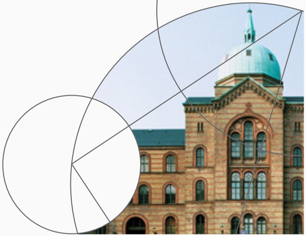
CENTER FOR
ECONOMIC
BEHAVIOR &
INEQUALITY

2. Consumption-Saving Models

Adv. Macro: Heterogenous Agent Models

Jeppe Druedahl & Patrick Moran

2022



Danmarks
Grundforskningsfond
Danish National
Research Foundation

Introduction

Disclaimer

- Note: The views expressed in this presentation are those of the author and do not represent the views of the Federal Reserve Board or Federal Reserve System.

Consumption-Saving Models

- **Goal for today:** Better understand household spending through the lens of traditional consumption-saving models

Consumption-Saving Models

- **Goal for today:** Better understand household spending through the lens of traditional consumption-saving models

- **Central economic questions:**
  1. How do households consume out of transitory income shocks?
  2. How to design models that match the empirical evidence on the Marginal Propensity to Consume (MPC)?
  3. What is the effect of income risk on consumption dynamics?

Consumption-Saving Models

- **Goal for today:** Better understand household spending through the lens of traditional consumption-saving models

- **Central economic questions:**
  1. How do households consume out of transitory income shocks?
  2. How to design models that match the empirical evidence on the Marginal Propensity to Consume (MPC)?
  3. What is the effect of income risk on consumption dynamics?

- **Plan for today:**
  1. Discuss the MPC, why it matters, and how it looks in the data
  2. Consider a variety of models that attempt to match the data
  3. Study the link between income risk and consumption behavior

MPC

The Marginal Propensity to Consume (MPC)

- **Definition:** How much a household spends out of a small, one-time, unanticipated income shock

$$MPC = \frac{\Delta C}{\Delta Y}$$

The Marginal Propensity to Consume (MPC)

- **Definition:** How much a household spends out of a small, one-time, unanticipated income shock

$$MPC = \frac{\Delta C}{\Delta Y}$$

- **Notes:**
  1. It is the MPC out of a transitory income shock (Friedman, 1957)
  2. It is the contemporaneous MPC (usually one quarter)
  3. It is measured based on spending on nondurables and services

The Marginal Propensity to Consume (MPC)

- **Definition:** How much a household spends out of a small, one-time, unanticipated income shock

$$MPC = \frac{\Delta C}{\Delta Y}$$

- **Notes:**
  1. It is the MPC out of a transitory income shock (Friedman, 1957)
  2. It is the contemporaneous MPC (usually one quarter)
  3. It is measured based on spending on nondurables and services
- For a comprehensive overview, see Kaplan and Violante (2021)

Why do we care about the MPC?

- Central concept in modern heterogeneous-agent macroeconomics

Why do we care about the MPC?

- Central concept in modern heterogeneous-agent macroeconomics
- Affects spending response to fiscal stimulus and monetary policy

Why do we care about the MPC?

- Central concept in modern heterogeneous-agent macroeconomics
- Affects spending response to fiscal stimulus and monetary policy
- Tension between data and models

Why do we care about the MPC?

- Central concept in modern heterogeneous-agent macroeconomics

- Affects spending response to fiscal stimulus and monetary policy

- Tension between data and models

- Disagreement among economists

Why do we care about the MPC?

- Central concept in modern heterogeneous-agent macroeconomics
- Affects spending response to fiscal stimulus and monetary policy
- Tension between data and models
- Disagreement among economists
- We need macro models that can reproduce the data on MPC

MPC in the Data: Methods

- Three strands of empirical evidence on the size of the MPC:

    1. Quasi-experimental evidence
       Johnson-Parker-Souleles (2006): Economic Impact Payments
       Shapiro et al. (2017): government shutdown
       Fagereng et al. (2020), Golosov et al. (2021): lottery wins

MPC in the Data: Methods

- Three strands of empirical evidence on the size of the MPC:

    1. Quasi-experimental evidence
       Johnson-Parker-Souleles (2006): Economic Impact Payments
       Shapiro et al. (2017): government shutdown
       Fagereng et al. (2020), Golosov et al. (2021): lottery wins

    2. Self-reported MPC from survey questions
       Bunn et al. (2018), Christelis et al. (2018), Fuster et al. (2020)

MPC in the Data: Methods

- Three strands of empirical evidence on the size of the MPC:

  1. Quasi-experimental evidence
     Johnson-Parker-Souleles (2006): Economic Impact Payments
     Shapiro et al. (2017): government shutdown
     Fagereng et al. (2020), Golosov et al. (2021): lottery wins

  2. Self-reported MPC from survey questions
     Bunn et al. (2018), Christelis et al. (2018), Fuster et al. (2020)

  3. Structural estimates
     Blundell-Pistaferri-Preston (2008), Commault (2019)

MPC in the Data: Findings

- The quarterly aggregate MPC is between 15% and 25%
    - Size dependence: MPC larger for small income shocks
    - Sign asymmetry: MPC much larger for negative income shocks

MPC in the Data: Findings

- The quarterly aggregate MPC is between 15% and 25%
    - Size dependence: MPC larger for small income shocks
    - Sign asymmetry: MPC much larger for negative income shocks
- There is large heterogeneity in MPCs across households
    - Liquid wealth: MPC larger for low wealth households
    - Fixed individual characteristics: MPC larger for young, low-income households

Taking Stock

- In the data, the MPC is large and heterogeneous

Taking Stock

- In the data, the MPC is large and heterogeneous

- These observations have important implications for modern macro

Taking Stock

- In the data, the MPC is large and heterogeneous

- These observations have important implications for modern macro

- Question: how can common macro models generate a large MPC?

