Monetary Policy with Heterogeneous Financial Markets

Adam Gulan Aino Silvo

Bank of Finland

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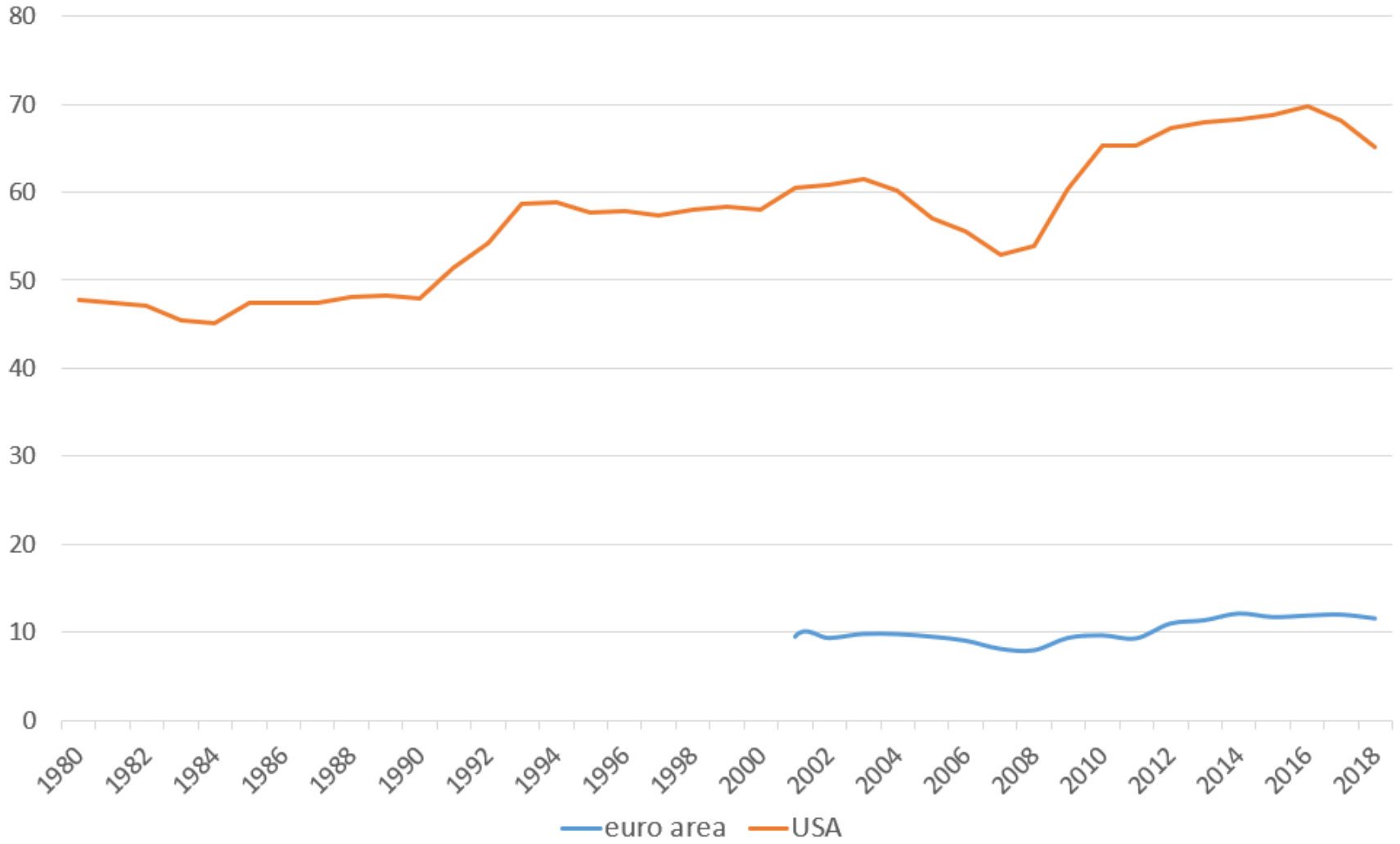
Market debt as share of total NFC debt in percent

