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

- 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
- **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.

Martin Wolf, Financial Times, September 2014

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.

Martin Wolf, Financial Times, September 2014

- Savers with different *asset durations* experience different welfare gains from low rates, and may adjust consumption differently

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.

Martin Wolf, Financial Times, September 2014

- 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

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.

Martin Wolf, Financial Times, September 2014

- 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 $\mathrm{Exposure}_{i,m}$ to dm
  - $\mathrm{Exposure}_{i,P}$ [Doepke and Schneider 2006]
  - marginal propensity to consume MPC_i

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 $\mathrm{Exposure}_{i,m}$ to dm
  - $\mathrm{Exposure}_{i,P}$ [Doepke and Schneider 2006]
  - marginal propensity to consume MPC_i
- Effect of redistribution through m on aggregate consumption?

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 $\mathrm{Exposure}_{i,m}$ to dm
  - $\mathrm{Exposure}_{i,P}$ [Doepke and Schneider 2006]
  - marginal propensity to consume MPC_i
- Effect of redistribution through m on aggregate consumption?

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

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 $\mathrm{Exposure}_{i,m}$ to dm
  - $\mathrm{Exposure}_{i,P}$ [Doepke and Schneider 2006]
  - marginal propensity to consume MPC_i
- Effect of redistribution through m on aggregate consumption?

$$\textbf{Redistribution elasticity} = \mathcal{E}_m = \mathrm{Cov}_I\left(MPC_i, \mathrm{Exposure}_{i,m}\right)$$

- $\mathcal{E}_m$: **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

- Focus on $m = r$. Cyclical monetary policy, stable inflation
- $\mathcal{E}_r$: "unhedged (interest)-rate exposure". For transitory change:

$$URE_i = \underbrace{\text{maturing assets}_i}_{\text{including income}} - \underbrace{\text{maturing liabilities}_i}_{\text{including consumption}}$$

Sufficient statistic: real interest rate change

- Focus on $m = r$. Cyclical monetary policy, stable inflation
- $\mathcal{E}_r$: "unhedged (interest)-rate exposure". For transitory change:

$$URE_i = \underbrace{\text{maturing assets}_i}_{\text{including income}} - \underbrace{\text{maturing liabilities}_i}_{\text{including consumption}}$$

- $\mathcal{E}_r = \mathrm{Cov}_I\left(MPC_i, URE_i\right)$ measurable in household surveys
  - Italy [Jappelli, Pistaferri 2014] & US [Johnson, Parker, Souleles 2006]

Sufficient statistic: real interest rate change

- Focus on $m = r$. Cyclical monetary policy, stable inflation
- $\mathcal{E}_r$: "unhedged (interest)-rate exposure". For transitory change:

$$URE_i = \underbrace{\text{maturing assets}_i}_{\text{including income}} - \underbrace{\text{maturing liabilities}_i}_{\text{including consumption}}$$

- $\mathcal{E}_r = \mathrm{Cov}_I \left(MPC_i, URE_i \right)$ measurable in household surveys
  - Italy [Jappelli, Pistaferri 2014] & US [Johnson, Parker, Souleles 2006]
  - $\mathcal{E}_r < 0$. **Redistribution channel** $\Rightarrow C \uparrow$ when $r \downarrow$

Sufficient statistic: real interest rate change

- Focus on $m = r$. Cyclical monetary policy, stable inflation
- $\mathcal{E}_r$: "unhedged (interest)-rate exposure". For transitory change:

$$URE_i = \underbrace{\text{maturing assets}_i}_{\text{including income}} - \underbrace{\text{maturing liabilities}_i}_{\text{including consumption}}$$

- $\mathcal{E}_r = \mathrm{Cov}_I\left(MPC_i, URE_i\right)$ measurable in household surveys
  - Italy [Jappelli, Pistaferri 2014] & US [Johnson, Parker, Souleles 2006]
  - $\mathcal{E}_r < 0$. **Redistribution channel** $\Rightarrow C \uparrow$ when $r \downarrow$
  - Adds to the *substitution channel*, same magnitude if EIS$\simeq 0.1$ to 0.3

Sufficient statistic: real interest rate change

- Focus on $m = r$. Cyclical monetary policy, stable inflation
- $\mathcal{E}_r$: "unhedged (interest)-rate exposure". For transitory change:

$$URE_i = \underbrace{\text{maturing assets}_i}_{\text{including income}} - \underbrace{\text{maturing liabilities}_i}_{\text{including consumption}}$$

- $\mathcal{E}_r = \mathrm{Cov}_I \left(MPC_i, URE_i \right)$ measurable in household surveys
    - Italy [Jappelli, Pistaferri 2014] & US [Johnson, Parker, Souleles 2006]
    - $\mathcal{E}_r < 0$. **Redistribution channel** $\Rightarrow C \uparrow$ when $r \downarrow$
    - Adds to the *substitution channel*, same magnitude if EIS$\simeq$ 0.1 to 0.3
- 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 $\mathcal{E}_r$ and predicts:

Dynamic general equilibrium model

- GE model calibrated to U.S. economy matches $\mathcal{E}_r$ and predicts:

1. $\mathcal{E}_r$ *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]

Dynamic general equilibrium model

- GE model calibrated to U.S. economy matches $\mathcal{E}_r$ and predicts:

1. $\mathcal{E}_r$ *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

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), ...
  - Role of mortgage structure: Calza, Monacelli, Stracca (2013), Rubio (2011), Garriga, Kydland and Sustek (2013)
  - Heterogenous effects : Gornemann, Kuester and Nakajima (2014)
- **MPC heterogeneity [theory and empirics]**
  - Measurement, comovement with balance sheets: Johnson et al (2006), Parker et al (2013), Mian, Rao, Sufi (2013), Baker (2013), ...
  - Aggregate demand effects: Galí, López-Salido, Vallés (2007), Eggertsson-Krugman (2012), Mian-Sufi (2014), Farhi-Werning (2013)
  - Role of incomplete markets: Guerrieri-Lorenzoni (2012), Oh-Reis (2013), Sheedy (2014), McKay-Reis (2014)

