# Liquidity Traps and Monetary Policy: Managing a Credit Crunch

PRELIMINARY

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## *Motivation & Question*

- Important economic contractions are often associated with large banking/financial crisis:
  - great depression, 1929-33
  - great recession, 2007-08
- Monetary policy (or the lack of it) is attributed a prominent role in ameliorating or exacerbating these contractions.

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- Important economic contractions are often associated with large banking/financial crisis:
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- Monetary policy (or the lack of it) is attributed a prominent role in ameliorating or exacerbating these contractions.
- What are the effects of alternative monetary policy during a credit crunch?

## *Motivation & Question (cont'd)*

- **great depression, 1929-33:** unresponsive monetary policy, large deflation, pronounce recession, large drop in TFP, ..., nominal interest rate near zero

- **great recession, 2007-08:** large increase in government liabilities, low and stable inflation, less pronounce recession but slow recovery, large drop in investment, ..., nominal interest rate near zero

# This Paper

Studies the effects of alternative monetary policies in an economy with heterogeneous producers during a credit crunch, i.e., a tightening of collateral constraints:

0. real benchmark, no government
1. unresponsive money supply
2. constant inflation target
3. distribution of welfare consequences

# *Preview of Results*

0. real benchmark, no government
   - drop in TFP, sharp drop in the real interest rate
1. unresponsive monetary policy
   - deflation, larger drop in TFP, particularly so if debts are nominal
2. constant inflation target
   - requires a large increase in money supply/government debt, leads to an initially less severe, but more persistent contraction
3. distribution of welfare consequences (see paper)

# *Model Economy*

- Entrepreneurs w/ heterogenous productivity, $z \sim \Psi(z)$, and workers.
- Financial frictions: collateral constraint.
- Money: cash-in-advance constraint, potential "store of value".

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- Entrepreneurs w/ heterogenous productivity, $z \sim \Psi(z)$, and workers.
- Financial frictions: collateral constraint.
- Money: cash-in-advance constraint, potential "store of value".
- No aggregate uncertainty, study response to unanticipated shocks
- Flexible prices.

## *Entrepreneurs' Problem*

$$\max_{\{c_t, m_{t+1}, l_t, k_{t+1}, b_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left[\nu \log c_{1t} + (1-\nu) \log c_{2,t}\right],$$

s.t.

$$k_{t+1} + \frac{m_{t+1}}{p_t} + c_{1t} + c_{2t} + T_t(z)$$

$$= (z_t k_t)^{\alpha} l_t^{1-\alpha} - w_t l_t + (1+r_t) b_t + (1-\delta) k_t + \frac{m_t}{p_t} - b_{t+1},$$

$$-b_{t+1} \leq \theta_t k_{t+1}, \quad \theta_t \in [0,1], \qquad \text{(borrowing constraint)}$$

$$c_{1,t} \leq \frac{m_t}{p_t}. \qquad \text{(cash-in-advance)}$$

# *(Simplified) Entrepreneurs' Problem*

$$\max_{\{c_t, m_{t+1}, a_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left[\nu \log c_{1t} + (1-\nu) \log c_{2,t}\right]$$

s.t.

$$a_{t+1} + \frac{m_{t+1}}{p_t} + c_{1t} + c_{2t} + T_t(z) = R_t(z) a_t + \frac{m_t}{p_t},$$

$$k_{t+1} \leq \lambda_t a_{t+1}, \quad \lambda_t \equiv \frac{1}{1-\theta_t} \in [1, \infty], \qquad \text{(borrowing constraint)}$$

$$c_{1,t} \leq \frac{m_t}{p_t}. \qquad \text{(cash-in-advance)}$$

## Optimal Portfolio Choice

Capital and bond demand (supply if $b_t < 0$)

$$k_t = \begin{cases} \lambda_{t-1} a_t, & z \geq \hat{z}_t \\ 0, & z < \hat{z}_t \end{cases}, \quad b_t = \begin{cases} -(\lambda_{t-1} - 1) a_t, & z \geq \hat{z}_t \\ a_t, & z < \hat{z}_t. \end{cases}$$

Gross return of net-worth

$$R_t(z) = \begin{cases} \lambda_{t-1}(\varrho_t z - r_t - \delta) + 1 + r_t, & z \geq \hat{z}_t \\ 1 + r_t, & z < \hat{z}_t \end{cases}$$

Marginal entrepreneur

$$\varrho_t \hat{z}_t = r_t + \delta$$

where $\varrho_t \equiv \alpha \left((1-\alpha)/w_t\right)^{(1-\alpha)/\alpha}$.

