# Discussion: A Model of Intermediation, Money, Interest, and Prices

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# Different Monetary Frameworks

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- Financial crisis: how do credit markets react to monetary policy?

# Monetary Policy as it is Actually Conducted

- A model of realistic modern monetary policy

  - ▶ **Central bank:** discount window, interest on reserves, and balance sheet

  - ▶ **Intermediaries:** loans and deposits, settle reserve surplus/deficits in interbank market

# Monetary Policy as it is Actually Conducted

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- Embedded within an incomplete-markets economy

  - ▶ **Distribution** of agents matter for consumption

  - ▶ **Production inefficiency:** Borrowing-constrained agents produce using inefficient process

# Policy Takeaways

- Two tools: **Corridor system** and **OMOs**

- Implement two targets: **credit spread** and **inflation targets**

- Can be used independently...under "normal" conditions
  - ▶ Explicit characterization of ZLB and conditions under which the interbank market breaks down

# Policy Takeaways

- Two tools: **Corridor system** and **OMOs**

- Implement two targets: **credit spread** and **inflation targets**

- Can be used independently...under "normal" conditions

  ▸ Explicit characterization of ZLB and conditions under which
    the interbank market breaks down

- But normative implications are tied to production process

- Monetary policy interlinked with fiscal policy

# Model Ingredients

- Heterogeneous households
  - Produce, consume, save/borrow

- Intermediaries
  - Supply loans and deposits for HHs
  - Must satisfy reserve requirement with CB

- Central bank
  - Sets policy rates and balance sheet
  - Also conducts fiscal policy (taxes/transfers)

# Central Bank

- Nominal policy rates:
    - Interest on reserves $i^m$
    - Discount window rate $i^{dw}$ ( $\implies$ spread $\iota = i^{dw} - i^m$)

- Balance sheet items:
    - Monetary base $M$
    - Net assets $E = L - M$

- Taxes/transfers to households $T$

# Bank Problem

- Deposits $a^b$, loans $\ell^b$, and reserves $m^b$ in order to maximize expected per-period profits
- Reserve requirement $\varrho \in [0, 1]$ fraction of deposits
- Subject to fraction deposit shocks $\pm\delta$ (Afonso and Lagos 2012, Bianchi and Bigio 2018)
- Expected profits

$$
\begin{aligned}
\pi^b \propto{} & i^\ell \ell^b + i^m m^b - i^a a^b \\
& + \frac{1}{2}\chi(m^b - \varrho a^b + (1-\varrho)\delta a^b) \\
& + \frac{1}{2}\chi(m^b - \varrho a^b - (1-\varrho)\delta a^b)
\end{aligned}
$$

where

$$
\chi(x) = \begin{cases} \chi^- \cdot x & \text{if } x \le 0 \\ \chi^+ \cdot x & \text{if } x > 0 \end{cases}
$$

# Market Tightness and the Liquidity Ratio

- $\chi^+, \chi^-$ is a function of market tightness $\theta = B^-/B^+$

$$B^- = -\int_b \min(m^b - \varrho a^b + z^b(1-\varrho)\delta a^b, 0) \, \mathrm{d}b$$

$$B^+ = \int_b \max(m^b - \varrho a^b + z^b(1-\varrho)\delta a^b, 0) \, \mathrm{d}b$$
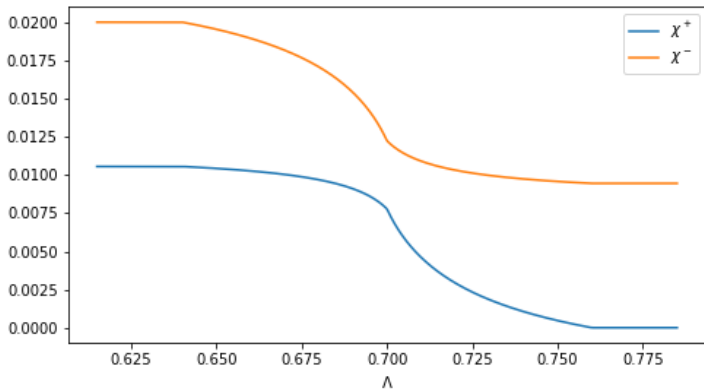
- Under some assumptions about distribution of $m^b, a^b$:

$$B^- = \sum_{z=-1,1} -\frac{1}{2} \min(M^b - \varrho A^b + z(1-\varrho)\delta A^b, 0)$$

$$B^+ = \sum_{z=-1,1} \frac{1}{2} \max(M^b - \varrho A^b + z(1-\varrho)\delta A^b, 0)$$