MPCs in Macro Models

Representative Agent (RA) Model

- No idiosyncratic risk, no borrowing constraint
- Household problem:

$$\max_{\{c_t, b_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\gamma}}{1-\gamma}$$

$$\text{s.t.}$$

$$c_t + b_{t+1} = Rb_t + y_t$$

- Consumption function:

$$c(b) = \mathfrak{m}^{CE}\left[Rb + \sum_{t=0}^{\infty}\left(\frac{1}{R}\right)^t y_t\right], \ \textit{where } \mathfrak{m}^{CE} = 1 - R^{-1}(R\beta)^{\frac{1}{\gamma}}$$

Representative Agent (RA) Model

- No idiosyncratic risk, no borrowing constraint
- Household problem:

$$\max_{\{c_t, b_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\gamma}}{1-\gamma}$$

s.t.

$$c_t + b_{t+1} = Rb_t + y_t$$

- Consumption function:

$$c(b) = \mathfrak{m}^{CE} \left[Rb + \sum_{t=0}^{\infty} \left(\frac{1}{R} \right)^t y_t \right], \text{ where } \mathfrak{m}^{CE} = 1 - R^{-1} (R\beta)^{\frac{1}{\gamma}}$$

- The consumption function is linear in asset holdings (b) $\rightarrow$ wealth distribution irrelevant for MPC

Representative Agent (RA) Model

- Parameterization:
  1. Log utility ($\gamma = 1$): then we can simplify to: $\mathfrak{m}^{CE} = 1 - \beta$
  2. Plausible (quarterly) calibrations: $\mathfrak{m}^{CE} = 0.5\%$
- Representative Agent model features a tiny MPC

$$c\left(b\right) = 0.005 * \left[Rb + \sum_{t=0}^{\infty}\left(\frac{1}{R}\right)^{t} y_t\right]$$

Main Takeaways for the MPC

Can macro models generate a high MPC, and if so, how?

1. RA model: No

One-Asset Heterogeneous Agent (HA) Model

- Add idiosyncratic income risk, realistic borrowing constraint
- Household problem:

$$\max_{\{c_t, b_{t+1}\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\gamma}}{1-\gamma}$$

$$\text{s.t.}$$

$$c_t + b_{t+1} = Rb_t + y_t$$

$$b_t \geq \underline{b}$$

One-Asset Heterogeneous Agent (HA) Model

- Add idiosyncratic income risk, realistic borrowing constraint

- Household problem:

$$\max_{\{c_t, b_{t+1}\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\gamma}}{1-\gamma}$$

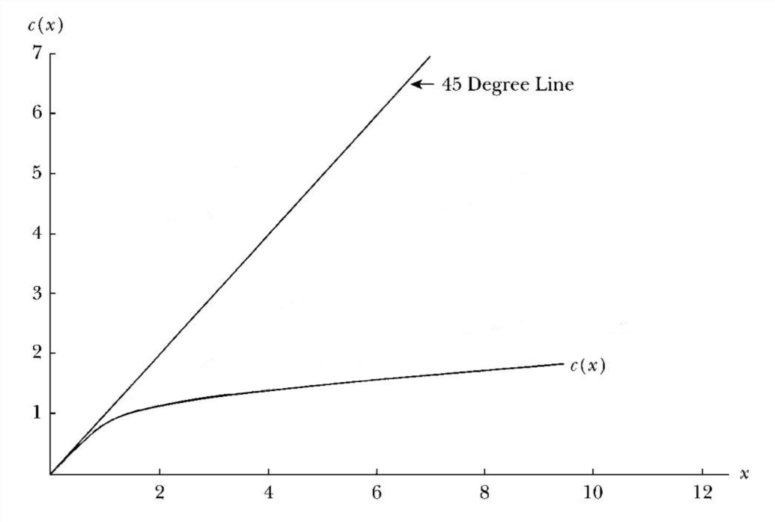
s.t.

$$c_t + b_{t+1} = Rb_t + y_t$$

$$b_t \geq \underline{b}$$

- Main takeaways:
  1. Consumption function $c(b)$ is concave due to precautionary motive
  2. There is an optimal buffer stock of assets that HHs want to achieve

Consumption function is concave



$x = {}^{b}/_{y}$ is the share of assets to permanent income (Carroll 2001)