## *Workers' Problem*

$$\max_{\{c_t, m_{t+1}, a_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left[\nu \log c_{1t} + (1-\nu) \log c_{2,t}\right]$$

s.t.

$$a_{t+1} + \frac{m_{t+1}}{p_t} + c_{1t} + c_{2t} + T_t^W = (1+r_t)a_t + \frac{m_t}{p_t},$$

$$a_{t+1} \geq 0, \qquad \text{(borrowing constraint)}$$

$$c_{1,t} \leq \frac{m_t}{p_t}. \qquad \text{(cash-in-advance)}$$

To derive analytical expressions we assume that for workers $\nu = 0$ and $a_t = 0$, but in the numerical example we treat workers and entrepreneurs symmetrically.

# *Government*

Budget constraint

$$\frac{M_{t+1}}{p_t} - \frac{M_t}{p_t} + B_{t+1} + \int T_t(z)\Psi(dz) + T_t^W = (1 + r_t)B_t.$$

## *Demographics & Mixing of Wealth*

- A fraction $1 - \gamma$ of entrepreneurs (workers) die and are replaced by equal number of new entrepreneurs (workers).
- Productivity $z$ of new entrepreneurs drawn from $\Psi(z)$, iid across entrepreneurs and over time.
- Each new entrepreneur (worker) inherits the assets of a randomly drawn dying entrepreneur (worker).
- These assumptions guarantee a non-degenerated distribution of net-wealth across types.

# *Equilibrium*

Given policies $\{M_{t+1}, B_{t+1}, T_t(z), T_t^W\}_{t=0}^{\infty}$ and $\{\theta_t\}_{t=0}^{\infty}$, an equilibrium is given by sequences of prices $\{r_t, w_t, p_t\}_{t=0}^{\infty}$, and corresponding quantities such that:

*(i)* Entrepreneurs and workers maximize, taking as given

$\{r_t, w_t, p_t\}_{t=0}^{\infty}$ and policies.

*(ii)* Government budget constraint is satisfied.

*(iii)* Markets clear

$$B_{t+1} + \int b_{t+1}^i di = 0, \quad \int l_t^i di = L, \quad \int m_{t+1}^i = M_{t+1}, \quad \text{for all } t.$$

## *Aggregate Output and TFP*

Aggregate output is given by a simple Cobb-Douglas function of aggregate TFP and capital

$$Y_t = Z_t K_t^{\alpha}$$

where aggregate TFP is

$$Z_t = \left( \frac{\int_{z \geq \hat{z}_t} z \Phi_t(dz)}{\int_{z \geq \hat{z}_t} \Phi_t(dz)} \right)^{\alpha}.$$

and $\Phi_t(z)$ is the (endogenous) distribution of net-worth.

# *Bond Market*

The bond market clearing condition is

$$\overbrace{\int_0^{\hat{z}_{t+1}} \Phi_{t+1}(dz)}^{\text{demand for bonds}} = \overbrace{(\lambda_t - 1)\int_{\hat{z}_{t+1}}^{\infty} \Phi_{t+1}(dz) + B_{t+1}}^{\text{supply of bonds}}.$$

and the marginal entrepreneur solve

$$\alpha \left(\frac{1-\alpha}{w_{t+1}}\right)^{(1-\alpha)/\alpha} \hat{z}_{t+1} = r_{t+1} + \delta.$$

Given $w_{t+1}$ and $\Phi_{t+1}(z)$, there is a positive relationship between $\lambda_t$ and $r_{t+1}$.

# *Evolution of Aggregate Capital*

Abstracting from the seigniorage, the evolution of aggregate capital is given by

$$
\begin{aligned}
K_{t+1} &= \beta\left[\alpha Y_t + (1-\delta)K_t\right] + (1-\beta)\sum_{j=1}^{\infty}\int_0^{\infty}\frac{T_{t+j}(z)}{\prod_{s=1}^{j}R_{t+s}(z)}\Psi(dz) \\
&\quad -(1-\beta)\sum_{j=1}^{\infty}\frac{\int T_{t+j}(z)\Psi(dz) + T_{t+j}^{W}}{\prod_{s=1}^{j}(1+r_{t+s})}
\end{aligned}
$$

The path of **lump-sum** taxes affects capital accumulation. Ricardian equivalence does not hold!

