Monetary Policy and the Redistribution Channel

Adrien Auclert

MIT

Mortgage Contract Design Conference
New York Fed
May 20, 2015
Mortgage contract structure appears to affect the strength of monetary policy effects on consumption.

Traditional monetary policy models cannot explain this:

- \( r \downarrow \Rightarrow C \uparrow \) mainly due to *intertemporal substitution*
- Redistributive effects on borrowers and savers net out
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**This paper:** redistribution is part of the transmission mechanism

- Those who gain from $r \downarrow$ have higher MPCs
- *Redistribution channel*, stronger in countries with ARMs
- Stress general equilibrium: borrowers and savers
Who gains and who loses?

My colleagues and I know that people who rely on investments that pay a fixed interest rate, such as certificates of deposit, are receiving very low returns, a situation that has involved significant hardship for some.

Ben Bernanke, October 2012

The Federal Reserve’s policies have benefited the relatively well off; it is trying to raise the prices of assets which are overwhelmingly owned by the rich.

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- Savers with different asset durations experience different welfare gains from low rates, and may adjust consumption differently
- To get the level effect, need to know consumption and income plans
- Moreover: monetary policy affects inflation, earnings, etc.
Where we are headed

- Monetary policy $\rightarrow$ macroeconomic aggregates $m = r, P, Y$
  - Real interest rates ($r$), inflation ($P$), and the level of output ($Y$)
- Household $i$ has
  - balance sheet Exposure$_{i,m}$ to $dm$
  - Exposure$_{i,P}$ [Doepke and Schneider 2006]
  - marginal propensity to consume $MPC_i$
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- Effect of redistribution through $m$ on aggregate consumption?
Introduction

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**Redistribution elasticity** $\mathcal{E}_m = \text{Cov}_I (MPC_i, \text{Exposure}_{i,m})$
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Redistribution elasticity $= \mathcal{E}_m = \text{Cov}_I (MPC_i, \text{Exposure}_{i,m})$

- $\mathcal{E}_m$: sufficient statistic [Harberger 1964, Chetty 2009]
Sufficient statistic: real interest rate change

- Focus on $m = r$. Cyclical monetary policy, stable inflation
- $\mathcal{E}_r$: “unhedged (interest)-rate exposure”.
Sufficient statistic: real interest rate change

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$$URE_i = \underbrace{\text{maturing assets}_i}_{\text{including income}} - \underbrace{\text{maturing liabilities}_i}_{\text{including consumption}}$$
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  - Italy [Jappelli, Pistaferri 2014] & US [Johnson, Parker, Souleles 2006]
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  - $\varepsilon_r < 0$. Redistribution channel $\Rightarrow C \uparrow$ when $r \downarrow$
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- Implication for general equilibrium models
  - Monetary policy shocks have larger output effects
  - Sufficient statistics provide a novel calibration procedure
Dynamic general equilibrium model

- GE model calibrated to U.S. economy matches $E_r$ and predicts:
  1. $E_r$ more negative when assets and liabilities have shorter maturities
     - If U.S. only had adjustable rate mortgages, surprise rate change would more than double current effect
     - Cross-country S-VAR evidence [Calza, Monacelli, Stracca 2013]
  2. Interest rate increases and cuts have asymmetric effects
     - $r \uparrow$ lowers output more than $r \downarrow$ increases it
     - [Cover 1992, de Long Summers 1988, Tenreyro Thwaites 2013]
     - Here: asymmetric response of borrowers close to their credit limits
Dynamic general equilibrium model

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Limits of analysis

- Framework that accommodates
  - Heterogeneity
  - Nominal and real financial assets of arbitrary duration
  - Precautionary savings, borrowing constraints

- Abstracts away from
  - Risk premia
  - Refinancing
  - Illiquidity and cash holdings
  - Collateral price effects on borrowing constraints
Related literature

- **Monetary policy and redistribution [empirics]**
  - Inflation: Doepke and Schneider (2006)
  - Earnings: Coibion, Gorodnichenko, Kueng, Silvia (2012)
  - Consumption effects: Di Maggio, Kermani, Ramcharan (2014); Keys, Piskorski, Seru and Yao (2014)

- **Monetary policy shocks and the transmission mechanism [theory]**
  - Christiano, Eichenbaum, Evans (1999, 2005), ...
  - Heterogenous effects : Gornemann, Kuester and Nakajima (2014)

- **MPC heterogeneity [theory and empirics]**
Outline

1. Partial equilibrium: $\mathcal{E}_r$ as sufficient statistic
   - Price theory
   - Incomplete markets
   - Aggregation

2. Measuring $\mathcal{E}_r$

3. General equilibrium model
Outline

1. Partial equilibrium: $\mathcal{E}_r$ as sufficient statistic
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2. Measuring $\mathcal{E}_r$

