



Credit and Banking in a DSGE Model

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WHAT is the paper about?



- This paper is an attempt to (meaningfully?) introduce a **banking** sector into a **DSGE** model

WHY is it interesting?



- 1. Banks are (still) very important in the funding of real activity**
 - Bank loans/total firm non-equity finance
 - ✦ 90% in the Euro Area
 - ✦ 60% in the US
 - Thus, bank rates are the relevant interest rates for a large part of the economy
- 2. Retail bank rates differ from policy rate**
 - i. Slow pass-through to retail rates of changes in the policy rate (Lown and Morgan, 19XX)
 - ii. Banks actively set credit-supply terms and conditions (interest rates, LTV) during the cycle

→ So, loan spreads move over the cycle
- 3. Bank B-S items display cyclical movements, e.g. ...**

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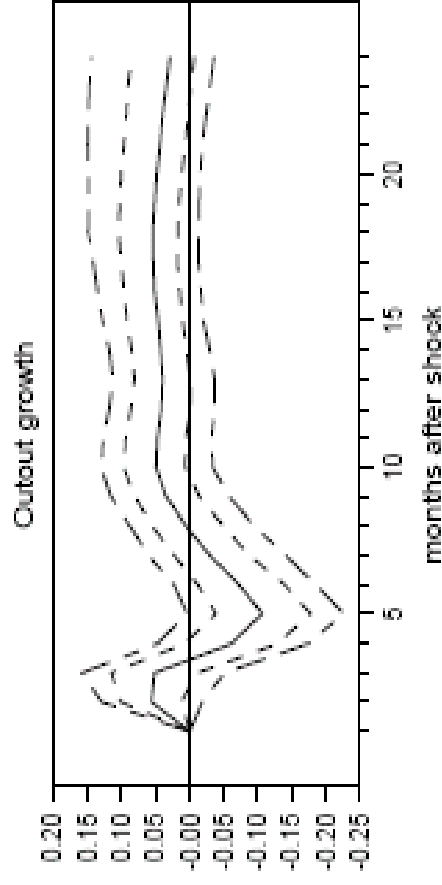
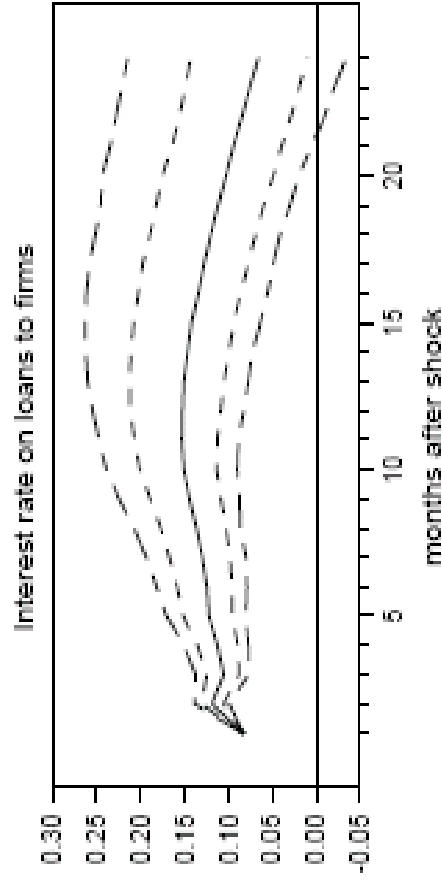
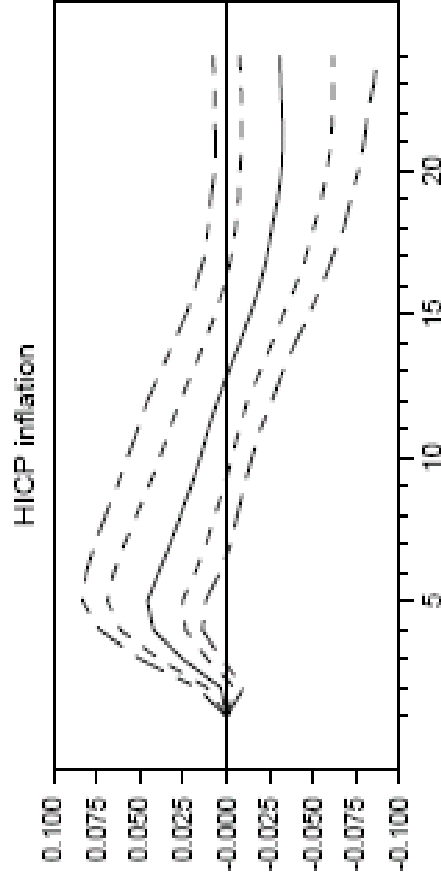
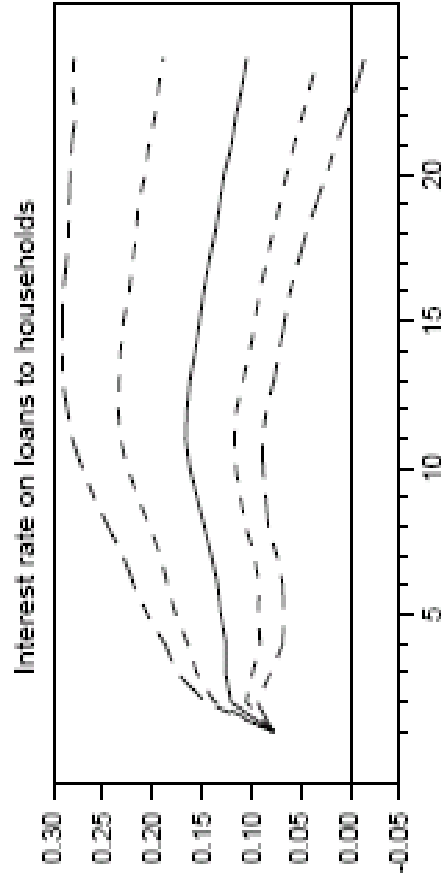
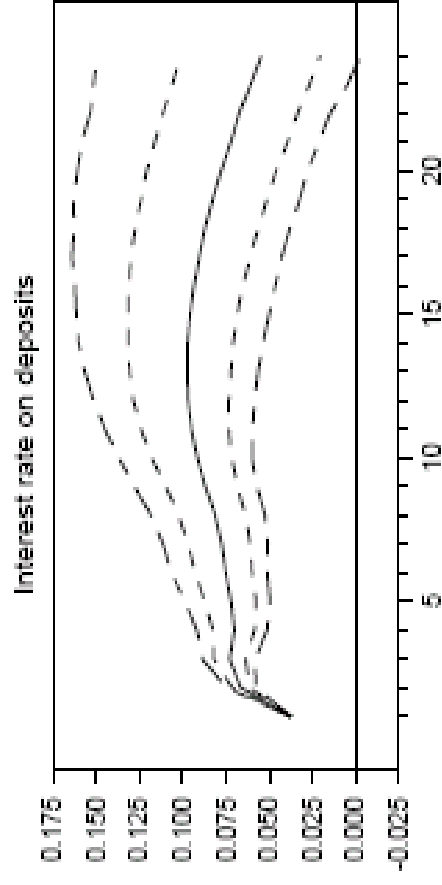
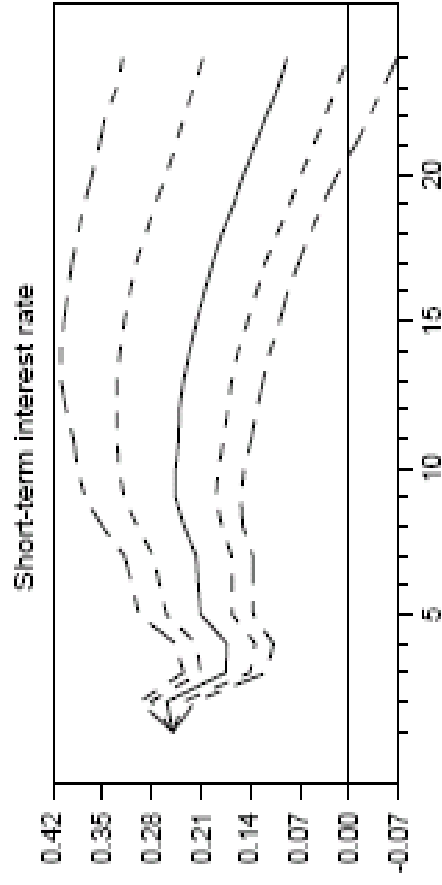


