Economics 742 Lecture 9: Inspecting the Mechanism: Redistribution and Incomplete Markets

Adam M. Guren[1]

Boston University

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[1] These slides borrow from Adrien Auclert's excellent slide decks.

Outline For Today

- 3 papers that try to make analytical progressunderstanding mechanisms at work in HANK models
  - And incomplete market models more generally.

1. Auclert (2019): The Redistribution Channel of Monetary Policy
   - With some Dopeke and Schneider (2006)
2. Auclert-Rognlie-Straub (2024): The Intertemporal Keynesian Cross (Briefly)
3. Werning (2015): Incomplete Markets and Aggregate Demand (Briefly)

Auclert: Redistribution Chanel of Monetary Policy

- How does monetary policy affect the real economy, and in particular consumption?
  - Traditional view: inter-temporal substitution.
  - Redistribution across heterogenous households induced by monetary policy "nets out."
- Auclert (2019) argues that redistribution does *not* net out.
  - Wealth effects matter because differential by MPC:
    1. Differential response of household incomes to monetary policy.
    2. Differential exposure of household balance sheets to inflation.
    3. Differential exposure of household balance sheets to changes in the real interest rate.
  - Quantifies importance of redistribution channels.
- Probably the single best and most influential macro JMP of the last decade.

Auclert: Redistribution Chanel of Monetary Policy

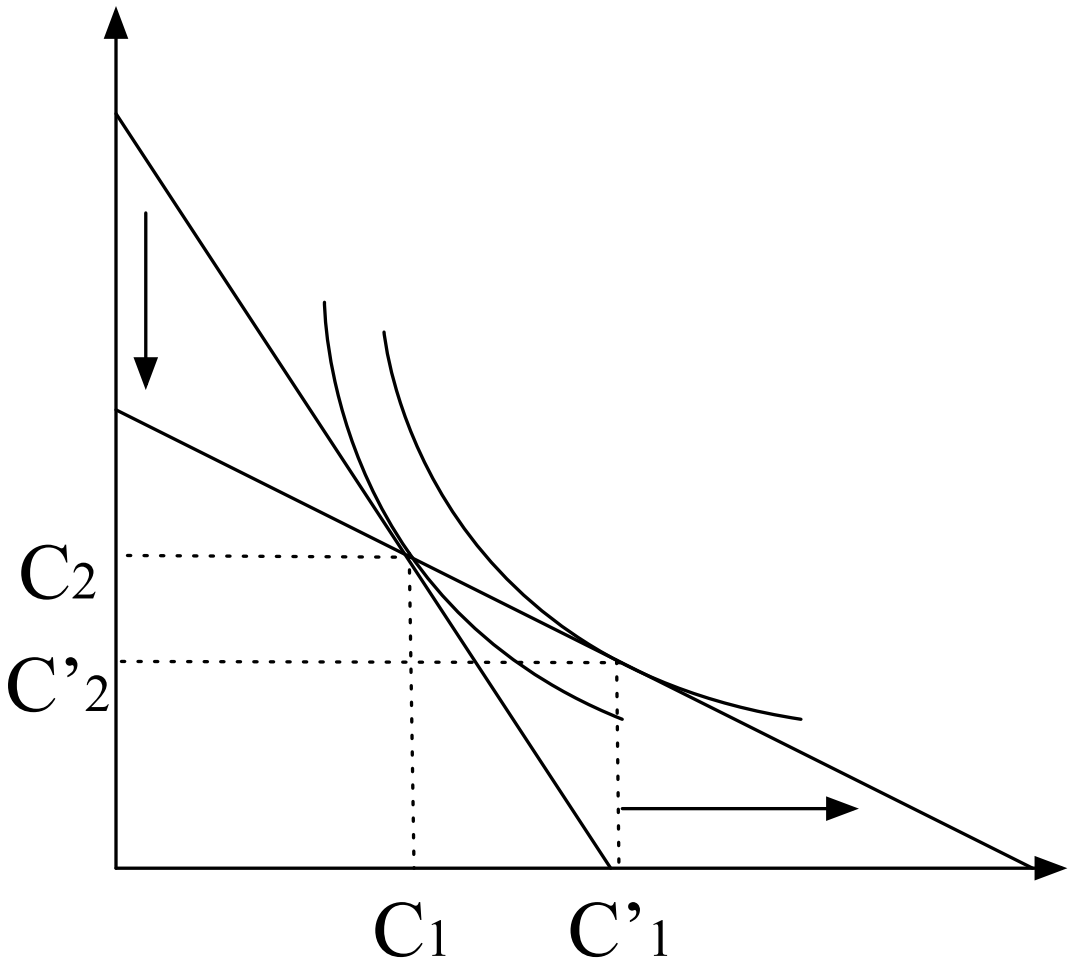
Aggregation would not matter if we could be sure the marginal propensities to spend from wealth were the same for creditors and debtors. But...the population is not distributed between debtors and creditors randomly. Debtors have borrowed for good reasons, most of which indicate a high marginal propensity to spend from wealth or from current income.

