



## Credit and Banking in a DSGE Model

A. Gerali, S. Neri, L. Sessa, and F. Signoretto

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# Credit and Banking in a DSGE Model



**A. GERALLI, S. NERI, L. SESSA, F. SIGNORETTI**  
Banca d'Italia

IMF Research Department Macro Modeling Workshop  
Washington D.C.  
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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. ...**

# WHY is it interesting?

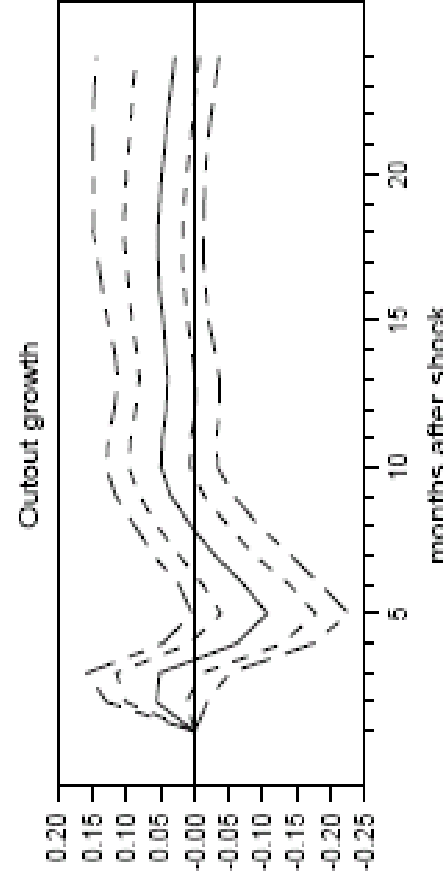
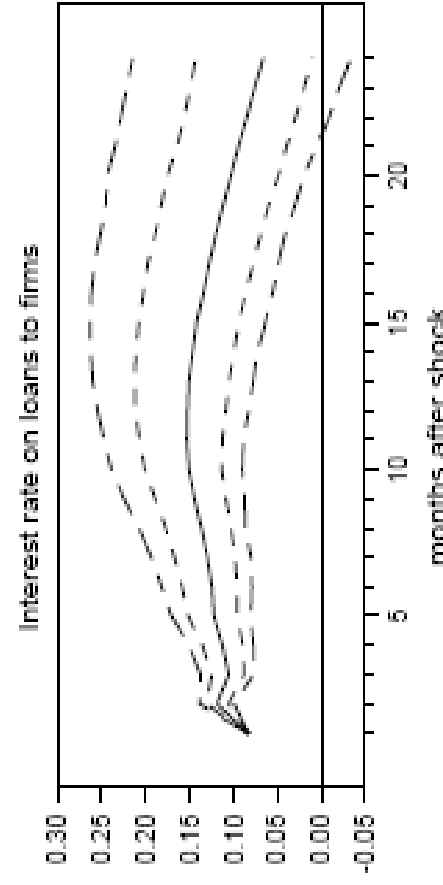
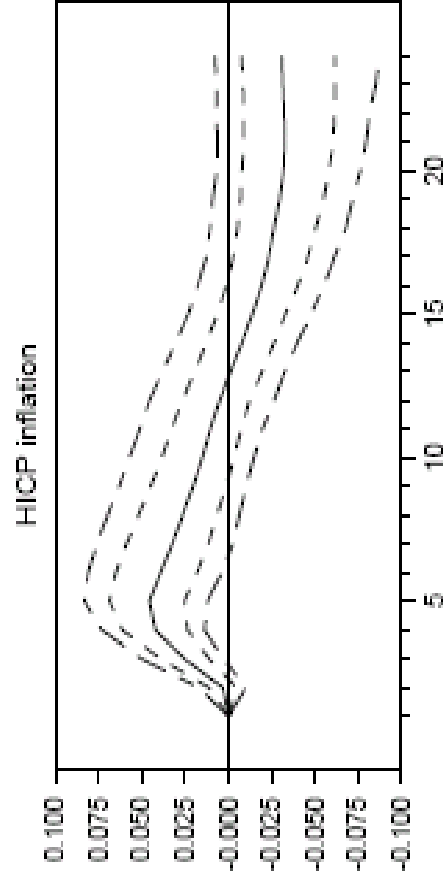
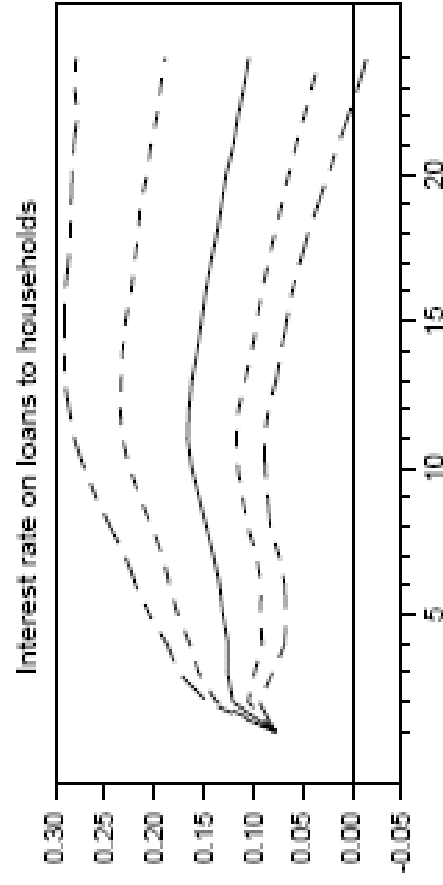
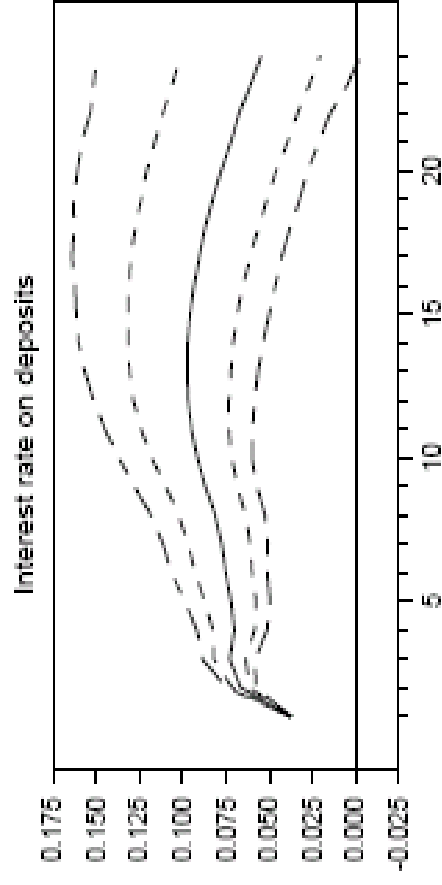
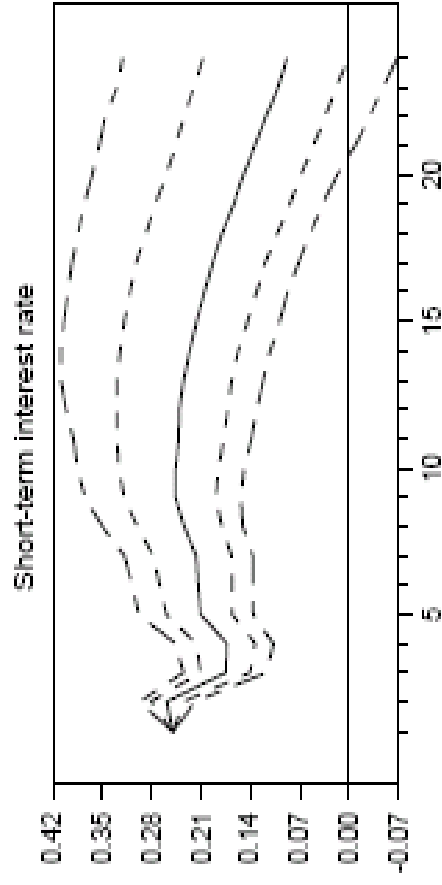


