Monetary Policy and the Redistribution Channel

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How does monetary policy work?

Why does it affect consumption?

- Traditional view: intertemporal substitution
  - Redistribution is part of the transmission mechanism
  - Those who gain from monetary expansions have higher MPCs

Three key dimensions of redistribution:

- Earnings heterogeneity channel (income $Y$
- Fisher channel (price level $P$
- Interest rate exposure channel (real interest rate $R$

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Why does it affect consumption?
  Traditional view: intertemporal substitution
Redistributive effects between “borrowers” and “savers”?
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  - Traditional view: netting out
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  - Those who gain from monetary expansions have higher MPCs
    - Redistribution channel
  - Three key dimensions of redistribution
    - Earnings heterogeneity channel (income $Y$)
    - Fisher channel (price level $P$)
    - Interest rate exposure channel (real interest rate $R$)
Who gains and who loses from changes in $R$?

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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- Asset durations matter
- **But also:** consumption and income plans
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- Asset durations matter
- But also: consumption and income plans
- What really matters: “unhedged interest rate exposures”

\[
URE = \text{maturing assets} - \text{maturing liabilities} \\
\quad \text{including income} - \text{including consumption}
\]
Main contributions

1. Define household-level *balance-sheet exposures* to transitory change in $m = Y, P, R$

   ▶ Sufficient statistics [Harberger 1964, Chetty 2009]

2. Show that the effect of redistribution through $m$ on aggregate consumption is given by a redistribution elasticity $E_m = \text{Cov}(\text{MPC}_i, \text{Exposure}_i, m)$

   ▶ All negative in data
   ⇒ redistribution contributes to monetary transmission

4. Calibrate a partial eqbm model that suggests:
   a. $E_R$ more negative when assets and liabilities have shorter maturities
      ▶ explains existing ARM evidence [Calza, Monacelli, Stracca 2013]
   b. $E_P$ implausibly negative with only nominal assets
   c. Asymmetric effects $R \uparrow$ vs $R \downarrow$ [Cover 1992]
      ▶ response of borrowers close to their credit limits
Main contributions

1. Define household-level balance-sheet exposures to transitory change in \( m = Y, P, R \)

2. Show that the effect of redistribution through \( m \) on aggregate consumption is given by a **redistribution elasticity**

\[
\mathcal{E}_m = \text{Cov}_I (MPC_i, \text{Exposure}_{i,m})
\]
Main contributions

1. Define household-level balance-sheet exposures to transitory change in $m = Y, P, R$

2. Show that the effect of redistribution through $m$ on aggregate consumption is given by a redistribution elasticity

\[ \varepsilon_m = \text{Cov}_I \left( MPC_i, \text{Exposure}_{i,m} \right) \]

- Sufficient statistics [Harberger 1964, Chetty 2009]
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- **Sufficient statistics** [Harberger 1964, Chetty 2009]

3. Measure \( \varepsilon_R, \varepsilon_P, \varepsilon_Y \) in three surveys (Italy 2010, US 1999–2013)

- All negative in data
- \( \Rightarrow \) redistribution contributes to monetary transmission

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   ➤ All negative in data
   
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      - response of borrowers close to their credit limits
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

- **Heterogeneous effects of monetary policy in the data**
  - Inflation: Doepke and Schneider (2006)
  - Earnings: Coibion, Gorodnichenko, Kueng, Silvia (2012)

- **Monetary policy shocks and the transmission mechanism**
  - Christiano, Eichenbaum, Evans (1999, 2005), ...

- **MPC heterogeneity**
Outline

1. Partial equilibrium: $\mathcal{E}_m$ as sufficient statistics
   Single agent, perfect foresight
   Incomplete markets
   Aggregation

2. Measuring redistribution elasticities

3. Insights from partial equilibrium model
Outline

1. Partial equilibrium: $\mathcal{E}_m$ as sufficient statistics
   - Single agent, perfect foresight
   - Incomplete markets
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2. Measuring redistribution elasticities

3. Insights from partial equilibrium model
Perfect foresight, no uncertainty

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

\[
\begin{align*}
\max & \quad U \left( \{c_t, n_t\} \right) \\
\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})
\end{align*}
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  - holds real long-term assets: \( \{t-1b_{t+s}\}_{s \geq 0} \)
- Date-0 term structure \( q_t = (0q_t) \), holdings \( \{-1b_{t+s}\}_{s \geq 0} \)
- Solves:
  \[
  \max \quad U (\{c_t, n_t\}) \\
  \text{s.t.} \quad c_t = y_t + w_t n_t + (t-1b_t) + \sum_{s \geq 1} (tq_{t+s})(t-1b_{t+s} - tb_{t+s})
  \]
Perfect foresight, no uncertainty

- Single agent
  - arbitrary non-satiable preferences and time horizon
  - earns real income $\{y_t\}$, real wage $\{w_t\}$
  - faces real term structure $\{t q_{t+s}\}_{s \geq 1}$
  - holds real long-term assets: $\{-1 b_{t+s}\}_{s \geq 0}$

- Date-0 term structure $q_t = (0 q_t)$, holdings $\{-1 b_{t+s}\}_{s \geq 0}$

- Solves:

\[
\begin{align*}
\max & \quad U(\{c_t, n_t\}) \\
\text{s.t.} & \quad \sum_{t \geq 0} q_t c_t = \sum_{t \geq 0} q_t (y_t + w_t n_t) + \sum_{t \geq 0} q_t (-1 b_t) 
\end{align*}
\]
Perfect foresight, no uncertainty

- Single agent
  - arbitrary non-satiable preferences and time horizon
  - earns real income \( \{ y_t \} \), real wage \( \{ w_t \} \); price level \( \{ P_t \} \)
  - faces real term structure \( \{ t q_{t+s} \}_{s \geq 1} \), nominal \( t Q_{t+s} = (t q_{t+s}) \frac{P_t}{P_{t+s}} \)
  - holds real long-term assets: \( \{ t-1 b_{t+s} \}_{s \geq 0} \), nominal \( \{ t-1 B_{t+s} \}_{s \geq 0} \)
- Date-0 term structure \( q_t = (0 q_t) \), holdings \( \{ -1 b_{t+s} \}_{s \geq 0}, \{ -1 B_{t+s} \}_{s \geq 0} \)
- Solves:

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\max & \quad U (\{ c_t, n_t \}) \\
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  - faces real term structure \{\tau_q t+s\}_{s \geq 1}, nominal \tau Q t+s = (\tau q t+s) \frac{P_t}{P_{t+s}}
  - holds real long-term assets: \{\tau b t+s\}_{s \geq 0}, nominal \{\tau B t+s\}_{s \geq 0}

- Date-0 term structure \tau q = (0 \tau q), holdings \{\tau b t+s\}_{s \geq 0}, \{\tau B t+s\}_{s \geq 0}

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& \quad \text{Financial wealth } \omega^F
\end{align*}
\]
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- Single agent
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  - earns real income \( \{ y_t \} \), real wage \( \{ w_t \} \); price level \( \{ P_t \} \)
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  \begin{array}{c}
  \text{Financial wealth } \omega^F
  \end{array}
  \]
  
- Initial balance sheet composition irrelevant conditional on \( \omega^F \)
Perfect foresight, no uncertainty

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  - arbitrary non-satiable preferences and time horizon
  - earns real income \( \{y_t\} \), real wage \( \{w_t\} \); price level \( \{P_t\} \)
  - faces real term structure \( \{tq_{t+s}\}_{s \geq 1} \), nominal \( tv_{t+s} = (tq_{t+s}) \frac{P_t}{P_{t+s}} \)
  - holds real long-term assets: \( \{-1b_{t+s}\}_{s \geq 0} \), nominal \( \{-1B_{t+s}\}_{s \geq 0} \)
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\end{align*}
\]

\[
\text{Financial wealth } \omega^F
\]

\[\rightarrow \quad \text{Initial balance sheet composition irrelevant conditional on } \omega^F\]

- Mortgage \( M \): \( \text{ARM} \quad -1B_0 = -L \iff \text{FRM} \quad -1B_t = -M \quad \text{if } \sum_{t=0}^{T} Q_t M = L \]
Comparative statics exercise

\[ \begin{align*}
\text{max} \quad & U \left( \{ c_t, n_t \} \right) \\
\text{s.t.} \quad & \sum_{t \geq 0} q_t c_t = \sum_{t \geq 0} q_t \left( y_t + w_t n_t + (-1 b_t) + \left( {-1 B_t} \over P_t \right) \right)
\end{align*} \]
Comparative statics exercise

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\begin{align*}
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\end{align*}
\]
Consumption response

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

s.t.  $$\sum_{t \geq 0} q_t c_t = \sum_{t \geq 0} q_t \left( y_t + w_t n_t + (-1) b_t + \left( \frac{-1}{P_t} B_t \right) \right) \equiv \omega$$

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

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

s.t. $$\sum_{t \geq 0} q_t c_t = \sum_{t \geq 0} q_t \left( y_t + w_t n_t + (-1 b_t) + \left( \frac{-1B_t}{P_t} \right) \right) \equiv \omega$$

$$\triangleright \ t = 0 \rightarrow \text{unexpected one-time shock to the real term structure } \left(\frac{dq_0}{q_0} = \frac{dR}{R}\right)$$

$$\triangleright \ \text{First-order change in consumption } dc_0?$$

$$dc_0 = \frac{\partial c_0}{\partial W} \cdot \left( y_0 + w_0 n_0 + (-1 b_0) + \frac{(-1B_0)}{P_0} - c_0 \right) \frac{dR}{R} + \underbrace{dc_0^h}_{\text{Substitution effect}} \underbrace{ \text{Wealth effect} }_{\text{Wealth effect}}$$
Consumption response

\[
\max \ U(\{c_t, n_t\})
\]
\[
s.t. \quad \sum_{t \geq 0} q_t c_t = \sum_{t \geq 0} q_t \left( y_t + w_t n_t + (-1 b_t) + \left( \frac{-1 B_t}{P_t} \right) \right) \equiv \omega
\]

\[ t = 0 \rightarrow \text{unexpected one-time shock to the real term structure } \left( \frac{dq_0}{q_0} = \frac{dR}{R} \right) \]

\[ \text{First-order change in consumption } dc_0? \]

\[
dc_0 = \frac{\partial c_0}{\partial W} \cdot \left( y_0 + w_0 n_0 + (-1 b_0) + \frac{(-1 B_0)}{P_0} - c_0 \right) \frac{dR}{R} + \underbrace{dc_0^h}_{\text{Wealth effect}} + \underbrace{dc_0^h}_{\text{Substitution effect}}
\]

\[ \text{Welfare change } dU = U_{c_0} \cdot \left( y_0 + w_0 n_0 + (-1 b_0) + \frac{(-1 B_0)}{P_0} - c_0 \right) \frac{dR}{R} \]
Consumption response

\[
\begin{align*}
\text{max} & \quad U (\{c_t, n_t\}) \\
\text{s.t.} & \quad \sum_{t \geq 0} q_t c_t = \sum_{t \geq 0} q_t \left( y_t + w_t n_t + (-1) b_t + \left( \frac{-1 B_t}{P_t} \right) \right) \equiv \omega
\end{align*}
\]

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

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dc_0 = \frac{\partial c_0}{\partial W} \cdot \left( y_0 + w_0 n_0 + (-1) b_0 + \frac{-1 B_0}{P_0} - c_0 \right) \frac{dR}{R} + \underbrace{dc_0^h}_{\text{Substitution effect}}
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- Welfare change \( dU = U_{c_0} \cdot \left( y_0 + w_0 n_0 + (-1) b_0 + \frac{-1 B_0}{P_0} - c_0 \right) \frac{dR}{R} \)
- Composition of balance sheet matters: e.g. “hedged” when

\[
-1 b_0 + \frac{-1 B_0}{P_0} = c_0 - (y_0 + w_0 n_0) \quad \forall t
\]
Consumption response

\[
\text{max } U \left( \{ c_t, n_t \} \right) \\
\text{s.t. } \sum_{t \geq 0} q_t c_t = \sum_{t \geq 0} q_t \left( y_t + w_t n_t + (-1) b_t \right) + \left( \frac{-1 B_t}{P_t} \right) \equiv \omega
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▷ \( t = 0 \rightarrow \) unexpected one-time shock to the real term structure \( \left( \frac{dq_0}{q_0} = \frac{dR}{R} \right) \)