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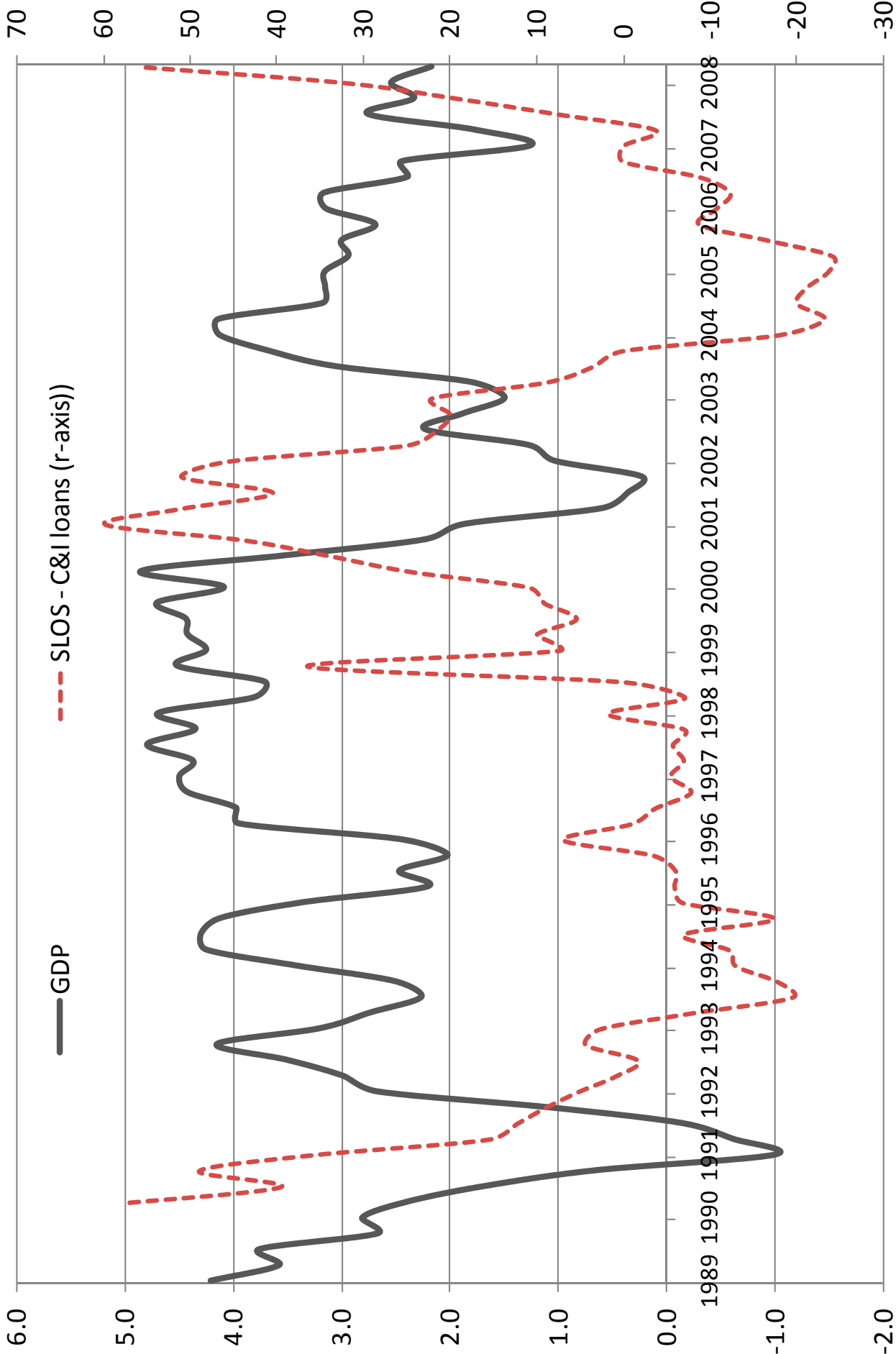
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US GDP growth and Credit Conditions

(y-o-y % change; net percentage of respondents)



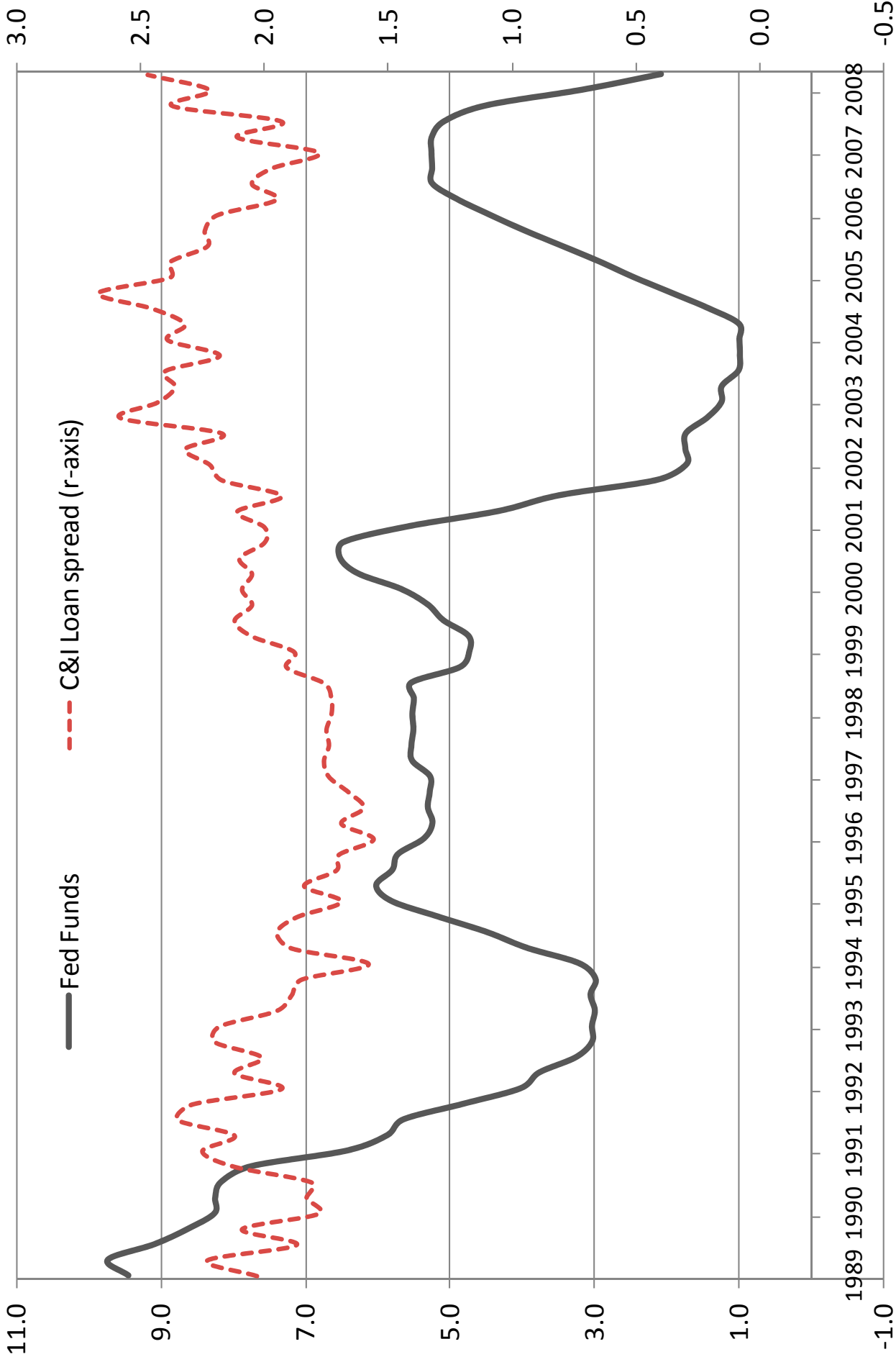
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US Policy Rate and Short-term Loan Spread

(percentage points)



Source: Federal Reserve

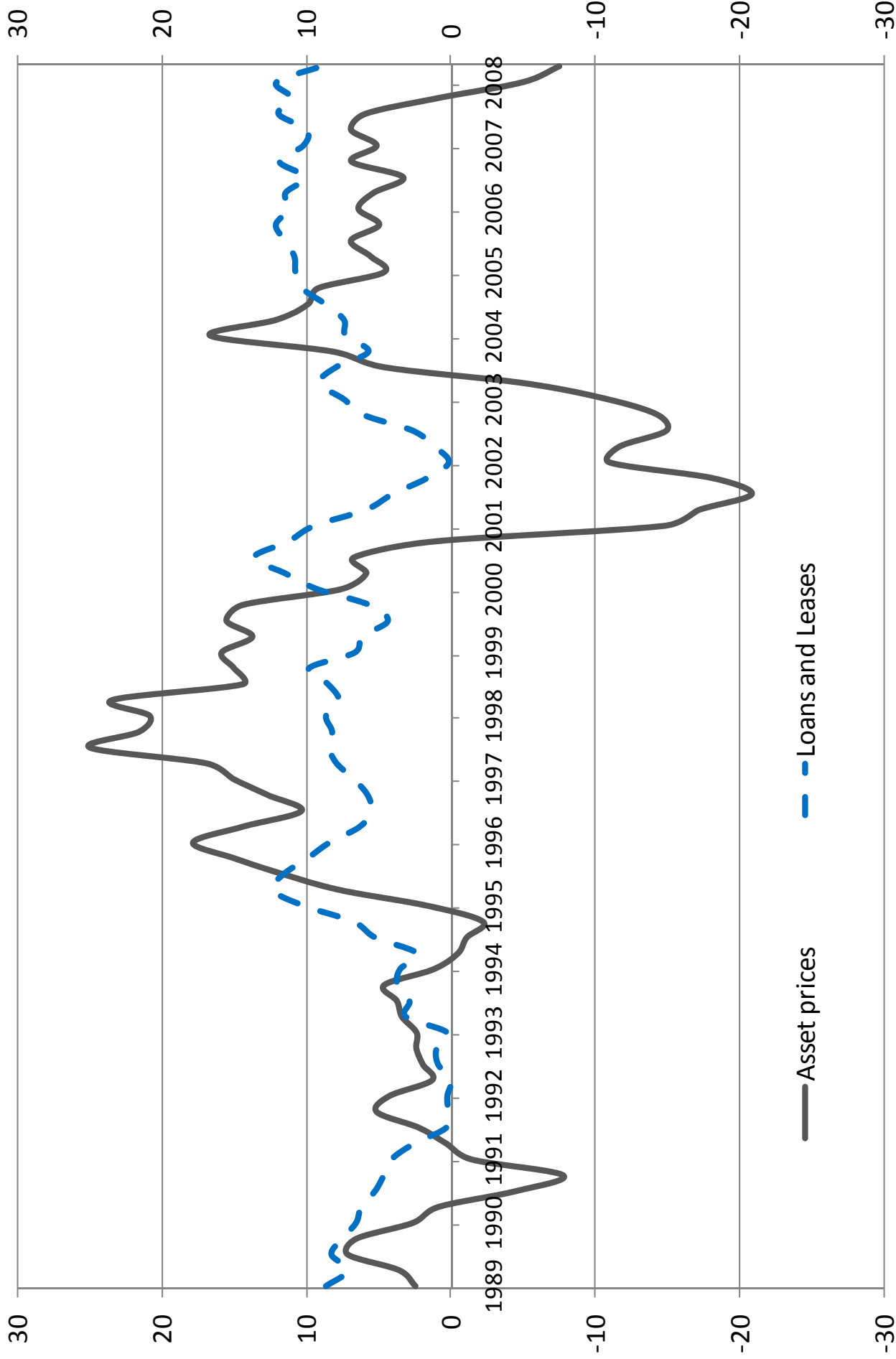
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US Commercial Banks' Balance-sheet Items and Asset Prices

(y-o-y % change)



Objectives/what do we want to study?



