Micro Risks and Macro Policies

Channeling Samuelson into Modern Macro

Mark Aguiar

SED Plenary
June 29, 2023

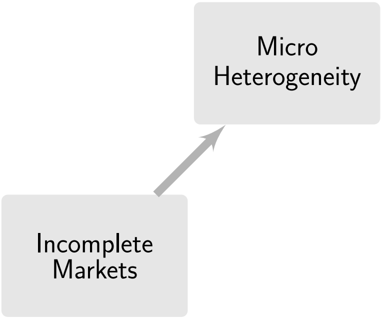
Inequality in Macroeconomics

Incomplete Markets

Inequality in Macroeconomics

Incomplete Markets	Bewley-Imrohoroglu-Huggett-Aiyagari OLG

Inequality in Macroeconomics



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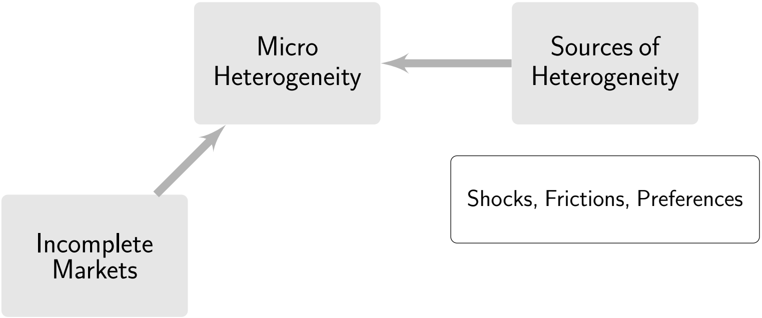

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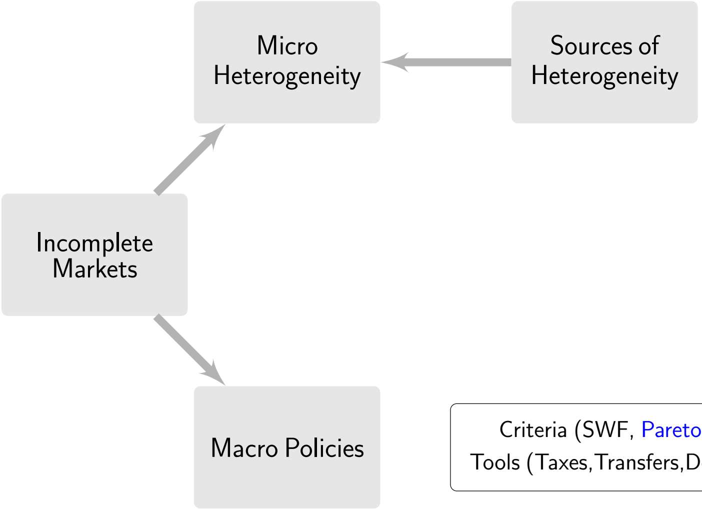

Criteria (SWF, Pareto)
Tools (Taxes,Transfers,Debt)