▷ First-order change in consumption \( dc_0 \)?

\[
dc_0 = \frac{\partial c_0}{\partial W} \cdot \left( y_0 + w_0 n_0 + (-1) b_0 \right) + \left( \frac{-1 B_0}{P_0} - c_0 \right) \frac{dR}{R} + \underbrace{dc_0^h}_{\text{Substitution effect}}
\]

▷ Welfare change \( dU = U_{c_0} \cdot (-1 URE_0) \frac{dR}{R} \)

▷ Composition of balance sheet matters: e.g. “hedged” when

\[
-1 b_0 + \left( \frac{-1 B_0}{P_0} \right) = c_0 - (y_0 + w_0 n_0) \quad \forall t \rightarrow -1 URE_0 = 0
\]
Consumption response

\[
\begin{align*}
\text{max} \quad & U \left( \{c_t, n_t\} \right) \\
\text{s.t.} \quad & \sum_{t \geq 0} q_t c_t = \sum_{t \geq 0} q_t \left( y_t + w_t n_t + (-1 b_t) + \left( \frac{-1 B_t}{P_t} \right) \right) \equiv \omega
\end{align*}
\]

\[ t = 0 \rightarrow \text{unexpected one-time shock to the real term structure} \left( \frac{dq_0}{q_0} = \frac{dR}{R} \right) \]

\[ \text{First-order change in consumption } dc_0? \]

\[
dc_0 = \frac{\partial c_0}{\partial y_0} \cdot \left( y_0 + w_0 n_0 + (-1 b_0) + \left( \frac{-1 B_0}{P_0} \right) - c_0 \right) \frac{dR}{R} + \underbrace{dc_0^h}_{\text{Substitution effect}}
\]

\[ \text{Welfare change } dU = U_{c_0} \cdot (-1 URE_0) \frac{dR}{R} \]

\[ \text{Composition of balance sheet matters: e.g. “hedged” when} \]

\[
-1 b_0 + \left( \frac{-1 B_0}{P_0} \right) = c_0 - (y_0 + w_0 n_0) \quad \forall t \quad \rightarrow \quad -1 URE_0 = 0
\]
Unhedged interest rate exposure

\[ URE \equiv -1 URE_0 = y_0 + w_0 n_0 + (-1 b_0) + \frac{(-1 B_0)}{P_0} - c_0 \]

- When all financial wealth \( \omega^F \) has short maturity:
  - \( URE = y + w n + \omega^F - c \)
  - Holder of short-term assets gains when \( R \) rises, ARM holder loses

- **No direct role for financial asset price change** in wealth effect
Unhedged interest rate exposure

\[ \text{URE} \equiv -1 \text{URE}_0 = y_0 + w_0 n_0 + (-1 b_0) + \frac{(-1 B_0)}{P_0} - c_0 \]

- When all financial wealth \( \omega^F \) has short maturity:
  - \( \text{URE} = y + wn + \omega^F - c \)
  - Holder of short-term assets gains when \( R \) rises, ARM holder loses

- No direct role for financial asset price change in wealth effect

- One-time \( dR \) change, generic \( U \)

\[ dc = MPC \cdot \text{URE} \cdot \frac{dR}{R} + dc_0^h \]
Unhedged interest rate exposure

\[
URE \equiv -1 URE_0 = y_0 + w_0 n_0 + (-1 b_0) + \frac{(-1 B_0)}{P_0} - c_0
\]

- When all financial wealth \( \omega^F \) has short maturity:
  - \( URE = y + wn + \omega^F - c \)
  - Holder of short-term assets gains when \( R \) rises, ARM holder loses
- No direct role for financial asset price change in wealth effect
- One-time \( dR \) change, separable \( \sum \beta^t \{ u (c_t) - v (n_t) \} \)

\[
dc = MPC \cdot URE \cdot \frac{dR}{R} - \sigma c \left( 1 - MPC \right) \frac{dR}{R}
\]

- \( \sigma \equiv -\frac{u'(c)}{cu''(c)} \) local EIS,
Unhedged interest rate exposure

\[ URE \equiv -1 URE_0 = y_0 + w_0 n_0 + (-1 b_0) + \frac{(-1 B_0)}{P_0} - c_0 \]

- maturing assets
- maturing liabilities

- When all financial wealth \( \omega^F \) has short maturity:
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- One-time \( dR \) change, separable \( \sum \beta^t \{ u(c_t) - v(n_t) \} \) + date-0 income \( dy \)

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

- \( \sigma \equiv -\frac{u'(c)}{cu''(c)} \) local EIS,
Unhedged interest rate exposure

\[
URE \equiv -1 URE_0 = y_0 + w_0 n_0 + (-1 b_0) + \left( \frac{-1 B_0}{P_0} \right) - c_0
\]

- When all financial wealth \( \omega^F \) has short maturity:
  - \( URE = y + wn + \omega^F - c \)
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- One-time \( dR \) change, separable \( \sum \beta^t \{ u(c_t) - v(n_t) \} \) + date-0 income \( dy \)
- + permanent change in price level \( dP \)

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

- \( \sigma \equiv -\frac{u'(c)}{cu''(c)} \) local EIS,
- \( NNP \equiv \sum_{t \geq 0} Q_t (-1 B_t) \) net nominal position
Unhedged interest rate exposure

\[ \text{URE} \equiv -1 \text{URE}_0 = y_0 + w_0n_0 + (-1b_0) + \frac{(-1B_0)}{P_0} - c_0 \]