1. Have a model that accounts for stylized facts in credit/financial markets and their interactions with the real economy

2. Answer questions such as:

1. How do bank rate-setting decisions affect the monetary policy transmission mechanism?
2. What are the effects of a credit-supply shock in a model with an explicit role for banks?
3. How do banking capital react to various types of shocks?
4. Financial stability and monetary policy: should CBs respond to asset prices, credit or bank equity [work in progress]?

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The Rest of the Talk



1. The Model
2. Applications

The model: two key ingredients



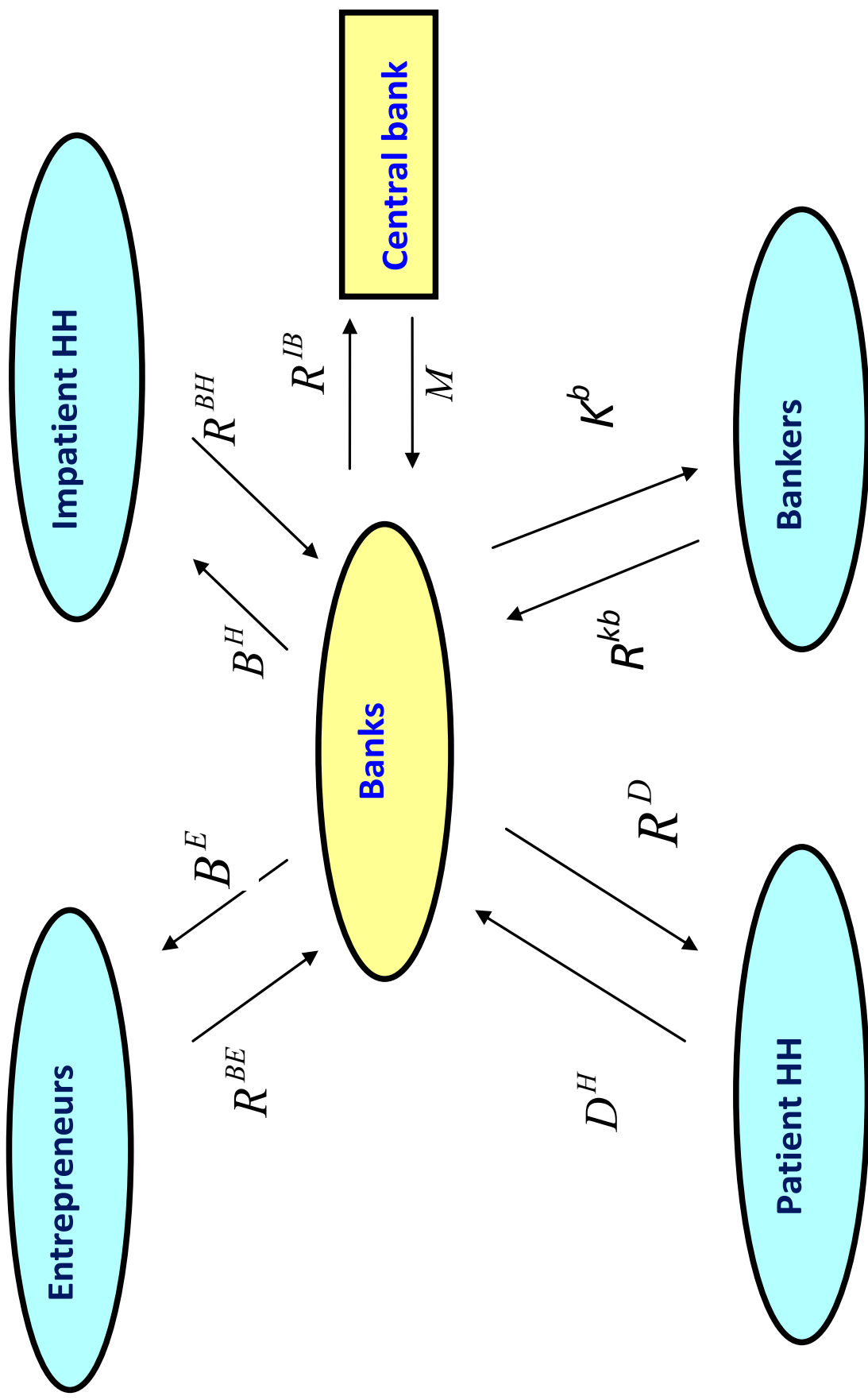
1. **Financial frictions** and **heterogeneous agents**, to generate credit flows in the first place
(Kyotaki and Moore, 1998; Iacoviello, 2005)
2. **Monopolistic competition** in the banking sector, so that banks **make decisions** when setting interest rates

Related work



- Christensen et. al (2007)
- Cúrdia and Woodford (2008)
- Andrés and Arce (2008) –Nice micro-foundation of monopolistic competition
- Christiano *et al.* (2007); Goodfriend and McCallum (2007)
- ...many other central banks

The Model in a Nutshell



Two types of Households



- Consume, enjoy housing services and work

$$E_0 \sum_{t=0}^{\infty} \beta_T^t \left[\log(c_t^T(i) - a^T c_{t-1}^T) + \varepsilon^h \log h_t^T(i) - \frac{U_t^T(i)^{1+\phi}}{1+\phi} \right]$$

$T = \{Patient, Impatient\}$

- Budget constraint is

$$P_t c_t^T(i) + Q_t^h \Delta h_t^T(i) + D_t^T(i) + R_{t-1}^{BH} B_{t-1}^T(i) \leq W_t l_t^T(i) + B_t^T(i) + R_{t-1}^D D_{t-1}^T(i) + Lump_t$$

- **Housing** (in fixed supply) is also used as **collateral** for bank loans (Kyotaki and Moore, 1998), i.e. borrowing constraint is:

$$R_t^{BH} B_t^T(i) \leq m^T E_t [Q_{t+1}^h h_{t+1}^T(i)]$$

Entrepreneurs



- Consume, choose labor, K and utilization rate

$$\text{Max } E_0 \sum_{t=0}^{\infty} \beta^t \log(c_t^E(i) - a^E c_{t-1}^E)$$

s.t.

$$\begin{aligned} P_t c_t^E(i) + W_t l_t^E(i) + D_t^E(i) + R_{t-1}^{BE} B_{t-1}^E(i) + P_t^k k_t^E(i) - P_t^k (1-\delta) k_{t-1}^E(i) \\ \leq P_t^w y_t^E(i) + B_t^E(i) + R_{t-1}^D D_{t-1}^E(i) + P_t \psi [u_t(i)] k_{t-1}^E(i) + S_A(i) \end{aligned}$$

and a borrowing constraint, tied to the value of **capital**

$$R_t^{BE} B_t^E(i) \leq m^E E_t(Q_{t+1}^k (1 - \delta) k_t^E(i))$$

Banks



- Obtain funding from
 - HH deposits (D)
 - Central Bank or Interbank market (M)
- Issue loans to HHs and Entrepreneurs
 - Production function for loans

$$B_t = f(D_t + M_t)$$

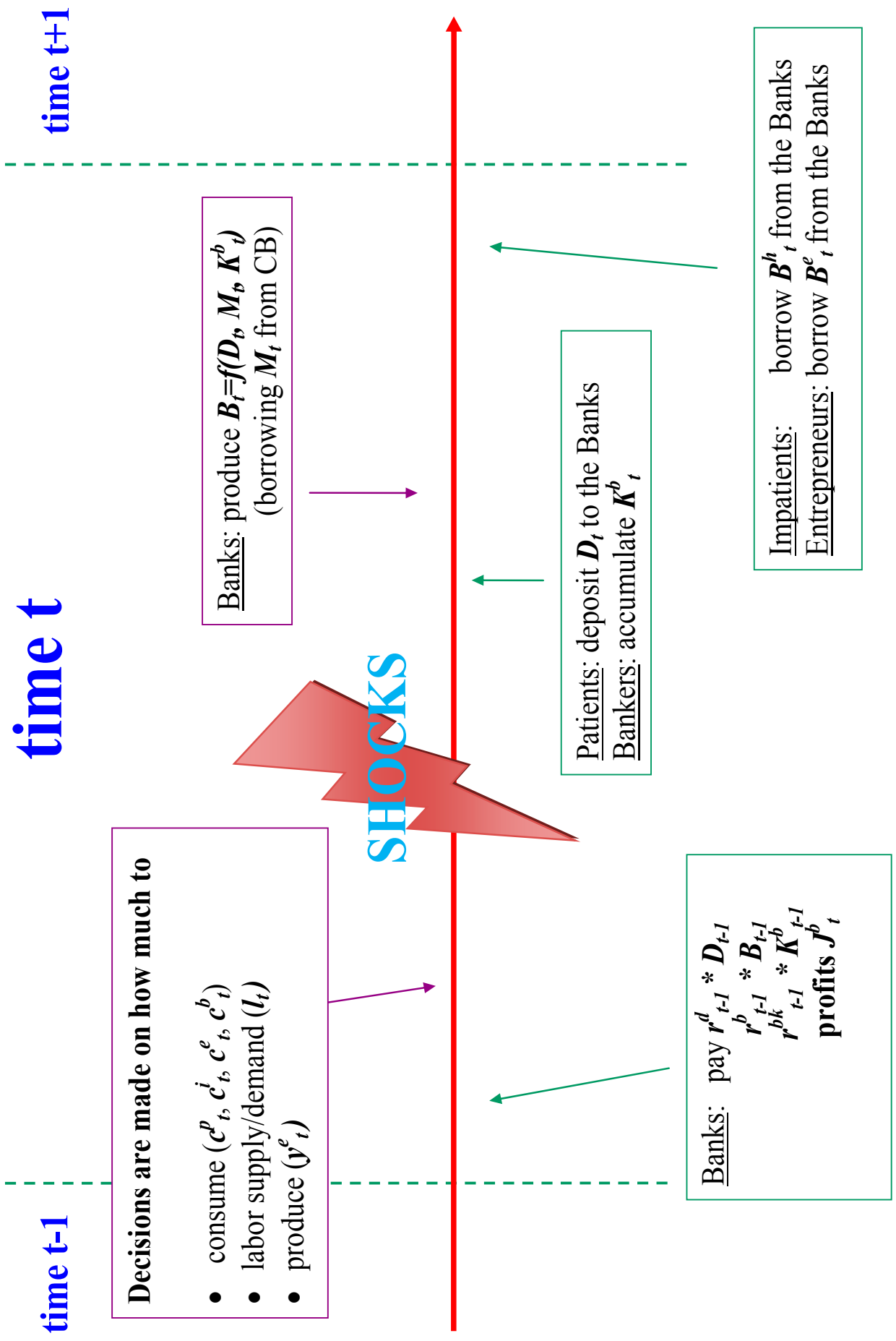
Banks (& Bankers)