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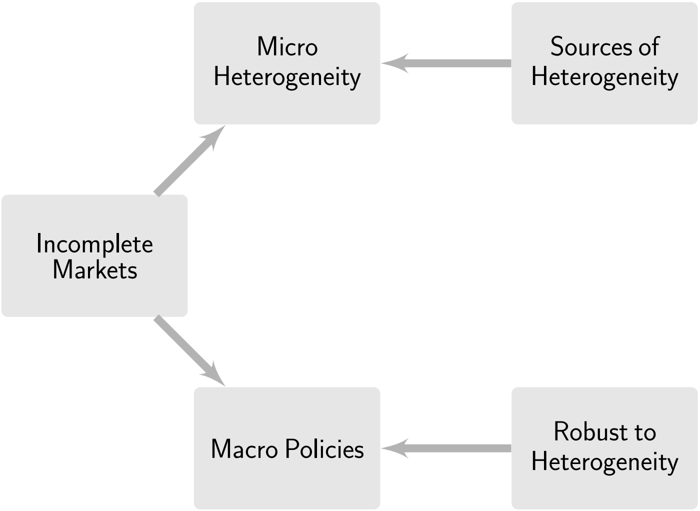
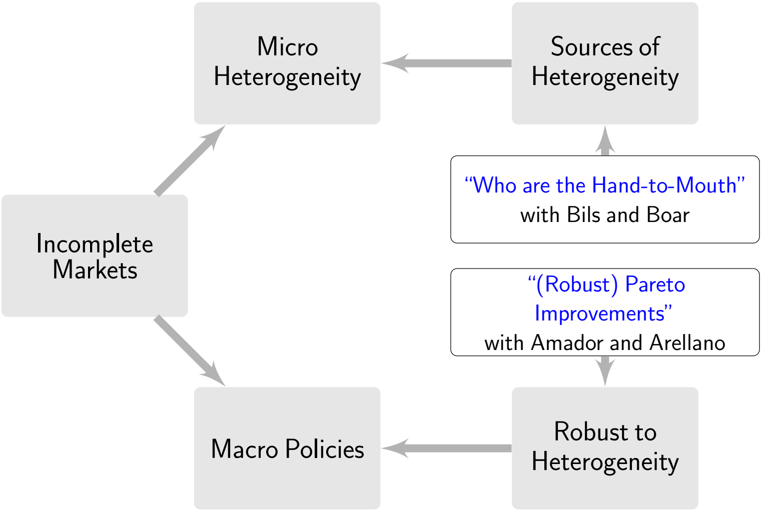


Roadmap


Micro Heterogeneity
Sources of Heterogeneity
"Who are the Hand-to-Mouth" with Bils and Boar
Incomplete Markets
"(Robust) Pareto Improvements" with Amador and Arellano
Macro Policies
Robust to Heterogeneity

Road Map

(i) ABB: How to realistically model inequality

- Why do some households hold little wealth
- Speaks to sources of heterogeneity
- Where does it matter

(ii) AAA: Explore Pareto Improvements

- Simple policies
- Government bonds
- Exploit low interest rates (leverage Samuelson)

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(i) ABB: How to realistically model inequality

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(ii) AAA: Explore Pareto Improvements

- Simple policies
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- Policies need to be *robust*
  - Pareto Criteria: Robust Pareto Improvements (RPI)

Environment:

Augmented Aiyagari

Environment
Households: Budget Sets

- HH budget constraint ($R_t \equiv 1 + r_t$):

$$c_t^i + a_{t+1}^i \leq w_t \underbrace{z_t^i n_t^i}_{\text{labor}} + \underbrace{\theta_t^i \Pi_t}_{\text{share of profits}} + \underbrace{R_t a_t^i}_{\text{savings}} + \underbrace{T_t}_{\text{transfers}}$$

- Idiosyncratic labor productivity: z_t^i
- Idiosyncratic return to entrepreneurial ability: θ_t^i
- Borrowing constraint: $a_{t+1}^i \geq \underline{a}^i$
- *Set* $\underline{a}^i = 0$ *for the talk*

Environment
Households: Preferences

- HH's preferences
  - Standard, no wealth effects on labor supply in baseline (generalization to isoelastic KPR)
- Can vary across individuals
- Can nest different cohorts indexed by t

Environment

Technology

- CRS technology: $F(k, l)$
- Purchases factors competitively: $(1 + \tau^k)r^k$ and $(1 + \tau^n)w$
- Product-market markup (exogenous): $\mu \geq 1$
  - Wedge between F_k and r
  - Alternative: Convenience yield on government bonds
- First-order conditions:

$$F_k = \mu(1 + \tau^k)r^k = (1 + \tau^k)(r + \delta)$$
$$F_l = \mu(1 + \tau^n)w$$

- Profits taxed at rate τ^π:

$$\Pi = (1 - \tau^\pi)\hat{\Pi} = (1 - \tau^\pi)\left(\frac{\mu - 1}{\mu}\right)F(k, l)$$

