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Credit and Banking in a DSGE Model

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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. …

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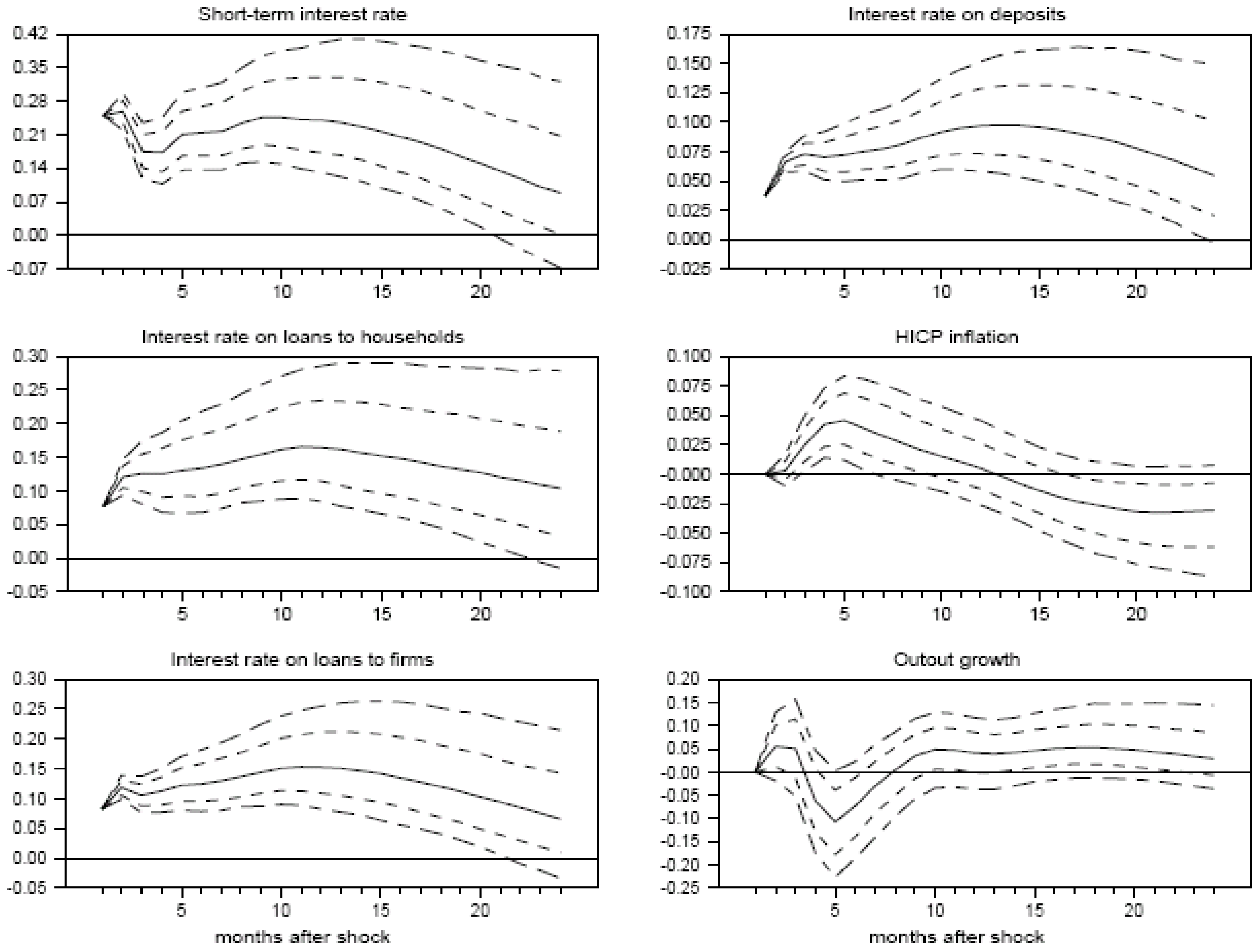
Short-term interest rate
Interest rate on deposits
Interest rate on loans to households
HICP inflation
Interest rate on loans to firms
Outout growth
months after shock
months after shock

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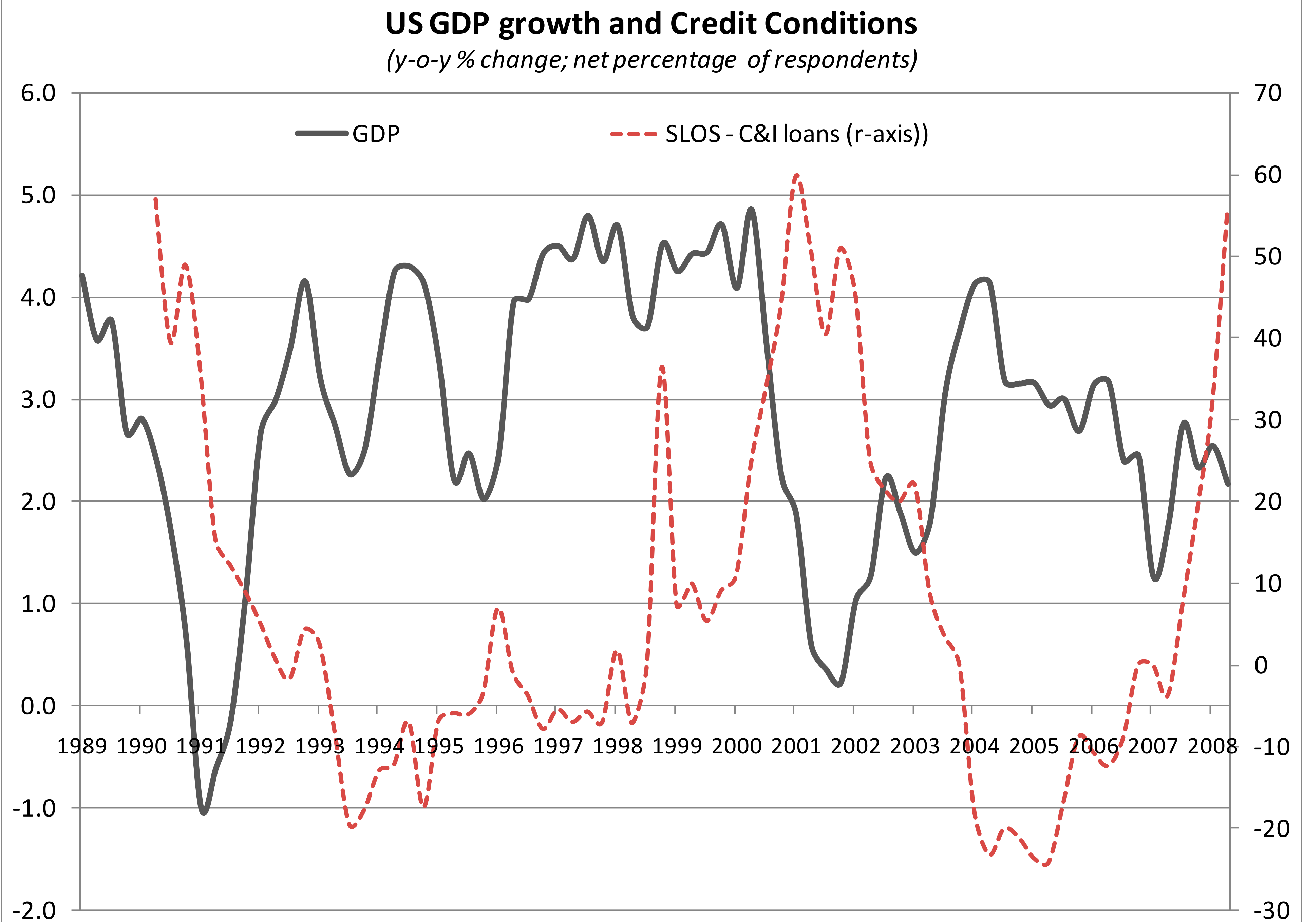

