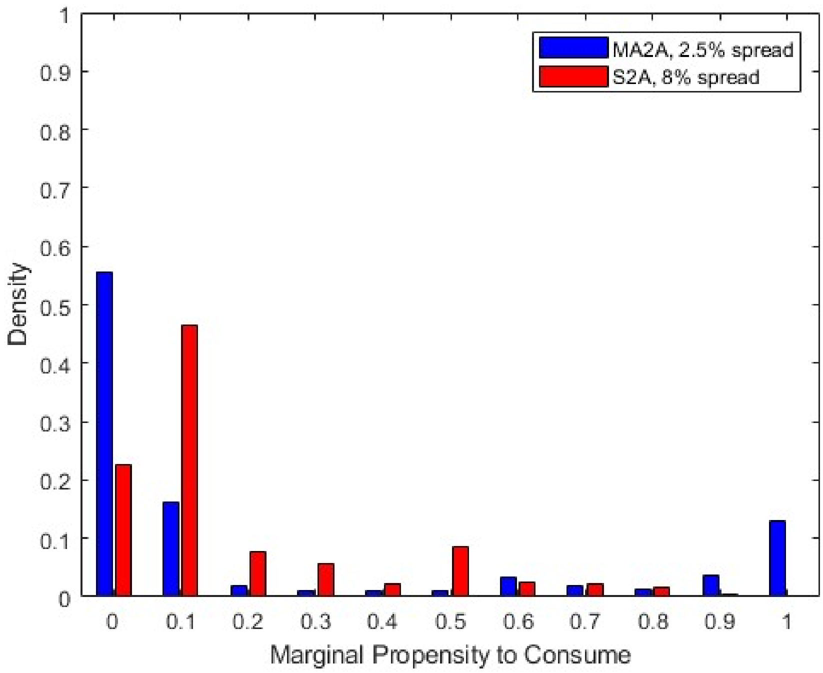



Figure 4.4. MPC Histogram for Mental Accounting (MA2A) and for Standard (S2A) model.

### 4.4.2 MPC Bi-modality

Figure 4.4 shows a histogram with the bi-modal distribution of individual MPCs. Households behave dichotomously as either Keynesian hand-to-mouth consumers with an MPC of 100% (a little over 10% of the population) or Life-Cycle consumers (75%), with an MPC that is approximately equal to the annuity value of the windfall. There is, however, a sizable share of households with MPCs in between.

From a conceptual point of view, Mental Accounting provides a micro-foundation for the spender-saver model (Campbell and Mankiw, 1989; 1991). From an empirical point of view, Mental Accounting brings the model closer to the evidence: the MPC bi-modality has been found both quantitatively (Misra and Surico, 2014) and qualitatively (Bunn et al., 2018), as argued in Kaplan and Violante (2014). In addition, the share of households with intermediate MPCs has been found most recently in Boehm et al. (2024).

### 4.4.3 MPCs across the Liquid Asset Distribution

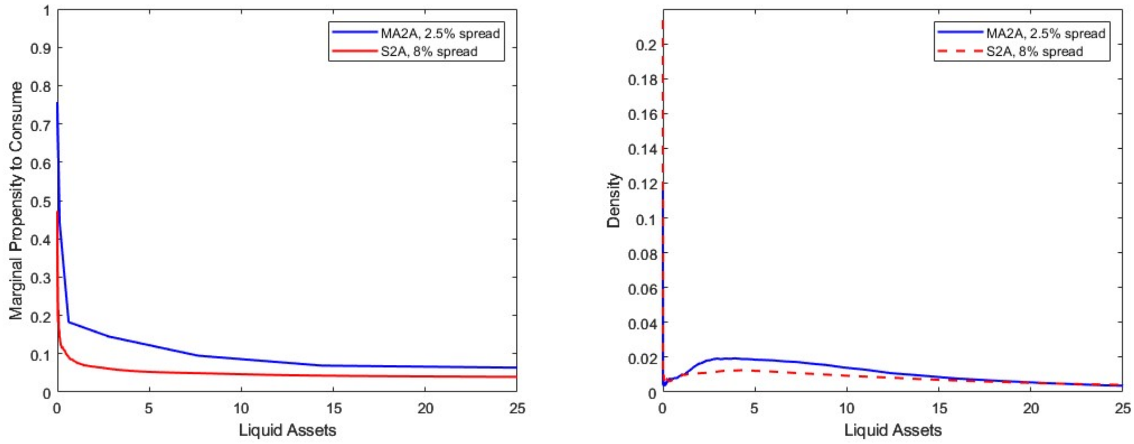
While Section 4.1 and Table 4.3 referred to individual MPCs, in this Section I consider the next level of aggregation: I compute averages over income and illiquid assets across the liquid asset spectrum, and I compare it to MPC estimates of (sub-)sample *averages*.

Figure 4.5 Panel A shows such average MPCs. In S2A-8, the ZL, the poor HtM and the wealthy HtM generate a high MPC close at low liquidity levels, but the MPC drops as the liquid assets grow. In turn, the MA2A curve shows how Mental Accounting amplifies the MPC for the low-liquidity households (poor HtM, and wealthy HtM), and then it maintains a higher average MPC even for higher liquid assets.

These predictions are consistent with evidence of high average MPCs in households with medium and high incomes (Bräuer et al., 2022; Kueng, 2018; Olafsson and Pagel, 2018; Misra and Surico, 2014; 2011; Parker, 1999; Sahm, Shapiro and Slemrod, 2010; Shapiro and Slemrod, 2009; 2003a; 2003b; 1995), high average MPCs in households with enough liquid wealth (Bräuer et al., 2022; Baugh et al., 2021; Kueng, 2018; Olafsson and Pagel, 2018; Misra and Surico, 2014; 2011; Souleles, 2002; Fagereng, Holm, and Natvik, 2021; Jappelli and Pistaferri, 2020; 2014). These empirical studies also find that the average MPC declines with different measures of cash-on-hand, consistent with the Mental Accounting model.

### 4.4.4 The Aggregate MPC, Aggregate Wealth, and the Return Spread

In this Section I take one more step and consider the next level of aggregation. Matching the aggregate MPC and the aggregate wealth in an economy should be a requirement for any model that attempts to be used for general-equilibrium analysis, Kaplan and Violante (2022) have recently argued. Naturally, the 2-asset model has been proposed to fulfil that role.




Panel A: MPC average over income and ill. assets. Panel B: PDF of liquid assets.

Figure 4.5. MPC out of income and probability density function across liquid assets: Mental Accounting vs. Standard model.

#### 4.4.4.1 Problems with the 2-Asset Model

However, the 2-asset environment with standard preferences calibrated to generate a realistic aggregate wealth has a difficulty in matching, at the same time, a realistic aggregate MPC and a realistic return spread (Kaplan and Violante, 2022). Now, what the realistic return spread is could be subject to debate, but for now I take the 4% estimate from Kaplan and Violante (2014)[51]. With a 4% spread, the aggregate MPC is less than 10% (Table 4.4), which is far below the minimum of 15% considered acceptable in Kaplan and Violante (2022), and is even further below the 25% proposed as benchmark in Kaplan and Violante (2014). The aggregate MPC is even lower (7%) for the alternative 2.5% spread. In order to generate a sufficiently high MPC (17%, from Table 4.4), Kaplan and Violante (2022) propose an 8% spread[52], but they acknowledge that such a spread is unrealistically high.

Moreover, there is an additional problem with the high return spread (Section 3.2): it generates an unrealistically high level of aggregate consumption, thereby compromising its suitability for business-cycle analysis. But the reason for matching the aggregate MPC

[51] They estimate 3.8%, but using 4% instead makes little difference. Also, with 3.8% the aggregate MPC predicted by the model would be even smaller and, thereby, further away from the evidence.
[52] They use 8.2%, but I resort to 8%, which makes a small difference, to make the point.

in the first place is to improve the accuracy of the aggregate consumption response to shocks (e.g. Kaplan and Violante, 2014), including its fluctuations in general-equilibrium applications (Kaplan and Violante, 2022). Hence, assuming too high a return spread defeats its own purpose, in some sense.

To sum up, the diagnosis of the problem is as follows: in order to generate a realistic aggregate MPC, the asset illiquidity friction is not enough on its own; hence, the model has to be stretched in implausible ways and beyond its natural limits to hit the MPC target.

#### 4.4.4.2 Mental Accounting: A Solution

Introducing Mental Accounting preferences into the 2-asset environment reconciles the model with the data on aggregate wealth, the aggregate MPC of 25%, and the return spread. In particular, Mental Accounting brings to the table a complementary source of hand-to-mouth behavior. This way, the asset illiquidity friction is not forced to produce an aggregate MPC that it cannot deliver on its own.

Even if asset illiquidity could generate the aggregate MPC on its own, such fictitious model would be at odds with the fact that a sizable portion of the aggregate MPC is generated by liquid households. Namely, the aforementioned evidence of high average MPCs among low-liquidity and liquid households, together with their respective large shares in the data, implies that both groups make sizable contributions to the aggregate MPC. Hence, a mechanism generating high MPCs among liquid households, such as Mental Accounting, needs to complement asset illiquidity in order to match the facts.

There are several additional advantages to this setup. As shown in Section 4.1, the Mental Accounting versions of the model are consistent with the estimated ranges of poor and wealthy hand-to-mouth. Therefore, after introducing Mental Accounting, the resulting model retains the essence of the 2-asset environment.

In addition, the result is robust to different return spreads, either 4% or 2.5%, because the strength of the Mental Accounting mechanism does not depend directly on them. This contrasts with the S2A model, which does very poorly with 2.5%.

Table 4.4. MPCs, Return Spread, and Wealth Moments

| *Preferences* | Standard | Standard | Standard | MA | MA |
|---|---|---|---|---|---|
| *Return Spread (Ann.)* | 8% | 4% | 2.5% | 4% | 2.5% |
| ***MPC*** | | | | | |
| Aggregate MPC out of income | 17.8% | 10.1% | 7.4% | 25.0% | 25.0% |
| MPC Contribution low-liq. HHs | 13.2pp | 6.3pp | 4.2pp | 15.4pp | 12.5pp |
| MPC Contribution liquid HHs | 4.6pp | 3.8pp | 3.2pp | 9.6pp | 12.5pp |
| ***Wealth Moments*** | | | | | |
| Total assets / annual income | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 |
| Mean liq. wealth / ann. income | 0.73 | 0.83 | 0.90 | 0.76 | 0.79 |

Finally, the model is able to match additional wealth moments from the data. Kaplan and Violante (2022) report a ratio of mean liquid wealth over mean annual household income of 0.56. In the environment with standard preferences, reducing the return spread (keeping constant the portfolio adjustment probability) decreases the attractiveness of the illiquid asset relative to the liquid asset, which is valuable as consumption insurance despite its negative return. Hence, for lower return spreads, the mean liquid wealth slowly drifts away from the data point. Conversely, with Mental Accounting households have a preference against dissaving, i.e. they are less prone to use liquid savings for consumption smoothing purposes. As a result, aggregate liquid asset holdings are not very sensitive to the return spread. Overall, the values of 0.76 and 0.79, not being calibration targets, are reasonably close to the data point above.[53]

### 4.4.5 Account-specific MPCs

Up to this point I have discussed the MPC out of a shock to the income account. In this section I discuss how it compares to the MPC out of shocks to the liquid asset and the illiquid asset accounts. The MPC of household $h$ out of liquid assets is given by:

$$MPC_h^b = \frac{C_i(b_h + T, a_h, y_h) - C_i(b_h, a_h, y_h)}{T}$$

[53] Just as a reference, the 2-asset model in Kaplan and Violante (2022), which is quite similar to the this one with an 8% spread, generates a ratio of mean liquid wealth to mean income of 0.23, which is also different from the data point.

and the MPC of household $h$ out of illiquid assets is given by:

$$MPC_h^a = \frac{C_i(b_h, a_h + T, y_h) - C_i(b_h, a_h, y_h)}{T}$$

where the notation is the same as above.

Table 4.5 reports the MPCs of the different groups of households out of shocks to different asset accounts, as well as the aggregate MPC out of income for comparison. Two effects are worth mentioning. First, Mental Accounting introduces a sizable wedge between the MPC out of income and out of liquid assets that is not present in the standard model, where all liquid resources are fungible. In fact, in the standard model, for the Adjusters, all three categories of wealth are fungible and therefore display the same MPC, reassuringly. With Mental Accounting, the households with a 100% MPC out of income have a 0% MPC out of liquid assets, due to the preference for not dissaving. There are, however, households with low liquidity (poor and wealthy HtM) who display sizable MPCs out of liquid assets because they have a positive Lagrange multiplier, although it is smaller than in the standard model because they are on the right hand-side of the utility. Second, Mental Accounting reduces the MPC out of illiquid assets, although this effect is less visible because the MPC out of illiquid assets is already small in the standard model.

I now discuss the predictions and evidence regarding stock market and housing wealth.

#### 4.4.5.1 Stock Market Wealth

Recent papers on the standard 2-asset model (Kaplan and Violante, 2022; Auclert et al., 2024) claim that DiMaggio et al.'s (2020) evidence on low MPCs from capital gains can be rationalized with the model MPC out of illiquid assets. However, DiMaggio et al. (2020), and also other empirical studies (Baker et al., 2007; Daniel et al., 2021), estimate a low consumption response to capital gains in households who *directly* hold stocks: they are not tied in some illiquid vehicle or pension plan subject to penalties for early withdrawal, but rather they can be accessed and managed directly by the households.

Table 4.5. Heterogeneity in MPCs out of Income, Liquid Assets, and Illiquid Assets

| *Preferences* | | Standard | Standard | Standard | MA | MA |
|---|---|---|---|---|---|---|
| *Return Spread (Ann.)* | | 8% | 4% | 2.5% | 4% | 2.5% |
| ***Household Type*** | ***Magnitude*** | | | | | |
| Average | $MPC^y$ (%) | 17.8 | 10.1 | 7.4 | 25.0 | 25.0 |
| | $MPC^b$ (%) | 17.8 | 10.1 | 7.4 | 9.3 | 6.6 |
| | $MPC^a$ (%) | 1.7 | 1.7 | 1.7 | 1.4 | 1.4 |
| Adjusters | $MPC^b$ (%) | 7.3 | 5.6 | 4.9 | 4.9 | 4.1 |
| | $MPC^a$ (%) | 7.3 | 5.6 | 4.9 | 4.9 | 4.1 |
| Non-Adjusters | $MPC^b$ (%) | 18.8 | 10.5 | 7.7 | 9.7 | 6.9 |
| | $MPC^a$ (%) | 1.1 | 1.3 | 1.4 | 1.1 | 1.1 |
| Poor HtM | Share (%) | 11.7 | 8.7 | 8.7 | 10.4 | 10.1 |
| $(b \leq \frac{y}{2},\ a = 0)$ | $MPC^b$ (%) | 37.3 | 32.3 | 28.8 | 25.1 | 21.8 |
| | $MPC^a$ (%) | 3.9 | 4.6 | 4.3 | 3.0 | 2.7 |
| Wealthy HtM | Share (%) | 26.6 | 14.9 | 9.2 | 16.5 | 10.2 |
| $(b \leq \frac{y}{2},\ a > 0)$ | $MPC^b$ (%) | 33.1 | 23.3 | 18.8 | 19.7 | 15.6 |
| | $MPC^a$ (%) | 1.0 | 1.7 | 2.0 | 1.3 | 1.3 |
| Liquid HHs | Share (%) | 62.2 | 76.4 | 82.1 | 73.2 | 79.9 |
| $(b > \frac{y}{2},\ \forall b)$ | $MPC^b$ (%) | 7.5 | 4.9 | 3.9 | 4.7 | 3.6 |
| | $MPC^a$ (%) | 1.6 | 1.4 | 1.4 | 1.3 | 1.2 |
| Poor ZL | Share (%) | 9.8 | 6.1 | 5.7 | 8.7 | 8.4 |
| $(b = 0,\ a = 0)$ | $MPC^b$ (%) | 42.1 | 40.2 | 37.2 | 28.1 | 24.4 |
| | $MPC^a$ (%) | 3.4 | 3.9 | 3.6 | 2.7 | 2.4 |
| Wealthy ZL | Share (%) | 10.5 | 4.4 | 2.5 | 5.1 | 3.0 |
| $(b = 0,\ a > 0)$ | $MPC^b$ (%) | 55.7 | 44.3 | 37.0 | 37.9 | 31.3 |
| | $MPC^a$ (%) | 0.3 | 0.5 | 0.6 | 0.5 | 0.6 |
| Liquid HtM 1 | Share (%) | 0 | 0 | 0 | 5.0 | 7.3 |
| $(c^* = y,\ b > \frac{y}{2})$ | $MPC^b$ (%) | - | - | - | 0.0 | 0.1 |
| | $MPC^a$ (%) | - | - | - | 0.0 | 0.0 |
| Liquid HtM 2 | Share (%) | 0 | 0 | 0 | 4.2 | 6.8 |
| $(MPC^y = 1,\ b > \frac{y}{2})$ | $MPC^b$ (%) | - | - | - | 0.2 | 0.3 |
| | $MPC^a$ (%) | - | - | - | 0.1 | 0.1 |
| Total HtM 1 | Share (%) | 18.6 | 8.8 | 6.9 | 18.9 | 19.2 |
| $(c^* = y,\ \forall b)$ | $MPC^b$ (%) | 52.8 | 48.2 | 42.6 | 22.9 | 15.3 |
| | $MPC^a$ (%) | 1.7 | 2.4 | 2.7 | 1.2 | 1.0 |
| Total HtM 2 | Share (%) | 0.2 | 0 | 0 | 11.7 | 13.0 |
| $(MPC^y = 1,\ \forall b)$ | $MPC^b$ (%) | 98.3 | - | - | 22.9 | 12.8 |
| | $MPC^a$ (%) | 0 | - | - | 1.0 | 0.7 |

Moreover, Baker et al. (2007) and DiMaggio et al. (2020) find that potential transaction costs associated with trading shares are not driving their results. Hence, in absence of any binding friction, the stocks are part of the household's *liquid* assets in the sense that they are perfectly accessible. As a result, these MPC estimates have to be compared with the model MPC out of liquid assets. But the standard model's MPC out of liquid assets is high, therefore the MPC out of capital gains is unrealistically high. In fact, because liquid assets and income are fungible, the standard model predicts that households consume capital gains from directly held stocks as if they were income, which is at odds with the evidence.

An additional empirical finding in the three empirical studies above (and also others, e.g. Bräuer et al., 2022) is that the MPC out of dividends is substantially higher than the MPC out of capital gains.[54] In this case, the model matches the high MPC out of dividends. But due to the framing-irrelevance property of rational choice, the standard model pools dividends and capital gains together and treats them in the same way: as a result, it predicts counterfactually that these two MPCs are equal.

With a lower return, the standard model does not improve. The MPC out of capital gains is lower and thereby closer to the evidence, but at the cost of generating an unrealistically low MPC out of dividends. The underlying problem is the equality between these two MPCs.

In contrast, the Mental Accounting predictions are more in line with the evidence. There are two essential properties at work. One is the non-fungibility between income and liquid assets. The second is the ability of households to classify liquid resources into different mental accounts, which generates different outcomes: framing is relevant. On one hand, households frame dividends as income (Bräuer et al., 2022), with a high MPC (see above), a bi-modal distribution of MPCs (Baker et al., 2007; Daniel et al., 2021), and high MPCs from liquid households (Bräuer et al., 2022; DiMaggio et al., 2020). On the other hand, they frame capital gains as liquid assets, with a low MPC (see above) and a uni-modal distribution of MPCs (Daniel et al., 2021). The MPC out of capital gains is a little high, though, as the empirical estimate is usually in the lower single digits. Finally, the unequal reactions to dividends and capital gains of directly held stocks violates the

[54] A frequently-cited study is Chodorow-Reich et al. (2021), but they use a measure of stock market wealth that capitalizes dividend income. Hence, it cannot shed light on the dividends vs. capital gains dichotomy.

indifference assumption underlying the Miller-Modigliani (1961) dividend irrelevance result.

The above discussion deals with aggregate predictions. However, one could argue that, because stock market participation is not universal, the comparison should only consider the subset of stockholders, or more precisely direct stockholders. In that case, the same argument holds: the properties of framing and fungibility are present at the individual level.[55] Therefore, even in subsets of the household distribution, the standard model would still produce an equality of MPCs out of capital gains and dividends that is counterfactual.

#### 4.4.5.2 Housing Wealth

Different from the stock market evidence cited above, making transactions in the real estate market, or borrowing against a house, can have associated costs. Therefore, in this case it is appropriate to compare the MPC estimates from capital gains in the value of the house with the model MPC out of illiquid assets. In this case, both models have similar predictions and they are, in turn, broadly consistent with the evidence cited in the previous Chapter (Mian, Rao, and Sufi, 2013; Aladangady, 2017; Guren et al., 2021; Paiella and Pistaferri, 2017; Andersen and Leth-Petersen, 2021; Christelis et al., 2021; Jappelli and Pistaferri, 2017).