- $\implies \theta$ is a function only of the aggregate bank liquidity ratio

$$\Lambda = \frac{M^b}{A^b}$$

# Interbank Cost Function $\chi$



Notes: function $\chi$ as a function of the liquidity ratio, for different values of interbank efficiency $\lambda$. Corridor spread $\iota = 0.02$
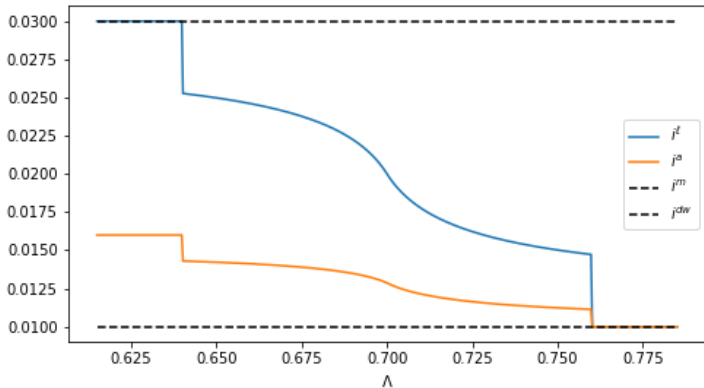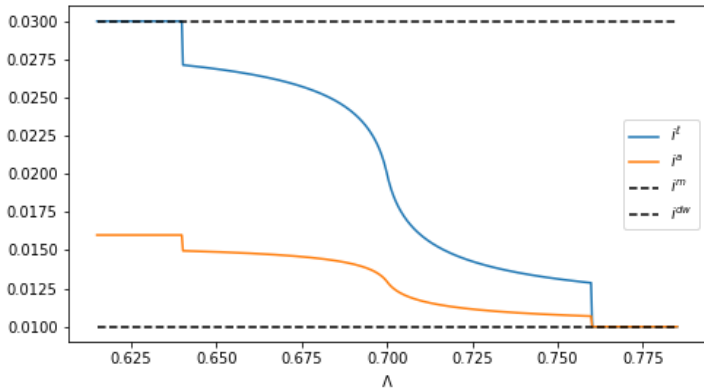
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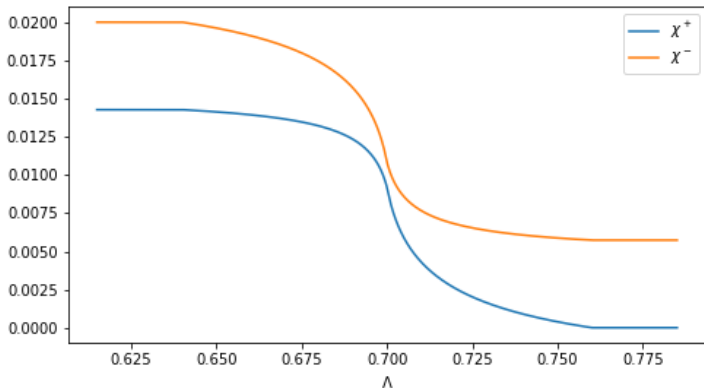


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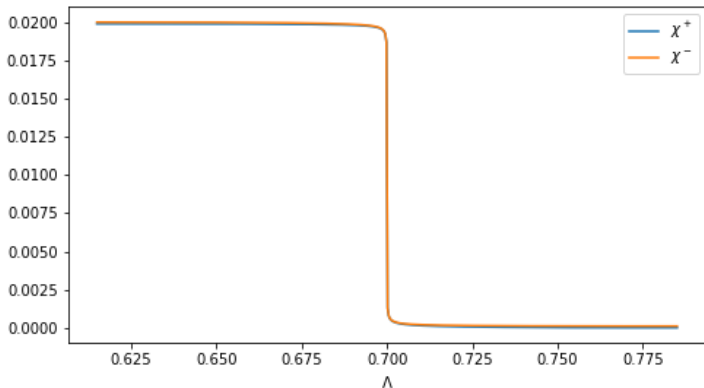