- James Tobin

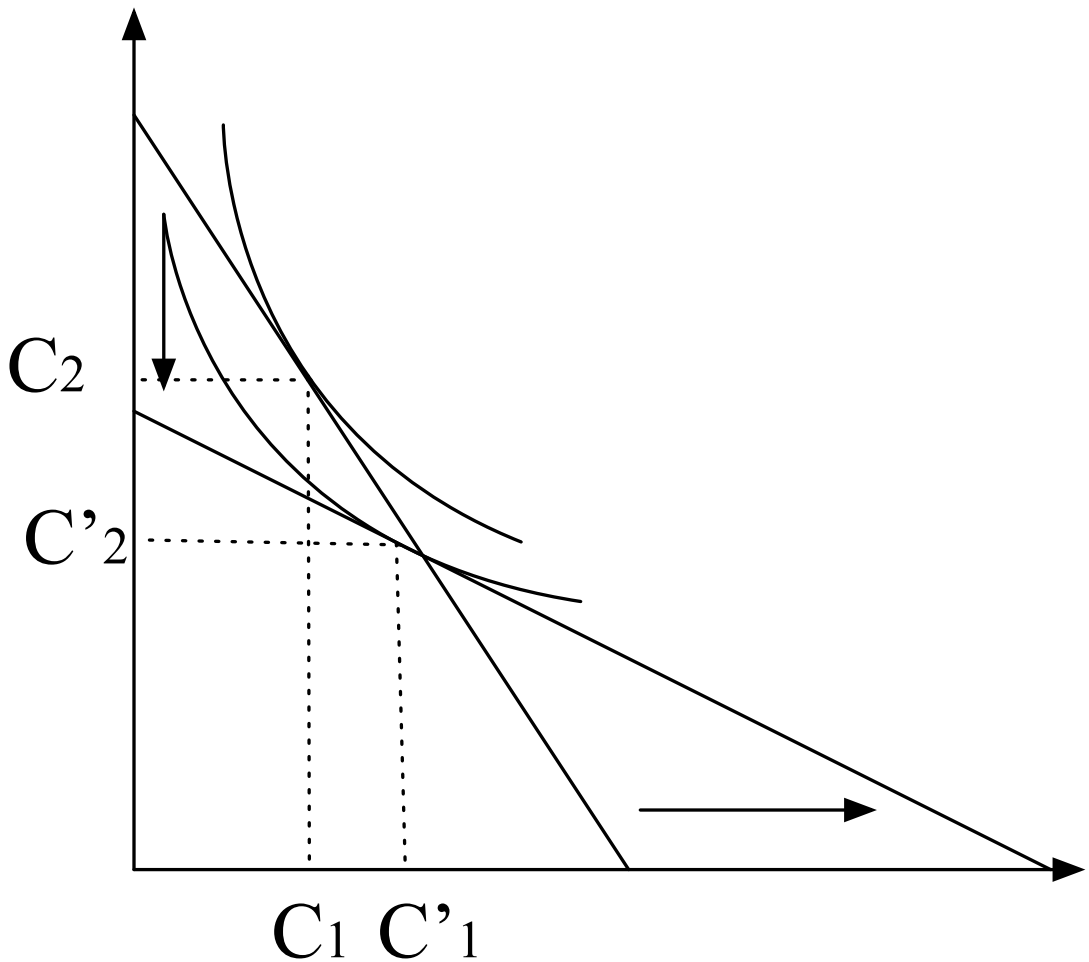
Auclert: Structure of Paper

1. Simple yet novel "sufficient statistics" approach.
   - Partial equilibrium analysis of household with rich balance sheet in complete and incomplete markets.
   - Aggregate to general equilibrium.
     - Covariances of MPC and "balance sheet exposures" matter.
   - Limited structure to identify channels at work and their magnitudes in a broad class of models.
     - While leaving particulars of GE closure of model unspecified.
2. Empirical Evidence: Interest rate exposure channel as strong as inter-temporal substitution channel.
3. Calibrated heterogenous agents model (cut by AER from JMP version).

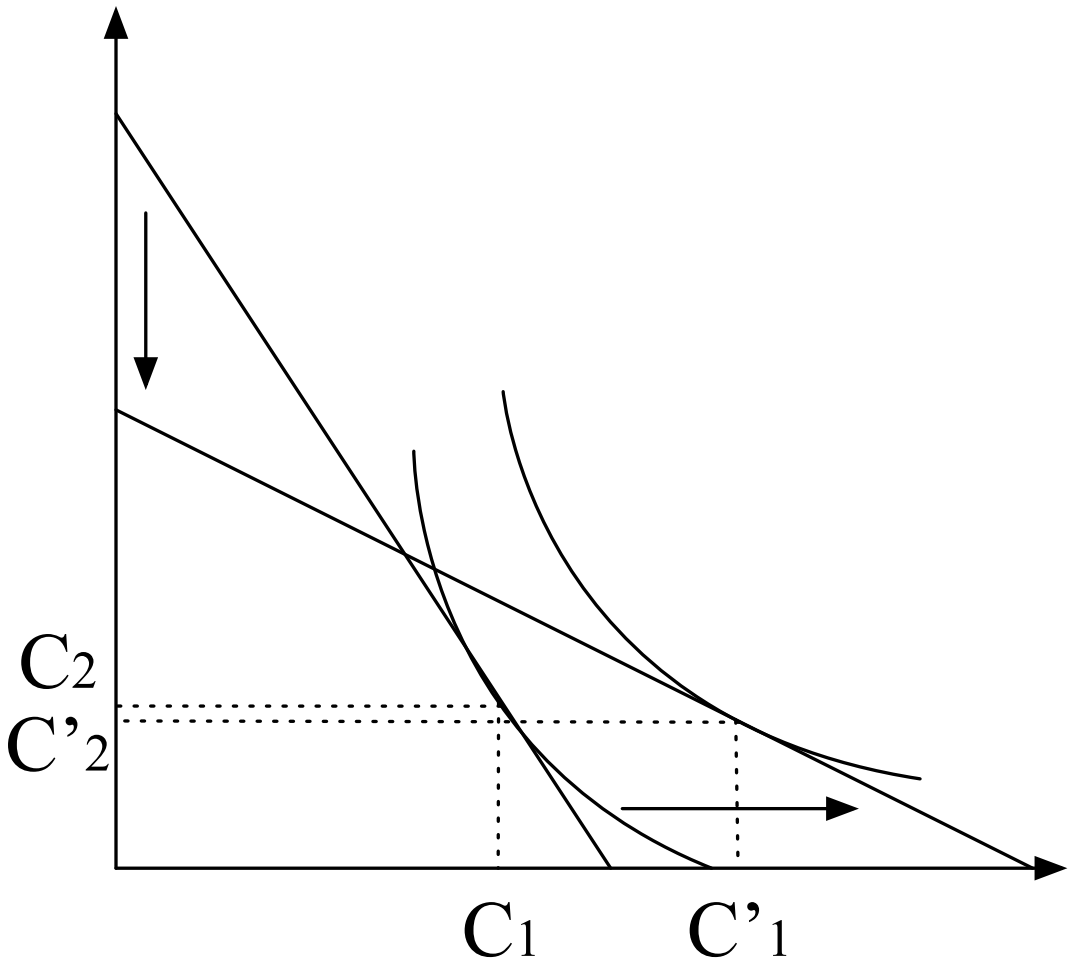
Basic Idea: Decline in Interest Rate With Zero Net Savings Generates No Wealth Effect



Basic Idea: Decline in Interest Rate For Net Saver Generates Negative Wealth Effect



Basic Idea: Decline in Interest Rate For Net Borrower Generates Positive Wealth Effect



Auclert: Intuition of Interest Rate Exposure Channel

- *Net saving/borrowing position relative to consumption plan is what matters for income effect when interest rate changes.*
- Auclert generalizes pictures to dynamic, many-asset case.
  - Key measure of balance sheet exposure is *unhedged interest rate exposure*.
  - Difference between all maturing assets and liabilities at point in time (for one-period unanticipated shock, today).
  - Includes income as asset and consumption plan as liability.
- $r \downarrow \Rightarrow$ redistribution towards negative UREs (net borrowers), who Auclert argues has higher MPC.