### 4.4.6 Size Effects in MPCs

The evidence has found that the MPC declines with the size of the transfer, both in the aggregate and in samples with liquid households (Kueng, 2018; Olafsson and Pagel, 2018; Christelis et al., 2019; Misra and Surico, 2014; Baker et al., 2007). The standard model generates this effect in the aggregate (as has been discussed by Kaplan and violante, 2022). But, again it is due solely to the behavior of the poor and wealthy hand-to-mouth, which are low-liquidity households. Conversely, the Mental Accounting model can rationalize these effects, even among liquid households, but it requires an additional assumption: that windfalls of small size are classified as income, hence the high MPC;

[55] This is not to say that the model generates the same predictions at the individual and aggregate level. In fact, it is apparent from Tables 4.3-4.5 and Figure 4.4 that the aggregation theorems do not hold in either of the models considered.

but windfalls of larger size are classified partly as income and partly as liquid assets, resulting in a lower MPC.

For the purposes of the conceptual discussion, I show in Table 4.6 the MPCs when households receive a transfer that is 5 times as large as above, i.e. $2,500. I assume, just for the sake of this conceptual exercise, that in the Mental Accounting model the household classifies half of the large transfer as income and the rest as liquid assets. Size effects are sizable in both cases. However, more evidence is needed to discipline this classification rule in the Mental Accounting model.

Table 4.6. Size Effects of MPCs

| *Preferences* | | Standard | Standard | Standard | MA | MA |
|---|---|---|---|---|---|---|
| *Return Spread (Ann.)* | | 8% | 4% | 2.5% | 4% | 2.5% |
| ***Household Type*** | ***Magnitude*** | | | | | |
| Average | $MPC^y$, T (%) | 17.8 | 10.1 | 7.4 | 25.0 | 25.0 |
| | $MPC^y$, 5T (%) | 12.5 | 7.5 | 5.6 | 15.5 | 17.9 |

### 4.4.7 Intertemporal MPCs

The evidence has observed systematically that the intertemporal MPC features non-anticipation[56], excess sensitivity[57], and no lagged effects[58] in response to an anticipated transitory income gain. In addition, consumption is sensitive to income both among low-liquidity and high-liquidity households, as already mentioned in Section 4.1 and 4.3.

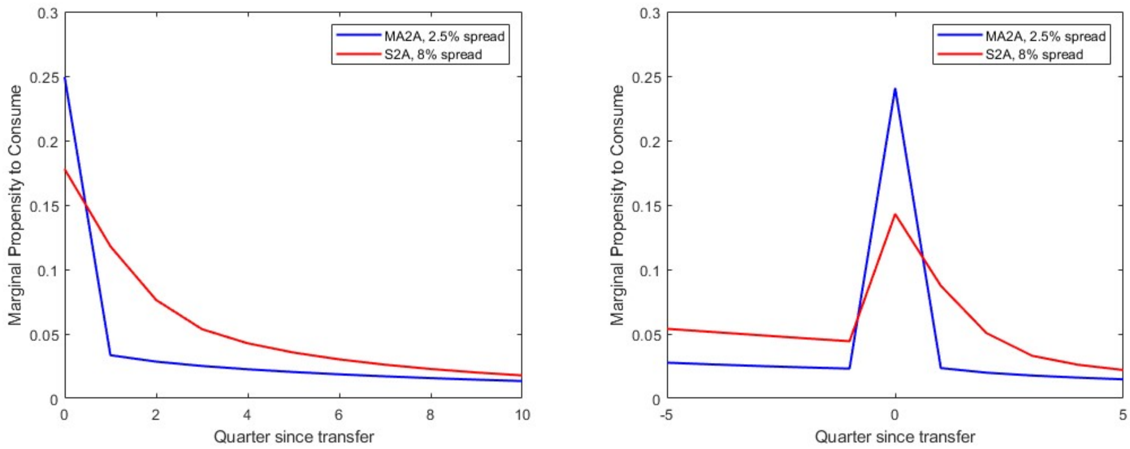
Figure 4.6 plots the intertemporal MPC to an unexpected (Panel A) and to an expected transitory income shock (Panel B) only for standard 2-asset model with 8% spread and the Mental Accounting version with a 2.5% spread. It is apparent that the standard model predicts a reasonable amount of excess sensitivity, but the anticipation and lagged effects are unrealistically high. This is due to the presence of households with intermediate values of MPCs between 0 and 1 (see Section 4.1) and to the fungibility between income and liquid assets. When the households become aware of a future income shock or react to a past transfer, they use the liquid assets to smooth consumption around the shock and

[56] See Baugh et al. (2021); Kueng (2018); Olafsson and Pagel (2018); Braüer et al. (2022).

[57] See Baugh et al. (2021); Kueng (2018); Olafsson and Pagel (2018); Braüer et al. (2022); Souleles (2002); Parker (1999); Shapiro and Slemrod (2003a); Sahm et al. (2010).

[58] See Boehm et al. (2024); Aladangady et al. (2023); Baugh et al. (2021); Kueng (2018); Olafsson and Pagel (2018); Braüer et al. (2022); Shapiro and Slemrod (2003b); Sahm et al. (2010).

elevate their consumption profile over time. In all periods, only low-liquidity households display excess sensitivity to the shock, which is at odds with the evidence.




Panel A: Unexpected shock. Panel B: Announced shock.

Figure 4.6. Intertemporal MPC out of an income transfer: Standard (S2A) model with an 8% spread vs. Mental Accounting (MA2A) with a 2.5% spread.

These counterfactual predictions can be improved by adding Mental Accounting, which improves the excess sensitivity and reduces the anticipation and lagged effects. Again, the non-fungibility and framing properties are at work. On one hand, households make less use of their liquid assets to smooth consumption either before or after the shock. On the other hand, they display a high sensitivity to income whenever the windfall transfer is classified in the income mental account, which happens only in the period when the shock hits. Moreover, the differential MPCs (Sections 4.1 and 4.5) appear among liquid households, rationalizing the excess sensitivity observed among liquid households.

However, the size of the anticipation and lagged effects, while more realistic than in the standard model, is too high and they should be closer to zero. This is probably because, despite the Mental Accounting friction, the MPC out of liquid assets is still significant, and when the unconsumed portion of the windfall is transferred into the liquid asset mental account, households still consume a sizable part of it.

#### 4.4.7.1 Fagereng et al. (2021): The Missing Role of Size

A few recent papers have used Fagereng et al. (2021), an empirical study of consumption responses to large lotteries, in order to discipline the intertemporal consumption behavior of models. In particular, Auclert, Rognlie, and Straub (forthcoming(a)) have argued that Fagereng et al.'s results support the 2-asset model's intertemporal MPC, in particular the sizable anticipation and lagged effects. In this section I revisit the estimates in Fagereng et al. (2021), and I discuss how they relate to the 2-asset model.

#### 4.4.7.1.1 A Surprise Shock

One important aspect of the experiment in Fagereng et al. is that the lottery winner does not know that she will win or how much she will win in advance. Therefore, Fagereng et al. only provides evidence for an unexpected shock: it is informative about the household's reaction in the period when the shock hits and in the periods after that; but it is not informative about the periods in advance of an anticipated shock. Auclert et al. (forthcoming(a)) circumvent this issue by positing that, if the lagged effects are consistent with the model, then the anticipation effects must be, too. This approach then requires making an additional assumption about the symmetry between anticipation and lagged effects, an assumption that can never be tested in the data because of the unanticipated nature of the experiment. However, this additional assumption seems unnecessary given that there are several recent, well-identified studies of intertemporal MPCs that can and do estimate anticipation effects (see Section 4.7), finding non-anticipation across the board.

#### 4.4.7.1.2 The Effect of Lottery Size

The key element that has been overlooked when interpreting Fagereng et al. is the substantial heterogeneity of consumption responses across lottery sizes. On one hand, Fagereng et al. find that, for the subsample of small lottery prizes, the consumption response is consistent with a spender model, where everything is spent upon receipt and the lagged effects are zero.[59] The subsample small lottery prizes are in the range $1,100–$2,070 (converted to US$ from 2000). On the other hand, Fagereng et al. find that, for the entire sample of lotteries, the consumption response is smaller on impact and then features substantial lagged effects. In turn, the range of lottery prizes in the full sample is

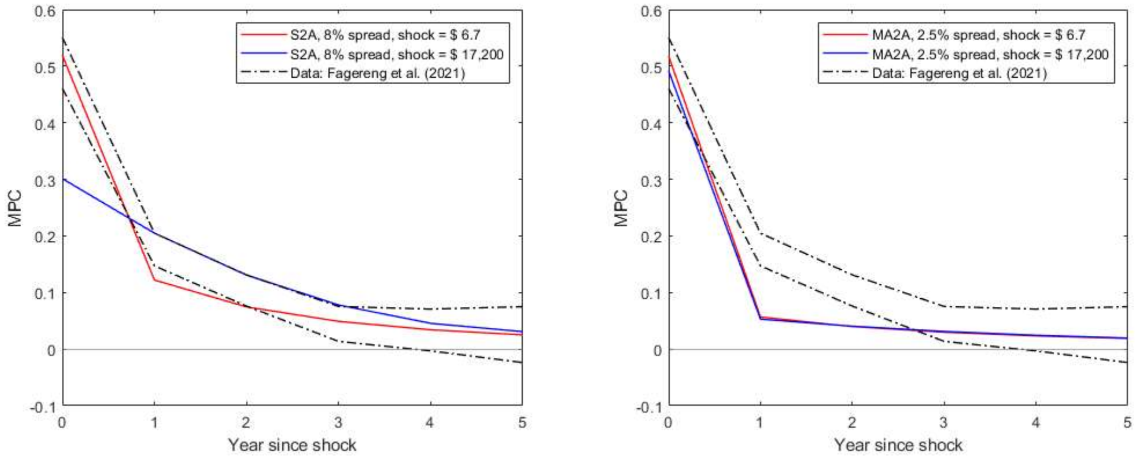
[59] Fagereng et al. (2021): "[…] we find that small prizes typically are consumed entirely within the [period] of winning. Hence, for small windfalls, our results are more in line with a simplistic rule of thumb model."

\$1,100–\$150,000 (converted to US\$ from 2000), with the average lottery being 38.3% of average annual after-tax income (their Table 1).

Now, Fagereng et al. report that their small-lottery estimates are rather inaccurate, whereas their full sample estimates are accurate. Based on this information, Auclert et al. decide to use the full-sample estimates to discipline their models. In particular, they try to match those estimates with their models' intertemporal MPC out of income, which in turn they obtain from their household Jacobian out of income. But the Jacobian is essentially a derivative that captures the model response close to the steady state: in this case, it is the consumption response to an infinitesimal change in income. In order to approximate this derivative numerically, they use an income shock of size $10^{-4}$ (Auclert et al., 2021), which is the equivalent of \$6.7 (as fraction of mean household income from SCF 2019). This means that they are comparing the model intertemporal MPC out of a \$6.7 transfer with the empirical estimates out of a sample of lottery payments with average \$17,200 (idem), that is over 3 orders of magnitude larger.

Figure 4.7 plots the exercise that I just described, with a yearly 2-asset model and an 8% spread as in Auclert et al. (Fagereng et al. provides yearly estimates). Figure 4.7 shows the model intertemporal MPC out of \$6.7, the full-sample estimates from Fagereng et al., and the intertemporal MPC out of a \$17,200 transfer. The result is apparent: the 2-asset model fails to match, by a substantial amount, the empirical estimate from Fagereng et al. This result is consistent with the size effects documented in Section 4.6: in the 2-asset model a larger transfer generates a smaller MPC. The reason is that the 2-asset model produces high MPCs with a mechanism based on low-liquidity households: therefore, a high transfer takes many of these households out of the low-liquidity area, where they display a much smaller sensitivity to income. In fact, Fagereng et al. (2021) solve a 2-asset model, they simulate the MPC out of their full sample of lotteries, they compare it with their own full-sample estimates, and they get the same result: that the 2-asset model is inconsistent with their evidence, because the lotteries are very large.[60]

[60] Fagereng et al. (2021): "[…] our model fails to match the high level of our estimated within-year MPC. The MPC in year 0 is 0.15 in the model, significantly lower than our baseline empirical estimate of 0.52. The main reason why a model like ours will struggle to match the MPC level is that the lottery prizes are relatively large. Even in a framework with many constrained households, such as in our calibration, the actual lottery prizes are large enough to move most households sufficiently far away from the borrowing constraint that its influence on MPCs is limited."




Panel A: Standard 2-asset model. Panel B: Mental Accounting model.

Figure 4.7. Intertemporal Consumption response to lotteries and sensitivity size: Evidence vs. Models. Standard model with 8% spread, and Mental Accounting model with 2.5% spread.

The lesson from this exercise is the following: empirical MPC estimates out of a certain shock size need to be matched with model MPC predictions out of a same-sized shock. This methodological principle is especially important when the model features strong sensitivity to size effects, as the 2-asset model. Yet it is also necessary more generally, as long as the empirical evidence in question finds substantial heterogeneity across different shock sizes. Finally, given that the term *marginal* propensity to consume usually refers to the reaction to small income changes, employing it in the case of large transfers can be misleading.

In turn, the Mental Accounting model can match the consumption profile of Fagereng et al. (2021) when the shock to the model has the appropriate size, but only if the entire lottery prize is classified as income. However, Mental Accounting features much smaller lagged effects than estimated in Fagereng et al. At this point it should be noted that this exercise is at odds with the general idea expressed in Section 4.6 that, with Mental Accounting, households classify the increasingly larger transfer as assets. This case should not convey the message that the Mental Accounting model is flexible and can be tailored to whatever the need is. Instead, more evidence on how households frame windfalls should be used to discipline the model on the important matter of size.

### 4.4.7.1.3 Household Heterogeneity

Until now I have discussed the aggregate implications, but this being a heterogeneous-agent model, there are aspects of the household distribution that are to be evaluated against the empirical evidence, as well. It turns out that, even if the model matched the aggregate estimates, they would come from the wrong place of the distribution, for two reasons. First, Fagereng et al. find that the consumption response is very high among a large number of liquid households, which is at odds with the standard 2-asset model. Second, the model generates an unrealistically large share of poor and wealthy hand-to-mouth households (see Table 4.7), by the estimates reported in Kaplan and Violante (2014; 2022) and discussed in Section 4.1. These unrealistically large shares are the reason why the model is able to generate an impact MPC of 52% out of a small shock. Conversely, both the contribution of liquid households and the shares of poor and wealthy HtM are areas where Mental Accounting performs better, but the shares remain too high.

Table 4.7. Type and Share of Hand-to-Mouth Households in Annual Model

| *Preferences* | Standard | MA |
|---|---|---|
| *Return Spread (Ann.)* | 8% | 2.5% |
| ***HtM Shares (%)*** | | |
| Poor HtM | 20.7 | 19.1 |
| Wealthy HtM | 45.5 | 30.0 |
| Poor ZL | 18.7 | 17.7 |
| Wealthy ZL | 19.9 | 8.4 |

#### 4.4.7.1.4 A Final Comment of Internal Consistency

The purpose of disciplining models of household behavior with empirical estimates on consumption is, at least in part, to inform general-equilibrium business-cycle models. In many cases, for typical business-cycle shocks, these models are solved using perturbation methods, that is assuming that the deviations of the economy from its steady state are small enough to be approximated with a derivative. This is, for instance, the underlying idea in the Sequence-Space Jacobian method (Auclert et al., 2021). But this is also the reason why these models are calibrated to match MPCs out of small windfalls ($500 in Kaplan, Moll, and Violante, 2018): they are supposed to capture the consumption reaction to income changes that are approximately in the order of magnitude of what could happen during a business cycle.

With this methodology in mind, using a 38.3% positive shock to annual after-tax income to discipline the model seems excessive and inadequate for the task at hand, for several reasons. First, I am not aware of any situation where the entire household population would gain, on average, nearly 40% of their income in one year. One could use that evidence to discipline the reaction to negative shocks, but the evidence would not be relevant because consumption behavior in such a situation would display sign asymmetries and non-linearities due to, among other things, liquidity constraints.

However, let's assume for the sake of argument that the evidence was indeed relevant. It would still be the case that such income fluctuations across the entire population are only experienced in an out-of-sample catastrophic event: according to the data, income fluctuations of this order of magnitude have not been documented even in severe crises in advanced or developed countries. For instance, Guntin et al. (2023) report: (i) an average drop of 10% of GDP among the Southern European countries plus Ireland in 2012 during the sovereign debt crisis; (ii) an average drop of 4% of GDP among emerging market economies that experienced sudden stop episodes since the 1980s; and (iii) an average drop of 20% of GDP among countries during the Great Depression starting in 1929. Moreover, Ganong and Noel (2019) find that during a typical unemployment spell in the US income only experiences a decrease larger than 30% for the long-term unemployed who exhaust their unemployment benefits, i.e. a very small population share.

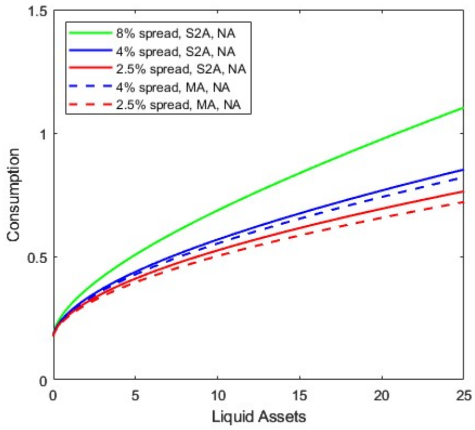
Finally, if the objective was still to analyze such type of catastrophic episodes, then one should not be using local perturbation methods, which are designed for small shocks. Instead, a global solution method would be more appropriate to handle large shocks.

### 4.5 Conclusion

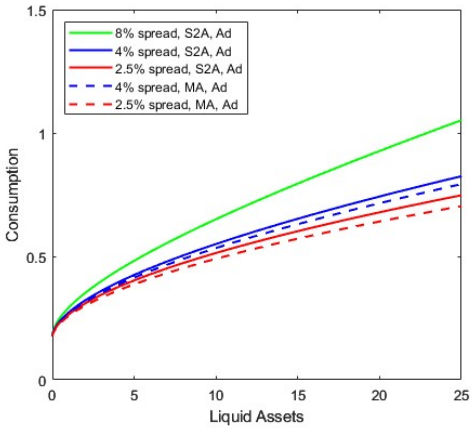
In this paper I show that Mental Accounting improves the explanatory power of the 2-asset model of consumption along a number of empirically relevant dimensions at the individual level, across the household distribution, and in the aggregate, both within and across time periods. For this reason, the Mental Accounting friction can be thought of as parsimonious complement for the 2-asset environment.

## Appendix 4.A. Effect of the Return Spread on the Consumption Policy Functions

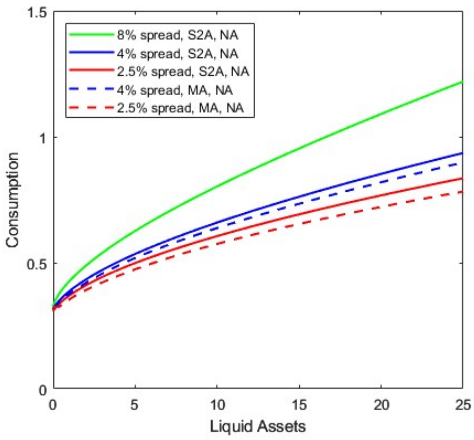
### Appendix 4.A.1 Zero Illiquid Assets



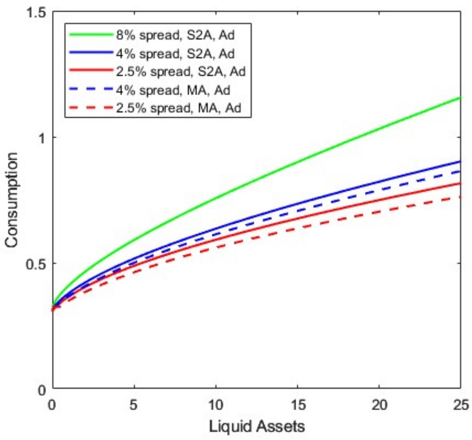

Panel A: CPF, NA, 25th perc. income.



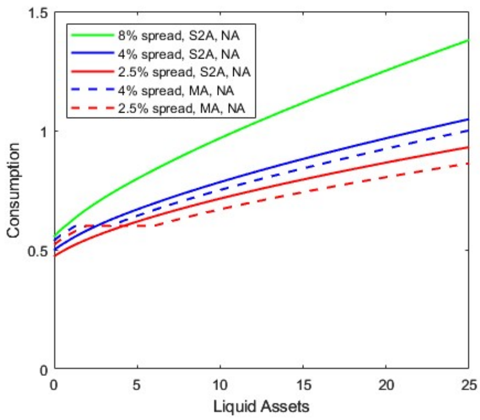

Panel B: CPF, Ad, 25th perc. income.