- When all financial wealth \( \omega^F \) has short maturity:
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- No direct role for financial asset price change in wealth effect
- One-time \( dR \) change, separable \( \sum \beta^t \{ u(c_t) - v(n_t) \} \) + date-0 income \( dy \)
- + permanent change in price level \( dP + dw \), and \( dY = d(y + wn) \)

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

- \( \sigma \equiv - \frac{u'(c)}{cu''(c)} \) local EIS, \( \hat{MPC} \equiv \frac{MPC}{MPC + MPS} \)
- \( \text{NNP} \equiv \sum_{t \geq 0} Q_t (-1B_t) \) net nominal position

Go general
1. Partial equilibrium: $\mathcal{E}_m$ as sufficient statistics
   - Single agent, perfect foresight
   - Incomplete markets
   - Aggregation

2. Measuring redistribution elasticities

3. Insights from partial 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 \( \delta \)
- Perfect foresight over nominal bond price \( Q_t \) and price level \( P_t \)

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

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

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

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

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

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

At time 0: permanent increase in price level $dP$, purely transitory change in income $dY = dy + ndw$ and the real interest rate $\frac{dR}{R} = -\frac{dQ}{Q}$
Individual consumption response: one-time change

- At time 0: permanent increase in price level $dP$, purely transitory change in income $dY = dy + ndw$ and the real interest rate $\frac{dR}{R} = -\frac{dQ}{Q}$

Sufficient statistics for consumption response to transitory shocks

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

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

where $\hat{MPC} = \frac{MPC}{MPC + MPS}$, with $MPC = \frac{\partial c}{\partial y}$ the consumption response to a one-time transitory income shock ($\hat{MPC} = 1$ 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, ...
Outline

1. Partial equilibrium: $E_m$ as sufficient statistics
   - Single agent, perfect foresight
   - Incomplete markets
   - Aggregation

2. Measuring redistribution elasticities

3. Insights from partial equilibrium model
Aggregation: environment

- Environment:
  - Closed economy with no government and no capital
  - \( i = 1 \ldots I \) heterogenous agents (date-0 income \( Y_i = y_i + w_i n_i \))
  - Face the same prices

- Aggregate up after transitory shock

\[
dc_i = M\hat{PC}_i \left( dY_i + URE_i \frac{dR}{R} - NNP_i \frac{dP}{P} \right) - \sigma_i c_i \left( 1 - M\hat{PC}_i \right) \frac{dR}{R}
\]
Aggregation: environment

- **Environment:**
  - Closed economy with no government and no capital
  - \(i = 1 \ldots I\) heterogeneous agents (date-0 income \(Y_i = y_i + w_i n_i\))
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\[
dc_i = \hat{MPC}_i \left( dY_i + URE_i \frac{dR}{R} - NNP_i \frac{dP}{P} \right) - \sigma_i c_i \left( 1 - \hat{MPC}_i \right) \frac{dR}{R}
\]

- Markets clear at date 0:
  - Assets

\[
\frac{1}{I} \sum_i NNP_i = \mathbb{E}_I [NNP_i] = 0
\]

  - Goods & assets

\[
C \equiv \mathbb{E}_I [c_i] = \mathbb{E}_I [Y_i] \equiv Y \quad \Rightarrow \quad \mathbb{E}_I [URE_i] = 0
\]
Aggregation with heterogeneity

Aggregate consumption response to transitory shock

\[ dC = \mathbb{E}_I \left[ \frac{Y_i}{Y} \hat{MPC}_i \right] dY + \text{Cov}_I \left( \hat{MPC}_i, dY_i - Y_i \frac{dY}{Y} \right) - \text{Cov}_I \left( \hat{MPC}_i, NNP_i \right) \frac{dP}{P} \]

- Aggregate income channel
- Earnings heterogeneity channel
- Fisher channel

\[ + \left( \text{Cov}_I \left( \hat{MPC}_i, URE_i \right) - \mathbb{E}_I \left[ \sigma_i \left( 1 - \hat{MPC}_i \right) c_i \right] \right) \frac{dR}{R} \]

- Interest rate exposure channel
- Substitution channel
Aggregation with heterogeneity

Aggregate consumption response to transitory shock

\[ dC = \mathbb{E}_l \left[ \frac{Y_i}{Y} \hat{MPC}_i \right] dY + \text{Cov}_l \left( \hat{MPC}_i, dY_i - \frac{Y_i}{Y} dY \right) - \text{Cov}_l \left( \hat{MPC}_i, NNP_i \right) \frac{dP}{P} \]

Aggregate income channel  
Earnings heterogeneity channel  
Fisher channel

\[ + \left( \text{Cov}_l \left( \hat{MPC}_i, URE_i \right) - \mathbb{E}_l \left[ \sigma_i \left( 1 - \hat{MPC}_i \right) c_i \right] \right) \frac{dR}{R} \]

Interest rate exposure channel  
Substitution channel

Logic of Keynesian model: “\( dC = dY \)” given \( dR \)

Representative agent:

- Intertemporal substitution only source of “first round” effect of \( R \downarrow \) on \( C \)
- Income adjustment only source of “second round” effect, total:

\[ dC = -\frac{\sigma \left( 1 - \hat{MPC} \right) C}{1 - \hat{MPC}} \frac{dR}{R} = -\sigma C \frac{dR}{R} \]
Aggregation with heterogeneity

Aggregate consumption response to transitory shock

\[ dC = \mathbb{E}_I \left[ \frac{Y_i}{Y} \hat{MPC}_i \right] dY + \text{Cov}_I \left( \hat{MPC}_i, dY_i - Y_i \frac{dY}{Y} \right) - \text{Cov}_I \left( \hat{MPC}_i, \text{NNP}_i \right) \frac{dP}{P} + \text{Cov}_I \left( \hat{MPC}_i, URE_i \right) - \mathbb{E}_I \left[ \sigma_i \left( 1 - \hat{MPC}_i \right) c_i \right] \frac{dR}{R} \]

- Aggregate income channel
- Earnings heterogeneity channel
- Fisher channel
- Interest rate exposure channel
- Substitution channel

