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Introducing financial frictions in DSGE-CH

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Financial Stability – Banking System
Swiss National Bank

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Why should we care?

- Since financial crisis, financial stability considerations take increasing importance in policy discussions at CBs and fiscal authorities

- Questions:
    - Importance of asset prices for monetary policy?
    - Interactions btw monetary and "macroprudential"policy: cooperation or centralization?
    - …
- Need understanding of macro-financial linkages

- **Problem**: the standard macro-model is built around <u>representative agent</u>
    - no borrowing
    - balance-sheets (banks and non-banks) irrelevant: Modigliani-Miller
    - no risk premia and limited effect of asset prices

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New macro models

- Boom in literature introducing active role for banks (C^S) in DSGE models:
  Gertler and Karadi, 2009, Gertler and Kiyotacki, 2010, Gerali et al., 2010, ...
    - Focus on asymmetric information between banks and their creditors (HH)
    - Bank capital mitigates asym. info. problem and risk premia

- **SNB** project (2010 ...) combines financial frictions btw banks and their creditors (C^S) with model of financial frictions btw banks and entrepreneurs (C^D à la BGG 1999) in a DSGE model of the Swiss economy

New Swiss model should serve to analyze:
  a. Interactions macro-banking sector (trans. shocks): quarterly monetary analysis
  b. Asset prices boom-bust and business cycle
  c. Macroprudential policies: mitigate leverage and cycles
  d. Interaction of monetary policy with macroprudential policies
  e. Effectiveness of unconventional monetary policy: counterfactual

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Outline

1. Benchmark DSGE-CH: performance and shortcomings

2. Introducing financial intermediation (C^D): DSGE-CH II

   a. Structure

   b. How fin. frictions affect standard shock transmission ?

   c. What is the effect of financial shocks ?

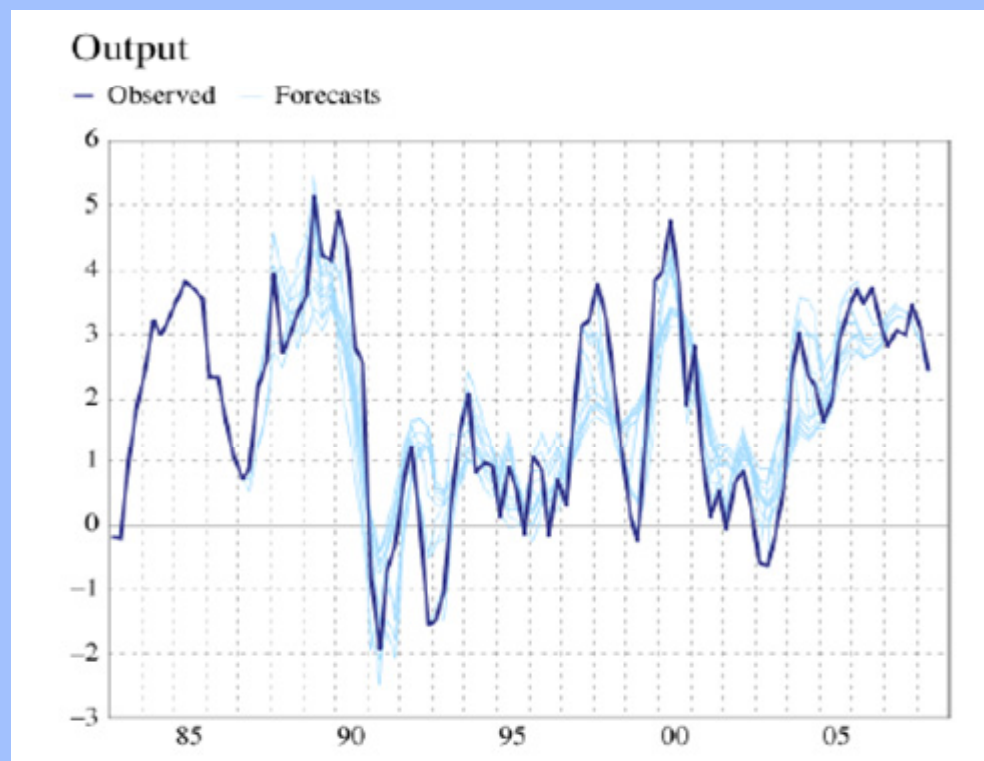3. Work in progress DSGE-CH III: introducing an active banking sector

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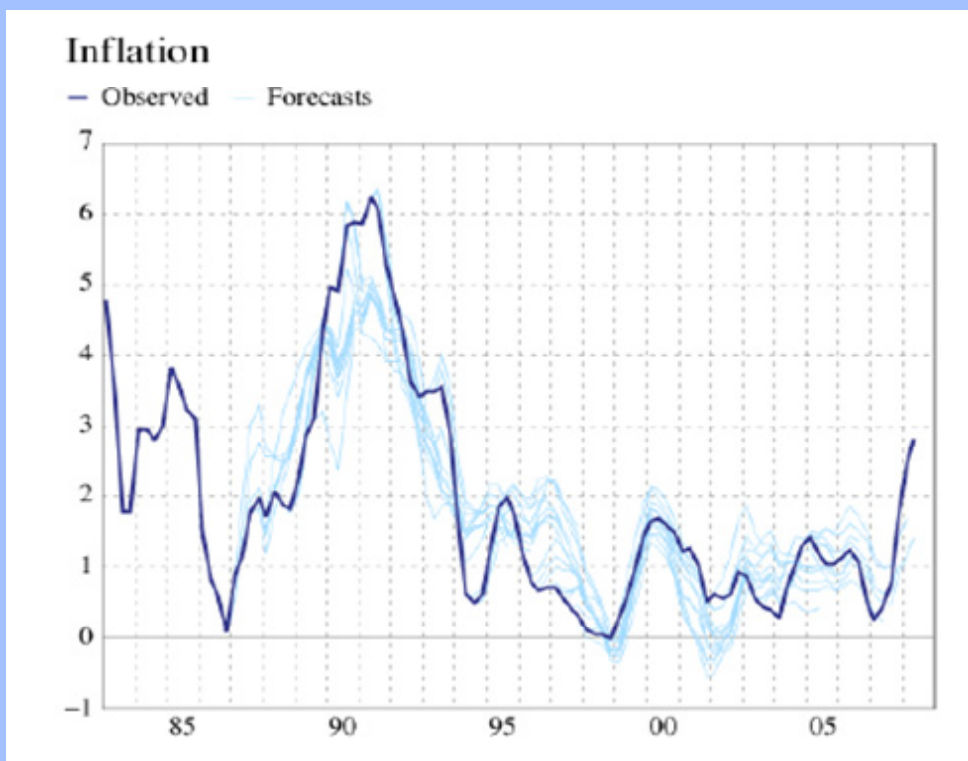BANCA NAZIUNALA SVIZRA
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1.   Benchmark DSGE-CH (2007)

- Medium-sized (60 eq.) SOE-DSGE model of the Swiss economy used for:

    1. Forecasting (quarterly) since 2007Q1

    2. Scenario analysis, "what if exchange rate…?"

    3. Optimal policy analysis

        - Fixed vs floating e-rate

        - Inflation vs monetary targeting

        - Optimal monetary policy with oil price shocks

        - Globalization and monetary policy …

  http://www.snb.ch/n/mmr/reference/economic_studies_2009_05/source

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Decent overall (pseudo) forecasting performance …