Environment
Government

- Issues bonds B_t, sets linear taxes on firms $\{\tau_t^n, \tau_t^k, \tau_t^\pi\}$
- Rebates lump-sum transfers: T_t
- Government budget constraint:

$$T_t \leq \underbrace{\tau_t^n w_t N_t + \tau_t^k r_t^k K_t + \tau_t^\pi \hat{\Pi}_t}_{\text{tax revenue}} + \underbrace{B_{t+1} - R_t B_t}_{\text{bond revenue}}$$

Environment
Equilibrium

Arbitrage: $r_t^k = r_t + \delta$, and

$$A_t = \int a^*_{i,t-1}(a^i_{t-1}, z^i_{t-1}, \theta^i_{t-1})di = K_t + B_t$$

$$N_t = \int z^i_t n^*_{i,t}(z^i_t)di = L_t$$

$$C_t = \int c^*_{i,t}di = F(K_t, N_t) - K_{t+1} + (1-\delta)K_t$$

Equilibrium

Given fiscal sequence $\{B_t, T_t, \tau^n_t, \tau^k_t, \tau^\pi_t\}$: HH's optimize, firm's minimize cost subject to markup, government budget constraint holds, markets clear.

Welfare Metric:
Robust Pareto Improvement (RPI)

RPI Path to Pareto Improvements

- At high level, CE clearly not PO
  - Obvious allocations that Pareto dominate CE

RPI Path to Pareto Improvements

- At high level, CE clearly not PO
  - Obvious allocations that Pareto dominate CE
- What allocations are feasible given simple instruments?
- What allocations guarantee Pareto improvement with limited knowledge of preferences and idiosyncratic risk?

$\Rightarrow$ Work through equilibrium prices rather than directly with allocations

Robust Pareto Improvements (RPI)

$$c_t^i + a_{t+1}^i \leq w_t z_t^i n_t^i + \theta_t^i \Pi_t + (1 + r_t) a_t^i + T_t$$

Let $\{w_t^o, r_t^o, \Pi_t^o, T_t^o\}$ be a reference starting equilibrium

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Let $\{w_t^o, r_t^o, \Pi_t^o, T_t^o\}$ be a reference starting equilibrium

Definition. A sequence $\{w_t, r_t, \Pi_t, T_t\}$ is an **RPI** if

- $w_t \geq w_t^o$
- $r_t \geq r_t^o$
- $\Pi_t \geq \Pi_t^o$
- $T_t \geq T_t^o$, (or $T_t^o - (r_t - r_t^o)\underline{a}$ in general)

with at least one inequality strict.

Robust Pareto Improvements

- Expands budget set at all time and idiosyncratic states
- Robust to:
  - Nature of preferences (just need that more is better)
  - Idiosyncratic risks
  - Life span
  - Trading off income across states/times

$\Rightarrow$ Requires limited information at micro/idiosyncratic level

RPI in context

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- Social security (Samuelson 1975): Tax young, transfer to old
- Government insurance: Tax in one state pays transfer in another

Feasibility

Thought Experiment

- Start from stationary equilibrium (for simplicity)
  - Initial factor prices (w^o, r^o, Π^o) and capital K^o
  - Initial debt $B_0 = 0$ and taxes $\{\tau^{ko}, \tau^{wo}, \tau^{\Pi o}\} = 0$
  - Assume $T^o = 0$
- At "$t = 0$" govt announces a fiscal policy plan $\{B_t, \tau_t^n, \tau_t^k, \tau_t^\pi, T_t\}$
- After the announcement, there is perfect foresight

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- After the announcement, there is perfect foresight
- Focus on policies such that $w_t = w^o$ and $\Pi_t = \Pi^o$

  $\Rightarrow$ "constant wage and profit" policies
  - Isolates roles of $r_t \geq r^o$ and $T_t \geq 0$
  - Baseline: no wealth effects $\Rightarrow N_t = N^o$