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
   - Price theory
   - Incomplete markets
   - Aggregation

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)

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 $\{{}_tq_{t+s}\}_{s\geq 1}$
  - holds *long-term real assets:* $\{{}_{t-1}b_{t+s}\}_{s\geq 0}$ (TIPS, PLAM)

- Solves:

$$
\begin{aligned}
\max \quad & U\left(\{c_t, n_t\}\right) \\
\text{s.t.} \quad & c_t = y_t + w_t n_t + \left({}_{t-1}b_t\right) + \sum_{s\geq 1} \left({}_tq_{t+s}\right)\left({}_{t-1}b_{t+s} - {}_tb_{t+s}\right)
\end{aligned}
$$

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 $\{{}_tq_{t+s}\}_{s\geq 1}$
  - holds *long-term real assets:* $\{{}_{t-1}b_{t+s}\}_{s\geq 0}$ (TIPS, PLAM)
- Date-0 holdings: $\{{}_{-1}b_{t+s}\}_{s\geq 0}$, term structure $q_t = ({}_0q_t)$
- Solves:

$$\begin{aligned} \max \quad & U\left(\{c_t, n_t\}\right) \\ \text{s.t.} \quad & c_t = y_t + w_t n_t + \left({}_{t-1}b_t\right) + \sum_{s\geq 1} \left({}_tq_{t+s}\right)\left({}_{t-1}b_{t+s} - {}_tb_{t+s}\right) \end{aligned}$$

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)
- Date-0 holdings: $\{{}_{-1} b_{t+s}\}_{s\geq 0}$, term structure $q_t = ({}_0 q_t)$
- Solves:

$$\begin{aligned} \max \quad & U(\{c_t, n_t\}) \\ \text{s.t.} \quad & \sum_{t\geq 0} q_t c_t = \sum_{t\geq 0} q_t (y_t + w_t n_t) + \underbrace{\sum_{t\geq 0} q_t ({}_{-1} b_t)}_{\text{Financial wealth } W^F} \end{aligned}$$

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 $\{{}_tq_{t+s}\}_{s\geq 1}$
  - holds *long-term real assets:* $\{{}_{t-1}b_{t+s}\}_{s\geq 0}$ (TIPS, PLAM)
- Date-0 holdings: $\{{}_{-1}b_{t+s}\}_{s\geq 0}$, term structure $q_t = ({}_0q_t)$
- Solves:

$$\begin{aligned} \max \quad & U(\{c_t, n_t\}) \\ \text{s.t.} \quad & \sum_{t\geq 0} q_t c_t = \sum_{t\geq 0} q_t (y_t + w_t n_t) + \underbrace{\sum_{t\geq 0} q_t ({}_{-1}b_t)}_{\text{Financial wealth } W^F} \end{aligned}$$

- $\rightarrow$ **Initial balance sheet composition irrelevant conditional on** W^F

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 $\{{}_tq_{t+s}\}_{s\geq 1}$
  - holds *long-term real assets:* $\{{}_{t-1}b_{t+s}\}_{s\geq 0}$ (TIPS, PLAM)
- Date-0 holdings: $\{{}_{-1}b_{t+s}\}_{s\geq 0}$, term structure $q_t = ({}_0q_t)$
- Solves:

$$\begin{aligned} \max \quad & U(\{c_t, n_t\}) \\ \text{s.t.} \quad & \sum_{t\geq 0} q_t c_t = \sum_{t\geq 0} q_t (y_t + w_t n_t) + \underbrace{\sum_{t\geq 0} q_t ({}_{-1}b_t)}_{\text{Financial wealth } W^F} \end{aligned}$$

- $\rightarrow$ **Initial balance sheet composition irrelevant conditional on** W^F
- Mortgage M: ARM ${}_{-1}b_0 = -M \Leftrightarrow$ PLAM ${}_{-1}b_t = -m$ if $\sum_{t=0}^{T} q_t m = M$

Unexpected shock

$$\begin{aligned} \max \quad & U\left(\{c_t, n_t\}\right) \\ \text{s.t.} \quad & \sum_{t\geq 0} q_t c_t = \sum_{t\geq 0} q_t \left(y_t + w_t n_t + \left({}_{-1}b_t\right)\right) \equiv W \end{aligned}$$

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

Unexpected shock

$$\begin{aligned} \max \quad & U\left(\{c_t, n_t\}\right) \\ \text{s.t.} \quad & \sum_{t\geq 0} q_t c_t = \sum_{t \geq 0} q_t \left(y_t + w_t n_t + \left({}_{-1}b_t\right)\right) \equiv W \end{aligned}$$

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

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

Unexpected shock

$$\begin{aligned} \max \quad & U\left(\{c_t, n_t\}\right) \\ \text{s.t.} \quad & \sum_{t\geq 0} q_t c_t = \sum_{t\geq 0} q_t \left(y_t + w_t n_t + \left({}_{-1}b_t\right)\right) \equiv W \end{aligned}$$

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

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

- Welfare change $dU \simeq U_{c_0} \cdot \left(y_0 + w_0 n_0 + \left({}_{-1}b_0\right) - c_0\right) dr$

Unexpected shock

$$\begin{aligned} \max \quad & U\left(\{c_t, n_t\}\right) \\ \text{s.t.} \quad & \sum_{t \geq 0} q_t c_t = \sum_{t \geq 0} q_t \left(y_t + w_t n_t + ({}_{-1}b_t)\right) \equiv W \end{aligned}$$

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

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

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

$${}_{-1}b_0 = c_0 - \left(y_0 + w_0 n_0\right) \quad \forall t$$

Unexpected shock

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

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

$$dc_0 \simeq \frac{\partial c_0}{\partial W} \cdot \overbrace{\left(y_0 + w_0 n_0 + ({}_{-1}b_0) - c_0\right)}^{{}_{-1}URE_0} dr + \underbrace{dc_0^h}_{\text{Substitution effect}}$$