# *Money Market*

If $(1 + r_{t+1})p_{t+1}/p_t > 0$, then the price level at $t$ is determined by

$$\overbrace{\frac{M_{t+1}}{p_t}}^{\text{money supply}} = \overbrace{\frac{\nu(1-\beta)\beta}{1-\nu(1-\beta)}\left[\int R_{t+1}(z)\Phi_{t+1}(dz)\right.}^{\text{money demand for transaction purposes}}$$

$$\left. - \sum_{j=0}^{\infty}\int_0^{\infty}\frac{T_{t+j}(z)}{\prod_{s=1}^{j} R_{t+s}(z)}\Psi(dz)\right].$$

At the ZLB, when monetary policy is unresponsive, the sequence of price levels must satisfy

$$p_t = (1 + r_{t+1})p_{t+1}$$

If policy implements an inflation target, this equation determines the real interest rate (and the supply of government liabilities must respond accordingly).

# *Numerical Examples*

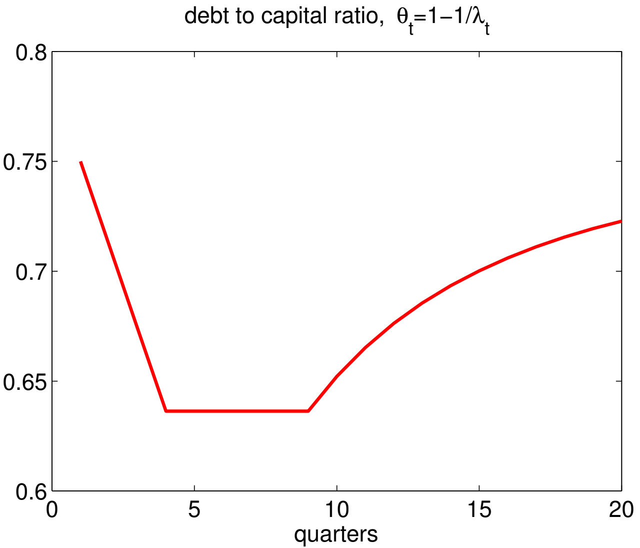
Simulate the effect of a credit crunch, i.e., an unanticipated shock to $\theta_t$, under alternative three scenarios:

*0.* benchmark real economy, no government

*1.* monetary economy, unresponsive monetary policy

*2.* monetary economy, constant inflation target

# *Credit Crunch*



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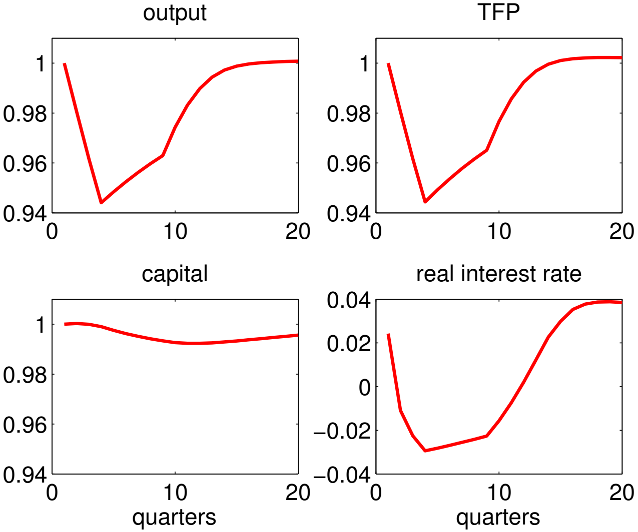
# *Benchmark Real Economy, No Government*

*Moll(2012), Buera & Moll (2012)*



## *Intuition: Bond Market*

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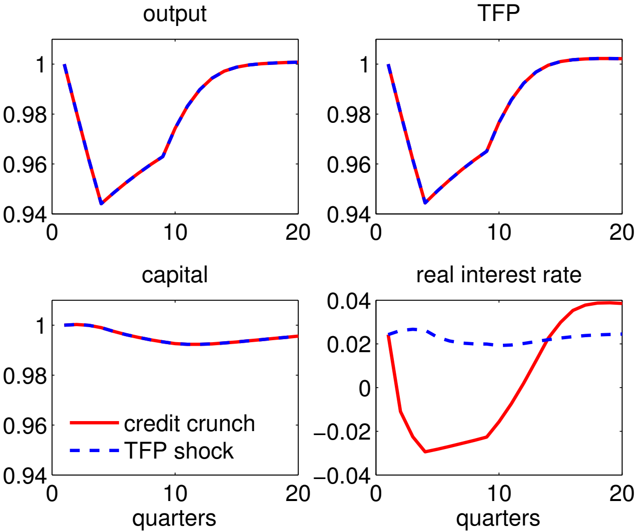
# *Comparison with Exogenous TFP Shock*