Source: Federal Reserve

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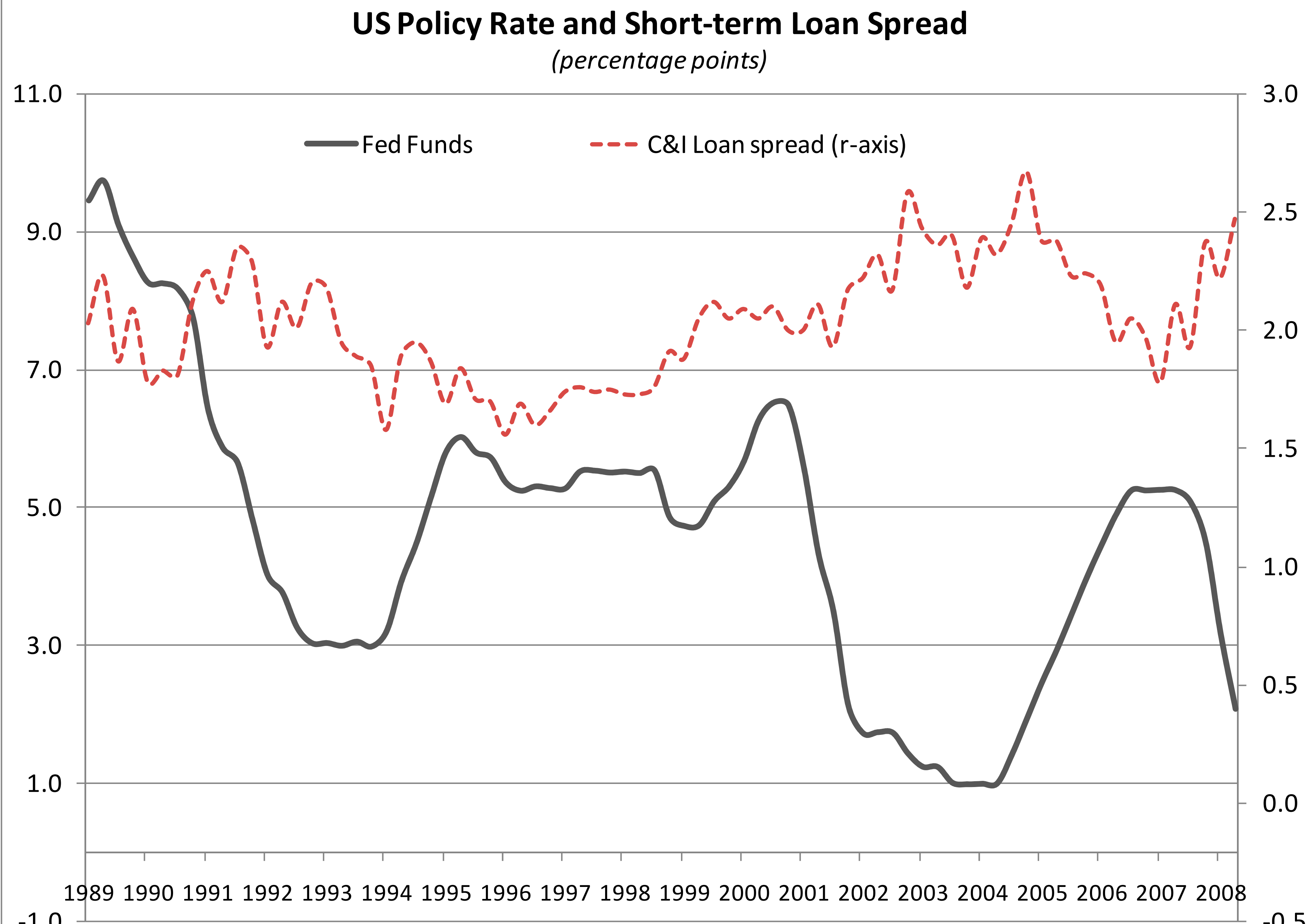

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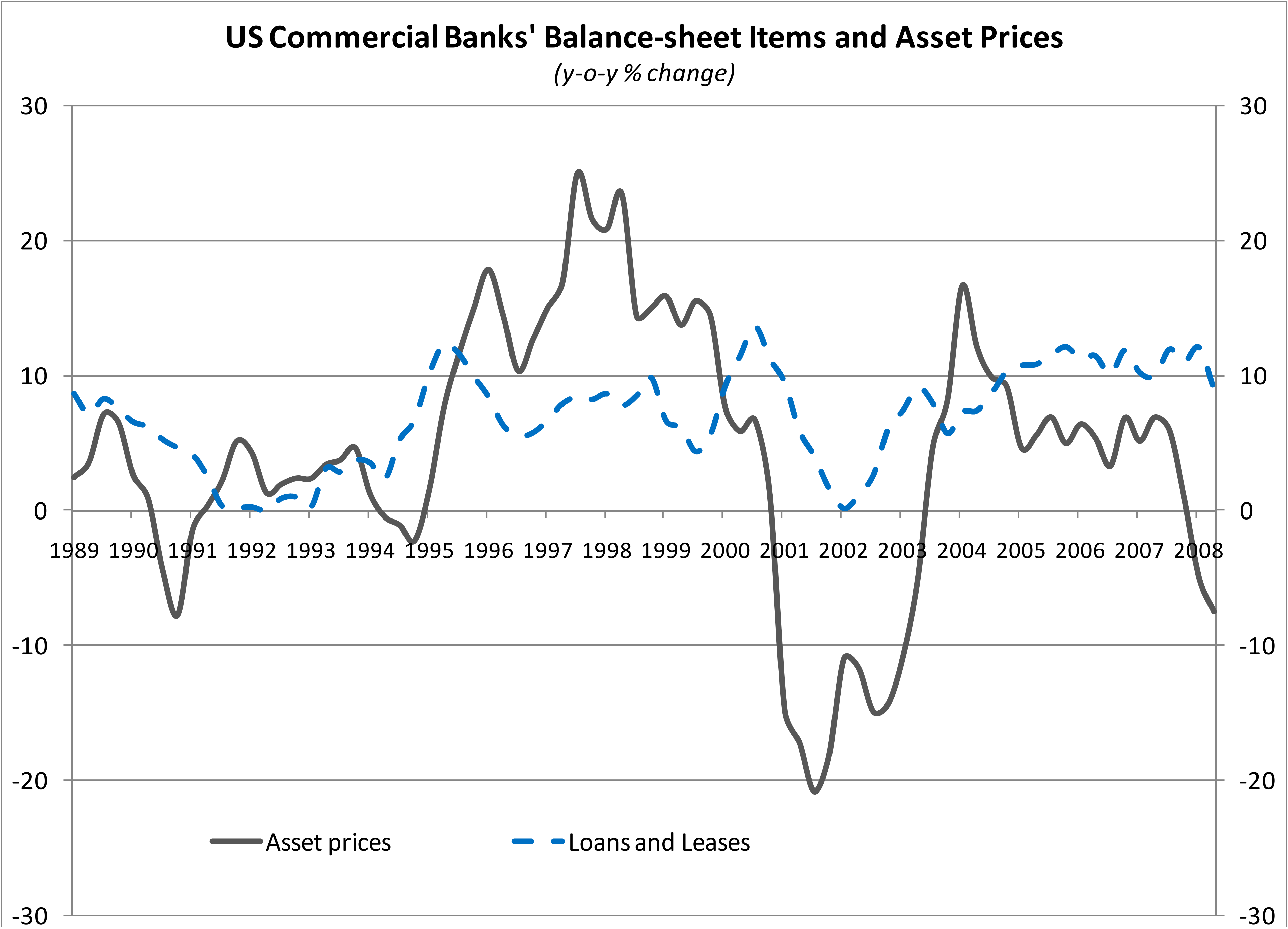