▶ Logic of Keynesian model: “\( dC = dY \)” given \( dR \)

▶ Representative agent:
  ▶ Intertemporal substitution only source of “first round” effect of \( R \downarrow \) on \( C \)
  ▶ Income adjustment only source of “second round” effect, total:

\[ dC = -\sigma \left( 1 - \hat{MPC} \right) \frac{C}{1 - \hat{MPC}} \frac{dR}{R} = -\sigma C \frac{dR}{R} \]

▶ Under heterogeneity, redistribution amplifies if:
\[ \text{Cov}_I \left( \hat{MPC}_i, URE_i \right) < 0, \quad \text{Cov}_I \left( \hat{MPC}_i, \text{NNP}_i \right) < 0, \quad \text{Cov}_I \left( \hat{MPC}_i, d \left( \frac{Y_i}{Y} \right) \right) > 0 \]
Aggregation with heterogeneity

- Let \( \gamma_i \equiv \frac{\partial \left( \frac{Y_i}{Y} - 1 \right)}{\left( \frac{Y_i}{Y} - 1 \right)} \) (elasticity of individual to aggregate income)
  - When \( \gamma_i < 0 \), low-\( Y_i \) lose more than high-\( Y_i \) when \( Y \) falls

Estimable moments

Assume that \( \sigma_i = \sigma \) and \( \gamma_i = \gamma \) are constant. Then

\[
\frac{dC}{C} = \left( \frac{\mathbb{E}_I \left[ \frac{Y_i}{\mathbb{E}_I [c_i]} M\hat{PC}_i \right]}{\mathcal{M}} + \gamma \text{Cov}_I \left( M\hat{PC}_i, \frac{Y_i}{\mathbb{E}_I [c_i]} \right) \frac{dY}{Y} - \text{Cov}_I \left( M\hat{PC}_i, \frac{NNP_i}{\mathbb{E}_I [c_i]} \right) \frac{dP}{P} \right)

+ \left( \frac{\text{Cov}_I \left( M\hat{PC}_i, \frac{URRE_i}{\mathbb{E}_I [c_i]} \right)}{\mathcal{E}_R} - \sigma \mathbb{E}_I \left[ \left( 1 - M\hat{PC}_i \right) \frac{c_i}{\mathbb{E}_I [c_i]} \right] \right) \frac{dR}{R}
\]

- 2 elasticities \((\sigma, \gamma)\) + 5 estimable moments \((\mathcal{M}, \mathcal{E}_P, \mathcal{E}_R, \mathcal{E}_Y, S)\) that
  - do not depend on the source of the shock
  - do not require identification (except for MPC)
Monetary, fiscal and other interactions

\[
\frac{dC}{C} = (M + \gamma \varepsilon_Y) \frac{dY}{Y} - \varepsilon_P \frac{dP}{P} + (\varepsilon_R - \sigma S) \frac{dR}{R}
\]

- **Next**: go to data, find \(\varepsilon_R < 0\), \(\varepsilon_P < 0\) and \(\varepsilon_Y < 0\)
  - If \(\gamma < 0\), shows that **redistribution amplifies** through all 3 channels
Monetary, fiscal and other interactions

\[
\frac{dC}{C} = (\mathcal{M} + \gamma \mathcal{E}_Y) \frac{dY}{Y} - \mathcal{E}_P \frac{dP}{P} + (\mathcal{E}_R - \sigma S) \frac{dR}{R}
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- **Next**: go to data, find \(\mathcal{E}_R < 0\), \(\mathcal{E}_P < 0\) and \(\mathcal{E}_Y < 0\)
  - If \(\gamma < 0\), shows that **redistribution amplifies** through all 3 channels
- **But**: usually, in household data \(\mathbb{E}_I[URE_i] > 0\) and \(\mathbb{E}_I[NNP_i] > 0\). Why?
  - Govt debt \((NNP_G < 0)\) and flow borrowing requirement \((URE_G < 0)\)
  - Maturity mismatch in the household sector (counterpart of banks)
  - My benchmark: “Ricardian” uniform rebate. \(\mathcal{E}_R, \mathcal{E}_P\) still correct.
Monetary, fiscal and other interactions

\[
\frac{dC}{C} = (\mathcal{M} + \gamma \varepsilon_Y) \frac{dY}{Y} - \varepsilon_P^{NR} \frac{dP}{P} + (\varepsilon_R^{NR} - \sigma S) \frac{dR}{R}
\]

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- If none of the gains are rebated, use instead

\[
\varepsilon_P^{NR} = \mathbb{E}_I \left[ MP\hat{C}_i \frac{NNP_i}{\mathbb{E}_I [c_i]} \right] \quad \varepsilon_R^{NR} = \mathbb{E}_I \left[ MP\hat{C}_i \frac{URE_i}{\mathbb{E}_I [c_i]} \right]
\]

> Interestingly \[ \ldots \] low rates could even hurt overall spending

Raghuram Rajan, November 2013
Monetary, fiscal and other interactions

\[
\frac{dC}{C} = (\mathcal{M} + \gamma \mathcal{E}_Y) \frac{dY}{Y} - \mathcal{E}^{NR}_P \frac{dP}{P} + (\mathcal{E}^{NR}_R - \sigma S) \frac{dR}{R}
\]

- **Next:** go to data, find \( \mathcal{E}_R < 0, \mathcal{E}_P < 0 \) and \( \mathcal{E}_Y < 0 \)
  - If \( \gamma < 0 \), shows that **redistribution amplifies** through all 3 channels
  - **But:** usually, in household data \( \mathbb{E}_I[URE_i] > 0 \) and \( \mathbb{E}_I[NNP_i] > 0 \). Why?
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    - Maturity mismatch in the household sector (counterpart of banks)
    - My benchmark: “Ricardian” uniform rebate. \( \mathcal{E}_R, \mathcal{E}_P \) still correct.
  - If **none** of the gains are rebated, use instead

\[
\mathcal{E}^{NR}_P = \mathbb{E}_I \left[ M\hat{P}C_i \frac{NNP_i}{\mathbb{E}_I[c_i]} \right] \quad \mathcal{E}^{NR}_R = \mathbb{E}_I \left[ M\hat{P}C_i \frac{URE_i}{\mathbb{E}_I[c_i]} \right]
\]