Households try to achieve an optimal buffer stock

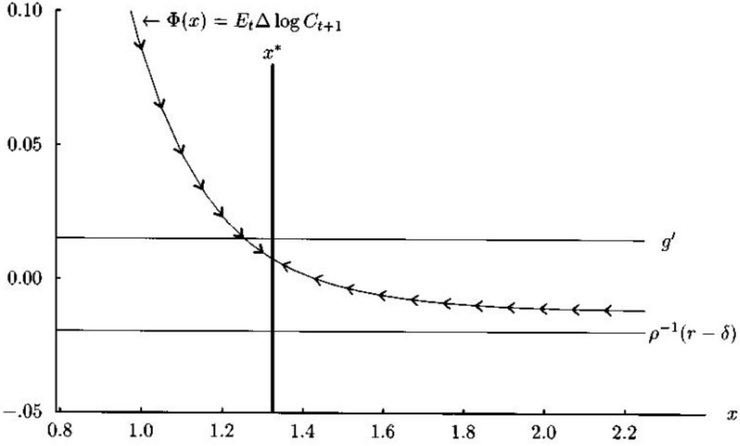


FIGURE Ia
Expected Consumption Growth as a Function of Cash on Hand

Households try to achieve an optimal buffer stock

Takeaways:

1. As $x \to \infty$, the expected growth rate of consumption (and the MPC) converge to their values in the RA model

Households try to achieve an optimal buffer stock

Takeaways:

1. As $x \to \infty$, the expected growth rate of consumption (and the MPC) converge to their values in the RA model
2. As $x \to 0$, the expected growth rate of consumption approaches infinity, and the MPC approaches one

Households try to achieve an optimal buffer stock

Takeaways:

1. As $x \to \infty$, the expected growth rate of consumption (and the MPC) converge to their values in the RA model
2. As $x \to 0$, the expected growth rate of consumption approaches infinity, and the MPC approaches one
3. If the consumer is impatient, there exists a unique target assets-to-permanent-income ratio (x^*)

From the inidividual to the aggregate MPC

- Individual MPC for a household with state (b, y):

$$m(b, y) = \frac{c(b + x, y) - c(b, y)}{x} \simeq \frac{\partial c(b, y)}{\partial b}$$

From the inidividual to the aggregate MPC

- Individual MPC for a household with state (b, y):

$$m(b, y) = \frac{c(b + x, y) - c(b, y)}{x} \simeq \frac{\partial c(b, y)}{\partial b}$$

- Aggregate MPC:

$$\overline{\mathrm{m}} = \int_{B \times Y} \mathfrak{m}(b, y) d\mu(b, y)$$

From the inidividual to the aggregate MPC

- Individual MPC for a household with state (b, y):

$$m(b, y) = \frac{c(b + x, y) - c(b, y)}{x} \simeq \frac{\partial c(b, y)}{\partial b}$$

- Aggregate MPC:

$$\overline{\mathrm{m}} = \int_{B \times Y} \mathfrak{m}(b, y) d\mu(b, y)$$

- Two key determinants:
  1. Consumption function $c(b, y) \Longrightarrow$ MPC function $m(b, y)$
  2. Wealth distribution $\mu(b, y)$

What determines the size of the aggregate MPC?

- Shape of the consumption function
  - Uninsurable income risk $\rightarrow$ precautionary saving motive
    - Prudence ($u''' > 0$)
    - Occasionally binding borrowing constraint
  - Strength of precautionary saving is decreasing in wealth
  - Consumption function is concave $\rightarrow$ MPC is decreasing in wealth
  - As wealth grows, the MPC $\rightarrow$ MPC in the RA model

What determines the size of the aggregate MPC?

- Shape of the consumption function
  - Uninsurable income risk $\rightarrow$ precautionary saving motive
    - Prudence ($u''' > 0$)
    - Occasionally binding borrowing constraint
  - Strength of precautionary saving is decreasing in wealth
  - Consumption function is concave $\rightarrow$ MPC is decreasing in wealth
  - As wealth grows, the MPC $\rightarrow$ MPC in the RA model
- Shape of the wealth distribution
  - Bigger mass at bottom, where c function is concave $\rightarrow$ large MPC
  - Hand-to-mouth (H2M) households with zero wealth and MPC$=1$

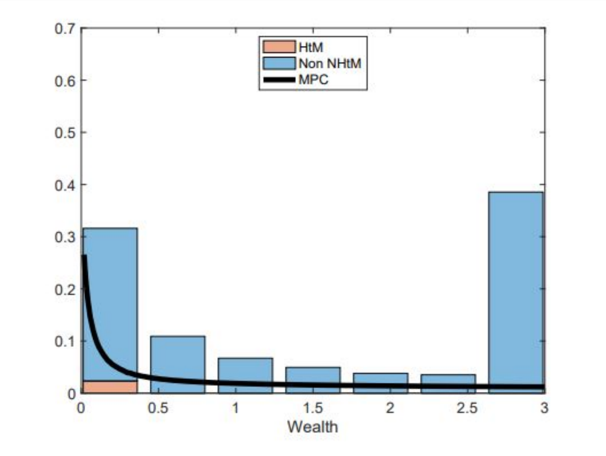
What is a reasonable calibration of such a model?

- **Calibration Strategy:**
    1. As before, we set $\gamma = 1$, so that we have log utility
    2. Set the interest rate r to be 1% per year
    3. Choose β so that the model matches some target of mean wealth

What is a reasonable calibration of such a model?

- **Calibration Strategy:**
  1. As before, we set $\gamma = 1$, so that we have log utility
  2. Set the interest rate r to be 1% per year
  3. Choose β so that the model matches some target of mean wealth
- **Calibration 1:**
  1. Target US data: wealth to income ratio of 4.1
  2. This gives an MPC of 4.6%

What is a reasonable calibration of such a model?