Source: Federal Reserve and BIS

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

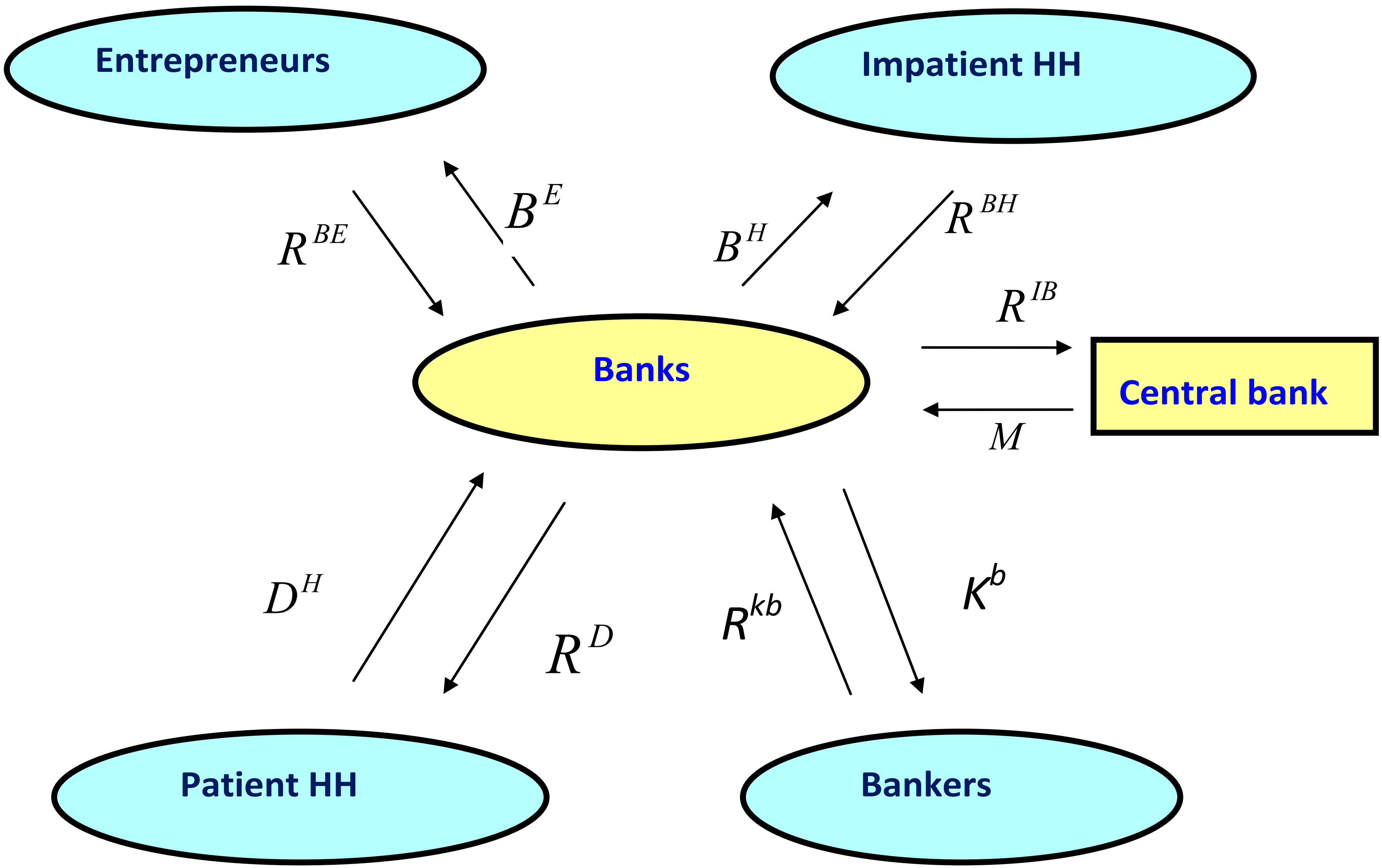
1. Financial frictions and heterogeneous agents, to generate credit flows in the first place
   (Kyotaki and Moore, 1998; Iacoviello, 2005)

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

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

$T = \{Patient, Impatient\}$

- 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:

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

Entrepreneurs

- Consume, choose labor, K and utilization rate

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

s.t.

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

and a borrowing constraint, tied to the value of capital

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

Banks

- Obtain funding from
  - HH deposits (D)
  - Central Bank or Interbank market (M)