- Obtain funding from
 - HH deposits (D)
 - Central Bank or Interbank market (M)
 - Reinvested earnings (K^b)

To introduce bank capital, we model '**Bankers**'. Bankers own the banks (get the profits), consume, and accumulate bank capital
- Issue loans to HHs and Entrepreneurs
 - Production function for loans

$$B_t = f(D_t + M_t, K_t^{bank})$$



time t

time t+1

Decisions are made on how much to

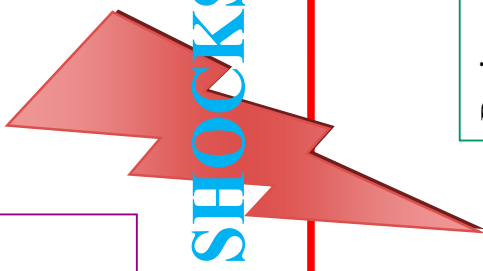
- consume ($c_t^p, c_t^i, c_t^e, c_t^b$)
- labor supply/demand (l_t)
- produce (y_t^e)

Banks: produce $B_t = f(D_t, M_t, K_t^b)$
(borrowing M_t from CB)

Patients: deposit D_t to the Banks
Bankers: accumulate K_t^b

Banks: pay $r_{t-1}^d * D_{t-1}$
 $r_{t-1}^b * B_{t-1}$
 $r_{t-1}^{bk} * K_{t-1}^b$
profits J_t^b

Impatients: borrow B_t^h from the Banks
Entrepreneurs: borrow B_t^e from the Banks



The Banking Sector (1)



- Monopolistic competition à la Dixit-Stiglitz
- They collect D_t , borrow M_t and accumulate K_t^B
- So, **banks fix rates** on
 - Deposits -> as a **mark-down** over policy rate

$$\hat{r}_t^D = \frac{\epsilon}{\epsilon+1} \hat{r}_t^B$$

- Loans -> as a **mark-up** over marginal cost

$$\hat{r}_t^B = \frac{\epsilon}{\epsilon-1} \hat{MC}_t^{bank}$$

The Banking Sector (2)



In the benchmark model, we assume imperfect rate pass-through
(quadratic adjustment costs to change rates)

Rates are then set according to:

Deposits

$$\hat{r}_t^D = \theta(\kappa, \varepsilon) \hat{r}_{t-1}^D + \theta(\kappa, \varepsilon) \beta_P E_t[\hat{r}_{t+1}^D] + \frac{\theta(\kappa, \varepsilon)(\varepsilon-1)}{\kappa} \hat{r}_t^{IB}$$

Loans

$$\hat{r}_t^B = \theta(\kappa, \varepsilon) \hat{r}_{t-1}^B + \theta(\kappa, \varepsilon) \beta_P E_t[\hat{r}_{t+1}^B] + \frac{\theta(\kappa, \varepsilon)(\varepsilon-1)}{\kappa} \hat{M}\hat{C}_t^{bank}$$

The Banking Sector (3)



What determines MC_t^{bank} (bank marginal cost?)

We assume, CES loan production function

$$B_t = [\chi^b K_t^{B\omega} + (1 - \chi^b)(M_t + D_t)^\omega]^{1/\omega}$$

For $\omega \rightarrow 1$ (Cobb-Douglas), we have

$$\bar{M}C_t^{bank} = \chi^b \bar{r}_t^{kb} + (1 - \chi^b) \bar{r}_t^{IB}$$

Calibration

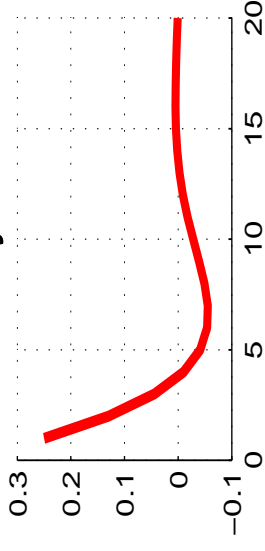
Parameter	Value	Parameter	Value
$\beta^P = \beta^B$	0.9943	ε_d (D demand el.)	-1.3 (-150bp spread)
$\beta^I = \beta^E$	0.975	ε_b^H (B^H demand el.)	5.1 (+160bp spread)
m^E (Firms' LTV)	0.25	ε_b^E (B^E demand el.)	3.5 (+130bp spread)
m^I (HHS' LTV)	0.7	κ_d (R^D stickiness)	11
		κ_h (R^{BH} stickiness)	6 (2 arts.)
		κ_e (R^{BE} stickiness)	5 (2 arts.)
		χ^b (loan inputs el.)	0.09 ($K^b/B = 8\%$)

Applications

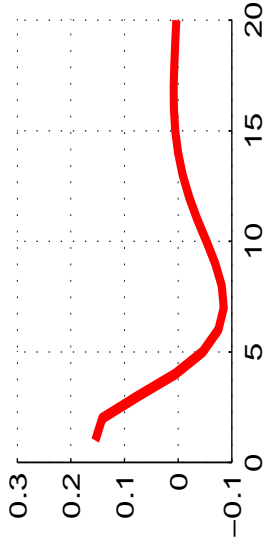
- 1** Contractionary Monetary Policy Shock
- 2** Expansionary Technology Shock
- 3** 'Credit-Supply Shock' Scenario:
 - * a tightening of collateral requirements and
 - * an exogenous increase in bank rates for both HH's and firms

Contractionary Monetary Policy Shock (25 b.p.)