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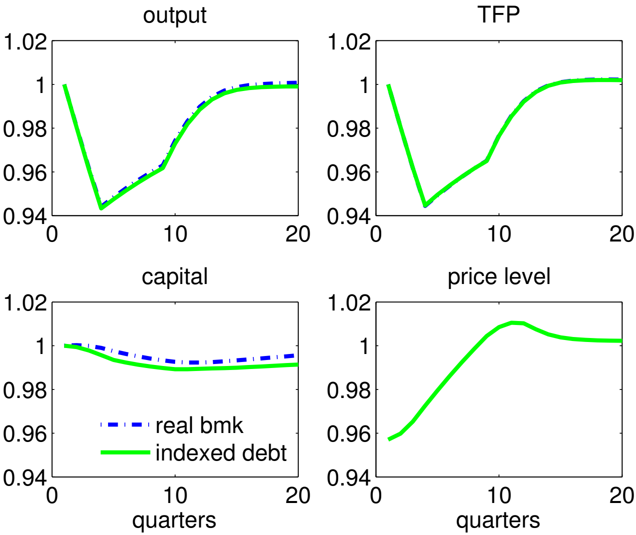
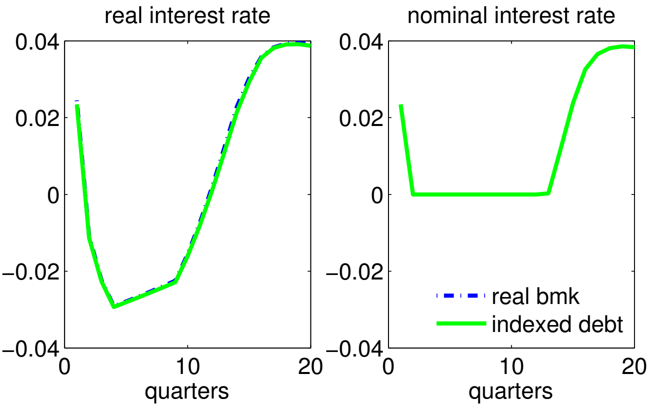
# *Monetary Economy: Unresponsive Policy*

*Indexed Bonds*



# *Monetary Economy: Unresponsive Policy*

*Indexed Bonds (cont'd)*

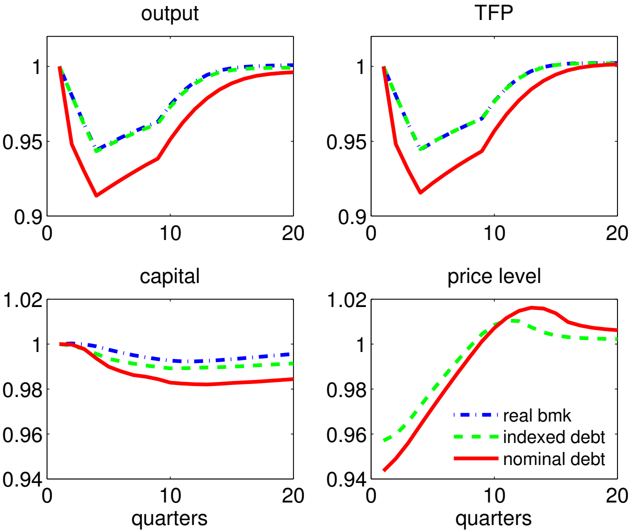


# *Intuition for the Deflation*

- the credit crunch generates a large drop in the real return of bonds, i.e., the real interest rate
- if the price level remains constant, excess demand for real cash balances, i.e., "store of value"
- since the supply of money is fixed, the price level must decline to clear the money market
- ... and the return of money must drop in the future, the inflation increase, so that money and bonds have the same real return

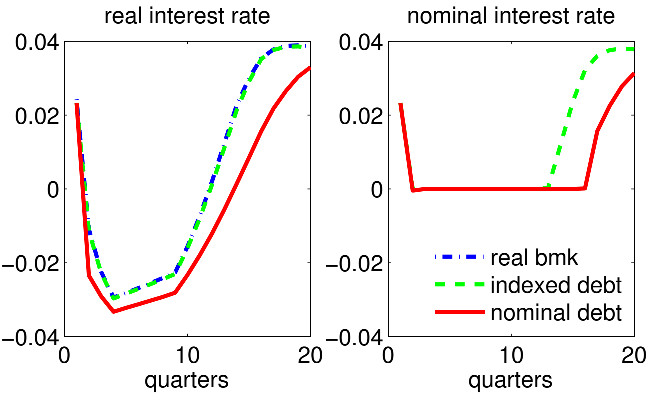
# *Monetary Economy: Unresponsive Policy*