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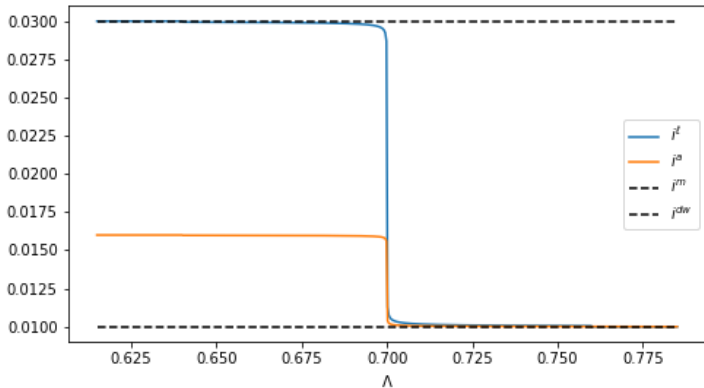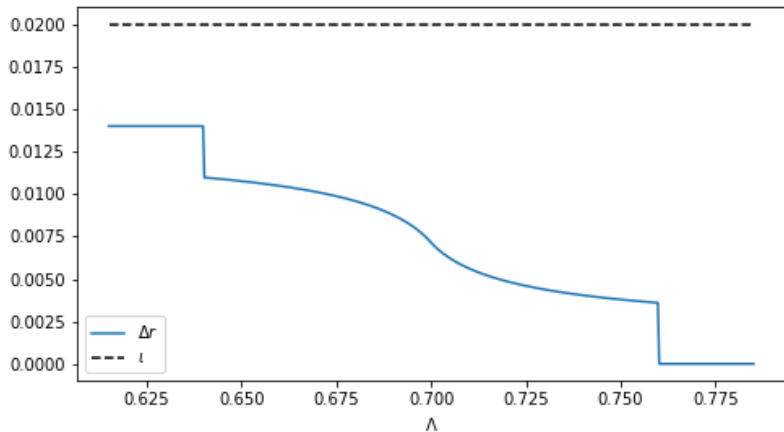
# Equilibrium Nominal Rates

- Linear profit function, perfect competition pins down rates



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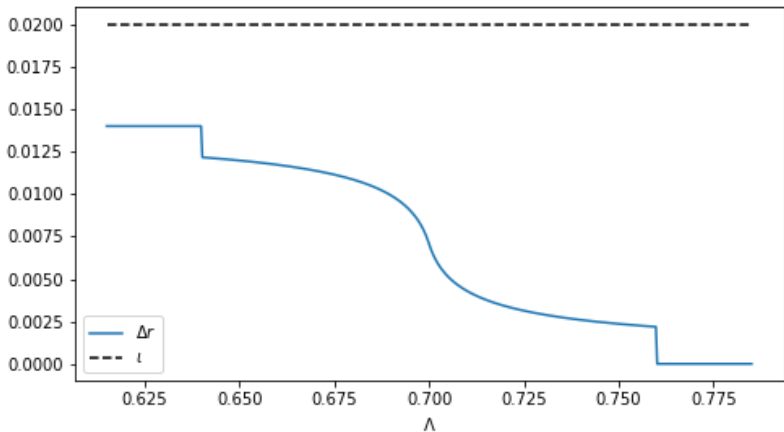