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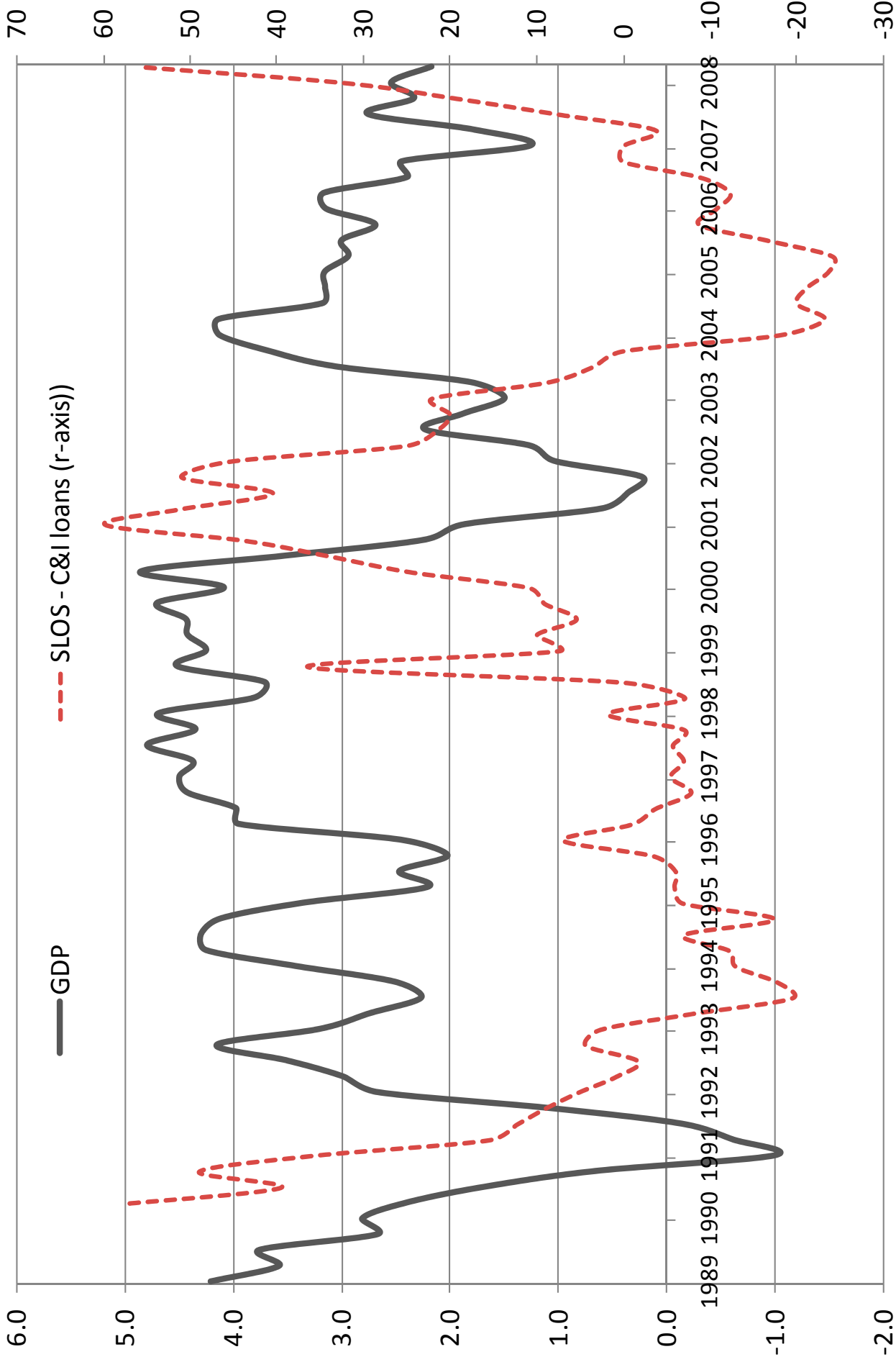


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# US GDP growth and Credit Conditions

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



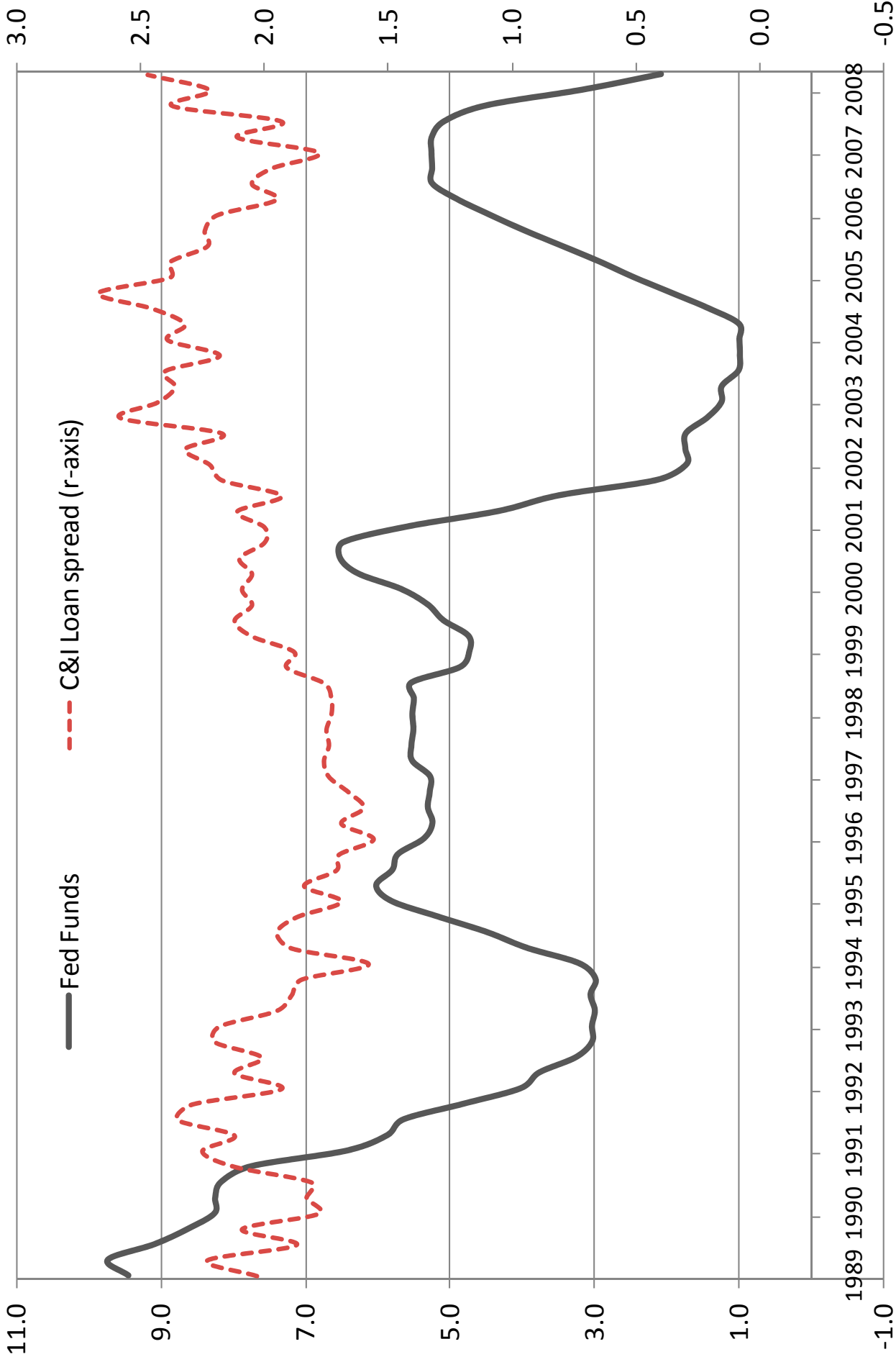
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# US Policy Rate and Short-term Loan Spread

(percentage points)



Source: Federal Reserve

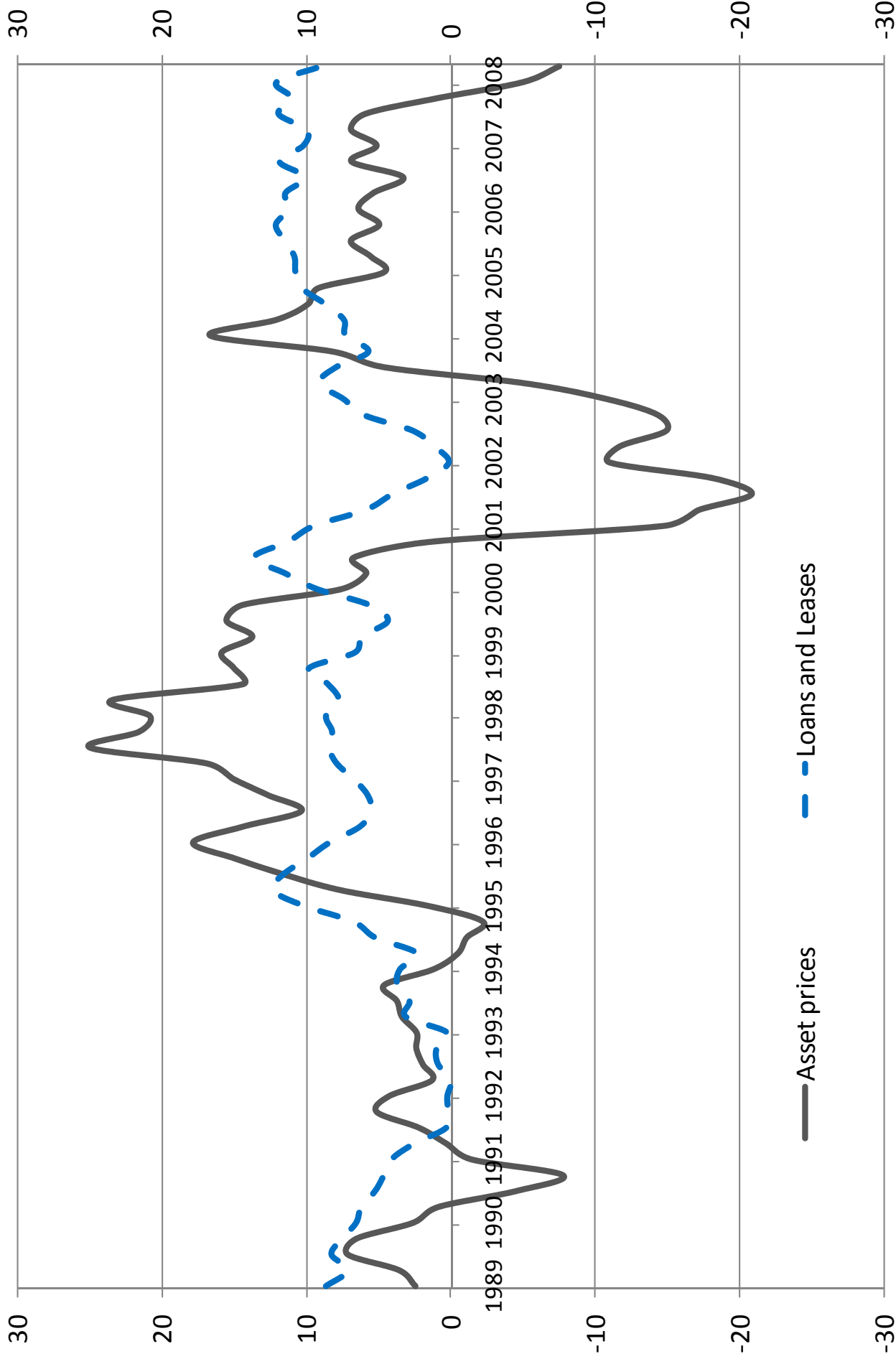
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# US Commercial Banks' Balance-sheet Items and Asset Prices