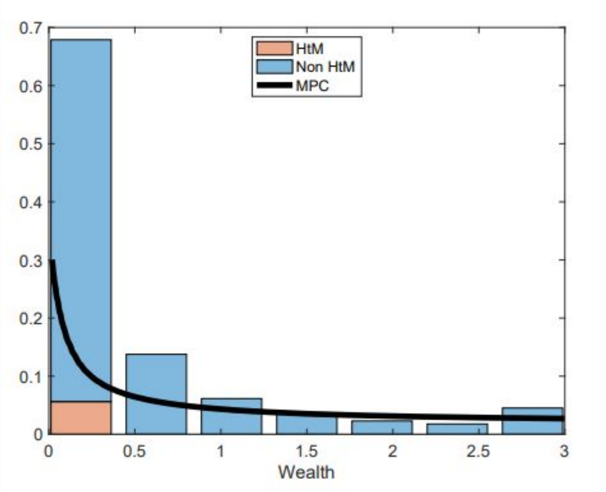


- Households want to escape the borrowing limit
- Very few high MPC households

What is a reasonable calibration of such a model?

- **Calibration Strategy:**
  1. As before, we set $\gamma = 1$, so that we have log utility
  2. Set the interest rate r to be 1% per year
  3. Choose β so that the model matches some target of mean wealth
- **Calibration 1:**
  1. Target US data: wealth-to-income ratio of 4.1
  2. This gives an MPC of 4.6%
- **Calibration 2:**
  1. Target a counterfactual wealth-to-income ratio of 0.5
  2. This gives an MPC of 14%

What is a reasonable calibration of such a model?



- Now we have a lot more high MPC households
- But we miss the vast majority of wealth in the economy

Main Takeaways for the MPC

- Can macro models generate a high MPC, and if so, how?
  1. RA model: No
  2. One-asset HA model: only by neglecting the majority of wealth

Main Takeaways for the MPC

- Can macro models generate a high MPC, and if so, how?
  1. RA model: No
  2. One-asset HA model: only by neglecting the majority of wealth

- Where do we go from here?

Main Takeaways for the MPC

- Can macro models generate a high MPC, and if so, how?
    1. RA model: No
    2. One-asset HA model: only by neglecting the majority of wealth

- Where do we go from here?

- Wanted: a version of the HA model that:
    1. Generates a large aggregate MPC
    2. Matches wealth holdings as in the data

Main Takeaways for the MPC

- Can macro models generate a high MPC, and if so, how?
  1. RA model: No
  2. One-asset HA model: only by neglecting the majority of wealth

- Where do we go from here?

- Wanted: a version of the HA model that:
  1. Generates a large aggregate MPC
  2. Matches wealth holdings as in the data

- Observation:
  1. Not all household wealth is <u>immediately</u> available for consumption smoothing
  2. Important difference between liquid and illiquid wealth
  3. In line with evidence that MPC declines in liquid wealth

Two-Asset HA Model

- Continuum of households

Two-Asset HA Model

- Continuum of households
- Face uninsurable idiosyncratic income shocks

Two-Asset HA Model

- Continuum of households
- Face uninsurable idiosyncratic income shocks
- Choose consumption, saving and portfolio allocation

Two-Asset HA Model

- Continuum of households
- Face uninsurable idiosyncratic income shocks
- Choose consumption, saving and portfolio allocation
- Two assets: liquid (m) and illiquid (a) with $r^a > r^m$
  - Liquid: cash + deposits + directly held stock - unsecured debt
  - Illiquid: housing equity + retirement account (85% of net worth)

Two-Asset HA Model

- Continuum of households
- Face uninsurable idiosyncratic income shocks
- Choose consumption, saving and portfolio allocation
- Two assets: liquid (m) and illiquid (a) with $r^a > r^m$
  - Liquid: cash + deposits + directly held stock - unsecured debt
  - Illiquid: housing equity + retirement account (85% of net worth)
- Fixed transaction cost κ to move funds into / out of illiquid account

Two-Asset HA Model

- Value function is the max of the value if you do not (N) or do adjust (A) illiquid assets

$$V_j\left(a_j, m_j, z_j\right) = max\left\{V_j^N\left(a_j, m_j, z_j\right),\ V_j^A\left(a_j, m_j, z_j\right)\right\}$$

Two-Asset HA Model

- Value function is the max of the value if you do not (N) or do adjust (A) illiquid assets

$$V_j\left(a_j, m_j, z_j\right) = max\left\{V_j^N\left(a_j, m_j, z_j\right),\ V_j^A\left(a_j, m_j, z_j\right)\right\}$$

- Value function if you do not adjust:

$$\begin{aligned}
V_j^N\left(a_j, m_j, z_j\right) = \max_{c_j, m_{j+1}} & \ u\left(c_j\right) + \beta\mathbb{E}_j\left[V_{j+1}\left(a_{j+1}, m_{j+1}, z_{j+1}\right)\right] \\
& \text{subject to} \\
& c_j + m_{j+1} \leq m_j\left(1 + r^m\right) + y_j\left(z_j\right) \\
& a_{j+1} = a_j(1 + r^a) \\
& m_{j+1} \geq \underline{m}
\end{aligned}$$