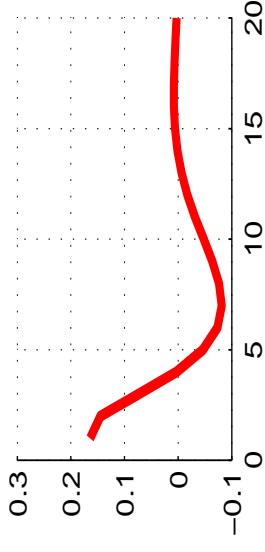
Policy rate



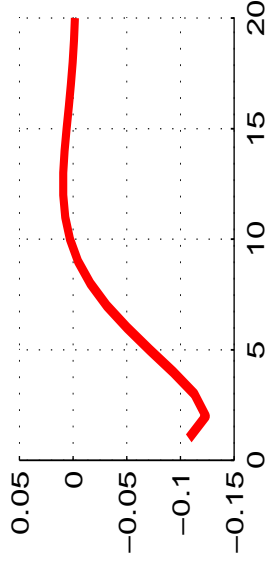
Interest rate: firms



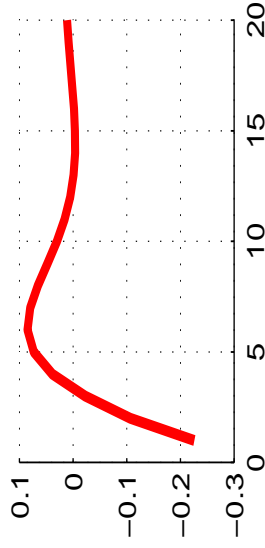
Interest rate: households



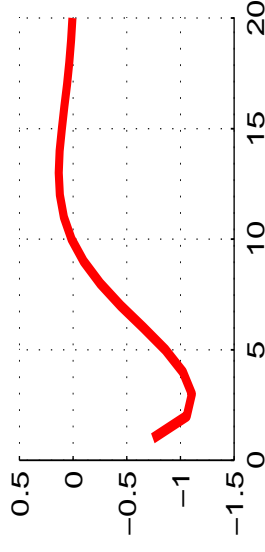
Inflation



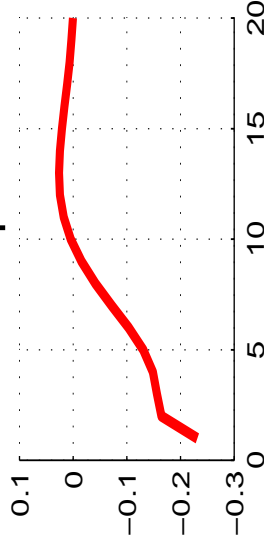
Loans to firms



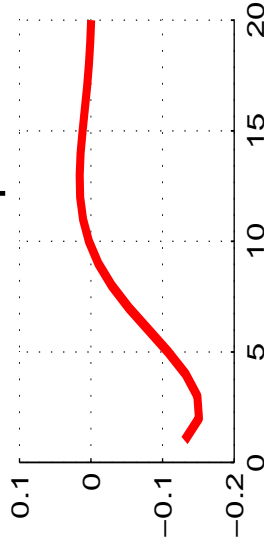
Loans to households



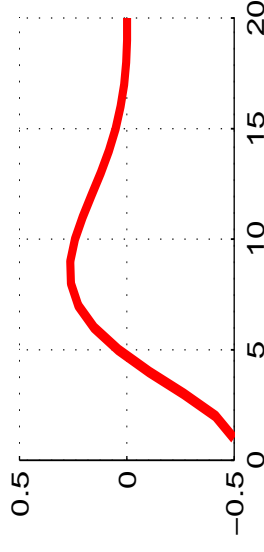
Output



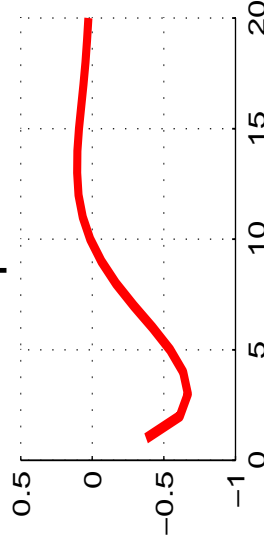
Consumption



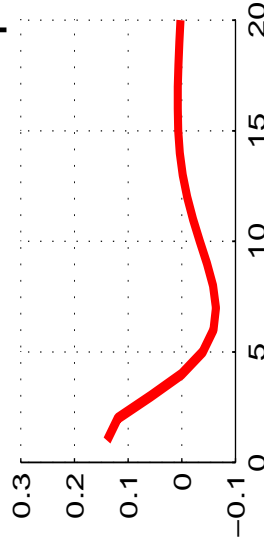
Investment



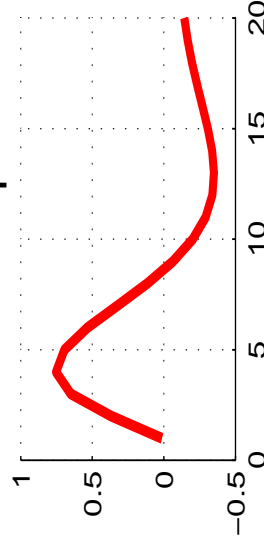
Deposits



Banks intermediation spread



Bank capital



quarters after shock

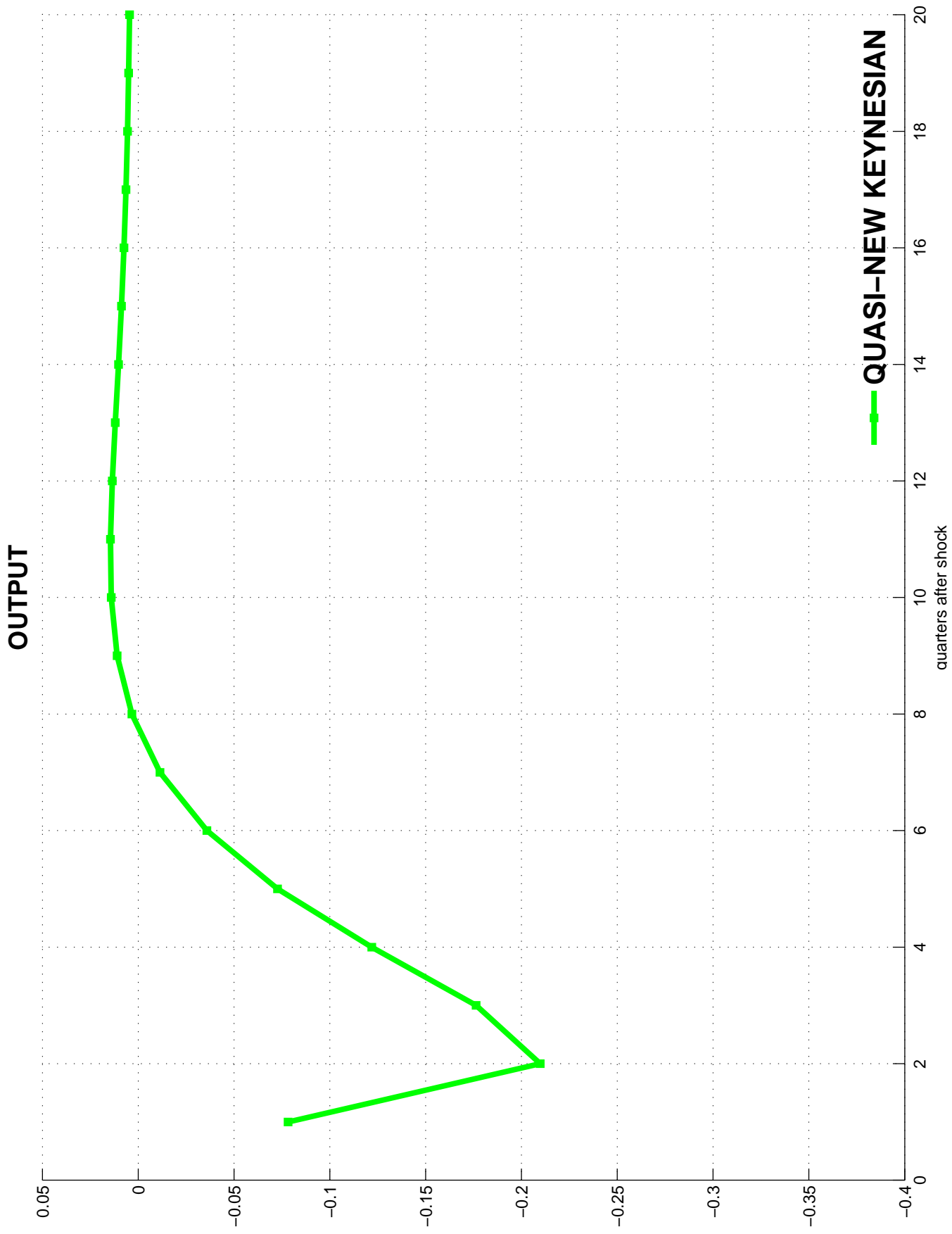
quarters after shock

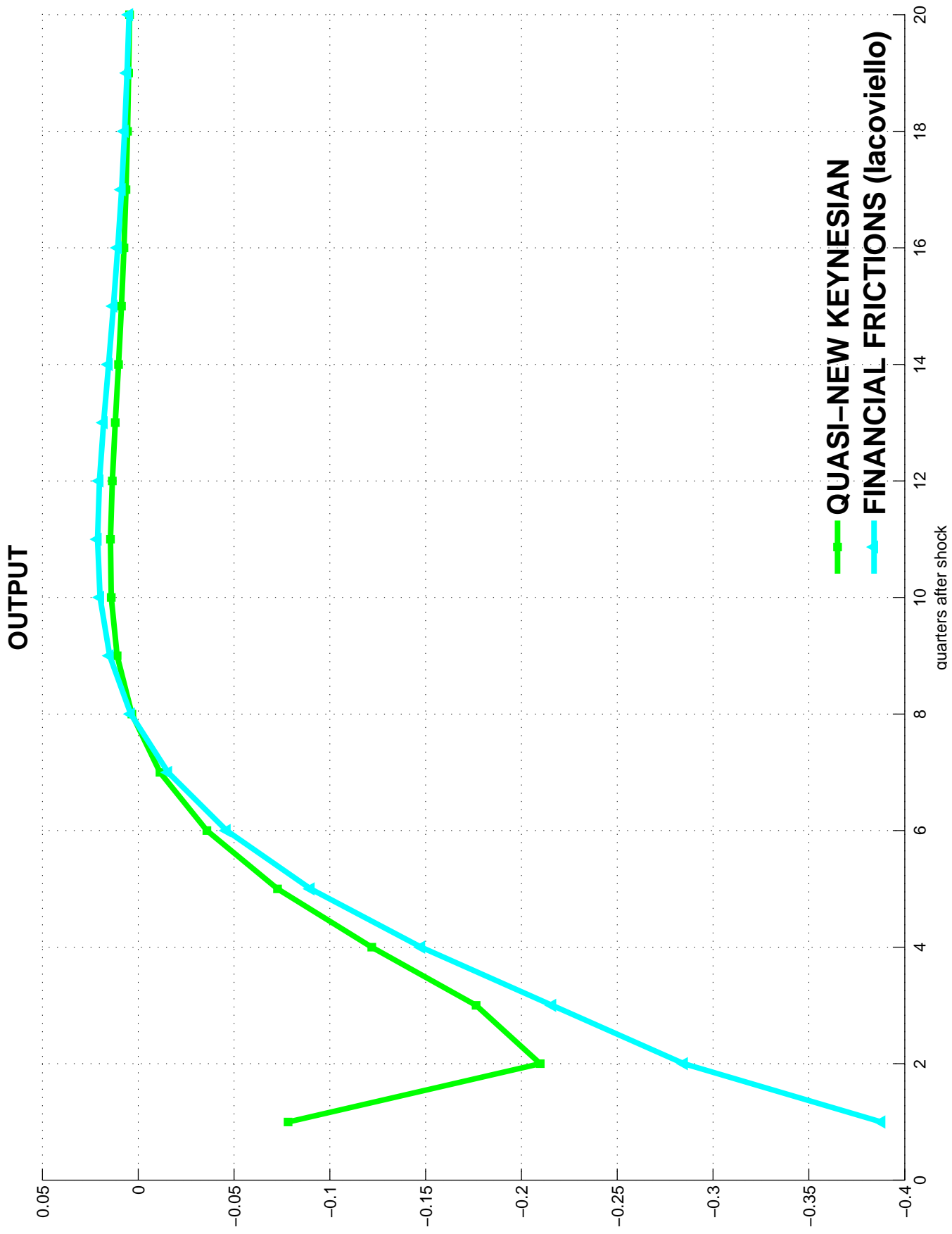