- Welfare change $dU \simeq U_{c_0} \cdot \left({}_{-1}URE_0\right) dr$
- **Composition of balance sheet matters**: e.g. "hedged" when

$${}_{-1}b_0 = c_0 - (y_0 + w_0 n_0) \quad \forall t \quad \rightarrow \quad {}_{-1}URE_0 = 0$$

Unexpected shock

$$\begin{aligned} \max \quad & U\left(\{c_t, n_t\}\right) \\ \text{s.t.} \quad & \sum_{t \geq 0} q_t c_t = \sum_{t \geq 0} q_t \left(y_t + w_t n_t + ({}_{-1}b_t)\right) \equiv W \end{aligned}$$

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

$$dc_0 \simeq \overbrace{\frac{\partial c_0}{\partial y_0}}^{MPC} \cdot \overbrace{\left(y_0 + w_0 n_0 + ({}_{-1}b_0) - c_0\right)}^{{}_{-1}URE_0} dr + \underbrace{dc_0^h}_{\text{Substitution effect}}$$

- Welfare change $dU \simeq U_{c_0} \cdot \left({}_{-1}URE_0\right) dr$
- **Composition of balance sheet matters**: e.g. "hedged" when

$${}_{-1}b_0 = c_0 - \left(y_0 + w_0 n_0\right) \quad \forall t \quad \rightarrow \quad {}_{-1}URE_0 = 0$$

Unhedged interest rate exposure

$$URE \equiv {}_{-1}URE_0 = \overbrace{y_0 + w_0 n_0 + \underbrace{({}_{-1}b_0)}_{}}^{\text{maturing assets}}\!\!\!\!\!\!\!\!\!\underbrace{\phantom{({}_{-1}b_0)} - c_0}_{\text{maturing liabilities}}$$

- 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

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

- 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, time-separable $\sum \beta^t U(c_t, n_t)$

$$dc = MPC \cdot URE \cdot dr - \sigma c (1 - MPC)\, dr$$

- $\sigma \equiv -\frac{U_c}{cU_{cc}}$ local EIS

Unhedged interest rate exposure

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

- 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, time-separable $\sum \beta^t U(c_t, n_t)$ + date-0 income dy

$$dc = MPC\,(dy + UREdr) - \sigma c\,(1 - MPC)\,dr$$

- $\sigma \equiv -\frac{U_c}{cU_{cc}}$ local EIS

Unhedged interest rate exposure

$$URE \equiv {}_{-1}URE_0 = \overbrace{y_0 + w_0 n_0 + \underbrace{\left({}_{-1}b_0\right) - c_0}_{\text{maturing liabilities}}}^{\text{maturing assets}}$$

- 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
- $+$ permanent change in price level dP (w/ nominal assets)

$$dc = MPC\left(dy + UREdr - NNP\frac{dP}{P}\right) - \sigma c\left(1 - MPC\right)dr$$

- $\sigma \equiv -\frac{U_c}{cU_{cc}}$ local EIS
- $NNP \equiv \sum_{t\geq 0} Q_t\left({}_{-1}B_t\right)$ net nominal position

Outline

1. Partial equilibrium: $\mathcal{E}_r$ as sufficient statistic
   - Price theory
   - Incomplete markets
   - Aggregation
2. Measuring $\mathcal{E}_r$
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 Λ_t, rate δ_N
- Perfect foresight over nominal bond price Q_t and price level P_t

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

$$P_t c_t = P_t y_t + P_t w_t n_t + \Lambda_t + Q_t(\delta_N \Lambda_t - \Lambda_{t+1})$$
$$\Lambda_{t+1} \geq -P_t \overline{\lambda}$$

- 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

- 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 $dr = -\frac{dQ}{Q}$

Sufficient statistics for consumption response to transitory shocks

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

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

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

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 $dr = -\frac{dQ}{Q}$

Sufficient statistics for consumption response to transitory shocks

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

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

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

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

2. Measuring $\mathcal{E}_r$

3. General equilibrium model

Aggregation: environment

- Environment:
  - Closed economy with no government
  - $i = 1 \dots I$ 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)

$$dc_i \simeq MPC_i \left(dY_i + URE_i dr - NNP_i \frac{dP}{P} \right) - \sigma_i c_i \left(1 - MPC_i\right) dr$$

Aggregation: environment

- Environment:
  - Closed economy with no government
  - $i = 1 \dots I$ 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)

$$dc_i \simeq MPC_i \left(dY_i + URE_i dr - NNP_i \frac{dP}{P} \right) - \sigma_i c_i \left(1 - MPC_i\right) dr$$

- Markets clear at date 0:
  - Goods

$$C \equiv \sum_i c_i = \sum_i Y_i \equiv Y \quad \Rightarrow \quad \sum_i URE_i \quad = 0$$

  - Assets (here all nominal)

$$\sum_i NNP_i = 0$$

Aggregation with heterogeneity

Aggregate consumption response to transitory shock

$$dC \simeq \underbrace{\left(\sum_i \frac{Y_i}{Y} MPC_i\right) dY}_{\text{Aggregate income channel}} + \underbrace{\mathcal{C}\text{ov}_I\left(MPC_i, dY_i - Y_i \frac{dY}{Y}\right)}_{\text{Earnings heterogeneity channel}} - \underbrace{\mathcal{C}\text{ov}_I\left(MPC_i, NNP_i\right)}_{\text{Fisher channel}} \frac{dP}{P}$$
$$+ \left(\underbrace{\mathcal{C}\text{ov}_I\left(MPC_i, URE_i\right)}_{\text{Interest rate exposure channel}} - \underbrace{\sum_i \sigma_i \left(1 - MPC_i\right) c_i}_{\text{Substitution channel}} \right) dr$$