(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



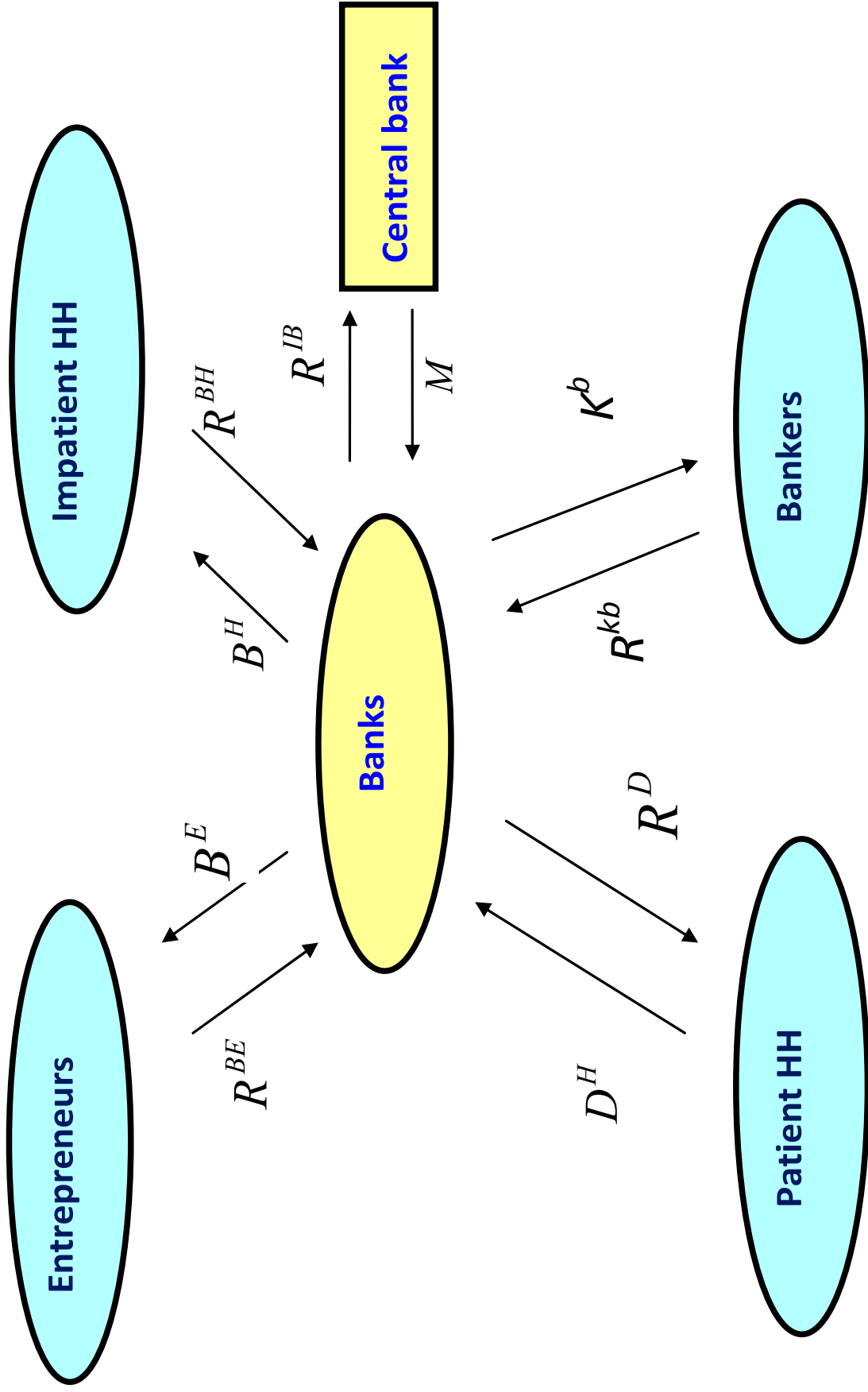
1. **Financial frictions** and **heterogeneous agents**, to generate credit flows in the first place  
(Kyotaki and Moore, 1998; Iacoviello, 2005)
2. **Monopolistic competition** in the banking sector, so that banks **make decisions** when setting interest rates

## 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

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

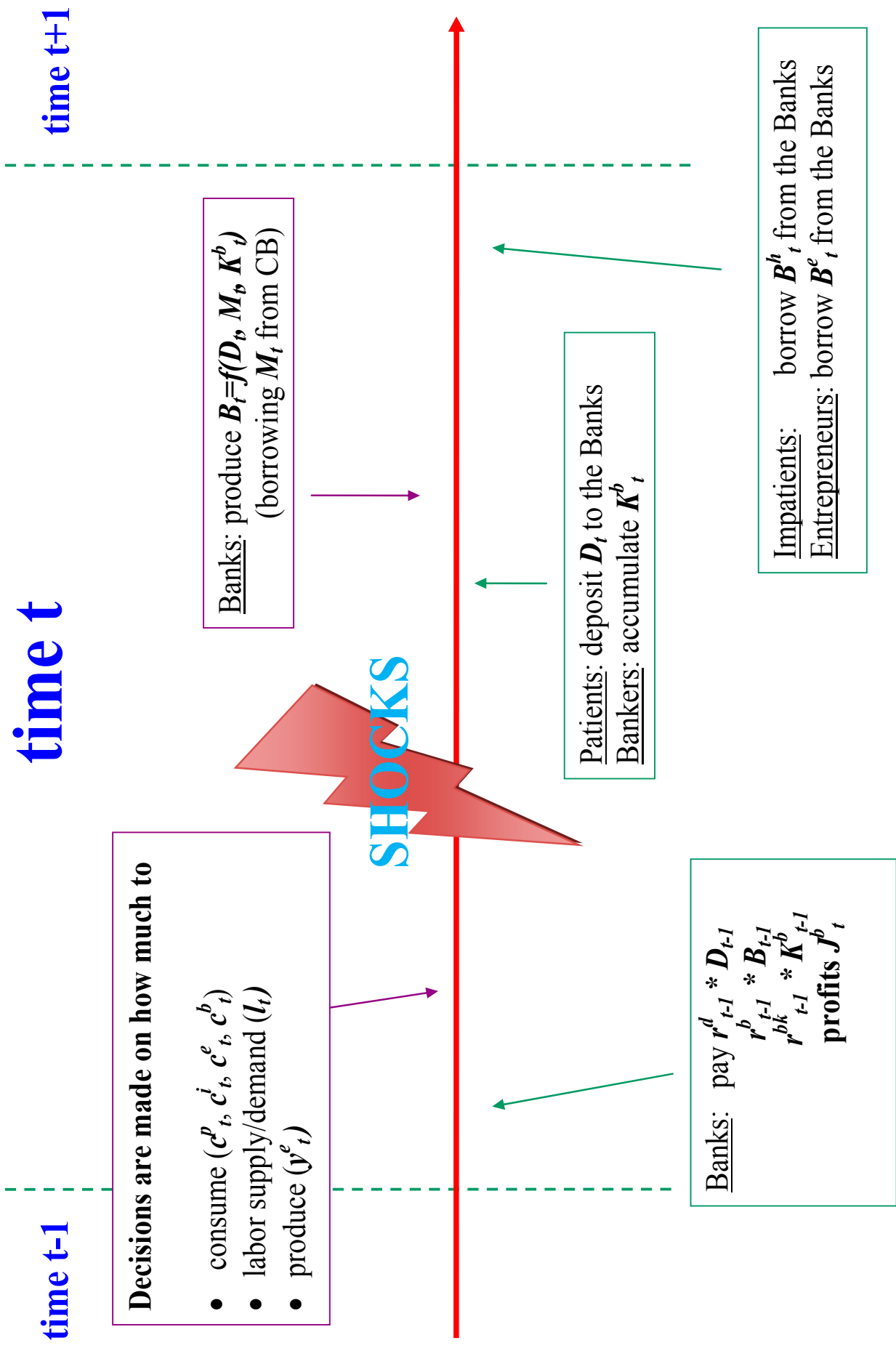
# Banks (& Bankers)