Forecast conditioned on: y^*, p^*, r^*, p^{oil}
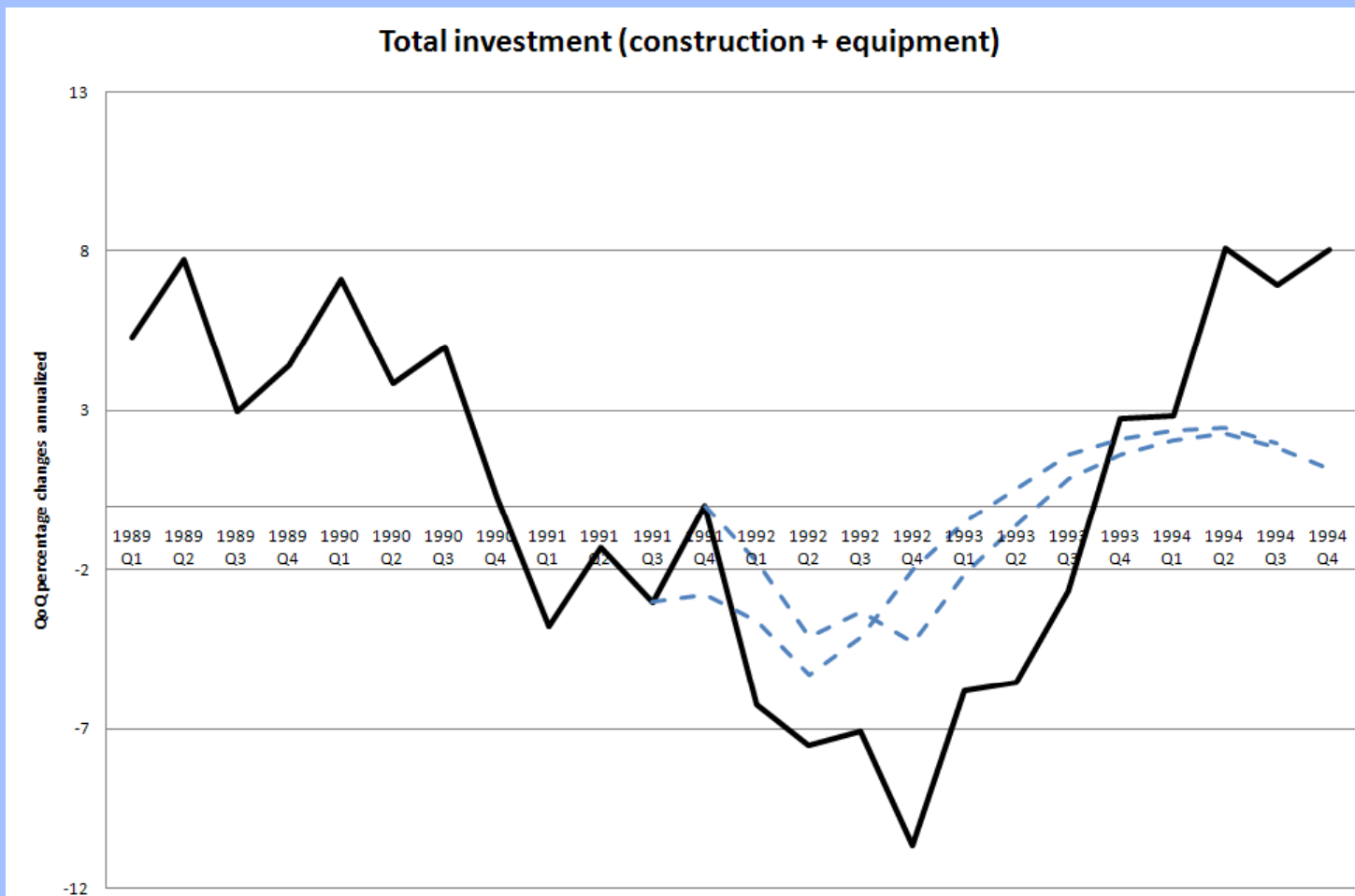
... and surprisingly also during the crisis.

Forecast conditioned on: y^*, p^*, r^*, p^{oil}
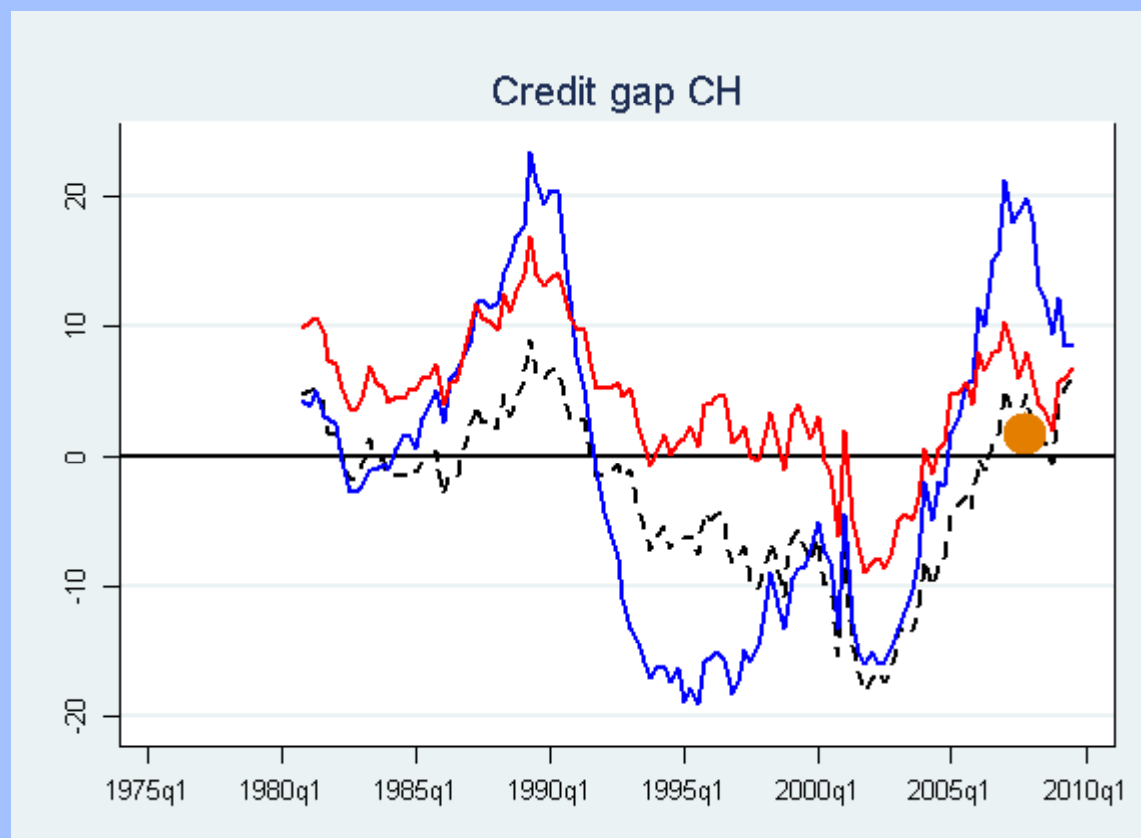
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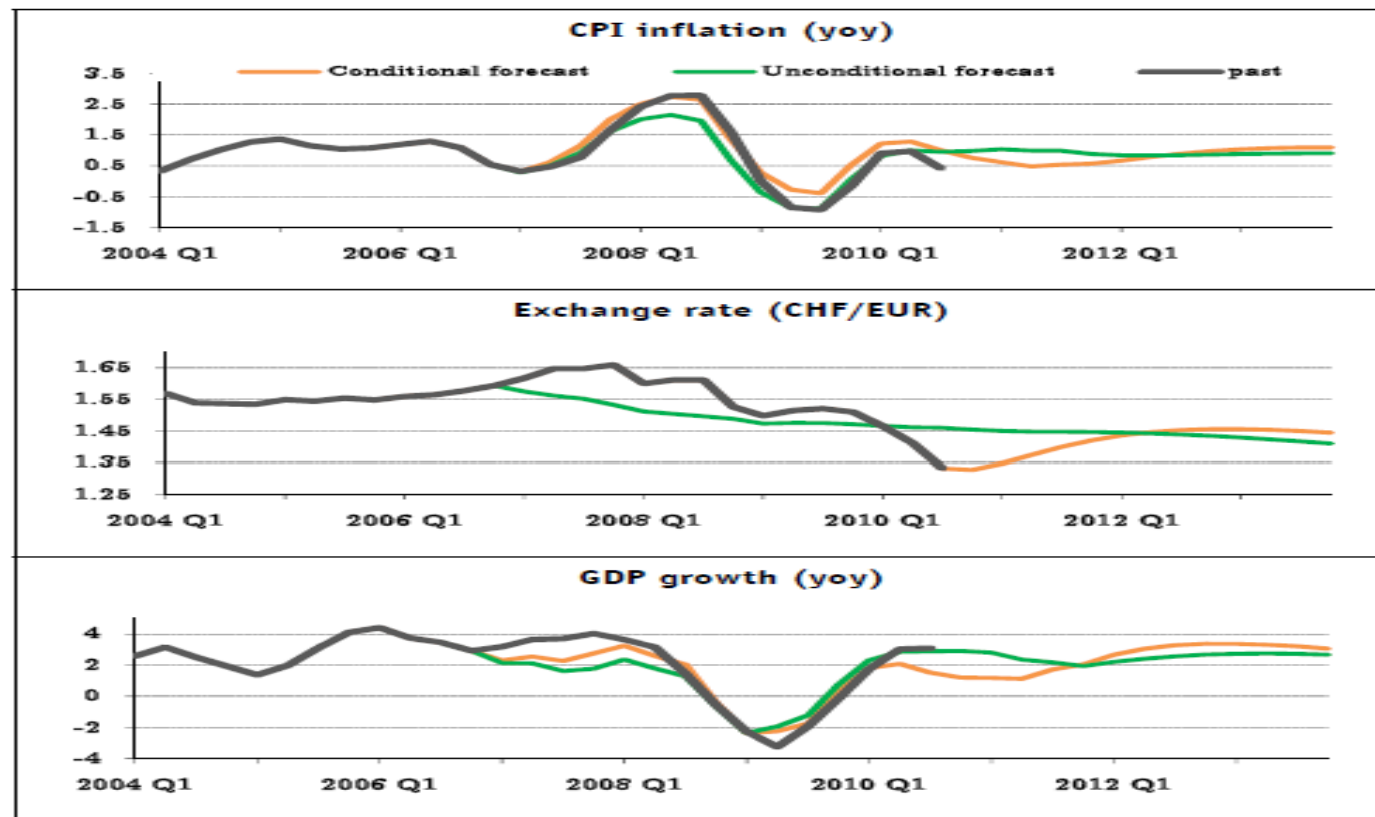
Comparing with housing/banking crisis of 90's