3. General equilibrium model
Perfect foresight, no uncertainty

- Single agent
  - arbitrary non-satiable preferences and time horizon
  - earns a stream of real income \( \{y_t\} \) and wages \( \{w_t\} \) (certain)
  - faces real term structure \( \{t q_{t+s}\}_{s \geq 1} \)
  - holds long-term real assets: \( \{t-1 b_{t+s}\}_{s \geq 0} \) (TIPS, PLAM)
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- Solves:

\[
\begin{align*}
\max & \quad U(\{c_t, n_t\}) \\
\text{s.t.} & \quad c_t = y_t + w_t n_t + (t-1 b_t) + \sum_{s \geq 1} (t q_{t+s}) (t-1 b_{t+s} - t b_{t+s})
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- Date-0 holdings: \( \{-1b_{t+s}\}_{s \geq 0} \), term structure \( q_t = (0_{q_t}) \)
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- **Solves**:

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& \quad \text{Financial wealth } W^F
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- Initial balance sheet composition irrelevant conditional on \( W^F \)
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  Financial wealth \( W^F \)

- → Initial balance sheet composition irrelevant conditional on \( W^F \)
- Mortgage \( M \): ARM \(-1 b_0 = -M \) ⇔ PLAM \(-1 b_t = -m \) if \( \sum_{t=0}^{T} q_t m = M \)
Unexpected shock

\[
\max \quad U(\{c_t, n_t\}) \\
\text{s.t.} \quad \sum_{t \geq 0} q_t c_t = \sum_{t \geq 0} q_t (y_t + w_t n_t + (-1) b_t) \equiv W
\]

- \( t = 0 \rightarrow \) unexpected one-time shock to the real term structure (\( \frac{dq_0}{q_0} = dr \))
- First-order change in consumption \( dc_0 \)?
Unexpected shock

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\[
dc_0 \simeq \frac{\partial c_0}{\partial W} \cdot (y_0 + w_0 n_0 + (-1 b_0) - c_0) \ dr + \underbrace{dc_0^h}_{\text{Wealth effect}} + \underbrace{dc_0^h}_{\text{Substitution effect}}
\]
Unexpected shock

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\max \quad U \left( \{ c_t, n_t \} \right)
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\]

- Wealth effect
- Substitution effect

- Welfare change \( dU \simeq U_{c_0} \cdot (y_0 + w_0 n_0 + (-1 b_0) - c_0) \) \( dr \)
Unexpected shock

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- Welfare change \( dU \simeq U_{c_0} \cdot (y_0 + w_0 n_0 + (-1b_0) - c_0) \ dr \)
- **Composition of balance sheet matters**: e.g. “hedged” when

\( -1b_0 = c_0 - (y_0 + w_0 n_0) \quad \forall t \)
Unexpected shock

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\begin{align*}
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- Substitution effect

Welfare change \( dU \simeq U_{c_0} \cdot (-1 URE_0) \ dr \)

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- $t = 0 \rightarrow$ unexpected one-time shock to the real term structure ($\frac{dq_0}{q_0} = dr$)
- First-order change in consumption $dc_0$?
  $$dc_0 \simeq \underbrace{\frac{\partial c_0}{\partial y_0}}_{\text{MPC}} \cdot \underbrace{(y_0 + w_0 n_0 + (-1 b_0) - c_0)}_{-1URE_0} dr + \underbrace{dc_0^h}_{\text{Substitution effect}}$$

- Welfare change $dU \simeq U_{c_0} \cdot (-1 URE_0) dr$
- **Composition of balance sheet matters:** e.g. “hedged” when
  $$-1 b_0 = c_0 - (y_0 + w_0 n_0) \quad \forall t \quad \rightarrow \quad -1 URE_0 = 0$$
Unhedged interest rate exposure

\[ URE \equiv -1 URE_0 = y_0 + w_0 n_0 + \left( -1 b_0 \right) - c_0 \]

- When all financial wealth \( W^F \) has short maturity:
  - \( URE = y + wn + W^F - c \)
  - Holder of short-term assets tends to gain when \( r \) rises

- One-time \( dr \) change, generic \( U \)
  - \( dc_0 = MPC \cdot URE \cdot dr + dc_0^h \)
Unhedged interest rate exposure

\[ URE \equiv -1 URE_0 = y_0 + w_0 n_0 + (\overbrace{-1 b_0}^{\text{maturing assets}}) - c_0 \]

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- One-time \( dr \) change, time-separable \( \sum \beta^t U(c_t, n_t) \)

\[ dc = MPC \cdot URE \cdot dr - \sigma c (1 - MPC) dr \]