- 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

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





# 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

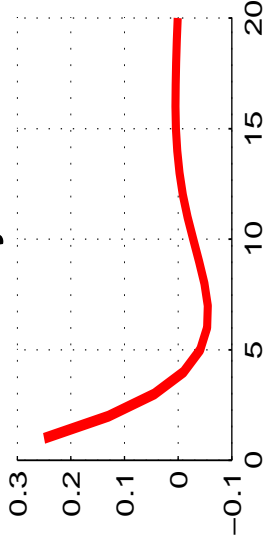
Parameter	Value	Parameter	Value
$\beta^P = \beta^B$	0.9943	$\varepsilon_d$ ( $D$ demand el.)	-1.3 (-150bp spread)
$\beta^I = \beta^E$	0.975	$\varepsilon_b^H$ ( $B^H$ demand el.)	5.1 (+160bp spread)
$m^E$ (Firms' LTV)	0.25	$\varepsilon_b^E$ ( $B^E$ demand el.)	3.5 (+130bp spread)
$m^I$ (HHS' LTV)	0.7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

## Applications

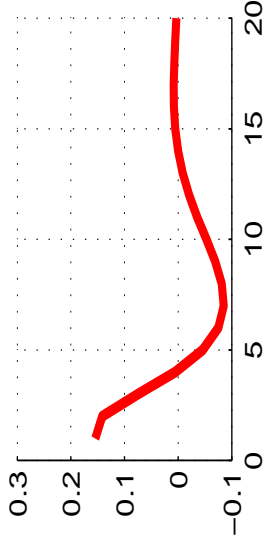
- 1** Contractionary Monetary Policy Shock
- 2** Expansionary Technology Shock
- 3** 'Credit-Supply Shock' Scenario:
  - \* a tightening of collateral requirements and
  - \* an exogenous increase in bank rates for both HH's and firms