- Issue loans to HHs and Entrepreneurs
  - Production function for loans

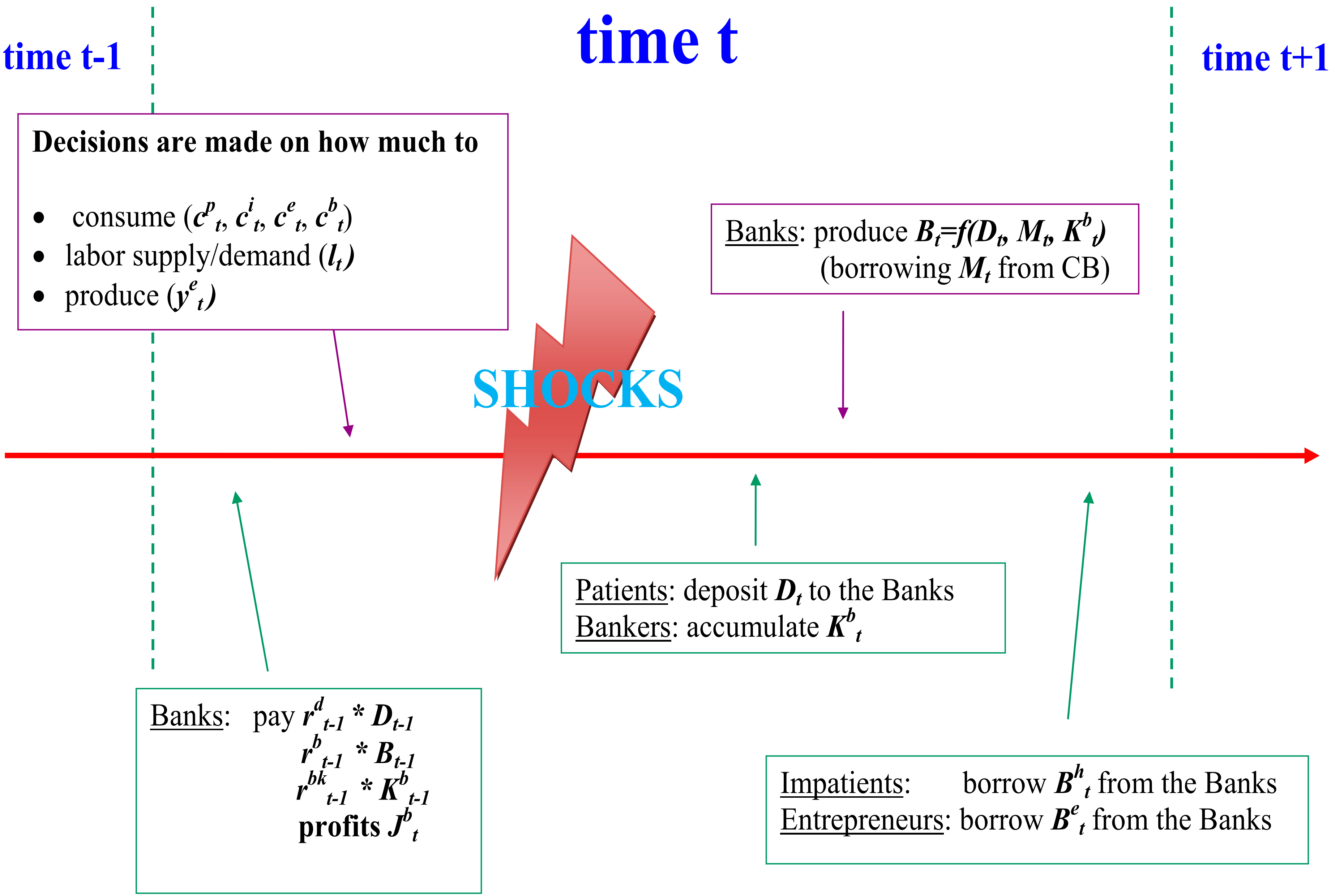
$$B_t = f(D_t + M_t)$$

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-1
time t
time t+1
Decisions are made on how much to
• consume (c^p_t, c^i_t, c^e_t, c^b_t)
• labor supply/demand (l_t)
• produce (y^e_t)
SHOCKS
Banks: produce $B_t=f(D_t, M_t, K^b_t)$
(borrowing M_t from CB)
Patients: deposit D_t to the Banks
Bankers: accumulate K^b_t
Banks: pay $r^d_{t-1} * D_{t-1}$
$r^b_{t-1} * B_{t-1}$
$r^{bk}_{t-1} * K^b_{t-1}$
profits J^b_t
Impatients: borrow B^h_t from the Banks
Entrepreneurs: borrow B^e_t 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

$$\hat{r}_t^D = \frac{\varepsilon}{\varepsilon+1}\hat{r}_t^{IB}$$

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

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

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

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

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

$$\widehat{MC}_t^{bank} = \chi^b \widehat{r}_t^{kb} + (1-\chi^b)\widehat{r}_t^{IB}$$

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 qrts.)
		κ_e (R^{BE} stickiness)	5	(2 qrts.)
		χ^b (loan inputs el.)	0.09	($K^b/B = 8\%$)

Applications

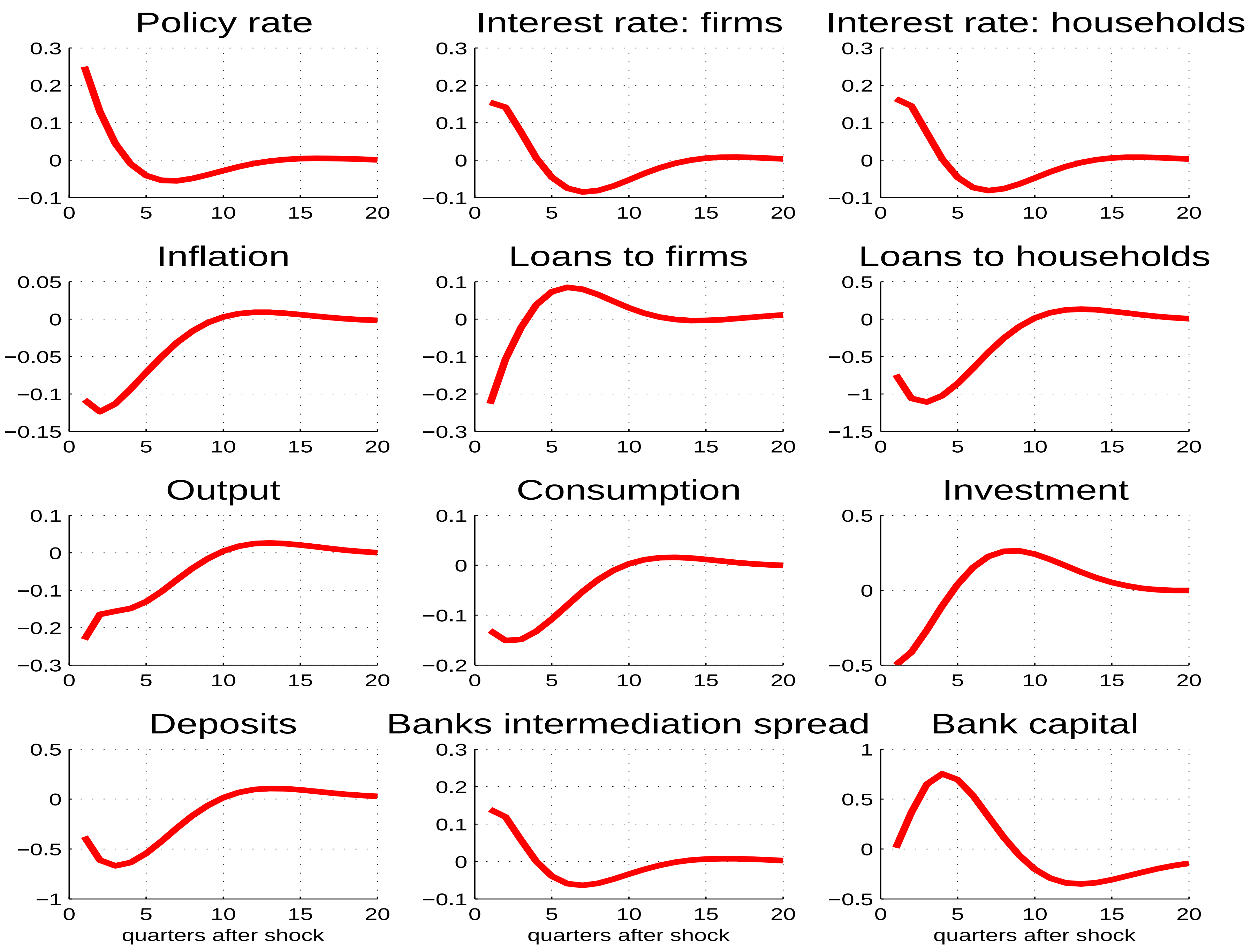
1 Contractionary Monetary Policy Shock

2 Expansionary Technology Shock

3 'Credit-Supply Shock' Scenario:

* a tightening of collateral requirements <u>and</u>
* 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?

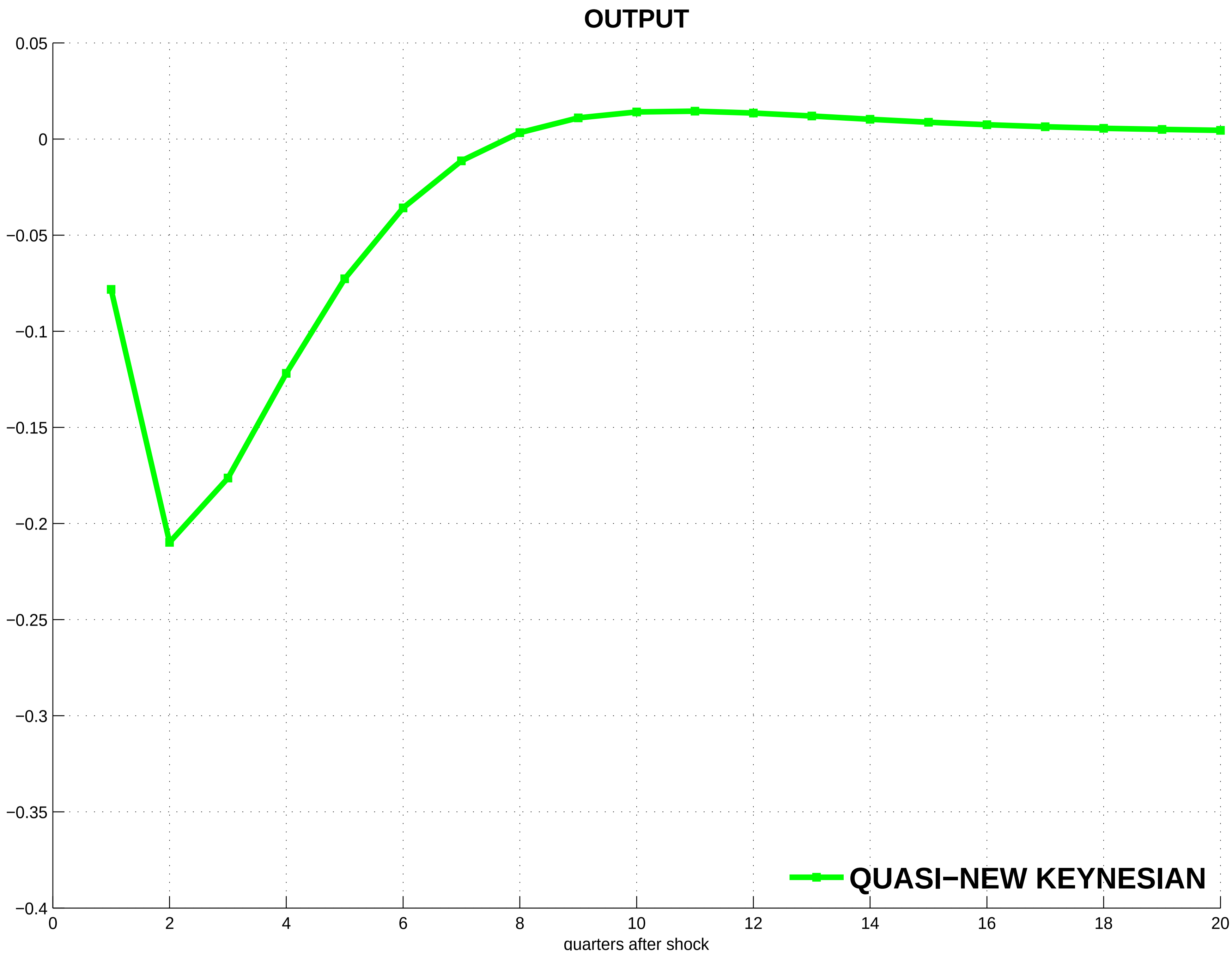
We **isolate effects** by **sequentially** **removing** **the corresponding feature** from our **Benchmark** (**BK: sticky bank rates & bank capital**), i.e. we **remove**:

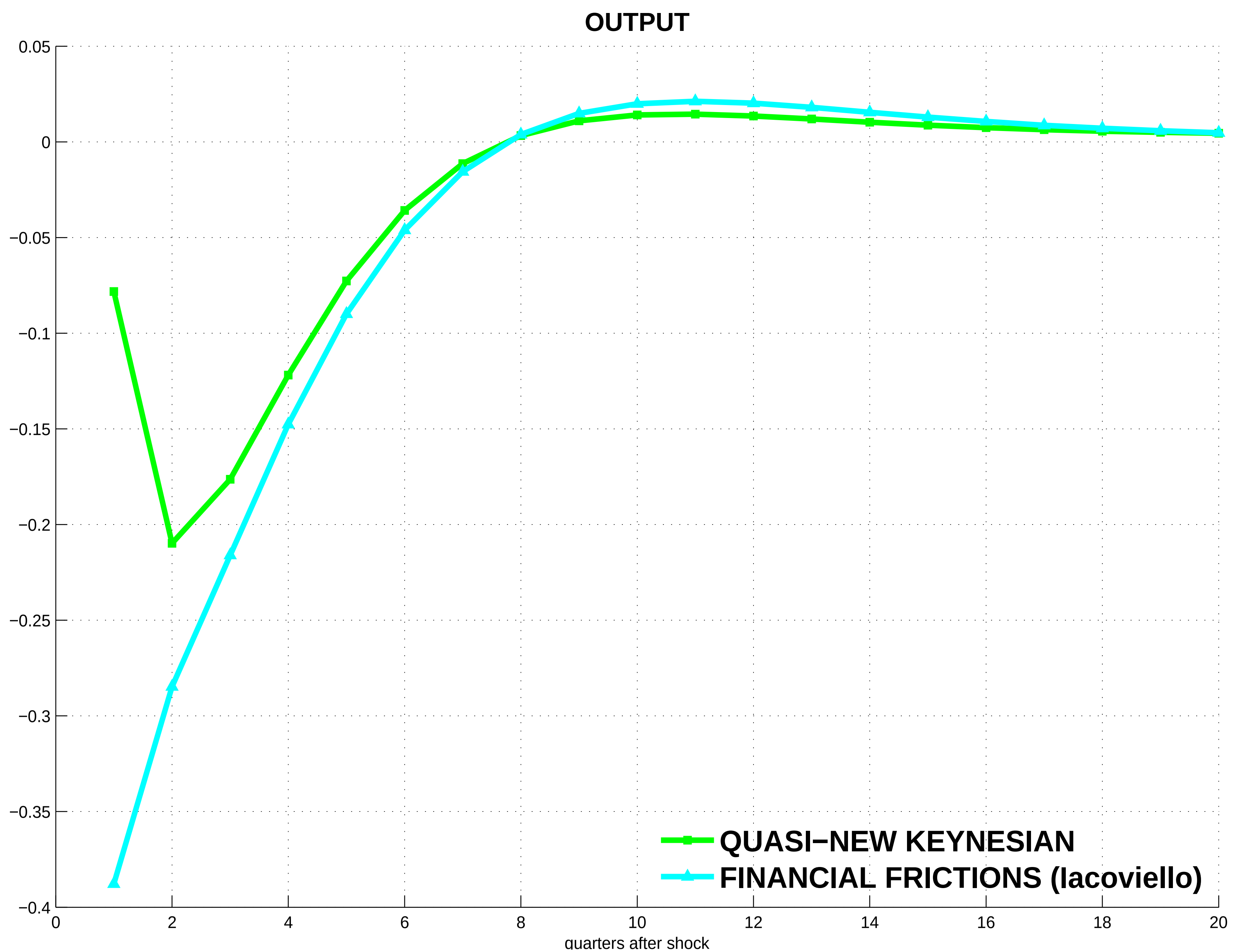
4 **Bank capital** and get a model with banks with market power (where $mc_t^b = R_t^{IB}$) and sticky rates (**noBK**)

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)