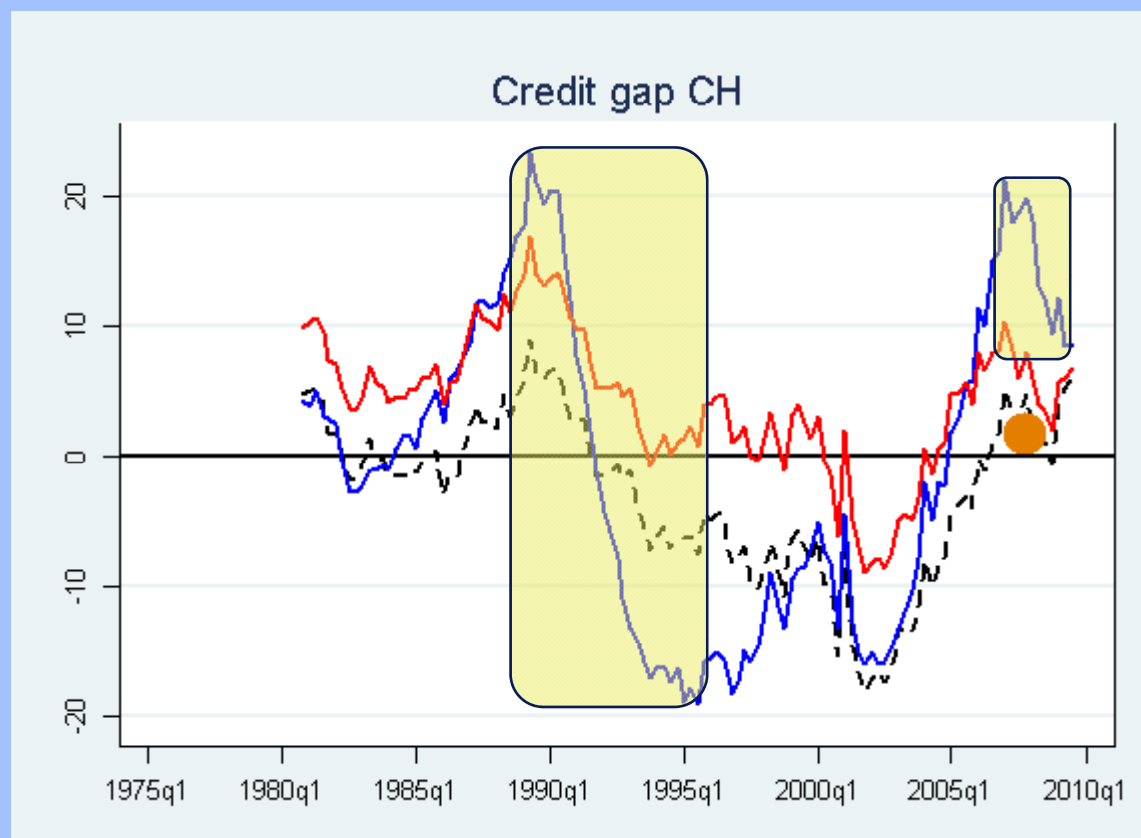Forecast conditioned on: y^*, p^*, r^*, p^{oil}

A puzzle?

Source: M. Drehmann, December 2009

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2009/2010: no severe disintermediation !

Source: M. Drehmann, December 2009

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Good luck? Good policy?

Need a model to run counterfactuals

Financial frictions in DSGE models

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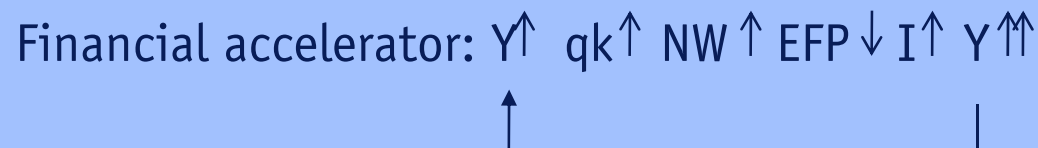# Introducing financial frictions: strategy

- Two stages (away of representative agent)
    1. DSGE-CH II (C^D): asymmetric info problem between banks and entrepreneurs BGG (1999)

    2. DSGE-CH III (C^S): asymmetric info problem between banks and banks' *share*- and *bond*-holders
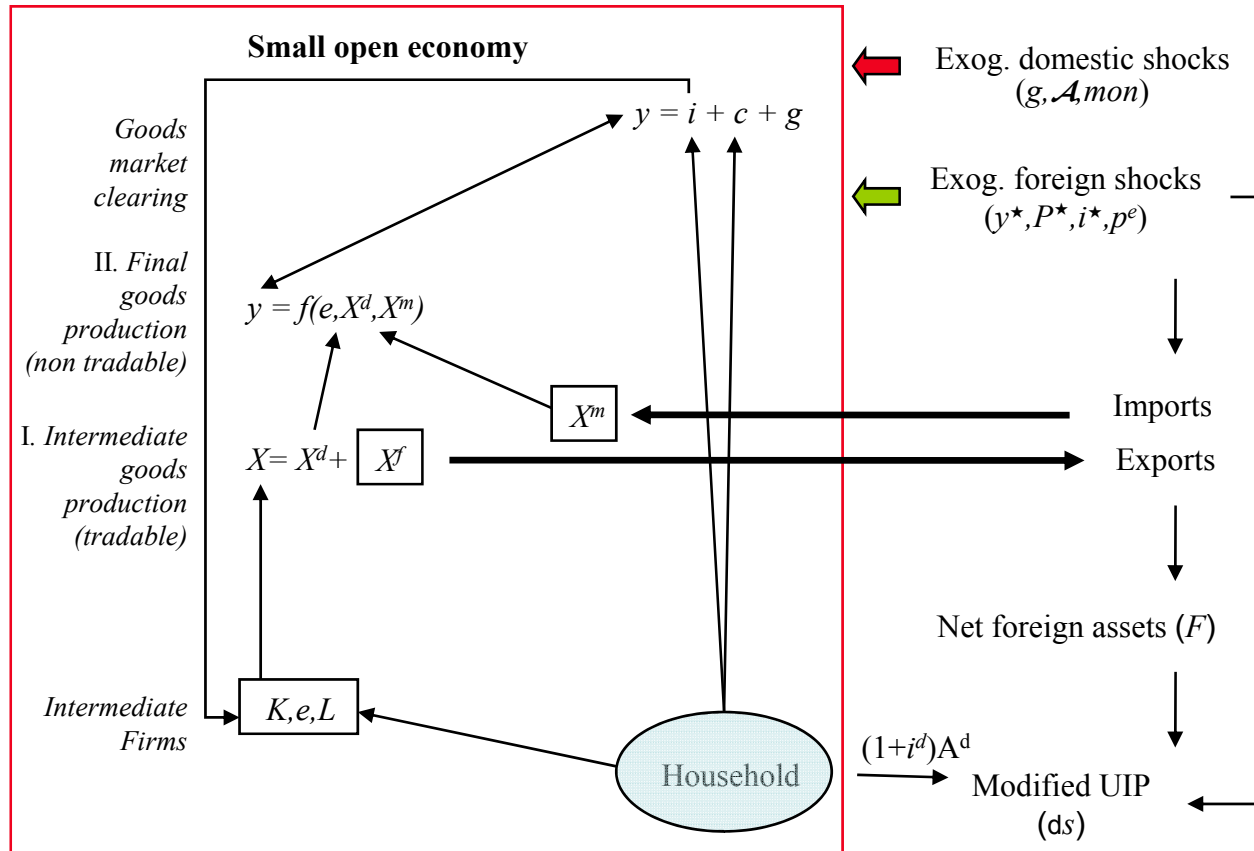
- Strategy: DSGE-CH, DSGE-CH II and III are nested
    1. DSGE-CH: good dynamic properties in normal times