Two-Asset HA Model

- Value function is the max of the value if you do not (N) or do adjust (A) illiquid assets

$$V_j\left(a_j, m_j, z_j\right) = max\left\{V_j^N\left(a_j, m_j, z_j\right),\ V_j^A\left(a_j, m_j, z_j\right)\right\}$$

- Value function if you do not adjust:

$$\begin{aligned} V_j^N\left(a_j, m_j, z_j\right) = \max_{c_j, m_{j+1}} & \ u\left(c_j\right) + \beta \mathbb{E}_j\left[V_{j+1}\left(a_{j+1}, m_{j+1}, z_{j+1}\right)\right] \\ & \text{subject to} \\ & c_j + m_{j+1} \leq m_j\left(1 + r^m\right) + y_j\left(z_j\right) \\ & a_{j+1} = a_j(1 + r^a) \\ & m_{j+1} \geq \underline{m} \end{aligned}$$

- States: $\left(a_j, m_j, z_j\right) =$ illiquid assets, liquid assets, productivity

Two-Asset HA Model

- Value function is the max of the value if you do not (N) or do adjust (A) illiquid assets

$$V_j\left(a_j, m_j, z_j\right) = max\left\{V_j^N\left(a_j, m_j, z_j\right),\ V_j^A\left(a_j, m_j, z_j\right)\right\}$$

- Value function if you do not adjust:

$$V_j^N\left(a_j, m_j, z_j\right) = \max_{c_j, m_{j+1}} u\left(c_j\right) + \beta \mathbb{E}_j\left[V_{j+1}\left(a_{j+1}, m_{j+1}, z_{j+1}\right)\right]$$

$$\text{subject to}$$

$$c_j + m_{j+1} \leq m_j\left(1 + r^m\right) + y_j\left(z_j\right)$$

$$a_{j+1} = a_j(1 + r^a)$$

$$m_{j+1} \geq \underline{m}$$

- States: (a_j, m_j, z_j) = illiquid assets, liquid assets, productivity
- Choices: (c_j, m_{j+1}) = consumption, liquid asset tmrw

Two-Asset HA Model

- Value function if you adjust:

$$V_j^A(a_j, m_j, z_j) = \max_{c_j, a_{j+1}, m_{j+1}} u(c_j) + \beta \mathbb{E}_j \left[v_{j+1}(a_{j+1}, m_{j+1}, z_{j+1}) \right]$$

subject to

$$c_j + a_{j+1} + m_{j+1} \leq a_j(1 + r^a) + m_j(1 + r^m) - \kappa + y_j(z_j)$$

$$a_{j+1} \geq 0, m_{j+1} \geq \underline{m}$$

- Choices: (c_j, a_{j+1}, m_{j+1}) = consumption, illiquid asset tmrw, liquid asset tmrw

Result: Two different Euler equations

- Short-Run Euler Equation - governed by saving vs dissaving in the liquid asset

$$u'(c_j) = \beta(1 + r^m)u'(c_{j+1})$$

Result: Two different Euler equations

- Short-Run Euler Equation - governed by saving vs dissaving in the liquid asset

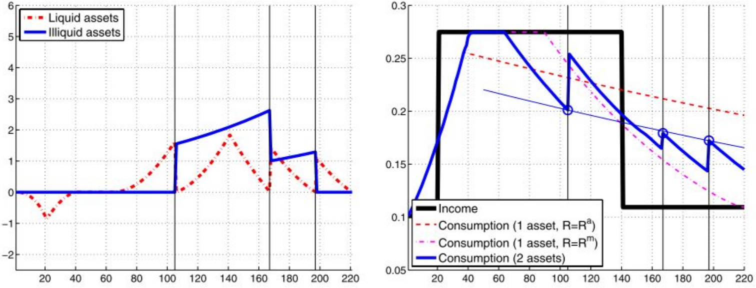
$$u'(c_j) = \beta(1 + r^m)u'(c_{j+1})$$

- Long-Run Euler Equation - governed by saving vs dissaving in the illiquid assets

$$u'(c_j) = \beta(1 + r^a)^N u'(c_{j+N})$$

  - where N is the number of periods between adjustment

Example 1

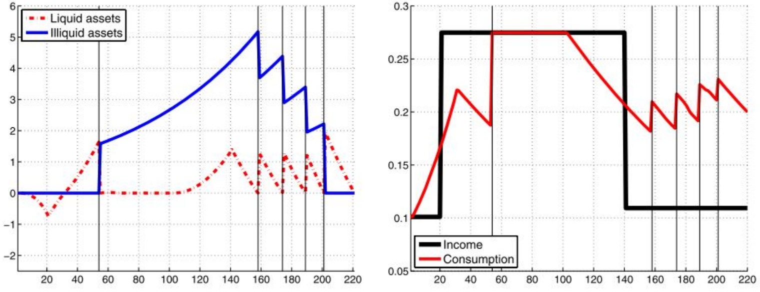


(a) Life-cycle asset accumulation (b) Life-cycle income and consumption path

FIGURE 1.—Example of life-cycle of a poor hand-to-mouth agent in the model.