OUTPUT
0.05
0
−0.05
−0.1
−0.15
−0.2
−0.25
−0.3
−0.35
−0.4
0
2
4
6
8
10
12
14
16
18
20
quarters after shock
QUASI−NEW KEYNESIAN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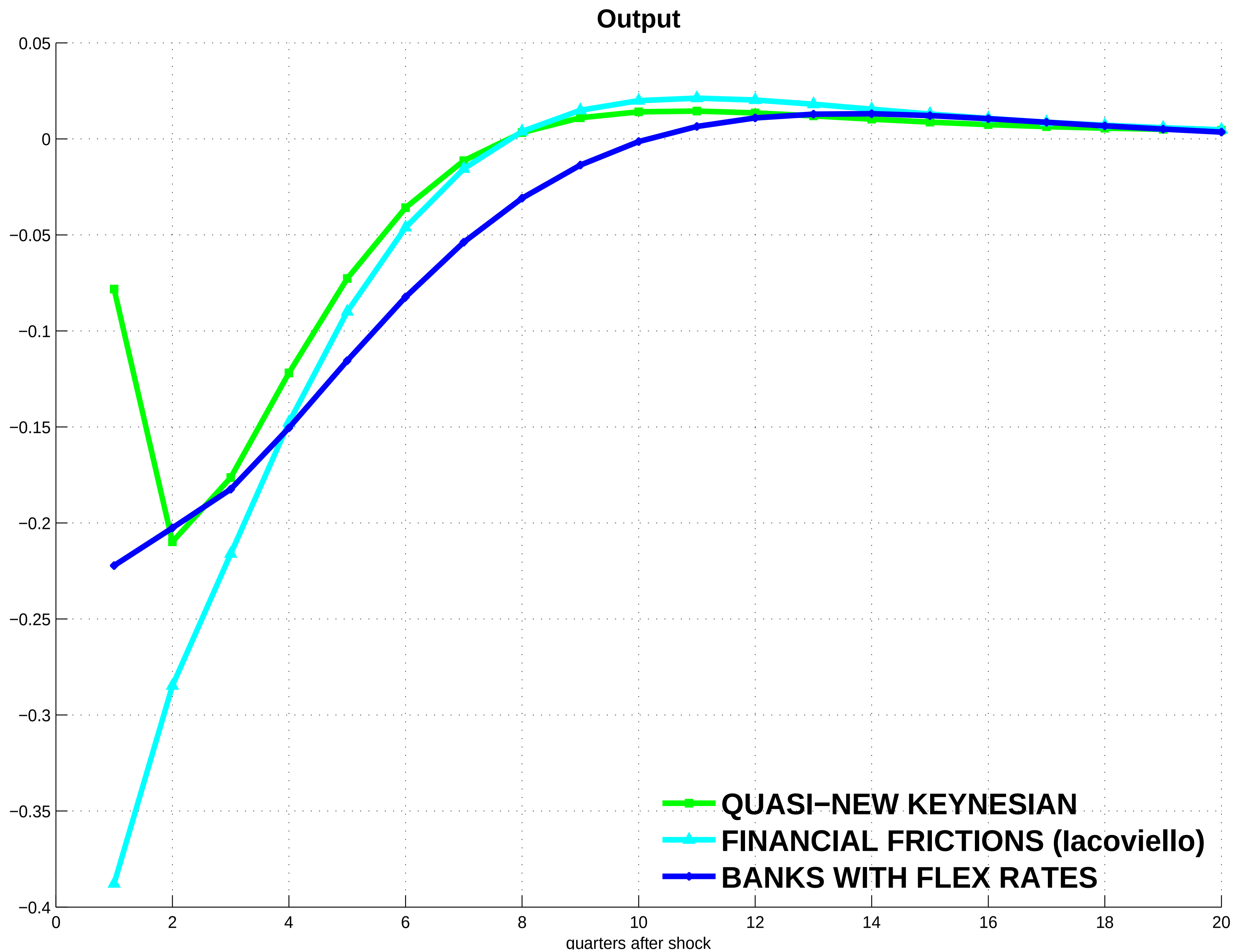
quarters after shock
QUASI−NEW KEYNESIAN
FINANCIAL FRICTIONS (Iacoviello)



Output
0.05
0
−0.05
−0.1
−0.15
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0
2
4
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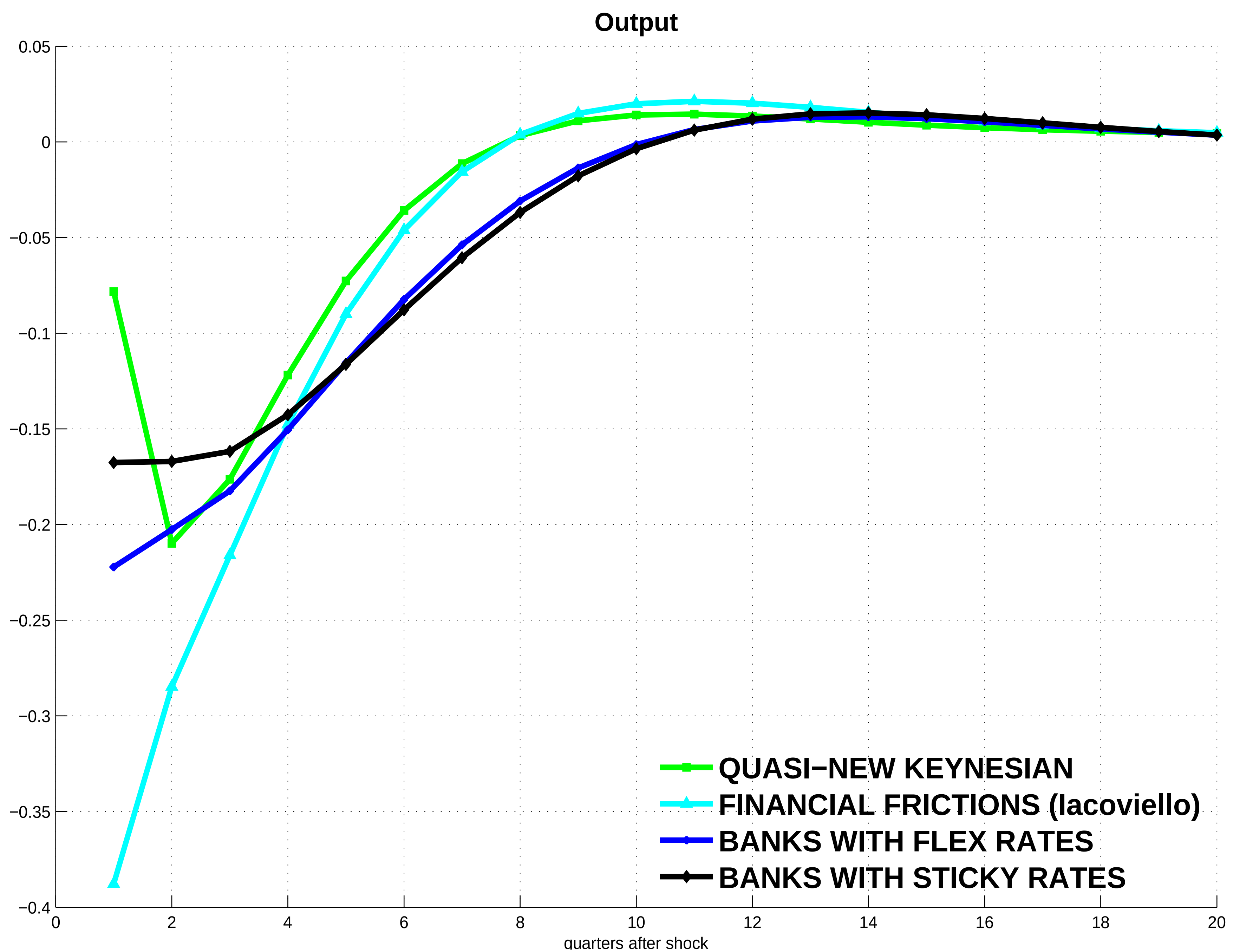
14
16
18
20
quarters after shock
QUASI−NEW KEYNESIAN
FINANCIAL FRICTIONS (Iacoviello)
BANKS WITH FLEX RATES


Output
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quarters after shock
QUASI−NEW KEYNESIAN
FINANCIAL FRICTIONS (Iacoviello)
BANKS WITH FLEX RATES
BANKS WITH STICKY RATES

A "Banking Attenuator Effect"