*Nominal Bonds, Debt Deflation*



# *Monetary Economy: Unresponsive Policy*

## *Nominal Bonds, Debt Deflation (cont'd)*



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Simulate the effect of a credit crunch, i.e., an unanticipated shock to $\theta_t$, under alternative three scenarios:

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# Monetary Economy: Constant Inflation Target

## Policy Rules

Government liabilities adjust to attain price stability

$$B_{t+1} = \begin{cases} \int_0^{\hat{z}_{t+1}} \Phi_{t+1}(dz) \\ -(\lambda_{t+1} - 1) \int_{\hat{z}_{t+1}}^{\infty} \Phi_{t+1}(dz) & \text{if } r_{t+1} = \frac{p_t}{p_{t+1}} - 1 \\ \\ B_t & \text{if } r_{t+1} > \frac{p_t}{p_{t+1}} - 1 \end{cases} .$$

and

$$\begin{aligned} M_{t+1} \quad = \quad & p_t \frac{\nu(1-\beta)\beta}{1-\nu(1-\beta)} \left[ \int R_{t+1}(z) \Phi_{t+1}(dz) \right. \\ & \left. - \sum_{j=0}^{\infty} \int_0^{\infty} \frac{T_{t+j}(z)}{\prod_{s=1}^{j} R_{t+s}(z)} \Psi(dz) \right]. \end{aligned}$$

# *Monetary Economy: Constant Inflation Target*

## *Policy Rules (cont'd)*

1. lump-sum case:
   - pure lump-sum taxes (transfers), $T_t(z) = T_t^W = T_t$,

$$T_t = \frac{M_t - M_{t+1}}{p_t} + (1 + r_t)B_t - B_{t+1}.$$

2. bailout case:
   - entrepreneurs receive proceeds of new bond issues,

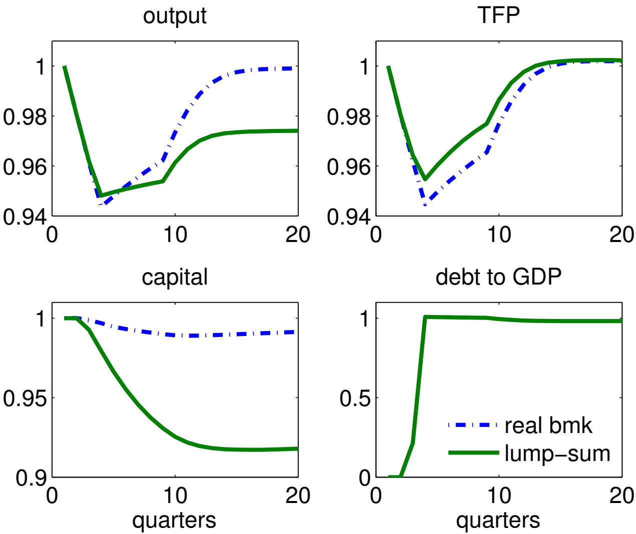
$$\int T_t(z)\Psi(dz) = \frac{M_t - M_{t+1}}{p_t} + (1 + r_t)B_t - B_{t+1}, \text{ if } B_{t+1} > B_t$$

   - lump-sum taxes (transfers) otherwise, $T_t(z) = T_t^W = T_t$,

$$T_t = \frac{M_t - M_{t+1}}{p_t} + (1 + r_t)B_t - B_{t+1}.$$

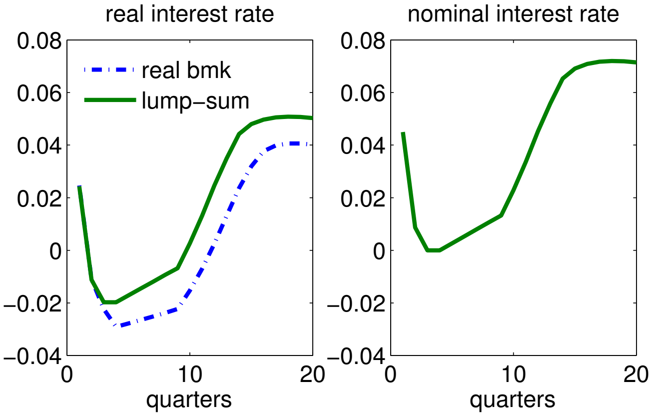
# *Monetary Economy: Constant Inflation Target*