- \( \sigma \equiv -\frac{U_c}{c U_{cc}} \) local EIS
Unhedged interest rate exposure

\[ URE \equiv -1 URE_0 = \underbrace{y_0 + w_0 n_0 + (-1 b_0)}_{\text{maturing assets}} - c_0 \underbrace{- c_0}_{\text{maturing liabilities}} \]

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  - Holder of short-term assets tends to gain when \( r \) rises
- One-time \( dr \) change, time-separable \( \sum \beta^t U(c_t, n_t) + \) date-0 income \( dy \)
  \[ dc = MPC (dy + UREdr) - \sigma c (1 - MPC) dr \]
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Unhedged interest rate exposure

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- When all financial wealth \( W^F \) has short maturity:
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- + permanent change in price level \( dP \) (w/ nominal assets)

\[
dc = MPC \left( dy + URE dr - \frac{dP}{P} \right) - \sigma c \left( 1 - MPC \right) dr
\]

- \( \sigma \equiv -\frac{U_c}{c U_{cc}} \) local EIS

- \( NNP \equiv \sum_{t \geq 0} Q_t (-1 B_t) \) net nominal position
Outline

1. Partial equilibrium: $E_r$ as sufficient statistic
   - Price theory
   - Incomplete markets
   - Aggregation

2. Measuring $E_r$

3. General equilibrium model
Incomplete markets, idiosyncratic risk

- Assume now incomplete markets with idiosyncratic uncertainty on \( \{y_t, w_t\} \)
- Nominal bonds with geometric-decay coupon \( \Lambda_t \), rate \( \delta_N \)
- Perfect foresight over nominal bond price \( Q_t \) and price level \( P_t \)

\[
\max \mathbb{E} \left[ \sum_t \beta^t U (c_t, n_t) \right]
\]

\[
P_t c_t = P_t y_t + P_t w_t n_t + \Lambda_t + Q_t (\delta_N \Lambda_t - \Lambda_{t+1})
\]

\[
\Lambda_{t+1} \geq -P_t \bar{\lambda}
\]

- Define net nominal position \( NNP_t \) and unhedged interest rate exposure

\[
NNP_t \equiv (1 + Q_t \delta_N) \frac{\Lambda_t}{P_t}
\]

\[
URE_t \equiv y_t + w_t n_t + \frac{\Lambda_t}{P_t} - c_t = \frac{Q_t}{P_t} (\Lambda_{t+1} - \delta_N \Lambda_t)
\]
Individual consumption response: one-time change

- Inelastic labor supply \( n \)
- At time 0: permanent increase in price level \( dP \), purely transitory change in income \( dY = dy + ndw \) and the real interest rate \( dr = -\frac{dQ}{Q} \)
**Individual consumption response: one-time change**

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**Sufficient statistics for consumption response to transitory shocks**

To first order, the consumption response at date 0 is given by

$$dc \simeq MPC \left( dY + URE dr - NNP \frac{dP}{P} \right) - \sigma c (1 - MPC) dr$$

where $MPC = \frac{\partial c}{\partial y}$ is the consumption response to a *one-time transitory income shock* ($MPC=1$ if constrained) and $\sigma = -\frac{U_c}{cU_{cc}}$ is the local EIS.
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- Logic: consumer is at an interior optimum \( \rightarrow \) behaves identically with respect to all changes in his balance sheet (or borrowing limit adapts)
- Extensions: elastic labor supply, trees with dividends, ...
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   - Price theory
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2. Measuring $\mathcal{E}_r$

3. General equilibrium model
Aggregation: environment

- Environment:
  - Closed economy with no government
  - $i = 1 \ldots I$ heterogenous agents (date-0 income $Y_i = y_i + w_in_i$)
  - All participate in financial markets and face the same prices
- Aggregate up (transitory shock, here inelastic labor supply)

$$dc_i \simeq MPC_i \left( dY_i + URE_i dr - NNP_i \frac{dP}{P} \right) - \sigma_i c_i (1 - MPC_i) dr$$
Partial equilibrium: $\mathcal{E}_r$ as sufficient statistic

**Aggregation: environment**

- **Environment:**
  - Closed economy with no government
  - $i = 1 \ldots I$ heterogenous agents (date-0 income $Y_i = y_i + w_i n_i$)
  - All participate in financial markets and face the same prices
- Aggregate up (transitory shock, here inelastic labor supply)
  \[
  dc_i \simeq MPC_i \left( dY_i + URE_i dr - NNP_i \frac{dP}{P} \right) - \sigma_i c_i (1 - MPC_i) \ dr
  \]
- Markets clear at date 0:
  - Goods
    \[
    C \equiv \sum_i c_i = \sum_i Y_i \equiv Y \Rightarrow \sum_i URE_i = 0
    \]
  - Assets (here all nominal)
    \[
    \sum_i NNP_i = 0
    \]
Aggregation with heterogeneity