Redistribution and Monetary Policy: Outline

1. Auclert (2019): Households
   - 1.1 Complete Markets
     - 1.1.1 Without Nominal Assets
     - 1.1.2 With Nominal Assets
   - 1.2 Incomplete Markets
2. Auclert (2019): General Equilibrium
3. Redistribution Channels
   - 3.1 Earnings Heterogeneity Channel: Auclert (2019)
   - 3.2 Fisher Channel: Doepke and Schneider (2006)
   - 3.3 Interest Rate Exposure Channel: Auclert (2019)

Complete Markets Setup With No Nominal Assets

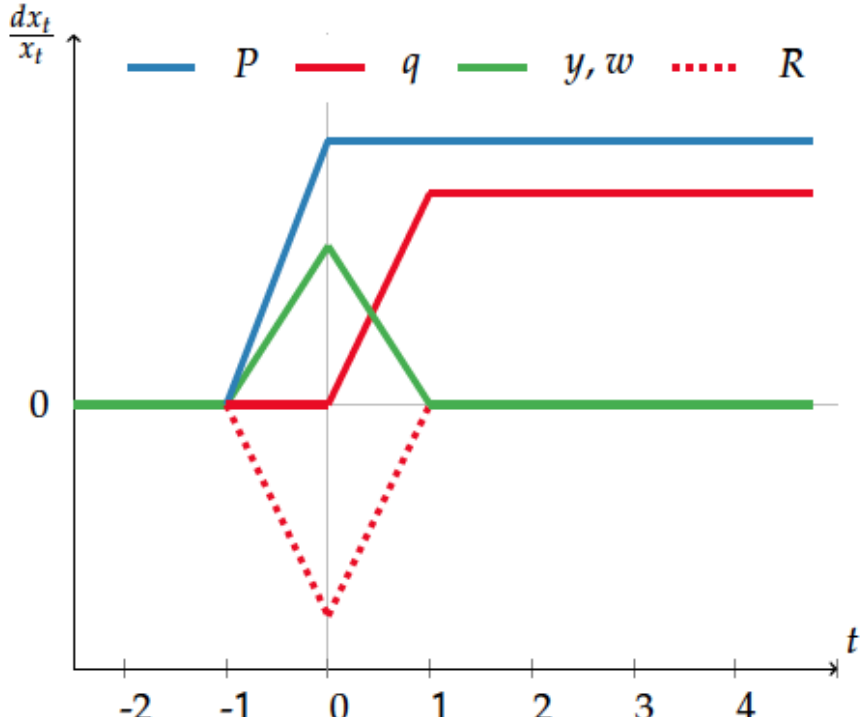
- Consider a household with access to rich set of financial assets:
  - Real income stream $\{y_t\}$, wages $\{W_t\}$, prices $\{P_t\}$ (certain).
  - Hold at beginning of period zero $\{_{-1}b_{t+s}\}_{s\geq 0}$ long-term real assets maturing at $t+s \Rightarrow$ real term structure $\{_{-1}q_t\}_{t\geq 0}$.
- Household problem:

$$\max \sum_t \beta_t \left[u\left(c_t\right) - v\left(n_t\right)\right]$$

$$\text{s.t. } P_t c_t = P_t y_t + W_t n_t + \textstyle\sum_{s\geq 1} \left({}_t q_{t+s}\right) P_{t+s} \left({}_{t-1}b_{t+s} - {}_t\, b_{t+s}\right)$$

Auclert's Experiment: Transitory Monetary Shock

- Keeping *balance sheets fixed* $\{_{-1}b_t\}_{t\geq 0}$, R falls for one period.
  1. All nominal prices rise in proportion $\frac{dP_t}{P_t} = \frac{dP}{P}\ \forall t \geq 0$.
  2. Present-value real discount rates rise in proportion $\frac{dq_t}{q_t} = -\frac{dR}{R}\ \forall t \geq 1$.
  3. Unearned income at $t = 0$ rises by dy and real wage $w = \frac{W}{P}$ rises by dw.



First-Order Response of Consumption

$$dc = MPC \times \underbrace{\left[dy + (1+\psi)\, ndw + (y + wn +_{-1} b_0 - c)\, \frac{dR}{R} \right]}_{\text{Wealth Change}} \underbrace{- \sigma c MPS \frac{dR}{R}}_{\text{Sub Effect}}$$

- Proof: Slutsky decomposition and Taylor approx.

$$\frac{\partial x_i}{\partial p_j} = \frac{\partial h_i}{\partial p_j} - \frac{\partial x_i}{\partial w} x_j$$

  - p_j is R, the real interest rate, and $x_i = c_0$.
  - $\frac{\partial h_i}{\partial p_j}$ is written as Hicksian elasticity (EIS $\sigma = -\frac{u'(c_0)}{c_0 u''(c_0)}$) appropriately adjusted for consumption-savings times $\frac{dR}{R}$.
  - $\frac{\partial x_i}{\partial w} = \frac{\partial c}{\partial w} = MPC$.
  - x_j is the wealth change resulting from $\frac{dR}{R}$, which is change in earned and unearned income $dy + (1+\psi)\, n \times dw$ (ψ is Frisch) plus change in wealth from $\frac{dR}{R}$ affecting balance sheet.

Unhedged Interest Rate Exposure

$$dc = MPC \times \left[dy + (1+\psi)\, ndw + (y + wn +_{-1} b_0 - c)\, \frac{dR}{R} \right] - \sigma c MPS \frac{dR}{R}$$

- Balance sheet hedged in period 0 when $_{-1}b_0 = c - (y + wn)$.
  - In this case, not a net borrower or saver.
  - dR generates no income effect beyond GE effect on income.
- Define *unhedged interest-rate exposure*:

$$URE = y + wn +_{-1} b_0 - c$$

  - $y + wn +_{-1} b_t$ are maturing assets (if long bonds).
  - $_{-1}b_t - c$ are maturing liabilities (if short bonds).
- *URE measures balance sheet exposure to change in R.*
  - Effect of interest rate is fall in price of $t = 0$ goods.
  - Benefits net purchasers of $t = 0$ goods, hurts net suppliers.
  - Exposure thus determined by mismatch of assets and liabilities in period of change.

Who Has High URE?

- Savers with large holdings of short-term assets have positive UREs.
- Households with large adjustable-rate debt (e.g., mortgages) have negative UREs.
  - ARM is long-term instrument, but changes value as interest rate changes
  - So think of it as asset with short maturity that is continually "rolled over."
- By contrast, fixed-rate mortgages have URE≈ 0
  - Assuming income covers consumption and mortgage payments.
  - Not revalued and thus "maturing" as interest rates change.

Adding in Nominal Assets

- Add nominal asset holdings $\{{}_{-1}B_t\}_{t\geq 0}$ at prices $\{{}_{-1}Q_t\}_{t\geq 0}$.
- Fisher equation holds for entire term structure:

$$ {}_tQ_{t+s} = {}_tq_{t+s}\frac{P_t}{P_{t+s}} \forall t, s $$

- Household problem is then:

$$ \max_{\{c_t\}\{n_t\}} \sum_t \beta_t \left[u\left(c_t\right) - v\left(n_t\right)\right] \text{ s.t.} $$

$$ P_t c_t = P_t y_t + W_t n_t + {}_{t-1}B_t + \sum_{s\geq 1} \left({}_tQ_{t+s}\right)\left({}_{t-1}B_{t+s} - {}_tB_{t+s}\right) $$

$$ + P_t\left({}_{t-1}b_t\right) + \sum_{s\geq 1}\left({}_tq_{t+s}\right)P_{t+s}\left({}_{t-1}b_{t+s} - {}_tb_{t+s}\right) $$

First-Order Response With Nominal Assets

$$dc = MPC\left(d\Omega + \psi n \times dw\right) - \sigma cMPS\frac{dR}{R}$$

$$dU = u'\left(c\right)d\Omega$$

- $d\Omega$ is net of consumption wealth change:

$$d\Omega = dy + n \times dw + \underbrace{\left(y + wn + \frac{{}_{-1}B_0}{P_0} + {}_{-1}b_0 - c\right)}_{\text{URE}}\frac{dR}{R} - \underbrace{\sum_{t\geq 0} {}_0Q_t\left(\frac{{}_{-1}B_t}{P_0}\right)}_{\text{Net Nominal Position}}\frac{dP}{P}$$

- *Net Nominal Position*: $-$ present value of nominal liabilities.
  - Exposure of nominal liabilities on balance sheet to inflation.
  - Inflation helps nominal debtors, hurts nominal lenders.