## **Contractionary Monetary Policy Shock (25 b.p.)**

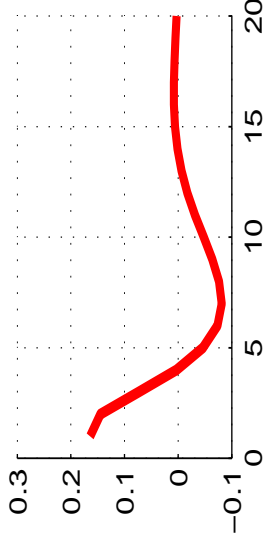
Policy rate



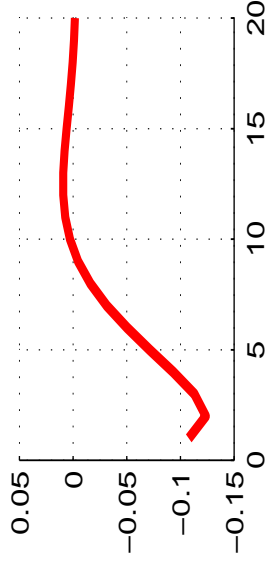
Interest rate: firms



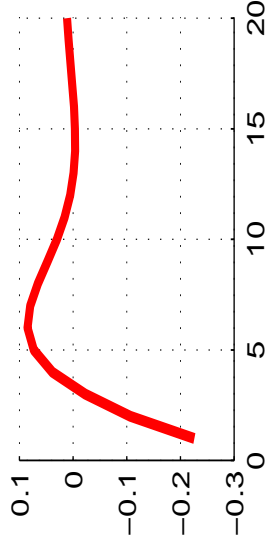
Interest rate: households



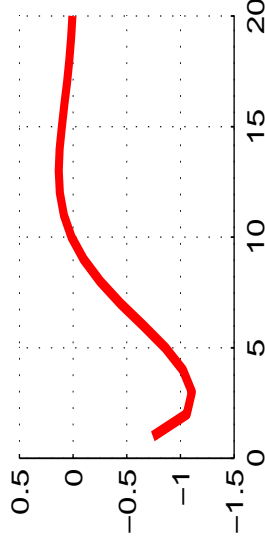
Inflation



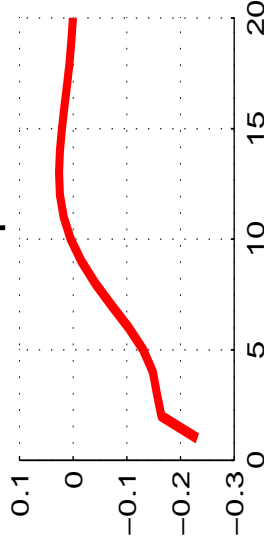
Loans to firms



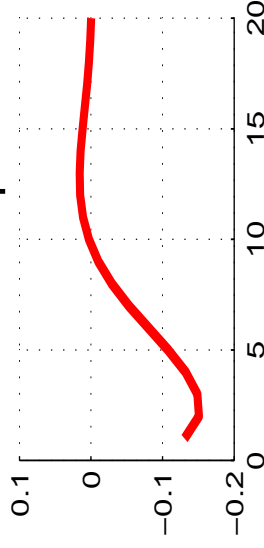
Loans to households



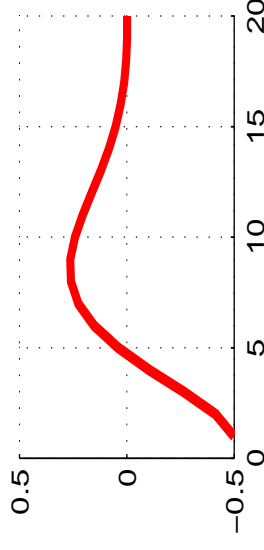
Output



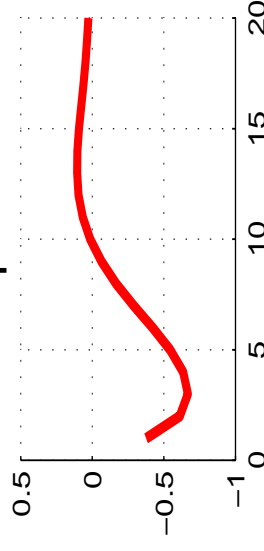
Consumption



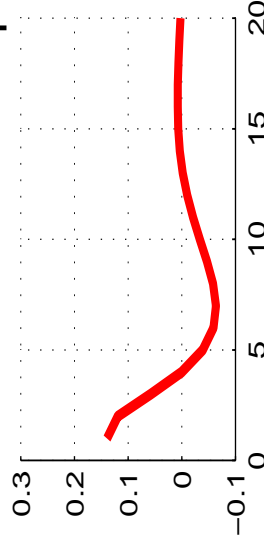
Investment



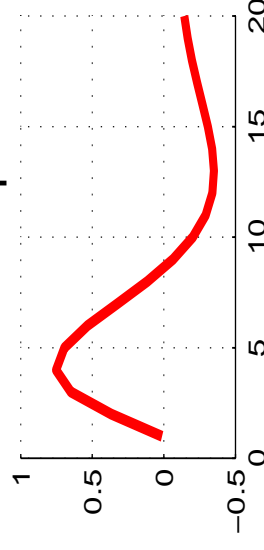
Deposits



Banks intermediation spread



Bank capital

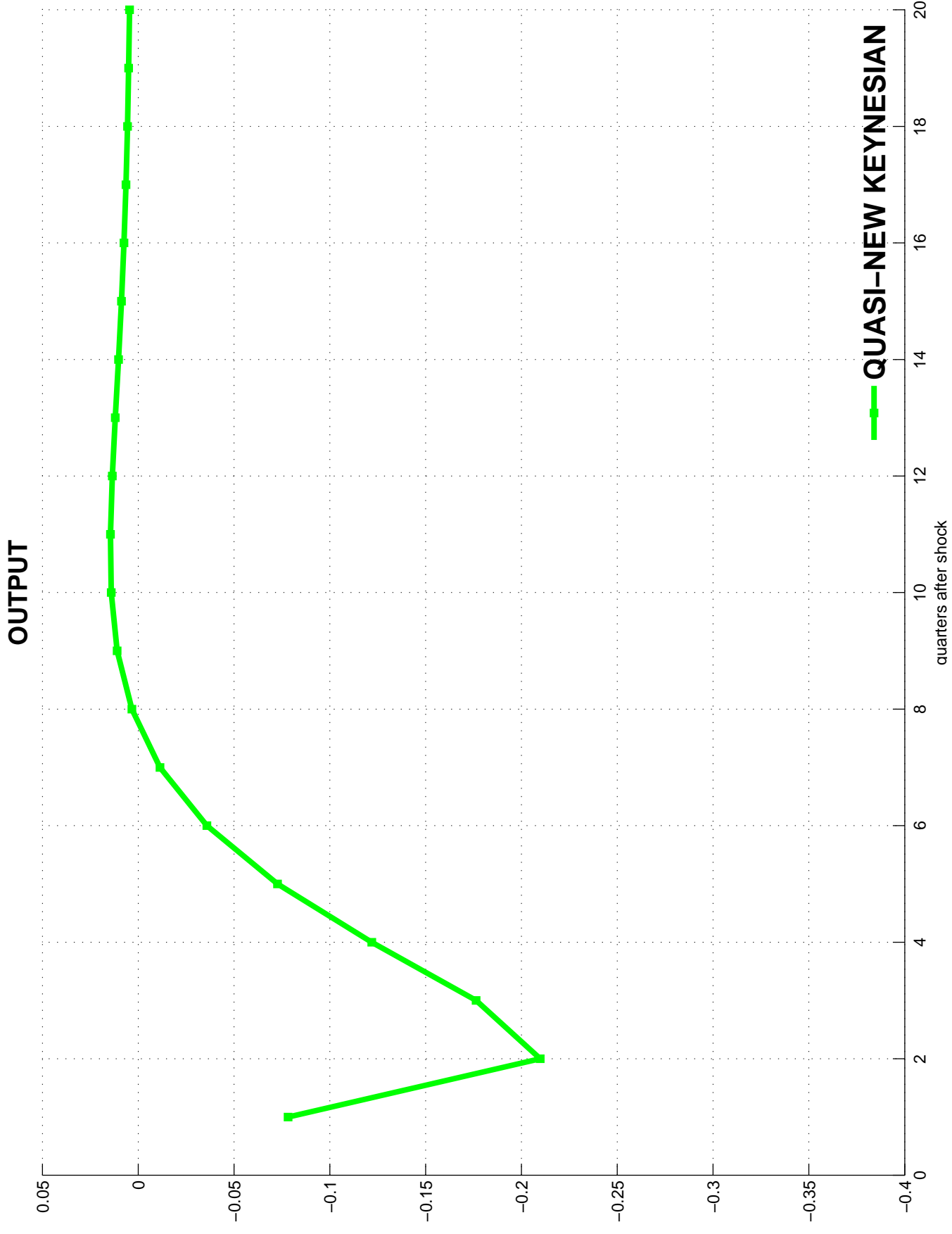


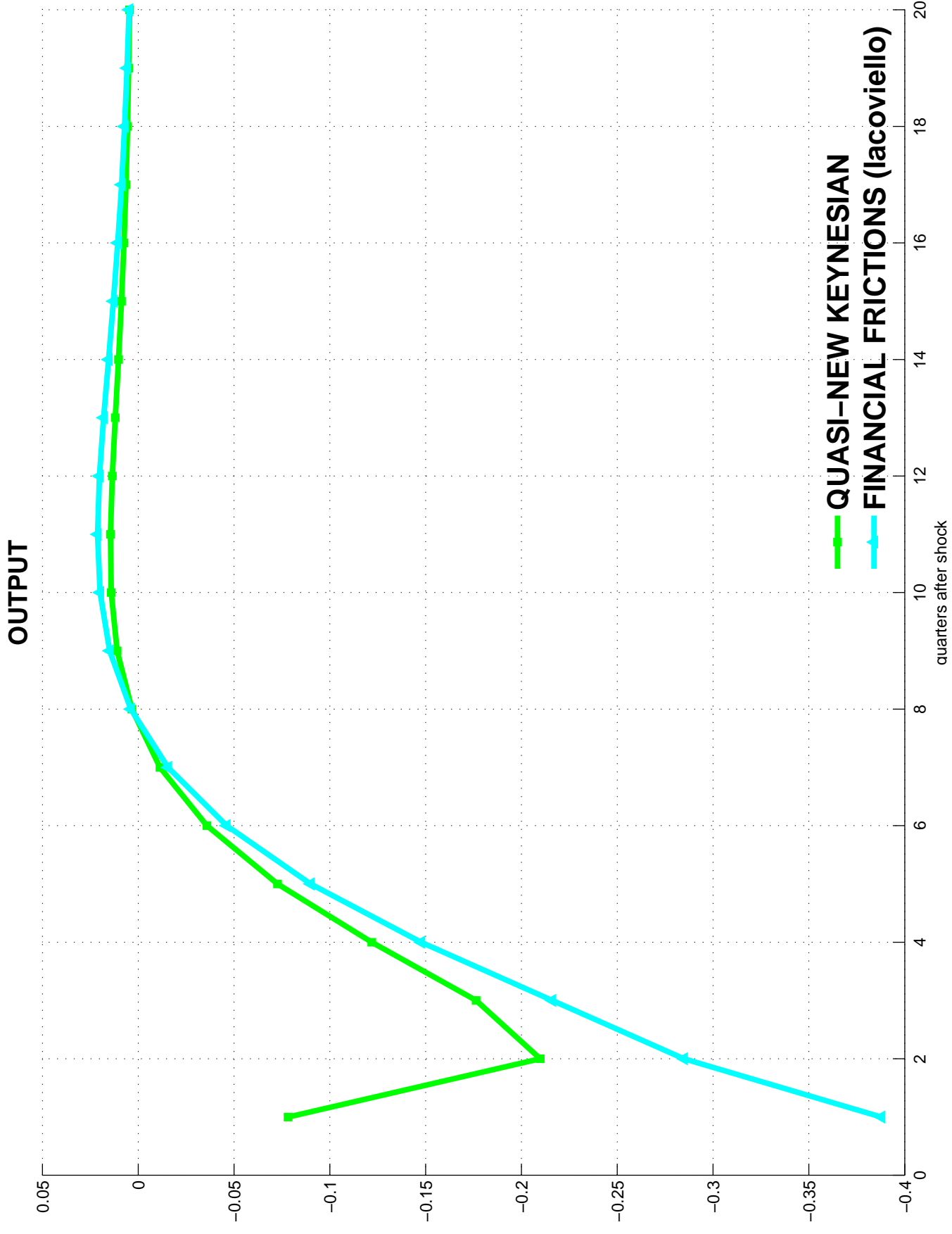
# What difference do banks, sticky rates and bank capital make?

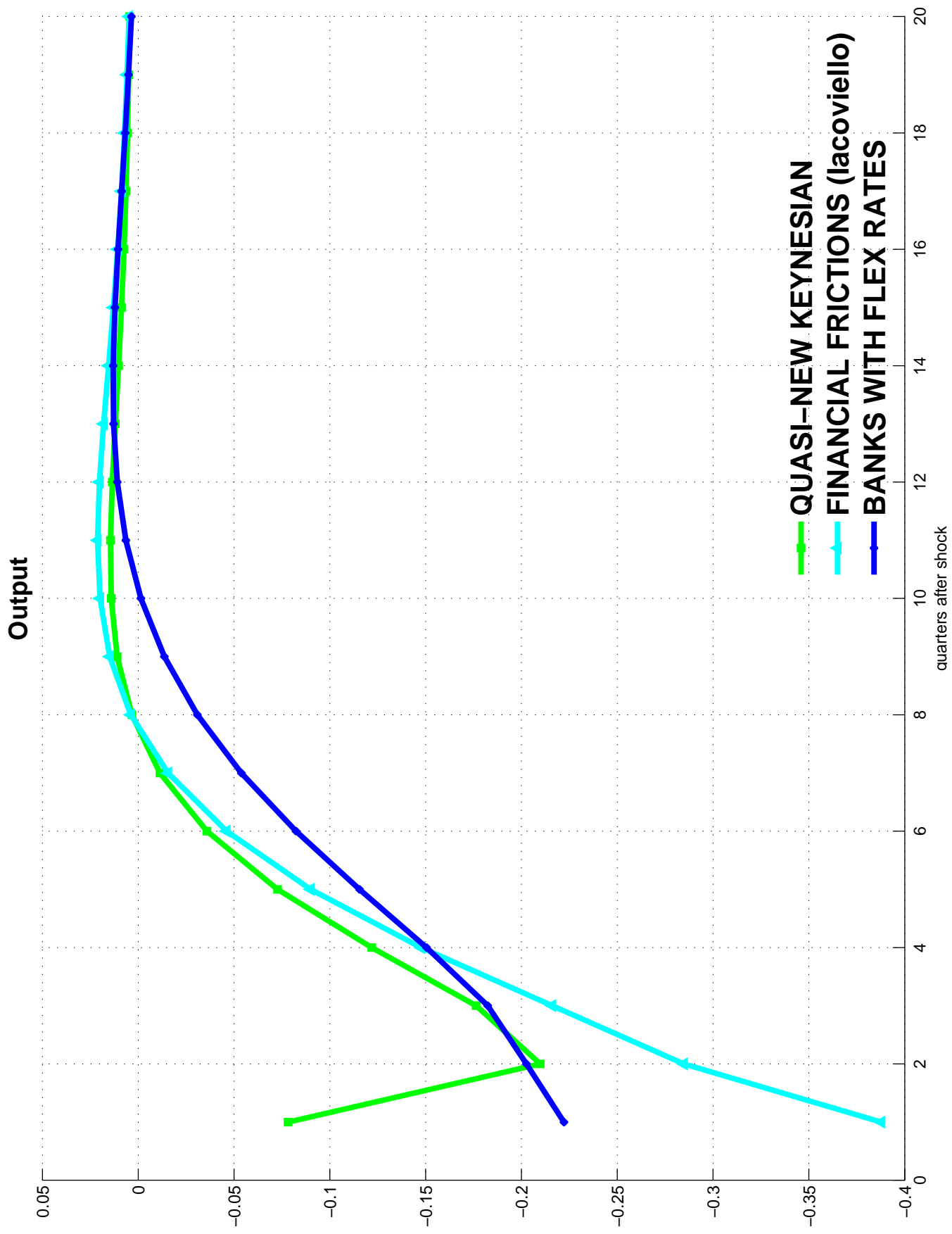
We isolate effects by sequentially **removing** the corresponding feature from our **Benchmark (BK: sticky bank rates & bank capital)**, i.e. we **remove**:

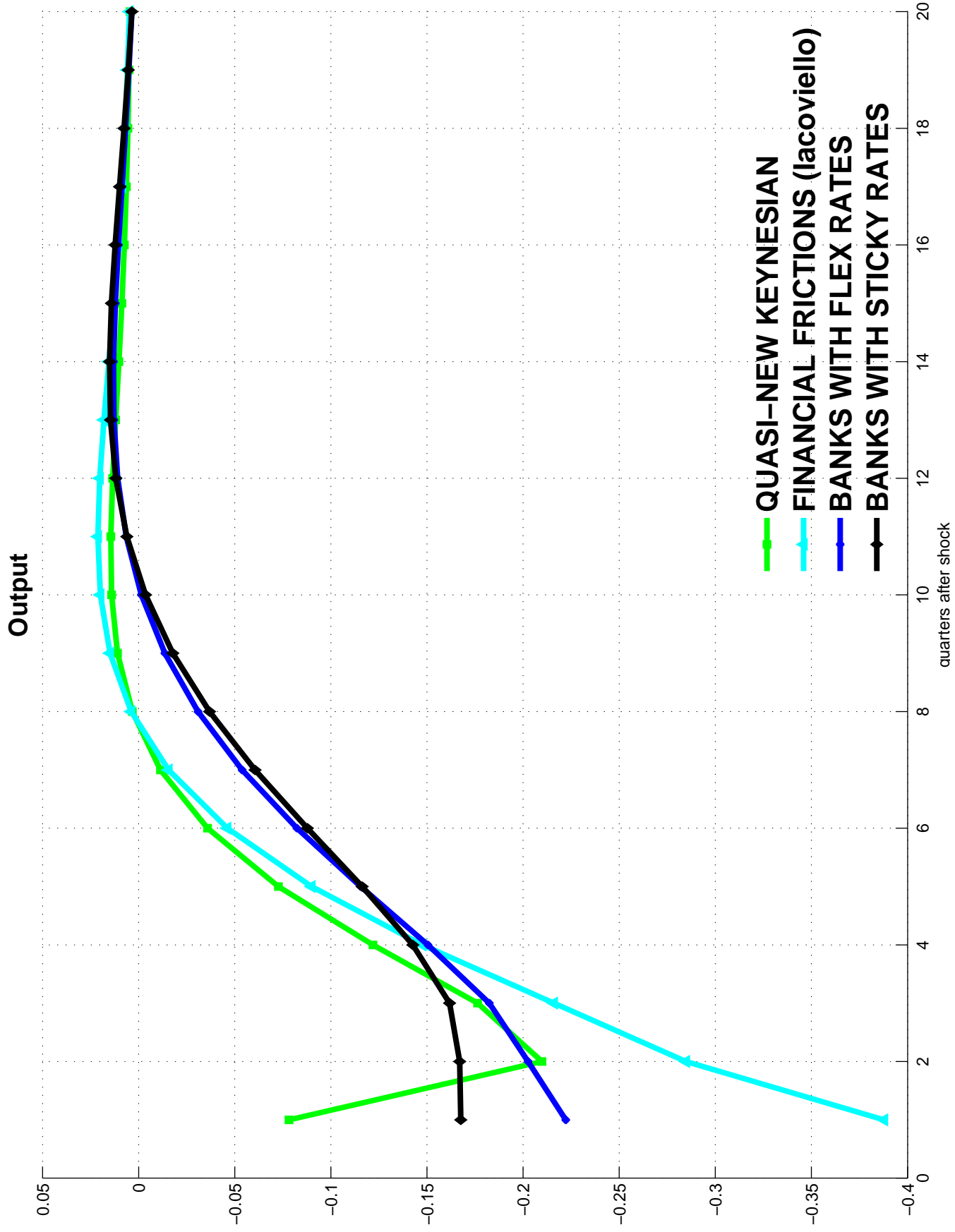
- 4 Bank capital** and get a model with banks with market power (where  $mc_t^b = R_t^{IB}$ ) and sticky rates (**noBK**)
- 3 Sticky rates** and get a model with banks with market power but flex rates (**FR**)
- 2 Banks** and get Iacoviello model (**FF**)
- 1 Collateral effects and nominal debt** and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