quarters after shock

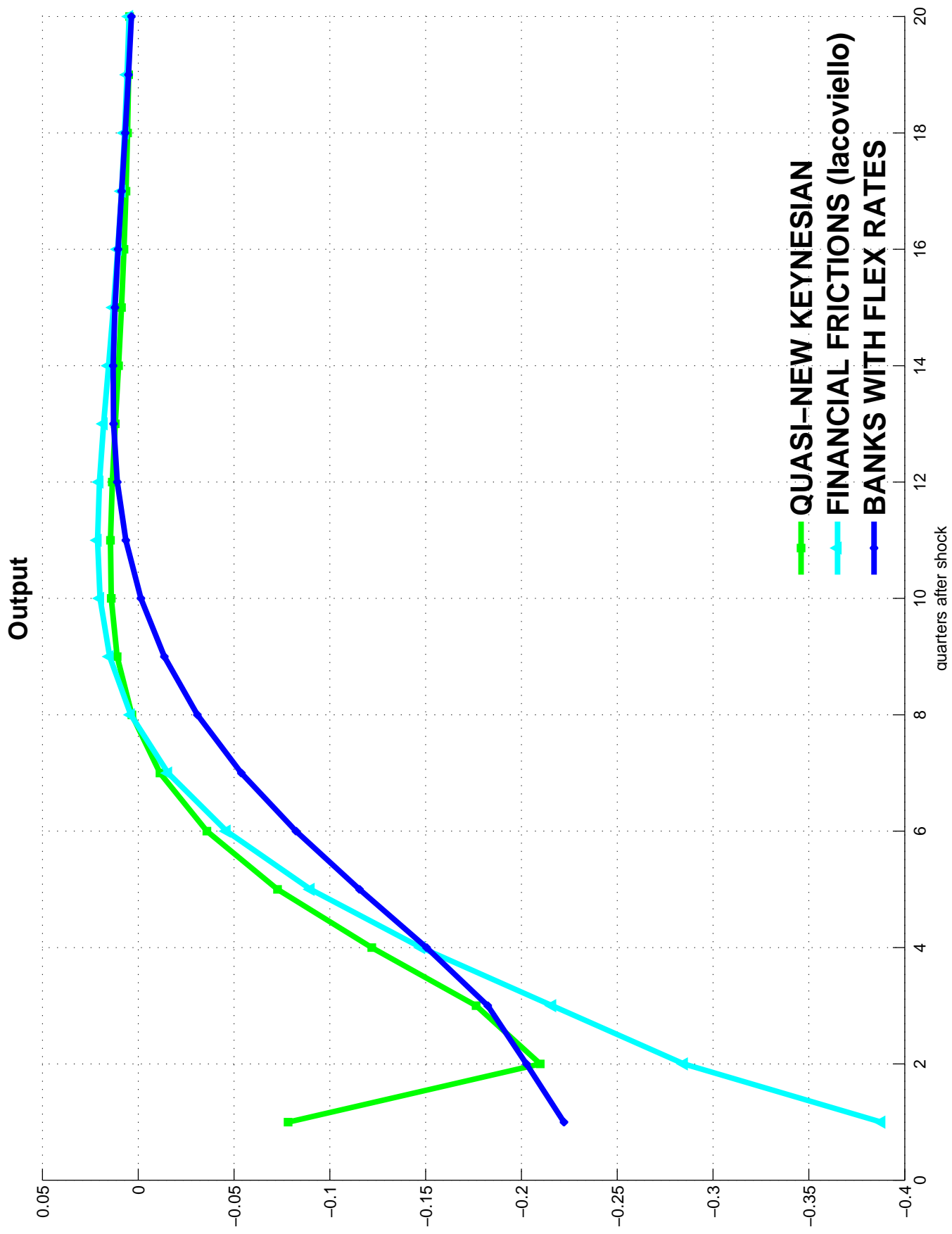
What difference do banks, sticky rates and bank capital make?

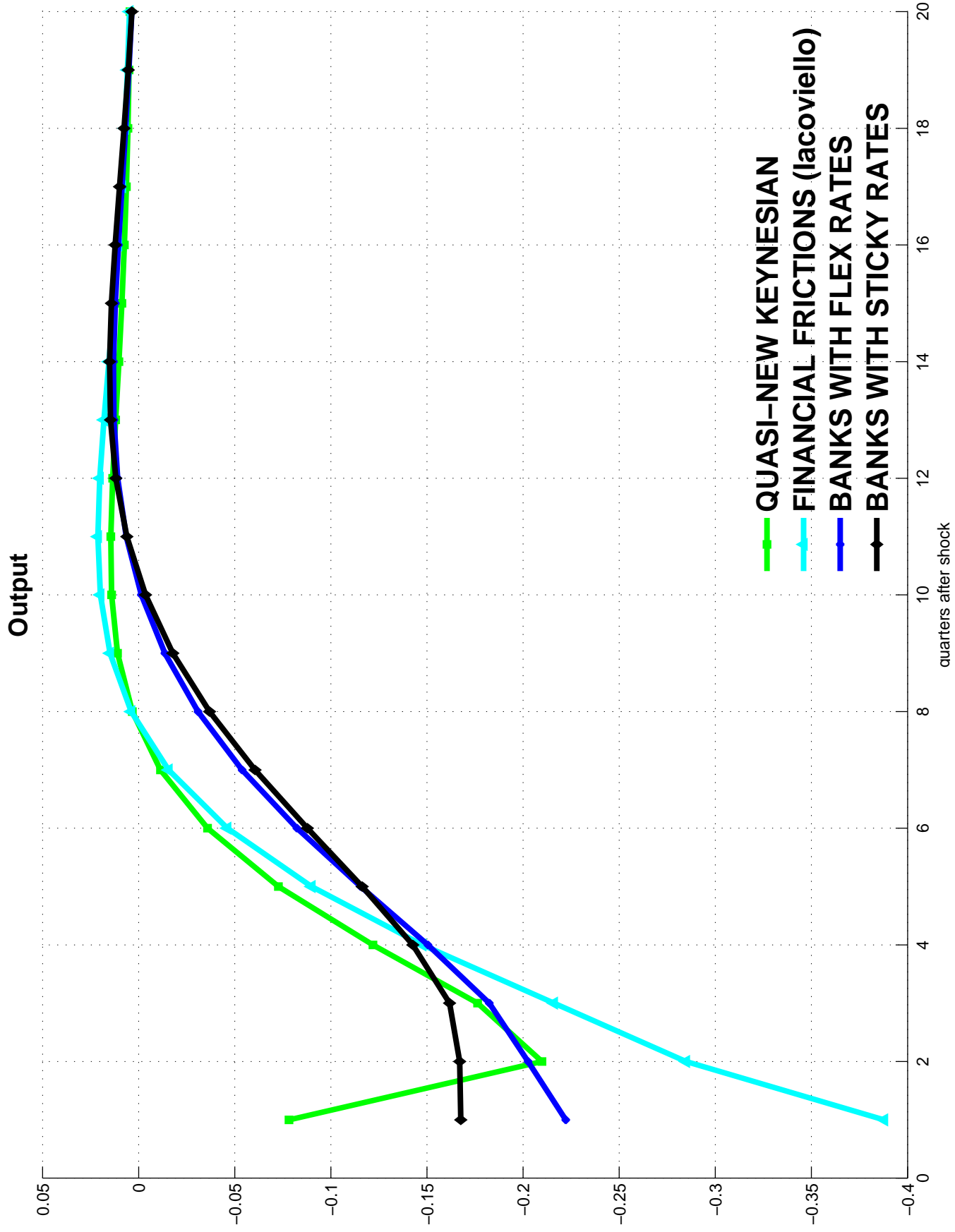
We isolate effects by sequentially **removing** the corresponding feature from our **Benchmark (BK: sticky bank rates & bank capital)**, i.e. we **remove**:

- 4 Bank capital** and get a model with banks with market power (where $mc_t^b = R_t^{IB}$) and sticky rates (**noBK**)
- 3 Sticky rates** and get a model with banks with market power but flex rates (**FR**)
- 2 Banks** and get Iacoviello model (**FF**)
- 1 Collateral effects and nominal debt** and get as close as possible to an NK model (**QNK**, still exist borrowing limits)









A "Banking Attenuator Effect"

