Lecture XIII

Two-asset models

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Quantitative Macroeconomics

Two-asset model with discrete adjustment

- Model with two consumption goods, one nondurable (c) and one durable (d)

- Adjustment of durable good subject to a fixed transaction cost ϕ

- Problem if not adjusting (N)

$$
V^N(a, d, y) = \max_{c, a'} u(c) + \nu(d') + \beta E\left[\mathbf{V}(a', d', y')\right]
$$

$$
s.t.
$$

$$
c + a' = Ra + y
$$

$$
d' = (1 - \delta) d
$$

with associated FOC:

$$
u_c\left(c^N\right) = \beta E\left[\mathbf{V}_a\left(a', (1 - \delta) d, y'\right)\right]
$$

Two-asset model with discrete adjustment

- Problem if adjusting (A)

$$V^A (\omega, y) = \max_{c, a', d'} u(c) + \nu(d') + \beta E[\mathbf{V}(a', d', y')]$$

$$s.t.$$

$$c + a' + d' = \omega + y - \phi$$

$$\omega = Ra + d$$

with FOCs:

$$u_c(c^A) = \beta E[\mathbf{V}_a(a', d', y')]$$

$$u_c(c^A) = \nu_d(d') + \beta E[\mathbf{V}_d(a', d', y')]$$

- Bold value: upper envelope of the values conditional on $\{A, N\}$

$$\mathbf{V}(a, d, y) = \max\{V^N(a, d, y), V^A(Ra + d, y)\}$$

Integrating the EGM with the discrete decision

- Grid on $\mathcal{G}^a \times \mathcal{G}^d$ on (a', d') our continuous states next period. Discretize y and call $\mathcal{G}^y$ the grid on y

- Guess values $\left\{ V^N \left(a', d', y' \right), V^A \left(Ra' + d', y' \right) \right\}$

- Compute the implied $\mathbf{V} \left(a', d', y' \right)$ approximated by a piecewise linear function off the grid.

- Consider first the non-adjusting case (N). Iterate over $\mathcal{G}^a \times \mathcal{G}^d$ for next period states:

$$\tilde{c}^N = u_c^{-1} \left\{ \beta R \sum_{y'} \mathbf{V}_a \left(a', d', y' \right) \pi \left(y', y \right) \right\}$$

through the EGM.

Integrating the EGM with the discrete decision

- From law of motion for d and the budget constraint

$$
\begin{aligned}
d &= \frac{d'}{1 - \delta} \\
\tilde{c}^N &= Ra + y - a'
\end{aligned}
$$

which yields $c^N(a, d, y)$ defined on a different grid for (a, d).

- Use piecewise linear approximation to re-define this function over the original grid $\mathcal{G}^a \times \mathcal{G}^d$.

Integrating the EGM with the discrete decision

- Now turn to the adjusting case (A). Iterate over $\mathcal{G}^a$ only for next-period asset holdings!

- Using the EGM on the first EE above, obtain an implicit function $\tilde{c}^A(a', d')$ of d'

$$\tilde{c}^A(a', d') = u_c^{-1}\left\{\beta R \sum_{y'} \mathbf{V}_a(a', d', y')\,\pi(y', y)\right\}$$

and, from the second Euler equation, solve for d' such that:

$$\tilde{d}'(a') = \nu_d^{-1}\left\{u_c\left(\tilde{c}^A(a', d')\right) - \beta \sum_{y'} \mathbf{V}_d(a', d', y')\,\pi(y', y)\right\}$$

which, unfortunately, requires a few steps of a root-finding method.

Integrating the EGM with the discrete decision

- Finally, from the budget constraint we have

$$\tilde{c}^A \left(a', \tilde{d}' \left(a' \right) \right) + a' + \tilde{d}' \left(a' \right) = \omega + y - \phi$$

  which implies a value of ω and thus functions $c^A \left(\omega, y \right)$ and $d' \left(\omega, y \right)$ that have to be, once again, redefined over the original grid

- Note: the grid for $\omega = Ra + d$ descends directly from the $\mathcal{G}^a \times \mathcal{G}^d$ grid.

Integrating the EGM with the discrete decision

- Then, update the values:

$$
\begin{aligned}
V_{i+1}^N (a, d, y) \;=\;\; & u\left(c_i^N (a, d, y) \right) + \nu \left(d \left(1 - \delta\right) \right) \\
& + \beta \sum_{y'} \mathbf{V}_i \left(Ra + y - c_i^N (a, d, y), d\left(1 - \delta\right), y' \right) \pi \left(y', y \right)
\end{aligned}
$$

and

$$
\begin{aligned}
V_{i+1}^A (\omega, y) \;=\;\; & u\left(c_i^A (\omega, y) \right) + \nu \left(d_i' (\omega, y) \right) \\
& + \beta \sum_{y'} \mathbf{V}_i \left(\omega + y - \phi - c_i^A (\omega, y) - d_i' (\omega, y), d_i' (\omega, y), y' \right) \pi \left(y', y \right)
\end{aligned}
$$

- Doing a few Howard improvement steps, as we know, may speed up convergence

The Wealthy Hand-to-Mouth

Greg Kaplan, Princeton University, IFS & NBER
Gianluca Violante, New York University, CEPR & NBER
Justin Weidner, Princeton University

The wealthy hand-to-mouth (W-HtM)

- **W-HtM:** households with little liquid wealth but substantial illiquid wealth

- **P-HtM:** households with little liquid wealth and little illiquid wealth

- **N-HtM:** households with substantial liquid wealth

- Like the P-HtM:

  - Large MPC out of small transitory income windfalls

- Unlike the P-HtM:

  1. Escape standard definitions and empirical measurement
  2. Similar demographic characteristics to the N-HtM
  3. Behave like the N-HtM for large income shocks

Outline

1. Emergence of W-HtM behavior

2. Strategy for identifying the HtM from household portfolio data

3. Apply strategy to survey data from 8 countries:

    US, Canada, Australia, UK, Germany, France, Italy, Spain

4. Estimation of MPC out of transitory shocks

5. Implications for fiscal policy: compare 3 models (paper)

W-HtM households in theory

- Why consume income every period, rather than use wealth to smooth shocks?