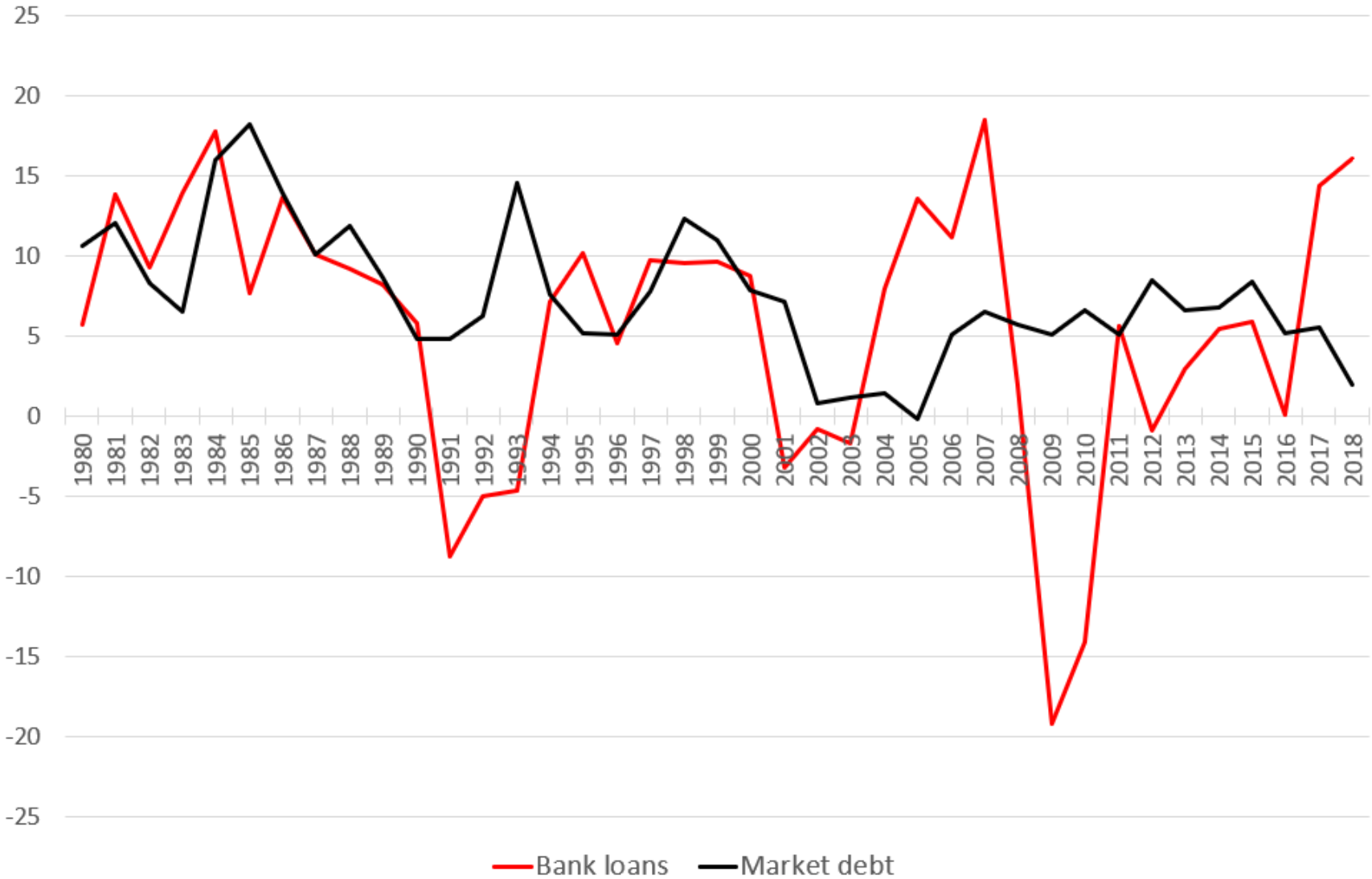


Sources: Eurostat, FED

Motivation: structural differences in financing modes by NFCs

- Very different NFC credit structure in Europe than in the US
- Growing global role of alternative sources of financing
- Disintermediation of the US economy in the late 1980s and early 1990s: bank lending channel weakened
  (Boivin, Kiley, Mishkin, HME 2011)
- plans for a Capital Markets Union in Europe
- Rise in corporate bond issuance in EMEs since mid-2000s
  (Chang, Fernandez, Gulan, JME 2017)

NFC bank loan and market debt growth rate US (in percent)



Source: FED (Flow of Funds)

NFC bank loan and market debt growth rate euro area (in percent)

Source: Eurostat (Financial account)

Motivation: cyclical differences between bond and loan financing

- varying use of bank vs unmonitored credit (bonds, etc.) over the business cycle (Becker, Ivashina, JME 2014)
- Substituting bonds for loans in Europe and the US following the Global Financial Crisis
  (De Fiore, Uhlig, JMCB 2011, 2015)
- Vast empirical literature identifying and assessing the relative importance of various forms of the credit channel (e.g. bank lending vs broad credit)
  Bernanke Gertler, Kashap Stein, Oliner Rudebusch, etc. . .
  Models wanted.

Some Questions

- How does financing structure affect MP propagation and its strength?
  What is the role of substitution between modes of finance (substitution channel)?
  What is the relative strength of the bank lending and broad credit channel?
  What is the role of the extensive margin (access to finance)?

- Is disintermediation desirable from central banks' point of view?
  (e.g. Capital Markets Union and Banking Union debates)

- What are the welfare and business cycles implications of different financial systems

This Project

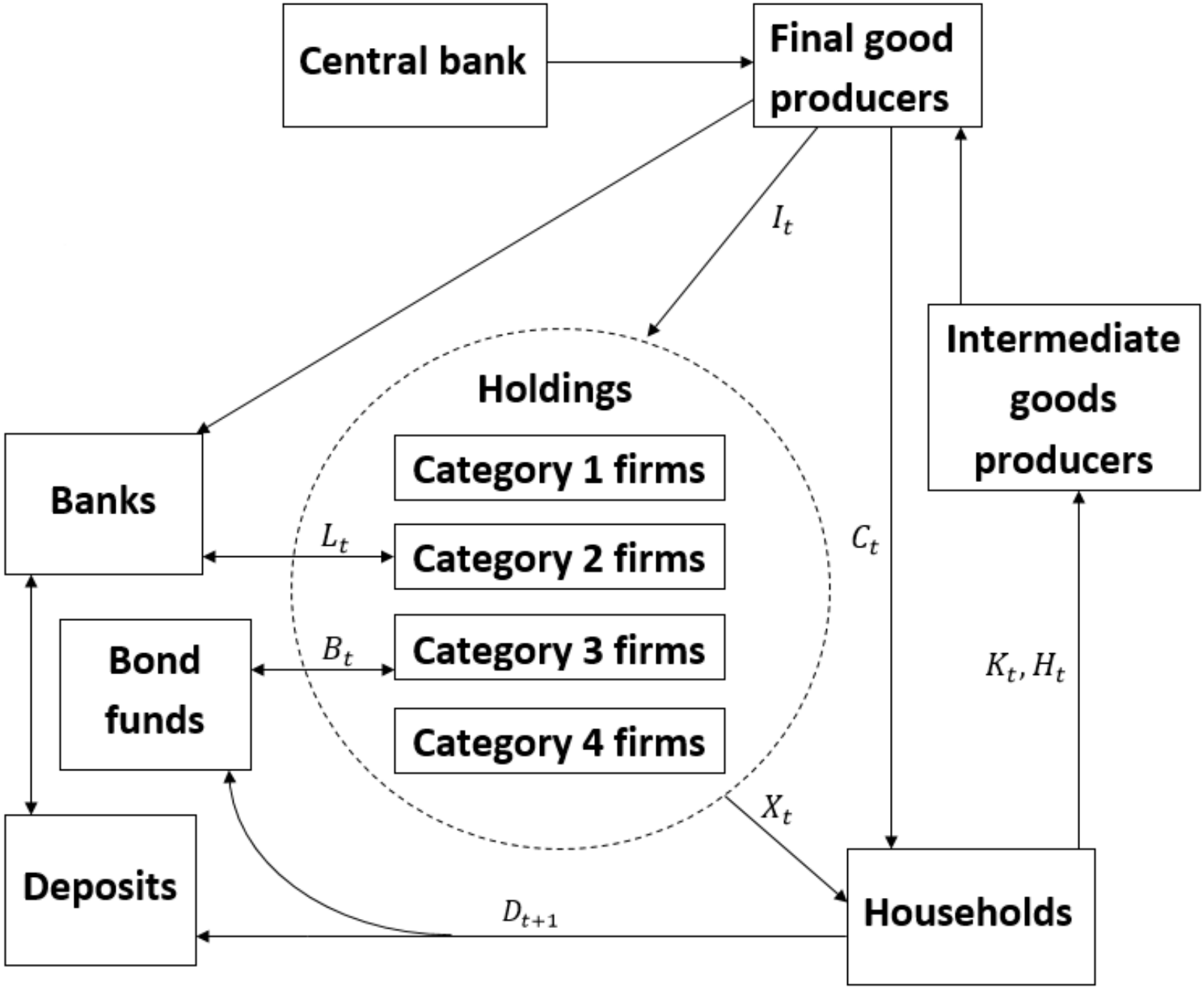
- Develops a model, in which the the firms' choice between direct (bond-based) and indirect (bank-based) finance is embedded into an otherwise standard New Keynesian model.

- Embeds the classic Holmström-Tirole (1997) framework which provides microfoundations for an optimal choice by firms between monitored and unmonitored credit.