Following a contractionary MP shock,

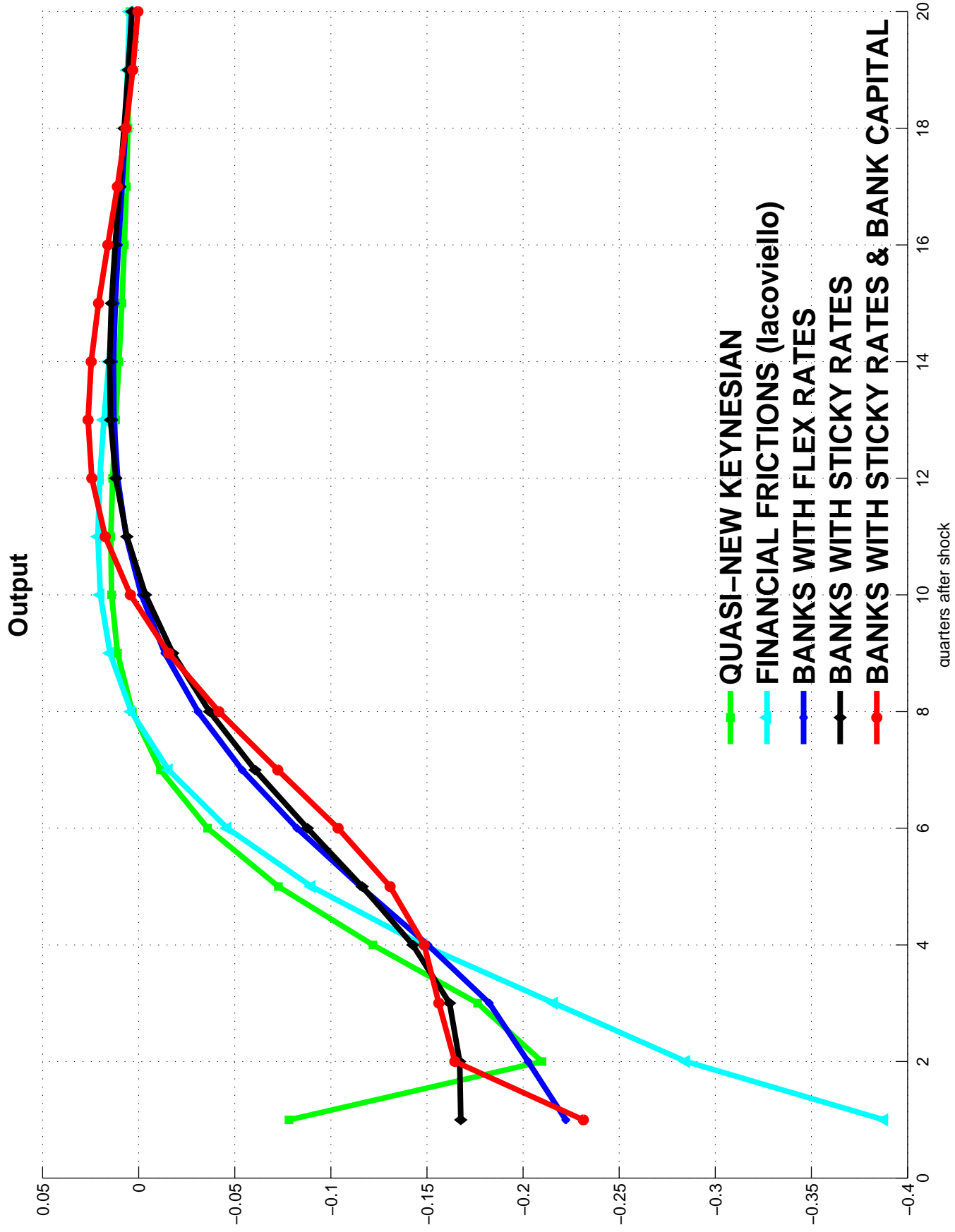
without banks

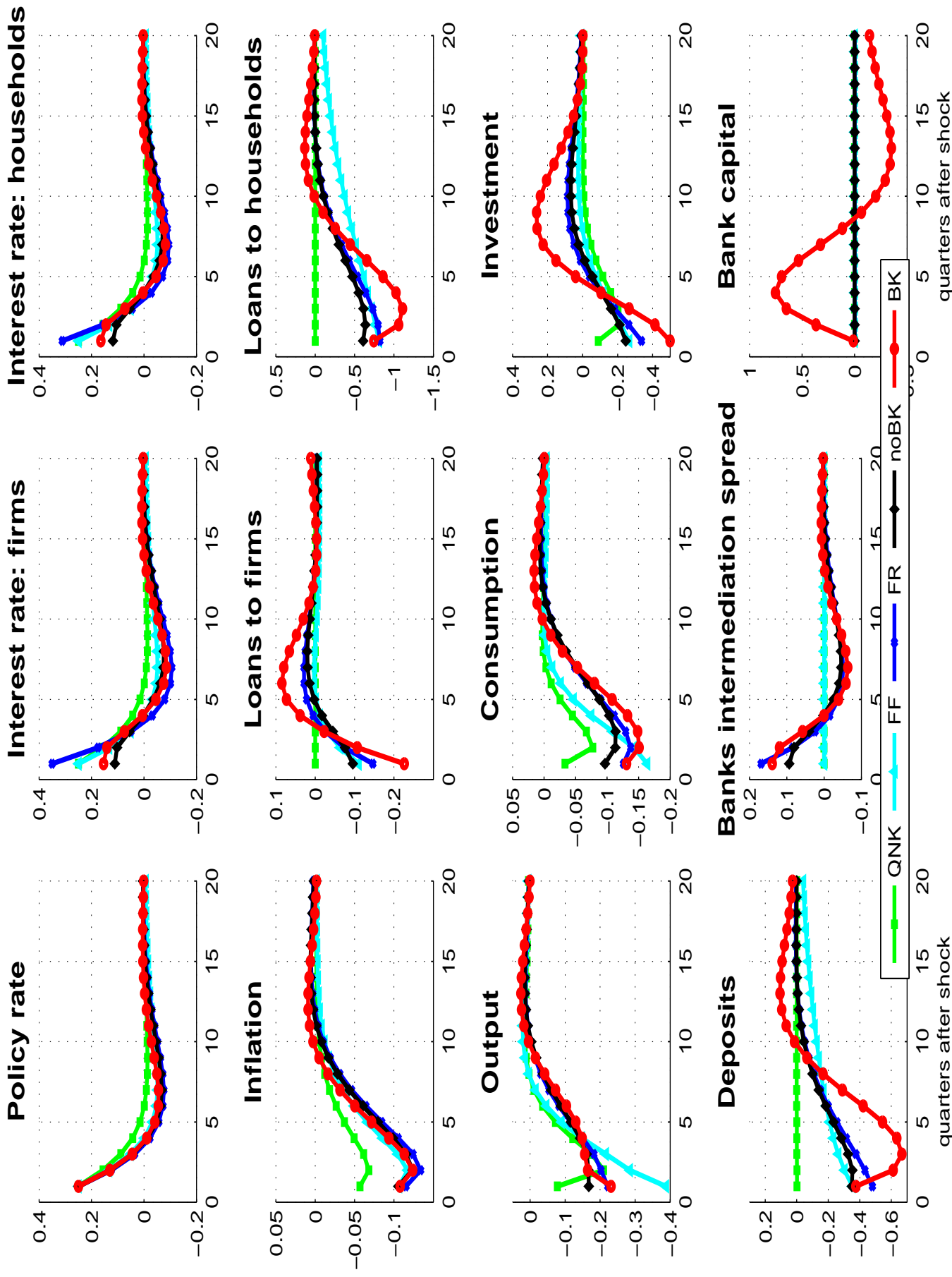
$$B_t \leq mE_t \left[\frac{Q_{t+1}^h h_t}{R_t \uparrow \uparrow} \right]$$

with banks

$$B_t \leq mE_t \left[\frac{Q_{t+1}^h h_t}{R_t^B \uparrow} \right]$$

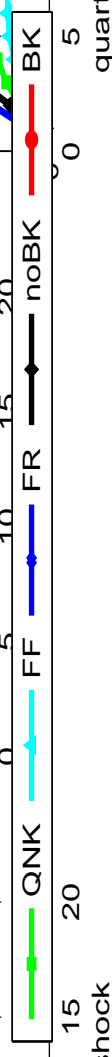
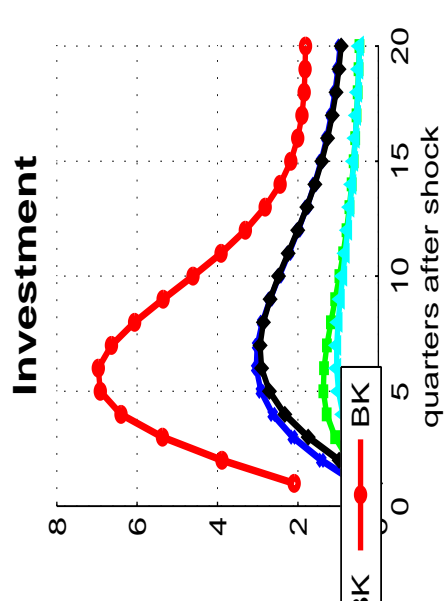
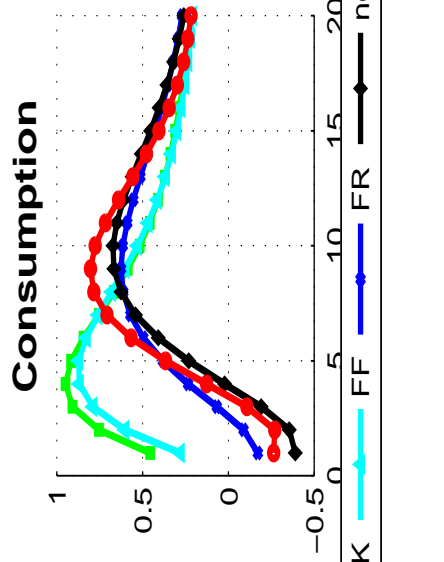
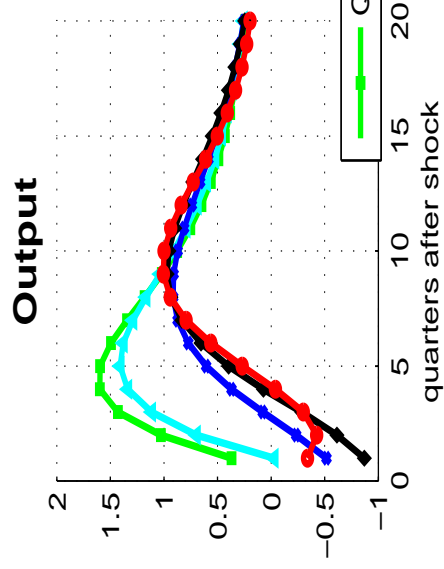
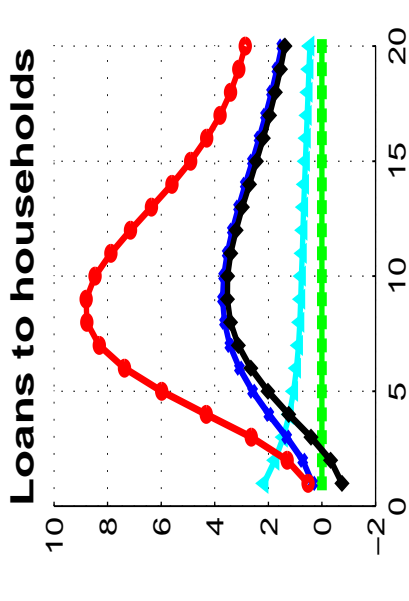
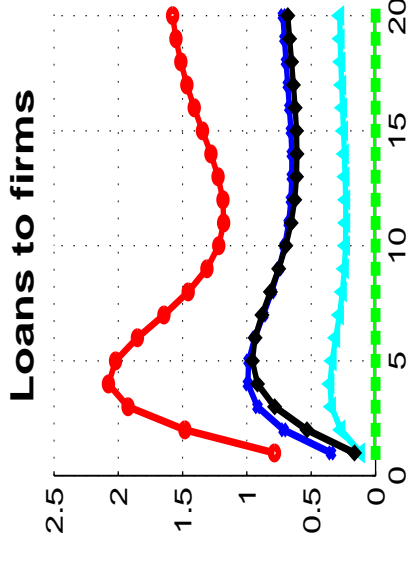
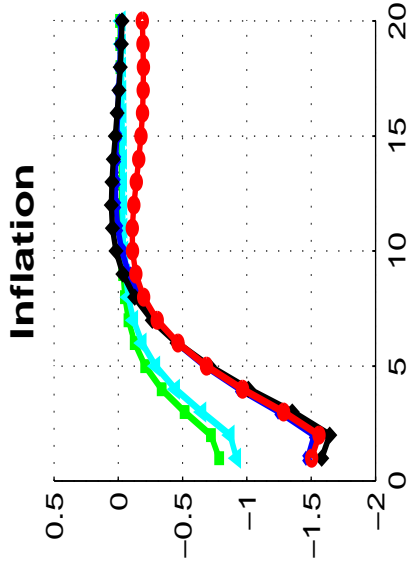
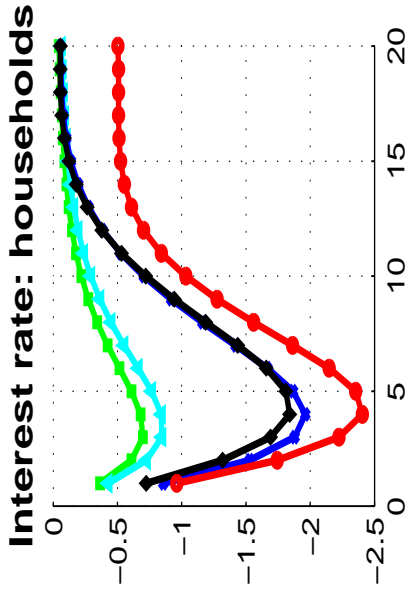
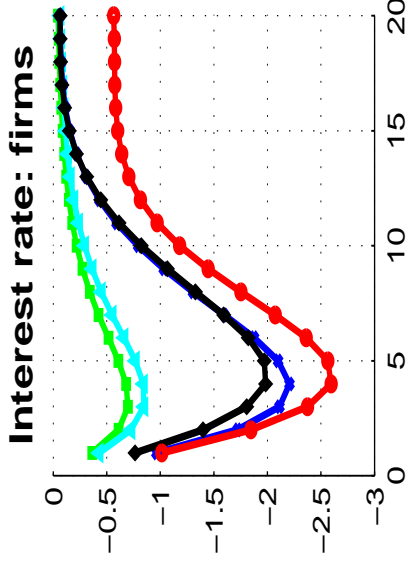
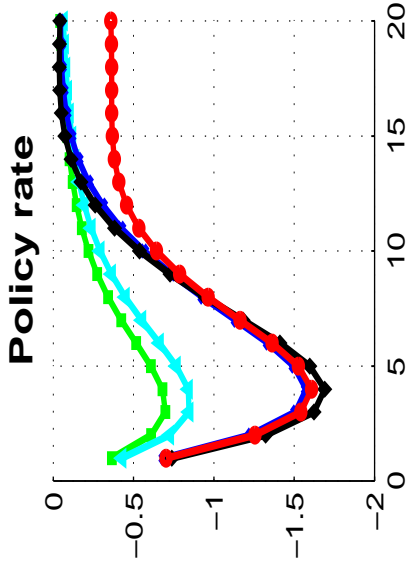
Rate-setting and stickiness attenuate the effects of MP shocks