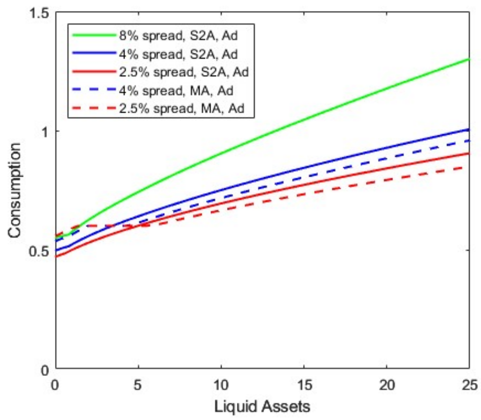

Panel C: CPF, NA, 50th perc. income.




Panel D: CPF, Ad, 50th perc. income.



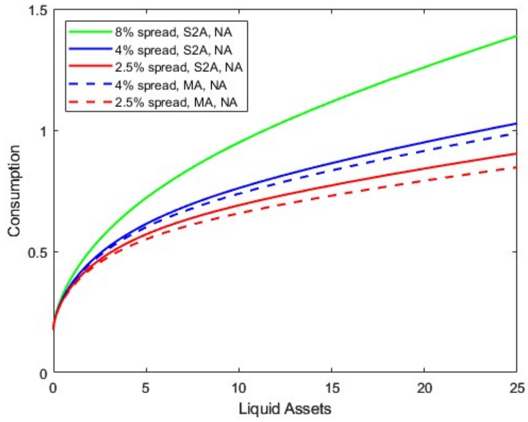

Panel E: CPF, NA, 75th perc. income.



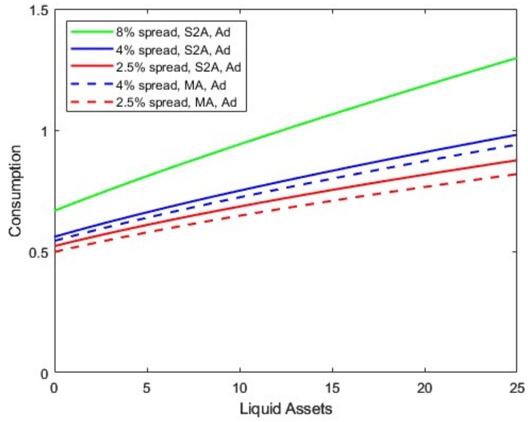

Panel F: CPF, Ad, 75th perc. income.

Figure 4.A.1. Consumption Policy Functions of Non-Adjusters (left) and Adjusters (right), across liquid assets, income levels, return spreads, preferences, and a level of illiquid assets that corresponds to: in Panels A-B, the 22nd percentile; in Panels C-D, the 47th percentile; in Panels D-F, the 80th percentile.

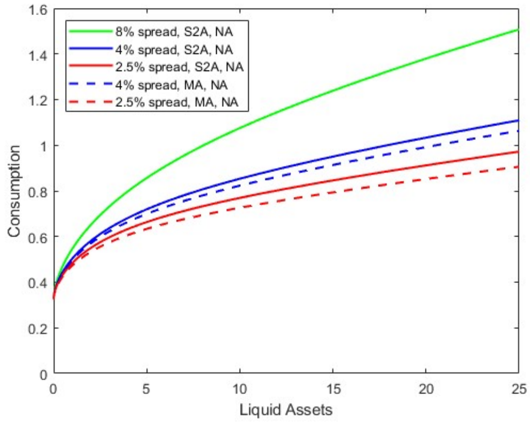
## Appendix 4.A.2 ‘High’ Illiquid Assets



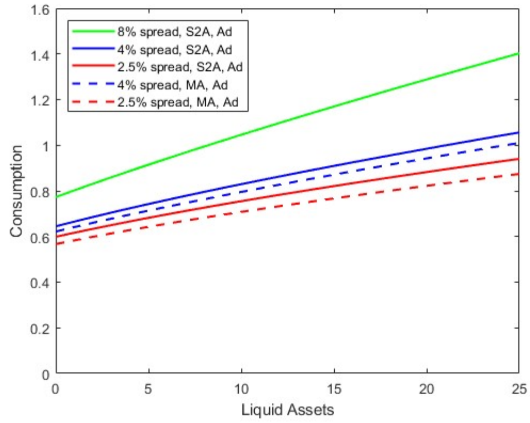

Panel A: CPF, NA, 25th perc. income.



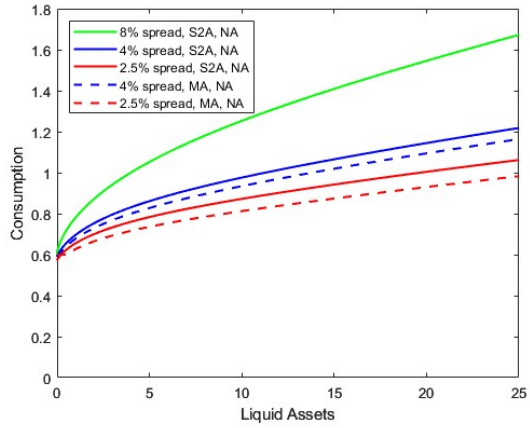

Panel B: CPF, Ad, 25th perc. income.



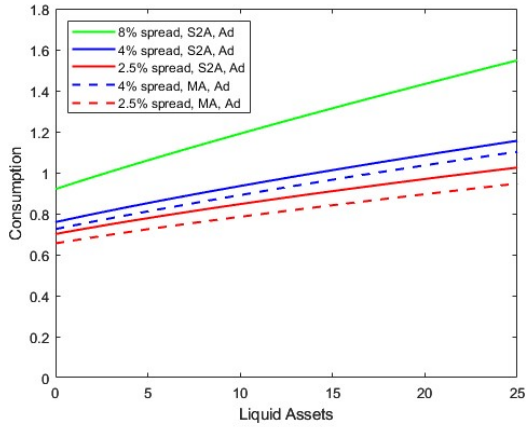

Panel C: CPF, NA, 50th perc. income.




Panel D: CPF, Ad, 50th perc. income.




Panel E: CPF, NA, 75th perc. income.




Panel F: CPF, Ad, 75th perc. income.

Figure 4.A.2. Consumption Policy Functions of Non-Adjusters (left) and Adjusters (right), across liquid assets, income levels, return spreads, preferences, and a level of illiquid assets that corresponds to: in Panels A-B, the 5th percentile; in Panels C-D, the 22nd percentile; in Panels D-F, the 66th percentile. Each graph has a different scale.

# 5. Chapter 4. Monetary and Fiscal Policy in a Mental Accounting HANK Model

## 5.1 Introduction

How do macroeconomic policies affect household consumption? The literature on Heterogeneous Agent New Keynesian (HANK) models has emphasized that matching consumption moments is crucial to answer that question. More specifically, it is the marginal propensities to consume (MPC) across households, as well as the intertemporal MPCs, which allow models to capture better the policies' incidence across the household distribution (Kaplan, Moll, and Violante, 2018) as well as the policies' dynamic effects over time (Auclert, Rognlie, and Straub, forthcoming).

However, leading HANK models are at odds with pieces of micro-economic evidence on consumption behavior that are relevant for the questions above. First, households with enough liquid resources display high MPCs and low Elasticities of Intertemporal Substitution (EIS). Second, the intertemporal MPCs are non-Ricardian and short-lived: they present little anticipation, excess sensitivity, and small lagged effects. Third, one-asset models cannot generate realistic values for the aggregate MPC, aggregate wealth, and median wealth, which are desirable in general equilibrium applications (Kaplan and Violante, 2022).

In order to overcome these challenges, I propose a 'Mental Accounting HANK' (MA-HANK) model to study the transmission of monetary and fiscal policy to consumption. This quantitative framework integrates a Mental Accounting incomplete-markets model of consumption (as in Gimeno-Ribes, 2022)[61] into a New Keynesian economy. Mental Accounting is expressed as a variant of reference-dependence with loss aversion and it captures the preference for households to consume out of their income account rather than out of their asset account. Besides this behavioral friction, the framework builds on the workhorse Bewley-Aiyagari-Huggett[62] environment, and the supply side of the model

[61] See also Shefrin and Thaler (1988); and Thaler (1990).

[62] See Bewley (1987), Aiyagari (1994), and Huggett (1993). See also Imrohoroğlu (1989) for a related setup in partial equilibrium.

features price and wage rigidity. In addition, the monetary authority operates a Taylor rule, and the government follows a fiscal rule.

I analyze different macroeconomic policy shocks in four different models: a Mental Accounting HANK, a HANK with standard preferences, a Two-Agent Model (TANK), and a Representative-Agent Model (RANK). In aggregate terms, the relationship between MA-HANK and HANK is similar to that between TANK and RANK, inasmuch as the presence of hand-to-mouth households brings the model closer to the evidence. However, the MA-HANK has the ability to match evidence on the distributional effects – substitution effects, wealth effects, and indirect income effects – that the other models do not have.

First, I consider a monetary policy shock. Its direct effects, i.e. via intertemporal substitution of consumption, are smaller than with standard preferences because hand-to-mouth households with a low EIS are spread across the entire asset and income distributions. These predictions are consistent with empirical evidence of small EIS both homogeneously across asset levels (Best et al., 2020) and in the aggregate (Havránek, 2015; Canzoneri, Cumby, and Diba, 2007; Yogo, 2005; Campbell and Mankiw, 1989; 1991; Hall, 1988).

The monetary policy shock generates large indirect effects that are transmitted through the labor market. This result also hinges on the presence of hand-to-mouth households, who have a high MPC and, therefore, increase consumption substantially in response to the increase in labor earnings. This prediction is consistent with recent empirical evidence of large general-equilibrium effects being transmitted through unconstrained liquid households (Holm, Paul, and Tischbirek, 2021). These results rely on the model prediction that liquid hand-to-mouth households have high MPCs, low EISs, and contribute substantially in the aggregate.

In addition, the monetary expansion generates a positive reaction of stock prices, in line with the empirical literature (Bernanke and Kuttner, 2005). This asset price revaluation arises mainly from a lower discount rate and it generates a relatively small effect on consumption because households have a small MPC out of capital gains. At the heart of these results is the property that households have account-specific MPCs, with the MPC out of income being around one order of magnitude larger than the MPC out of assets.

Second, I analyze the effects of a forward guidance shock, that is an announcement of a monetary policy shock in the future. By reducing the overall EIS of the model, Mental Accounting reduce the effective discounting of future shocks. As a result, forward guidance is less powerful than contemporaneous shocks. Although the effect is relatively small, it provides conceptually a rationalization of the forward guidance puzzle (Del Negro, Giannoni, and Patterson, 2023).

Third, I consider a government spending shock. By comparing the deficit-financed multiplier with the balanced-budget multiplier, I show that Mental Accounting introduces a violation of Ricardian Equivalence. The intertemporal MPC reveals that households do not consume out of anticipated future income shocks before they are realized, but their consumption does react substantially to current income shocks. Hence, in a deficit-financed fiscal expansion the anticipated future tax hikes have almost no effect on consumption when the shock occurs. Conversely, in the balanced-budget case the current tax hikes rein in consumption significantly.

Government spending multipliers differ depending on the type of monetary policy response, yet the associated deficit-financed multiplier remains greater than one with “active” monetary policy. In terms of the transmission to consumption, this result provides further proof that households under Mental Accounting are more responsive to income changes and more immune to changes in the real interest rate.

Fourth, I consider a central yet perhaps understudied question in fiscal policy that acquired special relevance during the Great Recession and the implementation of austerity programs: namely, whether deficits are expansionary enough to finance themselves. In particular, I ask whether a deficit-financed fiscal transfer to households, on its own, provides enough aggregate stimulus and tax revenue to bring government debt back to its initial level without any further fiscal adjustment (as in Angeletos, Lian, and Wolf, 2023). I find that the expansion in aggregate demand increases the tax base, but only a small portion of the deficit can be self-financed. The demand boom is not persistent enough and, after some time, the debt interest payments outgrow the increase in tax revenues, requiring a fiscal adjustment to keep government debt from exploding in the long run. At the heart of this result is an empirically realistic intertemporal MPC (iMPC) without lagged effects (see Section 6 for evidence). In an exercise with nominal government debt, the date-0 inflation surprise erodes somewhat the real value of the bonds, but it does not materially alter the results.

### 5.1.1 Literature

This paper contributes to two main strands of the literature. The first strand encompasses a vast set of recent papers developing business cycle models that incorporate departures from consumption-smoothing behavior into the New Keynesian model with nominal rigidities. This is achieved either with limited household heterogeneity in the form of a spender-saver structure (Campbell and Mankiw, 1989; 1991)[63]; with full heterogeneity in an incomplete-markets environment[64]; or in an overlapping generations structure with perpetual youth, re-interpreted as occasionally binding constraints[65].

Relative to these papers, I make several contributions. First, previous work introduces low-liquidity Hand-to-Mouth households by means of liquidity constraints and capital market frictions that create a kink in the budget set. In turn, Mental Accounting creates a kink in the utility function that generates non-smoothing behavior in constrained *and* unconstrained households, thereby improving the explanatory power of the model's consumption block. Second, while previous papers have emphasized the low-liquidity hand-to-mouth households introducing the difference between direct and indirect effects of monetary policy (Kaplan, Moll, and Violante, 2018; Auclert, 2019), with Mental Accounting a large portion of these effects is transmitted via liquid households' consumption, as documented empirically.

Third, this literature has shown that the intertemporal MPC is key in the transmission of fiscal policy (Auclert, Rognlie, and Straub, forthcoming), I obtain two fiscal policy implications of my model. First, Mental Accounting constitutes a violation of Ricardian Equivalence (Barro, 1974).[66,67] The second implication for fiscal policy is that deficits

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[63] See Galí, López-Salido, and Vallés (2007); Bilbiie (2008); Acharya and Dogra (2020).

[64] See Oh and Reis (2012); Werning (2015); McKay, Nakamura, and Steinsson (2016); McKay and Reis (2016); Guerrieri and Lorenzoni (2017); Ravn and Sterk (2017); Kaplan, Moll, and Violante (2018); Den Haan, Rendahl, and Riegler (2018); Auclert, Rognlie, and Straub (forthcoming); Bayer et al. (2019); among many others.

[65] See Angeletos, Lian, and Wolf (2024).

[66] Known violations of Ricardian Equivalence include: present bias (Laibson, 1997); liquidity constraints (Heathcote, 2005); a two-asset structure (Kaplan, Moll, and Violante, 2018); sticky wages (Auclert, Bardóczy, and Rognlie, 2023); and finite lives (Angeletos, Lian, and Wolf, 2023).

[67] For other analyses of government spending in heterogeneous-agent models, see: Bayer, Born, and Luetticke (forthcoming); Hagedorn, Manovskii, and Mitman (2019); Broer, Krusell, and Öberg (2021).

cannot finance themselves, a result that contrasts with Angeletos, Lian, and Wolf (2023). The difference is that they support their model choice with one empirical paper (Fagereg et al., 2021), whereas my model is consistent with many other papers, including a more nuanced interpretation of Fagereng et al. (2021), as I argued in Chapter 3.

The second strand of the literature studies the macroeconomic implications of behavioral frictions. An early contribution is Barro (1999), who studies a representative-agent neoclassical growth model with present bias. The closest to this paper is Laibson, Maxted, and Moll (2021), who study the transmission of monetary and fiscal policy to consumption in a heterogeneous-agent model with present bias. My paper follows their lead, but while they use a partial equilibrium environment and focus on the mortgage refinancing channel, I analyze a general equilibrium model with a New Keynesian supply side and without housing.

A related subset of this literature studies business cycles with deviations from the full-information rational-expectations benchmark (see Angeletos and Lian, 2023, for a survey; see also Bianchi, Ilut, and Saijo, 2021). Almost the entirety of these papers consider representative-agent environments and focus on the rationalization of the forward guidance puzzle. The closest to this paper is Farhi and Werning (2019), who study monetary policy and forward guidance in a one-asset HANK model with level-k thinking; my paper studies macroeconomic policy transmission under a different behavioral friction.[68]

The outline of the paper is as follows. Section 2 introduces the models. Section 3 discusses their consumption properties. Sections 4 – 7 discuss the results on the transmission of monetary and fiscal policy. Section 8 concludes.

## 5.2 Model

This section presents the general-equilibrium models that will be used for macroeconomic policy analysis in later sections. I present alternative household blocks, but the supply and policy blocks stay the same. This allows for a cleaner comparison of the different demand structures.

[68] Angeletos and Huo (2021) have argued that these two types of features – information frictions / bounded rationality on one hand, and non-smoothing consumption behavior / high MPCs on the other hand – are complementary rather than mutually exclusive.

### 5.2.1 Household Problem

I present three different environments. First, an incomplete markets setting, with household heterogeneity and a utility function that nests mental accounting and standard preferences. Second, a representative household with access to complete markets. And third, a model with two types of households, one with access to complete markets, and a poor, purely Keynesian consumer.

#### 5.2.1.1 Incomplete Markets Environment with Mental Accounting

Households choose consumption to maximize:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[ U\left( c_{h,t} \middle| r_{h,t} \right) \right]$$

subject to

$$c_{h,t} + a_{h,t} = (1 + R_t) a_{h,t-1} + e_{h,t} + T_t$$

and

$$a_{h,t} \geq 0,$$

where $c_{h,t}$ denotes consumption of household $h$ at time $t$ and $T_t$ is a lump-sum transfer. Households can save in a liquid asset, $a_{h,t}$, with real interest rate $R_t$ between periods $t - 1$ and $t$, but they cannot borrow because of the borrowing constraint. The after-tax labor earnings of household $h$ at time $t$ are:

$$e_{h,t} = (1 - \tau_t) w_t z_{h,t} l_{h,t},$$

where $z_{h,t}$ is the stochastic idiosyncratic labor productivity, which follows a Markov chain whose transition probabilities are $\Pr(z_{h,t+1} | z_{h,t})$. The transition matrix of the Markov chain is constant over time. The initial cross-sectional distribution is set equal to the ergodic distribution of the Markov chain, such that the distribution is constant over time and denoted by $\Gamma^z(z)$. Households also supply labor $l_{h,t}$, which is uniform across all households and it is determined to meet market demand. The aggregate real wage, $w_t$, is determined in the market for labor. The productivity, labor supply, and wage jointly determine the household's pre-tax labor earnings, $w_t z_{h,t} l_{h,t}$, on which households pay a tax rate $\tau_t$.

#### 5.2.1.1.1 Utility

Household utility $U$ is defined as follows:

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

where $r_{h,t}$ denotes the reference point of household $h$ in period $t$. Utility consists of the "intrinsic" consumption utility $u(c_{h,t})$, and gain-loss utility $u(r_{h,t}) - u(c_{h,t})$, where $u(\cdot)$ is an increasing and concave function with constant relative risk aversion (CRRA). Gain-loss utility is expressed in terms of $u(\cdot)$ because departures from the reference point are connected to the utility assigned to each level of consumption. When consumption is below or at the reference point ($c_{h,t} \leq r_{h,t}$), the household derives gain utility $u(r_{h,t}) - u(c_{h,t}) > 0$ with weight $\eta$. Conversely, when consumption is above the reference point ($c_{h,t} > r_{h,t}$), the household derives loss utility $u(r_{h,t}) - u(c_{h,t}) < 0$ with weight $\eta\lambda$, where $\lambda > 1$ is the loss-aversion parameter. Importantly, at $c_{h,t} = r_{h,t}$ the utility function has a non-differentiability point or kink. This specification nests the standard model as a special case when $\eta = 0$.

The reference point is equal to income, $r = I$, where $I$ denotes the resources that the household classifies in the 'income' mental account. In this model, $I$ is equal to the after-tax labor earnings plus the lump-sum transfer. In turn, the asset holdings and their returns belong in the 'assets' mental account.

While the theory of Mental Accounting has posited that dividends are classified as income and capital gains are classified as assets, the data show that following a monetary policy shock the fluctuations in capital gains are at least one order of magnitude larger than fluctuations in dividends (Holm, Paul, and Tischbirek, 2021). Therefore, the assumption that all the profits are capitalized and paid to households as a rate of return on their assets should have a negligible impact on results.

#### 5.2.1.1.2 Recursive Problem

The household problem is characterized by the following Bellman equation:

$$V(a_h, z_h) = \max_{c_h} U(c_h|r_h) + \beta E[V(a'_h, z'_h)]$$

subject to

$$c_h + a'_h = (1+R)a_h + e_h + T$$

and

$$a'_h \geq 0,$$

where $V(a_h, z_h)$ denotes the value function for household $h$ in the current period, $a'_h$ and $z'_h$ are next-period variables, and the rest of the notation is as introduced above. The expectations operator $E$ is taken over the different possible realizations of the stochastic earnings process, using the conditional probabilities $\Pr(z'_h | z_h)$.