- High-return illiquid assets generate trade-off:

  Better consumption smoothing (short-run)

  vs

  Higher lifetime consumption (long-run)

- Smoothing requires either:

  1. Opportunity cost of holding large cash balances
  2. Borrowing at expensive rates
  3. Paying transaction cost to adjust illiquid asset

- Intuition: welfare losses from not smoothing are second order

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From theory to measurement

- Two kinks in household budget constraint:

    1. Zero liquid wealth
    2. Credit limit

- HtM households end period at one of these kinks

- Mismatch in timing of c and y within a pay-period

- Survey data: HtM households may hold some liquid wealth

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Identifying the HtM in survey data

- Households with positive net liquid wealth:

  P-HtM at the zero kink: $\quad a_{it} = 0, \quad 0 \leq m_{it} \leq \frac{y_{it}}{2}$

  W-HtM at the zero kink: $\quad a_{it} > 0, \quad 0 \leq m_{it} \leq \frac{y_{it}}{2}$

Identifying the HtM in survey data

- Households with positive net liquid wealth:

P-HtM at the zero kink: $\quad a_{it} = 0, \quad 0 \leq m_{it} \leq \frac{y_{it}}{2}$

W-HtM at the zero kink: $\quad a_{it} > 0, \quad 0 \leq m_{it} \leq \frac{y_{it}}{2}$

- Households with negative net liquid wealth:

P-HtM at the credit limit: $\quad a_{it} = 0, \quad m_{it} \leq \frac{y_{it}}{2} - \underline{m}$

W-HtM at the credit limit: $\quad a_{it} > 0, \quad m_{it} \leq \frac{y_{it}}{2} - \underline{m}$

Empirical details

- **Pay-period:** Bi-weekly

- **Income:** All labor income before taxes, plus government transfers that are regular inflows of liquid wealth

- **Liquid wealth:** Checking, savings, money market and call accounts plus directly held mutual funds, stocks and corporate bonds, plus imputed cash holdings, net of credit card debt

- **Illiquid wealth:** Value of housing and real estate net of mortgages and HELOC, private retirement accounts, cash value of life insurance, certificates of deposit and saving bonds

- **Borrowing limit:** One month of income

How large is the share of HtM in the US?
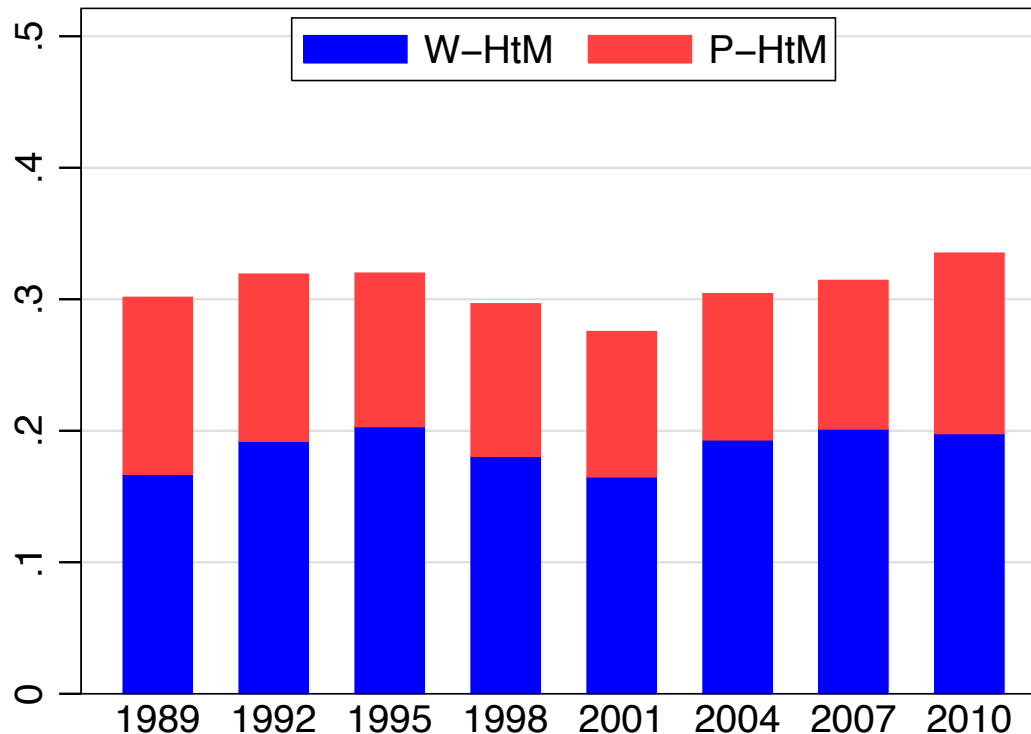
- 30% of US households are HtM, 2/3 of which are W-HtM