- 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

$$\frac{dC}{C} \simeq \underbrace{\mathbb{E}_I\left[\frac{Y_i}{Y}MPC_i\right]}_{\mathcal{M}}\frac{dY}{Y} + \underbrace{\mathrm{Cov}_I\left(MPC_i, \frac{dY_i - Y_i\frac{dY}{Y}}{\mathbb{E}_I\left[c_i\right]}\right)}_{dE^h} \underbrace{-\mathrm{Cov}_I\left(MPC_i, \frac{NNP_i}{\mathbb{E}_I\left[c_i\right]}\right)}_{\mathcal{E}_P}\frac{dP}{P}$$
$$+\left(\underbrace{\mathrm{Cov}_I\left(MPC_i, \frac{URE_i}{\mathbb{E}_I\left[c_i\right]}\right)}_{\mathcal{E}_r} - \sigma \underbrace{E_I\left[(1 - MPC_i)\frac{c_i}{E_I\left[c_i\right]}\right]}_{S}\right)dr$$

- σ: weighted average of σ_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

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

- **Next**: go to data, find $\mathcal{E}_r = \mathrm{Cov}_I\left(MPC_i, \frac{URE_i}{\mathbb{E}_I[c_i]}\right) < 0$
  - compare to σ using $\sigma^* = -\frac{\mathcal{E}_r}{S}$

Focus on slope term

$$\frac{dC}{C} \simeq \mathcal{M}\frac{dY}{Y} + dE^h + \mathcal{E}_P\frac{dP}{P} - S\left(\sigma^* + \sigma\right)dr$$

- **Next**: go to data, find $\mathcal{E}_r = \mathrm{Cov}_I\left(MPC_i, \frac{URE_i}{\mathbb{E}_I[c_i]}\right) < 0$
  - compare to σ using $\sigma^* = -\frac{\mathcal{E}_r}{S}$

Focus on slope term

$$\frac{dC}{C} \simeq \mathcal{M}\frac{dY}{Y} + dE^h + \mathcal{E}_P\frac{dP}{P} - S\left(\sigma^* + \sigma\right)dr$$

- **Next**: go to data, find $\mathcal{E}_r = \mathrm{Cov}_I\left(MPC_i, \frac{URE_i}{\mathbb{E}_I[c_i]}\right) < 0$
  - compare to σ using $\sigma^* = -\frac{\mathcal{E}_r}{S}$
- **But**: usually, in household data $\mathbb{E}_I\left[URE_i\right] > 0$. Why?
  - Maturity mismatch in the household sector (counterpart of banks)
  - Government with flow borrowing requirements (negative URE)
  - My benchmark: "Ricardian view" (uniform rebate). $\mathcal{E}_r$ still correct.

Focus on slope term

$$\frac{dC}{C} \simeq \mathcal{M}\frac{dY}{Y} + dE^h + \mathcal{E}_P\frac{dP}{P} - S\left(\sigma^* + \sigma\right) dr$$

- **Next**: go to data, find $\mathcal{E}_r = \mathrm{Cov}_I\left(MPC_i, \frac{URE_i}{\mathbb{E}_I[c_i]}\right) < 0$
  - compare to σ using $\sigma^* = -\frac{\mathcal{E}_r}{S}$
- **But**: usually, in household data $\mathbb{E}_I\left[URE_i\right] > 0$. Why?
  - Maturity mismatch in the household sector (counterpart of banks)
  - Government with flow borrowing requirements (negative URE)
  - My benchmark: "Ricardian view" (uniform rebate). $\mathcal{E}_r$ still correct.
- If *none* of the gains are rebated: $\mathcal{E}_r^{NR} = \mathbb{E}_I\left[MPC_i \frac{URE_i}{\mathbb{E}_I[c_i]}\right]$

Focus on slope term

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

- **Next**: go to data, find $\mathcal{E}_r = \mathrm{Cov}_I\left(MPC_i, \frac{URE_i}{\mathbb{E}_I[c_i]}\right) < 0$
  - compare to σ using $\sigma^* = -\frac{\mathcal{E}_r}{S}$
- **But**: usually, in household data $\mathbb{E}_I\left[URE_i\right] > 0$. Why?
  - Maturity mismatch in the household sector (counterpart of banks)
  - Government with flow borrowing requirements (negative URE)
  - My benchmark: "Ricardian view" (uniform rebate). $\mathcal{E}_r$ still correct.
- If *none* of the gains are rebated: $\mathcal{E}_r^{NR} = \mathbb{E}_I\left[MPC_i\frac{URE_i}{\mathbb{E}_I[c_i]}\right]$
  - $\mathcal{E}_r^{NR} - \sigma S > 0$?

Focus on slope term

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

- **Next**: go to data, find $\mathcal{E}_r = \mathrm{Cov}_I\left(MPC_i, \frac{URE_i}{\mathbb{E}_I[c_i]}\right) < 0$
  - compare to σ using $\sigma^* = -\frac{\mathcal{E}_r}{S}$
- **But**: usually, in household data $\mathbb{E}_I\left[URE_i\right] > 0$. Why?
  - Maturity mismatch in the household sector (counterpart of banks)
  - Government with flow borrowing requirements (negative URE)
  - My benchmark: "Ricardian view" (uniform rebate). $\mathcal{E}_r$ still correct.
- If *none* of the gains are rebated: $\mathcal{E}_r^{NR} = \mathbb{E}_I\left[MPC_i \frac{URE_i}{\mathbb{E}_I[c_i]}\right]$
  - $\mathcal{E}_r^{NR} - \sigma S > 0$?