- Agent exhibits poor hand-to-mouth behavior between periods 40-60, when she consumes all of her income and holds zero liquid assets

Example 2



(a) Life-cycle asset accumulation (b) Life-cycle income and consumption path

FIGURE 2.—Example of life-cycle of a wealthy hand-to-mouth agent in the model.

- Agent exhibits wealthy hand-to-mouth behavior between periods 55 to 100, when she owns illiquid wealth, but zero liquid wealth

Result: Emergence of Wealthy HtM Households

- Three types of households in the model:
  - Unconstrained (60%)
  - Poor HtM: zero net worth (14%)
  - Wealthy HtM: zero liquid wealth, but positive illiquid wealth (26%)

Result: Emergence of Wealthy HtM Households

- Three types of households in the model:
  - Unconstrained (60%)
  - Poor HtM: zero net worth (14%)
  - Wealthy HtM: zero liquid wealth, but positive illiquid wealth (26%)
- Why hold zero liquid and some illiquid wealth at the same time?

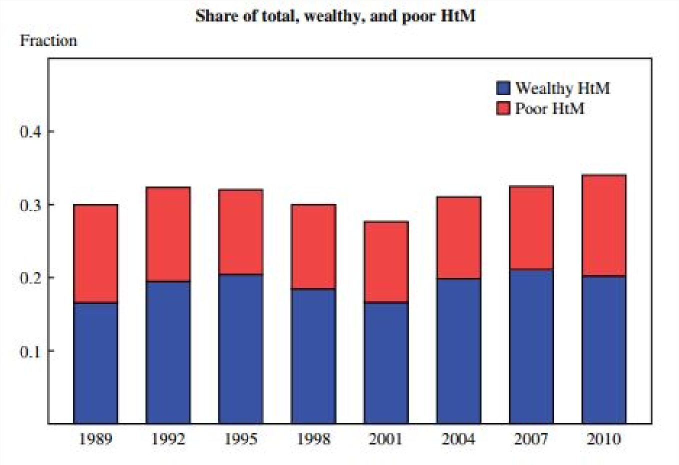
Result: Emergence of Wealthy HtM Households

- Three types of households in the model:
  - Unconstrained (60%)
  - Poor HtM: zero net worth (14%)
  - Wealthy HtM: zero liquid wealth, but positive illiquid wealth (26%)
- Why hold zero liquid and some illiquid wealth at the same time?
- Trade-off between higher return and illiquidity:
  - Long-run gain: higher level of consumption
  - Short-run cost: worse consumption smoothing

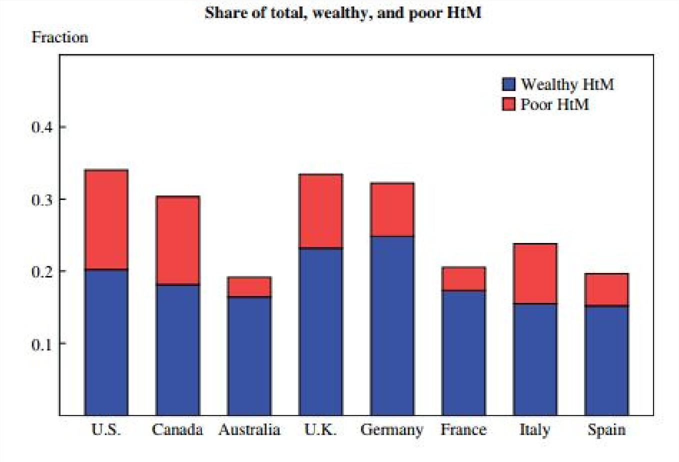
Result: Emergence of Wealthy HtM Households

- Three types of households in the model:
  - Unconstrained (60%)
  - Poor HtM: zero net worth (14%)
  - Wealthy HtM: zero liquid wealth, but positive illiquid wealth (26%)
- Why hold zero liquid and some illiquid wealth at the same time?
- Trade-off between higher return and illiquidity:
  - Long-run gain: higher level of consumption
  - Short-run cost: worse consumption smoothing
- If gains exceeds costs $\Longrightarrow$ Wealthy HtM

Wealthy HtM households in the data



Wealthy HtM households in the data



What is a reasonable calibration of such a model?

- **Calibration Strategy:**
  - As before, we set $\gamma = 1$, so that we have log utility
  - Set the interest rate r^{liq} on liquid assets to -2% per year (cash)

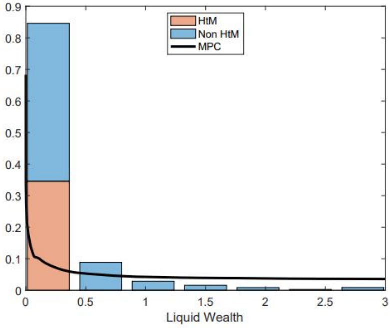
What is a reasonable calibration of such a model?

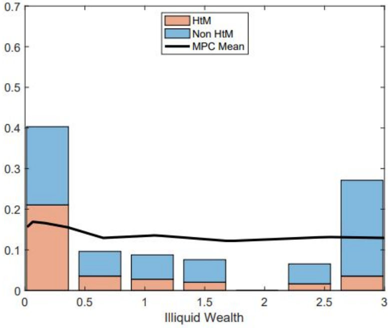
- **Calibration Strategy:**
  - As before, we set $\gamma = 1$, so that we have log utility
  - Set the interest rate r^{liq} on liquid assets to -2% per year (cash)
  - There remains three parameters:
    - Discount rate β
    - Return on illiquid assets r^{illiq}
    - Transaction cost κ

What is a reasonable calibration of such a model?