Incomplete Markets

- Perhaps surprisingly, Auclert shows that these formulae hold in an incomplete markets setting with liquidity constraints:
  - Define $dY = dy + n \times dw + w \times dn$
  - Define MPC adjusted for labor supply as $\hat{MPC} = \frac{MPC}{MPC+MPS}$.
    - If reduce n with positive income effect, $MPC + MPS < 1$.
  - Theorem:

$$dc = \hat{MPC}\left(dY + URE\frac{dR}{R} - NNP\frac{dP}{P}\right) - \sigma c\left(1 - \hat{MPC}\right)\frac{dR}{R}$$

- Intuition:
  - With nonbinding liquidity constraint, $\hat{MPC}$ summarizes way in which consumer reacts to *all* balance sheet revaluations.
  - When liquidity constraint does bind, $MPS = 0 \Rightarrow \hat{MPC} = 1$ and only income effects matter (hand to mouth).
- However welfare result on dU no longer holds.

Auclert: Aggregation

- Consider a class of GE heterogenous agent models with $i = \{1, ..., I\}$ households as described above.
  - Discount rate, utility, disutility of labor, and borrowing limit can be individual-specific.
  - Rational expectations.
  - Closed economy, with government with no debt and period-by-period balanced budget.
- In equilibrium, zero net supply of nominal assets:

$$E_I [NNP_i] = \frac{1}{I} \sum_{i=1}^{I} NNP_i = 0$$

- Combine with market clearing $C = E_I [c_i] = E_I [Y_i] = Y$:

$$E [URE_i] = 0$$

Auclert: GE Sufficient Statistic

$$dC = \underbrace{E_I\left[\frac{Y_i}{Y}\hat{MPC}_i\right]dY}_{\text{Agg Income Channel}} + \underbrace{Cov_I\left(\hat{MPC}_i, dY_i - Y_i\frac{dY}{Y}\right)}_{\text{Earnings Heterogeneity Channel}}$$
$$\underbrace{- Cov_I\left(\hat{MPC}_i, NNP_i\right)\frac{dP}{P}}_{\text{Fisher Channel}}$$
$$+ \underbrace{Cov_I\left(\hat{MPC}_i, URE_i\right)\frac{dR}{R}}_{\text{Int Rate Exposure Channel}} \underbrace{- E_I\left[\sigma_i c_i\left(1 - \hat{MPC}_i\right)\right]\frac{dR}{R}}_{\text{Substitution Channel}}$$

- $dC \simeq E_I[dc_i]$. Plug in previous result and:
  1. Decompose $dY_i = \frac{Y_i}{Y}dY + \left(dY_i - \frac{Y_i}{Y}dY\right)$
  2. Use $E_I[URI_i] = E_i[NNP_i] = E_I\left[dY_i - \frac{Y_i}{Y}dY\right] = 0$ to transform expectations of products into covariances.

How Does Sufficient Statistic Relate to Full Model?

$$
\begin{aligned}
dC \;=\; & \underbrace{E_I\left[\frac{Y_i}{Y}MPC_i\right]dY}_{\text{Agg Income Channel}} \;+\; \underbrace{Cov_I\left(\hat{MPC}_i, dY_i - Y_i\frac{dY}{Y}\right)}_{\text{Earnings Heterogeneity Channel}} \\
& \underbrace{- Cov_I\left(\hat{MPC}_i, NNP_i\right)\frac{dP}{P}}_{\text{Fisher Channel}} \\
& + \underbrace{Cov_I\left(\hat{MPC}_i, URE_i\right)\frac{dR}{R}}_{\text{Int Rate Exposure Channel}} \;\underbrace{- E_I\left[\sigma_i c_i\left(1-\hat{MPC}_i\right)\right]\frac{dR}{R}}_{\text{Substitution Channel}}
\end{aligned}
$$

- Auclert leaves GE responses $\frac{dP}{dR}$ and $\frac{dY}{dR}$ and $\frac{dY_i}{dR}$ unspecified.
  - Need full GE model to get these responses.
  - But *any* heterogenous agent model will have these channels.

Comparison With Representative Agent Model

- Representative agent model has:

$$dC = \hat{MPC}\, dY - \sigma \left(1 - \hat{MPC}\right) C \frac{dR}{R}$$

1. Aggregate Income Channel: Weak PIH $\Rightarrow$ low MPC.
2. Intertemporal Substitution Channel: Dominant.

- Heterogeneity introduces three redistributive channels:
  1. Earnings Heterogeneity Channel: Earned/unearned income response to monetary policy vary across population.
     - Amplifies monetary transmission if $Cov_I\left(\hat{MPC}_i, dY\right) < 0$
  2. Fisher Channel: Net nominal borrowers win if $P \uparrow$.
     - Amplifies monetary transmission if $Cov_I\left(\hat{MPC}_i, NNP_i\right) < 0$.
  3. Interest Rate Exposure Channel: Net borrowers win if $R \downarrow$.
     - Amplifies monetary transmission if $Cov_I\left(\hat{MPC}_i, URE_i\right) < 0$.

Estimable Moments

- Auclert makes two further simplifications to write things in terms of estimable moments
  1. Individuals have common IES $\sigma_i = \sigma$.
  2. Individuals have a common elasticity of relative income to aggregate income.
- Then:

$$\frac{dC}{C} = (\mathcal{M} + \gamma\varepsilon_y)\frac{dY}{Y} - \varepsilon_P\frac{dP}{P} + (\varepsilon_R - \sigma S)\frac{dR}{R}$$

  - ε_Y,ε_P, and ε_R are *redistribution elasticities* that relate to appropriately normalized covariances.
  - $\mathcal{M}$ is an income-weighted aggregate MPC related to aggregate income elasticity.
  - S is a Hicksian scaling factor.

Earnings Heterogeneity Channel

- Auclert argues the earnings heterogeneity channel amplifies monetary transmission.