Quasi-Primal Approach

- Consider candidate sequences $(\boldsymbol{r}, \boldsymbol{T})$:

$$\boldsymbol{r} = \{r_t\}_{t\geq 0}, \text{ and } \boldsymbol{T} = \{T_t\}_{t\geq 0}$$

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Definition. $(\boldsymbol{r}, \boldsymbol{T})$ is *feasible* if $\exists \{B_t, \tau_t^n, \tau_t^k, \tau_t^\pi, T_t\}_{t\geq 0}$ with $B_0 = 0$ that so that $\boldsymbol{r}$ is a part of CE with $K_0 = K^o$ and $A_0 = A^o$

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- Restrictions imposed by equilibrium conditions
- Starting from the initial distribution of wealth, let
  - $\mathcal{A}_t(\boldsymbol{r}, \boldsymbol{T})$: aggregate HH wealth at t

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- Restrictions imposed by equilibrium conditions
- Starting from the initial distribution of wealth, let
  - $\mathcal{A}_t(\boldsymbol{r}, \boldsymbol{T})$: aggregate HH wealth at t
  - $\mathcal{C}_t(\boldsymbol{r}, \boldsymbol{T})$: aggregate consumption at t

$$\mathcal{C}_t(\boldsymbol{r}, \boldsymbol{T}) \equiv w^o N^o + \Pi^o + R_t \mathcal{A}_t(\boldsymbol{r}, \boldsymbol{T}) - \mathcal{A}_{t+1}(\boldsymbol{r}, \boldsymbol{T}) + T_t$$

Feasibility
Income Accounting

$F(K^o, N^o) =$

$w^o N^o$	0
Π^o	$(r^o + \delta)K^o$

$F(K_t, N^o) =$

$w^o N^o$	Taxes_t
Π^o	$(r_t + \delta)K_t$

- Change in tax revenue:

$$\Delta \text{Taxes}_t = F(K_t, N^o) - F(K^o, N^o) - (r_t + \delta)K_t + (r^o + \delta)K^o$$

Feasibility

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- Fiscal Feasibility:

$$T_t + (1 + r_t)B_t \leq \Delta \text{Taxes}_t + B_{t+1}$$

Feasibility Condition

Lemma 1

$(\boldsymbol{r}, \boldsymbol{T})$ is feasible if there exists $\{K_t, B_t\}$ with $K_0 = K^o$, $B_0 = 0$ and for all $t \geq 0$

$$(i) \quad \mathcal{A}_{t+1}(\boldsymbol{r}, \boldsymbol{T}) = B_{t+1} + K_{t+1}, \text{ and}$$

$$(ii) \quad T_t + (1 + r_t)B_t - B_{t+1} \leq F(K_t, N^o) - F(K^o, N^o) - (r_t + \delta)K_t - (r^o + \delta)K^o$$

- If (i) and (ii) can find $\{\tau_t^n, \tau_t^k, \tau_t^\pi\} \rightarrow$ CE
- Collapses micro heterogeneity and CE restrictions into $\mathcal{A}$

Simpler with Walras Law

- Replace gov't budget constraint with aggregate resource constraint ...

Corollary 1

$(\boldsymbol{r}, \boldsymbol{T})$ is feasible if there exists $\{K_t\}$ with $K_0 = K^o$, and

$$\mathcal{C}_t(\boldsymbol{r}, \boldsymbol{T}) \leq F(K_t, N^o) + (1-\delta)K_t - K_{t+1}$$

Looking for RPIs

Constant-K Policy

- Start from $B^o = 0$ and maintain $K_t = K^o$

Proposed RPI:

$$r_t = r' > r^o, \text{ and } T_t = T' = 0$$

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> Proposed RPI:
>
> $$r_t = r' > r^o, \text{ and } T_t = T' = 0$$

- Increase r reduces firms' demand for K (all else equal)
  - Government must subsidize K to avoid crowding out
  - Change in tax revenue

$$\{F(K_t, N^o) - (r_t + \delta)\} - \{F(K^o, N^o) - (r^o + \delta)K^o\}$$
$$= -(r' - r^o)K^o$$