- The model allows to rationalize some basic empirical facts about bank and bond borrowing cyclicalities:
  - rebalancing from bank loans towards bonds following a contractionary MP shock
  - tighter access to bank credit (due to endogenous monitoring)

- An structurally higher bond-to-loan ratio is likely to:
  - mute the response of output and investment following MP shocks (in line with the bank lending channel)
  - weaken the sensitivity of the economy to bank-originating credit shocks

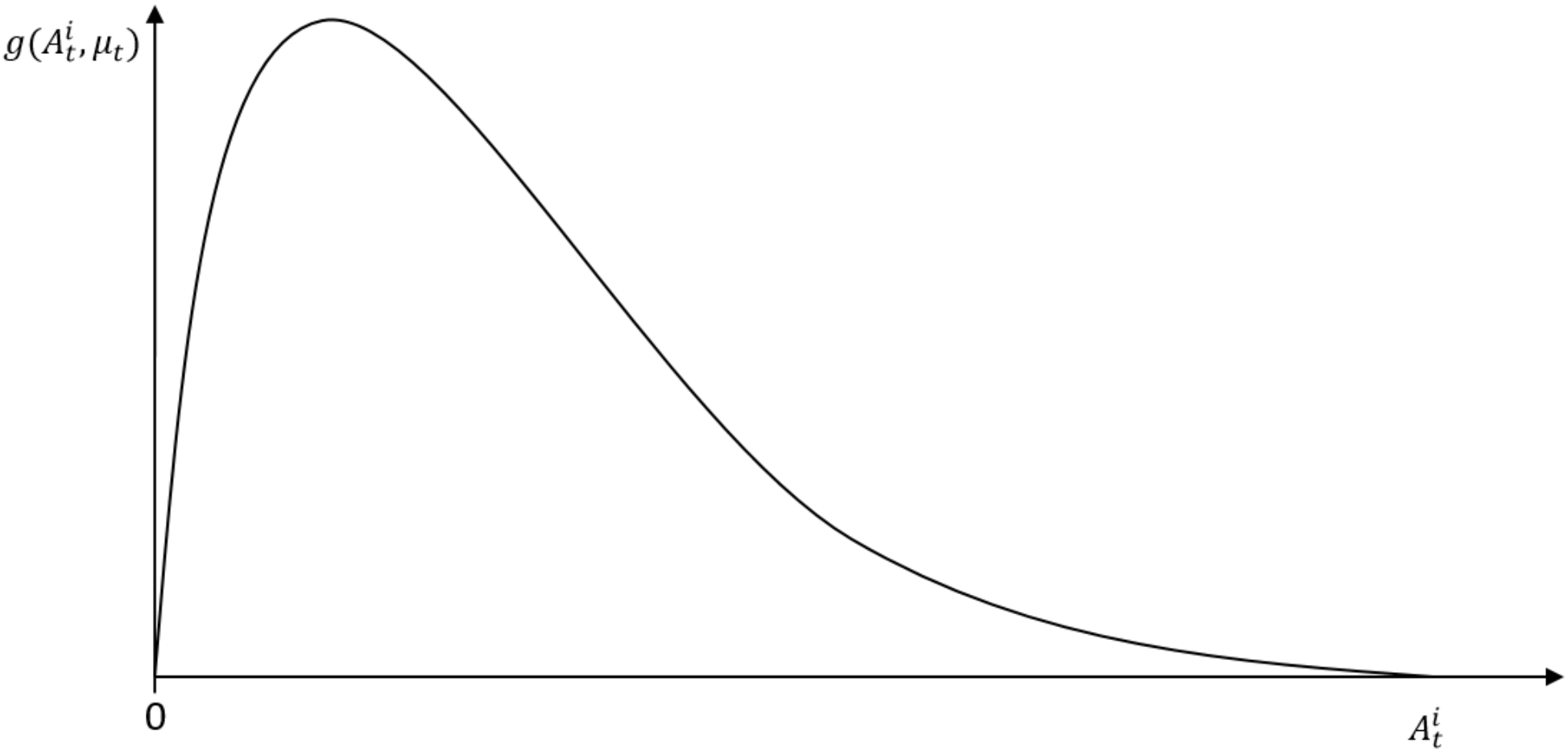
Road Map


Central bank
Final good producers
I_t
Intermediate goods producers
Holdings
Category 1 firms
Banks
L_t
Category 2 firms
C_t
Bond funds
B_t
Category 3 firms
K_t, H_t
Category 4 firms
X_t
Deposits
D_{t+1}
Households