    2. Benefit of additional model features

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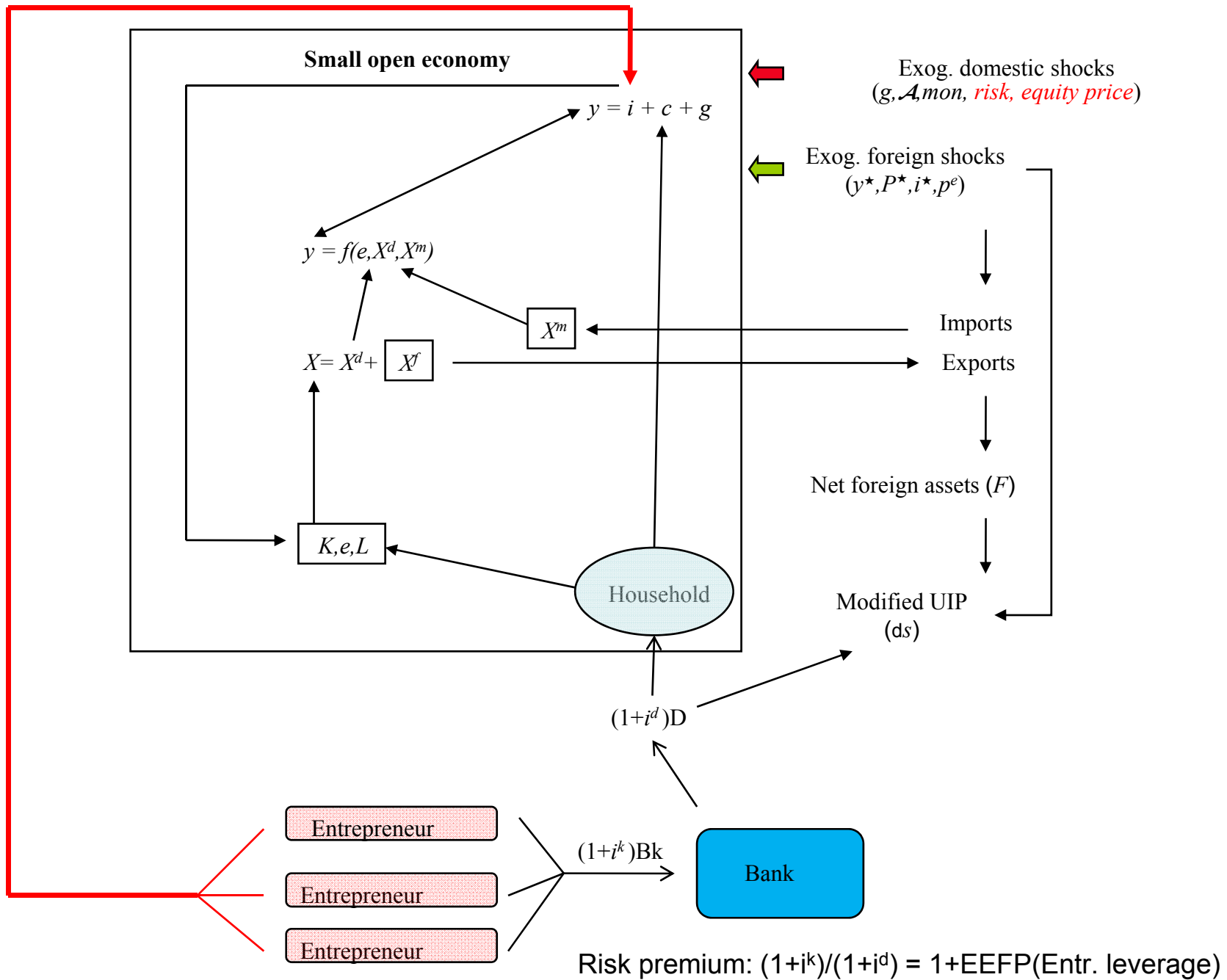BANCA NAZIUNALA SVIZRA
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2.   DSGE-CH II (2010 - ...)

- Moral hazard problem between banks and entrepreneurs (SOE version of BGG, 1999)
    - New agent: entrepreneurs has tendency to underreport profit
    - Moral hazard problem requires costly monitoring financed by premium on loans (EFP)
    - The more "skin in the game" (NW or collateral), the smallest is the default probability and the cheapest is credit

- As in BGG, entrepreneur's net worth (collateral) is key for transmission of shocks $\longrightarrow$ importance of asset prices
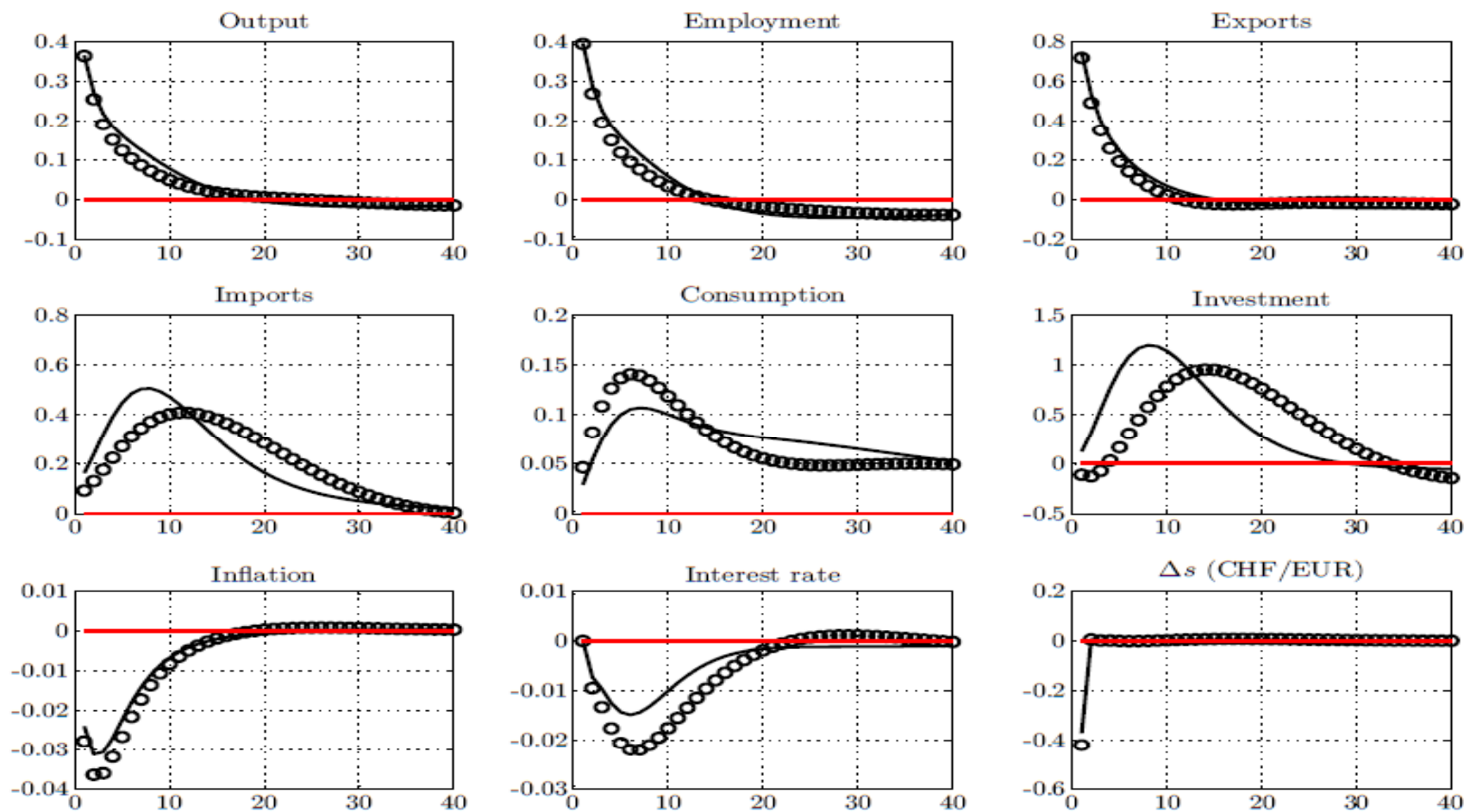
Financial accelerator: Y↑ qk↑ NW↑ EFP↓ I↑ Y⇑

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Small open economy

Exog. domestic shocks
$(g, \mathcal{A}, mon)$

Exog. foreign shocks
$(y^\star, P^\star, i^\star, p^e)$

Goods market clearing

$y = i + c + g$

II. Final goods production (non tradable)

$y = f(e, X^d, X^m)$

X^m

Imports

I. Intermediate goods production (tradable)

$X = X^d + X^f$

Exports

Net foreign assets (F)

Intermediate Firms

K, e, L

Household

$(1 + i^d) A^d$

Modified UIP
(ds)

Small open economy

Exog. domestic shocks
($g, \mathcal{A}, mon, risk, equity\ price$)

Exog. foreign shocks
($y^{\star}, P^{\star}, i^{\star}, p^{e}$)

$y = i + c + g$

$y = f(e, X^{d}, X^{m})$

X^{m}

$X = X^{d} + $ X^{f}

Imports

Exports

K, e, L

Net foreign assets (F)

Household

Modified UIP
(ds)

$(1+i^{d})$D

Entrepreneur

Entrepreneur

Entrepreneur

$(1+i^{k})$Bk

Bank

Risk premium: $(1+i^{k})/(1+i^{d}) = 1+EEFP$(Entr. leverage)

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Transmission of standard shocks