"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

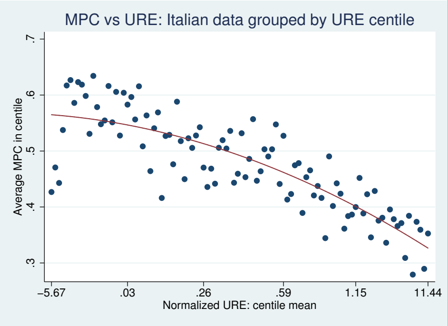
$$URE_i = Y_i - C_i + B_i - D_i$$

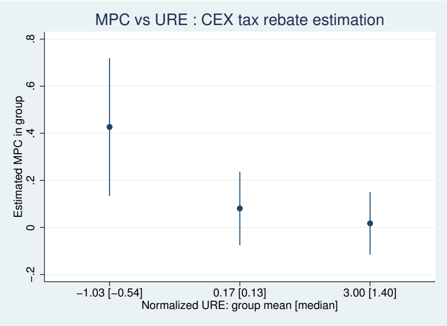
   - Y_i: income from all sources
   - C_i: consumption (incl. durables, mtge paymts, excl. house purchase)
   - B_i: maturing asset stocks (especially deposits)
   - D_i: maturing liability stocks (adjustable rate mortgages, cons. credit)

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] Question
   - US Consumer Expenditure Survey 2001-2002
     - Estimate from randomized receipts of tax rebates [JPS 2006] Details

3. Estimate $\mathcal{E}_r$, S, $\sigma^* = -\frac{\mathcal{E}_r}{S}$ and $\mathcal{E}_r^{NR}$ Summary Statistics

Both surveys and methods show that $\mathcal{E}_r < 0$





$$\Rightarrow \quad \mathcal{E}_r = \mathrm{Cov}_I\left(MPC_i, \frac{URE_i}{\mathbb{E}_I\left[c_i\right]}\right) < 0$$

Italian data estimation

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

$$\widehat{\mathcal{E}_r} = \widehat{\mathrm{Cov}_I}\left(MPC_i, \frac{URE_i}{\mathbb{E}_I[c_i]}\right) \quad \widehat{S} = \widehat{\mathbb{E}_I}\left[(1 - MPC_i)\frac{c_i}{\mathbb{E}_I[c_i]}\right] \quad \widehat{\mathcal{E}_r^{NR}} = \widehat{\mathbb{E}_I}\left[MPC_i \frac{URE_i}{\mathbb{E}_I[c_i]}\right]$$

Time Horizon		Annual	
Parameter		Estimate	95% C.I.
Redistribution elasticity	$\widehat{\mathcal{E}_r}$	-0.06	[-0.09; -0.04]
Hicksian scaling factor	$\widehat{S}$	0.55	[0.53; 0.57]
Equivalent EIS	$\widehat{\sigma^*} = -\frac{\widehat{\mathcal{E}_r}}{\widehat{S}}$	0.12	[0.06; 0.17]
No-rebate elasticity	$\widehat{\mathcal{E}_r^{NR}}$	0.21	[0.17; 0.23]

All statistics computed using survey weights

CEX data estimation from JPS

- Run MPC estimation over $J = 3$ groups of URE and compute:

$$\widehat{\mathcal{E}_r^{NR}} = \widehat{\mathbb{E}_J}\left[MPC_j \frac{URE_j}{\mathbb{E}_I\left[c_i\right]}\right] \quad \widehat{\mathcal{E}_r} = \widehat{\mathrm{Cov}_J}\left(MPC_j, \frac{URE_j}{\mathbb{E}_I\left[c_i\right]}\right) \quad \widehat{S} = \widehat{\mathbb{E}_J}\left[\left(1 - MPC_j\right)\right]$$

Consumption measure		Food	
Parameter		Estimate	95% C.I.
Redistribution elasticity	$\widehat{\mathcal{E}_r}$	-0.24	[-0.42; -0.07]
Hicksian scaling factor	$\widehat{S}$	0.82	[0.69; 0.95]
Equivalent EIS	$\widehat{\sigma^*} = -\frac{\widehat{\mathcal{E}_r}}{\widehat{S}}$	0.30	[0.05; 0.54]
No-rebate elasticity	$\widehat{\mathcal{E}_r^{NR}}$	-0.12	[-0.27; 0.02]

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 $\mathcal{E}_r$ and σ^* 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:

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

  - CES in net consumption σ, constant elasticity of labor supply ψ
- All uncertainty is *purely idiosyncratic*
  - Idiosyncratic productivity process $\Pi_e\left(e'|e\right)$
  - Independent discount factor process $\Pi_\beta\left(\beta'|\beta\right)$
  - Aggregate state $\mathbf{s} = (e, \beta)$ is in its stationary distribution
- Two-tiered production:
  - Measure 1 of intermediate good firms, identical linear production

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

  - Final good Y_t: aggregator of x_t^j, elasticity ϵ

Markets and government

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

$$P_t c_t^i = (1-\tau) W_t e_t^i n_t^i + P_t T_t + \Lambda_t^i + Q_t \left(\delta_N \Lambda_t^i - \Lambda_{t+1}^i\right)$$

$$Q_t \Lambda_{t+1}^i \geq -\overline{D} P_t$$

- Perfectly competitive final good (P_t) and labor markets (W_t)
- Monopolistically competitive intermediate goods (P_t^j)

Markets and government

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

$$P_t c_t^i = (1-\tau) W_t e_t^i n_t^i + P_t T_t + \Lambda_t^i + Q_t \left(\delta_N \Lambda_t^i - \Lambda_{t+1}^i\right)$$

$$Q_t \Lambda_{t+1}^i \geq -\overline{D} P_t$$

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

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

- 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 $\overline{D}$) is invariant to δ_N

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

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

  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 δ_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 $\mathbb{E}[n] = 1$
  - Average quarterly MPC $= 0.25$

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 $\mathbb{E}[n] = 1$
  - Average quarterly MPC $= 0.25$
- Parameters:
  - Time preference process Π_β: patient $(\beta_P)^4 = 0.97$/imp. $(\beta_I)^4 = 0.82$
    - 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 $\delta_N = 0.95$
  - Borrowing limit as fraction of average consumption $\overline{D} = 185\%$
  - Productivity discretized AR(1), $\rho = 0.95$ and $\tau^* = 0.4$ Details