#### 5.2.1.1.3 Aggregation

The household distribution is an aggregate state variable of the problem in the sense that it is required to compute aggregate consumption, aggregate wealth, and aggregate labor by the aggregation of individual choices:

$$C_t \equiv \int c_t(a,z)\Gamma_t(z,a)dzda,$$

$$A_t = \int a'(a,z)\Gamma_t(z,a)dzda,$$

$$L_t = \int z_{h,t} l_{h,t}(a,z)\Gamma_t(z,a)dzda,$$

where $\Gamma_t(z,a)$ denotes the distribution of households over their individual state variables, namely productivity and asset holdings, at date *t*. The law of motion of the distribution is as follows:

$$\Gamma_{t+1}(A, z') = \int_{\{(a,z):a\prime(a,z)\in A\}} \Pr(z'|z)d\Gamma_t(a,z)$$

for all sets $A \subset \mathbb{R}$.

### 5.2.1.2 Representative Agent with Complete Markets

The representative household chooses consumption to maximize:

$$E_0 \sum_{t=0}^{\infty} \beta^t [U(C_t)]$$

subject to

$$C_t + A_t = (1 + R_t)A_{t-1} + E_t + T_t,$$

where the variables denote the same as before, only that capital letters denote aggregates. There is a degenerate distribution of households where the representative agent has a probability mass of one, and its consumption, wealth, and labor supply are equal to its aggregate counterparts. Accordingly, there is only one level of labor productivity that the representative agent maintains invariantly, therefore the agents does not receive any idiosyncratic shocks to income, only aggregate shocks. Households have access to a complete set of contingent securities to insure themselves against any state of the world; however, because they can only trade with themselves, they choose to save in a riskless asset of the characteristics explained above. The utility function is assumed to be of standard CRRA form, that is corresponding to the case where $\eta = 0$.

The First-Order Conditions of the problem are:

$$U_c(C_t) = \beta(1 + R)U_c(C_{t+1}).$$

Because households have access to complete markets and face no liquidity constraints or other frictions, their behavior is governed by the above Euler Equation, implying that they engage primarily in intertemporal substitution of consumption.

#### 5.2.1.3 Two-Agent Model

This economy is populated by two types of households: a share $\chi$ of spenders and a share (1–$\chi$) of savers. These shares and, thereby, the household distribution, are constant over time. Each type supplies the same amount of labor and receives the share of aggregate earnings plus transfers that corresponds to the household type.

The spenders have zero wealth holdings, they do not have access to financial markets, and their consumption is equal to their earnings:

$$C_t^{Sp} = \chi(E_t + T_t).$$

In turn, the savers hold the entire wealth in the economy and their consumption, $C_t^{Sav}$, is determined by solving the maximization of:

$$E_0 \sum_{t=0}^{\infty} \beta^t [U(C_t^{Sav})]$$

subject to

$$C_t^{Sav} + A_t = (1 + R_t)A_{t-1} + (1 - \chi)(E_t + T_t),$$

where the household has access to a complete set of contingent securities and faces the same specification as in the representative-agent case. This problem gives the following First-Order Condition:

$$U_c(C_t^{Sav}) = \beta(1 + R)U_c(C_{t+1}^{Sav}).$$

Finally, aggregate consumption is the sum of the two types:

$$C_t = C_t^{Sp} + C_t^{Sav}.$$

### 5.2.2 Firms

#### 5.2.2.1 Final Goods Producers

The final good is produced by a representative firm that aggregates intermediate inputs:

$$Y_t = \left(\int_0^1 y_{j,t}^{1/\mu}\right)^{\mu}$$

where $Y_t$ is the final good produced at time *t*, $y_{j,t}$ represents the intermediate good produced by firm *j* in period *t*, and $\mu$ is the markup. Final goods producers solve a cost minimization problem, and the demand for intermediate good *j* is given by:

$$y_{j,t} = \left(\frac{p_{j,t}}{P_t}\right)^{\mu/(1-\mu)} Y_t\ ,$$

where $p_{j,t}$ is the price charged by intermediate-good firm *j* in period *t*, and the aggregate price index is equal to:

$$P_t = \left(\int_0^1 p_{j,t}^{1/(1-\mu)}\right)^{1-\mu}.$$

#### 5.2.2.2 Intermediate Goods Producers

The producers of intermediate goods are monopolistically competitive firms. These firms hire labor in the market in order to produce the intermediate good:

$$y_{j,t} = f(n_{j,t}) = n_{j,t} - fc$$

where $n_{j,t}$ denotes the labor hired by firm $j$ in period $t$. The fixed production cost $fc$ allows to target the steady-state value of intermediate firm equity in the calibration.

These intermediate goods firms are operated by a risk-neutral manager who discounts the future profits at rate $R_t^e$ and each producer sets its price subject to price-adjustment costs (Rotemberg, 1982):

$$\Theta_{j,t}(p_{j,t}, p_{j,t-1}) = \frac{\theta}{2}\left(log\frac{p_{j,t}}{p_{j,t-1}}\right)^2 Y_t.$$

Intermediate-goods producers choose the optimal price, the quantity of intermediate good produced, and the demand for labor in order to maximize the sum of profits and its end-of-period (or ex-profit) price:

$$J_{t-1} = \max_{p_{j,t}, n_{j,t}} \frac{1}{(1 + R_{t-1}^e)} E_{t-1}\left\{\frac{p_{j,t}}{P_t} y_{j,t} - w_t n_{j,t} - \Theta_{j,t} + J_t\right\}$$

subject to

$$y_{j,t} = \left(\frac{p_{j,t}}{P_t}\right)^{\mu/(1-\mu)} Y_t$$

where $J_t$ is the value of the firm at time $t$ and $w_t$ is the wage in period $t$. Imposing symmetry among all firms ($p_{j,t} = P_t$, $n_{j,t} = N_t$), the above maximization problem yields the Phillips curve:

$$log(1 + \pi_t) = \frac{\mu}{\theta(\mu - 1)}\left(MC_t - \frac{1}{\mu}\right) + \frac{1}{1 + R_t^e} E_t\left\{\frac{Y_{t+1}}{Y_t} log(1 + \pi_{t+1})\right\}$$

where $\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}}$ is net inflation, the marginal cost is given by cost minimization

$$MC_t = w_t,$$

and aggregate output is

$$Y_t = F(N_t) = N_t - FC.$$

The per-period profits of the intermediate goods firms are:

$$X_t = Y_t - w_t N_t - \Theta_t,$$

where $\Theta_t = \frac{\theta}{2} log(1 + \pi_t)^2 Y_t$ are total price adjustment costs. The value of the firms, $J_t$, is the present discounted value of their stream of profits, $X_t$.

### 5.2.3 Labor Market

Workers are compensated for the labor according to a wage-setting rule as in Alves, Kaplan, Moll, and Violante (2020):

$$w_t = w_{SS} \left( \frac{N_t}{N_{SS}} \right)^{\varepsilon_w}$$

where $N_t$ is the aggregate labor demand, $w_t$ is the real wage, $N_{SS}$ and $w_{SS}$ are steady-state values, and $\varepsilon_w$ is the wage elasticity with respect to labor demand. With a low calibrated elasticity, this rule generates wages that are quite rigid to fluctuations in labor demand. This assumption is empirically plausible (e.g. Taylor, 2016) and, in combination with sticky prices, it avoids countercyclical monopoly profits, which are counterfactual (Broer et al., 2020).

The amount of labor supplied is demand-determined given the wage, and allocated across workers according to an equal rationing rule. This setup has several advantages. First, it avoids unrealistic differences in endogenous labor supply that arise in incomplete markets models. And second, it prevents high-MPC households from having counterfactually large "marginal propensities to earn" (Auclert, Bardóczy, and Rognlie, 2023).

### 5.2.4 Monetary Authority

The Monetary Authority sets the nominal interest rate by responding to changes in inflation, following a Taylor rule:

$$i_t = R_{SS} + \phi \pi_t + \epsilon_t,$$

where $R_{SS}$ is the steady state real interest rate, $\epsilon_t$ is the innovation term which is zero in steady state, and $\phi$ governs the responsiveness of the Central Bank to deviations of inflation from steady state. The nominal interest rate and inflation are related to the real interest rate through the Fisher equation, in a standard fashion:

$$1 + R_t^e = E_t\left[\frac{1 + i_t}{1 + \pi_{t+1}}\right].$$

### 5.2.5 Fiscal Authority

The government issues bonds, $B_t$, and levies taxes on households' labor earnings in order to finance public transfers, $T_t$, and expenditures, $G_t$, while maintaining a balanced budget in each period:

$$B_t + \int \tau_t\left(w_t z_{h,t} l_{h,t}\right)\Gamma_t(z,a)dzda = (1 + R_{t-1}^e)B_{t-1} + G_t + T_t.$$

The government also operates the following fiscal rule:

$$\tau_t - \tau_{SS} = \varphi_B \frac{B_{t-1} - B_{SS}}{Y_{SS}},$$

where $\varphi_B$ determines the speed of adjustment of the tax rate to the deviations of debt from its steady-state level normalized with respect to steady-state output (as in Auclert, Rognlie, and Straub, 2020). This rule captures a "passive" fiscal response to a shock: the government runs a deficit/surplus in the short term and then adjusts its debt and brings it back to the steady state level over time. Hence, this rule allows to study monetary policy on its own merits, with limited interference from the fiscal response. For a discussion of fiscal rules in the context of government spending shocks, see Section 5.

### 5.2.6 Financial Intermediary

All households deposit their wealth with the financial intermediary, which in turn holds a portfolio of two assets: (i) government bonds, $B_t$; and (ii) equity shares of the intermediate goods producers, $J_t$. No arbitrage implies that the two assets offer ex-ante the same expected return $R_t^e$ between periods *t* and *t+1*:

$$1 + R_t^e = E_t\left[\frac{1 + i_t}{1 + \pi_{t+1}}\right] = E_t\left[\frac{X_{t+1} + J_{t+1}}{J_t}\right],$$

where $R_t^e$ is pinned down by the monetary authority.

The portfolio delivers a realized rate of return $R_t$ between periods *t-1* and *t*. This ex-post return is the weighted average of the realized return on all assets:

$$1 + R_t = \frac{B_{t-1}}{B_{t-1} + J_{t-1}}(1 + R_{t-1}^e) + \frac{J_{t-1}}{B_{t-1} + J_{t-1}}\frac{X_t + J_t}{J_{t-1}},$$

where the portfolio weights are the shares of wealth invested in each asset. Because I analyze perfect-foresight paths, the realized return on equities differs from the return on government bonds in the first period.

### 5.2.7 Equilibrium

The clearing condition for the asset market is:

$$A_t = B_t + J_t,$$

where household asset supply must equal the asset demand from firms and government. The goods market clearing condition is:

$$C_t + G_t + \Theta_t = Y_t,$$

where aggregate private and public consumption of goods and services plus price adjustment costs must equal aggregate production by firms.

Household labor supply is pinned down by the labor demand of intermediate-goods firms, such that:

$$L_t = N_t.$$

An equilibrium of this economy is defined by the policy function $\{c_t(a,z)\}_{t=0}^{\infty}$ that solves the household's problem, the household distribution $\{\Gamma_t(a,z)\}_{t=0}^{\infty}$ that evolves according to its law of motion, policy functions that solve the problems of intermediate goods and final goods producers $\{n_t, y_t, p_t\}_{t=0}^{\infty}$, and a sequence of prices, monetary and fiscal policies $\{i_t, w_t, \pi_t, R_t, \tau_t, T_t, B_t, G_t\}_{t=0}^{\infty}$, such that the asset market and the goods market all clear, and the government budget constraint holds. The labor demand of intermediate-goods firms, $N_t$, together with the wage-setting rule determine the wage.

### 5.2.8 Calibration

The model period is one quarter, the coefficient of relative risk aversion is 2 and the real interest rate is 0.5% (2% annually). The calibration for the different models is summarized in Table 5.1.

Table 5.1. List of Calibrated Parameters

| **Parameter** | **Value** | | | | **Target / Source** |
|---|---|---|---|---|---|
| ***Model*** | *MA-HANK* | *HANK* | *TANK* | *RANK* | |
| ***Preferences*** | | | | | |
| $\gamma$ (risk aversion) | 2 | | | | Standard value |
| $\beta$ (discount factor) | 0.985 | 0.981 | 0.995 | 0.995 | Assets / annual pre-tax income = 4.10[a] |
| $\eta$ (gain-loss utility) | 0.27 | 0 | - | - | Aggregate MPC = 25.0%[b] |
| $\lambda$ (loss aversion) | 2.5 | 2.5 | - | - | Literature[c] |
| $\chi$ (share of spenders) | - | - | 25% | - | Aggregate MPC = 25.0%[b] |
| ***Production*** | | | | | |
| $\mu$ (markup) | 1.10 | | | | Literature[d] |
| $\theta$ (price stickiness) | 122 | | | | Slope of Phillips Curve = 0.09[e] |
| $FC$ (fixed cost) | 0.033 | | | | Asset Market Clearing |
| ***Labor Market*** | | | | | |
| $\varepsilon_w$ (wage elasticity) | 0.10 | | | | Literature[f] |
| ***Policy*** | | | | | |
| $\phi$ (Taylor rule coeff.) | 1.25 | | | | Literature[g] |
| $B$ (Bonds / annual GDP) | 0.70 | | | | Literature[h] |
| $\tau$ (tax rate) | 0.33 | | | | Literature[i] |
| $\varphi_B$ (fiscal rule) | 0.10 | | | | $B_{ss}$ at medium term[f] |

[a]Kaplan and Violante (2022).

[b]Kaplan and Violante (2014) and references therein.

[c]Gimeno-Ribes (2022).

[d]McKay and Reis (2016).

[e]Bayer et al. (2019).

[f]Alves, Kaplan, Moll, and Violante (2020).

[g]Kaplan, Moll, and Violante (2018).

[h]Straub (2019).

[i]DeLong and Summers (2012).

#### 5.2.8.1 Household block in MA-HANK and HANK

The idiosyncratic income process is modelled as an AR(1) process with an autoregressive coefficient of 0.9657 (Floden and Lindé, 2001; McKay, Nakamura, and Steinsson, 2016; Farhi and Werning, 2019), and an unconditional cross-sectional standard deviation of 0.92 (Song et al., 2015), as in Auclert et al. (forthcoming). In the heterogeneous-agent models, I calibrate the discount factor to match a ratio of aggregate wealth to annual pre-tax income of 4.10 (Kaplan and Violante, 2022), a wealth that is held by households in the form of bonds and firm equity. The loss aversion parameter is set to 2.5, which is within the range of plausible values in the literature (see Gimeno-Ribes, 2022). For the Mental Accounting variant, the weight on the gain-loss utility is calibrated to match a 25% quarterly MPC, based on Kaplan and Violante's (2014) survey of empirical estimates. For the variant with standard CRRA utility, I set $\eta = 0$.

#### 5.2.8.2 Household block in RANK and TANK

These models abstract from idiosyncratic income risk; the single productivity level is the average productivity from the incomplete markets economy; and (the shares of) individual income coincides with (the shares of) aggregate income. For the representative agent model I set the discount factor equal to the inverse of the gross interest rate, and I assume for comparison that aggregate consumption is equal to the heterogeneous-agent case (as in Debortoli and Galí, 2024). In turn, for the two-agent model, I assume a share of spenders equal to 25% to match the quarterly MPC target, I set the discount factor for the savers equal to the inverse of the gross interest rate, and I assume that aggregate consumption is equal to the heterogeneous-agent counterpart.

#### 5.2.8.3 Production

The production structure is calibrated as follows. The price markup is set to 1.10 (McKay and Reis, 2016), and the parameter on the Rotemberg price adjustment costs is chosen to match a 0.09 slope in the Phillips Curve (Bayer et al., 2019). The fixed cost of production is calibrated to set the steady-state value of firm equity over annual output (following a similar strategy to Auclert, Bardóczy, and Rognlie, 2023) equal to the overall aggregate wealth minus government bonds. The wage elasticity to labor demand is set to 0.10 (Alves et al., 2020).

#### 5.2.8.4 Policy

The parameters governing the monetary and fiscal policy are as follows. The steady-state ratio of government bonds to annual output is 0.70 (Straub, 2019). The Taylor rule coefficient on inflation takes a standard value of 1.25. The tax rate is 0.33 (DeLong and Summers, 2012), steady-state transfers are zero, and government spending is obtained as a residual from the budget constraint. The fiscal rule parameter is chosen such that the government debt converges to its steady state level over the medium term after a monetary shock (Alves et al., 2020).

### 5.2.9 Computation

The household problem is solved employing a variant of the Endogenous Grid Method that accommodates the presence of Mental Accounting preferences. The Impulse Response Functions (IRF) are obtained as perfect-foresight transition paths of the economy in response to an MIT shock (Boppart, Krusell, and Mitman, 2018), following a strategy similar to McKay, Nakamura, and Steinsson (2016).

## 5.3 Consumption Behavior and the Household Distribution

In this section I present the consumption properties of the models that have implications for policy transmission. MPCs are obtained as the consumption response out of a transfer:

$$MPC_h^y = \frac{C(a_h, y_h + T) - C(a_h, y_h)}{T}.$$

In turn, the effective Elasticity of Intertemporal Substitution (EIS) is obtained as the substitution effect on consumption due to a change in the interest rate:

$$EIS_h = \frac{\Delta log \frac{C_{t+1}(a_h, y_h)}{C_t(a_h, y_h)}}{\Delta R}.$$

For the MPC I consider a typically-sized windfall transfer of $500. The intertemporal MPC to an anticipated shock is obtained with 4 quarters of anticipation and 4 quarters of lag (as in Kaplan and Violante, 2022). For the EIS I consider a negative 1bps change in the real rate. The results are reported in Table 5.2 and in Figures 5.1 and 5.2. Appendix 5.A contains the graphic intuition for the EIS results in a two-period model.

For hand-to-mouth (HtM) households I consider several definitions in order to capture the specific features of each model: the poor HtM are those whose wealth is less than half their pay-period earnings, and the liquid households are the rest; the zero liquidity households hold zero assets; the liquid HtM (I borrow this term from Olafsson and Pagel, 2018) have assets over half of their pay-period earnings and set optimal consumption equal to income; and the total HtM are all households whose optimal consumption is equal to income. The average household captures the aggregate reaction of the economy.

Starting from the simplest environment, the RANK presents an aggregate MPC of 0% out of income and assets because the representative household is always on the Euler Equation and it engages in intertemporal substitution. As a result, the model's effective Elasticity of Intertemporal Substitution (EIS) is equal to the inverse of the CRRA coefficient, 50%. The representative agent holds all the wealth in the economy, therefore it is classified in the category of liquid households in Table 5.2. The agent is not classified as a HtM, since it does not have low liquidity nor does it set optimal consumption equal to income, because in steady state she also consumes the returns on wealth.

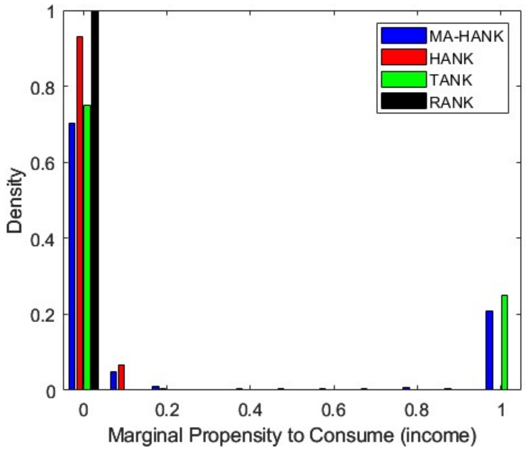
The TANK model has, by assumption, a 25% share of spenders who have zero wealth, who consume their income and who have an MPC of 100% out of income and an MPC of 0% out of wealth. The presence of spenders reduces the effective EIS to 37.3%, since now less than the entire population engages in intertemporal substitution.[69] Therefore, these households fall into the category of Poor HtM, Zero Liquidity households; and also Total HtM, although with a slight abuse of terminology since the consumption of the spenders is not optimally equal to income, but rather it is assumed to be. The rest of the households, who are savers, are classified as liquid households because they own the entire stock of wealth, and have an MPC of 0% out of income and wealth. The spender-saver dichotomy is depicted in the MPC Histogram in Figure 5.1. Moreover, this

[69] Reassuringly, my results are consistent with the formula (Auclert, 2019): EIS = 1/CRRA*(1 – MPC).

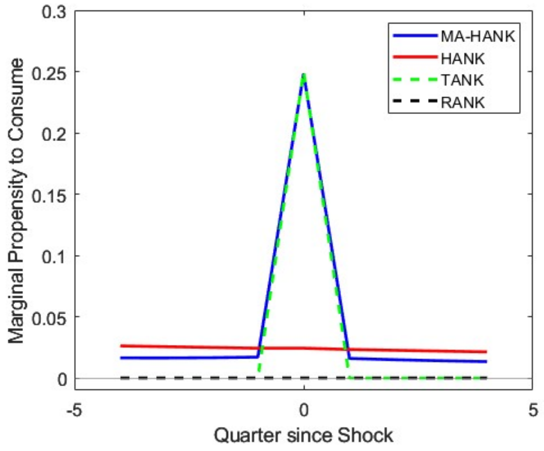
consumption structure generates a non-Ricardian intertemporal MPC out of an expected shock with non-anticipation, no lagged effects, and excess sensitivity.