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What are the ages of HtM households?
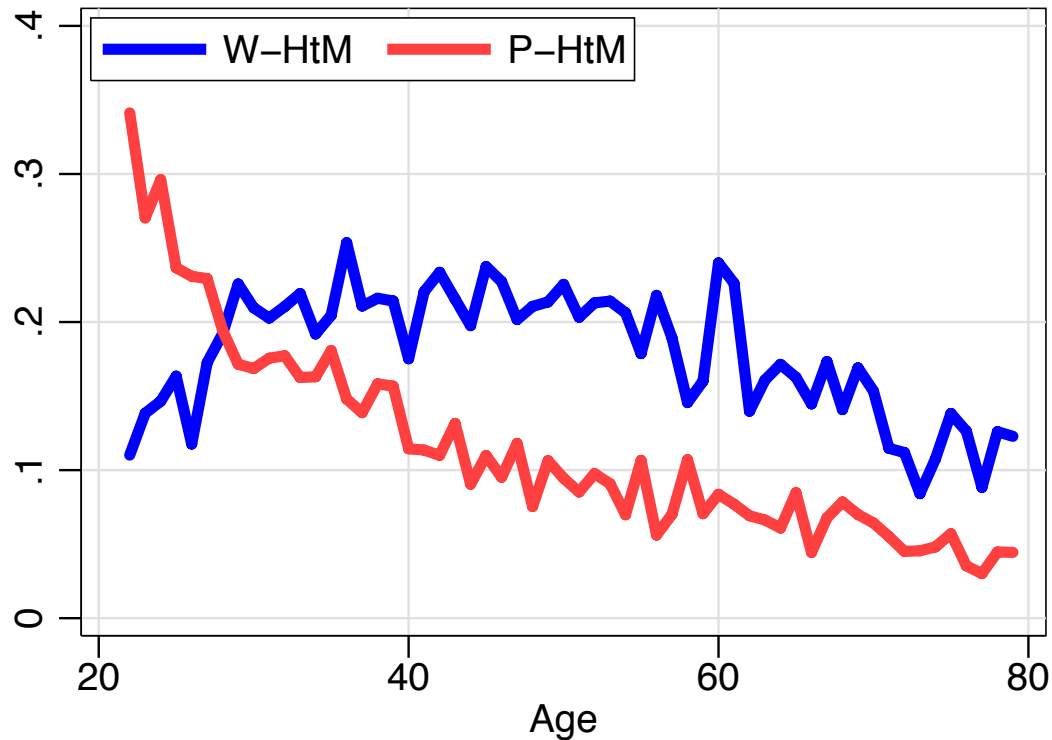
- P-HtM: young households
- W-HtM: middle-age households
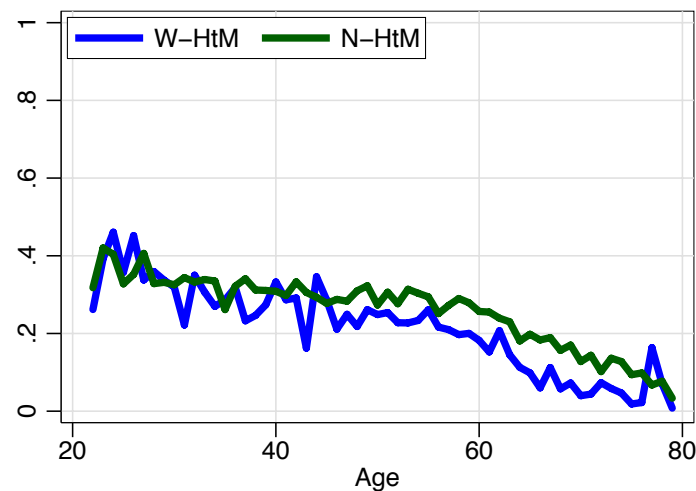
Do W-HtM look more like P-HtM or N-HtM?
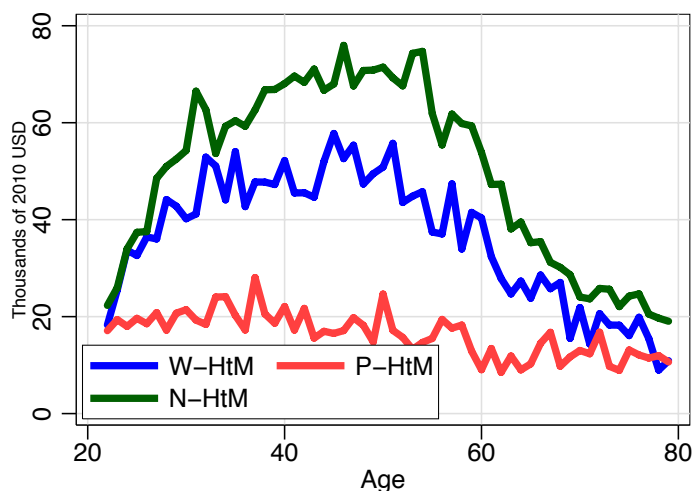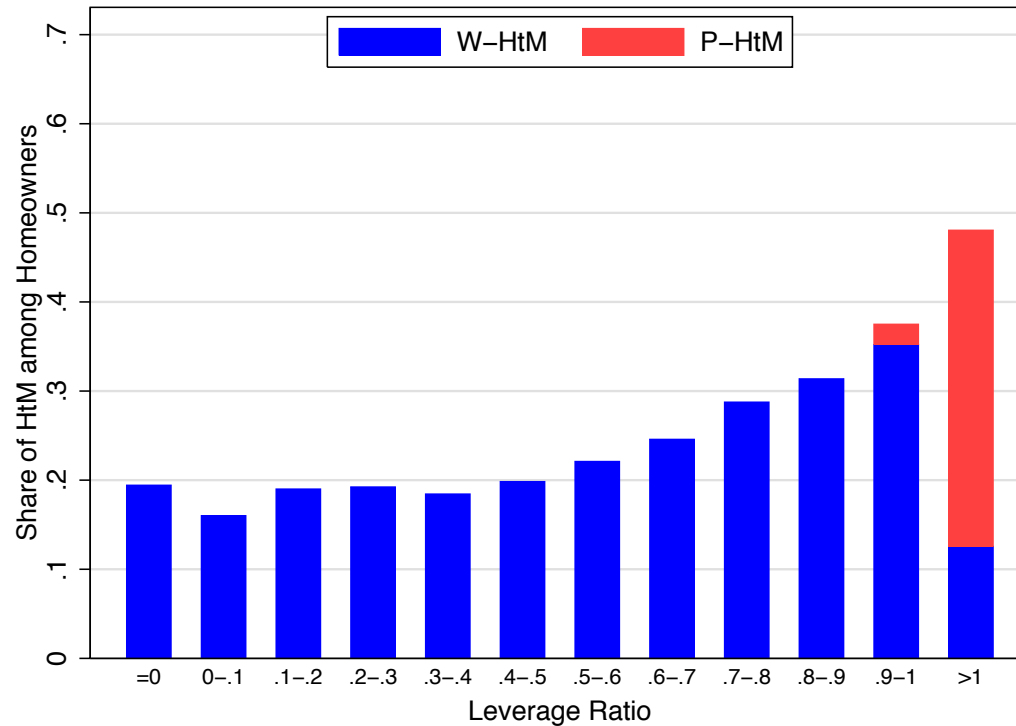