Redistribution channel in the model

- For transitory monetary policy shock, can show:

$$\frac{dC}{C} \simeq \mathcal{M}\frac{dY}{Y} + \underbrace{dE^h}_{\mathcal{E}_Y \frac{dY}{Y}} + \mathcal{E}_P \frac{dP}{P} - S\left(\sigma^* + \sigma\right) dr \qquad \underbrace{+\mathcal{T}\frac{dY}{Y}}_{\text{Complementarity channel}}$$

Details and compare to data		Steady-state value	
		$\delta_N = 0.95$ U.S.	$\delta_N = 0$ "Only ARMs"
Redistribution elasticity for r	$\mathcal{E}_r$	-0.09	
Hicksian scaling factor	S	0.57	
Equivalent EIS	$\sigma^* = -\frac{\mathcal{E}_r}{S}$	0.15	
Income weighted MPC	$\mathcal{M}$	0.16	
Earnings heterogeneity factor	$\mathcal{E}_Y$	-0.09	
Redistribution elasticity for P	$\mathcal{E}_P$	1.77	
Consumption-labor compl. term	$\mathcal{T}$	0.46	

Redistribution channel in the model

- For transitory monetary policy shock, can show:

$$\frac{dC}{C} \simeq \mathcal{M}\frac{dY}{Y} + \underbrace{dE^h}_{\mathcal{E}_Y \frac{dY}{Y}} + \mathcal{E}_P \frac{dP}{P} - S\left(\sigma^* + \sigma\right) dr \qquad \underbrace{+\mathcal{T}\frac{dY}{Y}}_{\text{Complementarity channel}}$$

Details and compare to data		Steady-state value	
		$\delta_N = 0.95$ U.S.	$\delta_N = 0$ "Only ARMs"
Redistribution elasticity for r	$\mathcal{E}_r$	-0.09	-1.76
Hicksian scaling factor	S	0.57	
Equivalent EIS	$\sigma^* = -\frac{\mathcal{E}_r}{S}$	0.15	3
Income weighted MPC	$\mathcal{M}$	0.16	
Earnings heterogeneity factor	$\mathcal{E}_Y$	-0.09	
Redistribution elasticity for P	$\mathcal{E}_P$	1.77	
Consumption-labor compl. term	$\mathcal{T}$	0.46	

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

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

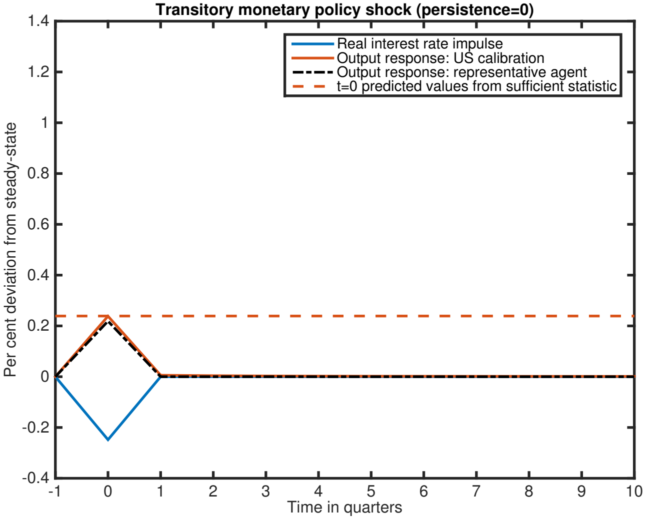
Sticky prices

- 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

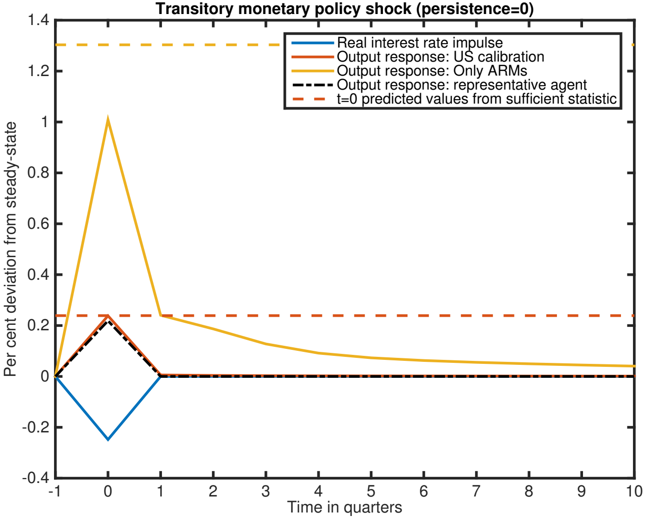
$$R_t = \rho R_{t-1} + (1-\rho) R - \epsilon_t$$