Table 5.2. Household Types, Shares, EIS, and MPC out of income or assets

| ***Model*** | | MA-HANK | HANK | TANK | RANK |
|---|---|---|---|---|---|
| ***Household Type*** | ***Magnitude*** | | | | |
| Average | $MPC^y$ (%) | 25.0 | 2.8 | 25.0 | 0.0 |
| | $MPC^a$ (%) | 2.0 | 2.8 | 0.0 | 0.0 |
| | EIS (%) | 38.2 | 48.3 | 37.3 | 49.8 |
| Zero Liquidity HHs | Share (%) | 1.0 | 0.9 | 25.0 | 0 |
| $(a = 0)$ | $MPC^y$ (%) | 92.0 | 13.9 | 100 | - |
| | $MPC^a$ (%) | 8.0 | 13.9 | 0.0 | - |
| | EIS (%) | 3.9 | 27.4 | 0.0 | - |
| Poor HtM | Share (%) | 1.3 | 1.00 | 25.0 | 0 |
| $(a \le \frac{y}{2})$ | $MPC^y$ (%) | 75.3 | 13.3 | 100 | - |
| | $MPC^a$ (%) | 8.4 | 13.3 | 0.0 | - |
| | EIS (%) | 12.2 | 28.9 | 0.0 | - |
| Liquid HHs | Share (%) | 98.7 | 99.0 | 75.0 | 100 |
| $(a > \frac{y}{2})$ | $MPC^y$ (%) | 24.4 | 2.7 | 0.0 | 0.0 |
| | $MPC^a$ (%) | 2.0 | 2.7 | 0.0 | 0.0 |
| | EIS (%) | 38.5 | 48.5 | 49.8 | 49.8 |
| Liquid HtM | Share (%) | 20.5 | 0 | 0 | 0 |
| $(c^* = y,\ a > \frac{y}{2})$ | $MPC^y$ (%) | 98.7 | - | - | - |
| | $MPC^a$ (%) | 0.0 | - | - | - |
| | EIS (%) | 0.0 | - | - | - |
| Total HtM | Share (%) | 21.4 | 0 | 25.0 | 0 |
| $(c^* = y,\ \forall a)$ | $MPC^y$ (%) | 98.7 | - | 100 | - |
| | $MPC^a$ (%) | 0.0 | - | 0.0 | - |
| | EIS (%) | 0.0 | - | 0.0 | - |

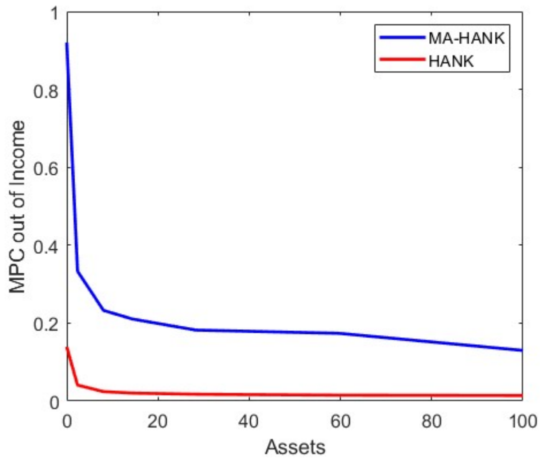



Panel A: MPC Histogram.

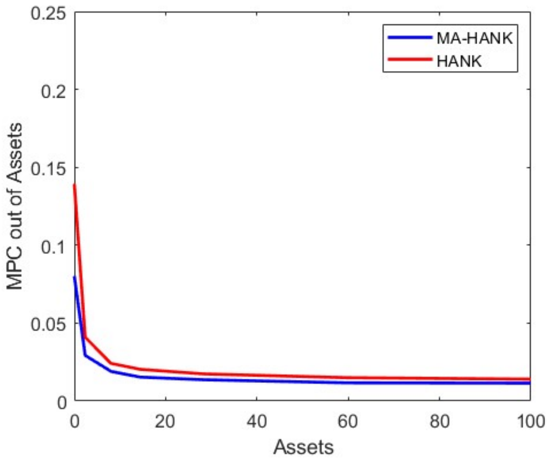



Panel B: Intertemporal MPC.

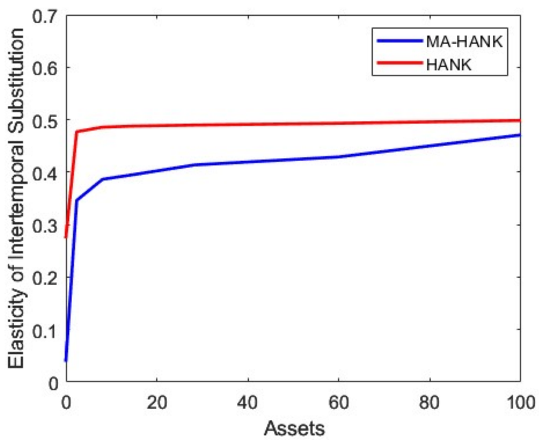
Figure 5.1. MPCs out of uniform transfer in all four models.



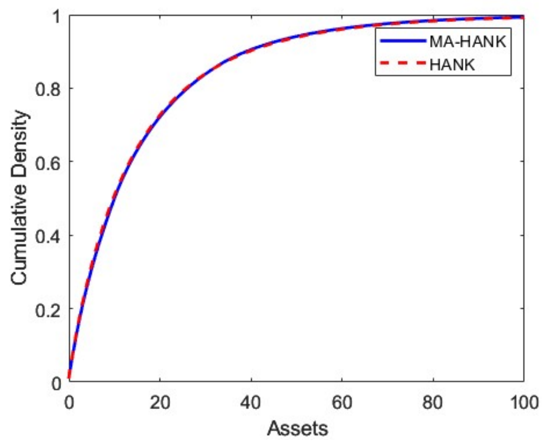

Panel A: MPC out of income.




Panel B: MPC out of assets.




Panel C: EIS.




Panel D: Assets CDF.

Figure 5.2. MPCs and EISs across the asset distributions in MA-HANK and in HANK.

Thus, TANK models have the advantage over RANK models that they can match the aggregate MPC (Kaplan and Violante, 2014), the intertemporal MPC (e.g. Kueng, 2018; Baugh et al., 2021; Boehm et al., 2023), the MPC bi-modality (Misra and Surico, 2014), and are closer to the aggregate EIS estimates (Hall, 1988; Yogo, 2004; Canzoneri et al., 2007; Havránek, 2015). However, both RANK and TANK models are unable by design to match consumption facts across the household distribution. In TANK, the entire MPC comes from a household with zero liquidity: this is at odds with the empirical literature, where households with enough liquid holdings have high MPCs (Olafsson and Pagel, 2018; Kueng, 2018; Baugh et al., 2021; Bräuer et al., 2022) and, as a result, they contribute substantially to the aggregate. Also, there is evidence of high MPCs both at low and high income levels (Misra and Surico, 2014), but the TANK model again cannot speak to that evidence by design. Finally, low EIS have been estimated homogeneously across the asset distribution (Best et al., 2020), and not just for liquidity-constrained households (Vissing-Jorgensen, 2002).

As for the MPCs out of asset shocks, both RANK and TANK predict MPCs of 0%. This is at odds with the empirical evidence that MPCs out of capital gains are in the single digits (Di Maggio et al., 2020; Baker et al., 2007; Chodorow-Reich et al., 2021). One could try to amend this difficulty by assuming that the spenders also consume returns to wealth, but then their MPC out of wealth would be the same as the MPC out of income, which would be even further apart from the data.

The incomplete markets economies are, by design, better equipped to make predictions across the household distribution. The HANK model generates a realistic MPC out of assets across the distribution and in the aggregate. However, because of the implicit assumption of fungibility between income and wealth, the MPC out of assets is equal to the MPC out of income (the red lines in Figure 5.2 Panel A and Figure 5.2 Panel B). But such equality is counterfactual, and that MPC out of income is too low, both across the distribution and also in the aggregate. The HANK model can only generate high MPCs for low liquidity households that are either at the constraint, and therefore incapable of reaching their optimal consumption, or close to the constraint, and therefore behave as if they had a shorter planning horizon (McKay, Nakamura, and Steinsson, 2016). Because the aggregate MPC out of income is too low, the intertemporal MPC does not feature enough sensitivity to the receipt of the shock.

The effective EIS can be thought of as the mirror image of the MPC. When households have low or zero liquidity and are therefore on the Euler Equation, their effective EIS is given by the inverse of the CRRA; but when they are constrained, the EIS drops. Since the share of constrained households is very low, the aggregate EIS of the HANK model is very close to that of RANK.

Adding Mental Accounting to the incomplete markets environment does improve these properties. First, and by virtue of the non-fungibility assumption, the aggregate MPCs out of income and wealth are almost one order of magnitude apart and are consistent with the evidence. Second, it generates excess sensitivity to the receipt of the shock in the intertemporal MPC. Third, it produces high MPCs out of income across the distribution, including for high assets and high income households. Fourth, the spender-saver structure arises endogenously, with the respective shares being in line with available estimates (Misra and Surico, 2014). Fifth, the presence of hand-to-mouth households due to the Mental Accounting friction reduces the effective EIS both at the constraint and for liquid households, thereby bringing the model closer to the data (Best et al., 2020).

### 5.4 Monetary Policy

In this section I analyze the effects of shock to the nominal interest rate. In particular, I consider a –25bps innovation to the Taylor rule in period $t = 0$ that reverts back to its steady state value following a quarterly AR(1) process $\epsilon_t = \rho_\epsilon \epsilon_{t-1} + \varepsilon_t^\epsilon$, with an autocorrelation of $\rho_\epsilon = 0.5$ (Galí, 2015).

#### 5.4.1 Aggregate Effects

Figure 5.B.1 in the Appendix 5.B.1 plots the IRFs of aggregate magnitudes to the monetary shock in all the models considered. The IRFs and, therefore, the model belongs to the "micro jump" literature, rather than to the "macro hump" literature, using the terminology in Auclert, Rognlie, and Straub (2020). That is, the model is able to match the response of consumption at the microeconomic level, but not the typical hump-shaped aggregate responses.

Consumption is more volatile than output because there is no investment in the model and government spending is kept fixed at its steady-state value. Nominal rigidities in prices and wages are clearly visible as they respond significantly less than output and labor, respectively. The increase in the value of stock prices is consistent with the evidence in Bernanke and Kuttner (2005). The monopolists' profits are practically acyclical due to the presence of sticky prices and wages, and because labor is the only factor of production. Hence, the reaction of stock prices is a pure revaluation effect generated by a lower discount rate.[70]

### 5.4.2 Direct and Indirect Effects in the Aggregate and Across the Distribution

In this Section I decompose the effects of the monetary policy shock on consumption into the different channels of prices and policies. For this exercise, I consider separately the effect of one price or policy on consumption, while holding fixed all the other inputs of the household problem. I consider separately the effect of real interest rates, $R_t^e$, the effect of returns on equity, the effect of labor income, and the effects of the fiscal adjustment (via taxes or transfers). This decomposition can be summarized by the following equation:

$$dC = \int_0^{\infty} \left( \frac{\partial C}{\partial R_t^e} dR_t^e dt + \frac{\partial C}{\partial R_t^J} dR_t^J dt + \frac{\partial C}{\partial w_t} dw_t + \frac{\partial C}{\partial \tau_t} d\tau_t + \frac{\partial C}{\partial T_t} dT_t \right) dt$$

where each term represents the effects of one of the prices and policies considered, computed for the entire duration of the shock.

Table 5.3 and Figure 5.3 show the total consumption response, as well as its decomposition into the different channels. Table 5.3 shows responses cumulated over the first year, whereas Figure 5.3 shows the IRFs for four years.

#### 5.4.2.1 Real Interest Rates

In Table 5.3, the effects of the real interest rate on consumption are further decomposed into substitution and wealth effect. These can be understood, respectively, through the model's effective EIS and MPC out of wealth documented Section 3.

The RANK model only registers effects on consumption through a substitution effect that is equal to the relative weight of the bond holdings in the portfolio; in turn, the wealth

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[70] While the stock price reaction is in the right direction, it is smaller than found in empirical studies – 1.9pp in Kekre and Lenel (2022). A reasonable explanation for this discrepancy is that the model only features a lower discount rate, whereas the evidence has identified an additional channel via risk premia (see Kekre and Lenel, 2022).

effect is counterfactually zero, as argued in Section 3. The TANK model also has a zero wealth effect, and the substitution effect is smaller because of the presence of spenders.

Table 5.3. Decomposition of the Effect of Monetary Shock on Aggregate Consumption

| *Model Version* | MA-HANK | HANK | TANK | RANK |
|---|---|---|---|---|
| *Total Response* | 0.46% | 0.43% | 0.48% | 0.46% |
| *Response Decomposition* | | | | |
| $R^e$ (substitution effect) | 14.4% | 18.3% | 12.7% | 18.2% |
| $R^e$ (wealth effect) | -20.4% | -32.2% | 0% | 0% |
| $R^e$ (total) | -8.4% | -14.2% | 12.7% | 18.2% |
| Labor | 26.2% | 5.9% | 16.8% | 0% |
| Equity (substitution effect) | 54.5% | 81.0% | 57.3% | 81.8% |
| Equity (wealth effect) | 0.3% | 0.4% | 0% | 0% |
| Equity (total) | 54.8% | 81.1% | 57.3% | 81.8% |
| Fiscal Rule | 28.7% | 28.4% | 13.3% | 0% |

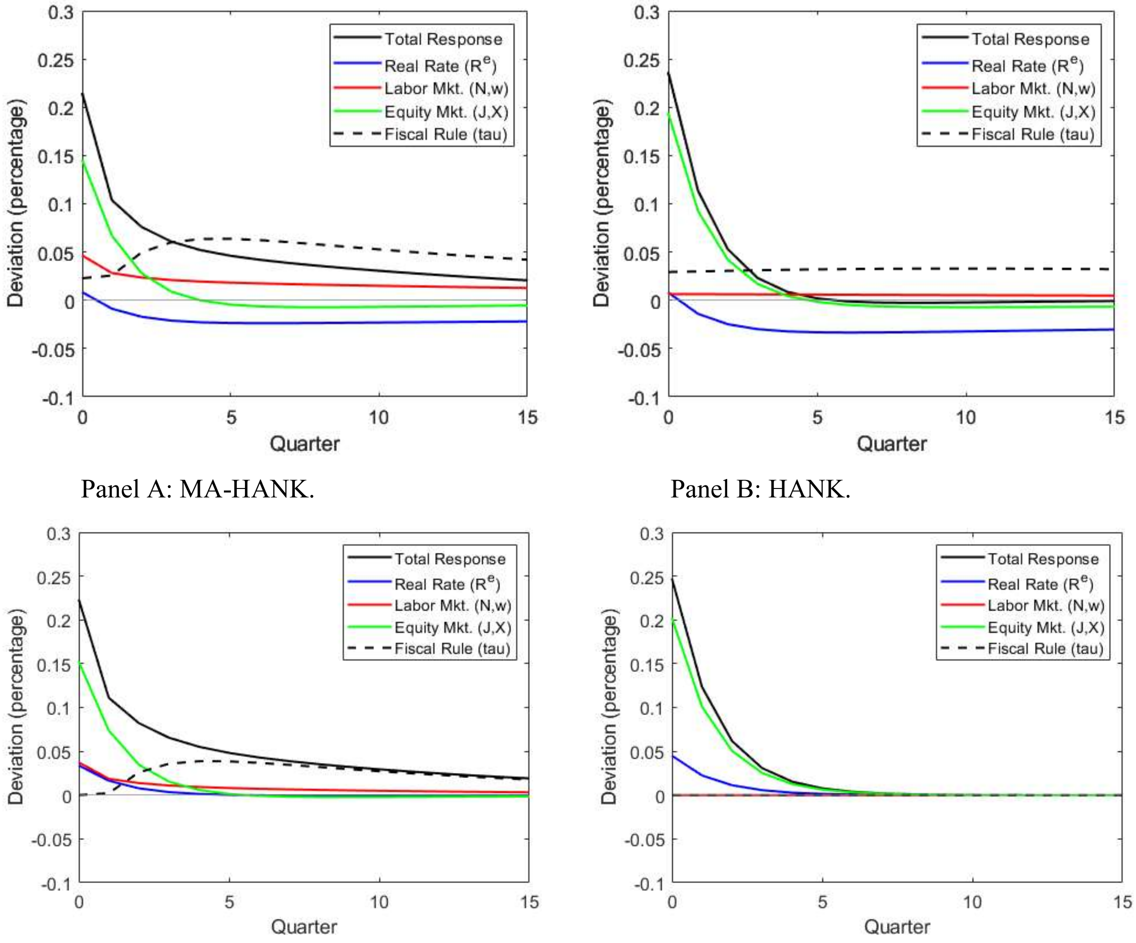
All reported values are cumulated effects over the first year. The 'total' effect on aggregate consumption is expressed as a fraction of its steady-state value. The components are expressed as a fraction of the effect on aggregate consumption.

The incomplete markets economies feature both substitution and wealth effects. The substitution effect in HANK is very similar to RANK, which is reassuring given that the effective EISs in both models are nearly identical. In turn, HANK also features a negative wealth effect, due to the drop in the real interest rate. Because the wealth effect is larger than the substitution effect in absolute value, the resulting total (net) effect of the real rate is negative.

The substitution effect in MA-HANK is in the same range as TANK, which makes sense because their effective EISs are very similar. However, MA-HANK also features a negative wealth effect, which is smaller in absolute value than in HANK because the MPC out of wealth is also smaller with Mental Accounting. The resulting total effect is also negative, yet smaller in absolute value than HANK.[71]

The differences in the sign of the total effects across models, as well as the difference in the magnitude of the wealth effects, is also visible in Figure 5.3.

[71] The net negative direct effect (due to the interest rate on bonds) is consistent with the aggregate-wealth calibration of the 1-asset model in Kaplan, Moll, and Violante (2018).




Panel A: MA-HANK. Panel B: HANK.

Panel C: TANK. Panel D: RANK.

Figure 5.3. Decomposition of the IRF of consumption to a monetary shock in all four models.

To sum up, household heterogeneity is necessary to generate realistic wealth effects (Di Maggio et al., 2020; Chodorow-Reich et al., 2021), and Mental Accounting helps to bring the model closer to the data by reducing the magnitude of both the substitution (Best et al., 2020) and the wealth effects (Baker et al., 2007).

#### 5.4.2.2 Labor Earnings

The above change in the real rate provides a stimulus to consumption that generates a general-equilibrium increase in labor demand and, as a result, in labor earnings. This rise in earnings further stimulates consumption, which also increases labor earnings, following a Keynesian cross logic.

RANK features a zero effect of labor earnings on consumption (Table 5.3, Figure 5.3). TANK improves the predictions on this dimension due to the presence of spenders. However, the shock is transmitted only through zero-liquidity households, whereas the evidence has found that a sizable share of the indirect labor-earnings effects is transmitted through households with ample levels of liquidity (Holm et al., 2021). In HANK, as it features an unrealistically low MPC, the labor effects are small and transmitted only through low-liquidity households. MA-HANK, with the higher MPC, can generate a substantial labor effect that is 20pp higher and that is transmitted through households with sufficient liquidity, consistent with the mentioned evidence. Although the MPC in MA-HANK and TANK is the same, the size of the effects in Table 5.3 differs because MA-HANK features a negative effect of the real rate, which implicitly scales up all the positive effects such that the sum of different components is around 100%.

#### 5.4.2.3 Fiscal Adjustment

The lower real rate on government bonds reduces the financial cost of the government. In addition, the rise in labor earnings increases tax revenues. Both these phenomena free up fiscal space that require the government to issue less debt. As a result, the fiscal rule implies that, over the subsequent periods and in order to drive the debt back to its steady-state level, the government reduces taxes.

The resulting increase in after-tax income also has different effects across models. Similar to the case of labor earnings, the effects of the lower taxes in RANK are zero (Table 5.3, Figure 5.3). TANK features a strong response that is also correlated with the tax changes, indicating that consumption tracks income closely. In HANK, the effects are again positive, but the nearly flat line in Figure 5.3 indicates that most households smooth consumption, which is consistent with its low MPC. Finally, in MA-HANK the somewhat hump-shaped response indicates a strong reaction to income changes, but again the effects are sizable across the asset distribution and not just for low-liquidity households, consistent with the evidence (Holm et al., 2021).[72]

#### 5.4.2.4 Returns on Equity

The revaluation of firm equity generates a surprise, positive return at impact, followed by negative returns generated in the bond rate that also appear in equities by the arbitrage

[72] In Holm et al. (2021) 'nonfinancial income' combines transfers and labor earnings. The latter display a strong response when the general-equilibrium effects kick in.

condition. However, the equity returns affect the household more significantly, as equity is approximately 81.2% of the portfolio.