1. Some VAR evidence that cutting nominal interest rate reduces income inequality (Coibion et al. 2017).
2. Also, key Guvenen et al. (2017) fact about countercyclical income risk.
   - In recessions, right tail of idiosyncratic income shock distribution shrinks and left tail expands.
   - Particularly for lower-skill individuals.
   - If mon policy reduces tail risk, helps high MPC households.

Fisher Channel: Doepke and Schneider (2006)

- Doepke and Schneider (2006) measure net nominal positions in the data.
  - Flow of Funds and Survey of Consumer Finances.
  - NNP is sum of present value payment streams (not values) of all nominal assets minus the same for all nominal liabilities.
    - Include indirect positions through investment intermediaries and ownership of firms.
- Construct NNP across sectors (household, government, foreign) over time, and in 1989 and 2000, across households by age and wealth.

Fisher Channel: Doepke and Schneider (2006)

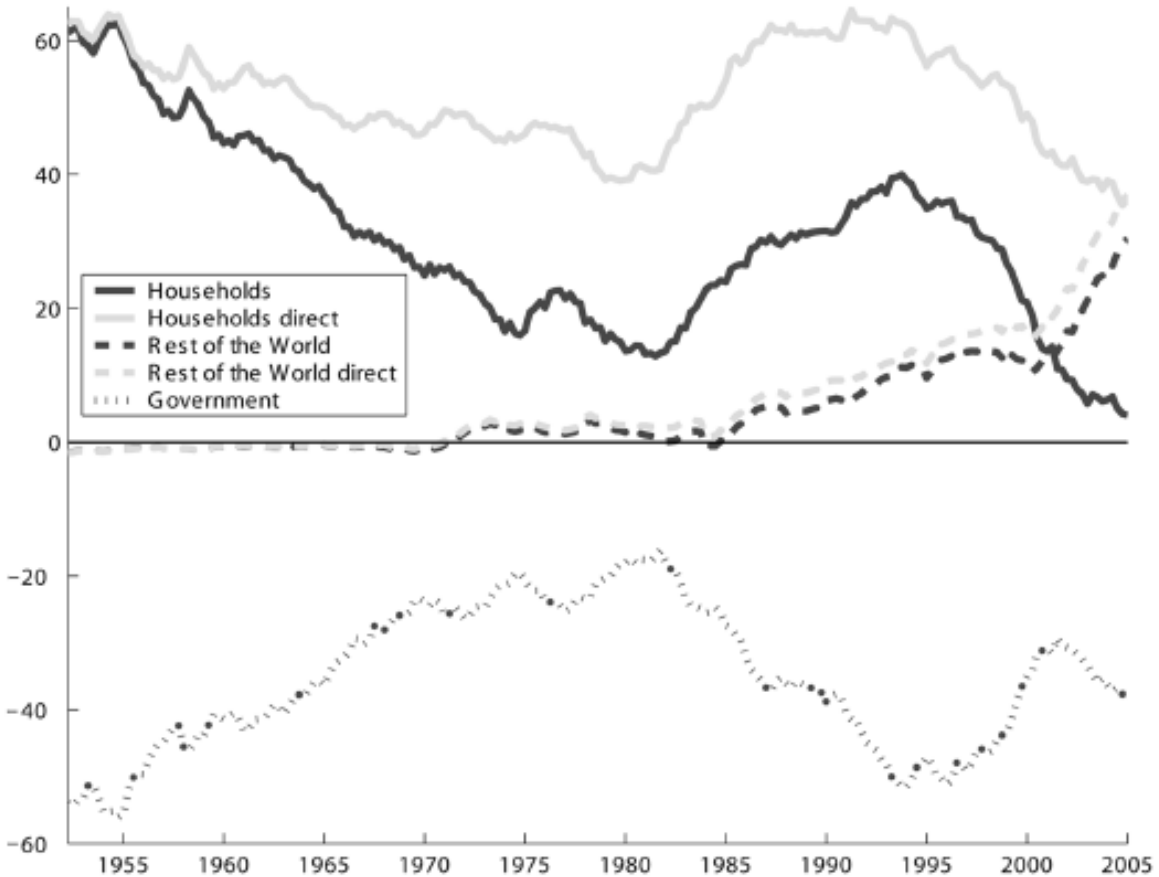


FIG. 1.—NNPs in the United States by sector from 1952 to 2004, as a percentage of GDP. Black lines: total NNP for households (solid), government (dotted), and the rest of the world (dashed). Grey lines: DNP for households (solid) and the rest of the world (dashed).

Fisher Channel: Doepke and Schneider (2006)

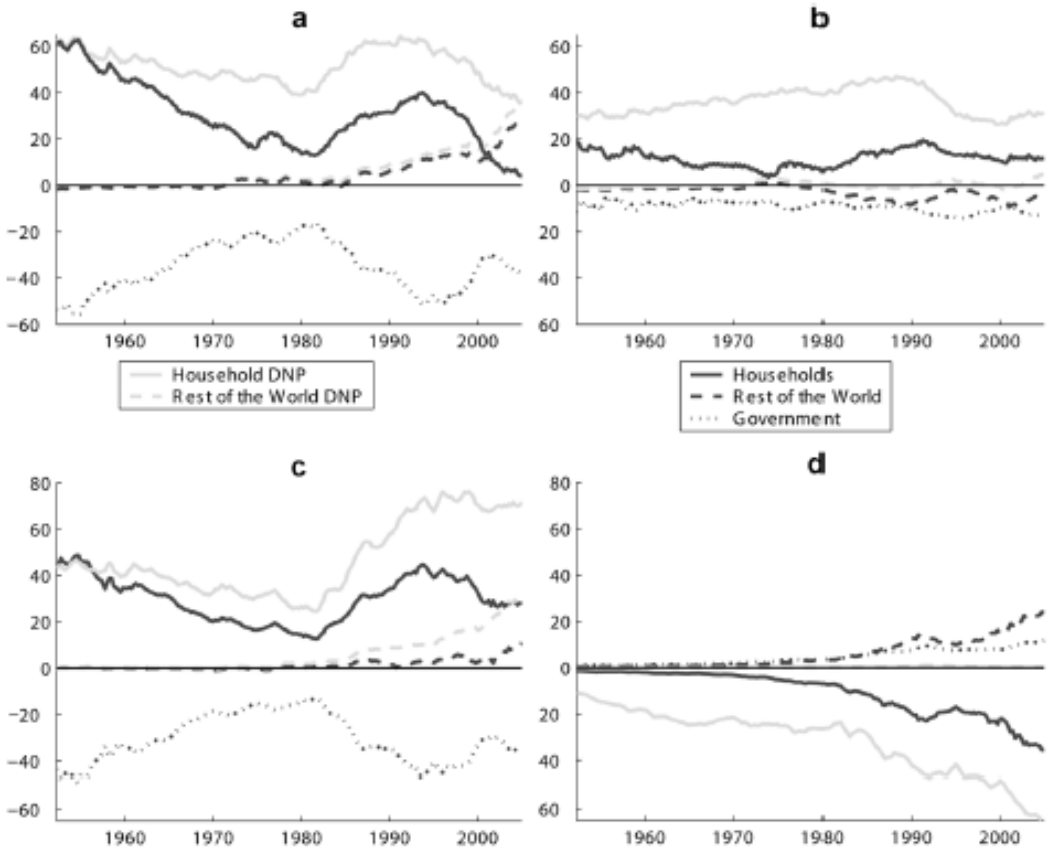


FIG. 2.—NNPs in the United States by sector and class of instrument, 1952–2004, as a percentage of GDP: *a*, total positions by sector (fig. 1); *b*, subtotals for short instruments with maturity up to one year; *c*, bonds with maturity above one year; *d*, mortgages. All panels are drawn to the same scale.