*Lump-Sum Case*



# *Constant Inflation Target*

## *Lump-Sum Case (cont'd)*



# *Intuition: Government Liabilities*

- the credit crunch results in an excess demand for bonds
- to maintain price stability the government must increase the supply of "store of value", money or bonds
- higher government liabilities imply higher future taxes
- unconstrained individuals further increase their savings, i.e., their demand for bonds, in anticipation of future taxes

# *Intuition: Non-Ricardian Model*

Again, assuming workers are hand-to-mouth, the evolution of aggregate capital is given by

$$\begin{aligned} K_{t+1} &= \beta\left[\alpha Y_t + (1-\delta)K_t\right] + (1-\beta)\sum_{j=1}^{\infty}\int_0^{\infty}\frac{T_{t+j}(z)}{\prod_{s=1}^{j} R_{t+s}(z)}\Psi(dz) \\ &\quad -(1-\beta)\sum_{j=1}^{\infty}\frac{\int T_{t+j}(z)\Psi(dz) + T_{t+j}^{W}}{\prod_{s=1}^{j}(1+r_{t+s})} \end{aligned}$$

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\end{aligned}
$$

- productive entrepreneurs are constrained, i.e., for $z > \hat{z}_{t+s}$, $R_{t+s}(z) > 1 + r_{t+s}$

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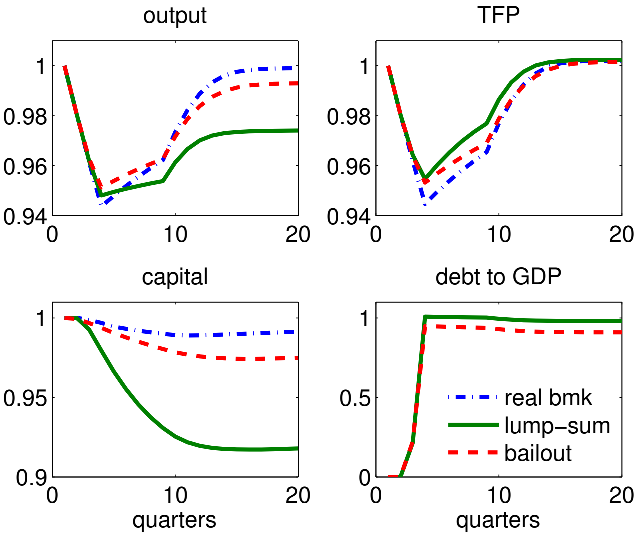
$$-(1-\beta)\sum_{j=1}^{\infty}\frac{\int T_{t+j}(z)\Psi(dz)}{\prod_{s=1}^{j}(1+r_{t+s})} - (1-\beta)\sum_{j=1}^{\infty}\frac{T^W_{t+j}}{\prod_{s=1}^{j}(1+r_{t+s})}$$

- productive entrepreneurs are constrained, i.e., for $z > \hat{z}_{t+s}$, $R_{t+s}(z) > 1 + r_{t+s}$
- transfers to workers are consumed

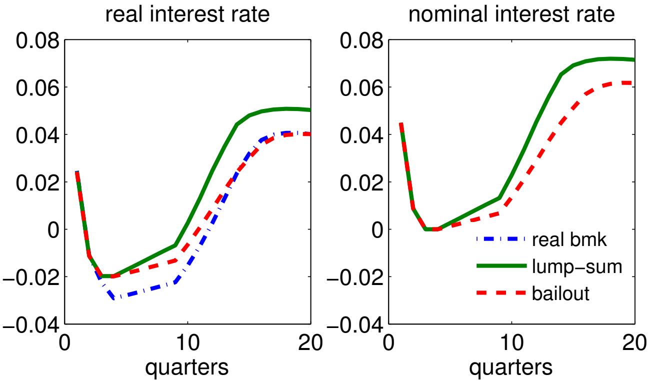
# *Monetary Economy: Constant Inflation Target*