- **Calibration Strategy:**
  - As before, we set $\gamma = 1$, so that we have log utility
  - Set the interest rate r^{liq} on liquid assets to -2% per year (cash)
  - There remains three parameters:
    - Discount rate β
    - Return on illiquid assets r^{illiq}
    - Transaction cost κ
  - Choose these three parameters so the model matches three targets:
    - Mean wealth-to-income ratio (4.1)
    - Share of HtM households (34%)
    - Share of wealthy HtM households (25%)

Results from the two-asset model





- What matters most for the MPC is liquid wealth, not total wealth
- Wealthy HtM have a very high MPC
- MPC remains high even for households with sizeable illiquid wealth
- Average MPC $= 15\%$

Main Takeaways for the MPC

- Can macro models generate a high MPC, and if so, how?
  - RA model: No.
    - MPC $\sim=$ 0.5%
  - One-asset HA model:
    - Realistic wealth calibration: MPC $=$ 4.6%
    - Low wealth calibration: MPC $=$ 15%
  - Two-asset HA model:
    - Realistic wealth calibration: MPC $=$ 15%

Unemployment Risk

Unemployment Risk and Consumption Dynamics

- **Question:** How does unemployment risk affect household spending?
  - During recessions, unemployment risk increases
  - This may induce HHs to increase their buffer stock of assets
  - The resulting fall in consumption may increase output volatility
  - This channel has been difficult (if not impossible) to capture with RA models

Unemployment Risk and Consumption Dynamics

- **Question:** How does unemployment risk affect household spending?
  - During recessions, unemployment risk increases
  - This may induce HHs to increase their buffer stock of assets
  - The resulting fall in consumption may increase output volatility
  - This channel has been difficult (if not impossible) to capture with RA models
- **Our goal:** Study a HA model that can capture this channel
  - We will closely follow Harmenberg and Öberg (2021)
  - Consumption falls in response to increased risk during recessions
  - Households increase their precautionary savings and postpone irreversible durable investments.

Model

- Start with a standard buffer stock model, expanded to have:
  1. Durable (D) and nondurable consumption (C)
  2. Time varying unemployment risk

Model

- Start with a standard buffer stock model, expanded to have:
  1. Durable (D) and nondurable consumption (C)
  2. Time varying unemployment risk

- Households maximize

$$\max_{\{C_{it}, D_{it}, B_{it}\}_{i=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t u(C_{it}, D_{it})$$

Model

- Start with a standard buffer stock model, expanded to have:
  1. Durable (D) and nondurable consumption (C)
  2. Time varying unemployment risk

- Households maximize

$$\max_{\{C_{it}, D_{it}, B_{it}\}_{i=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t u\left(C_{it}, D_{it}\right)$$

- Subject to

$$C_{it} + D_{it} + qB_{it} \leq \Upsilon\left(Y_{it}, n_{it}\right) + (1-\delta)D_{it-1} + B_{it-1} - A\left(D_{it}, D_{it-1}\right),$$
$$C_{it}, D_{it}, B_{it} \geq 0.$$

Model

- Adjustment costs to durable consumption

$$A\left(D_{it}, D_{it-1}\right) = \begin{cases} 0 & \text{if } D_{it} = (1-\delta)D_{it-1}, \\ hD_{it-1} & \text{if } D_{it} \neq (1-\delta)D_{it-1} \end{cases}$$

Model

- Adjustment costs to durable consumption

$$A\left(D_{it}, D_{it-1}\right) = \begin{cases} 0 & \text{if } D_{it} = (1-\delta)D_{it-1}, \\ hD_{it-1} & \text{if } D_{it} \neq (1-\delta)D_{it-1} \end{cases}$$

- Income depends on both productivity and employment status

$$\Upsilon\left(Y_{it}, n_{it}\right) = Y_{it}\left(n_{it} + b\left(1 - n_{it}\right)\right)$$

Model

- Adjustment costs to durable consumption

$$A\left(D_{it}, D_{it-1}\right)=\begin{cases} 0 & \text{if } D_{it}=(1-\delta)D_{it-1}, \\ hD_{it-1} & \text{if } D_{it}\neq(1-\delta)D_{it-1} \end{cases}$$

- Income depends on both productivity and employment status

$$\Upsilon\left(Y_{it}, n_{it}\right)=Y_{it}\left(n_{it}+b\left(1-n_{it}\right)\right)$$

- Where the employment process is governed by two parameters:
  - The job finding probability
  - The job separation probability

Model

- Adjustment costs to durable consumption

$$A\left(D_{it}, D_{it-1}\right) = \begin{cases} 0 & \text{if } D_{it} = (1-\delta)D_{it-1}, \\ hD_{it-1} & \text{if } D_{it} \neq (1-\delta)D_{it-1} \end{cases}$$

- Income depends on both productivity and employment status

$$\Upsilon\left(Y_{it}, n_{it}\right) = Y_{it}\left(n_{it} + b\left(1 - n_{it}\right)\right)$$