- 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 Details

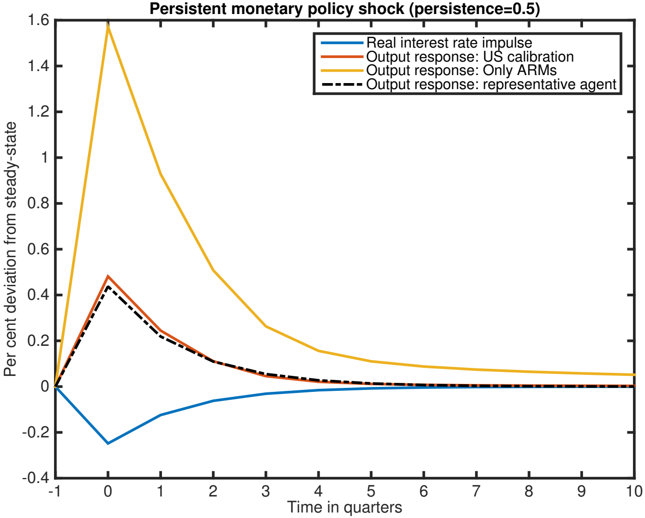
Transitory monetary policy easing



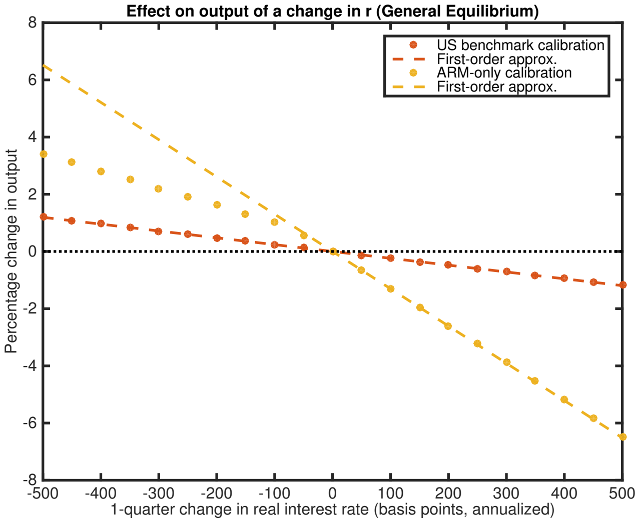
Transitory monetary policy easing



Prolonged monetary policy easing



Asymmetric effects



Conclusion

- Monetary policy redistributes:
  - One reason why it affects aggregate consumption
  - Likely to be the dominant one in ARM countries
  - Sufficient statistics, $\mathcal{E}_m = \mathrm{Cov}_I\left(MPC_i, \mathrm{Exposure}_{i,m}\right)$, 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)

Back

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

Back

Datasets: summary statistics

	SHIW 2010		CEX 2001	
Variable	mean	n.s.d.	mean	n.s.d.
Income from all sources (Y_i, per year)	36,114	0.90	45,617	1.01
Consumption incl. mortgage payments (C_i, per year)	27,976	0.61	36,253	0.79
Deposits and maturing assets (B_i)	14,200	1.45	7,147	0.77
ARM mortgage liabilities and consumer credit (D_i)	6,228	1.03	2,872	0.22
Unhedged interest rate exposure (URE_i, per year)	16,110	1.92	13,639	1.27
Unhedged interest rate exposure (URE_i, per Q)	10,007	7.07	6,616	3.39
Marginal Propensity to Spend (annual)	0.47	0.35		
Count	7,951		9,443	

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

"n.s.d": normalized standard deviation, $sd_I\left(\frac{X_i}{\mathbb{E}_I[C_i]}\right)$ for $X_i = Y_i, C_i, B_i, URE_i$ and $sd_I\left(MPC_i\right)$ for MPC

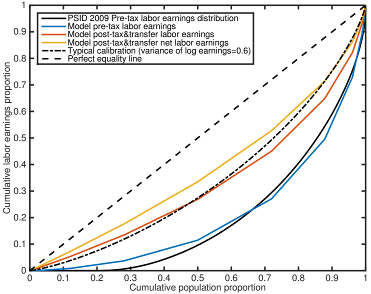
Back

Calibration (continued)

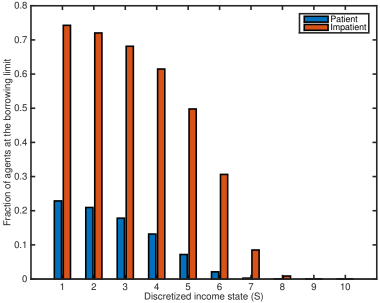
- Idiosyncratic productivity process: discretized $AR(1)$

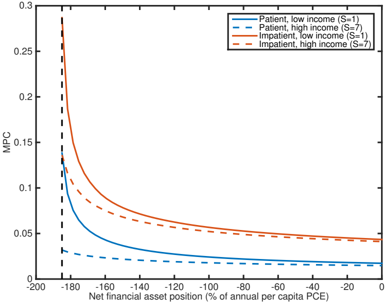
$$\log e_t = \rho \log e_{t-1} + \sigma_e \sqrt{1-\rho^2}\epsilon_t \quad \epsilon_t \sim \mathcal{N}(0,1)$$

  - 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) Back

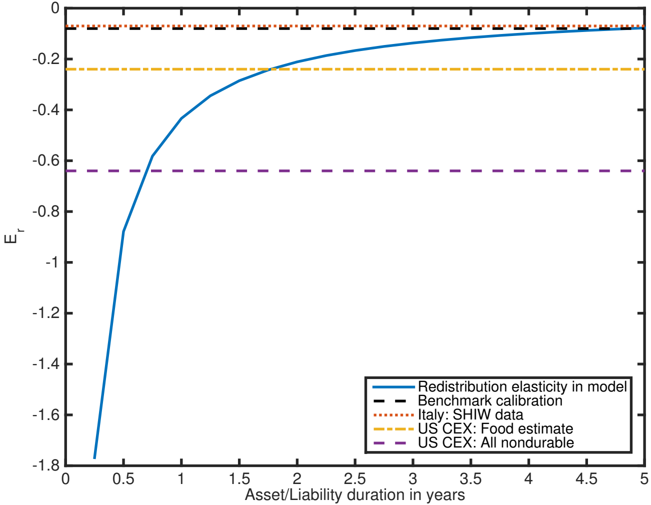


Constrained agents and MPCs in steady state





Redistribution elasticity $\mathcal{E}_r$ in the model and in data



Back

Other moments

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

		Mean	sd	P5	P25	Median	P75	P95	P99
$\frac{Q\Lambda}{\mathbb{E}[c]}$	PSID 2009	1.17	32.51	-28.42	-6.88	0.00	1.78	35.86	113.90
	Model	0	17.96	-7.4	-7.27	-6.11	0.32	25.96	54.05