(a) Median income
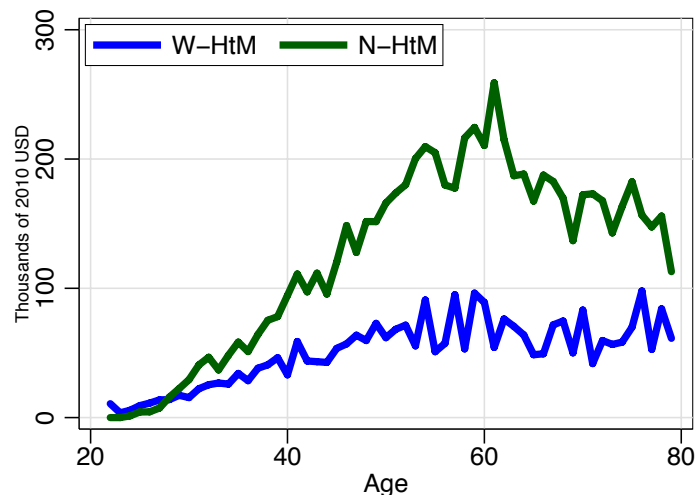
(b) Median illiquid wealth
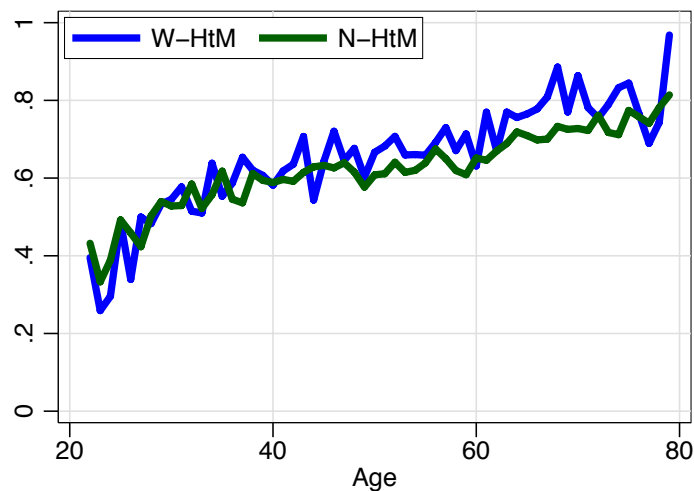
(c) Portfolio share: housing

(d) Portfolio share: retirement accounts

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W-HtM among homeowners, by leverage

- Leverage ratio is a strong predictor of HtM status

Persistence of HtM status

2007 to 2009	P	W	N
P	0.548	0.127	0.326
W	0.101	0.455	0.444
N	0.055	0.129	0.816
Ergodic	0.126	0.191	0.683

- Expected durations:

  P-HtM status: 4.5 years
  W-HtM status: 3.5 years
  N-HtM status: 11 years
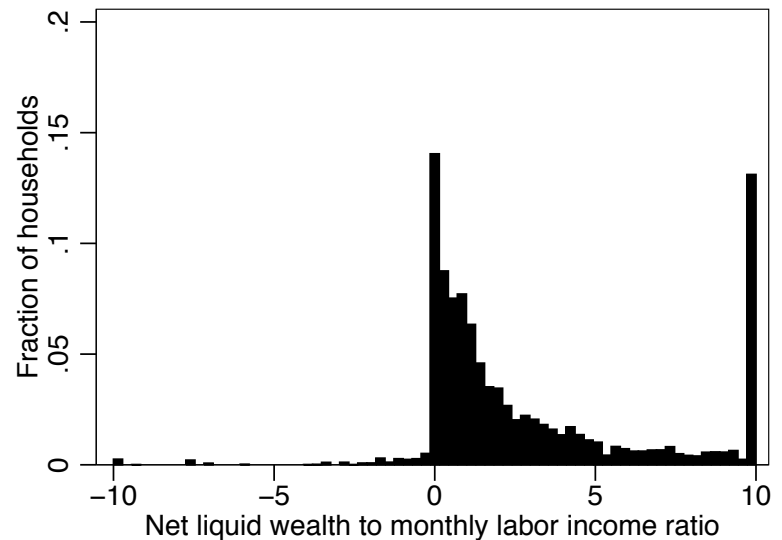
Share of HtM households across countries
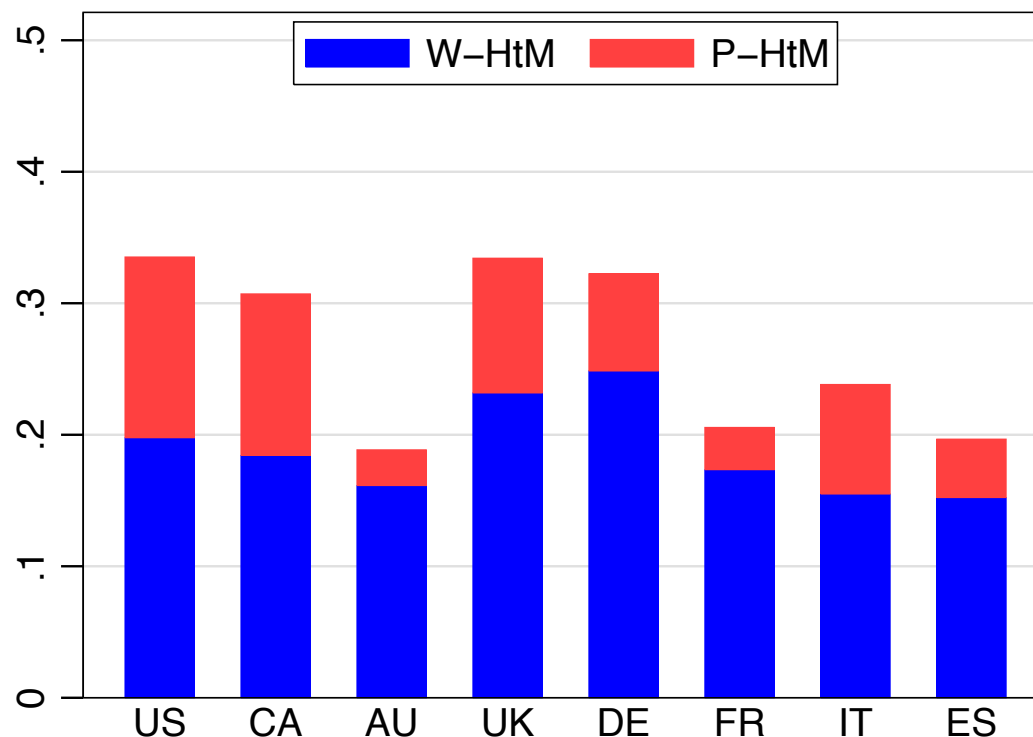
- Substantial cross-country variation in share of HtM
- In all countries, twice as many W-HtM as P-HtM