Fisher Channel: Doepke and Schneider (2006)

NET NOMINAL POSITIONS OF U.S. HOUSEHOLDS IN 1989

TYPE OF INSTRUMENT	AGE COHORT					
	≤ 35	36–45	46–55	56–65	66–75	> 75
	A. All Households					
Short-term	−2.3	4.4	5.5	10.8	12.4	18.1
Bonds	11.7	13.2	11.4	12.6	12.4	16.4
Mortgages	−47.5	−23.4	−10.5	−4.7	−1.4	−.4
Equity	−4.5	−4.3	−4.1	−3.5	−4.0	−3.5
Total NNP	−42.6	−10.1	2.3	15.2	19.4	30.6
	B. Poor					
Short-term	−35.9	−10.3	.5	8.9	17.7	25.0
Bonds	15.3	5.4	3.0	3.7	5.8	2.0
Mortgages	−13.2	−24.9	−6.5	−3.5	−5.9	−.1
Equity	−2.8	−4.0	−2.5	−1.6	−.1	−.5
Total NNP	−36.6	−33.8	−5.5	7.5	17.5	26.4
	C. Middle Class					
Short-term	−14.6	2.0	6.2	11.0	17.6	31.7
Bonds	14.9	13.7	11.5	13.4	11.2	8.6
Mortgages	−112.6	−45.4	−20.8	−8.7	−2.3	−.9
Equity	−1.7	−1.9	−1.7	−1.7	−1.3	−1.3
Total NNP	−114.0	−31.6	−4.8	14.0	25.2	38.1
	D. Rich					
Short-term	3.6	6.5	5.2	10.8	9.7	11.8
Bonds	10.3	13.4	11.6	12.5	13.2	20.5
Mortgages	−22.2	−10.4	−4.8	−2.5	−.8	−.1
Equity	−5.7	−5.7	−5.4	−4.5	−5.4	−4.7
Total NNP	−14.0	3.8	6.6	16.3	16.7	27.5

Fisher Channel: Doepke and Schneider (2006)

1. Main losers from inflation are bondholders, who are the old and the rich.
   - These people tend to have low MPCs.
   - In last 25 years, also foreign holders of U.S. nominal debt.
2. Main winners from inflation are young and low-to-middle-class households with fixed-rate mortgage debt.
   - These people tend to have higher MPCs.
   - Also a boon for the government.

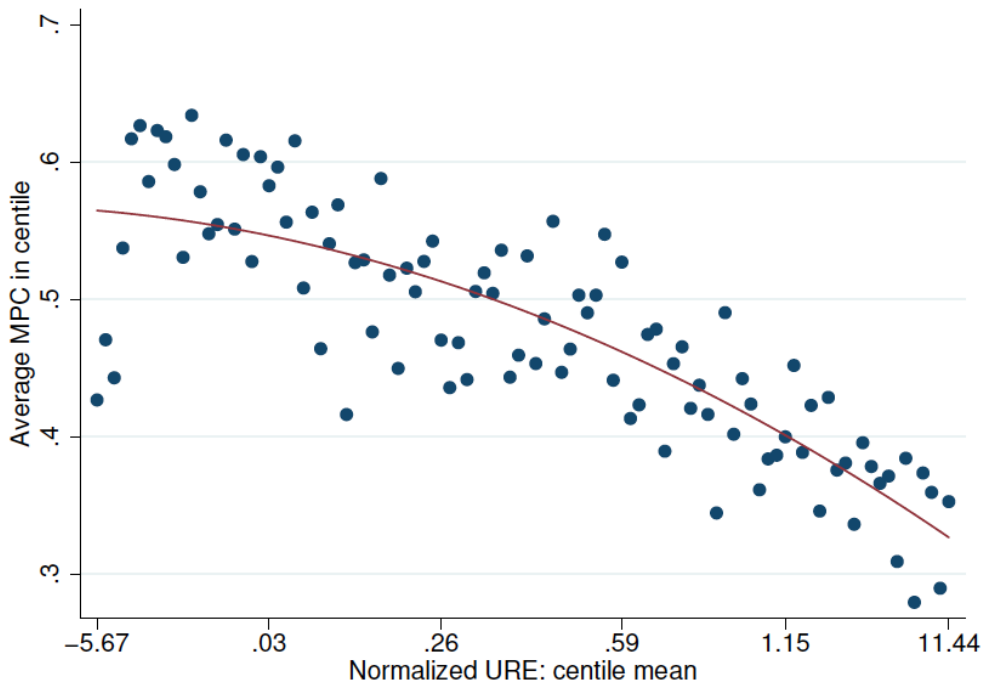
- Seems that $Cov_I\left(\hat{MPC}_i, NNP_i\right) < 0$, so Fisher channel amplifies monetary transmission.

Interest Rate Exposure Channel:

- Auclert quantifies interest rate exposure channel using three sources:
  1. Italian Survey of Household Income and Wealth
  2. PSID semi-structural approach.
  3. Johnson et al. (2006) data on 2001 income tax rebate in Consumer Expenditure Survey.
- All three of these are somewhat heroic exercises. Later two are very noisy so I will skip.
- This is why Auclert downplays the results a bit (the contribution of the paper is the framework).

Interest Rate Exposure Channel

- In my view best evidence is from Italy:
  - MPC from question: What fraction of hypothetical windfall would spend immediately? (Jappelli and Pistaferri, 2014)
  - Construct $URE_i = Y_i - C_i + B_i - D_i$
  - Both MPC and URE are noisy measures, but have them for lots of people.



Rate Exposure Channel and Adjustable-Rate Mortgages

- Thought experiment: If only two channels are URI and intertemp sub, what EIS would generate interest rate exposure channel of equal size to intertemporal substitution channel?
  - Estimable elasticities formula tells us compare σ to $-\varepsilon_R/S$.
  - Three empirical approaches: $-\varepsilon_R/S$ is between 0.1 and 0.4.
  - Typical estimates of EIS are around $\sigma = 0.5$.
  - URE channel roughly same magnitude as intertemp sub.
- Another implication: Economies with adjustable-rate mortgages have more powerful monetary transmission.
  - Under ARMs, UREs are more negative for mortgage borrowers because ARMs "mature" each period.
  - Calibrated model in JMP: MP $2\times$ as powerful with all ARMs.
  - Formalizes folk wisdom at Bank of England (where mortgages all ARMs) that MP works through MPCs interacting with wealth effects as size of mortgage interest payments change.