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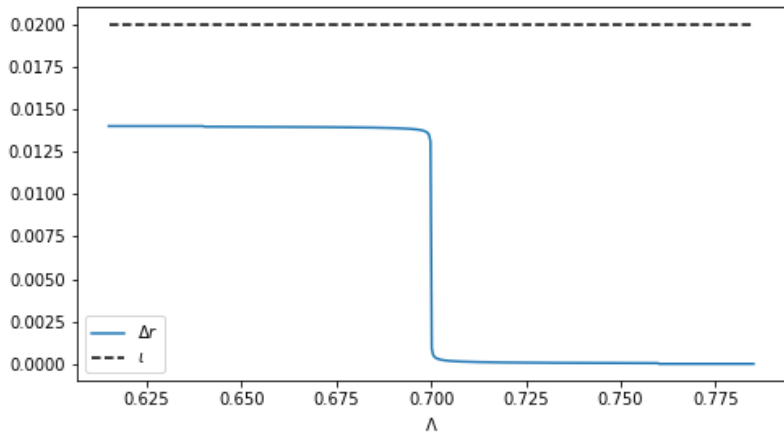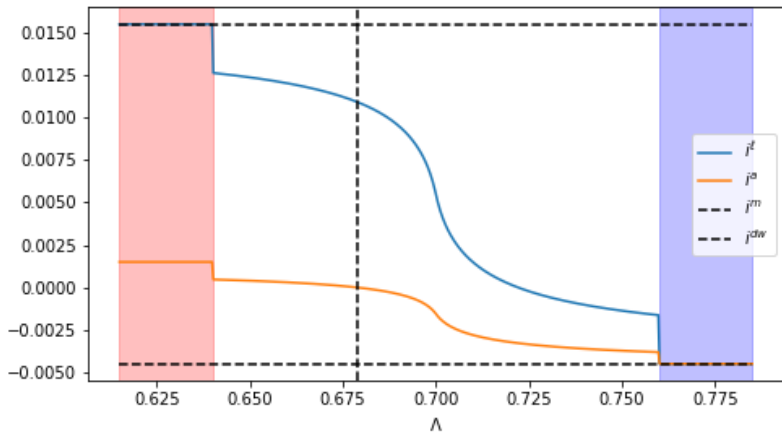# Equilibrium (Real) Spread



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# ZLB, Satiation, and Scarcity



Notes: Nominal rates under different liquidity regimes.

# Household Problem

- (Mostly) standard Huggett setup
- Wealth evolves according to (subject to some conditions on precautionary savings motive)

$$ds = \begin{cases} (r^a s + y^H + T - c)\, dt + \sigma\, dZ & \text{if } s \geq 0 \\ (r^\ell s + y^H + T - c)\, dt + \sigma\, dZ & \text{if } \tilde{s} < s < 0 \\ (r^\ell s + y^L + T - c)\, dt & \text{if } s \leq \tilde{s} \end{cases}$$
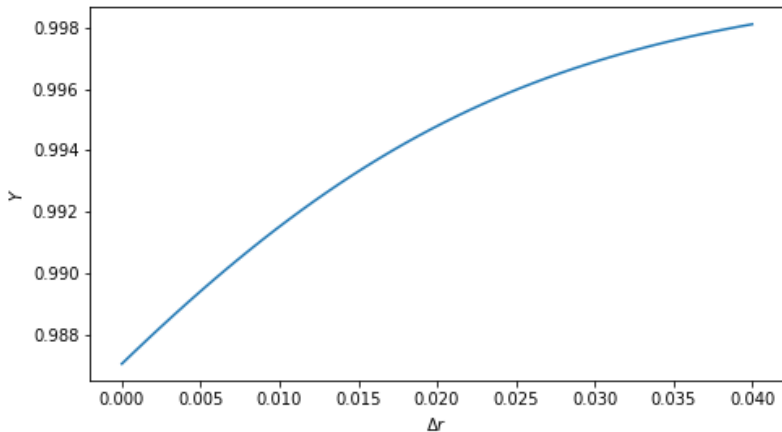
- $\implies$ standard HJB equation, KF equation
- Household problem determined by real rates $r^a, r^\ell$ (and $T$)