In the RANK model, consumption responds via intertemporal substitution, with a weight that mimics the share of equity in the portfolio. The positive return on impact has no wealth effect in the RANK model, which is counterfactual. In the TANK model the wealth effect is still zero, but the return on equity otherwise has a smaller effect because only the savers respond to it via intertemporal substitution.

In turn, the HANK model does feature a response in both substitution and wealth effects. In this case, the return at impact is positive and large, hence both effects have the same sign when cumulated over the first year (Table 5.3, Figure 5.3). However, the substitution effect dominates and is of a similar size as in RANK, because both models have a similar effective EIS. The difference in the total effects between both models is due to the wealth effect, given the small MPC out of wealth in HANK.

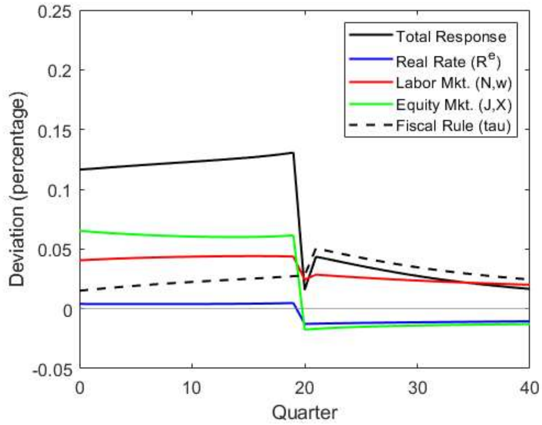
The Mental Accounting model shares with TANK a substantial reduction in the substitution effects (in MA-HANK, the hand-to-mouth have an effective EIS of zero). In addition, the MA-HANK has a small wealth effect in the same order of magnitude than HANK based on the small MPC out of wealth.

### 5.5 Forward Guidance

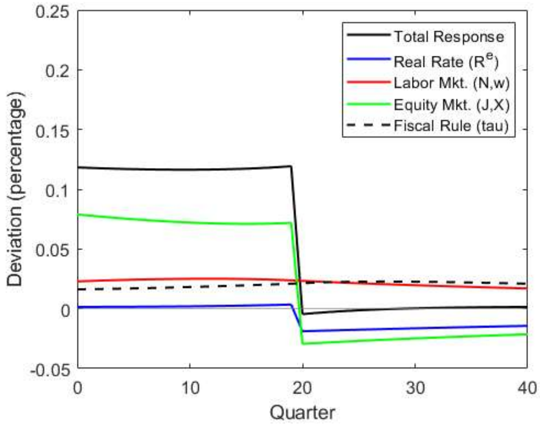
In this section I study the effects of a monetary policy announcement in a similar fashion as in McKay, Nakamura, and Steinsson (2016). For this section, I assume that the central bank operates a different monetary policy rule: $R_t = R_t^n + \epsilon_{t,t-j}$, ensuring that in all periods the interest rate is equal to the natural rate, which is also the steady-state value at all times. The error term accommodates the shock that occurs at time $t$ and is announced $j$ periods ahead. I consider a –25bps shock 20 quarters ahead, i.e. with $j = 20$.

Figure 5.B.2 in the Appendix 5.B.2 shows the aggregate effects. In turn, Figure 5.4 shows the total consumption response, as well as its decomposition into the effects of different prices and policies, analogously to Section 4.

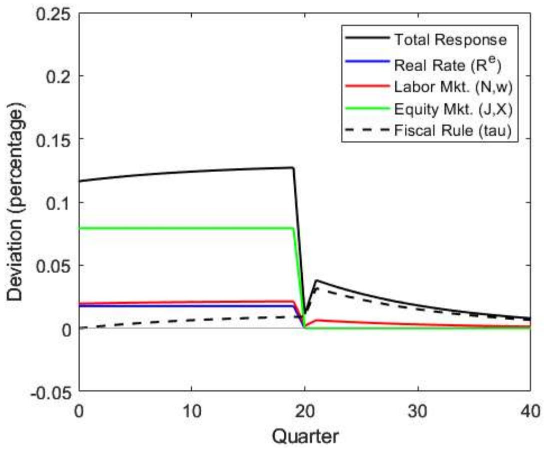
In RANK, the announcement of a future monetary policy shock has counterfactually the same effects as a contemporaneous shock, which is known as the 'forward guidance puzzle' (Del Negro et al., 2023). In terms of decomposition, consumption only responds via intertemporal substitution, and the relative importance of the real rate and the return on equity is proportional to their shares in the household portfolio. The responses to labor income and the fiscal adjustment are nonexistent.



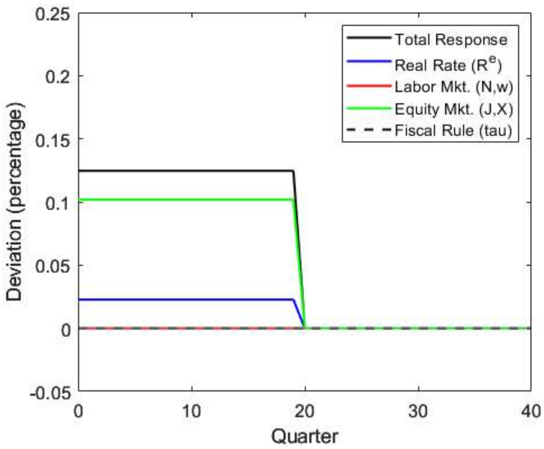

Panel A: MA-HANK.




Panel B: HANK.




Panel C: TANK.




Panel D: RANK.

Figure 5.4. Decomposition of the IRF of consumption to a forward guidance shock in all four models.

In the TANK model, the higher aggregate MPC procures a positive consumption response to the increase in labor earnings and to the fiscal adjustment; whereas the lower effective EIS generates a smaller response to the real rate and, most visibly, to the return on equity. These effects aggregate such that the effect of the announcement in the present is about 9% smaller than the effect of the shock when it occurs. The interest rate channels stay constant throughout the announcement horizon until the shock occurs, for the same reason as in RANK, namely because agents are on the Euler Equation. Conversely, the income channels feature some reduction as the horizon of the shock becomes more distant. Such effect is most visible in the case of the fiscal adjustment, where the expansion generates enough fiscal space to increasingly reduce taxes, thereby generating the upward sloping effect of the fiscal adjustment. After the interest cut occurs, the resulting drop in debt triggers a larger tax reduction, which drives the response afterwards.

The HANK model features a response to the real rate that is virtually zero before the shock occurs, as the substitution effect approximately cancels out with expectation of the negative wealth effect; after the shock, the negative wealth effect dominates. The return on equity now acts through a substitution effect, as well as through a positive wealth effect that is most visible when the announcement is made; in turn, after the shock the negative wealth effect dominates. As for the labor income and the fiscal adjustment channels, they have rather smooth profiles, owing to the overwhelming majority of savers in the household distribution. As a result, the aggregate response is similar to RANK before the shock occurs, and therefore the forward guidance puzzle persists in this economy. However, after the shock is quite different: the responses go below zero because of the negative wealth effect of the rate cut, something that does not appear in RANK or TANK because of the absence of wealth effects.

In the Mental Accounting model, the announcement effect is an 11% weaker than the contemporaneous shock, which is in the direction of resolving the forward guidance puzzle. Similar to HANK, the response to the real rate is nearly zero because the negative wealth effect counteracts the substitution effect. The effect of the equity returns is the smallest in absolute value, because of the lower effective EIS and small MPC out of wealth. The effects of labor income and fiscal adjustment are now stronger and reflect the property that consumption tracks income more closely. The intuition for the spike right after the shock is the same as in TANK, namely the effect of the fiscal adjustment.

### 5.6 Government Spending

In this section I consider a shock that increases government purchases by 1% of steady-state output in period $t = 0$, and then reverts back to its steady state value following an AR(1) process with a quarterly autocorrelation of $\rho_G = 0.9$ (Auclert et al., 2023).

I study the effects of the shock on consumption and output under alternative settings. In terms of monetary policy, I consider both a Taylor rule ("active"), as well as a monetary authority that does not respond to inflation and targets the steady-state real interest rate, such that $R_t^e = R_{ss}^e$ ("passive"). In terms of fiscal policy, I consider different financing schemes. Table 5.4 contains the multipliers on output, $\frac{dY_0}{dG_0}$, under the different cases, in all four models.

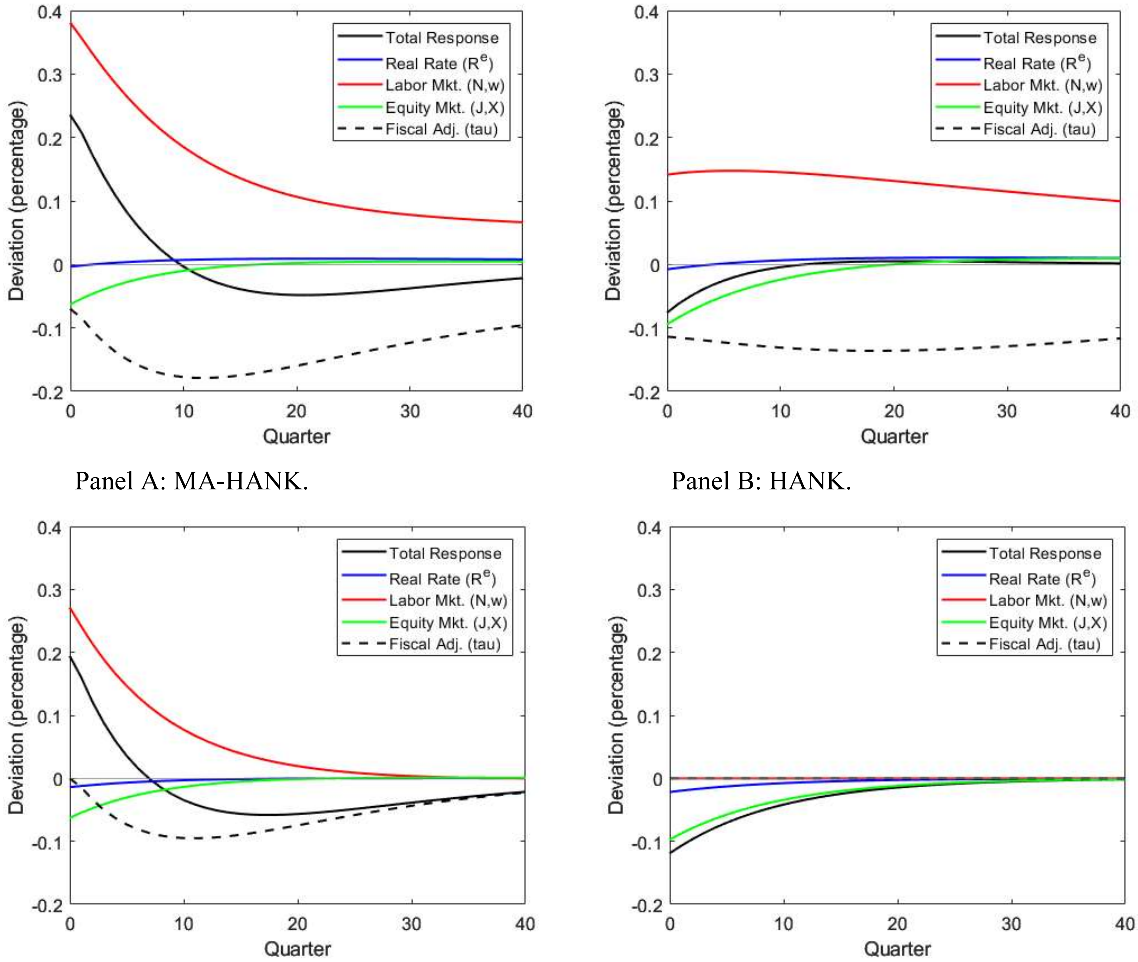
Table 5.4. Government Spending Multipliers

| **Model** | MA-HANK | | HANK | | TANK | | RANK | |
|---|---|---|---|---|---|---|---|---|
| **Monetary Policy** | Active | Passive | Active | Passive | Active | Passive | Active | Passive |
| **Fiscal Adjustment** | | | | | | | | |
| *Deficit, tax rule* | 1.17 | 1.24 | 0.95 | 1.04 | 1.14 | 1.21 | 0.92 | 1.00 |
| *Balanced budget, tax* | 0.92 | 1.01 | 0.92 | 1.00 | 0.92 | 1.00 | 0.92 | 1.00 |

The expansion in government spending generates an increase in output and, thereby, in labor demand; at the same time, it triggers an immediate or delayed fiscal adjustment in the form of higher taxes or lower transfers. The rise in output generates inflation, to which the central bank responds raising the nominal interest rate; as a result, households face a higher real rate on bonds and equity, as well as a negative equity revaluation at impact. The response of aggregate variables for the different cases is plotted in Appendix 5.B.3. Figures 5.5 and 5.6 report consumption responses under active monetary policy.

I start the analysis by comparing the effects on consumption and output of a deficit-financed fiscal expansion with those of a balanced-budget expansion, both in an active and in a passive monetary policy regime. For the former I assume the fiscal rule in the baseline model (Section 2.5), which assumes that the entire increase in government spending is financed with debt. For the balanced-budget case I assume that the tax rate on labor income is adjusted to keep government debt constant at its steady-state level.

In the RANK model, the shock only affects consumption when monetary policy is active through the higher real rate on bonds and equity, which via intertemporal substitution reduces consumption (Figure 5.5 Panel D). The negative revaluation of equity at impact does not have any impact, the same as the labor demand increase or the fiscal adjustment. Hence the multiplier is smaller than one. When monetary policy is passive, the interest rate does not change, hence consumption remains at its steady-state value, and the multiplier is equal to one. Because the fiscal adjustment does not have any impact, the timing of it is irrelevant (Figures 5.5 and 5.6, Panels D): Ricardian Equivalence holds, and the deficit and balanced-budget multipliers coincide under both monetary regimes.




Panel A: MA-HANK.

Panel B: HANK.

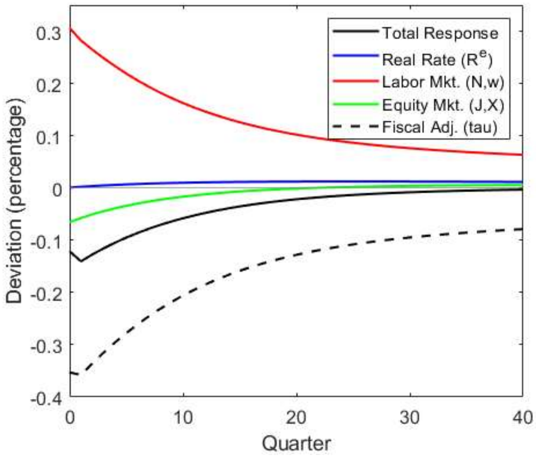
Panel C: TANK.

Panel D: RANK.

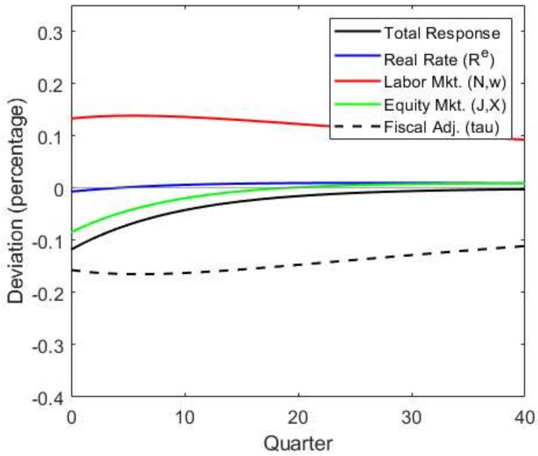
Figure 5.5. Decomposition of the IRF of consumption to a deficit-financed government spending shock under active monetary policy into the effects in all four models.

In TANK, the substitution effects of interest rates on bond and equity are reduced due to the lower share of savers – while the wealth effects are zero. The labor income and fiscal adjustment do affect aggregate consumption due to the presence of spenders (Figure 5.5 Panel C). Hence, the timing of the fiscal adjustment matters, and the deficit-financed multiplier is larger than the balanced-budget multiplier (Figure 5.6 Panel C), and Ricardian Equivalence fails in this environment. With passive monetary policy, the interest rate effects vanish and both multipliers are higher.

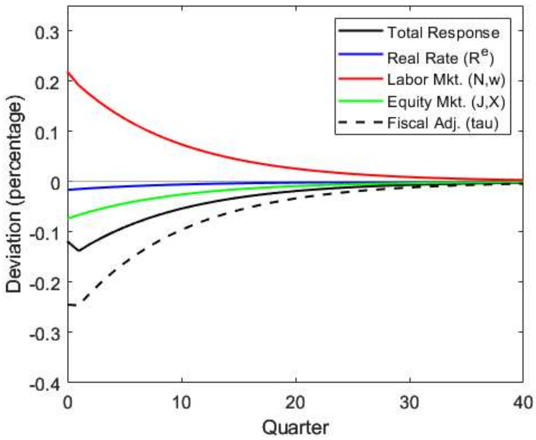
In the balanced-budget scheme, the consumption drops down slightly in the first period after the shock, before converging back to its steady state. In that period, consumption responds to the higher taxes needed to close the larger fiscal imbalance, due to a higher interest paid on debt and lower tax base, in turn due to a smaller amount of hours worked.



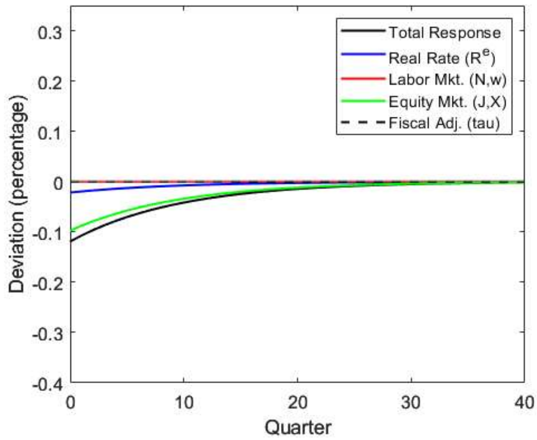

Panel A: MA-HANK.




Panel B: HANK.




Panel C: TANK.




Panel D: RANK.

Figure 5.6. Decomposition of the IRF of consumption to a balanced-budget government spending shock under active monetary policy in all four models.

The HANK environment displays a similar response under to interest rate channels as the RANK model, both channels being closer to zero because the negative substitution effects are now counteracted with positive wealth effects, including the first-period surprise wealth effect on equity (Figure 5.5 Panel B, Figure 5.6 Panel B. The labor income and fiscal adjustment channels are now larger and smoother.

The responses in HANK are quite similar with deficit-financing and with a balanced budget, the latter being weaker because the fiscal adjustment is more front-loaded. However, the positive MPC out of income, due to the presence of some liquidity constrained households, explains this violation of Ricardian Equivalence. This difference is similar in both monetary regimes.

The MA-HANK model shows, on one hand, less of a response to interest rate changes than HANK due to the presence of hand-to-mouth households with zero EIS and zero MPC out of wealth (Figure 5.5 Panel A, Figure 5.6 Panel A). On the other hand, the effects of the labor earnings and fiscal adjustment channels are larger due to the higher MPC out of income. The small blip in the first period after the shock arises due to the same reasons as in TANK.

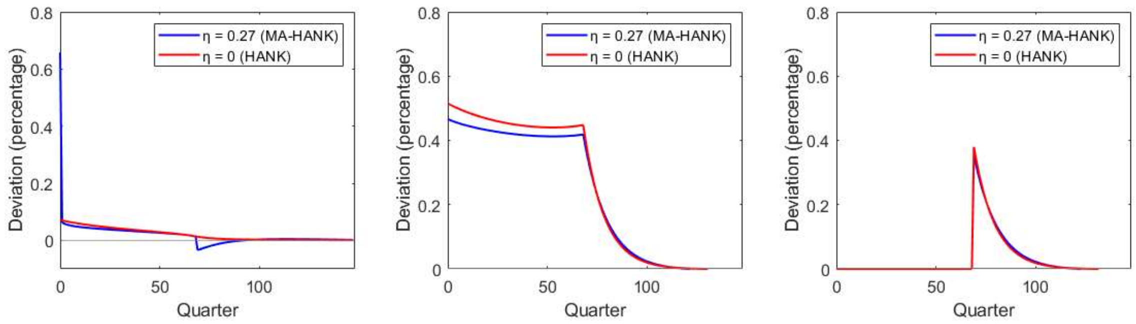
The Mental Accounting model generates the largest difference between the multiplier of the deficit-financed expansion and that of the balanced-budget expansion, showing that Ricardian Equivalence does not hold across monetary regimes. The intertemporal MPC indicates that households do not respond in anticipation to future income changes, hence consumption does not respond to the anticipated future tax hike in the deficit-finance case, but it does respond to the current tax hike in the balanced-budget case.