Auclert (2019): Take Aways

- Important question, fresh sufficient statistic approach.
  - Ideal JMP: Shows broad mix of skills.
  - Importance of having a framework to interpret micro-data.
  - Sufficient statistics may be useful in other contexts.
- Drawbacks
  1. Shocks unanticipated. Why don't people hedge?
  2. Sufficient statistics only works with incomplete markets with transitory shocks.
  3. Focus on change in R. Nothing about credit supply, risk premia, effects of changing collateral prices, or refinancing.
  4. No investment.
  5. Measuring URE in data is difficult and requires lots of assumptions. Best he can, but still heroic.
  6. Sufficient statistics still in some sense "partial equilibrium" because need GE model to get $\frac{dY}{dR}$, $\frac{dY_i}{dR}$, and $\frac{dP}{dR}$.

Two Other Papers That Inspect HANK Mechanisms

- Want to briefly touch on two other papers that unpack mechanisms in HANK models like Auclert's.
  - Unfortunately do not have time to cover them in detail.
  - Want to cover main take aways and leave details to you if you are interested.
  - Lots more in both these papers, which are highly recommended.

1. Auclert-Rognlie-Straub: "The Intertemporal Keynesian Cross"
   - Thinking in terms of sequence space and intertemporal MPCs disciplines thinking and discriminates between models.
2. Werning: "Incomplete Markets and Aggregate Demand"
   - Brilliant paper that uses a toy model to elucidate mechanisms at work with incomplete markets and heterogenous agents.
   - Learn a lot from this paper, but hard to replicate this kind of research.

Auclert, Rognlie, Straub: The Intertemporal Keynesian Cross

- How does fiscal policy affect agg economic activity?
- Old answer: **Keynesian Cross**
  - Combine $Y = C + G$ with $C_t = C(Y_t, T_t)$ to obtain:

$$dY_t = dG_t - mpc \times dT_t + mpc \times dY_t$$

- ARS: ***Intertemporal*** **Keynesian Cross** holds for class of microfounded GE models:

$$d\mathbf{Y} = d\mathbf{G} - \mathbf{M} \cdot d\mathbf{T} + \mathbf{M} \cdot d\mathbf{Y}$$

  - $d\mathbf{Y} = \{dY_t\}$, $d\mathbf{G} = \{dG_t\}$, $d\mathbf{T} = \{dT_t\}$.
  - $\mathbf{M} = \begin{bmatrix} \frac{\partial C_t}{\partial Y_t} & \frac{\partial C_t}{\partial Y_{t+\mathbf{1}}} & \cdots \\ \frac{\partial C_{t+\mathbf{1}}}{\partial Y_t} & \frac{\partial C_{t+\mathbf{1}}}{\partial Y_{t+\mathbf{1}}} & \cdots \\ \vdots & \vdots & \ddots \end{bmatrix}$ where C is agg consumption and Y is agg income is the **intertemporal MPC (iMPC)** matrix.
- **M** matrix is a **sequence space Jacobian** that tells us how much of income change at date s is spent at date t.

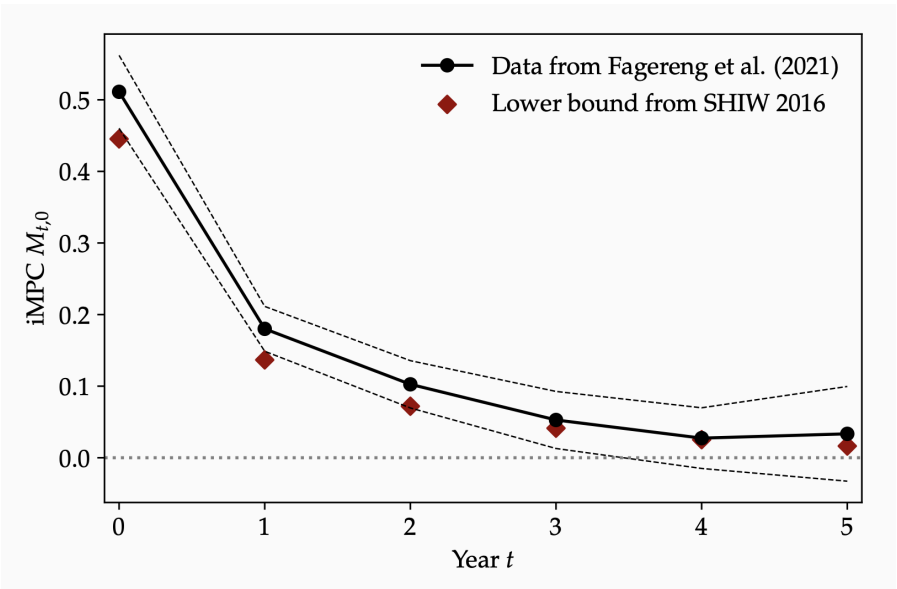
ARS Implication 1: The Importance of iMPCs

$$d\mathbf{Y} = d\mathbf{G} - \mathbf{M} \cdot d\mathbf{T} + \mathbf{M} \cdot d\mathbf{Y}$$

- iMPCs fully characterize transmission of fiscal shocks to Y.
  - Sufficient statistic for the heterogeneity in the model.
    - If constant real rate, no capital, sticky wages, flex prices.
    - If relax, C response to r and surprise cap gain also matter, leading to more complicated $\mathbf{M}$.
  - *Entire complexity* of HANK model is summarized by the iMPC!
  - Bardoczy et al. Sequence Space Jacobian computational approach is an application of this!
- **Useful to think in terms of terms of iMPCs**.
  - Not just for fiscal shocks.
  - Includes GE effects, aggregate effects of heterogeneity, etc.
  - ARS show this holds for a broad class of models, including RANK, TANK, one- and two-asset TANK, etc.
- iMPCs matter for deficit financing of fiscal shocks; irrelevant with balanced budget.