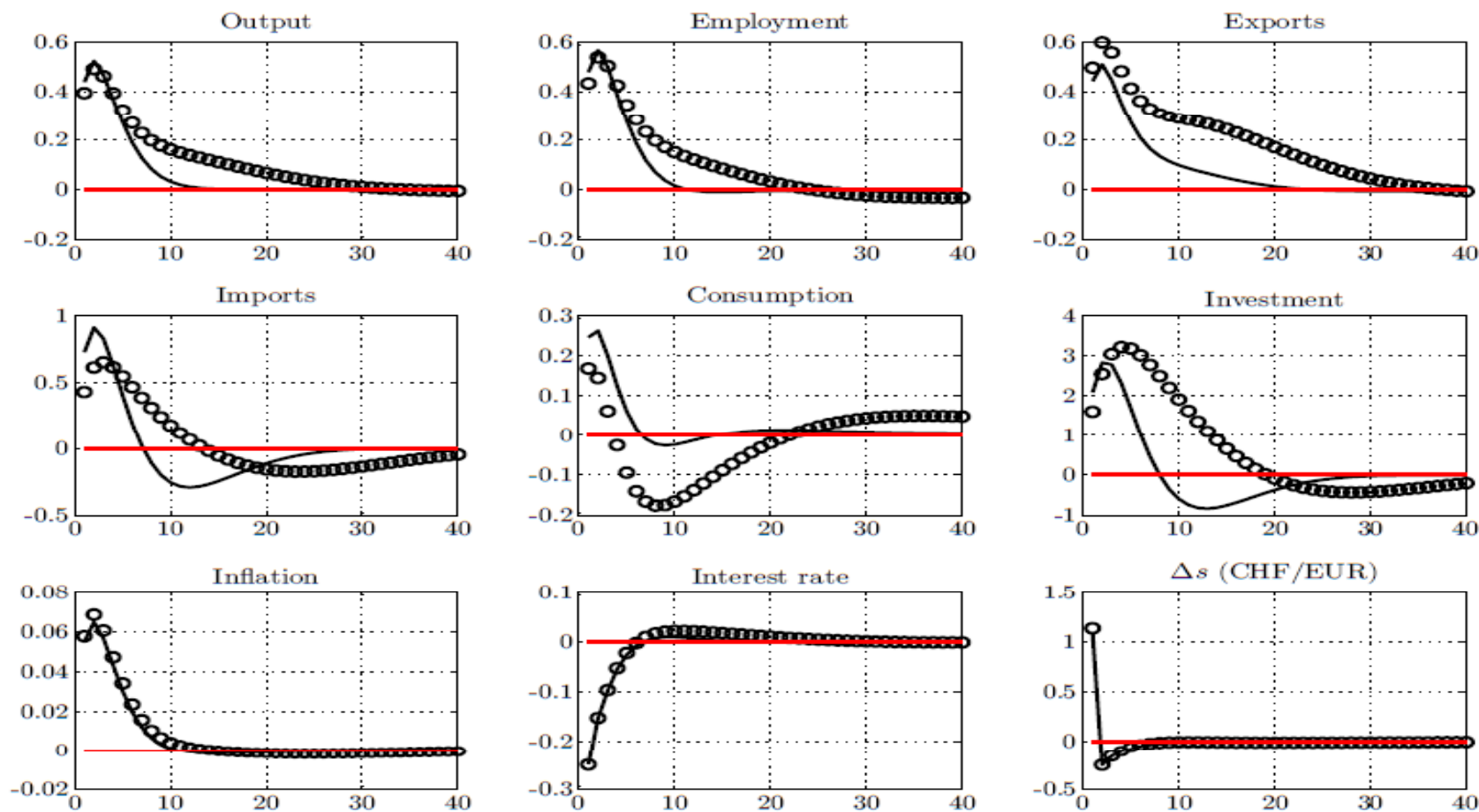Figure 5 IRF to a foreign output shock

Note: The positive shock happens to the foreign demand ($y^\star$).
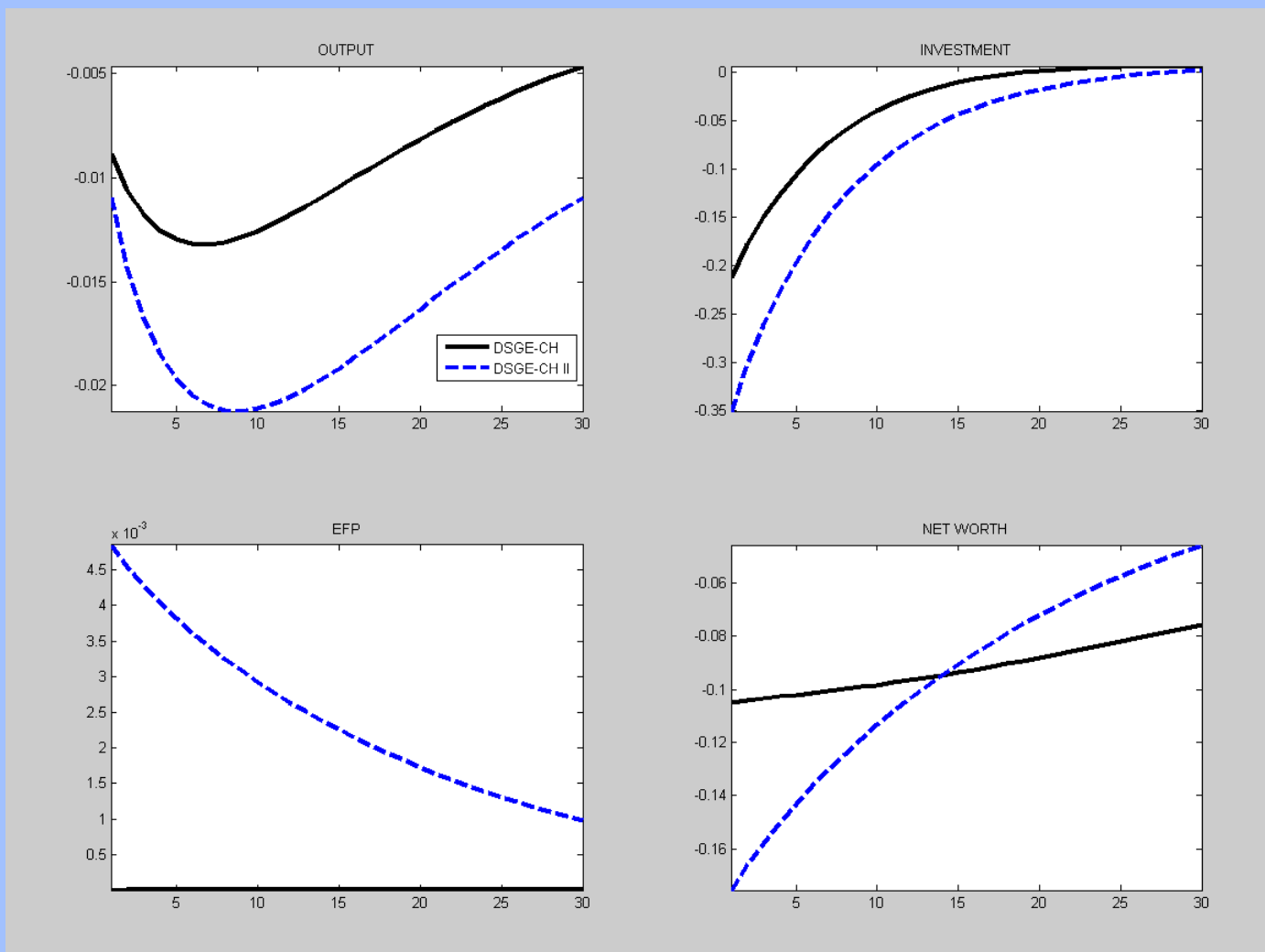
Transmission of standard shocks

Figure 6 – IRF to a monetary policy shock

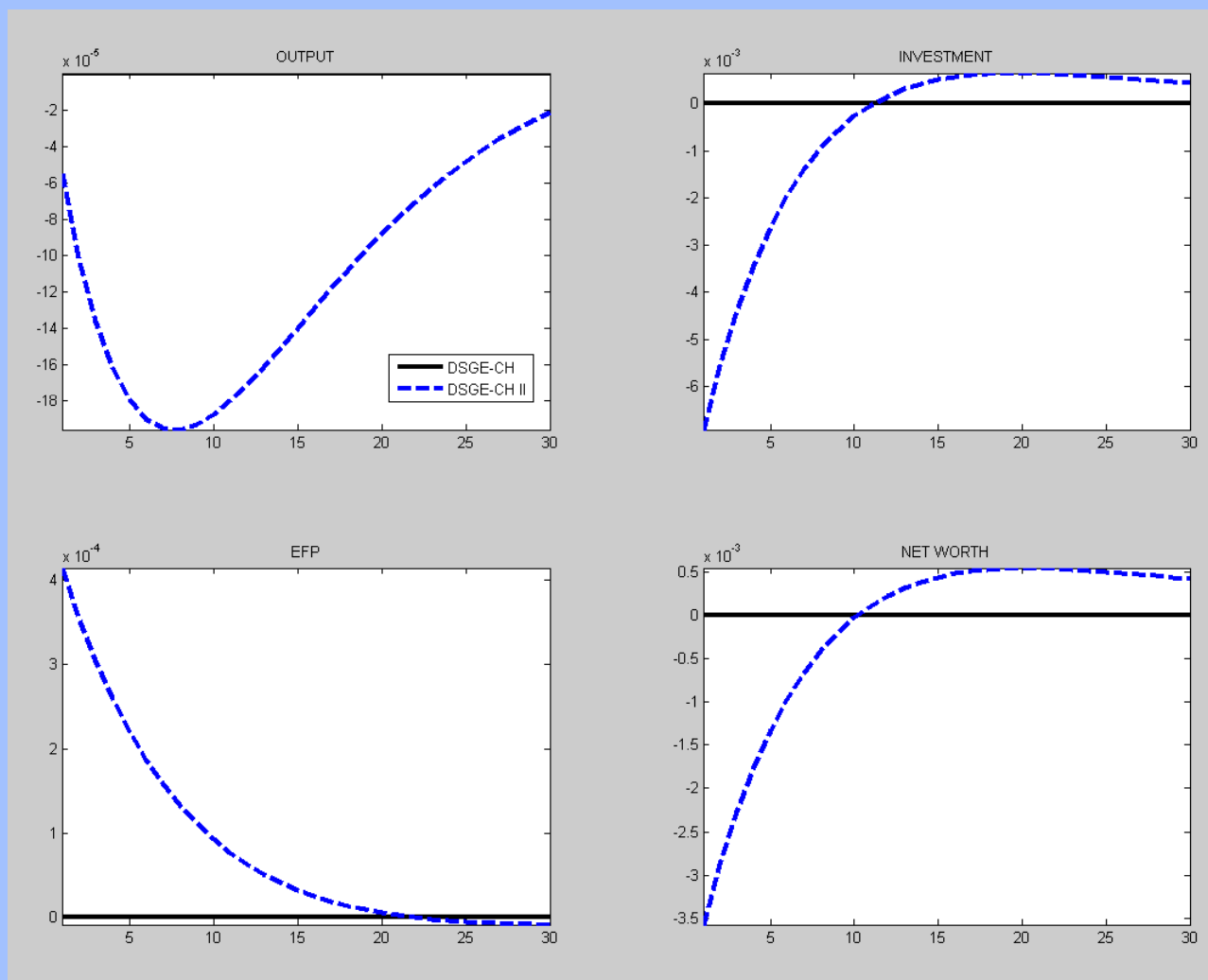*Note*: The positive monetary policy shock happens to the domestic interest rate (*mon*).