*Bailout Case*



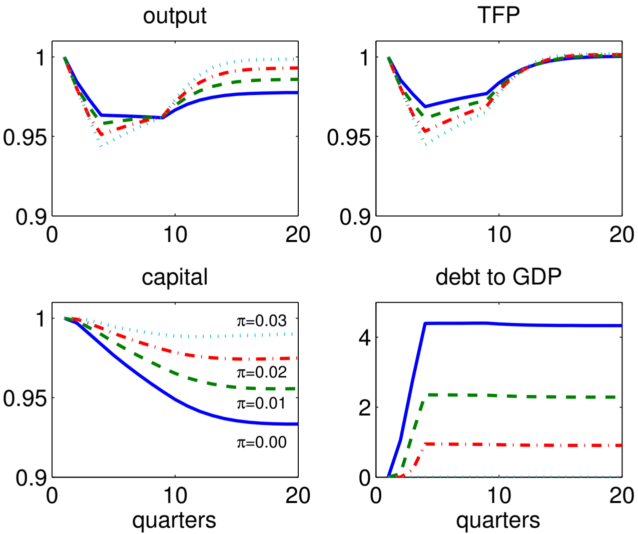
# *Monetary Economy: Constant Inflation Target*

*Bailout Case (cont'd)*



# *Monetary Economy: Constant Inflation Target*

## *Bailout Case, Alternative Inflation Targets*



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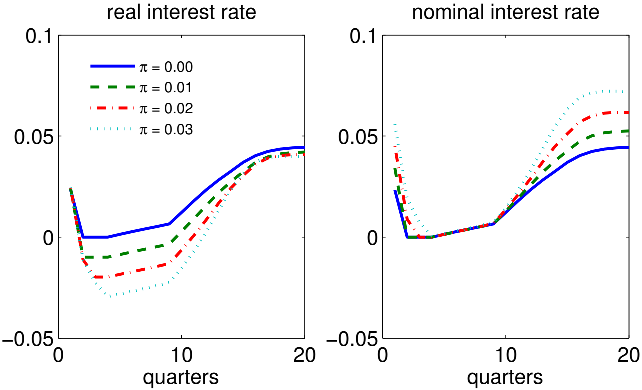
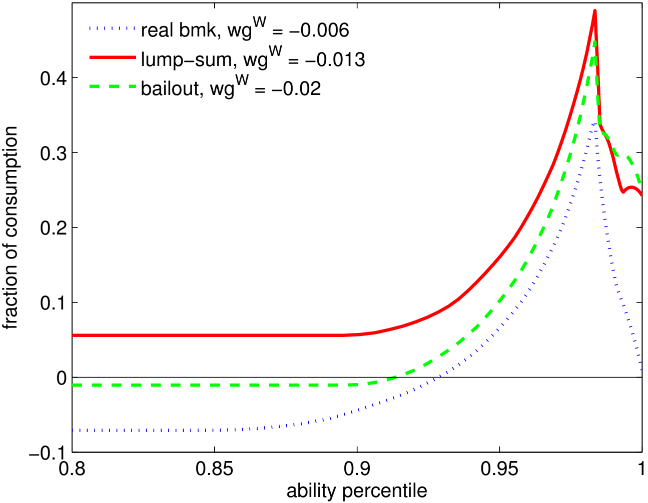