Following a contractionary MP shock,

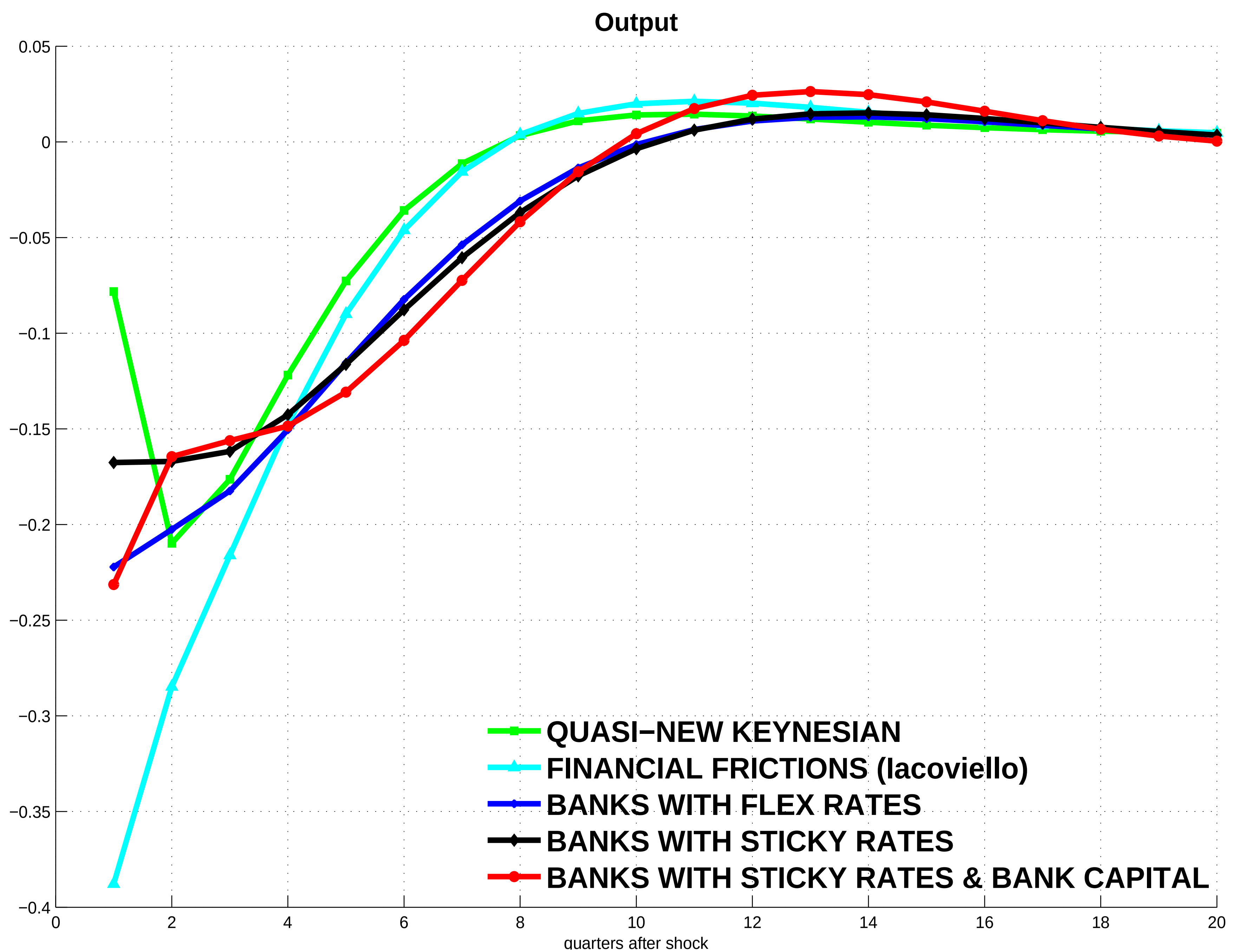
without banks

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

with banks

$$B_t \leq mE_t \left[\frac{Q^h_{t+1} h_t}{R^B_t \uparrow} \right]$$

Rate-setting and stickiness attenuate the effects of MP shocks


Output
0.05
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−0.05
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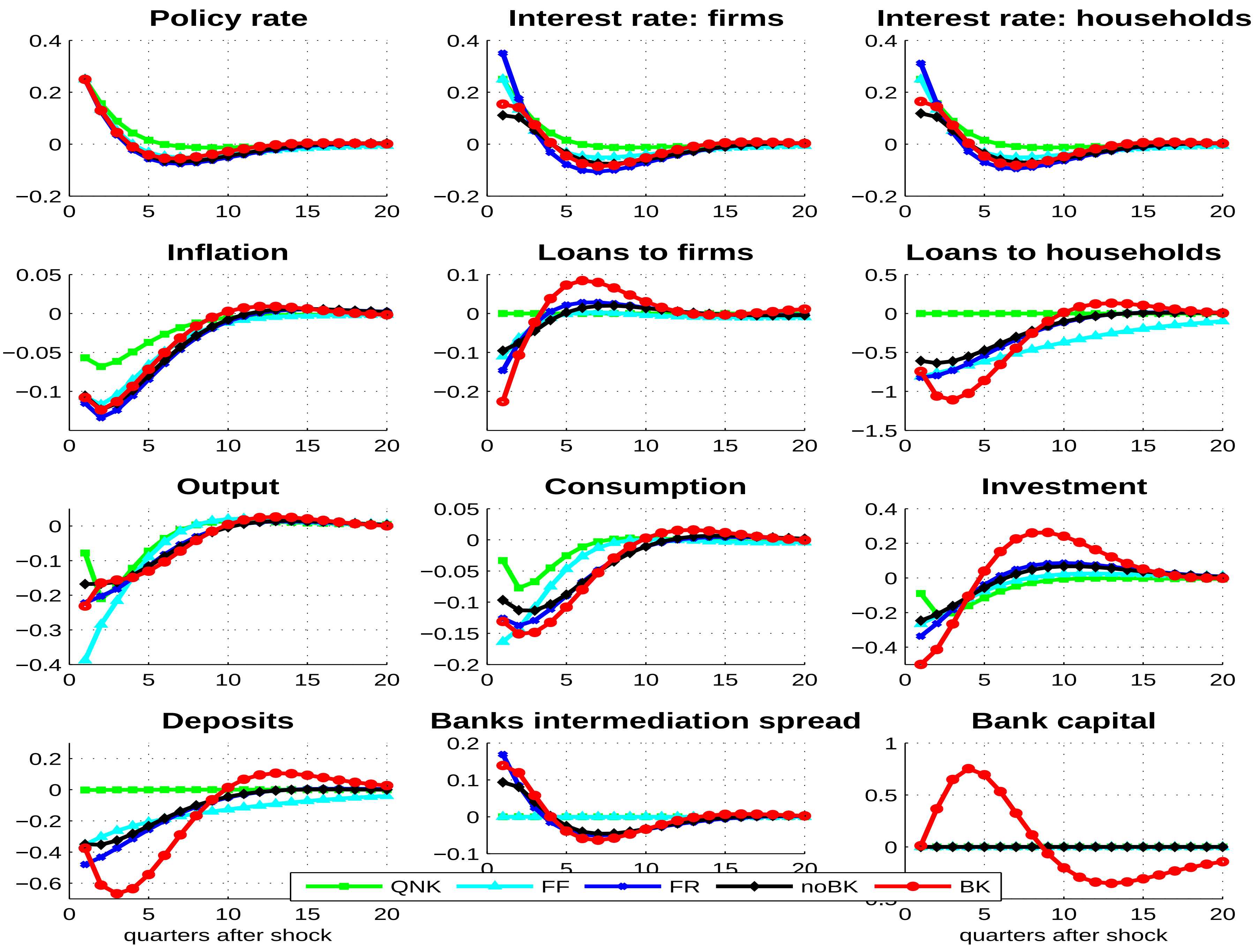
quarters after shock
QUASI−NEW KEYNESIAN
FINANCIAL FRICTIONS (Iacoviello)
BANKS WITH FLEX RATES
BANKS WITH STICKY RATES
BANKS WITH STICKY RATES & BANK CAPITAL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Interest rate: households
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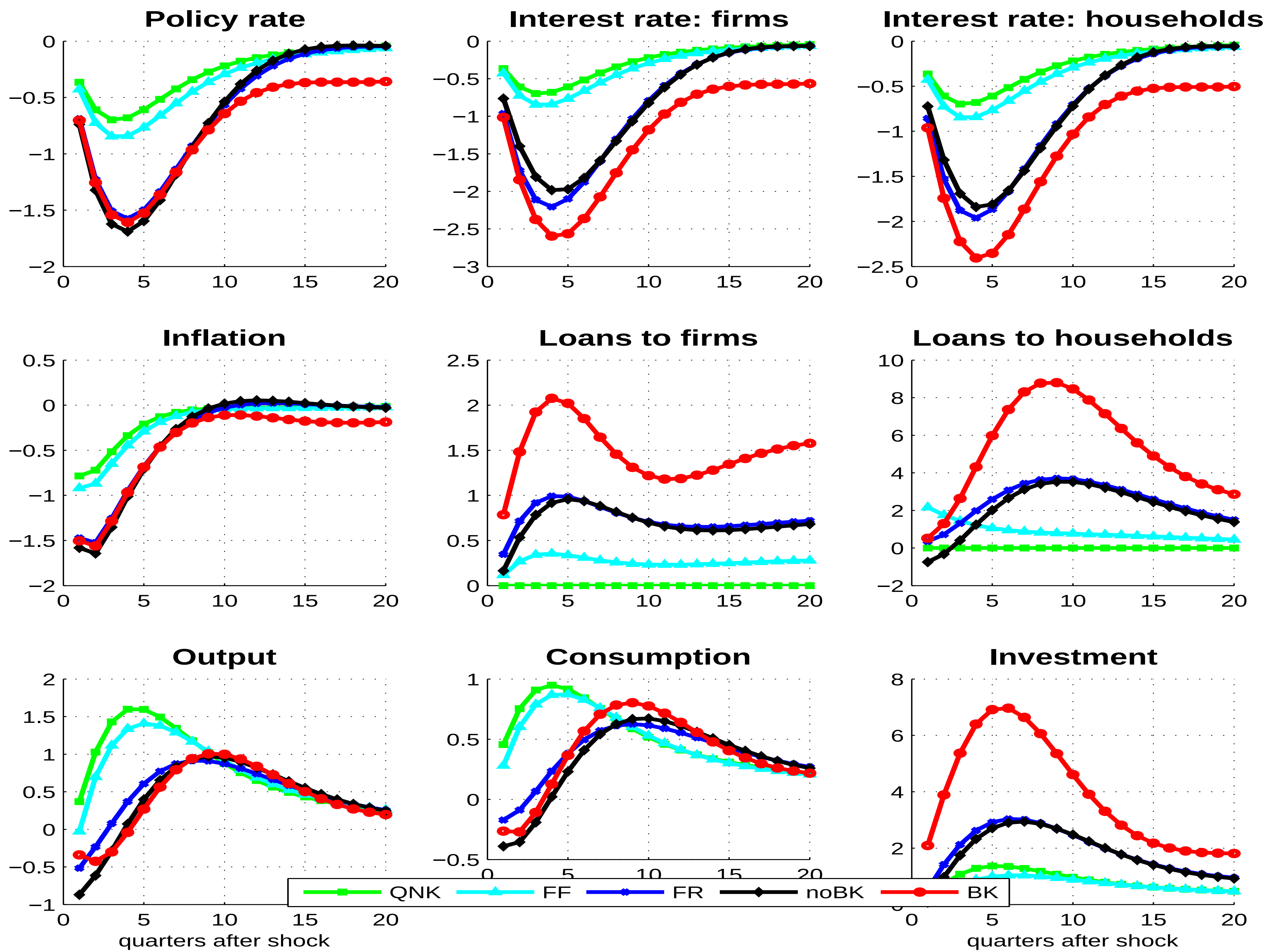
Loans to firms
Loans to households
Output
Consumption
Investment
Deposits
Banks intermediation spread
Bank capital
quarters after shock
quarters after shock
QNK
FF
FR
noBK
BK