- Where the employment process is governed by two parameters:
    - The job finding probability
    - The job separation probability
- Job separation probability $= 1\%$ in expanisions and 2% in recessions

Model

- Adjustment costs to durable consumption

$$A\left(D_{it}, D_{it-1}\right) = \begin{cases} 0 & \text{if } D_{it} = (1-\delta)D_{it-1}, \\ hD_{it-1} & \text{if } D_{it} \neq (1-\delta)D_{it-1} \end{cases}$$

- Income depends on both productivity and employment status

$$\Upsilon\left(Y_{it}, n_{it}\right) = Y_{it}\left(n_{it} + b\left(1 - n_{it}\right)\right)$$

- Where the employment process is governed by two parameters:
    - The job finding probability
    - The job separation probability
- Job separation probability $= 1\%$ in expanisions and 2% in recessions
- Job finding probability $= 2\%$ in both expansions and recessions

How might unemployment risk affect consumption

- Two channels:
  - Unemployment-risk channel (ex-ante)
  - Unemployment channel (ex-post)

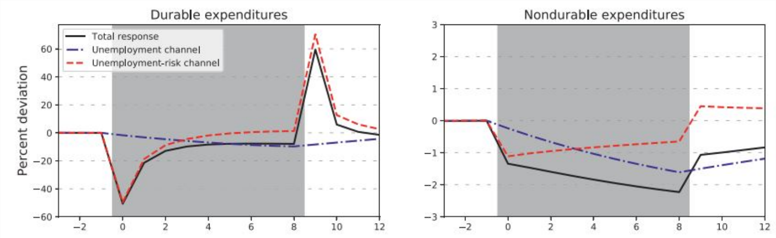
How might unemployment risk affect consumption

- Two channels:
  - Unemployment-risk channel (ex-ante)
  - Unemployment channel (ex-post)
- What is the difference between the two channels?
  - The first captures the saving response to an increase in future job separation probability
    - Increased unemployment-risk $\Longrightarrow$ larger optimal buffer stock
  - The second captures the fall in consumption induced by being hit by a bad shock
    - Decreased income $\Longrightarrow$ less resources available for consumption

How might unemployment risk affect consumption

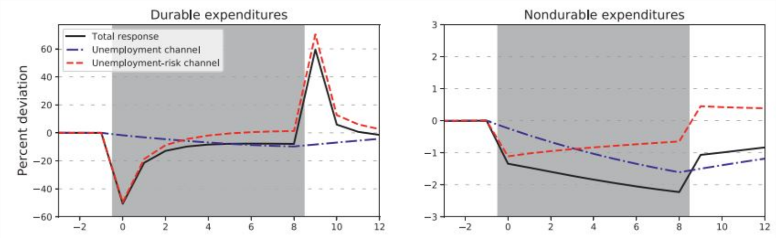
- Two channels:
  - Unemployment-risk channel (ex-ante)
  - Unemployment channel (ex-post)
- What is the difference between the two channels?
  - The first captures the saving response to an increase in future job separation probability
    - Increased unemployment-risk $\Longrightarrow$ larger optimal buffer stock
  - The second captures the fall in consumption induced by being hit by a bad shock
    - Decreased income $\Longrightarrow$ less resources available for consumption
- Which of these channels is more important?

Results



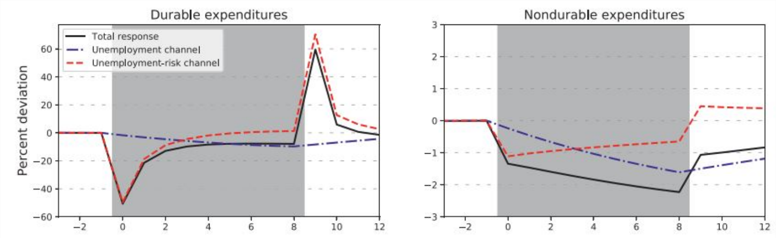
- Response of durables is much larger than nondurables

Results



- Response of durables is much larger than nondurables
- For durables: unemployment-risk channel is most important

Results



- Response of durables is much larger than nondurables
- For durables: unemployment-risk channel is most important
- For nondurables: unemployment-risk matters initially, but unemployment accounts for the majority in the long-term

Summary

Summary and next week

- **Today:** Three applications of dynamic programming to understand household spending dynamics
  1. The role of credit constraints
  2. Modeling the large average MPC to income shocks
  3. Consumption dynamics with time-varying unemployment risk

Summary and next week

- **Today:** Three applications of dynamic programming to understand household spending dynamics
    1. The role of credit constraints
    2. Modeling the large average MPC to income shocks
    3. Consumption dynamics with time-varying unemployment risk

- **Next week:** Life-cycle consumption-saving models with deviations from full rationality

Summary and next week

- **Today:** Three applications of dynamic programming to understand household spending dynamics
  1. The role of credit constraints
  2. Modeling the large average MPC to income shocks
  3. Consumption dynamics with time-varying unemployment risk

- **Next week:** Life-cycle consumption-saving models with deviations from full rationality

- **Homework exercises:** Start with the model from week 1
  1. Adjust the discount factor, β, to target 3 different levels of average wealth. How does the average MPC change across calibrations?
  2. Add unemployment risk and unemployment benefits to the model. How does it change average savings?