# Distribution Given $r^a, \Delta r, T$
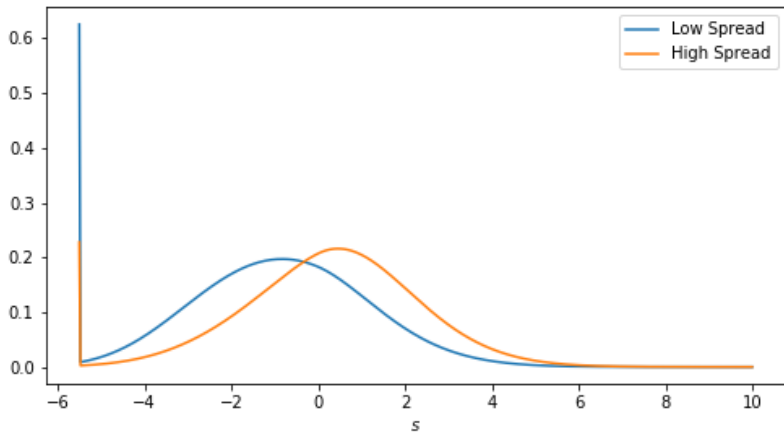


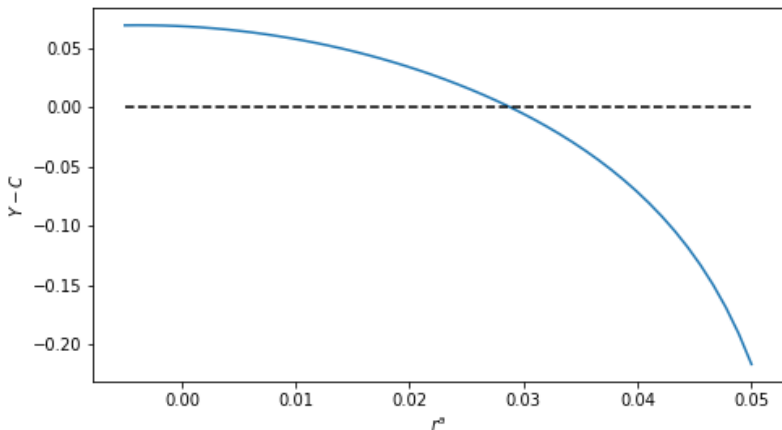Notes: distribution of households, for different spread $\Delta r$.

# Output as a Function of $\Delta r$



Notes: output, for different spread $\Delta r$ (fixing $r^a$, $T$).

# Goods Market Clearing

$$\int_{-\infty}^{\infty} c(s) f(s) \, \mathrm{d}s \equiv C = Y \equiv \int_{-\infty}^{\infty} y(s) f(s) \, \mathrm{d}s$$



Notes: Market clearing condition for deposit rates $r^a$ (fixing $\Delta r$, $T$).

# Equilibrium and Monetary Policy

- Evolution of CB asset position given real wealth clearing $E/P = \mathcal{E} = -\int_{-\infty}^{\infty} sf(s)\,\mathrm{d}s$

$$\mathrm{d}\mathcal{E} = -\left[ r^{\ell}\int_{-\infty}^{0} sf(s)\,\mathrm{d}s + r^{a}\int_{0}^{\infty} sf(s)\,\mathrm{d}s + T \right]\mathrm{d}t$$

- How does the CB implement an equilibrium?

  - ▶ Intermediaries determine nominal rates, real spread

  - ▶ HHs determine (set of) equilibrium real deposit rates

  - ▶ $\implies$ CB sets real spread using corridor spread and OMOs

  - ▶ $\implies$ CB chooses equilibrium according to its net asset position $\mathcal{E}$, transfers $T$

# Experiment: Credit Crunch

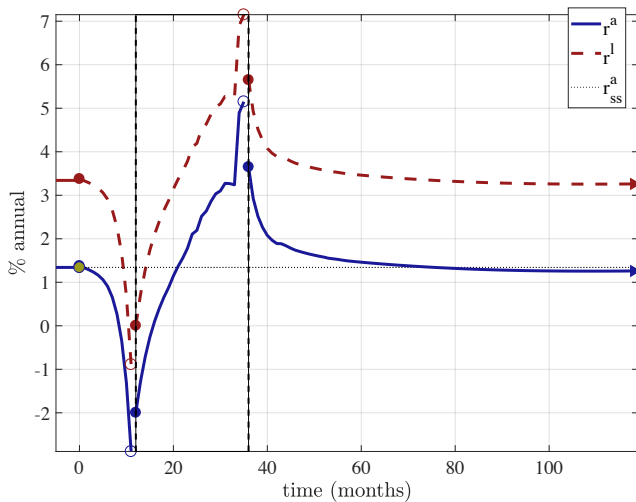Effects of credit crunch (temporary and anticipated)