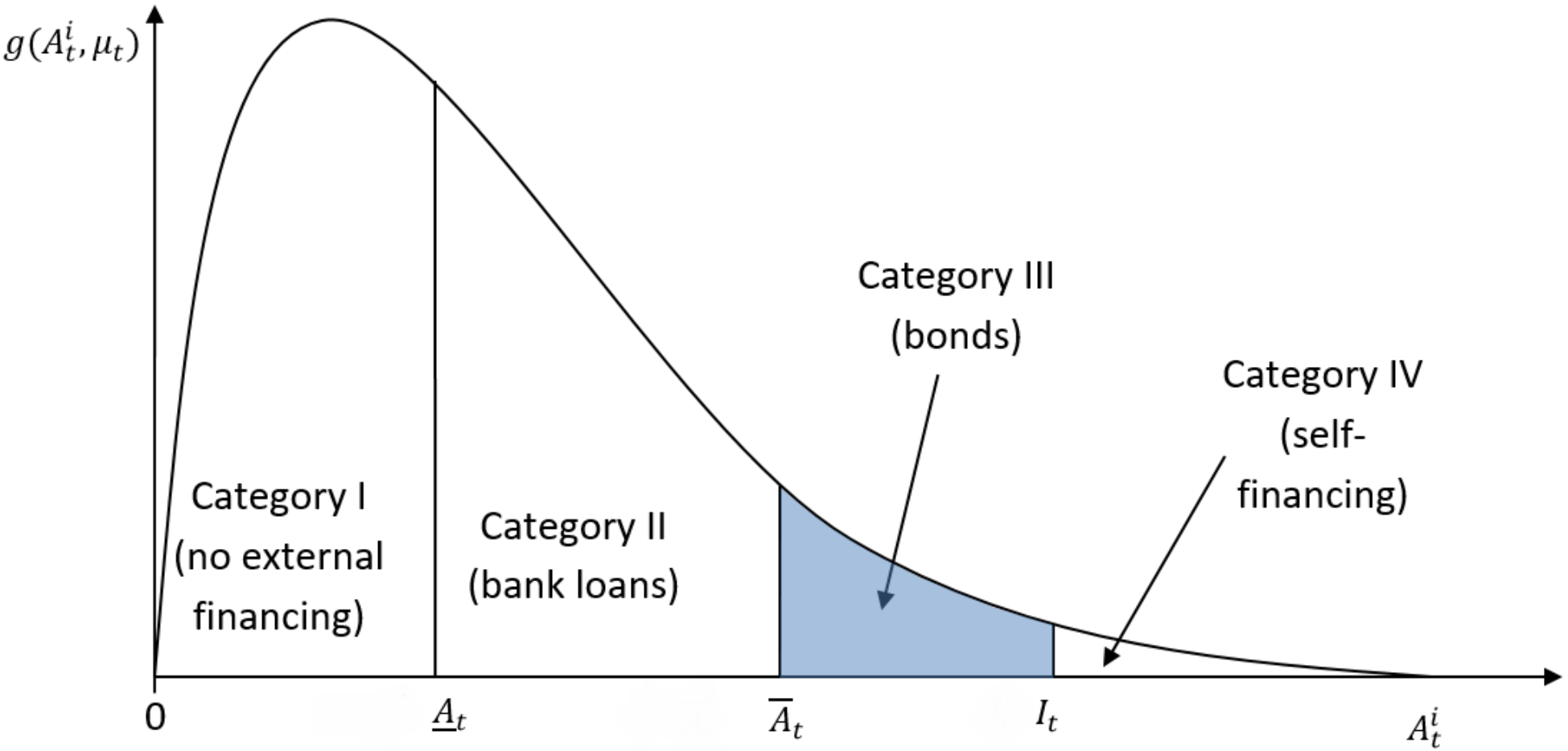
Financial friction

- Capital goods are produced by firms (members of "holdings"). Holding chooses optimal investment size I_t (common to all firms), subject to financial constraint.
- Firms obtain common equity K_t^h but are subject to idiosyncratic "input efficiency" shock $\ln z_t^i \sim N\left(0, \sigma_G^2\right)$, which turns K_t^h into firm-specific equity $A_t^i = z_t^i K_t^h$.
- Usually $A_t^i < I_t$ so firms borrow but face moral hazard. If they "shirk", they earn benefit $b_H I_t$, but this reduces project success from p_H to p_L.
- Firms short of equity can be monitored by banks. This reduces private benefit to $b_L < b_H$ at a cost cI_t. To make monitoring credible, banks must put their own equity into the project.

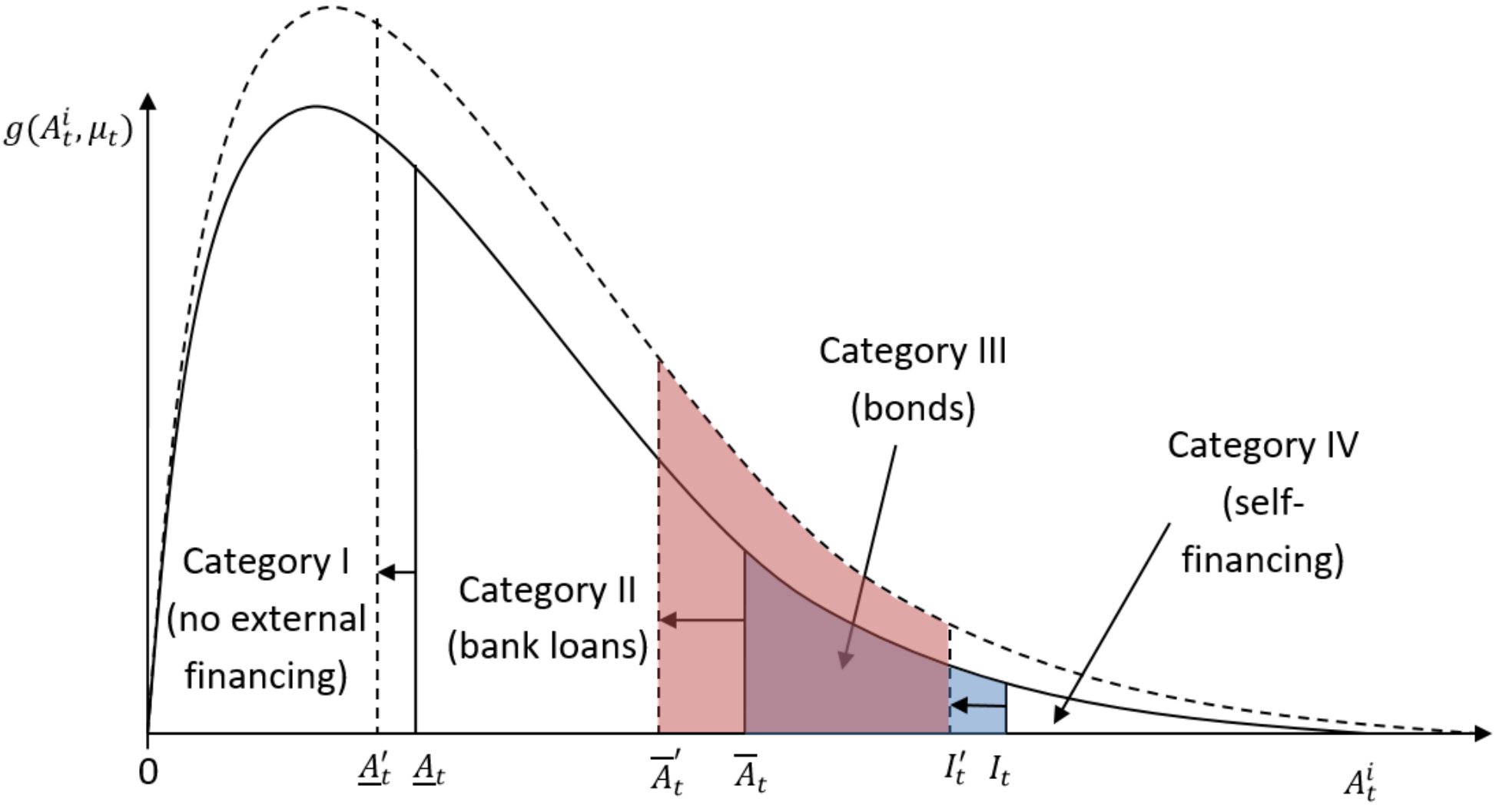
Equity Distribution of Holdings' Firms



Equity Distribution of Holdings' Firms



Equity Distribution of Holdings' Firms



Endogenous monitoring

Banks optimally choose monitoring intensity, which changes moral hazard over the cycle (e.g. Silvo JMCB 2019):

$$b_{L,t} = b_L(c_t) = \Gamma c_t^{-\frac{\eta}{1-\eta}}$$

With lower monitoring intensity, moral hazard goes up and credit conditions tighten.

This effectively means a contraction in bank loan supply.