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Liquid wealth holdings across countries
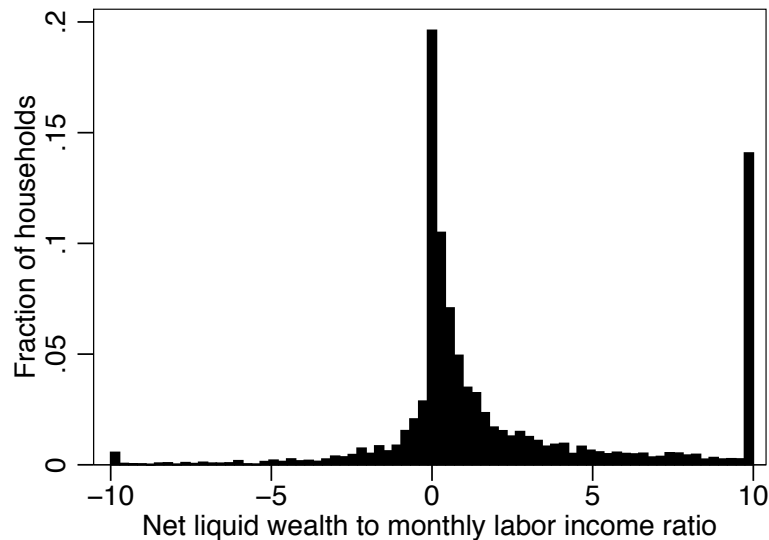
United States

Spain

- Higher liquid wealth in Europe possibly due to lower credit availability

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MPC out of transitory income shocks

- Bi-annual panel data on income, consumption and wealth

- Identify transitory shocks using strategy from Blundell et al. (2008)

	3 HtM groups			2 HtM groups	
	P-HtM	W-HtM	N-HtM	HtM-NW	N-HtM-NW
MPC out of transitory income shock	0.24	0.30	0.13	0.23	0.20
	(0.06)	(0.05)	(0.04)	(0.05)	(0.03)

- W-HtM have largest point estimate, significantly bigger than N-HtM

- Split based on net worth uninformative

Not all HtM households are created equal …

P-HtM	W-HtM
1/10 population	1/5 population
young	middle age
low income	middle income
no wealth	substantial illiquid wealth
	portfolio like N-HtM
persistent state	transient state

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… and it matters

P-HtM	W-HtM
small shocks: high MPC	small shocks: high MPC
large shocks: high MPC	large shocks: small MPC
target low income	target middle income

A Model of the Consumption Response to Fiscal Stimulus Payments

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Princeton University and NBER   New York University, CEPR and NBER

European Central Bank

March 18, 2013

Fiscal stimulus payments (a.k.a. tax rebates)

Frequently used instrument to stimulate spending during recessions

They are small, anticipated, temporary, (almost) lump-sum

1. 2009: *American Recovery and Reinvestment Act* refundable tax credit up to $400 per adult ("Making Work Pay").

2. 2008: *Economic Stimulus Act* provided most households with payments of $300-$600 per adult and $300 per child.
   Total payout was $79b, or 2.2% of quarterly Y.

3. 2001: *Economic Growth and Tax Relief Reconciliation Act*:
   taxpayers entitled to rebate of up to $300 per adult.
   Total payout was $38b: 8% of quarterly G, or 1.7% of quarterly Y.