Amplification of asset price shocks

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Risk has 1st order effect on activity (Christiano et al. 2010)

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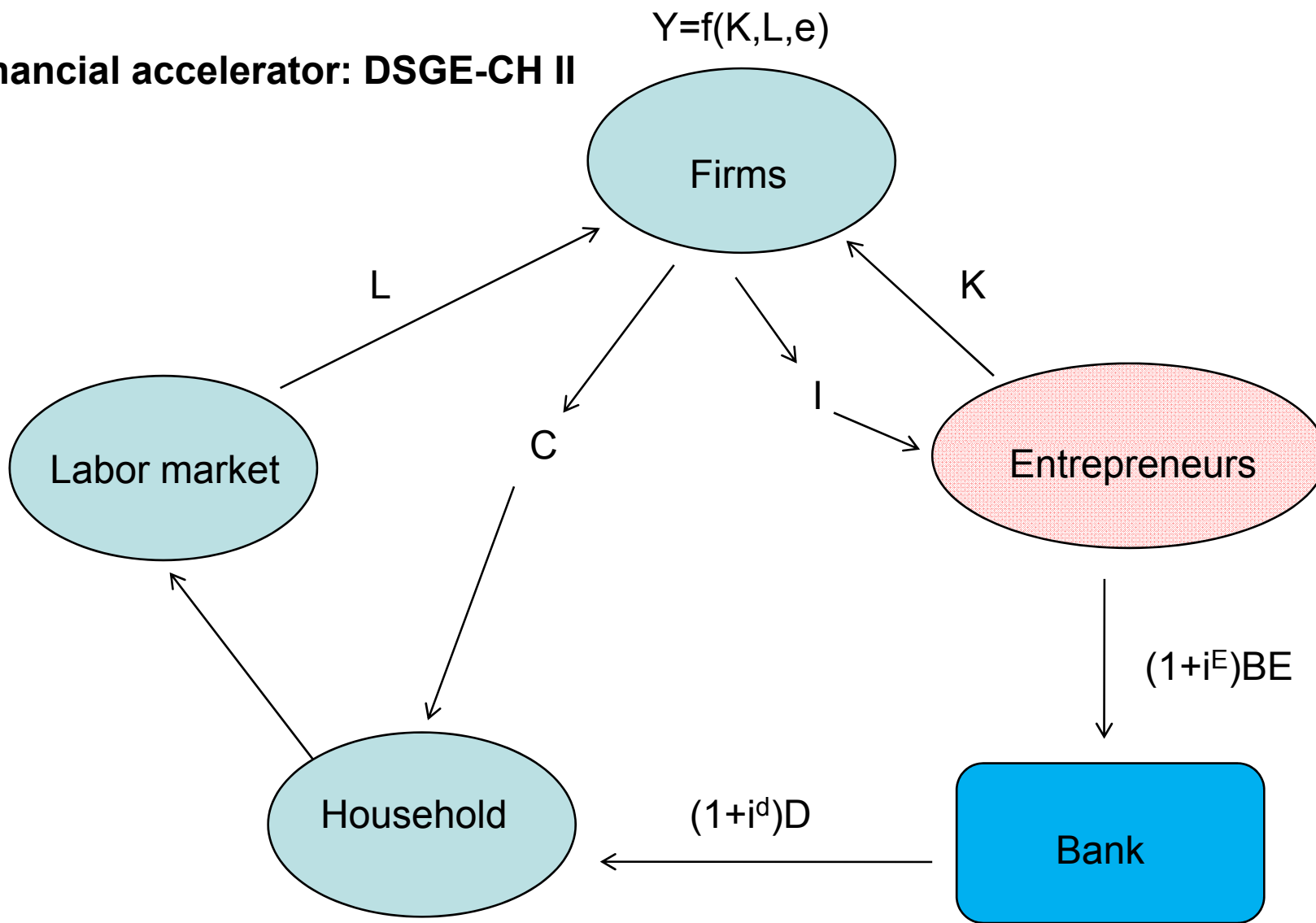BANCA NAZIUNALA SVIZRA
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In a nutshell

- Standard model is a good approximation for transmission of macro-shocks. Its use in "normal times" should not be a cause for concern.

- When asset prices are grossly out of line with fundamentals, the standard model is bad approximation.

- DSGE-CH II: missing elements
    - a) banks are safe and are financed at risk-free rates from depositors
    - b) because banks are safe, bank capital plays no role in transmission of shocks
    - c) because of a) and b), there is no way to analyze macroprudential policies that focus on the evolution of banks' balance sheets

- Work in progress nests DSGE-CH II and introduces an active and risky banking sector.

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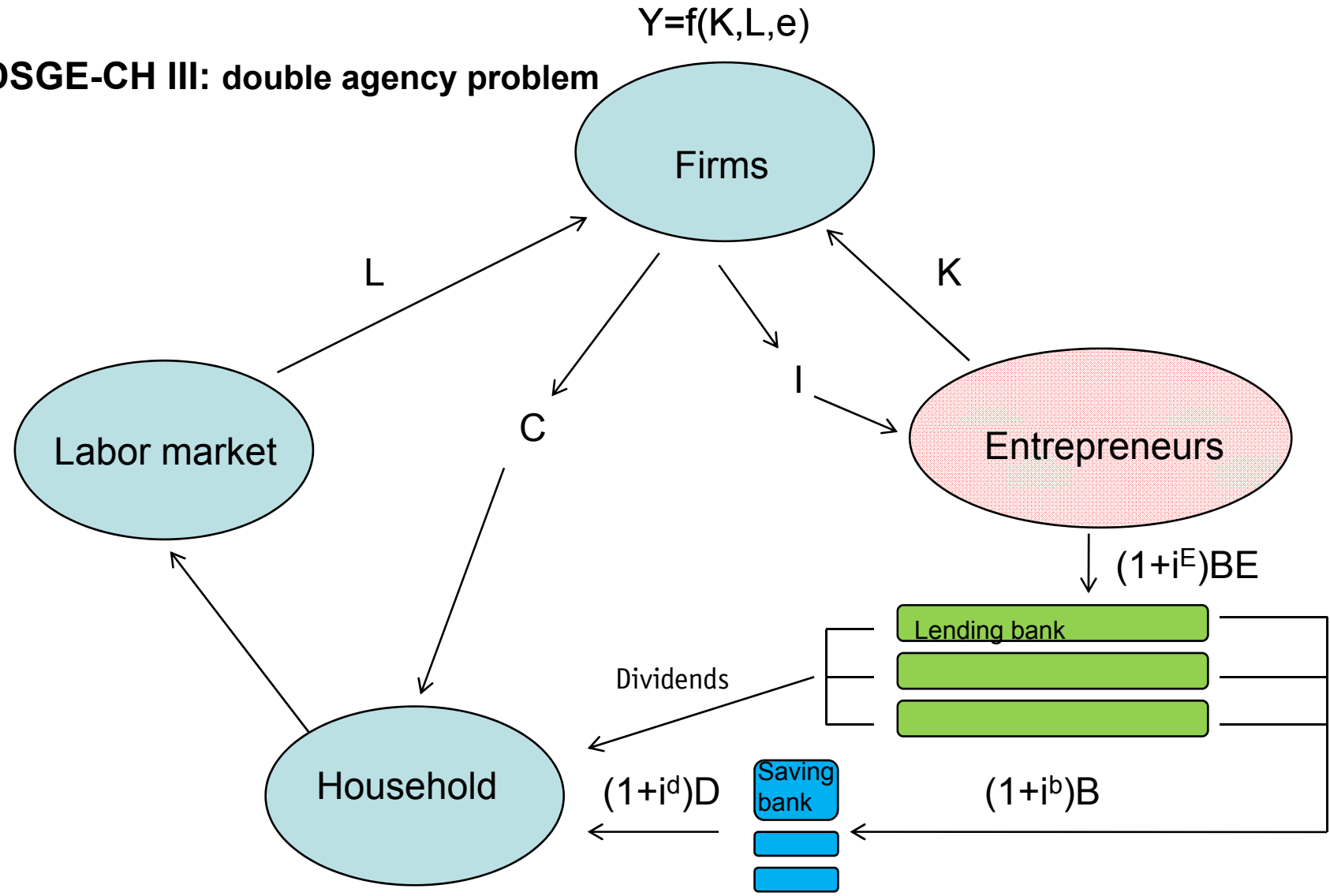# 3. DSGE-CH III (work in progress)

- Model is based on Gertler and Karadi (JME, 2010), Gertler and Kiyotacki (2010), Gerali et al. (JMCB, 2010), Bernanke et al. (1999) and Dib (2010).