Optimal banks' choice of monitoring trades off:

- additional cost from more intensive monitoring vs
- revenue from additional marginal bank customers (due to lower moral hazard)

Standard NK parts of the model

- Households:
  - smooth consumption using deposits or bonds (indifferent)
  - assemble new capital goods
  - work, facing additive disutility
  - have differentiated labor skills and set nominal wages in staggered contracts (sticky wages)
  - consume, maximizing utility with habits
- Intermediate good varieties produced with Cobb-Douglas and subject to Calvo mechanism.
- Homogenous final good.
- Taylor Rule as in Smets Wouters 2007:

$$R_{t+1} = (\beta R_t)^{\rho_r} \Pi_t^{(1-\rho_r)\rho_\Pi} \left(\frac{Y_t}{Y_t^p} \right)^{(1-\rho_r)\rho_Y} \left(\frac{Y_t / Y_t^p}{Y_{t-1} / Y_{t-1}^p} \right)^{\rho_{dY}} \frac{M_t}{\beta}$$

$$\ln M_t = \rho_M \ln M_{t-1} + \epsilon_r$$

Parameterization of financial parameters

- At the core of the parameterization are objects: c, b_L, b_H, σ_G, Z and pH. They are found by attempting to match the following targets:

Condition	*Target*	*Model EA*	*US counterf.*
Bank operating costs to assets	0.0050	0.0038	0.0046
Bank loans to NFCs to equity	2.16	3.15	2.59
Holding assets to equity	1.95	1.87	1.15
monitoring elasticity parameter	0.95	0.94	0.79
NFC bank loans to bonds:			
euro area	0.115	0.127	
US	1.685		1.678

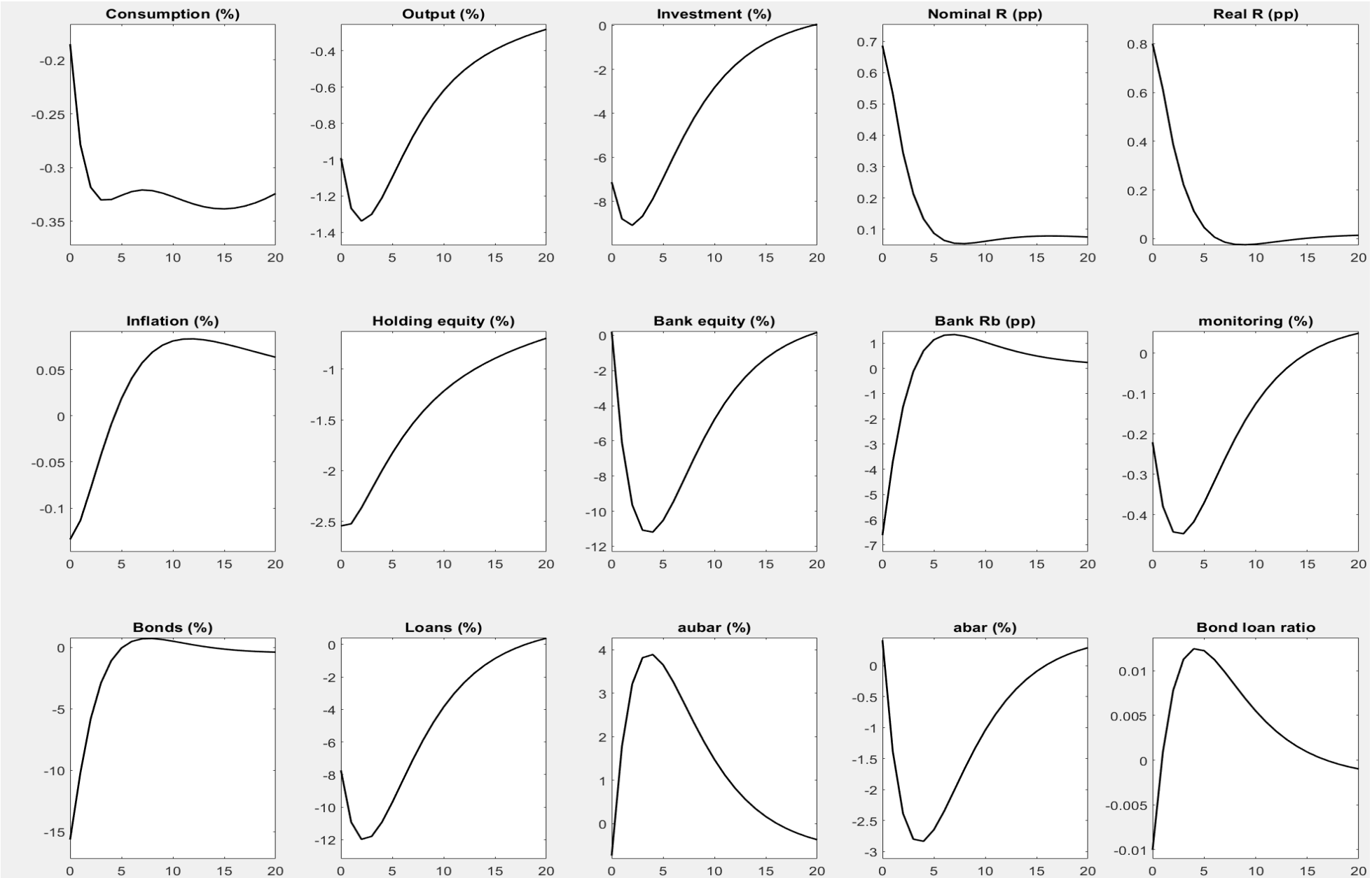
- US counterfactual is obtained by increasing the degree of moral hazard of monitored firms b_L.

- Even though the system above has one free parameter, perfect match is impossible because of:
  - strong nonlinearities
  - additional inequality and regularity conditions