Feasibility

- Feasibility condition:

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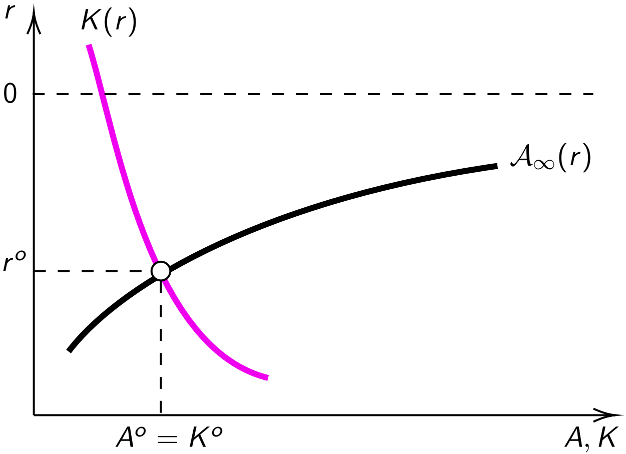
- "Seigniorage" $\geq K$ subsidy: Need $r^o < r' < 0$

Constant-K Policy: Long Run



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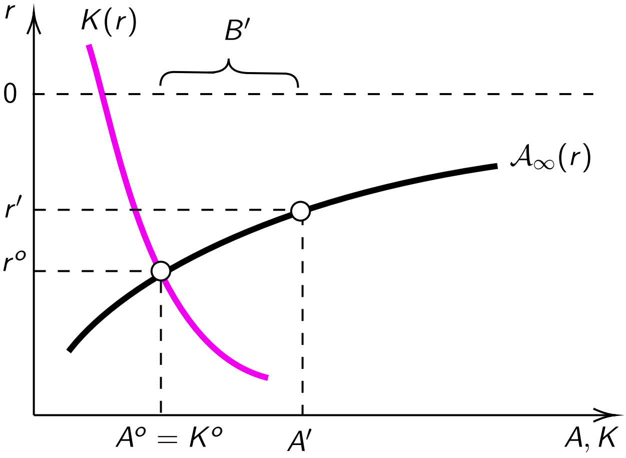

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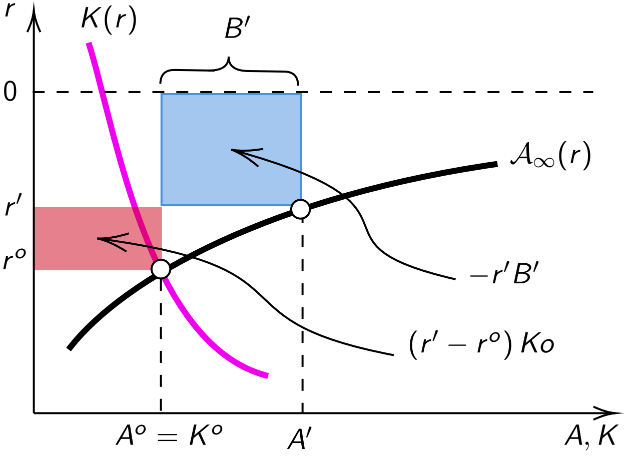

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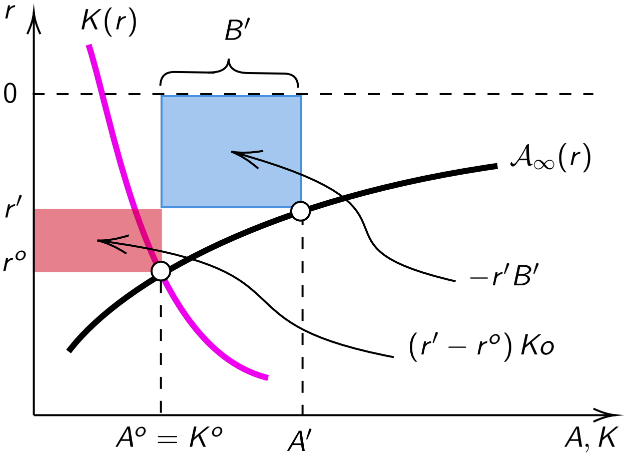

- RPI: If can increase B with small effect on r
- Feasibility depends on elasticity of $\mathcal{A}_\infty(r)$ function

Constant-K Policy: RPI, but how?