- Introduces risky banking: bankers may default/divert assets if the cost of doing so - proportional to bank capital - is smaller than benefit.

- Two financial frictions interact. Feedback loop: asset prices, entrepreneur's profit, I, Y, banks' profit, credit supply, back to asset prices

- The model nests DSGE-CH II.

Financial accelerator: DSGE-CH II

$$Y=f(K,L,e)$$

Firms

Labor market

Entrepreneurs

Household

Bank

L

C

I

K

$(1+i^E)BE$

$(1+i^d)D$

$(1+i^E)/(1+i^d)= 1+EEFP(\text{Entr. leverage})$

$$Y=f(K,L,e)$$

DSGE-CH III: double agency problem

Firms

Labor market

L

C

K

I

Entrepreneurs

$(1+i^E)BE$

Lending bank

Dividends

Household

$(1+i^d)D$

Saving bank

$(1+i^b)B$

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$$(1+i^E)/(1+i^d) = [1+EEFP(\text{Entr. leverage})]x[1+BEFP(\text{Lending bank leverage})]$$

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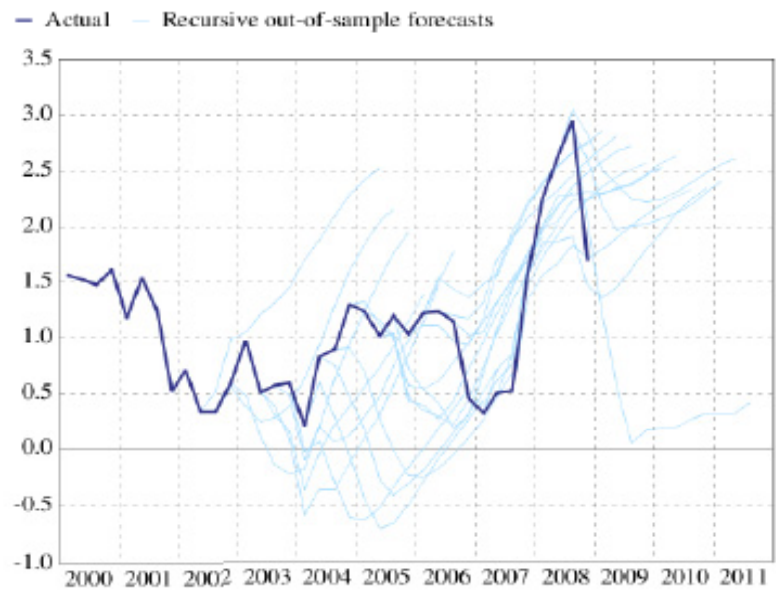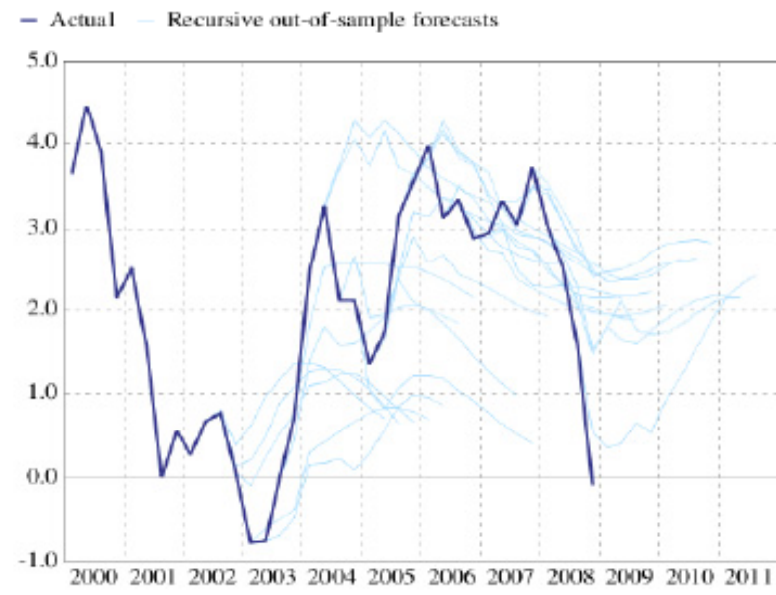BANCA NAZIUNALA SVIZRA
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Looking ahead

- DSGE models are promising tools to assess the impact of financial shocks on the economy and evaluate alternative macroprudential/monetary policies

- **But:** existing state of the art models do not explain:
    - i) endogenous increases in leverage (banks and non-banks)
    - ii) boom-bust cycles

- Models have not yet reached the stage to make normative recommendations:
    - How much capital is enough ?
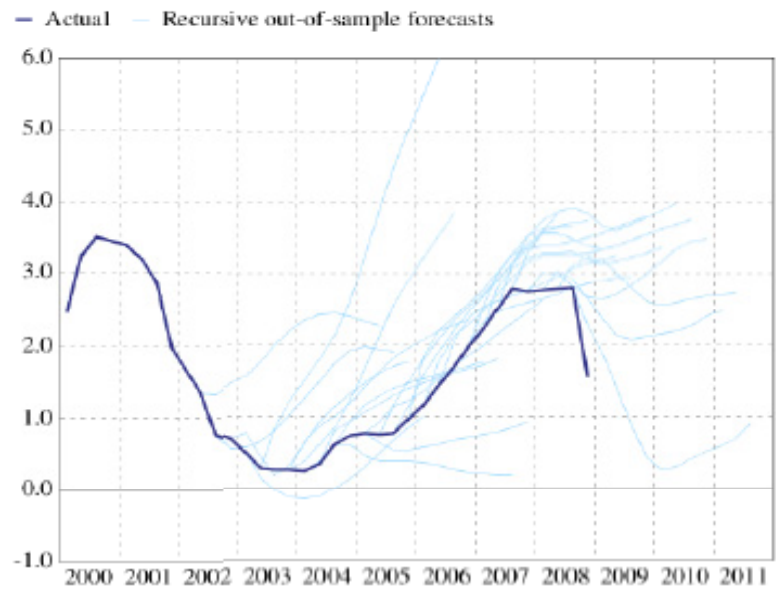   - How much dampening of credit cycle is desirable?

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Appendix

Inflation

Actual — Recursive out-of-sample forecasts

GDP growth yoy

Actual — Recursive out-of-sample forecasts

Three-month Libor
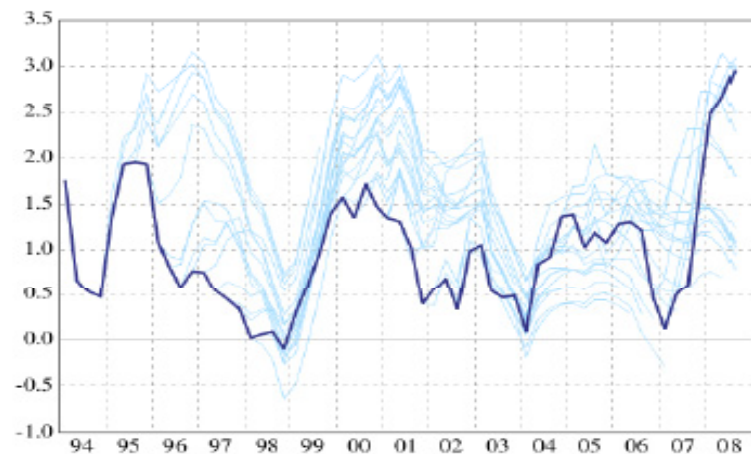
Actual — Recursive out-of-sample forecasts

CVAR

Chart 8: Forecasting performance – rolling parameter estimates
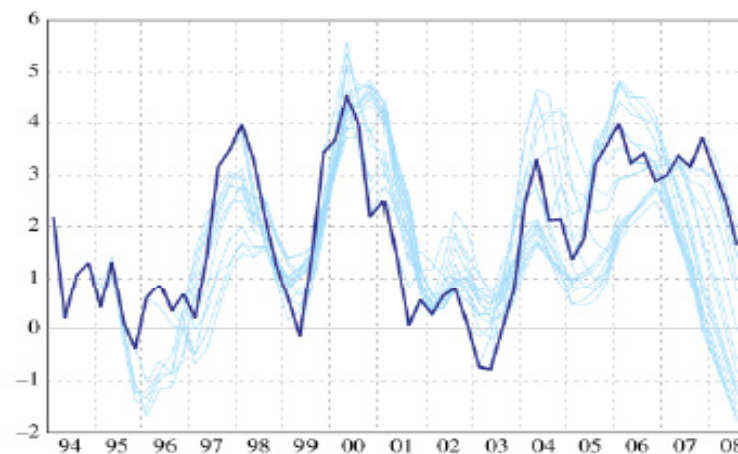
CPI inflation
yoy in %
— Actual — Forecasts