Expansionary Technological Shock

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


Policy rate
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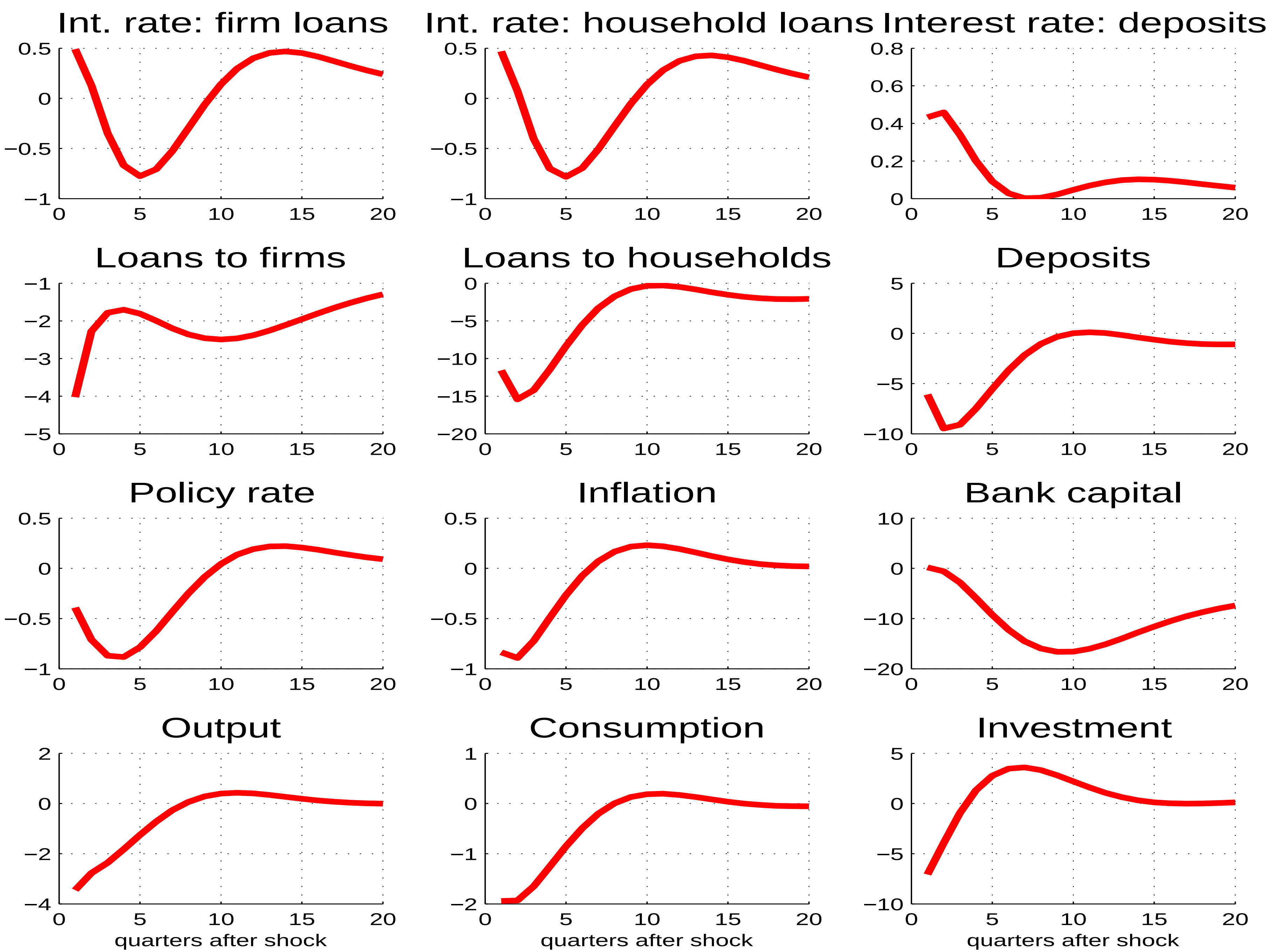
Interest rate: households
Inflation
Loans to firms
Loans to households
Output
Consumption
Investment
quarters after shock
quarters after shock
QNK
FF
FR
noBK
BK

'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
quarters after shock
quarters after shock
quarters after shock

CONCLUSIONS

- **Demand shocks (MP)**
  - **Stabilizing** role of **credit market power** and **rate stickiness** (*attenuator effect*).
  - **Amplifying** role of **bank capital** (*accelerator effect*).
  - **Short-lived**

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  - With **banks**, greater **propagation** and **persistence**.

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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.