Expansionary Technological Shock

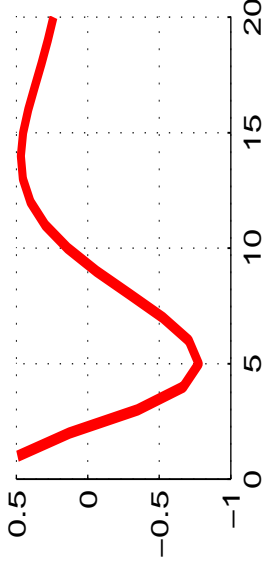
Positive shock to technology that increases output
(at the peak) by 1.0 per cent from its steady state value



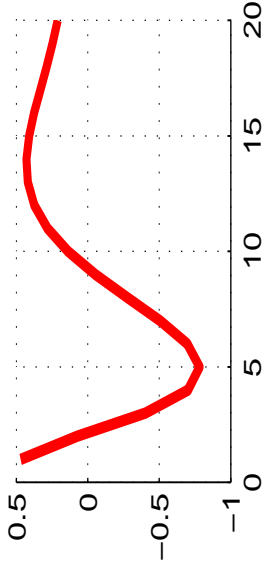
'Credit crunch' scenario

- Unexpected reduction in loans supply to HH's and firms (ex-ante, 5% on average)
 - implemented by increasing collateral requirements, i.e. by decreasing m^E e m^I
- Unexpected increase in bank rates on loans to HH's and firms (ex-ante, 100 b.p.)
 - implemented by increasing markups, i.e. by decreasing ε_b^E & ε_b^H
- Unexpected increase in bank rates on deposits (ex-ante, 50 b.p.)
 - implemented by increasing markdown, i.e. by decreasing ε_d
- All independent of policy

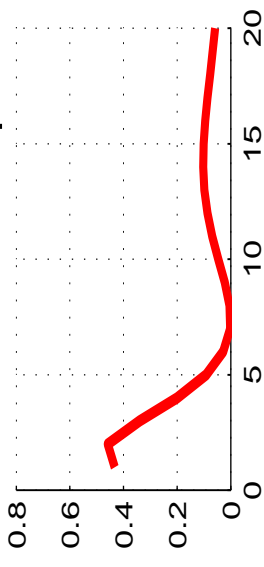
Int. rate: firm loans



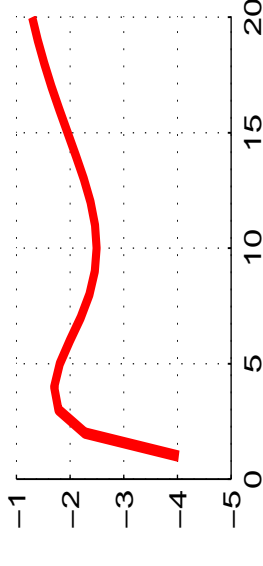
Int. rate: household loans



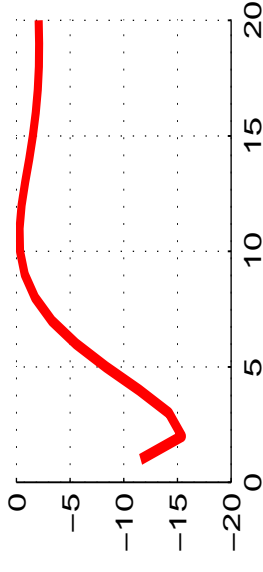
Interest rate: deposits



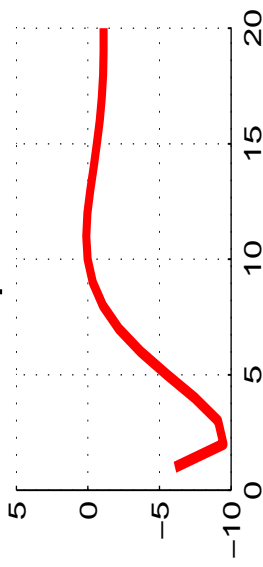
Loans to firms



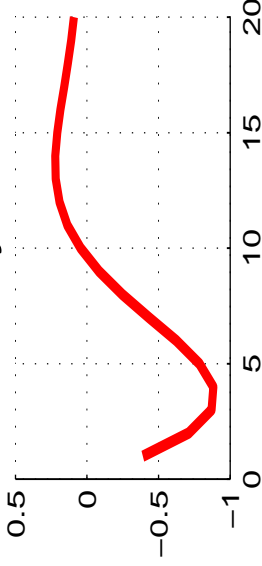
Loans to households



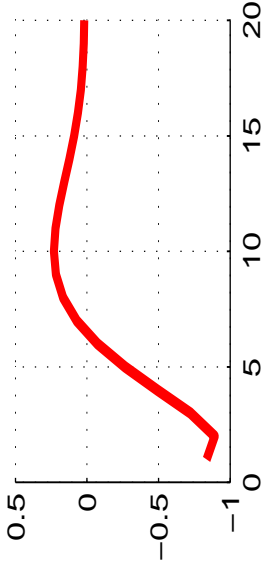
Deposits



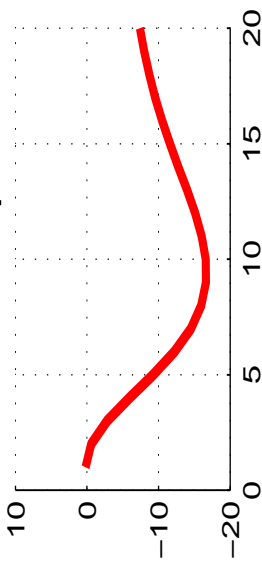
Policy rate



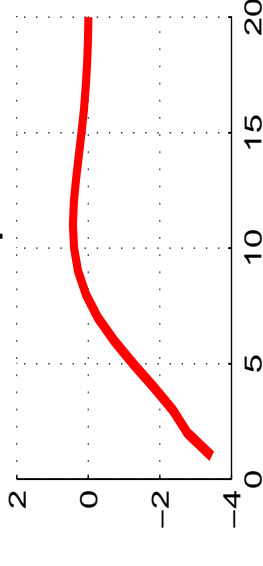
Inflation



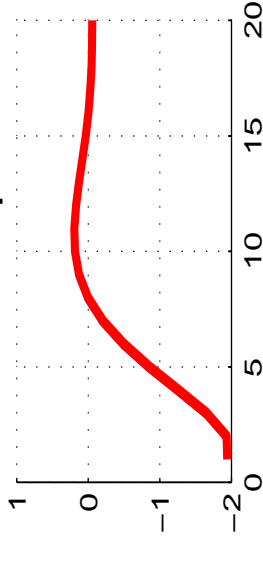
Bank capital



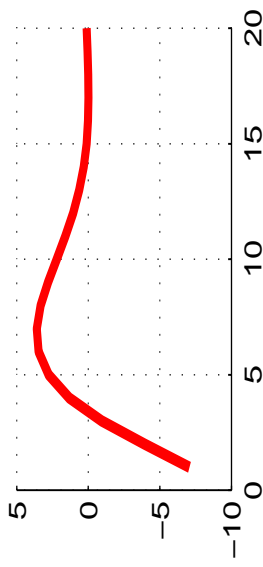
Output



Consumption



Investment



CONCLUSIONS

- **Demand shocks (MP)**
 - **Stabilizing** role of credit market power and rate stickiness (*attenuator effect*).
 - **Amplifying** role of bank capital (*accelerator effect*).
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- **Supply shocks (TS)**
 - With **banks**, greater **propagation** and **persistence**.
- **Credit crunch**
 - The presence of banks allows to assess the economic impact of **changes in bank rates** and **credit supply** to HH's and firms.
 - **Negative** effects on **output** and **investment**, more severe if tightening is on **firms**.

EXTENSIONS

- Risk.
- Write-offs and valuation effects.
- Multiperiod loan contracts.
- Bayesian estimation.