- All households budget sets expanded at all dates and states
- But $K_t = K^o$, $N_t = N^o \rightarrow C_t = C^o$

  aggregate consumption does not change!
- Issuance of debt induces better risk sharing

  Samuelson's chocolate wrappers but in Aiyagari

  Need government subsidy
- Need HHs willing to hold B without large Δr

  (but tighter than debt Laffer curve)
- Note:
  - No need to know micro details
  - No need to know production elasticities
  - No need to know μ or info on over-accumulation of capital

Two Views of Government Debt/Money

- Bonds as Claim on Future Taxes: Woodford (1990), Aiyagari-McGrattan (1998)
  - Issue bonds $\rightarrow$ liquid asset
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- Bonds as Social Contrivance: Samuelson (1958)
  - Bonds are storage technology
  - Not a claim on anything physical ($r < g$)

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- Bonds as Social Contrivance: Samuelson (1958)
  - Bonds are storage technology
  - Not a claim on anything physical ($r < g$)
- Leverage Samuelson's insight

Key distinctions with Samuelson

- Richer micro-heterogeneity
- Neoclassical Production
  - Physical capital is sensitive to interest rates
  - Changes in factor prices have distributional consequences
- Key elasticity
  - Aggregate saving elasticity to interest rate
  - Not elasticity of money (or liquidity) demand vs other assets
- Need the government
  - Private bubble not a path to RPI

Loose Ends

- We have ignored the transition:

$$B_{t+1} - (1 + r')B_t \geq (r' - r^o)K^o$$

or equivalently,

$$\mathcal{A}_{t+1}(\{r'\}) - (1 + r')\mathcal{A}_t(\{r'\}) \geq -r^o K^o$$

$\Rightarrow$ Short-term elasticities of $\mathcal{A}$ also matter

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$\Rightarrow$ Short-term elasticities of $\mathcal{A}$ also matter

- Ruling out capital changes is an unnecessary restriction
  - Interesting case: K below Golden Rule ($F_k > \delta$)

Dynamic RPI

- Suppose gov't perturbs interest rate at time $\tau > 0$:

$$r_t = \begin{cases} r^o & \text{if } t \neq \tau \\ r' > r^o & \text{if } t = \tau \end{cases}$$

- Let $\xi_{t,\tau}$ be the sequence of saving elasticities for $t = 0, 1, \ldots$

$$\xi_{t,\tau} \equiv \frac{\partial \mathcal{A}_t}{\partial r_\tau} \frac{R^o}{A^o}$$

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- Sufficient condition involves PDV of elasticities:

$$\boxed{\left(\frac{\tilde{F}_k - R^o}{R^o} \right) \sum_{t=1}^{\infty} \tilde{F}_k^{-(t-\tau)} \xi_{t,\tau} > 1}$$

- Inter-temporal ToT is $\tilde{F}_k \equiv F_k + 1 - \delta$ not $R^o \equiv 1 + r^o$

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- Inter-temporal ToT is $\tilde{F}_k \equiv F_k + 1 - \delta$ not $R^o \equiv 1 + r^o$
- Can use B and K to "average" short- and long-term elasticities

What is the Elasticity of Aggregate Savings?

- Calibrated version (IES=1):
  - An increase in B of 60% of GDP $\Rightarrow$ r increases $\approx$ 40 bp in short run, 30 bp in long run
  - Short-run elasticity: 4.6
  - Long-run elasticity: 75
- RPI exists for a wide range of μ and IES
- Are large elasticities plausible?