Aggregate consumption response to transitory shock

\[ dC \simeq \left( \sum_i \frac{Y_i}{Y} MPC_i \right) dY + \text{Cov}_I \left( MPC_i, dY_i - Y_i \frac{dY}{Y} \right) - \text{Cov}_I \left( MPC_i, NNP_i \right) \frac{dP}{P} \]

\[ + \left( \text{Cov}_I \left( MPC_i, URE_i \right) - \sum_i \sigma_i (1 - MPC_i) c_i \right) dr \]

- Logic of Keynesian model: “\( dC = dY \)” given \( dr \)
- Two sources of “first-round” effects of \( r \downarrow \) on consumption
- Second-round effects: income and price adjustment
- With representative-agent (New-Keynesian model), fixed point is

\[ dC = -\sigma C dr \]
Aggregation with heterogeneity

Aggregate consumption response to transitory shock

\[
\frac{dC}{C} \simeq \mathbb{E}_I \left[ \frac{Y_i}{Y} \cdot MPC_i \right] \frac{dY}{Y} + \text{Cov}_I \left( MPC_i, \frac{dY_i - Y_i \frac{dY}{Y}}{\mathbb{E}_I [c_i]} \right) - \text{Cov}_I \left( MPC_i, \frac{NPN_i}{\mathbb{E}_I [c_i]} \right) \frac{dP}{P} \\
+ \left( \text{Cov}_I \left( MPC_i, \frac{URE_i}{\mathbb{E}_I [c_i]} \right) - \sigma \mathbb{E}_I \left[ (1 - MPC_i) \frac{c_i}{\mathbb{E}_I [c_i]} \right] \right) dr
\]

- \( \sigma \): weighted average of \( \sigma_i \)
- \( \mathcal{M}, \mathcal{E}_P, \mathcal{E}_r \) and \( S \) are measurable
  - do not depend on the source of the shock
  - do not require identification (except for MPC)
- \( dE^h \) more complex
Focus on slope term

\[
\frac{dC}{C} \simeq \mathcal{M} \frac{dY}{Y} + dE^h + \mathcal{E}_P \frac{dP}{P} + (\mathcal{E}_r - \sigma S) \, dr
\]

▶ **Next**: go to data, find \( \mathcal{E}_r = \text{Cov}_I\left(MPC_i, \frac{\text{URE}_i}{\mathbb{E}_I[c_i]}\right) < 0 \)

▶ compare to \( \sigma \) using \( \sigma^* = -\frac{\mathcal{E}_r}{S} \)
Focus on slope term

\[ \frac{dC}{C} \simeq M \frac{dY}{Y} + dE^h + \varepsilon_P \frac{dP}{P} - S (\sigma^* + \sigma) \, dr \]

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Next: go to data, find \( \varepsilon_r = \text{Cov}_I \left( \text{MPC}_i, \frac{\text{URE}_i}{\mathbb{E}_t[c_i]} \right) < 0 \)

- compare to \( \sigma \) using \( \sigma^* = -\frac{\varepsilon_r}{S} \)

But: usually, in household data \( \mathbb{E}_t [\text{URE}_i] > 0 \). Why?

- Maturity mismatch in the household sector (counterpart of banks)
- Government with flow borrowing requirements (negative URE)
- My benchmark: “Ricardian view” (uniform rebate). \( \varepsilon_r \) still correct.
**Partial equilibrium: \( \mathcal{E}_r \) as sufficient statistic**

**Aggregation**

### Focus on slope term

\[
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- If *none* of the gains are rebated: \( \mathcal{E}^{NR}_r = \mathbb{E}_I \left[ \text{MPC}_i \frac{\text{URE}_i}{\text{E}_I[c_i]} \right] \)
Focus on slope term

\[
\frac{dC}{C} \simeq \mathcal{M} \frac{dY}{Y} + dE^h + \mathcal{E}_P \frac{dP}{P} + (\mathcal{E}_r^{NR} - \sigma S) \, dr
\]

- **Next**: go to data, find \( \mathcal{E}_r = \text{Cov}_I \left( \text{MPC}_i, \frac{URE_i}{E_I[c_i]} \right) < 0 \)
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  - \( \mathcal{E}_r^{NR} - \sigma S > 0 \)?
**Focus on slope term**

\[
\frac{dC}{C} \simeq \mathcal{M} \frac{dY}{Y} + dE^h + \mathcal{E}_P \frac{dP}{P} + (\mathcal{E}_{r}^{NR} - \sigma S) \, dr
\]

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  - \( \mathcal{E}_{r}^{NR} - \sigma S > 0 ? \)

“Interestingly [...] low rates could even hurt overall spending”

Raghuram Rajan, November 2013
Outline

1. Partial equilibrium: $\mathcal{E}_r$ as sufficient statistic
   - Price theory
   - Incomplete markets
   - Aggregation