## 5.7 Can Deficits Finance Themselves? The Case of Fiscal Stimulus Transfers

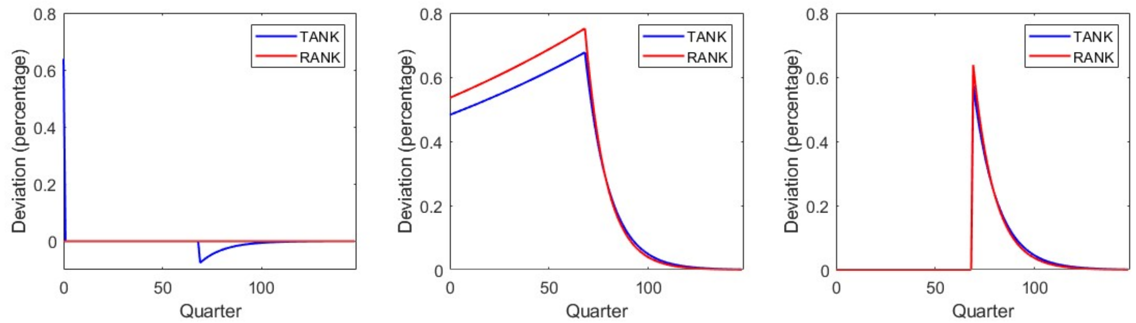
In this section I consider a deficit-financed ($500) transfer distributed uniformly to households. I evaluate whether transfer-induced boom in aggregate demand generates enough additional tax revenues to pay back the debt without any further fiscal adjustment.

For the exercise, I delay the fiscal adjustment (the activation of the baseline tax rule) for 70 quarters, in line with Angeletos, Lian, and Wolf (2023). This way, if the economy has not been able to repay the debt by then, the fiscal measures can reduce the debt to its steady state level and therefore keep it from exploding. Also, I make two assumptions in order to generate the most favorable conditions. First, the central bank that keeps the real interest rate at its neutral, steady-state level, such that monetary policy does not dampen the expansionary effects of the transfer. Second, government debt is defined in nominal terms: because I consider perfect-foresight paths, only the inflation surprise in the first period erodes the value of government debt. Figure 5.7 plots the resulting dynamics of the relevant aggregate variables in all four models.

In RANK, the receipt of the transfer has no effect on consumption, and therefore, no effect on output, on labor demand, and on tax revenues, neither contemporaneously nor in the periods after the shock. The only effect in the model is a fiscal imbalance that is registered in the first period by the rise in government debt. Because nothing else changes, the government debt rises monotonically until the fiscal adjustment kicks in many periods later. When the taxes start adjusting, there is no effect on consumption or output either, only on the government budget constraint.




Panel A: Consumption. Panel B: Government debt. Panel C: tau.




Panel D: Consumption. Panel E: Government debt. Panel F: tau.

Figure 5.7. IRFs of consumption, government debt, and tax rate to the deficit-financed transfer shock in all four models with nominal government debt: top row for MA-HANK and HANK; bottom row for TANK and RANK.

In TANK, the receipt of the transfer generates a contemporaneous effect on consumption proportional to its MPC out of income; however, it does not generate any lagged effects on consumption, consistent with the intertemporal MPC (Figure 5.1 Panel B). As a result, the only rise in output, labor demand, and tax revenues occurs in the first period; and the associated rise in government debt in the first period is smaller than in RANK. After the first period, the government debt rises monotonically on an upward path, until the taxes start adjusting after period 70.

The HANK model generates a small reaction to the transfer, because its MPC out of income is small; but it does generate lagged effects on consumption because of its intertemporal MPC properties. Hence, after the jump in government debt in the first period, the lagged effects on aggregate demand are large enough that the tax revenues keep rising and the government falls until period 50, approximately. However, after that the consumption lagged effects are smaller than the interest payments on government debt, which starts to rise from that point onwards. When period 70 arrives, the fiscal adjustment is necessary to bring debt back to its steady state level. However, the level of government debt in period 50 and even in period 70 is smaller than when the deficit-financed transfer is distributed.

The MA-HANK displays a large consumption response at the receipt of the transfer, which generates a smaller jump in government debt than in HANK. After the shock, there are small lagged effects on consumption that increase the tax revenues until period 50, approximately. After that, the tax revenues are outpaced by the interest payments on government debt, which starts to rise until the fiscal adjustment kicks in.

## 5.8 Conclusion

In this paper I study the implications of a Mental Accounting friction for the transmission of different monetary and fiscal policies. As a source of hand-to-mouth behavior, Mental Accounting reduces the importance of intertemporal substitution channels triggered by interest rate changes, and it increases the weight of income channels; effects that become especially evident after a government spending shock. Mental Accounting retains model parsimony, yet it delivers effects that are broadly consistent with the 2-asset model. Moreover, it improves the ability of the workhorse incomplete markets model to match the transmission to household consumption at the microeconomic level.

## Appendix 5.A. The Elasticity of Intertemporal Substitution with Mental Accounting in a Two-Period Model

Consider a simple environment where the consumer solves the following problem:

$$\max_{c_1, c_2} \qquad U(c_1|r_1) + U(c_2|r_2)$$

subject to

$$c_1 + \frac{c_2}{1+R} = e_1 + \frac{e_2}{1+R} = W_{LC}$$

where $c_i$ and $e_i$ denote $i$-period consumption and earnings, R is the net real interest rate, the utility function is of the form defined in the main text with r being the reference point, and $W_{LC}$ is 'life-cycle' wealth.

Figure 5.A.1 represents schematically the optimal choice of a hand-to-mouth consumer. Point E on the budget constraint (blue line) represents the endowment point. Because the hand-to-mouth consumer chooses optimally to consume her income ($c_1^* = e_1$), point E represents also the optimal choice (marked with a circle). Typically, point E would be denoted as the "tangency point" between the budget constraint and the indifference curve, where the marginal rate of substitution (MRS) is equal to the marginal rate of transformation (MRT). However, the marginal utility of consumption, $U_c(e|r)$, is not defined at the kink where consumption is equal to income; instead, only the generalized derivative exists, which includes a right-hand and a left-hand derivative. Hence, at point E there are two marginal rates of substitution, one for each side of the derivative of utility. Instead of the tangency condition, the optimal choice at the kink is better characterized by the following inequality:

$$MRS_{LH} < -(1+R) < MRS_{RH}$$

where

$$MRS_{LH} = -\frac{U_c(e_1 - \varepsilon|r_1)}{U_c(e_2 + \varepsilon|r_2)} = -\frac{(1-\eta)}{(1-\eta\lambda)}\frac{u_c(e_1-\varepsilon)}{u_c(e_2+\varepsilon)}$$

and

$$MRS_{RH} = -\frac{U_c(e_1 + \varepsilon|r_1)}{U_c(e_2 - \varepsilon|r_2)} = -\frac{(1-\eta\lambda)}{(1-\eta)}\frac{u_c(e_1+\varepsilon)}{u_c(e_2-\varepsilon)}$$

for $\varepsilon$ arbitrarily small. To verify the inequality, it suffices to consider the limit where $\varepsilon$ goes to zero and realize that $\frac{(1-\eta\lambda)}{(1-\eta)} < 1$.

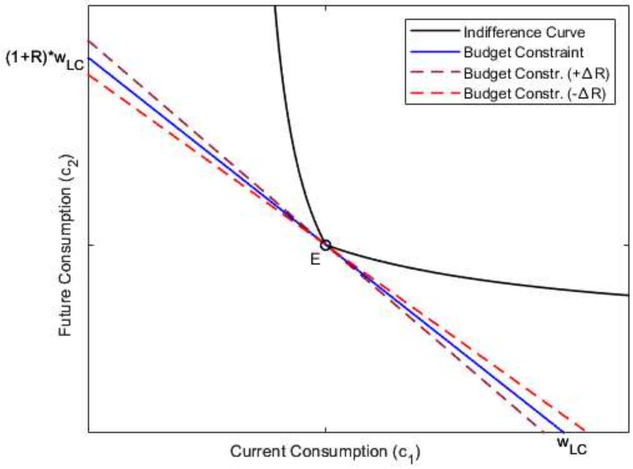



Figure 5.A.1. Two-period model: optimal choice and sensitivity to the real interest rate of a hand-to-mouth consumer.

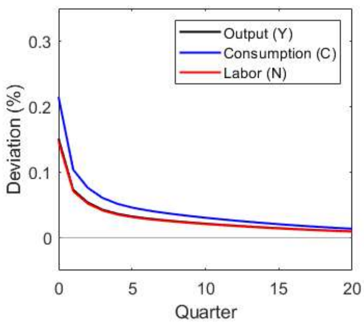
Intuitively, point E is the optimal choice when the slope of the budget constraint is between the two marginal rates of substitution. On one hand, the marginal utility of increasing $c_1$ above $e_1$ at the cost of reducing $c_2$ below $e_2$ is lower than the cost of the extra borrowing (1+R). On the other hand, the marginal disutility of decreasing $c_1$ below $e_1$ at the benefit of raising $c_2$ above $e_2$ is higher than the return on the extra saving (1+R). Graphically, the above inequality implies that point E is a kink in the indifference curve. This jump in the MRS manifests the wedge in the marginal utility introduced by the Mental Accounting friction.

For small changes in the real interest rate, the budget constraint rotates around the endowment point (Figure 5.A.1). However, as long as the MRT is between the two MRS, point E is still the optimal choice. Importantly, this lack of responsiveness to the real interest rate shocks is independent from liquidity constraints – or kinks in the budget set, more generally – and hence has the ability to affect household behavior regardless of their access to liquid wealth.

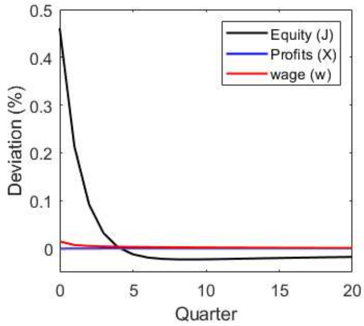
Finally, note that when the Mental Accounting friction vanishes, the two MRSs collapse into one and the household faces the same trade-offs as in the standard model.

## Appendix 5.B. Aggregate Impulse Response Functions

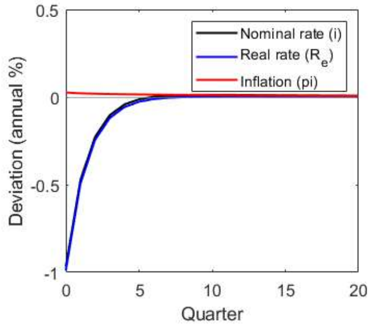
### Appendix 5.B.1 Monetary Policy



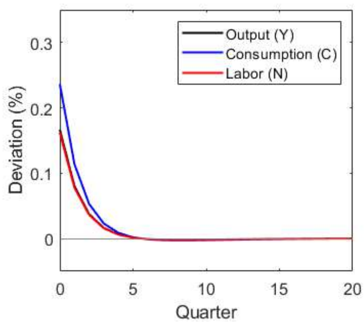

Panel A: Y, C, N.



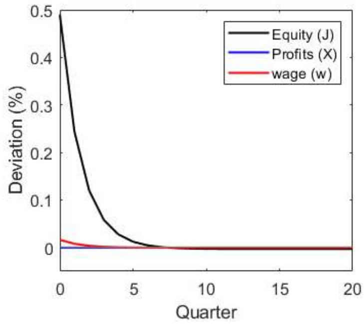

Panel B: J, X, wage.



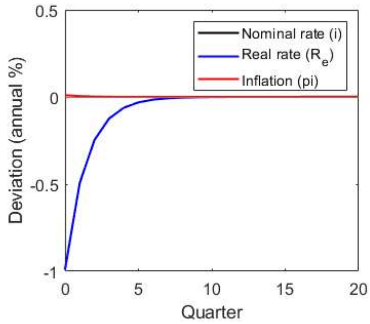

Panel C: i, $R^e$, pi.



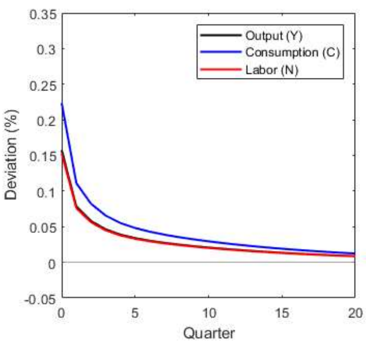

Panel D: Y, C, N.



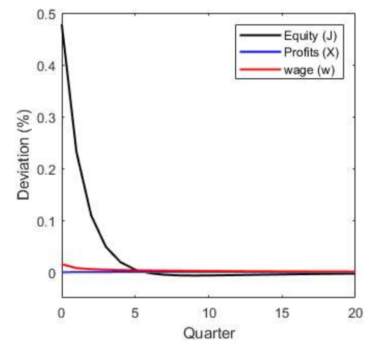

Panel E: J, X, wage.



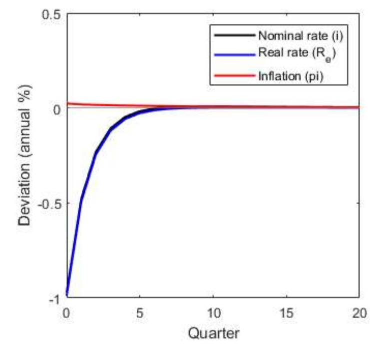

Panel F: i, $R^e$, pi.



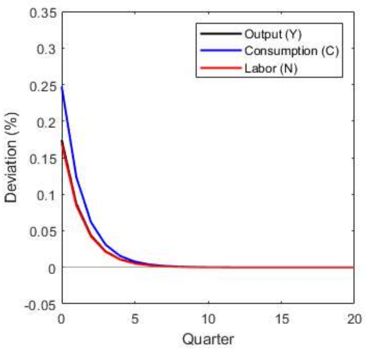

Panel G: Y, C, N.



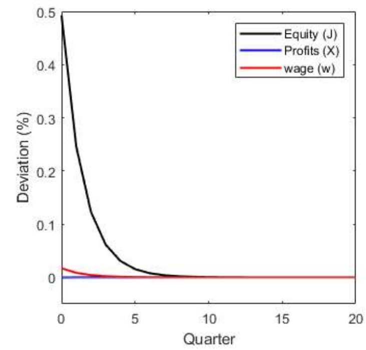

Panel H: J, X, wage.



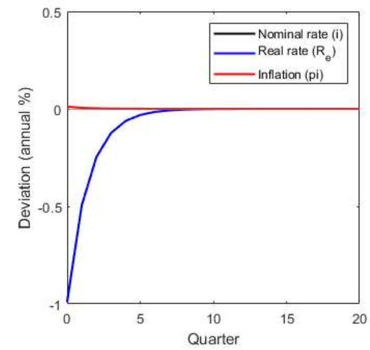

Panel I: i, $R^e$, pi.




Panel J: Y, C, N.



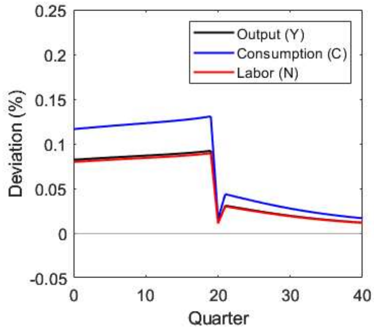

Panel K: J, X, wage.

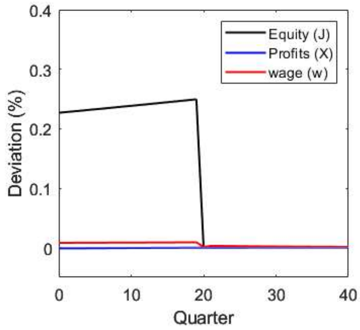


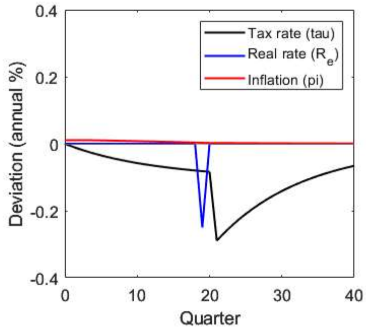

Panel L: i, $R^e$, pi.

Figure 5.B.1. Monetary IRFs in MA-HANK (Panels A-C), HANK (D-F), TANK (G-I), RANK (J-L).

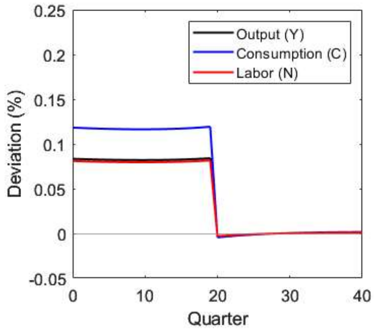
## Appendix 5.B.2 Forward Guidance

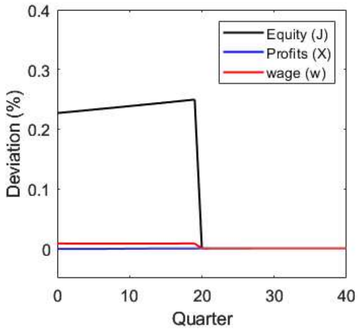


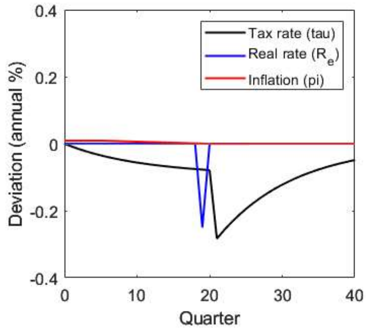



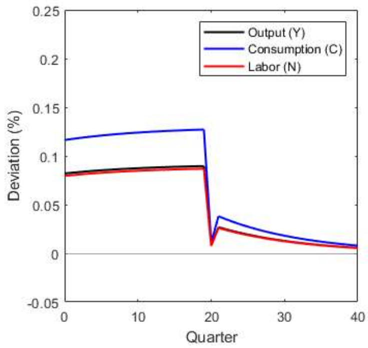

Panel A: Y, C, N. Panel B: J, X, wage. Panel C: tau, $R^e$, pi.

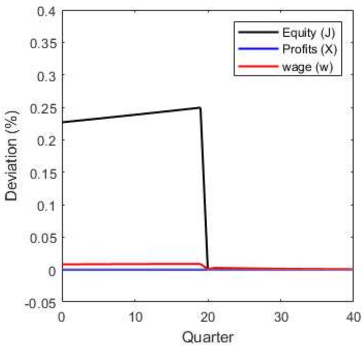


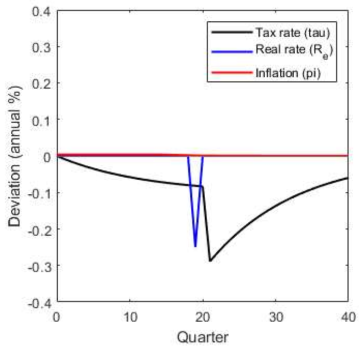



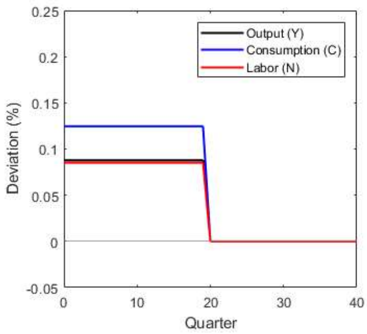

Panel D: Y, C, N. Panel E: J, X, wage. Panel F: tau, $R^e$, pi.

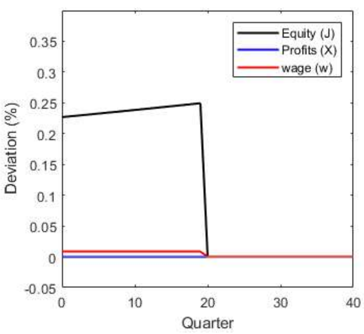


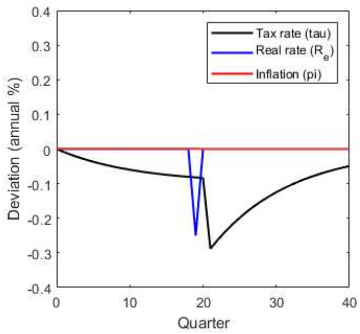




Panel G: Y, C, N. Panel H: J, X, wage. Panel I: tau, $R^e$, pi.



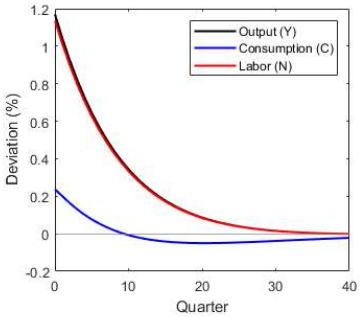




Panel J: Y, C, N. Panel K: J, X, wage. Panel L: tau, $R^e$, pi.

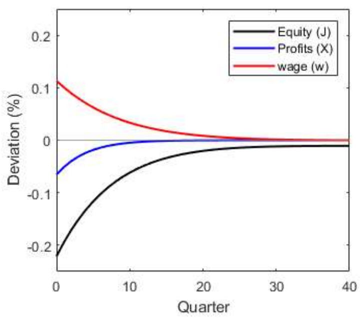
Figure 5.B.2. Forward Guidance IRFs in MA-HANK (Panels A-C), HANK (D-F), TANK (G-I), and RANK (J-L).