Units: average quarterly consumption

Transition after shocks

- Debt limit maintains next period real coupon payments fixed:

$$\overline{D_t} = Q_t \overline{d} \quad \Leftrightarrow \quad \lambda_{t+1} \geq -\overline{d}$$

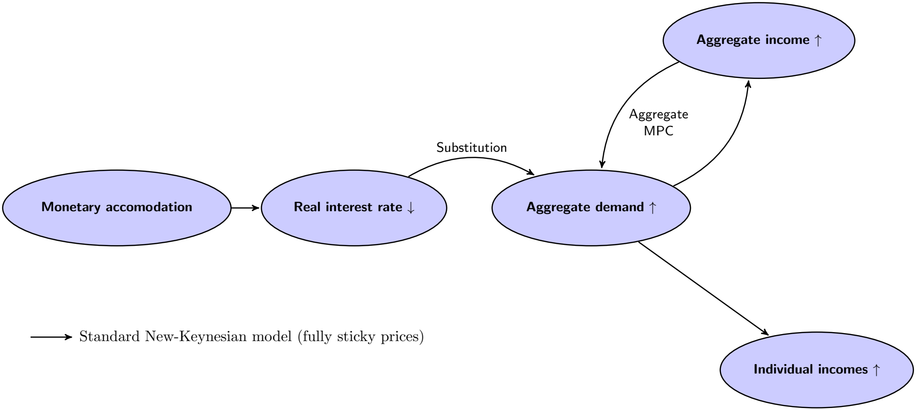
- When $\Pi_t = 1$, B.C. of agents at the borrowing limit:

$$c_t^i = y_t^i - \left(\overline{d} + \frac{Q_t}{Q} \times \underbrace{\left(-\overline{D}\left(1-\delta_N\right)\right)}_{\underline{URE}} \right)$$

	Steady-state value	
	$\delta_N = 0.95$	$\delta_N = 0$
$\min\left\{y^i\right\}$	0.413	0.413
$\overline{d}$	0.413	7.455
$\underline{URE}$	-0.358	-7.400
$(R-1)\,\overline{D}$	0.055	0.055

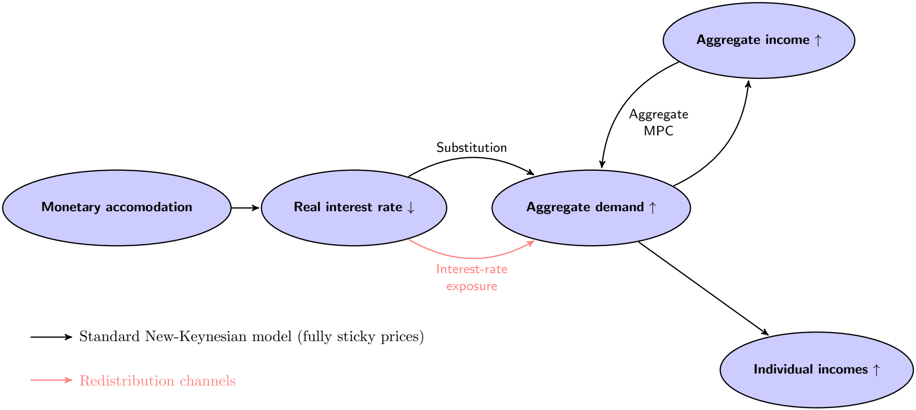
Back

Monetary policy and the redistribution channels



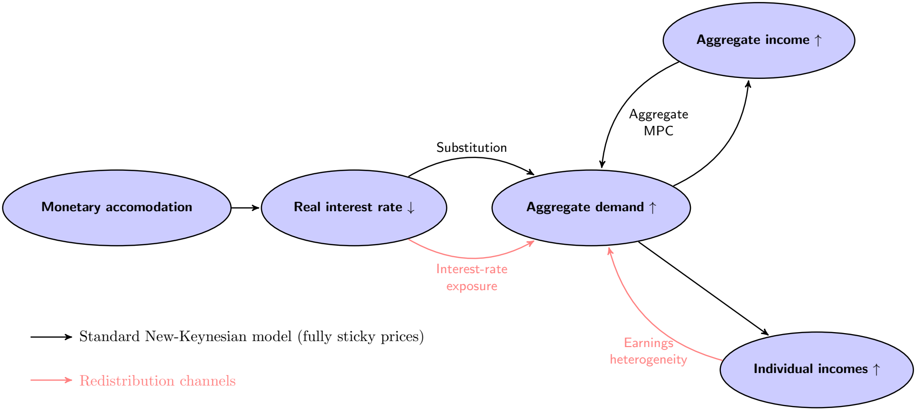
Back

Monetary policy and the redistribution channels



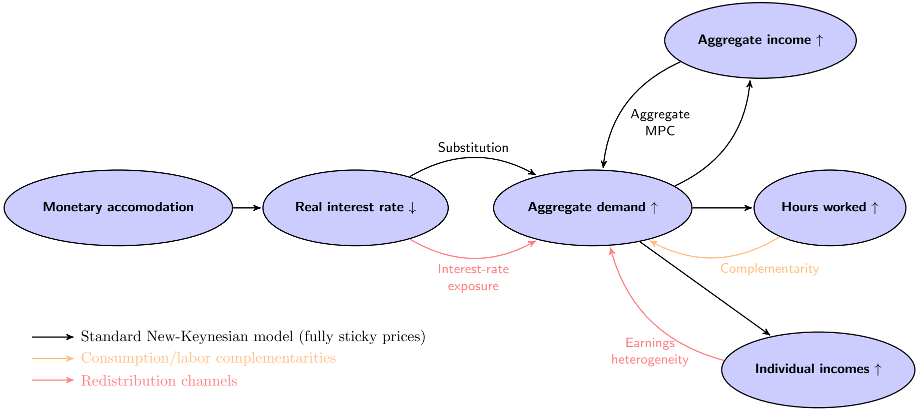
Back

Monetary policy and the redistribution channels



Back

Monetary policy and the redistribution channels



Back