2. Measuring $\mathcal{E}_r$

3. General equilibrium model
Map to data

1. Construct a URE measure at the household level

\[ URE_i = Y_i - C_i + B_i - D_i \]

- \( Y_i \): income from all sources
- \( C_i \): consumption (incl. durables, mtge paymts, excl. house purchase)
- \( B_i \): maturing asset stocks (especially deposits)
- \( D_i \): maturing liability stocks (adjustable rate mortgages, cons. credit)

2. Use a procedure to evaluate \( MPC_i \) at the household or group level

- Italy Survey of Household Income and Wealth 2010
  - Survey measure [Jappelli Pistaferri 2014]
  - Estimate from randomized receipts of tax rebates [JPS 2006]

3. Estimate \( \varepsilon_r, S, \sigma^* = -\frac{\varepsilon_r}{S} \) and \( \varepsilon_r^{NR} \)
Both surveys and methods show that $\mathcal{E}_r < 0$.

\[ \mathcal{E}_r = \text{Cov}_i \left( MPC_i, \frac{URRE_i}{\mathbb{E}_i[c_i]} \right) < 0 \]
Italian data estimation

- Household-level information on MPC and URE: compute directly

\[ \hat{E}_r = \text{Cov}_I \left( MPC_i, \frac{URE_i}{\mathbb{E}_I [c_i]} \right) \]

\[ \hat{S} = \mathbb{E}_I \left[ (1 - MPC_i) \frac{c_i}{\mathbb{E}_I [c_i]} \right] \]

\[ \hat{E}_{NRr} = \mathbb{E}_I \left[ MPC_i \frac{URE_i}{\mathbb{E}_I [c_i]} \right] \]

<table>
<thead>
<tr>
<th>Time Horizon</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
<td>Estimate</td>
</tr>
<tr>
<td>Redistribution elasticity</td>
<td>( \hat{E}_r )</td>
</tr>
<tr>
<td>Hicksian scaling factor</td>
<td>( \hat{S} )</td>
</tr>
<tr>
<td>Equivalent EIS</td>
<td>( \hat{\sigma}^* = -\frac{\hat{E}_r}{\hat{S}} )</td>
</tr>
<tr>
<td>No-rebate elasticity</td>
<td>( \hat{E}_{NRr} )</td>
</tr>
</tbody>
</table>

All statistics computed using survey weights
Run MPC estimation over $J = 3$ groups of URE and compute:

\[
\begin{align*}
\hat{\varepsilon}_{r}^{NR} &= \mathbb{E}_j \left[ MPC_j \frac{URE_j}{E_j [c_i]} \right] \\
\hat{\varepsilon}_r &= \text{Cov}_J \left( MPC_j, \frac{URE_j}{E_j [c_i]} \right) \\
\hat{S} &= \mathbb{E}_j \left[ (1 - MPC_j) \right]
\end{align*}
\]

<table>
<thead>
<tr>
<th>Consumption measure</th>
<th>Food</th>
</tr>
</thead>
<tbody>
<tr>
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<td>No-rebate elasticity</td>
<td>$\hat{\varepsilon}_{r}^{NR}$</td>
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</table>

Confidence intervals are bootstrapped by resampling households 100 times with replacement.
Outline

1. Partial equilibrium: $\mathcal{E}_r$ as sufficient statistic
   - Price theory
   - Incomplete markets
   - Aggregation

2. Measuring $\mathcal{E}_r$

3. General equilibrium model
General equilibrium model

- **Objectives**
  - Propose a rationale for sign and magnitude of $E_r$ and $\sigma^*$ in the data
  - Understand the role of (mortgage) market structure
  - Evaluate the aggregate effect of persistent shocks
  - Explore non-linearities in economy’s response

- **Model is stylized**
  - “ARM” experiment only illustrative
  - Earnings heterogeneity ($dE^h$) not disciplined by data
  - Unexpected shock
Preferences and production

- Measure 1 of households $i$ with GHH preferences:

$$\mathbb{E} \left[ \sum_{t=0}^{\infty} (\beta^t_i) u (c_t^i - v (n_t^i)) \right]$$

- CES in net consumption $\sigma$, constant elasticity of labor supply $\psi$

- All uncertainty is purely idiosyncratic
  - Idiosyncratic productivity process $\Pi_e (e' | e)$
  - Independent discount factor process $\Pi_\beta (\beta' | \beta)$
  - Aggregate state $s = (e, \beta)$ is in its stationary distribution

- Two-tiered production:
  - Measure 1 of intermediate good firms, identical linear production

$$x_t^j = A t l_t^j = \int_i e_t^i n_t^{i,j} di$$

- Final good $Y_t$: aggregator of $x_t^j$, elasticity $\epsilon$
Markets and government