## A "Banking Attenuator Effect"

Following a contractionary MP shock,

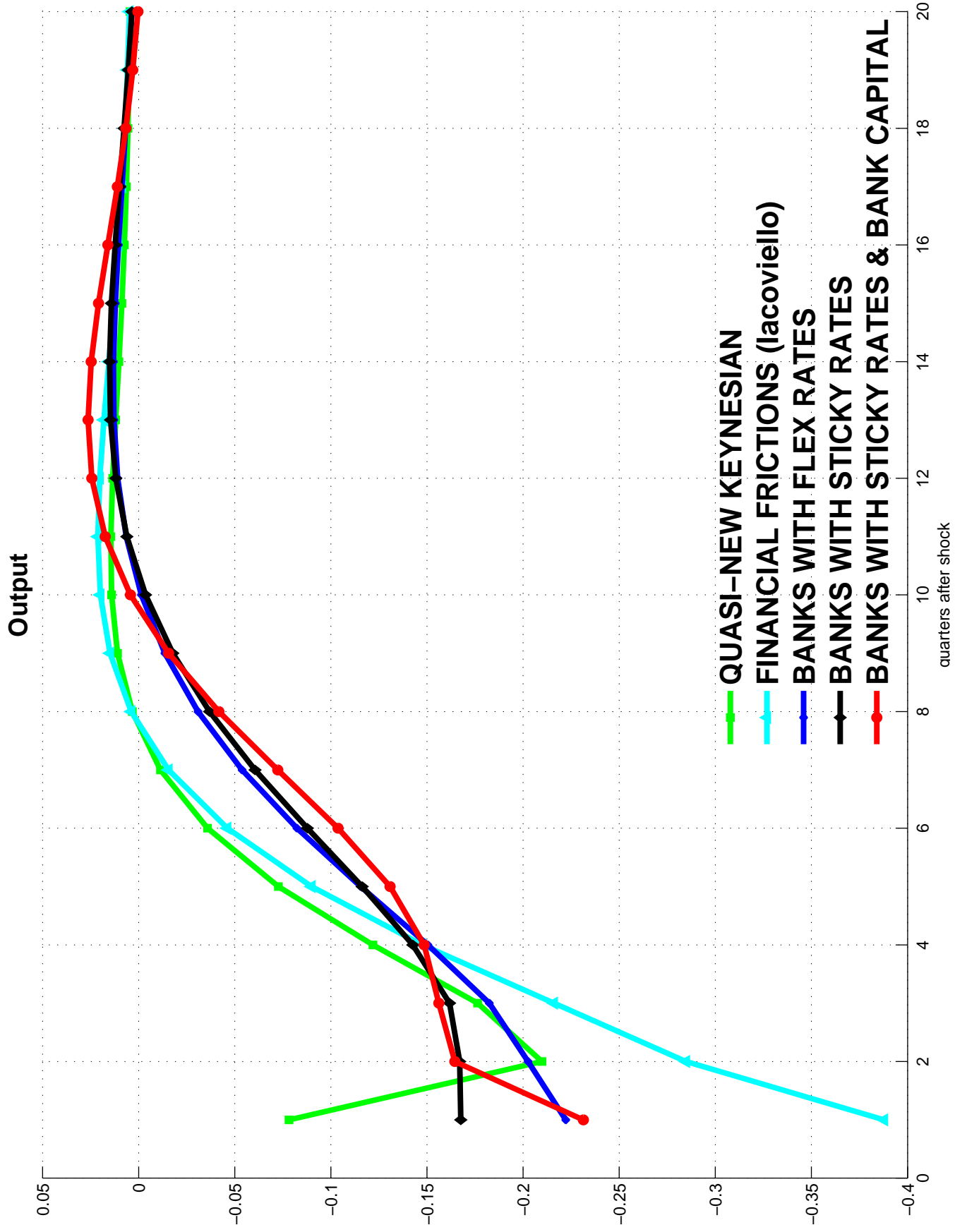
without banks

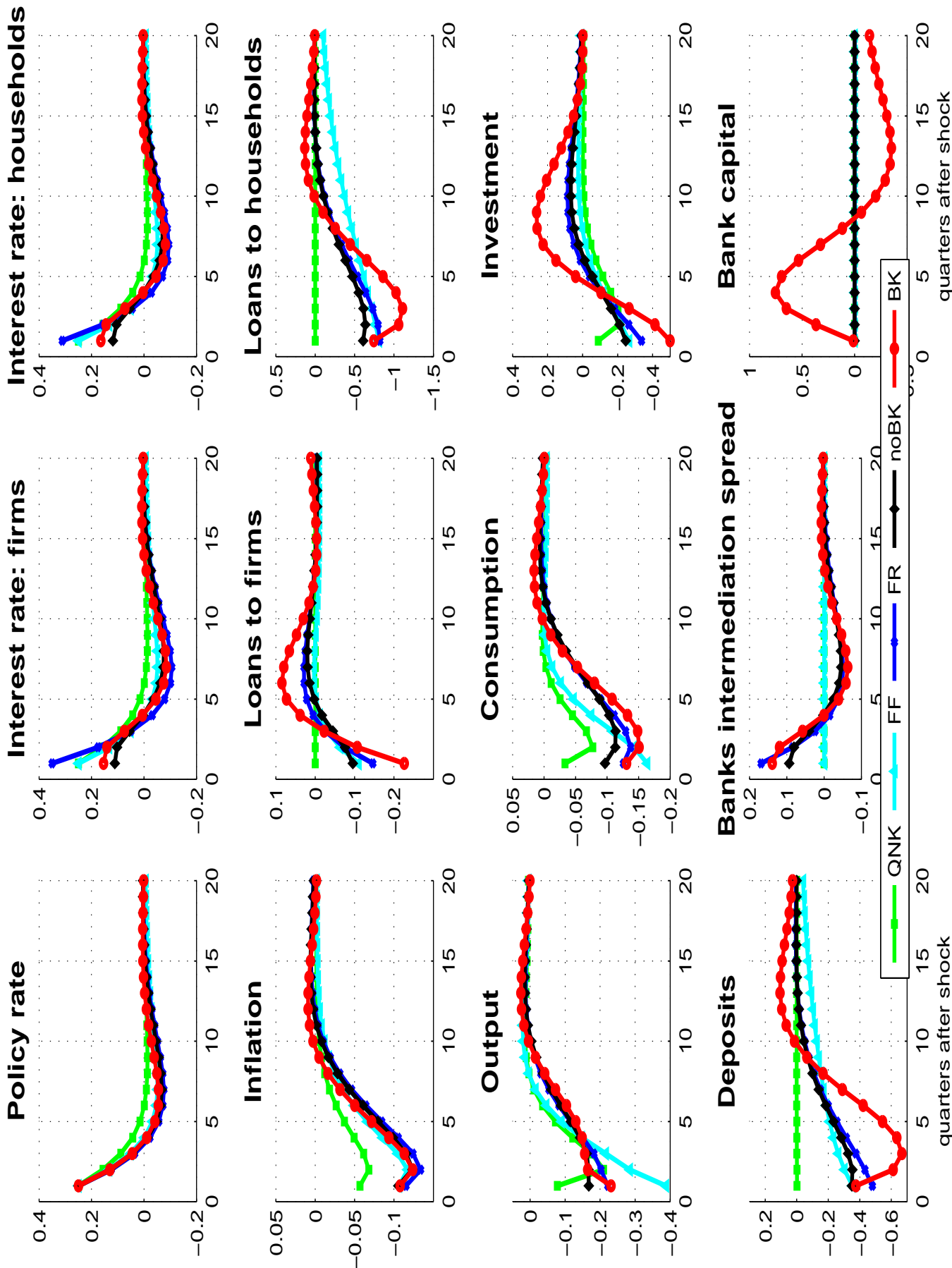
$$B_t \leq mE_t \left[ \frac{Q_{t+1}^h h_t}{R_t \uparrow \uparrow} \right]$$

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*

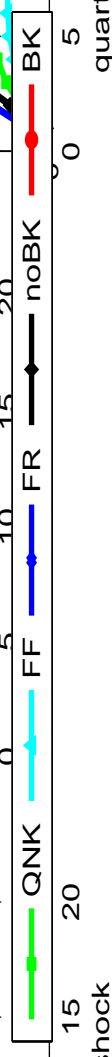
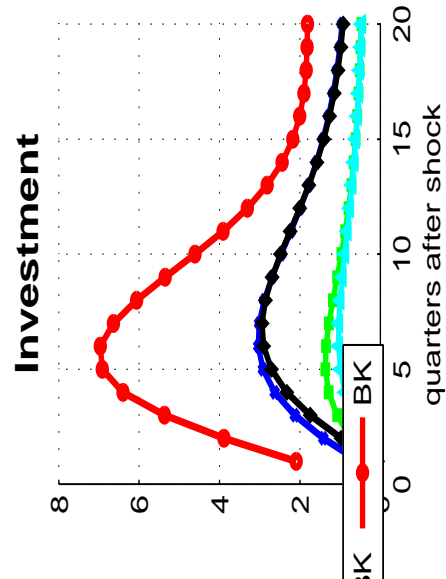
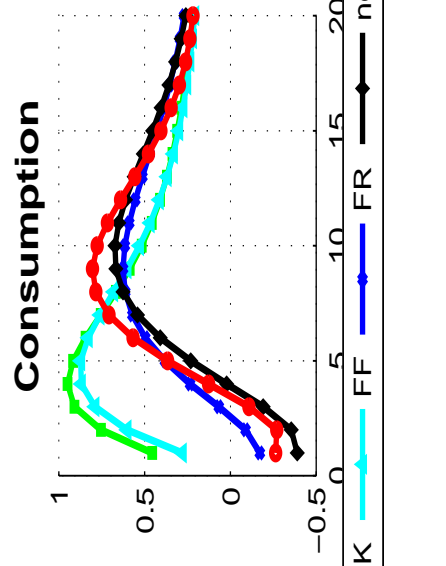
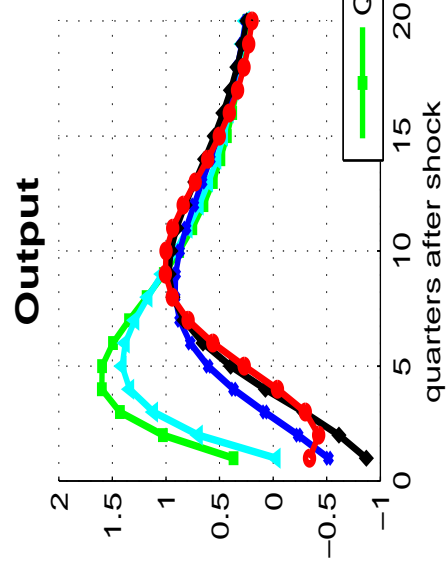
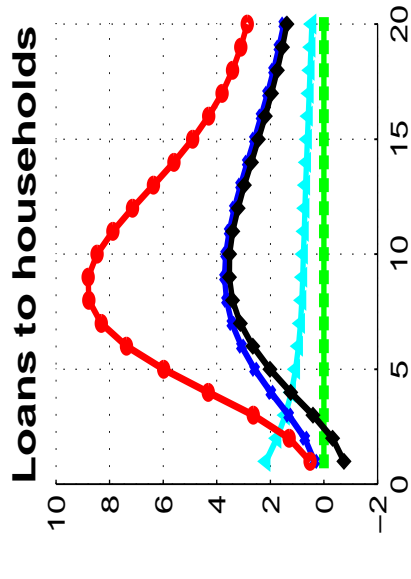
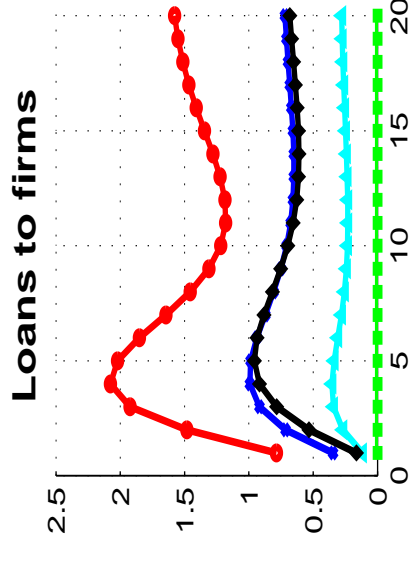
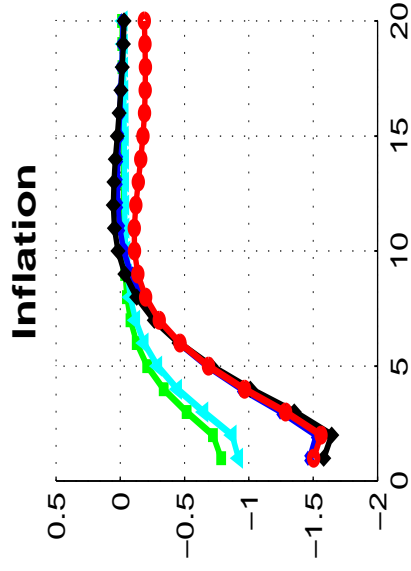
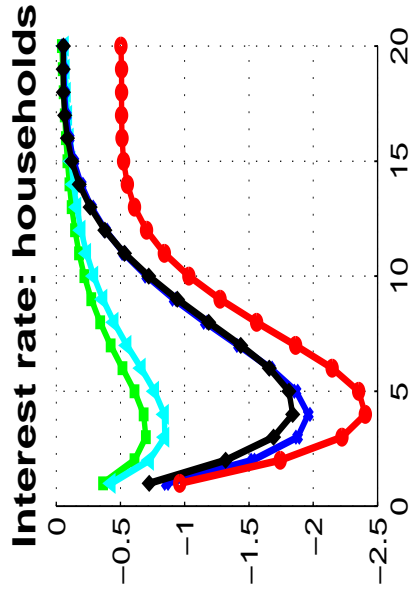
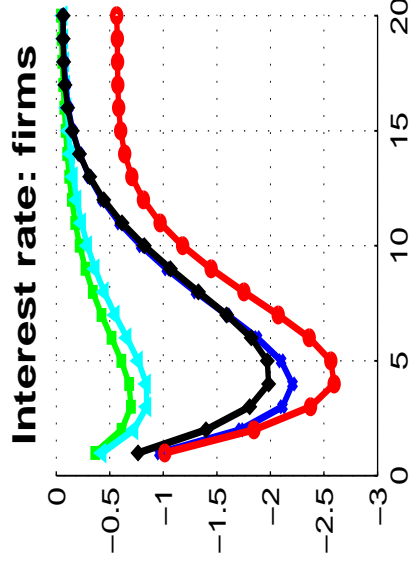
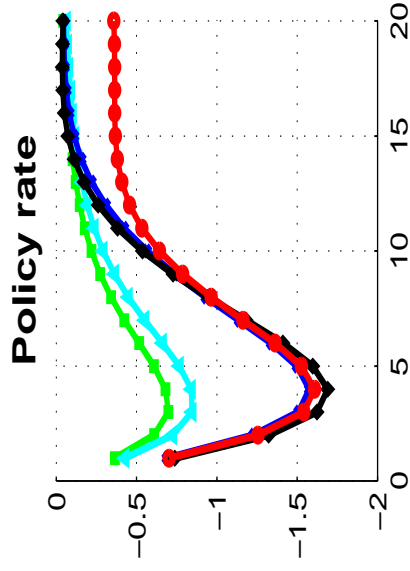