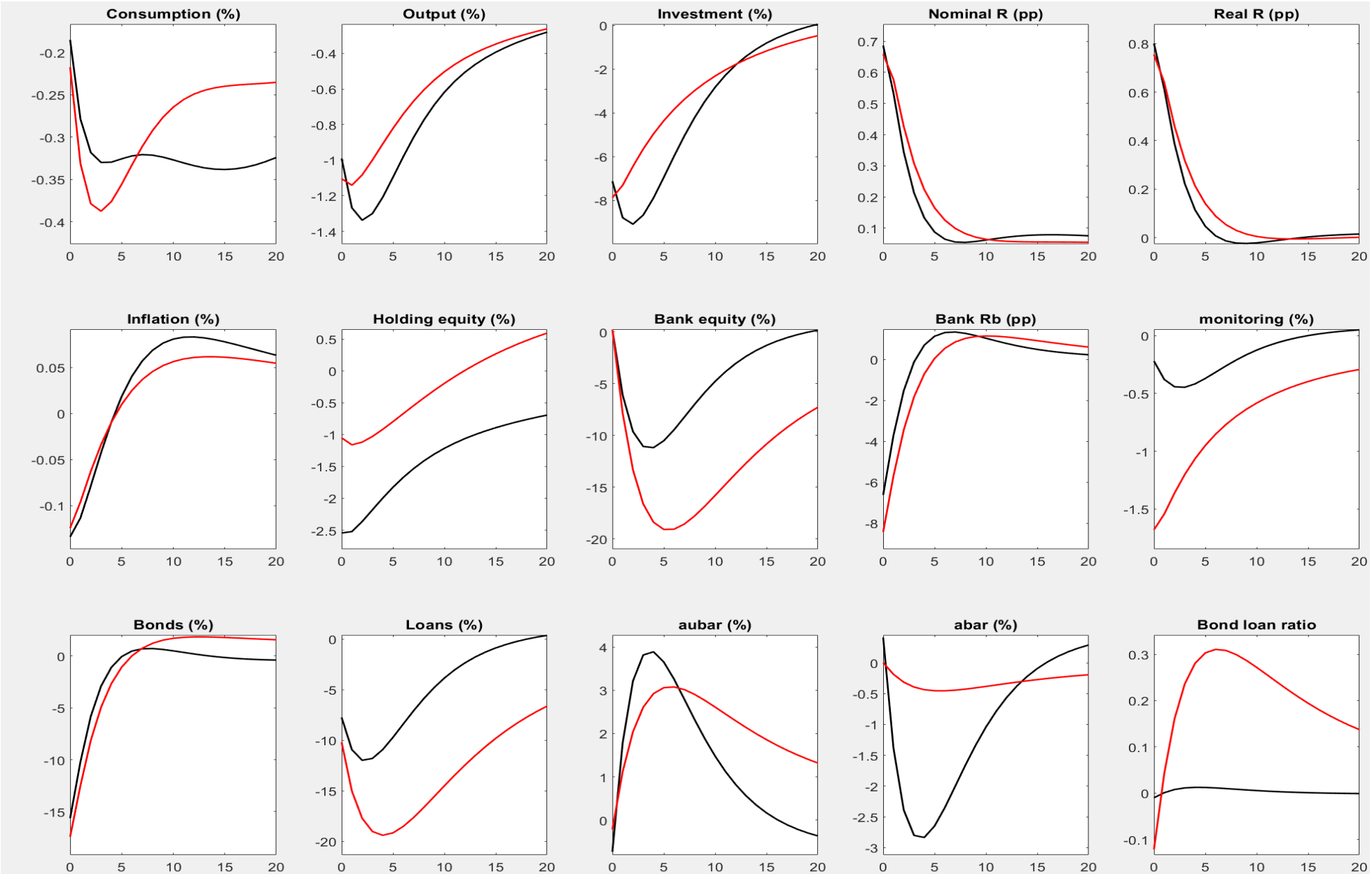
Parameterization (quarterly)

Object	Description	Value	Source
R	riskless interest rate, sets β	1.005	approx. real FFR/EONIA
R^b	rate of return to bank equity	1.02	approx. WB GFDD
ϕ^b	retained earnings of banks	0.992	approx. fin. accounts
ϕ^h	retained earnings of holdings	0.992	found endogenously
α	capital share	0.45	avg. btw. EA and US data
$\frac{K}{Y}$	capital to output ratio	12	avg. btw. EA and US data
$\frac{X}{Y}$	investment to output ratio, sets δ	0.21	avg. btw. EA and US data
H	labor time	0.33	RBC literature
σ	relative risk aversion	2	RBC literature
h	habit	0.65	avg. btw. EA and US Smets Wouters
τ	labor disutility (Frisch)	0.67	found endogenously
ω	price stickiness	0.65	NK literature
ω^w	wage stickiness	0.65	NK literature
θ	intermediate good varieties	1.5	NK literature
θ^w	labor varieties	1.66	NL literature
ρ_r	interest rate persistence	0.81	NK literature
ρ_Π	inflation weight in MP rule	1.85	NK literature
ρ_Y	output gap weight in MP rule	0.25	NK literature
ρ_{dY}	output smoothing in MP rule	0.23	NK literature
ρ_M	MP shock persistence	0.14	NK literature