- **Incomplete markets**: risk-free nominal bond + borrowing constraint
- Affine tax and transfer schedule on labor income *alone*:

\[ P_t c_t^i = (1 - \tau) W_t e_t^i n_t^i + P_t T_t + \Lambda_t^i + Q_t (\delta N^i \Lambda_t^i - \Lambda_{t+1}^i) \]

\[ Q_t \Lambda_{t+1}^i \geq -DP_t \]

- Perfectly competitive final good \((P_t)\) and labor markets \((W_t)\)
- Monopolistically competitive intermediate goods \((P^j_t)\)
Markets and government

- **Incomplete markets**: risk-free nominal bond + borrowing constraint
- Affine tax and transfer schedule on labor income *alone*:

\[
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\]

\[Q_t \Lambda_{t+1}^i \geq -DP_t\]

- Perfectly competitive final good \((P_t)\) and labor markets \((W_t)\)
- Monopolistically competitive intermediate goods \((P_t^i)\)
- Government *collects all profits*, runs a balanced budget with no debt

\[P_t T_t = \int_j \left[ P_t^i x_t^i - W_t l_t^i \right] dj + \tau \int_i W_t e_t^i n_t^i di\]

- No external supply of assets: market clearing \(\int_i Q_t \Lambda_{t+1}^i di = 0\)
Steady-state neutrality of maturity structure

Maturity neutrality

The flexible-price steady state (constant productivity $A$, constant inflation rate $\Pi = 1$, constant gross debt limit $\bar{D}$) is invariant to $\delta_N$

- Constant term structure of interest rates
  - $\rightarrow$ short and long-term assets span the same set of contingencies
- Unhedged interest rate exposures

$$URE_t^i \equiv (1 - \tau) \frac{W_t}{P_t} e_t n_t^i + T_t + \frac{\Lambda_t^i}{P_t} - c_t^i$$

vary with maturity structure, but are refinanced at constant $R$

- Change $\delta_N \rightarrow$ change average duration of assets, leave all else equal
- **Experiment**: Calibrate $\delta_N$ to U.S. then set $\delta_N = 0$: “only ARMs”
Calibration

- Calibration: quarterly frequency
- Targets:
  - Annual eqbm. $R = 3\%$ and debt/PCE ratio of 113\% (U.S. 2013)
  - Asset/liability duration of 4.5 years (from Doepke-Schneider)
  - $Y = C = 1$ and $\mathbb{E} [\eta] = 1$
  - Average quarterly MPC $= 0.25$

Parameters:
- Time preference process $\beta$: patient ($\beta = 0.97$) and impatient ($\beta = 0.82$)
- 50\% of impatient agents
- Average state duration of 50 years
- Elasticity of labor supply $\psi = 1$
- Elasticity of substitution in net consumption $\sigma = 0.5$
- Asset/liability coupon decay rate $\delta = 0.95$
- Borrowing limit as fraction of average consumption $D = 185\%$
- Productivity discretized AR(1), $\rho = 0.95$ and $\tau^* = 0.4$
Calibration

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  - Borrowing limit as fraction of average consumption $\overline{D} = 185\%$
  - Productivity discretized AR(1), $\rho = 0.95$ and $\tau^* = 0.4$
Redistribution channel in the model

For transitory monetary policy shock, can show:

\[
\frac{dC}{C} \simeq M \frac{dY}{Y} + dE^h + E_P \frac{dP}{P} - S (\sigma^* + \sigma) \, dr
\]

+ \underbrace{T \frac{dY}{Y}}_{\text{Complementarity channel}}

Details and compare to data

<table>
<thead>
<tr>
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</tr>
<tr>
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</tr>
<tr>
<td><strong>Consumption-labor compl. term</strong></td>
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Redistribution channel in the model

- For transitory monetary policy shock, can show:

\[
\frac{dC}{C} \approx \mathcal{M} \frac{dY}{Y} + \underbrace{dE_{\text{h}}^{\text{h}}}_{\mathcal{E}_Y \frac{dY}{Y}} + \mathcal{E}_P \frac{dP}{P} - S (\sigma^* + \sigma) \, dr 
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<td>Consumption-labor compl. term</td>
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</tr>
</tbody>
</table>
Sticky prices

- In a steady-state, suppose prices are fully sticky: $P_t = P_{t-1}$
- Central bank stabilizes, nominal interest rate = steady-state $R$
  - Replicates the flexible-price allocation
- Monetary policy shock: unexpectedly lowers the nominal rate

$$R_t = \rho R_{t-1} + (1 - \rho) R - \epsilon_t$$
Sticky prices

- In a steady-state, suppose prices are fully sticky: \( P_t = P_{t-1} \)
- Central bank stabilizes, nominal interest rate = steady-state \( R \)
  - Replicates the flexible-price allocation
- **Monetary policy shock**: unexpectedly lowers the nominal rate
  \[
  R_t = \rho R_{t-1} + (1 - \rho) R - \epsilon_t
  \]
- Fisher channel is shut down
- Full nonlinear solution keeping track of wealth distribution
  - find sequence \( \{w_t\} \) ensuring market clearing \( C_t = Y_t \)
- Borrowing limits keep real value of payments next period fixed
Transitory monetary policy easing