## **Expansionary Technological Shock**

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

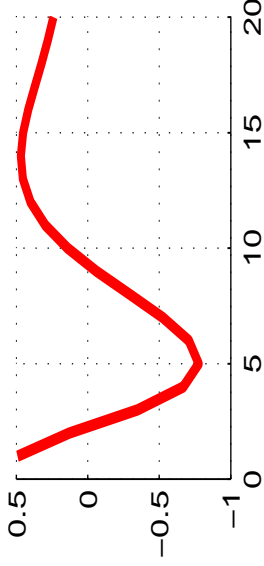




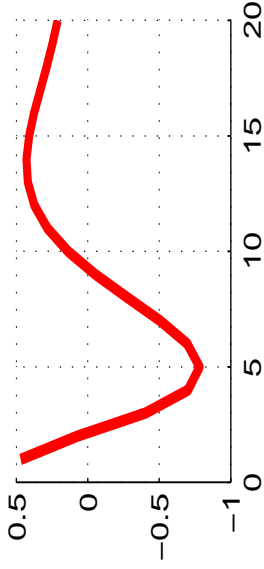
## 'Credit crunch' scenario

- 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  $\varepsilon_b^E$  &  $\varepsilon_b^H$
- Unexpected increase in bank rates on deposits (ex-ante, 50 b.p.)
  - implemented by increasing markdown, i.e. by decreasing  $\varepsilon_d$
- All independent of policy

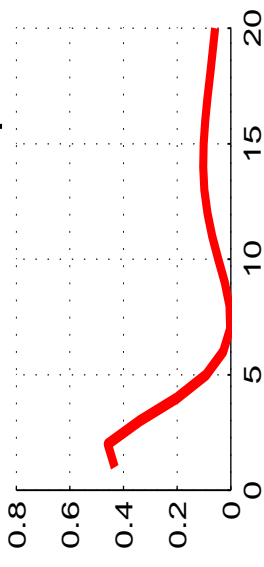
Int. rate: firm loans



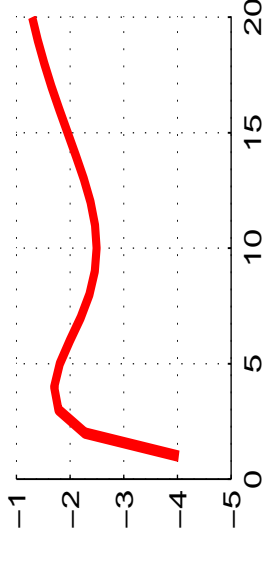
Int. rate: household loans



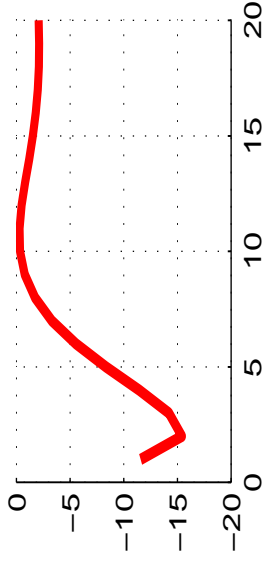
Interest rate: deposits



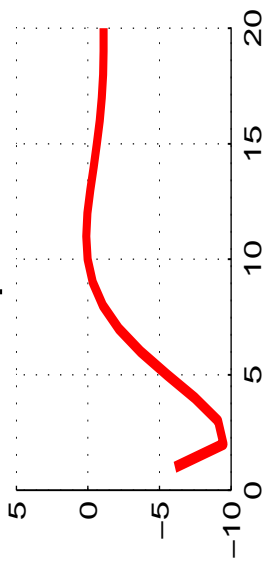
Loans to firms



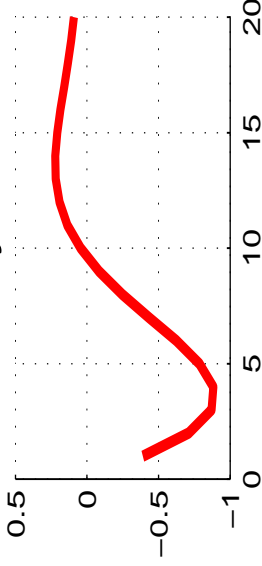
Loans to households



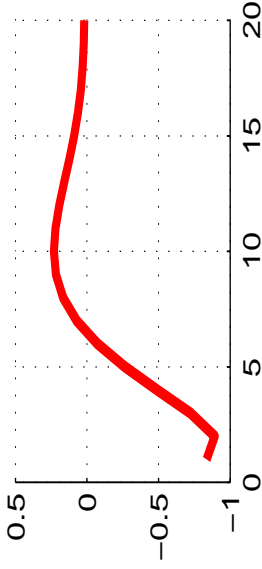
Deposits



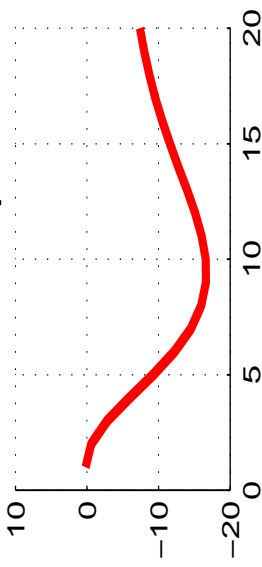
Policy rate



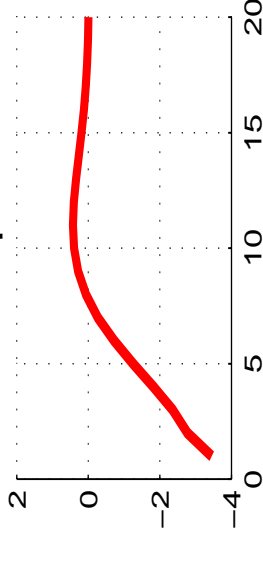
Inflation



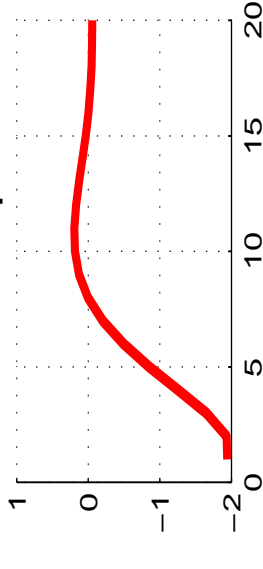
Bank capital



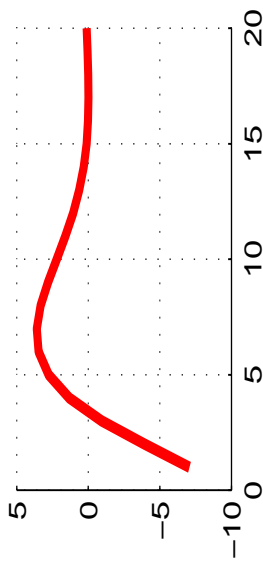
Output



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.