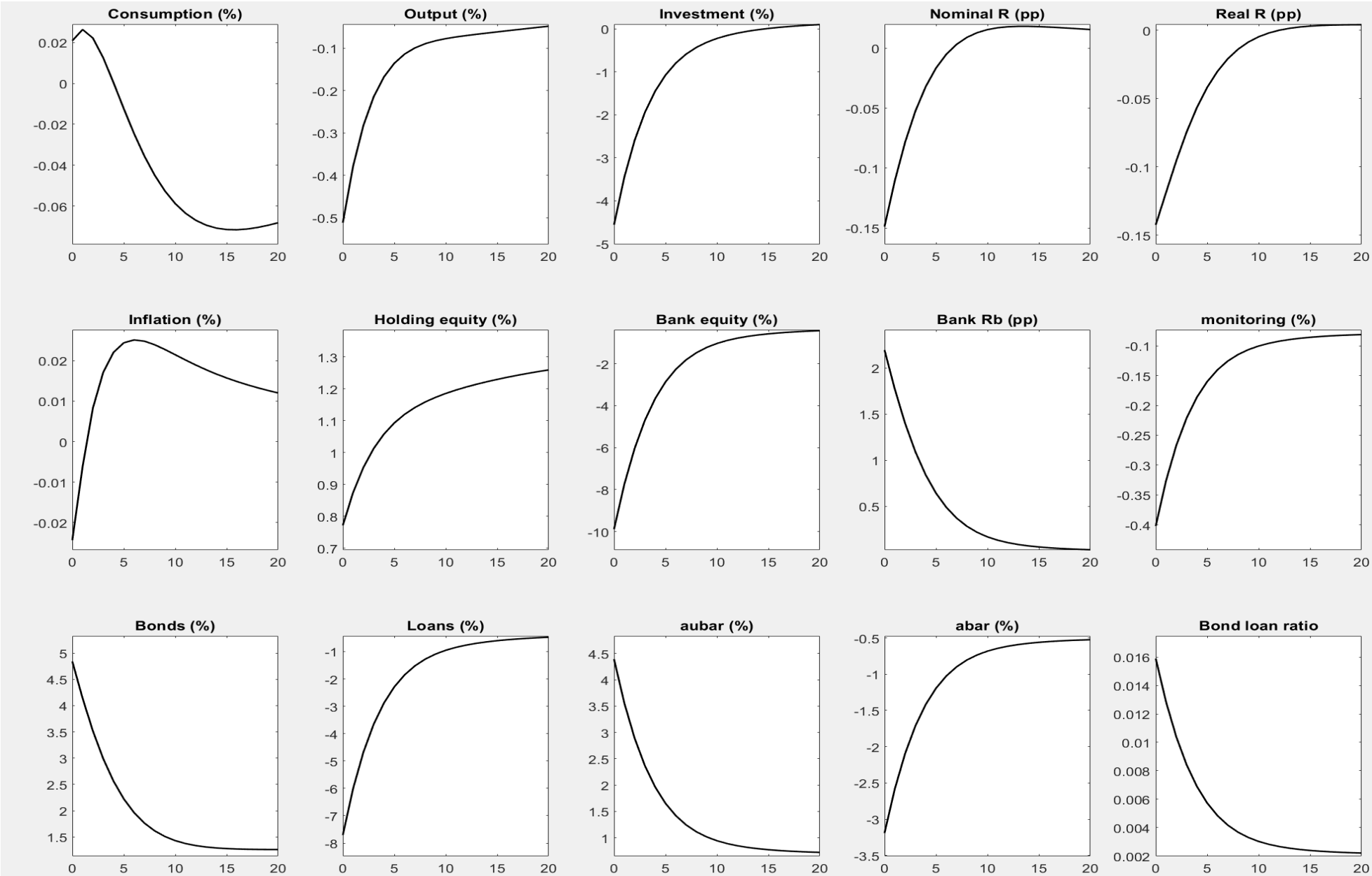
1pp MP shock, euro area



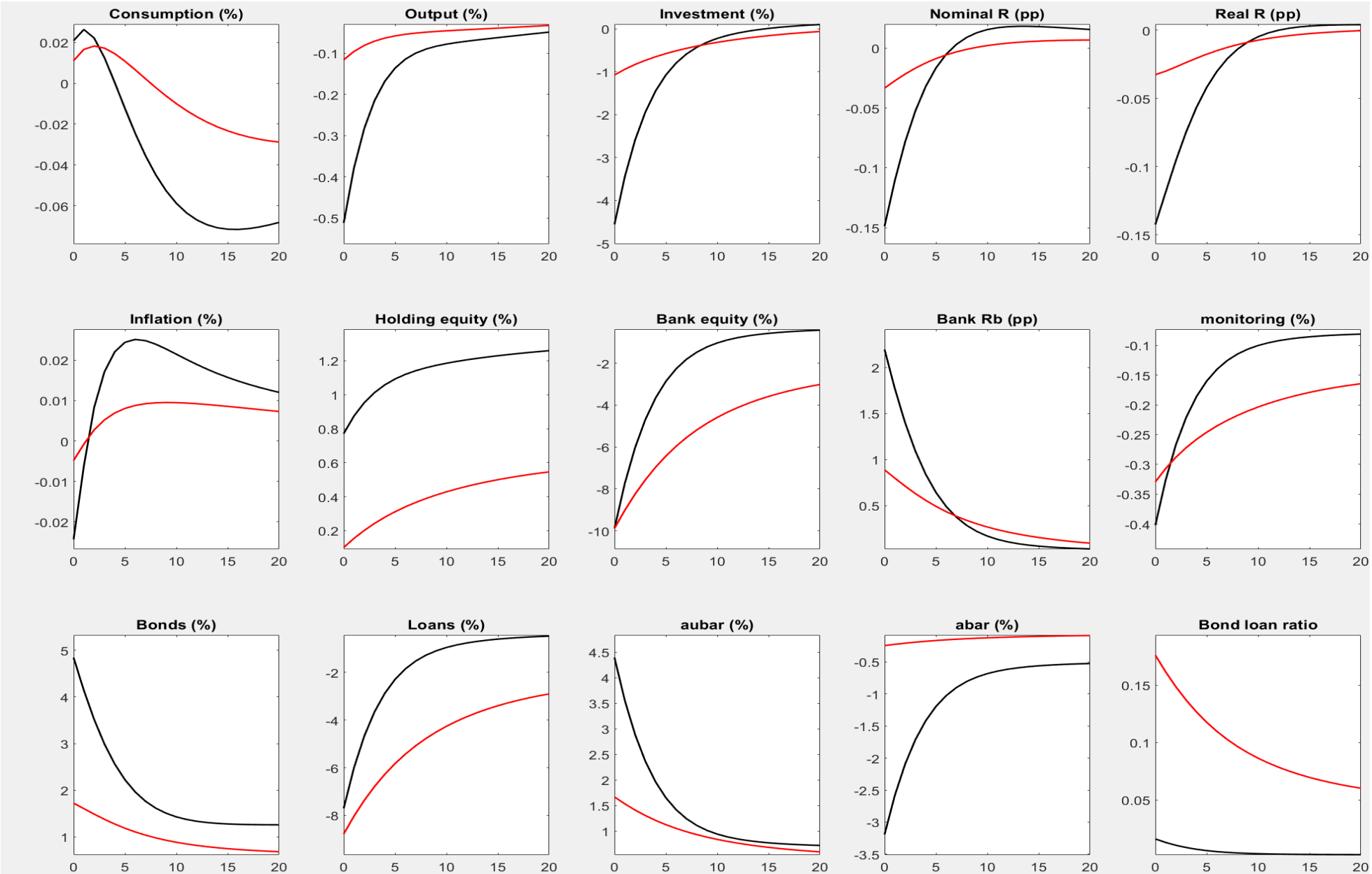
1pp MP shock, euro area vs "US counterfactual"



10pp bank equity shock, euro area



10pp bank equity shock, euro area vs "US counterfactual"



Conclusions and final remarks

- We develop a tractable DSGE model with endogenous determination of direct versus indirect finance.
- The model allows to rationalize some basic empirical facts about bank and bond borrowing cyclicalities:
  - rebalancing from bank loans towards bonds following a contractionary MP shock
  - tighter access to bank credit (due to endogenous monitoring)
- An structurally higher bond-to-loan ratio is likely to:
  - mute the response of output and investment following MP shocks (in line with the bank lending channel)
  - weaken the sensitivity of the economy to bank-originating credit shocks
- The model emphasizes the importance of NFC debt structure and choice for aggregate outcomes.

Thank you!

Additional slides

Households

- Preferences are Cobb-Douglas over consumption and labor:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{\left(C_t - hC_{t-1}\right)^{1-\sigma}}{1-\sigma} - \frac{H_t^{1+\tau}}{1+\tau} \right]$$

- Budget constraint:

$$C_t + \frac{Q_t}{P_t} X_t + \frac{D_{t+1} + B_{t+1}}{P_t} = \frac{W_t}{P_t} H_t + \frac{r_t^K}{P_t} K_t + \frac{\left(D_t + B_t\right)\left(1 + r_t\right)}{P_t} + \frac{\Pi_t^m}{P_t}$$

- Households have only access to one period, nominally riskless debt which can be allocated in bonds B_{t+1} or bank deposits D_{t+1}. Both modes of saving yield interest r_{t+1} and are perfect substitutes from households' point of view.