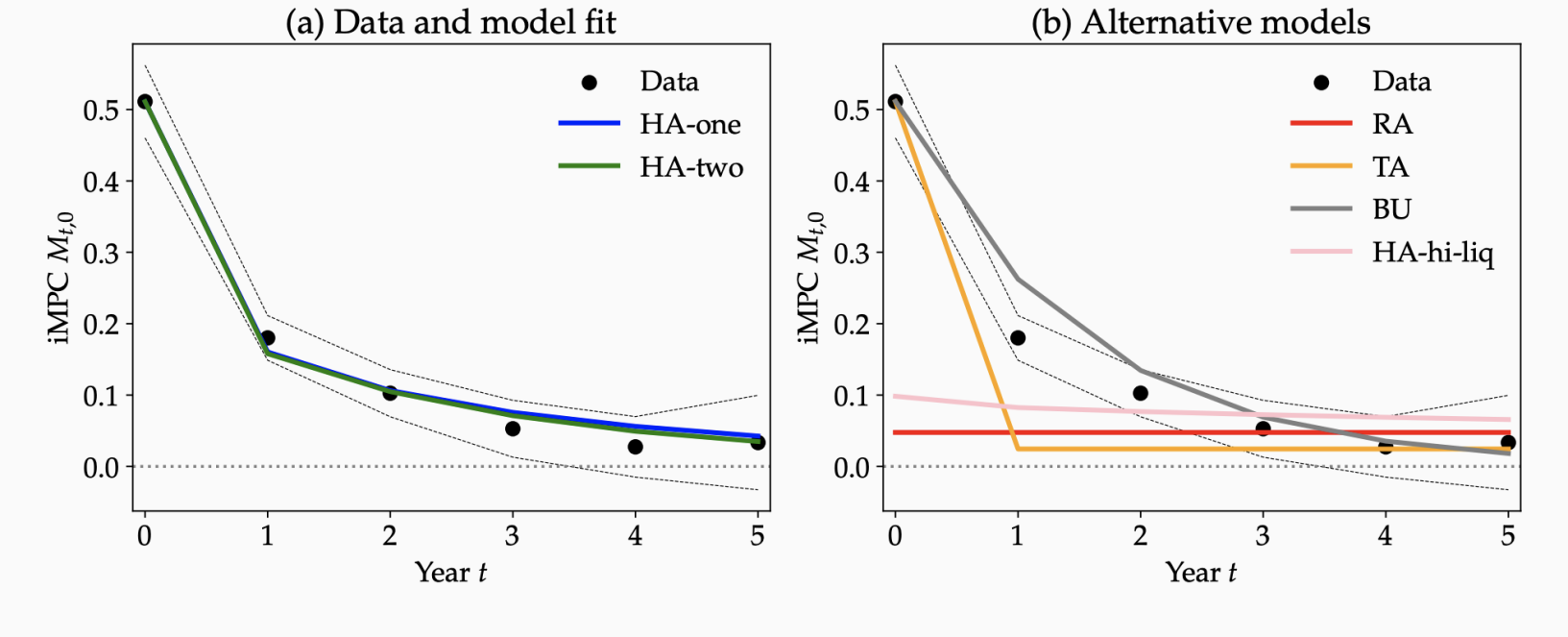
ARS Implication 2: iMPCs Discriminate Between Models

- Can write iMPC as income-weighted integral of individual MPCs. Can then estimate first column $M_{t,0}$ in data.
  1. Fagereng, Holm, and Natvik (2021) MPC from lottery winnings.
  2. Italian survey data from Auclert (2019).



- Key data feature: Still high in years 1 and 2.

ARS Implication 2: iMPCs Discriminate Between Models



- RANK: MPC too low.
- TANK: MPC high in period one when hand to mouth agents eat everything but low thereafter.
- Argue model favors two-asset HANK based on consumption out of surprise cap gains.

Werning Motivation: The Forward Guidance Puzzle

- In NK models, **forward guidance is too powerful**.
  - McKay, Nakamura, and Steinsson (2016) thought experiment.
    - If promise 1pp lower real rate for a quarter 5 years from now, 18× stronger impact on inflation than if promise today!
    - Intuition: **Consumption Euler equation is undiscounted**. If promise in 5 years, consumption higher for 5 years until rate falls. Cumulative C response change drives inflation.
- MNS: **Introducing incomplete markets and idiosyncratic income risk attenuates forward guidance puzzle**.
  - Their intuition: Borrowing constraints and desire for buffer stock shorten planning horizon.
  - This introduces discounting into the Euler equation which mutes consumption response to rate cuts in the future.
- Werning wants to know how general this result is.
  - **What are effects of market incompleteness on aggregate demand in GE?**

Werning: Incomplete Markets and Aggregate Demand

- Standard Bewley-Hggett-Aiyagari incomplete markets on household side.
- Crucial new assumption that cuts through complexity and allows for "simple" GE:
  - Household income is a function of idiosyncratic shock s and aggregate income/spending Y: $y_t^i(s_t) = \gamma_t^i(s, Y)$.
  - Puts focus on demand side effects of incomplete markets.
  - Also turns of permanent heterogeneity (e.g., wealthier agents have more or less cyclical income).
- Then close model in GE: $C = Y$, bond markets clear.
  - **GE feedbacks are key**.
- Define *liquidity* as the value of outside assets and borrowing.
  - Consider zero liquidity case: In autarky.
  - Later positive liquidity.
- Consider acyclical, countercyclical, or procyclical income risk

Werning: "As If" Result

- Theorem: With CRRA, acyclical income risk ($\gamma_t^i(s, Y) = \tilde{\gamma}_t^i(s)\, Y$, and zero liquidity, it is *"as if" there exists a representative agent and an Euler equation holds*:

$$U'(C_t) = \beta_t R_t U'(C_{t+1})$$

  for a β_t for which Werning provides an expression.
  - Incomplete markets affects *levels* of consumption by $\downarrow \beta_t$.
  - But does **not** affect *sensitivity* of C_t to R_t and C_{t+1}, which are still determined by the as if Euler equation.
- Implication: **Forward guidance is just as powerful as in rep agent model in incomplete markets model**.
  - Why? McKay, Nakamura, and Steinsson's intuition was partial equilibrium logic that does not survive in GE.
  - Although MNS say Werning's conclusion depends on everything scaling proportionately with agg income. Weakened if extra income disproportionately received by the rich.

Werning: "As If" Result Intuition

- What is wrong with the MNS logic? Shouldn't constrained people respond less to interest rates?
  - Yes in partial equilibrium.
- But in *general equilibrium*...
  - Households on their Euler equation consume more when interest rates fall.
  - This increases aggregate demand and $C = Y$ so *income rises for the constrained agents*.
  - And the *constrained agents are particularly sensitive to income* even if they are not in PE sensitive to interest rates.
  - **This is just the logic of the Keynesian Cross**!
- In Werning's special case, the constrained and unconstrained households *respond proportionally for different reasons*.
  - Werning shows the exact special case where all agents respond proportionally regardless of how constrained they are.

Werning: Deviations from "As If"

- Werning then perturbs away from the special case and shows how economy strays from the "as if" benchmark.
  - He does this through a serious of ingenious extensions.

Assumptions On			Response of Agg C
Income Risk	Liquidity		to Interest Rates
Countercyclical	Procyclical	$\rightarrow$	Higher Sensitivity
Acyclical	Acyclical	$\rightarrow$	"As If" Representative Agent
Procyclical	Countercyclical	$\rightarrow$	Lower Sensitivity

- Relevant case: Income risk is countercyclical and liquidity is procyclical, both of which would lead to *higher* sensitivity!
- How did MNS get dampening?
  - Procyclical income risk: Countercyclical profits rebated and constant employment probabilities.
  - Countercyclical liquidity: Fixed absolute debt.
- Take away: What matters for ***sensitivities*** *(not levels)* is ***interaction*** of incomplete markets with other factors.