Preview of idea and results

- Structural model to study consumption response to fiscal stimulus payments

- Baumol-Tobin model of money-demand integrated within life cycle, incomplete markets framework→ two assets:

  1. liquid asset + credit

  2. illiquid asset s.t. transaction cost, but with:
     (i) higher return
     (ii) flow of consumption services

- Model generates wealthy hand-to-mouth households

  Consistent with SCF data

  Micro foundation for spender-saver models of fiscal policy

- Quantitatively account for observed rebate coefficients

Model

Demographics: household i works for J^{work} periods
lives as retiree for J^{ret} periods

Preferences: $V_{ij}^{1-\sigma} = \left(c_{ij}^{\phi} s_{ij}^{1-\phi} \right)^{1-\sigma} + \beta \left(\mathbb{E}_j \left[V_{ij+1}^{1-\gamma} \right] \right)^{\frac{1-\sigma}{1-\gamma}}$

c_{ij} : non-durable consumption
s_{ij} : housing services

Earnings: idiosyncratic household earnings risk

$$\log y_{ij} = \chi_j + z_{ij} + u_{ij}$$

z_{ij} is unit root, u_{ij} is *i.i.d.* interpreted as measurement error

No aggregate uncertainty

Model

Two Assets: 1) liquid asset $m_{ij} \geq -\bar{m}_{ij}$ with return $R^m \equiv \frac{1}{q^m}$

$$R^m_- \geq R^m_+$$

2) illiquid asset $a_{ij} \geq 0$ with return $R^a \equiv \frac{1}{q^a} > R^m_+$

Housing: $s_{ij} = h_{ij} + \zeta a_{ij+1}$
$\qquad\quad$ = purchases of housing services
$\qquad\qquad$ + flow from housing component of illiquid asset

Transactions Cost: fixed money, utility, or time cost κ for each
$\qquad\qquad\qquad\quad$ deposit into or withdrawal from illiquid account

Government: taxes income progressively, consumption linearly,
$\qquad\qquad\quad$ runs a progressive SS system and respects an
$\qquad\qquad\quad$ intertemporal budget constraint

Model

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

Model

$$
\begin{aligned}
V_j^N(a_j, m_j, z_j) &= \max_{c_j, h_j, m_{j+1}} \left\{ \left(c_j^\phi s_j^{1-\phi} \right)^{1-\sigma} + \beta \left(\mathbb{E}_j \left[V_{j+1}^{1-\gamma} \right] \right)^{\frac{1-\sigma}{1-\gamma}} \right\}^{\frac{1}{1-\sigma}} \\
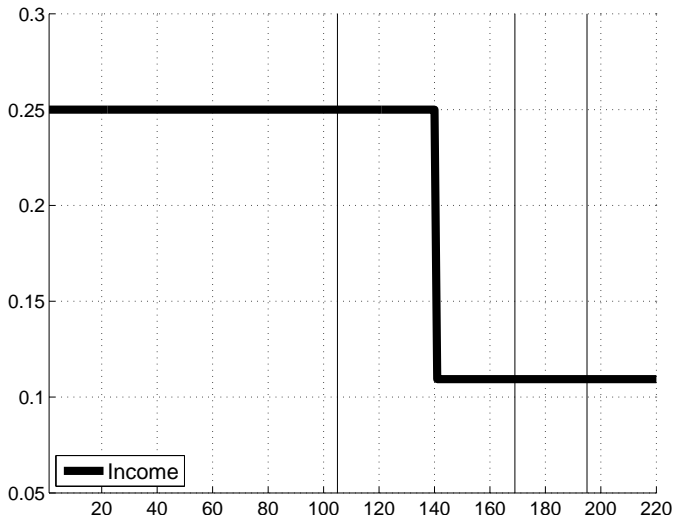&\quad \text{subject to} \\
&\quad c_j + h_j + q^m m_{j+1} \leq m_j + y_j(z_j) - \mathcal{T}(y_j, a_j, m_j, c_j) \\
&\quad q^a a_{j+1} = a_j \\
&\quad s_j = h_j + \zeta a_{j+1} \\
&\quad m_{j+1} \geq -\bar{m}_j \\
V_j^A(a_j, m_j, z_j) &= \max_{c_j, h_j, a_{j+1}, m_{j+1}} \left\{ \left(c_j^\phi s_j^{1-\phi} \right)^{1-\sigma} + \beta \left(\mathbb{E}_j \left[V_{j+1}^{1-\gamma} \right] \right)^{\frac{1-\sigma}{1-\gamma}} \right\}^{\frac{1}{1-\sigma}} \\
&\quad \text{subject to} \\
&\quad c_j + h_j + q^a a_{j+1} + q^m m_{j+1} \leq a_j + m_j - \kappa + y_j(z_j) - \mathcal{T}(\cdot) \\
&\quad s_j = h_j + \zeta a_{j+1} \\
&\quad a_{j+1} \geq 0, m_{j+1} \geq -\bar{m}_j
\end{aligned}
$$