Transitory monetary policy shock (persistence=0)

- Real interest rate impulse
- Output response: US calibration
- Output response: representative agent
- t=0 predicted values from sufficient statistic

Per cent deviation from steady-state

Time in quarters
-1 0 1 2 3 4 5 6 7 8 9 10

Adrien Auclert (MIT)
Transitory monetary policy easing

Transitory monetary policy shock (persistence=0)

- Real interest rate impulse
- Output response: US calibration
- Output response: Only ARMs
- Output response: representative agent
- t=0 predicted values from sufficient statistic

Per cent deviation from steady-state vs. Time in quarters:

-1 0 1 2 3 4 5 6 7 8 9 10
Prolonged monetary policy easing

![Graph showing persistent monetary policy shock (persistence=0.5)]

- Real interest rate impulse
- Output response: US calibration
- Output response: Only ARMs
- Output response: representative agent

Per cent deviation from steady-state
Asymmetric effects

Effect on output of a change in $r$ (General Equilibrium)

- US benchmark calibration
- First-order approx.
- ARM-only calibration
- First-order approx.
Monetary policy redistributes:

- One reason why it affects aggregate consumption
- Likely to be the dominant one in ARM countries
- Sufficient statistics, $\mathcal{E}_m = \text{Cov}_1 \left( \text{MPC}_i, \text{Exposure}_{i,m} \right)$, establish orders of magnitude and discipline model calibrations

Implications for mortgage market design and monetary policy:

- Capital gains can act against MPC-aligned redistribution
- The effects of monetary policy may vary (with $\mathcal{E}_r$) over the cycle
- Redistribution elasticities, tracked through household surveys, can inform monetary policy decisions
Thank you!
SHIW MPC question

- In the 2010 survey [analyzed by Jappelli and Pistaferri 2014]

Imagine you unexpectedly receive a reimbursement equal to the amount your household earns in a month. How much of it would you save and how much would you spend? Please give the percentage you would save and the percentage you would spend.

- In the 2012 survey

Imagine you receive an unexpected inheritance equal to your household’s income for a year. Over the next 12 months, how would you use this windfall? Setting the total equal to 100, divide it into parts for three possible uses:

1. Portion saved for future expenditure or to repay debt \((MPS)\)
2. Portion spent within the year on goods and services that last in time (jewellery and valuables, motor vehicles, home renovation, furnishing, dental work, etc.) that otherwise you would not have bought or that you were waiting to buy \((MPD)\)
3. Portion spent during the year on goods and services that do not last in time (food, clothing, travel, holidays, etc.) that ordinarily you would not have bought \((MPC)\)
Johnson, Parker, Souleles (2006) tax rebates

- Sort all households into $J$ quantiles of $URE$
- Run main estimating equation from JPS:

$$C_{i,m,t+1} - C_{i,m,t} = \alpha_m + \beta X_{i,t} + \sum_{j=1}^{J} MPC_j R_{i,t+1} QURE_{i,j} + u_{i,t+1}$$

- $C_{i,m,t}$: level of $i$’s consumption expenditure in month $m$ and date $t$
- $X_{i,t}$: age and family composition
- $R_{i,t+1}$: dollar amount of the rebate receipt
- $QURE_{i,j} = 1$ if household $i \in$ interest rate exposure group $MPC_j$
- Estimation of $MPC_j$ exploits randomized variation in timing of receipt of tax rebate among households in $URE$ group $j$
## Datasets: summary statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>SHIW 2010</th>
<th>CEX 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>mean</strong></td>
<td><strong>n.s.d.</strong></td>
<td><strong>mean</strong></td>
</tr>
<tr>
<td>Income from all sources ($Y_i$, per year)</td>
<td>36,114</td>
<td>0.90</td>
</tr>
<tr>
<td>Consumption incl. mortgage payments ($C_i$, per year)</td>
<td>27,976</td>
<td>0.61</td>
</tr>
<tr>
<td>Deposits and maturing assets ($B_i$)</td>
<td>14,200</td>
<td>1.45</td>
</tr>
<tr>
<td>ARM mortgage liabilities and consumer credit ($D_i$)</td>
<td>6,228</td>
<td>1.03</td>
</tr>
<tr>
<td>Unhedged interest rate exposure ($URE_i$, per year)</td>
<td>16,110</td>
<td>1.92</td>
</tr>
<tr>
<td>Unhedged interest rate exposure ($URE_i$, per Q)</td>
<td>10,007</td>
<td>7.07</td>
</tr>
<tr>
<td>Marginal Propensity to Spend (annual)</td>
<td>0.47</td>
<td>0.35</td>
</tr>
<tr>
<td>Count</td>
<td>7,951</td>
<td></td>
</tr>
</tbody>
</table>