Households' optimality conditions

- Euler:

$$\lambda_t = \beta \left(1 + r_{t+1}\right) E_t \frac{P_t}{P_{t+1}} \lambda_{t+1}$$

  where

$$\lambda_t = \left(C_t - hC_{t-1}\right)^{-\sigma} - h\beta E_t \left(C_{t+1} - hC_t\right)^{-\sigma}$$

- Labor supply:

$$\frac{W_t}{P_t} = \frac{H^\tau}{\lambda_t} \mu_t^w$$

- Capital goods demand:

$$\frac{Q_t}{P_t} = \frac{r_t^K}{P_t} + E_t \beta \frac{\lambda_{t+1}}{\lambda_t} \frac{Q_{t+1}}{P_{t+1}} \left(1 - \delta\right)$$

Intermediate and final goods' producers, and the central bank

- Intermediate goods are produced by monopolistically-competitive firms:

$$Y_{l,t} = A_t K_{l,t}^{\alpha} H_{l,t}^{1-\alpha}$$

  who set prices p_t^* for their variety according to the Calvo pricing mechanism.
- Final goods producers purchase $Y_{l,t}$ varieties and combine them into a homogeneous final good Y_t.
- Taylor Rule as in Smets Wouters 2007:

$$R_{t+1} = (\beta R_t)^{\rho_r} \Pi_t^{(1-\rho_r)\rho_\Pi} \left(\frac{Y_t}{Y_t^p} \right)^{(1-\rho_r)\rho_Y} \left(\frac{Y_t / Y_t^p}{Y_{t-1} / Y_{t-1}^p} \right)^{\rho_{dY}} \frac{M_t}{\beta}$$

$$\ln M_t = \rho_M \ln M_{t-1} + \epsilon_r$$

Market clearing conditions

r^b_{t+1} adjusts to equate demand for bank equity to its supply:

$$K^b_t = I^b_t \left[G\left(\bar{A}_t; \mu_t\right) - G\left(\underline{A}_t; \mu_t\right) \right]$$

The price of new capital goods, Q_t, adjusts to clear the market:

$$X_t = p_H Z_{t-1} \frac{I_{t-1}}{P_{t-1}} \left[1 - G\left(\underline{A}_{t-1}; \mu_{t-1}\right) \right]$$

Final goods market:

$$Y_t = C_t + C^h_t + C^b_t + \frac{I_t}{P_t} \left[1 - G\left(\underline{A}_t; \mu_t\right) \right] + \frac{cI_t}{P_t} \left[G\left(\bar{A}_t; \mu_t\right) - G\left(\underline{A}_t; \mu_t\right) \right]$$

Holding Company Profit

Representative holdings' expected profit $E_t \Pi^h_{t+1}$ consists of:

1. gross income from all undertaken projects

$$p_H E_t \frac{Q_{t+1}}{P_t} Z_t I_t \left[1 - G\left(\underline{A}_t; \mu_t\right)\right]$$

2. income generated by firms which have too little equity to pursue the project

$$\int_0^{\underline{A}_t} \left(1 + r_{t+1}\right) A^i_t \mathrm{d}G\left(A^i_t; \mu_t\right)$$

3. superfluous equity of firms that have more equity than the size of the investment project

$$\int_{I_t}^{\infty} \left(1 + r_{t+1}\right) \left(A^i_t - I_t\right) \mathrm{d}G\left(A^i_t; \mu_t\right)$$

Holding Company Profit

...less payments made to:

1. bankers:
$$\frac{p_H c l_t}{\Delta} \left[G\left(\bar{A}_t; \mu_t\right) - G\left(\underline{A}_t; \mu_t\right) \right]$$
2. depositors
$$\int_{\underline{A}_t}^{\bar{A}_t} \left(1 + r_{t+1}\right) \left(l_t - l_t^b - A_t^i \right) \mathrm{d}G\left(A_t^i; \mu_t\right)$$
3. bond investors
$$\int_{\bar{A}_t}^{l_t} \left(1 + r_{t+1}\right) \left(l_t - A_t^i \right) \mathrm{d}G\left(A_t^i; \mu_t\right)$$

Optimal Project Size

- The holding's manager chooses I_t to maximize expected profits:

$$\max_{I_t} E_t \Pi^h_{t+1}$$

subject to

$$\bar{A}_t = I_t \left[1 - \frac{p_H}{1 + r_{t+1}} \left(E_t \frac{Q_{t+1}}{P_t} Z_t - \frac{b_H}{\Delta} \right) \right]$$

and

$$\underline{A}_t = I_t \left[1 - p_H \frac{c}{\Delta \left(1 + r^b_{t+1} \right)} - \frac{p_H}{1 + r_{t+1}} \left(E_t \frac{Q_{t+1}}{P_t} Z_t - \frac{b_L + c}{\Delta} \right) \right]$$

The FOC is:

$$\left(p_H E_t \frac{Q_{t+1}}{P_t} Z_t - (1 + r_{t+1}) \right) \left[1 - G \left(\underline{A}_t; \mu_t \right) \right]$$

$$- \frac{p_H c}{\Delta \left(1 + r^b_{t+1} \right)} \left(r^b_{t+1} - r_{t+1} \right) \left[G \left(\bar{A}_t; \mu_t \right) - G \left(\underline{A}_t; \mu_t \right) \right] = \lambda^{\bar{A}}_t \frac{\bar{A}_t}{I_t} + \lambda^{\underline{A}}_t \frac{\underline{A}_t}{I_t}$$

Dynamics of Equity

Holding's (capital producers') equity:

$$K_{t+1}^{h} = \phi^{h} \Pi_{t}^{h}$$

where $1 - \theta^{h}$ is the fraction of equity payed out as dividend and consumed by holding managers.

Banks' equity:

$$K_{t+1}^{b} = \phi^{b} \Pi_{t}^{b}$$

where $1 - \theta^{b}$ is the fraction of equity payed out as dividend and consumed by bankers and bank profits are defined as

$$\Pi_{t}^{b} = \frac{p_{H} cl_{t-1}}{\Delta} \left[G\left(\bar{A}_{t-1}; \mu_{t-1}\right) - G\left(\underline{A}_{t-1}; \mu_{t-1}\right) \right] - cl_{t} \left[G\left(\bar{A}_{t}; \mu_{t}\right) - G\left(\underline{A}_{t}; \mu_{t}\right) \right]$$

Literature

- **Bonds, loans and MP (empirics):** Adrian, Colla, Shin (NBER MA, 2012), Darmouni, Giesecke, Rodnyansky (WP, 2019), Grosse-Rueschkamp, Steffen, Streiz (JFE, 2019), Holm-Hadulla, Thürwächter (WP, 2020), Lhuissier, Szczerbowicz (WP, 2018), Lo Duca, Nicoletti, Vidal Martínez (JIMF, 2016)
- **Bonds, loans and MP (theory):** Bolton, Freixas (RFS, 2006), Kashyap, Stein, Wilcox (AER, 1993), Repullo, Suarez (2000)
- **Determinants of debt structure (empirics):** Becker, Ivashina (JME, 2014), Caballero, Fernández, Park (JIE, 2019), Denis, Mihov (JFE, 2003), Grjebine, Szczerbowicz, Tripier (EER, 2018), Johnson (JFQA, 1997), Rauh, Sufi (RFS, 2010)
- **Determinants of debt structure (theory):** Besanko, Kanatas (RFS, 1993), Bolton, Scharfstein (JPE, 1996), Diamond (JPE, 1991), Holmström, Tirole (QJE, 1997), Rajan (JF, 1992)
- **Heterogeneous finance in dynamic models:** Chang, Fernandez, Gulan (JME, 2017), Crouzet (RES, 2018), De Fiore, Uhlig (JMCB, 2011,2015)
- **Holmström Tirole in in dynamic models (no bonds):** Chen (JME, 2001), Meh, Moran (JDEC, 2010), Silvo (JMCB, 2019)