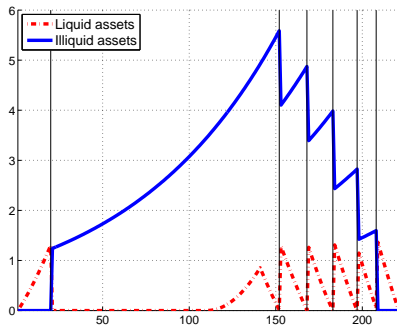## Example of two-asset economy

Example of two-asset economy
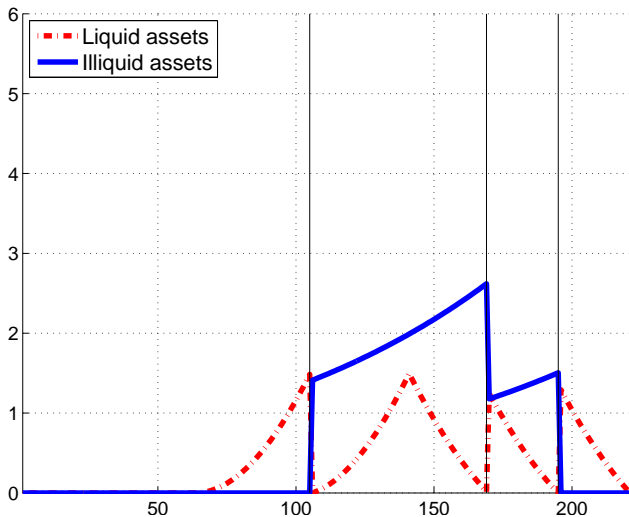
Example of two-asset economy
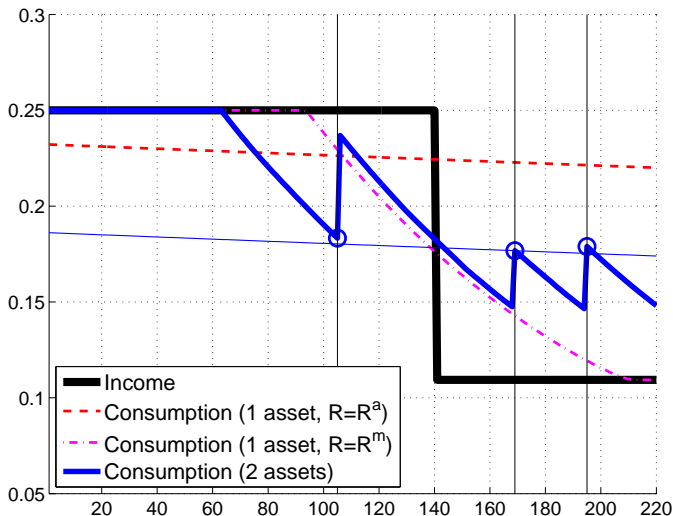
[Euler Equations]

A wealthy hand-to-mouth household
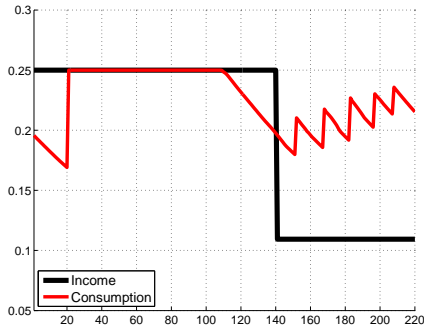
- ▶ Agent features endogenous hand to mouth behavior
- ▶ Consumes the rebate check and does not respond to the news
- ▶ Small welfare gain of smoothing vs κ and $R^a - R^m$
  Cochrane (1989)

Parametrization (quarterly model)

- Demographics: $J^{work} = 38$ years (22-59)
  $J^{ret} = 20$ years (60-79)

- Preferences: $\frac{1}{\sigma} = 1.5$ (IES)
  $\gamma = 4$ (risk aversion)
  $\phi = 0.85$ (1 - exp. share on housing)

- Earnings: Match growth of earnings inequality over life cycle

- Credit limit: $\bar{m}_{ij} = 0.18 \cdot y_{ij}$ (SCF)

- Government: expenditures, debt, tax system and SS system
  reproduce key features of US counterpart in 2001

- Set $\{R^m, R^a, \kappa, \beta, \zeta\}$ from micro data on household portfolios

Calibration

- Assets Returns:

    Illiquid asset   After-tax real return $r^a = 2.3\%$

    Liquid asset   After-tax real return $r^m_+ = -1.5\%$

- Housing Services ζ: Match imputed rent of owner-occupied housing net of maintenance, mortgage interest, and property tax $\Rightarrow 4.0\%$ (annualized)

- Discount Factor β: Match median illiquid wealth of $54,600$ $\Rightarrow 0.953$ (annualized)

- Borrowing rate r^m_-: Match fraction of households with revolving cc debt of 20% $\Rightarrow 6\%$ (annualized)

- Transactions Cost κ: Match fraction of hand-to-mouth households of 1/3 $\Rightarrow \$1,000$

Tax rebate experiment

- In 2001 : $Q2$, govt announces all households will receive a tax rebate of $500 paid out at 2001 : $Q2$ (group A) or 2001 : $Q3$ (group B)

- After 10 years, permanent additional proportional earnings tax

- Two features of economic environment in 2001

  1. Bush tax cuts (EGTRRA)
     - Unexpected tax reform announced in 2001:Q2 (with rebate), takes effect gradually from 2002:Q1

  2. Mild 2001-02 recession
     - Unexpected 1.5% decline in earnings, over 3 quarters, followed by 8 quarter recovery
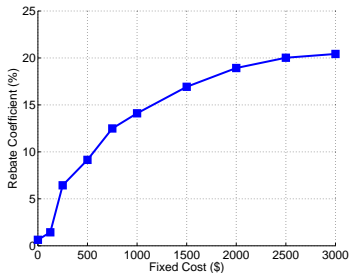
Rebate coefficient in the model
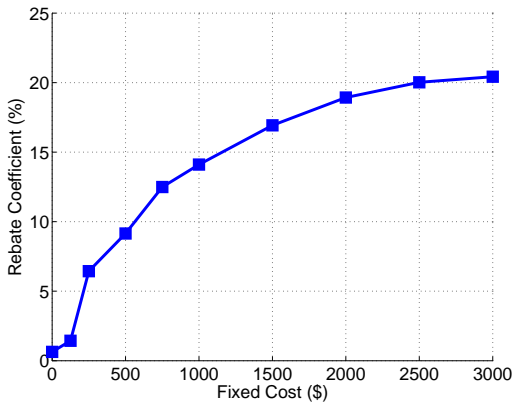
- Rebate coefficient rising with κ (1% in one-asset model)