"mean": sample mean computed using sample weights (in € for SHIW; current USD for CEX)

"n.s.d": normalized standard deviation, $sd_i \left( \frac{X_i}{\mathbb{E}[C_i]} \right)$ for $X_i = Y_i, C_i, B_i, URE_i$ and $sd_i (MPC_i)$ for MPC
Idiosyncratic productivity process: discretized AR(1)

\[ \log e_t = \rho \log e_{t-1} + \sigma_e \sqrt{1 - \rho^2} \epsilon_t \quad \epsilon_t \sim \mathcal{N}(0, 1) \]

- Lognormal stationary distribution of pre-tax earnings, var. \( \sigma_e^2 (1 + \psi)^2 \)
- Set \( \sigma_e (1 + \psi) = 1.04 \) to empirical counterpart in 2009 PSID
- \( \tau^* = 0.4 \) matches typical calibration for (post-tax) earnings
- Moderate persistence level: \( \rho = 0.95 \) (quarterly)
Constrained agents and MPCs in steady state

![Graph showing fraction of agents at the borrowing limit vs. discretized income state (S)]

![Graph showing MPC vs. net financial asset position (% of annual per capita PCE)]
Redistribution elasticity $\mathcal{E}_r$ in the model and in data

![Graph showing redistribution elasticity $\mathcal{E}_r$](image)
Other moments

- Construct counterpart to $Q\Lambda$: net interest-paying assets (Deposits, IRAs and other assets minus all debts)

<table>
<thead>
<tr>
<th>$Q\Lambda$</th>
<th>Mean</th>
<th>sd</th>
<th>P5</th>
<th>P25</th>
<th>Median</th>
<th>P75</th>
<th>P95</th>
<th>P99</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSID 2009</td>
<td>1.17</td>
<td>32.51</td>
<td>-28.42</td>
<td>-6.88</td>
<td>0.00</td>
<td>1.78</td>
<td>35.86</td>
<td>113.90</td>
</tr>
<tr>
<td>Model</td>
<td>0</td>
<td>17.96</td>
<td>-7.4</td>
<td>-7.27</td>
<td>-6.11</td>
<td>0.32</td>
<td>25.96</td>
<td>54.05</td>
</tr>
</tbody>
</table>

Units: average quarterly consumption
Transition after shocks

- Debt limit maintains next period real coupon payments fixed:
  \[ \overline{D_t} = Q_t \overline{d} \iff \lambda_{t+1} \geq -\overline{d} \]

- When \( \Pi_t = 1 \), B.C. of agents at the borrowing limit:

\[
c^i_t = y^i_t - \left( \overline{d} + \frac{Q_t}{\overline{Q}} \times \left( \overline{D} (1 - \delta_N) \right) \right)
\]

<table>
<thead>
<tr>
<th></th>
<th>Steady-state value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \delta_N = 0.95 )</td>
<td>( \delta_N = 0 )</td>
</tr>
<tr>
<td>( \text{min} {y^i} )</td>
<td>0.413</td>
</tr>
<tr>
<td>( \overline{d} )</td>
<td>0.413</td>
</tr>
<tr>
<td>( \overline{URE} )</td>
<td>-0.358</td>
</tr>
<tr>
<td>( (R - 1) \overline{D} )</td>
<td>0.055</td>
</tr>
</tbody>
</table>
Monetary policy and the redistribution channels

Standard New-Keynesian model (fully sticky prices)
Monetary policy and the redistribution channels

Monetary accommodation → Real interest rate ↓ → Aggregate demand ↑ → Aggregate income ↑ → Individual incomes ↑

Standard New-Keynesian model (fully sticky prices)

Redistribution channels
Monetary policy and the redistribution channels

- Monetary accommodation
- Real interest rate ↓
- Aggregate demand ↑
- Aggregate income ↑
- Individual incomes ↑

Standard New-Keynesian model (fully sticky prices)

Redistribution channels
Monetary policy and the redistribution channels

- Monetary accommodation
- Real interest rate ↓
- Aggregate demand ↑
- Aggregate income ↑
- Hours worked ↑
- Individual incomes ↑

- Complementarity
- Interest-rate exposure
- Substitution
- Aggregate MPC
- Earnings heterogeneity

- Standard New-Keynesian model (fully sticky prices)
- Consumption/labor complementarities
- Redistribution channels