- \( \mathcal{E}^{NR}_R - \sigma S > 0? \)
Monetary, fiscal and other interactions

\[
\frac{dC}{C} = (\mathcal{M} + \gamma \mathcal{E}_Y) \frac{dY}{Y} - \mathcal{E}^{NR}_P \frac{dP}{P} + (\mathcal{E}^{NR}_R - \sigma S) \frac{dR}{R}
\]

▶ **Next**: go to data, find \(\mathcal{E}_R < 0, \mathcal{E}_P < 0\) and \(\mathcal{E}_Y < 0\)

▶ If \(\gamma < 0\), shows that *redistribution amplifies* through all 3 channels

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▶ Govt debt \((NNP_G < 0)\) and flow borrowing requirement \((URE_G < 0)\)

▶ Maturity mismatch in the household sector (counterpart of banks)

▶ My benchmark: “Ricardian” uniform rebate. \(\mathcal{E}_R, \mathcal{E}_P\) still correct.

▶ If *none* of the gains are rebated, use instead

\[
\mathcal{E}^{NR}_P = \mathbb{E}_l \left[ \hat{M}PC_i \frac{NNP_i}{\mathbb{E}_l [c_i]} \right] \quad \mathcal{E}^{NR}_R = \mathbb{E}_l \left[ \hat{M}PC_i \frac{URE_i}{\mathbb{E}_l [c_i]} \right]
\]

▶ \(\mathcal{E}^{NR}_R - \sigma S > 0\)?
Monetary, fiscal and other interactions

\[
d\frac{C}{C} = (\mathcal{M} + \gamma \mathcal{E}_Y) \frac{dY}{Y} - \mathcal{E}_{NR}^P \frac{dP}{P} + (\mathcal{E}_{NR}^R - \sigma S) \frac{dR}{R}
\]

- **Next**: go to data, find \( \mathcal{E}_R < 0, \mathcal{E}_P < 0 \) and \( \mathcal{E}_Y < 0 \)
  - If \( \gamma < 0 \), shows that **redistribution amplifies** through all 3 channels
  - **But**: usually, in household data \( \mathbb{E}_I [URE_i] > 0 \) and \( \mathbb{E}_I [NNP_i] > 0 \). Why?
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  - If none of the gains are rebated, use instead

\[
\mathcal{E}_{NR}^P = \mathbb{E}_I \left[ M\dot{P}C_i \frac{NNP_i}{\mathbb{E}_I [c_i]} \right] \quad \mathcal{E}_{NR}^R = \mathbb{E}_I \left[ M\dot{P}C_i \frac{URE_i}{\mathbb{E}_I [c_i]} \right]
\]

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

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

Raghuram Rajan, November 2013
Outline

1. Partial equilibrium: $\mathcal{E}_m$ as sufficient statistics
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3. Insights from partial equilibrium model
Map to data

1. Construct a URE, NNP measures at the household level, for example

\[ URE_i = Y_i - C_i + A_i - L_i \]

- \( Y_i \): income from all sources (including dividends)
- \( C_i \): consumption (including durables, excluding house purchases)
- \( A_i \): maturing asset stocks (mostly deposits)
- \( L_i \): maturing liability stocks (FRM payments, ARM principal,...)

2. Use a procedure to evaluate \( M\hat{P}C_i \) at the household or group level
   a. Italy Survey of Household Income and Wealth 2010
   b. US Panel Study of Income Dynamics 1999-2013
      ▶ Semi-parametric method [Blundell, Pistaferri, Preston 2008]
   c. US Consumer Expenditure Survey 2001-2002
      ▶ Randomization from tax rebates [Johnson, Parker, Souleles 2006]

Result 1: $\mathcal{E}_R < 0$

\[ \Rightarrow \mathcal{E}_R = \text{Cov}_l \left( \text{MPC}_i, \frac{\text{URE}_i}{\mathbb{E}_l [c_i]} \right) < 0 \]
Result 2: $\mathcal{E}_P < 0$

$\Rightarrow \mathcal{E}_P = \text{Cov}_I \left( MPC_i, \frac{NNP_i}{E_I [c_i]} \right) < 0$
Result 3: $\mathcal{E}_Y < 0$

\[ \Rightarrow \quad \mathcal{E}_Y = \text{Cov}_I \left( MPC_i, \frac{Y_i}{\mathbb{E}_I [c_i]} \right) < 0 \]
Estimates of all 7 moments in all 3 surveys

- In SHIW, household-level information on \( MPC \) and \( URE \)
- In PSID/URE, group households in bins and compute cov. across bins

<table>
<thead>
<tr>
<th>Survey</th>
<th>SHIW</th>
<th>PSID</th>
<th>CE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>95% C.I.</td>
<td>Estimate</td>
</tr>
<tr>
<td>( \hat{E}_R )</td>
<td>-0.11</td>
<td>[-0.16, -0.06]</td>
<td>-0.05</td>
</tr>
<tr>
<td>( \hat{E}_{NR}^R )</td>
<td>0.34</td>
<td>[0.29, 0.39]</td>
<td>0.01</td>
</tr>
<tr>
<td>( \hat{S} )</td>
<td>0.55</td>
<td>[0.53, 0.58]</td>
<td>0.97</td>
</tr>
<tr>
<td>( \hat{E}_P )</td>
<td>-0.07</td>
<td>[-0.12, -0.03]</td>
<td>-0.02</td>
</tr>
<tr>
<td>( \hat{E}_{NR}^P )</td>
<td>0.05</td>
<td>[0.01, 0.10]</td>
<td>-0.07</td>
</tr>
<tr>
<td>( \hat{M} )</td>
<td>0.57</td>
<td>[0.55, 0.59]</td>
<td>0.08</td>
</tr>
<tr>
<td>( \hat{E}_Y )</td>
<td>-0.05</td>
<td>[-0.07, -0.03]</td>
<td>-0.04</td>
</tr>
</tbody>
</table>

All statistics computed using survey weights.