## Appendix 5.B.3 Government Spending

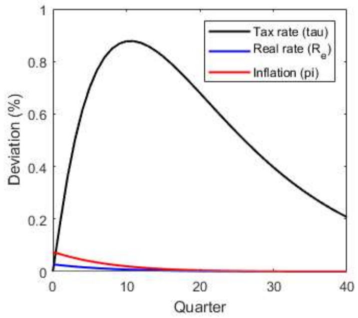
### Appendix 5.B.3.1 Deficit-Financed Expansion, Tax Rule, Active Monetary Policy



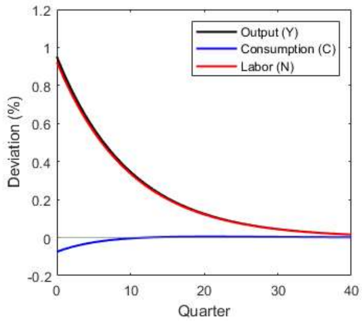

Panel A: Y, C, N.



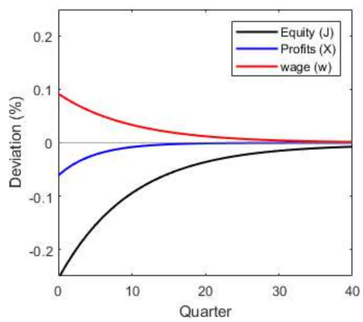

Panel B: J, X, wage.



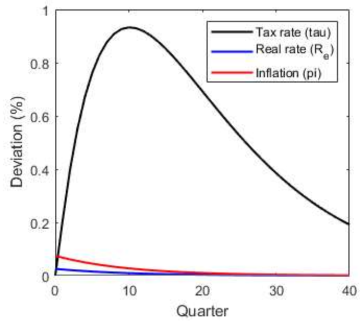

Panel C: tau, $R^e$, pi.



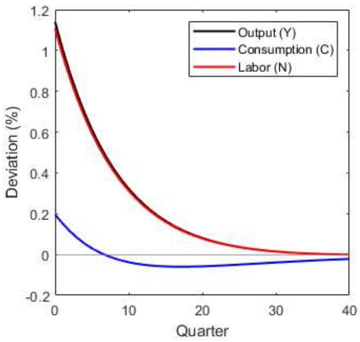

Panel D: Y, C, N.



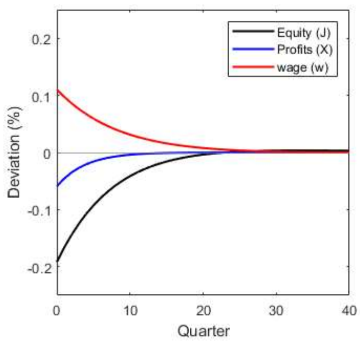

Panel E: J, X, wage.



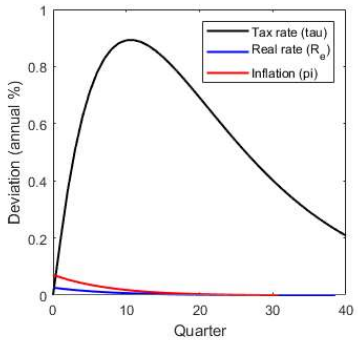

Panel F: tau, $R^e$, pi.



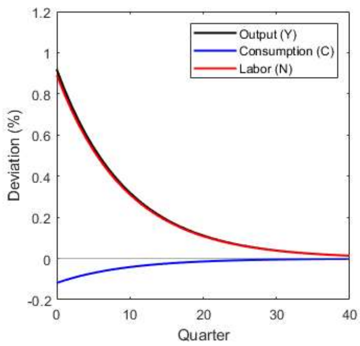

Panel G: Y, C, N.



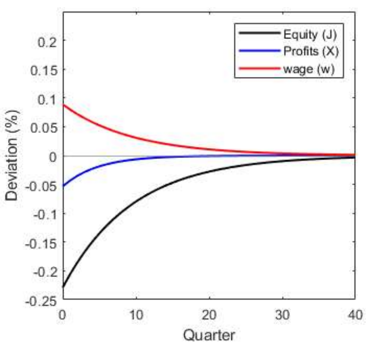

Panel H: J, X, wage.



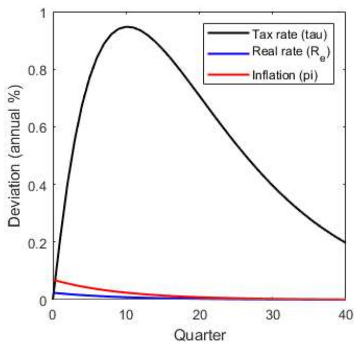

Panel I: tau, $R^e$, pi.




Panel J: Y, C, N.



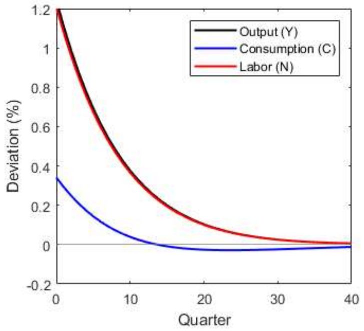

Panel K: J, X, wage.



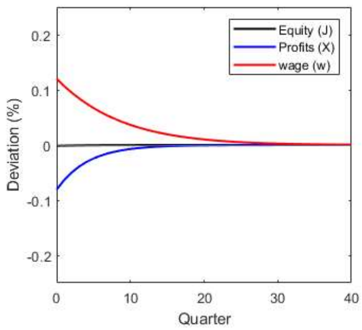

Panel L: tau, $R^e$, pi.

Figure 5.B.3.1. Fiscal IRFs in MA-HANK (Panels A-C), HANK (D-F), TANK (G-I), and RANK (J-L).

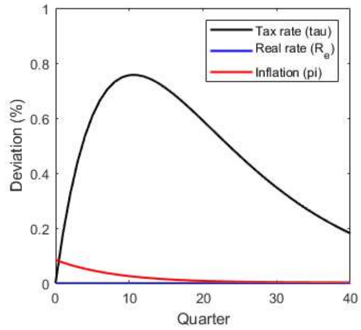
## Appendix 5.B.3.2 Deficit-Financed Expansion, Tax Rule, Passive Monetary Policy



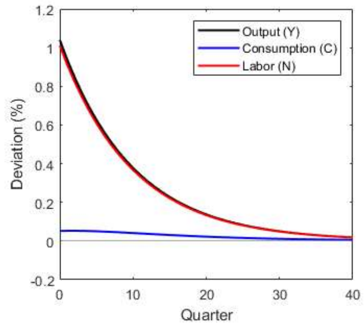

Panel A: Y, C, N.



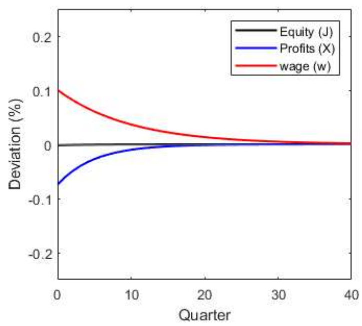

Panel B: J, X, wage.



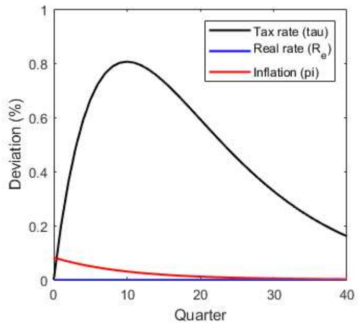

Panel C: tau, $R^e$, pi.



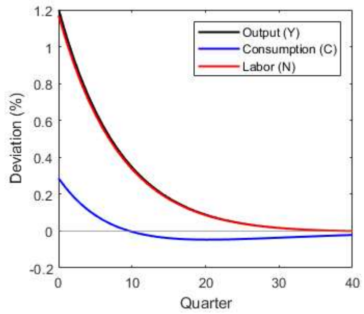

Panel D: Y, C, N.



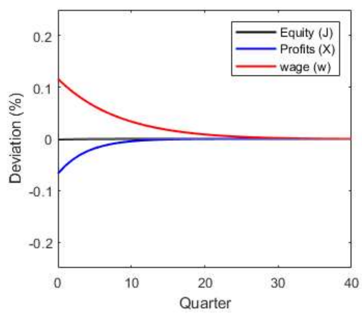

Panel E: J, X, wage.



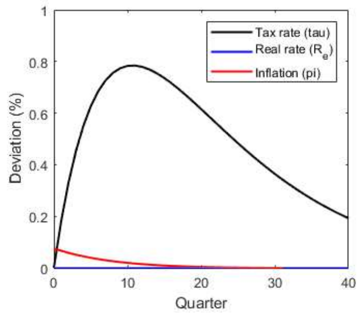

Panel F: tau, $R^e$, pi.



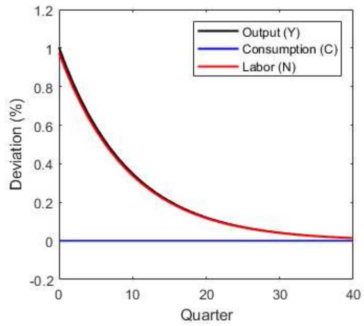

Panel G: Y, C, N.



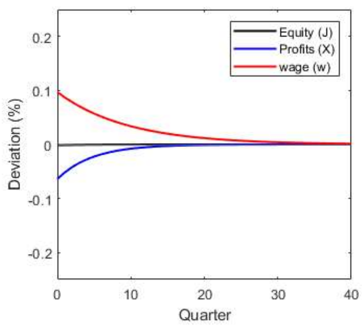

Panel H: J, X, wage.



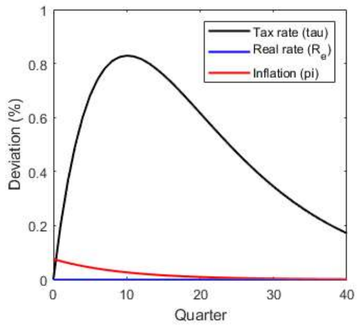

Panel I: tau, $R^e$, pi.




Panel J: Y, C, N.



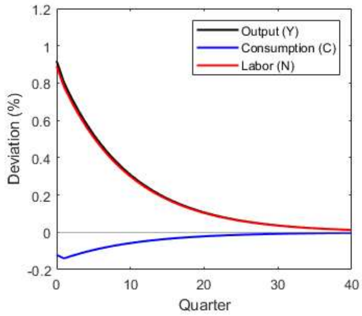

Panel K: J, X, wage.



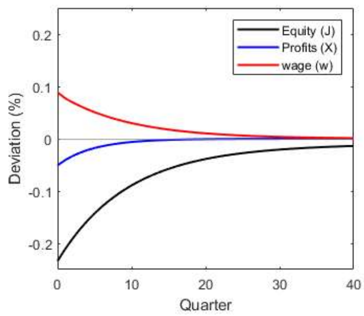

Panel L: tau, $R^e$, pi.

Figure 5.B.3.2. Fiscal IRFs in MA-HANK (Panels A-C), HANK (D-F), TANK (G-I), and RANK (J-L).

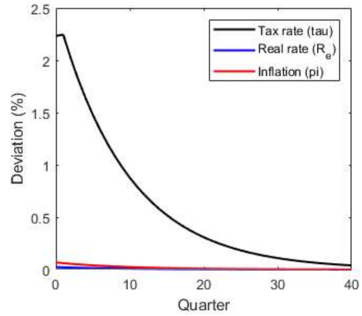
## Appendix 5.B.3.3 Balanced-Budget Expansion, Active Monetary Policy



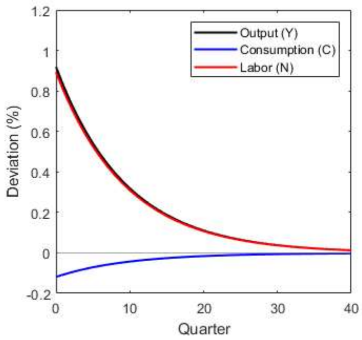

Panel A: Y, C, N.



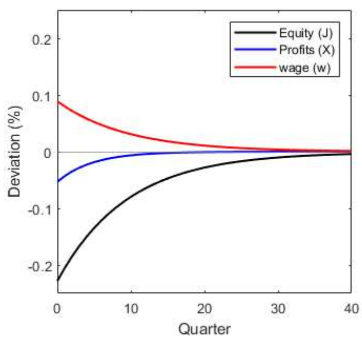

Panel B: J, X, wage.



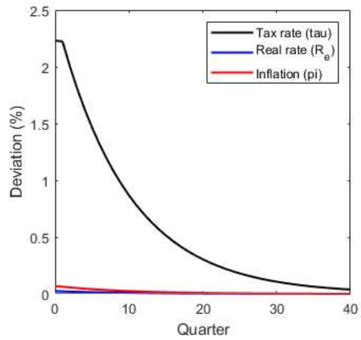

Panel C: tau, $R^e$, pi.



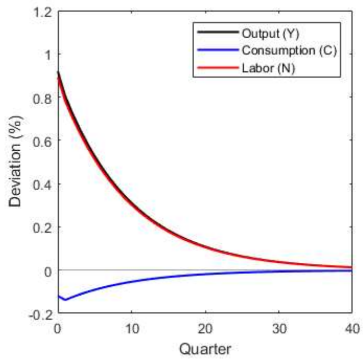

Panel D: Y, C, N.



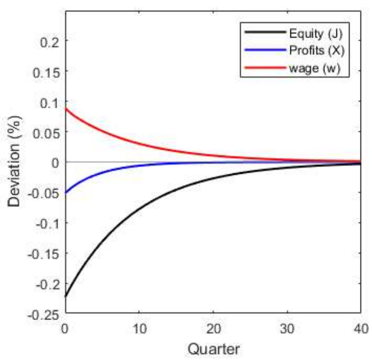

Panel E: J, X, wage.



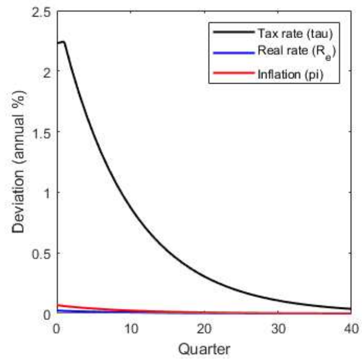

Panel F: tau, $R^e$, pi.



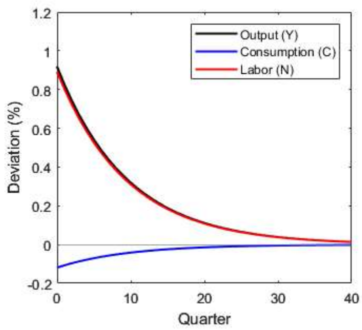

Panel G: Y, C, N.



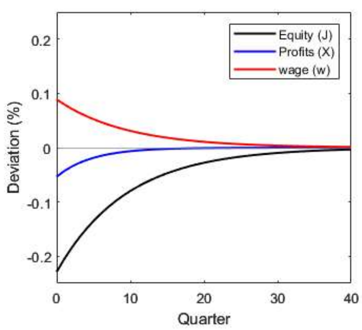

Panel H: J, X, wage.



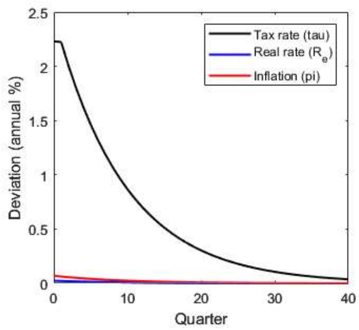

Panel I: tau, $R^e$, pi.




Panel J: Y, C, N.



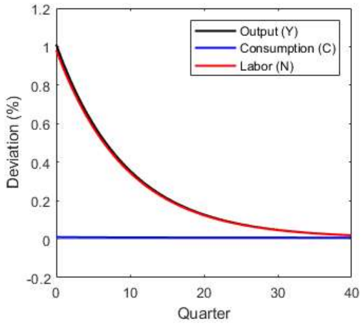

Panel K: J, X, wage.



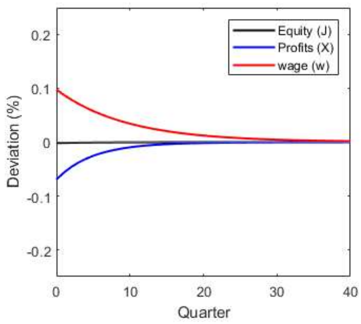

Panel L: tau, $R^e$, pi.

Figure 5.B.3.3. Fiscal IRFs in MA-HANK (Panels A-C), HANK (D-F), TANK (G-I), and RANK (J-L).

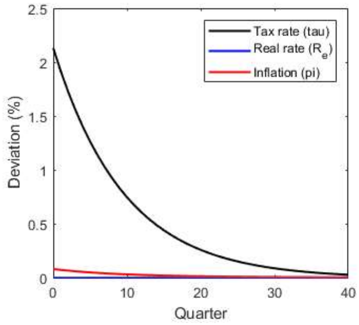
## Appendix 5.B.3.4 Balanced-Budget Expansion, Passive Monetary Policy



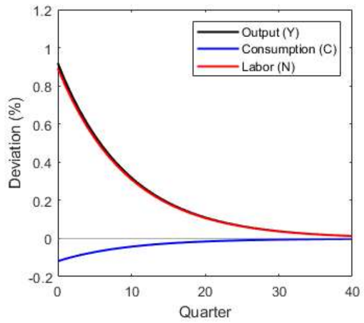

Panel A: Y, C, N.



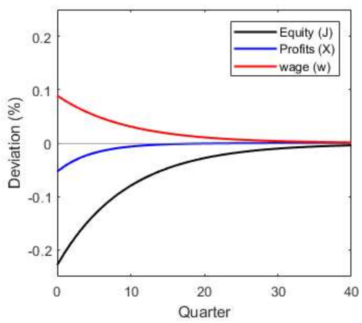

Panel B: J, X, wage.



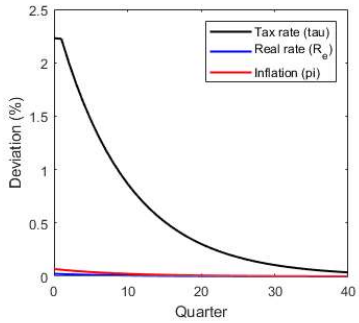

Panel C: tau, $R^e$, pi.



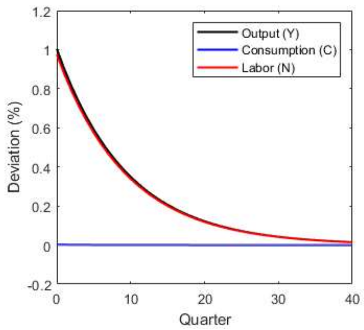

Panel D: Y, C, N.



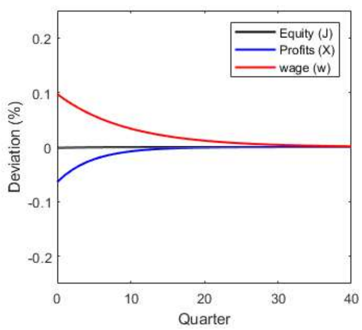

Panel E: J, X, wage.



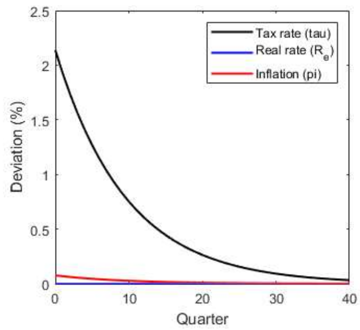

Panel F: tau, $R^e$, pi.



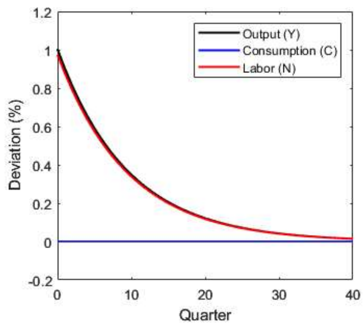

Panel G: Y, C, N.



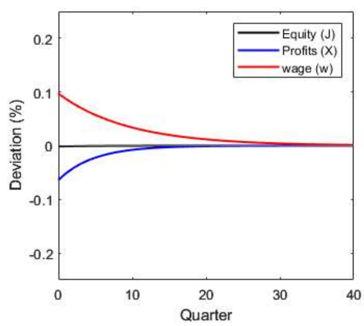

Panel H: J, X, wage.



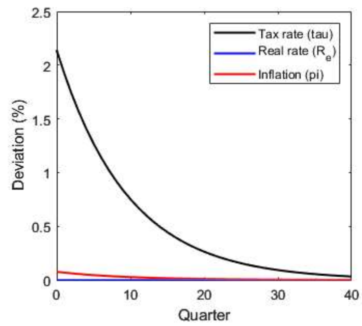

Panel I: tau, $R^e$, pi.




Panel J: Y, C, N.




Panel K: J, X, wage.




Panel L: tau, $R^e$, pi.

Figure 5.B.3.4. Fiscal IRFs in MA-HANK (Panels A-C), HANK (D-F), TANK (G-I), and RANK (J-L).

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