Role of hand-to-mouth households
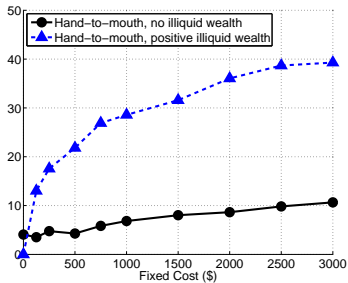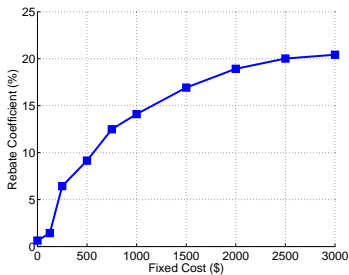
▶ Rebate coef. rising with fraction of hand-to-mouth households
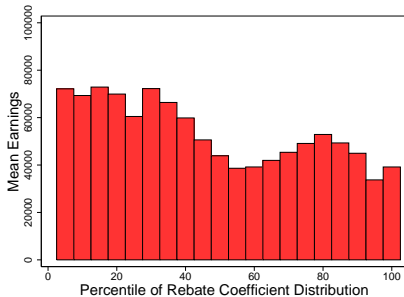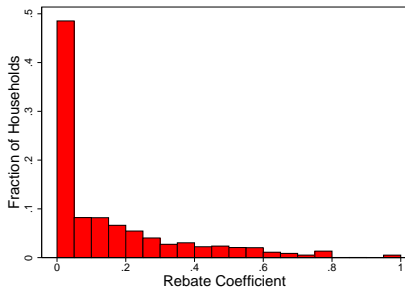
MPC across household types
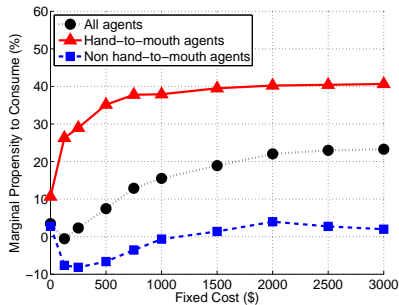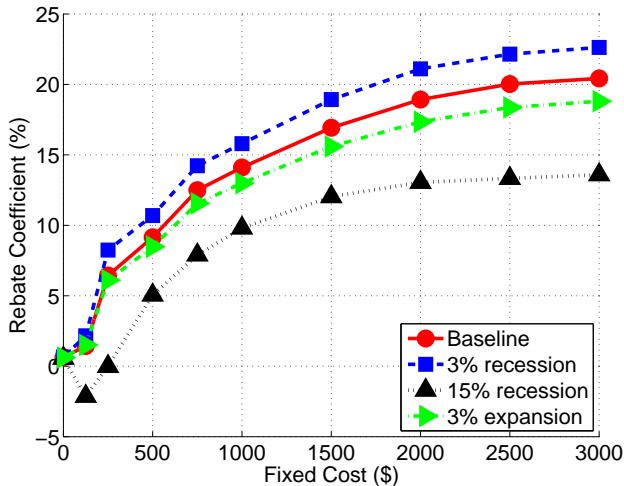

▶ Action entirely from hand-to-mouth households

Heterogeneity in rebate coefficients

Misra & Surico (2011):

1. Consumption responses are heterogenous in the population
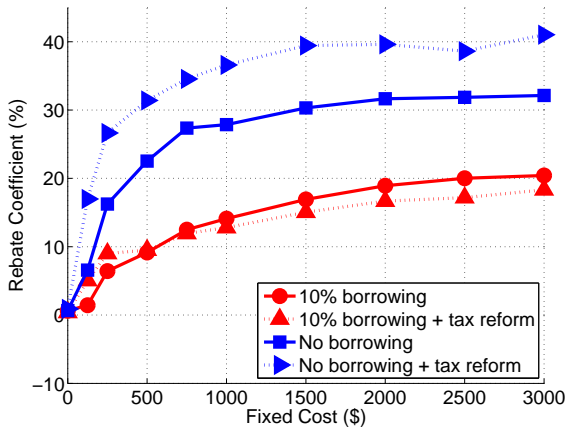
2. High income households at both ends of distribution

Aggregate economic conditions

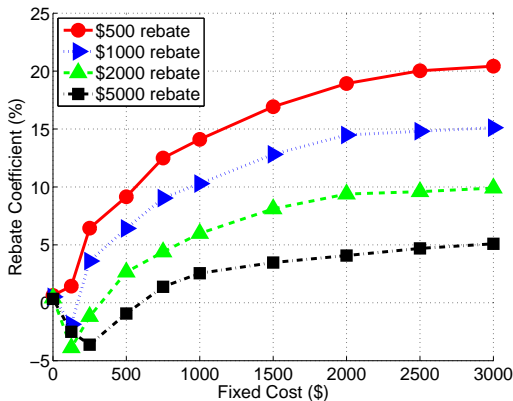
▶ Size of recession matters for borrowing and adjustment

Tax reform

- ▶ Availability of credit determines sign of effect

Size-asymmetry of responses (Hsieh)

Same households who have large MPC out of 2001 tax rebate do not respond to (larger) distributions from Alaskan Permanent Fund

▶ Larger rebate ⇒ more adjustment ⇒ lower consumption response

Conclusions

- Baumol-Tobin model of money demand integrated into a lifecycle incomplete markets framework

- Generates wealthy hand-to-mouth consumers

  Microfoundation for Campbell-Mankiw spender-saver model

- Model capable of responses to fiscal stimulus payments that are: (i) large; (ii) heterogeneous; and (iii) size-asymmetric

- Model displays strong non-linearities in the aggregate

Liquid and illiquid wealth in SCF 2001

	50th pct	Mean	Fraction Positive	After-Tax Real Return
Earnings + benefits (22-59)	41,000	52,745	–	–
Net worth	62,441	150,411	0.95	1.8
Net liquid wealth	2,630	31,001	0.77	-1.5
Cash, checking, saving, MM	2,816	12,456	0.87	-2.0
MF, stocks, bonds, T-Bills	0	19,935	0.28	1.9
Revolving credit card debt	0	1,617	0.20	–
Net illiquid wealth	54,600	119,409	0.93	2.3
Housing net of mortgage debt	31,000	72,592	0.68	2.0
Retirement accounts	950	34,455	0.53	3.8×1.35
Life insurance	0	7,740	0.27	0.4
Certificates of deposit	0	3,807	0.14	1.2
Saving bonds	0	815	0.17	0.4