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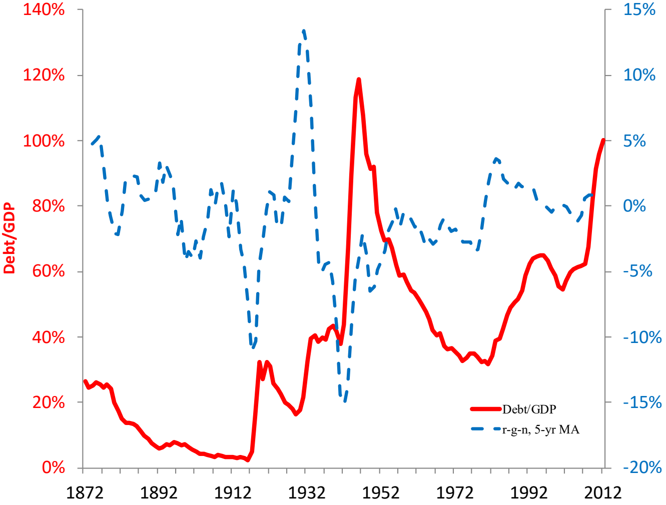

Mehrotra and Sergeyev (2021)

Taking Stock

- Higher r and more B facilitate risk sharing
  - Willingness to delay consumption when times are good
  - Consume more when times are bad
- Central prediction of the buffer stock model of savings

Taking Stock

- Higher r and more B facilitate risk sharing
  - Willingness to delay consumption when times are good
  - Consume more when times are bad
- Central prediction of the buffer stock model of savings
- To what extent do people smooth this way?
- Do the data say something about micro heterogeneity

Behavior of the Hand-to-Mouth (H2M)

- Euler Equation:

$$\mathbb{E}_t \left[\beta R \left(\frac{c_{t+1}}{c_t} \right)^{-\frac{1}{\sigma}} \right] \leq 1,$$

- If log-normal shocks to c:

$$\mathbb{E}_t \Delta \ln c_{t+1} \geq \sigma \ln(\beta R) + \frac{1}{2\sigma} Var_t(\Delta \ln c_{t+1}).$$

- Constrained and low-asset households anticipate higher future consumption growth

- Build up buffer stock of assets over time

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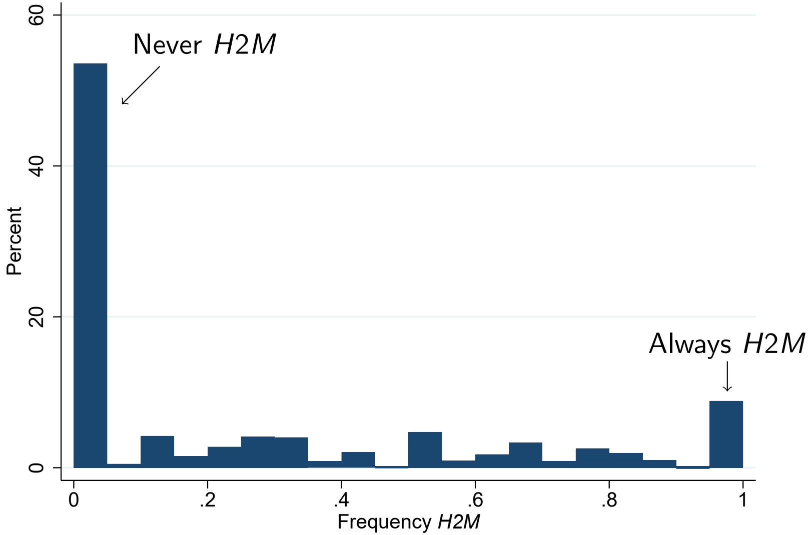
- Constrained and low-asset households anticipate higher future consumption growth
- Build up buffer stock of assets over time
- What do the data say?
  - Do they speak to preference heterogeneity?