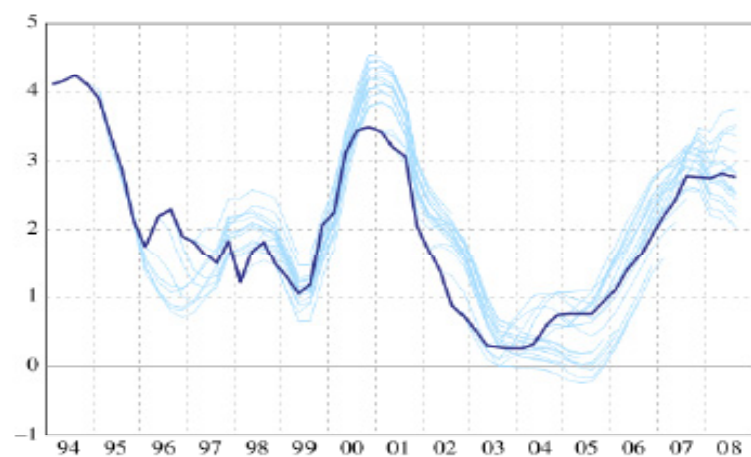**GDP growth**
qoq in %, annualised
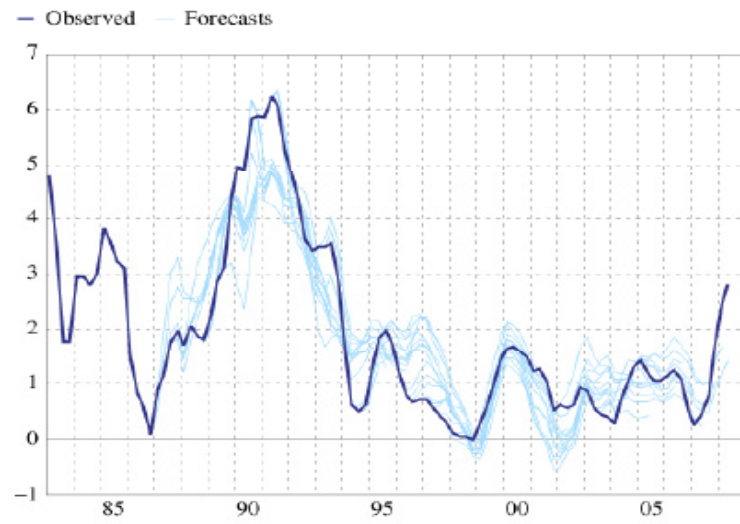— Actual — Forecasts

Three-month Libor
in %
— Actual — Forecasts

LSEM

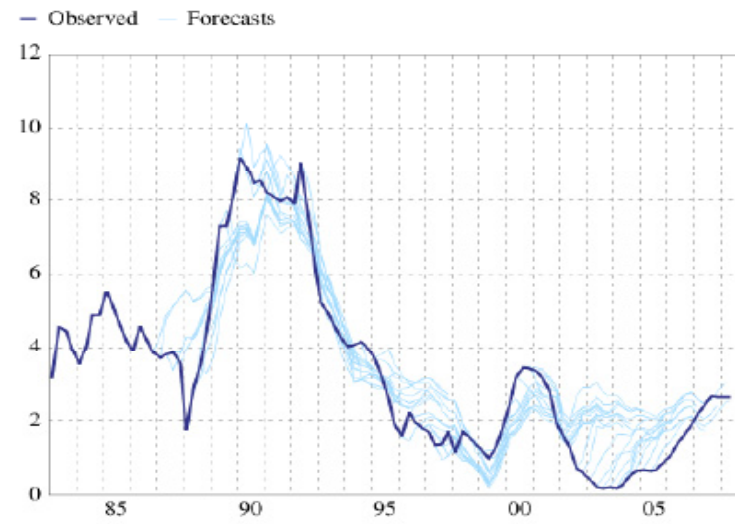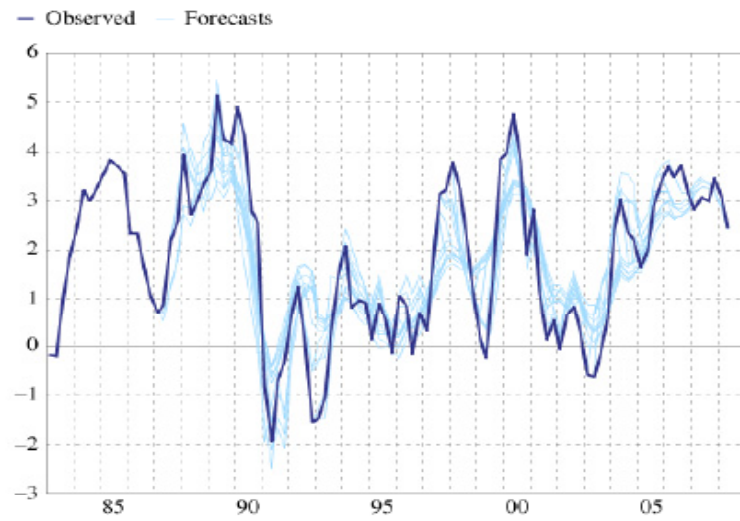Inflation

Interest rate

Output

DSGE-CH

Table 4: RMSE for CVAR model

Model	Variable	Forecast horizon					
		1	2	3	4	8	12
CVAR in sample	π	0.47	0.51	0.57	0.63	0.70	0.70
1982 Q1 to 2008 Q4	i^{3M}	0.51	0.55	0.57	0.56	0.63	0.72
	y	0.63	0.69	0.77	0.92	1.04	1.06
GVAR in sample	π	0.33	0.57	0.79	0.92	1.59	2.42
CVAR recursive	π	0.25	0.39	0.52	0.67	0.85	0.68
1995 Q1 to 2008 Q4	i^{3M}	0.36	0.59	0.68	0.75	0.86	1.01
	y	0.47	0.74	1.00	1.22	1.31	1.66
Naive AR	π	0.34	0.58	0.88	1.24	1.68	1.79
CVAR pseudo real time	π	0.30	0.58	0.79	0.99	0.83	0.68
2002 Q3 to 2008 Q4	i^{3M}	0.35	0.57	0.58	0.67	1.24	1.78
	y	0.48	0.84	1.18	1.46	1.09	2.00
Naive AR	π	0.36	0.55	0.78	1.06	1.04	1.17

Note: The second panel reports the RMSE for recursive out-of-sample forecasts, based on actual values for the exogenous variables. The last panel shows the RMSE for a pseudo-real-time experiment, based on the exogenous assumptions. For comparison, the 'Naive AR' lines report the RMSE from autoregressive out-of-sample forecasts of inflation from a simple AR model.

LSEM – in sample:

Table 1: Forecasting performance - Parameters estimated on full sample

	Forecast horizon (in quarters)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Root-mean-squared errors (in percentage points)															
CPI inflation	0.34	0.51	0.65	0.72	0.67	0.65	0.62	0.63	0.64	0.68	0.69	0.72	0.74	0.76	0.8	0.84
GDP growth	0.54	0.70	0.80	0.89	1.05	1.11	1.15	1.19	1.20	1.19	1.16	1.14	1.15	1.17	1.22	1.27
3-month Libor	0.47	0.66	0.69	0.66	0.61	0.60	0.60	0.62	0.64	0.66	0.68	0.67	0.67	0.66	0.67	0.67

LSEM – out of sample:

Table 2: Forecasting performance – rolling parameter estimates

	Forecast horizon (in quarters)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Root-mean-squared errors (in percentage points)															
CPI inflation	0.25	0.40	0.64	0.87	0.94	0.99	0.98	0.95	0.92	0.90	0.85	0.83	0.80	0.80	0.83	0.92
Naïve AR	0.34	0.58	0.88	1.24	1.43	1.55	1.63	1.68	1.72	1.76	1.78	1.79	-	-	-	-
GDP growth	0.65	0.94	1.17	1.36	1.22	1.14	1.09	1.09	1.12	1.16	1.22	1.27	1.37	1.42	1.48	1.55
3-month Libor	0.28	0.43	0.53	0.58	0.59	0.59	0.58	0.54	0.54	0.56	0.57	0.58	0.60	0.61	0.62	0.63

Note: Estimation period 1981 Q1 - 1994 Q4, forecast period 1995 Q1 - 1998 Q4

Estimation period 1981 Q1 - 1995 Q1, forecast period 1995 Q2 - 1999 Q1

. . .

Estimation period 1998 Q1 - 2004 Q3, forecast period 2004 Q4 - 2008 Q3.

DSGE-CH – out of sample:

Table 1: Inflation forecast evaluation: Root mean squared errors

Horizon	1	2	3	4	5	6	7	8	9	10	11	12
Naive	0.45	0.67	1.03	1.30	1.48	1.62	1.71	1.78	1.82	1.84	1.83	1.82
DSGE-CH	0.17	0.35	0.52	0.67	0.68	0.64	0.58	0.54	0.47	0.41	0.38	0.36