# Welfare Gains of a Credit Crunch

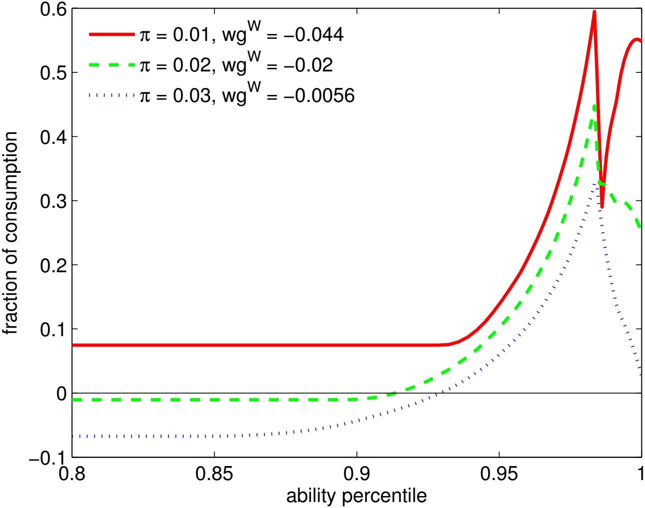
# *Welfare Gains of a Credit Crunch*

## *Alternative Tax Schemes*



# *Welfare Gains of a Credit Crunch*

## *Alternative Inflation Targets, Bailout Case*



# *Conclusions*

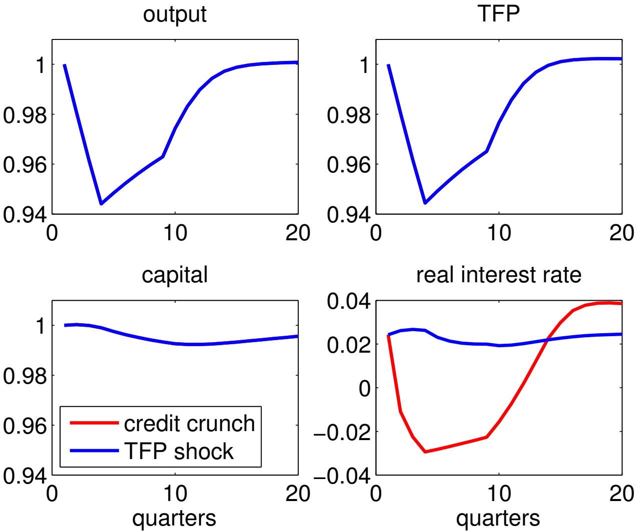
- credit contractions lead to a large drop in the return of safe assets
- money offers an alternative "store of value", thus the zero lower bound
- what is the role of (lack of) monetary policy?
  - an unresponsive monetary policy leads to a deflation, and debt deflation if debts are not indexed (Fisher, 1933)
  - monetary/debt policy needs to be very expansionary to stabilize prices, and output, at the cost of crowding out private investment and generating a slow recovery

# Dynamics of the Wealth Distribution

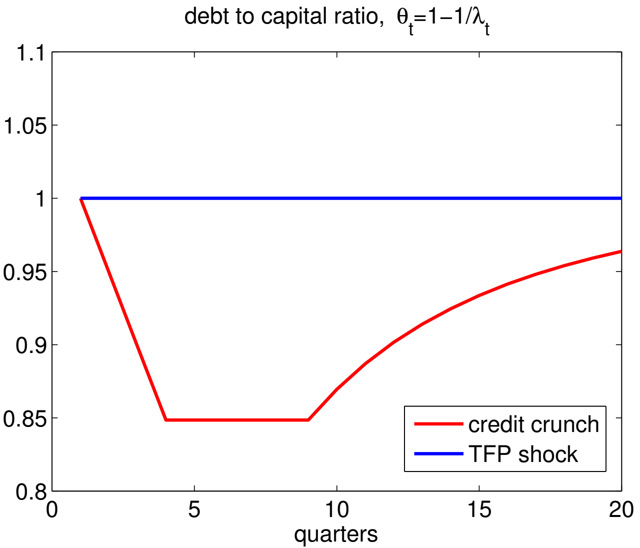
$$\begin{aligned}
\Phi_{t+1}(z) &= \gamma\beta R_t(z)\Phi_t(z) + (1-\gamma)\Psi(z)\beta \int R_t(\tilde{z})\Phi_t(d\tilde{z}) \\
&= \gamma\beta R_t(z)\Phi_t(z) + (1-\gamma)\Psi(z)K_{t+1}
\end{aligned}$$

back

## *Comparison with exogenous TFP shock*



# *Comparison with exogenous TFP shock (cont'd)*

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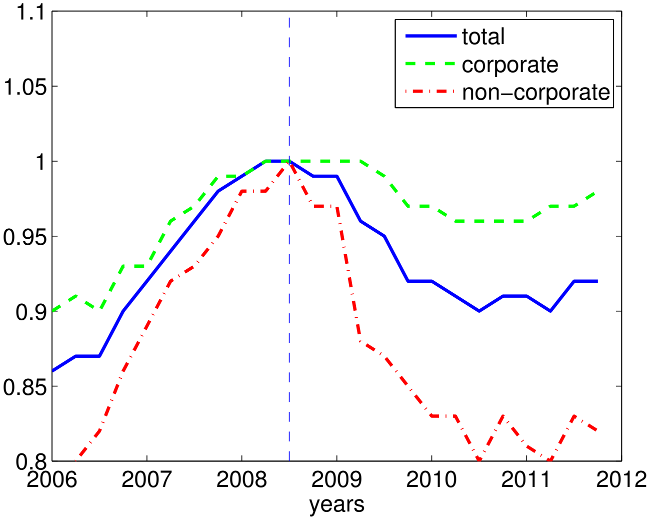
# *Aggregate Debt to Non-financial Assets in the Great Recession*

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# *First Order Conditions*

Euler equation (credit goods):

$$\frac{1}{\beta}\frac{c_{2t+1}}{c_{2t}} = R_{t+1}(z)$$

and, cash and credit goods margin tomorrow

$$\frac{1-\nu}{\nu}\frac{c_{1t+1}}{c_{2t+1}} = \frac{1}{R_{t+1}(z)\frac{p_{t+1}}{p_t}}$$

back