Confidence intervals are bootstrapped by resampling households 100 times with replacement.
Covariance decomposition in SHIW

- Can do a covariance decomposition:

\[
\text{Cov} (\text{MPC}_i, \text{URE}_i) = \text{Cov} (\mathbb{E} [\text{MPC}_i | Z_i], \mathbb{E} [\text{URE}_i | Z_i]) + \mathbb{E} [\text{Cov} (\text{MPC}_i, \text{URE}_i | Z_i)]
\]

- Explained part of covariance + \(\mathbb{E} [\text{Cov} (\text{MPC}_i, \text{URE}_i | Z_i)]\)

- Unexplained part of covariance

- Implement using OLS, variable-by-variable

<table>
<thead>
<tr>
<th>(Z_i)</th>
<th>(\text{Var} (Z_i))</th>
<th>(\hat{\beta}_M)</th>
<th>(\hat{\beta}_R)</th>
<th>% expl.</th>
<th>(\hat{\beta}_P)</th>
<th>% expl.</th>
<th>(\hat{\beta}_Y)</th>
<th>% expl.</th>
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<tbody>
<tr>
<td>Age bins</td>
<td>0.77</td>
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<td>9%</td>
<td>0.521</td>
<td>15%</td>
<td>0.062</td>
<td>3%</td>
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<tr>
<td>Male</td>
<td>0.24</td>
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<td>0.396</td>
<td>5%</td>
<td>0.285</td>
<td>5%</td>
<td>0.282</td>
<td>7%</td>
</tr>
<tr>
<td>Married</td>
<td>0.18</td>
<td>-0.016</td>
<td>0.116</td>
<td>0%</td>
<td>-0.070</td>
<td>-0%</td>
<td>0.417</td>
<td>2%</td>
</tr>
<tr>
<td>Years of ed.</td>
<td>18.8</td>
<td>-0.005</td>
<td>0.064</td>
<td>6%</td>
<td>0.031</td>
<td>4%</td>
<td>0.088</td>
<td>17%</td>
</tr>
<tr>
<td>Family size</td>
<td>1.71</td>
<td>0.023</td>
<td>-0.107</td>
<td>4%</td>
<td>-0.215</td>
<td>12%</td>
<td>0.122</td>
<td>-10%</td>
</tr>
<tr>
<td>Res. South</td>
<td>0.22</td>
<td>0.198</td>
<td>-0.481</td>
<td>19%</td>
<td>-0.255</td>
<td>15%</td>
<td>-0.561</td>
<td>48%</td>
</tr>
<tr>
<td>City size</td>
<td>1.21</td>
<td>0.037</td>
<td>0.029</td>
<td>-1%</td>
<td>0.053</td>
<td>-3%</td>
<td>0.068</td>
<td>-6%</td>
</tr>
<tr>
<td>Unemployed</td>
<td>0.04</td>
<td>0.189</td>
<td>-0.728</td>
<td>5%</td>
<td>-0.308</td>
<td>3%</td>
<td>-0.624</td>
<td>10%</td>
</tr>
</tbody>
</table>

\(\hat{\beta}_M, \hat{\beta}_R, \hat{\beta}_P\) and \(\hat{\beta}_Y\) are OLS regression coefficients of MPC, URE, NNP and Y on \(Z_i\). Explained part is \(\text{Var} (Z_i) \hat{\beta}_M \hat{\beta}_R\).
Outline

1. Partial equilibrium: $E_m$ as sufficient statistics
   - Single agent, perfect foresight
   - Incomplete markets
   - Aggregation

2. Measuring redistribution elasticities

3. Insights from partial equilibrium model
Partial equilibrium model

- Use a standard Bewley/Huggett model to
  - Compare signs and magnitudes of redistribution moments
  - Understand theoretical determinants
  - Evaluate robustness to large shocks/asymmetries
  - (in paper) Evaluate robustness to persistent shocks

- Many ways to close the model in GE:
  - See recent “HANK” literature:
Households

- Measure 1 of households $i$ with CES preferences:
  \[
  \mathbb{E}\left[\sum_{t=0}^{\infty} (\beta_t^i)^t \frac{(c_t^i)^{1-\frac{1}{\sigma}}}{1 - \frac{1}{\sigma}}\right]
  \]

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

- Trades nominal and real assets subject to borrowing constraint
  - Indifferent in equilibrium between both, constant share $\kappa$ in real assets

- Steady state:
  - Huggett model: circulating private IOUs, no government
  - Constant nominal price $P$
Calibration

- Calibration: quarterly frequency

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
<th>Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elasticity of intertemporal substitution $\sigma$</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Impatient discount factor $\beta^I$</td>
<td>0.93</td>
<td>Average MPC</td>
</tr>
<tr>
<td>Patient discount factor $\beta^P$</td>
<td>0.99</td>
<td>Real interest rate (annual)</td>
</tr>
<tr>
<td>Borrowing limit (% of pc annual $C$) $\bar{D}$</td>
<td>195%</td>
<td>Household debt (% of $C$)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Data point estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red elasticity for $R$ ($\delta = 0.95$) $\varepsilon_R$</td>
<td>$-0.09$ [$-0.05, -0.11$]</td>
</tr>
<tr>
<td>Hicksian scaling factor $S$</td>
<td>0.84</td>
</tr>
<tr>
<td>Red elasticity for $P$ ($\kappa = 0$) $\varepsilon_P$</td>
<td>$-1.8$ [$-0.02, -0.11$]</td>
</tr>
<tr>
<td>Income-weighted MPC $M$</td>
<td>0.17</td>
</tr>
<tr>
<td>Redistribution elasticity for $Y$ $\varepsilon_Y$</td>
<td>$-0.08$ [$-0.04, -0.05$]</td>
</tr>
</tbody>
</table>
Redistribution channel: model v. data

- \( \delta \) (coupon decay rate)
- \( \kappa \) (indexation share)