- Economy starts in steady state

- One year from now, borrowing limit $\tilde{s}$ increases

- Returns to normal after two years

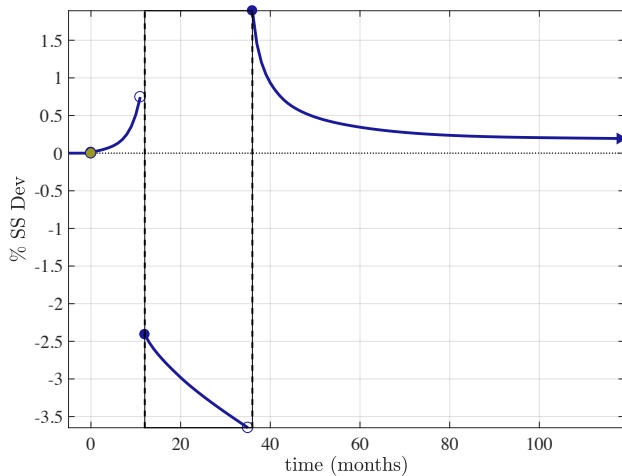# Deposit and Loan Response
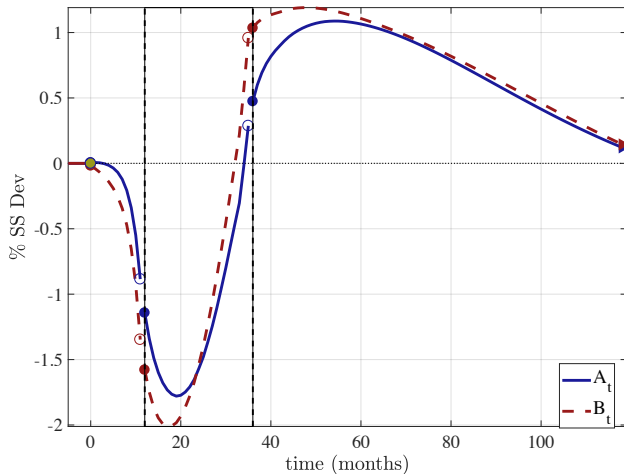


Notes: credit response to credit crunch.

# Rate Response



Notes: rate response to credit crunch.

# Output Response



Notes: output response to credit crunch.

## Intermediaries: More than Pass-Through Entities?

- Stylized bank problem

  ▶ In equilibrium: banks indifferent between any choice of loans and deposits

  ▶ Out of equilibrium: unbounded loans and deposits

- Extension: risk-bearing capacity, limited arbitrage

  ▶ Allows for studying portfolio rebalancing channel of LSAPs

- Also: sensitivity to interbank efficiency?

# ZLB Revisited
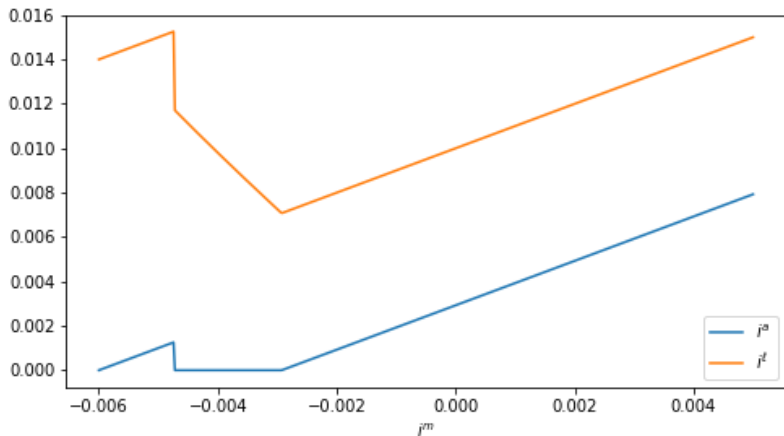


Notes: deposit and loan rates for negative interest on reserves.

# Production Efficiency

- Production inefficiency $\iff$ borrowing-constrained HHs

  ▶ No capital, borrowing is purely for consumption

  ▶ Long-run production benefit from making borrowing painful
    (at a price of lower ex-ante insurance)

- Extension: Huggett to Aiyagari?

  ▶ Efficiency gain from higher borrowing of most productive
    agents

  ▶ Do policy implications change?

# Combined Monetary/Fiscal Authority

- Pluses and minuses...

- Results depend on induced changes in taxes/transfers

- Monetary results (and some paradoxes) can depend on counter-factual fiscal responses (Caramp and Silva 2018)

- Idiosyncratic request: show the fiscal response more clearly

# Concluding Remarks

- Advances our understanding of how realistic monetary policy works within an incomplete markets setup

- Bridges the gap between different monetary frameworks