The $H2M$ stay $H2M$

- Define $H2M$ in PSID as net-worth$<$ 2 months labor earnings
- Almost quarter of sample
- Conditional on $H2M$ today:
  - 65% are $H2M$ in 2 years
  - 58% are $H2M$ in 4 years
- Distribution of $H2M$ status is bi-modal
  - 53% are never observed to be $H2M$ in sample
  - 9% are *always* $H2M$

Frequency *H2M*



The $H2M$ do not average higher c growth

$$\mathbb{E}_t \Delta \ln c_{t+1} \geq \sigma \ln(\beta R) + \frac{1}{2\sigma} Var_t(\Delta \ln c_{t+1}).$$

- Regress realized $\Delta \ln c_{t+1}$ on $H2M_t$ status and controls:

	(1)
$H2M$	.002
	(.004)
Fixed Effects	No

- On average, $H2M$ have no additional consumption growth

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- Regress realized $\Delta \ln c_{t+1}$ on $H2M_t$ status and controls:

	(1)	(2)
$H2M$	.002	.020
	(.004)	(.007)
Fixed Effects	No	Yes

- On average, $H2M$ have no additional consumption growth
- *Within* household variation consistent with theory
  - Households differ in "target assets"

More Patterns

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- Not just confined to low-income households

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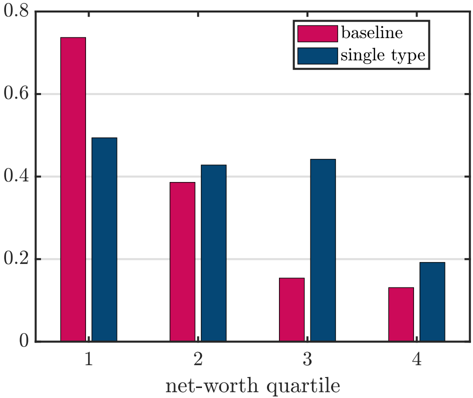
- Crucial moment: Consumption growth regression

Implications

- *H2M* are not just constrained, but different
- 84% of difference in MPC of *H2M* is due to type
- Significantly amplifies sensitivity of MPC to wealth



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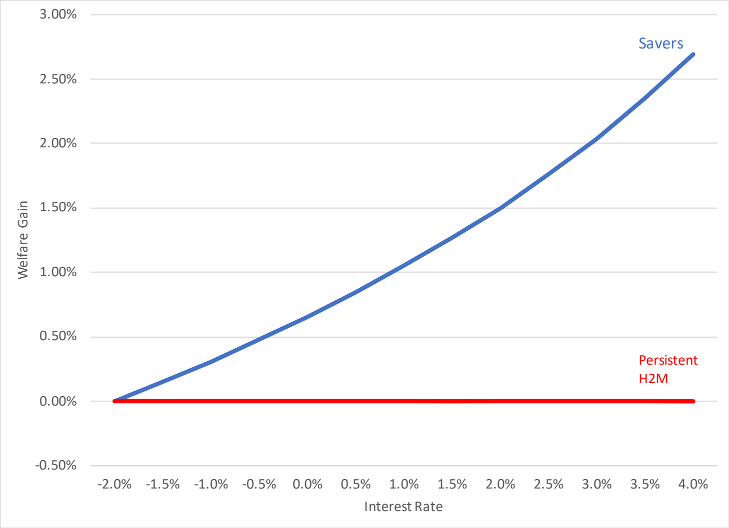
- Who benefits and how from bond issuance?
- Conceptually, two legs to welfare gains:
  - **(i)** Transfer when debt is issued: Favors $H2M$
  - **(ii)** Higher r in transition and new steady state: Favors savers

PE Welfare Gains at Birth from Higher r



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- Room for Pareto Improving bond issuance when $r < g$
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- Room for Pareto Improving bond issuance when $r < g$
- Need to offset factor price declines with subsidies
- Key elasticity is that of Aggregate Saving
- Avoids explicit redistribution
- Can be extended to monetary policy
- No Panacea
  - Roughly 25% are persistently $H2M$
  - Higher r not a clear benefit
  - Sensitive to transfers

¡Gracias!