- Explains why \( R \) transmission is more potent with ARMs
- Overstates empirical Fisher channel
  - Except if almost all assets are indexed
Asymmetric effects

Effect on consumption of a transitory shock to $R$

Benchmark

ARMs only

Sufficient statistics predictions
Conclusion

- Monetary policy redistributes:
  - Affects aggregate consumption via three redistribution channels
    - *Fisher, earnings heterogeneity* and *interest rate exposure*
    - Each of them is likely to amplify the transmission mechanism
    - Interest rate exposure likely very important in ARM countries
  - Sufficient statistics, $\mathcal{E}_m = \text{Cov}_l \left( MPC_i, \text{Exposure}_{i,m} \right)$, establish orders of magnitude and discipline model calibrations

- Implications for policy:
  - Capital gains can act against MPC-aligned redistribution
  - The effects of monetary policy may vary (with $\mathcal{E}_m$'s) over the cycle
Thank you!
Additional wealth effects

- Introduce nominal assets:
  - price level $\{P_t\}$ (perfectly foreseen)
  - nominal holdings: $\{-1B_{t+s}\}_{s \geq 0}$ (deposits, bonds, mortgage)
  - Fisher equation for nominal term structure $Q_{t+s} = q_{t+s} \frac{P_t}{P_{t+s}}$

- Unexpected shock to $\{q_t\}$ as well as
  - Price level $\{P_0, P_1 \ldots\}$
  - Real income stream $\{y_0, y_1 \ldots\}$
  - Real wage sequence $\{w_0, w_1 \ldots\}$

- Write first-order change in consumption $dc_0$, hours $dn_0$, welfare $dU$ using

$$ MPC \equiv \frac{\partial c_0}{\partial y_0}, \quad MPN \equiv \frac{\partial n_0}{\partial y_0}, \quad \epsilon_x^h = \frac{\partial x^h}{\partial p_t} \frac{p_t}{x_0}, \quad x_0 \in \{c_0, n_0\}, \quad p_t \in \{q_t, w_t\} $$
Consumption, hours and welfare response

Impulse response to the shock

To first order, $dU \simeq U_c d\Omega$ and

$$dc_0 \simeq \text{MPC} d\Omega + c_0 \left( \sum_{t \geq 0} \epsilon_{c_0,q_t} \frac{dq_t}{q_t} + \sum_{t \geq 0} \epsilon_{c_0,w_t} \frac{dw_t}{w_t} \right)$$

$$dn_0 \simeq \text{MPN} d\Omega + n_0 \left( \sum_{t \geq 0} \epsilon_{n_0,q_t} \frac{dq_t}{q_t} + \sum_{t \geq 0} \epsilon_{n_0,w_t} \frac{dw_t}{w_t} \right)$$

where

$$d\Omega = \sum_{t \geq 0} q_t \left( y_t + w_t n_t + (-1) b_t + \left( \frac{-1 B_t}{P_t} \right) - c_t \right) \frac{dq_t}{q_t} + \sum_{t \geq 0} (q_t y_t) \frac{dy_t}{y_t}$$

Real unearned income change

$$+ \sum_{t \geq 0} (q_t w_t n_t) \frac{dw_t}{w_t} - \sum_{t \geq 0} Q_t \left( \frac{-1 B_t}{P_0} \right) \frac{dP_t}{P_t}$$

Real earned income change

Revaluation of net nominal position
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 ($MPC$)
Datasets: summary statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>SHIW</th>
<th></th>
<th>PSID</th>
<th></th>
<th>CE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>s.d.</td>
<td>mean</td>
<td>s.d.</td>
<td>mean</td>
<td>s.d.</td>
</tr>
<tr>
<td>Income after tax ($Y_i - T_i$)</td>
<td>1.31</td>
<td>0.92</td>
<td>2.13</td>
<td>2.63</td>
<td>1.16</td>
<td>1.03</td>
</tr>
<tr>
<td>Consumption ($C_i$)</td>
<td>1.00</td>
<td>0.61</td>
<td>1.00</td>
<td>0.63</td>
<td>1.00</td>
<td>0.83</td>
</tr>
<tr>
<td>Maturing assets ($A_i$)</td>
<td>0.98</td>
<td>2.64</td>
<td>1.46</td>
<td>6.38</td>
<td>0.48</td>
<td>1.70</td>
</tr>
<tr>
<td>Maturing liabilities ($L_i$)</td>
<td>0.34</td>
<td>1.55</td>
<td>0.81</td>
<td>2.11</td>
<td>0.53</td>
<td>1.55</td>
</tr>
<tr>
<td>Unhedged interest rate exposure ($URE_i$)</td>
<td>0.95</td>
<td>3.13</td>
<td>1.78</td>
<td>7.60</td>
<td>0.16</td>
<td>2.36</td>
</tr>
<tr>
<td>Nominal assets</td>
<td>0.82</td>
<td>2.61</td>
<td>1.41</td>
<td>5.00</td>
<td>1.90</td>
<td>7.50</td>
</tr>
<tr>
<td>Nominal liabilities</td>
<td>0.55</td>
<td>1.65</td>
<td>2.72</td>
<td>3.95</td>
<td>4.97</td>
<td>7.73</td>
</tr>
<tr>
<td>Net nominal position ($NNP_i$)</td>
<td>0.27</td>
<td>2.92</td>
<td>-1.31</td>
<td>6.10</td>
<td>-2.79</td>
<td>10.06</td>
</tr>
<tr>
<td>Income before tax ($Y_i$)</td>
<td>1.31</td>
<td>0.92</td>
<td>2.67</td>
<td>4.11</td>
<td>1.25</td>
<td>1.11</td>
</tr>
<tr>
<td>Marginal propensity to consume ($MPC_i$)</td>
<td>0.47</td>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of households</td>
<td>7,951</td>
<td></td>
<td>9,620</td>
<td></td>
<td>4,833</td>
<td></td>
</tr>
</tbody>
</table>

In each survey, 'mean' and 's.d.' represent the sample mean and standard deviation.

All stats. computed using sample weights, all variables except for MPC normalized by average consumption in sample.