Bubbles, Crashes & the Financial Cycle: The Limits to Credit Growth

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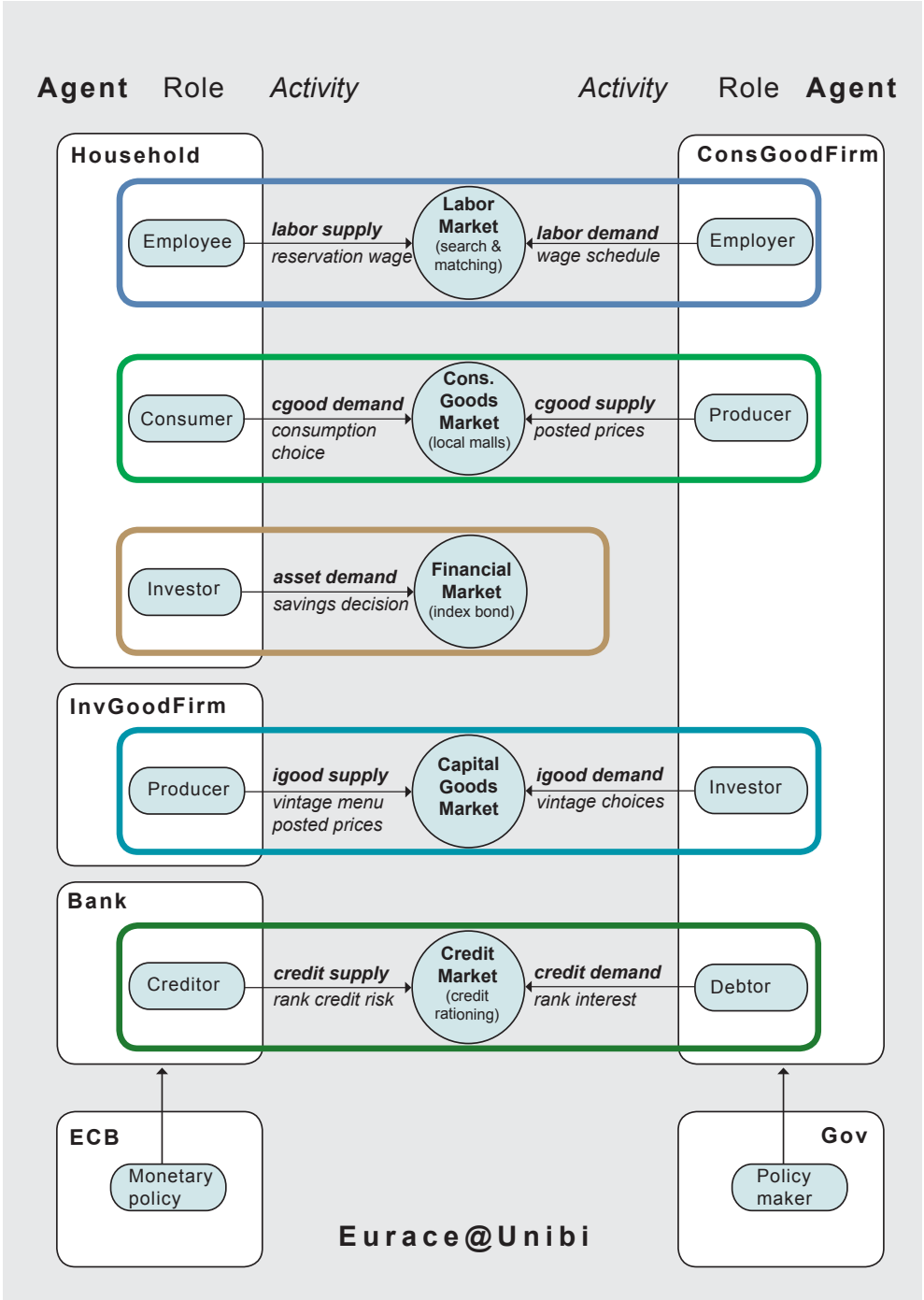
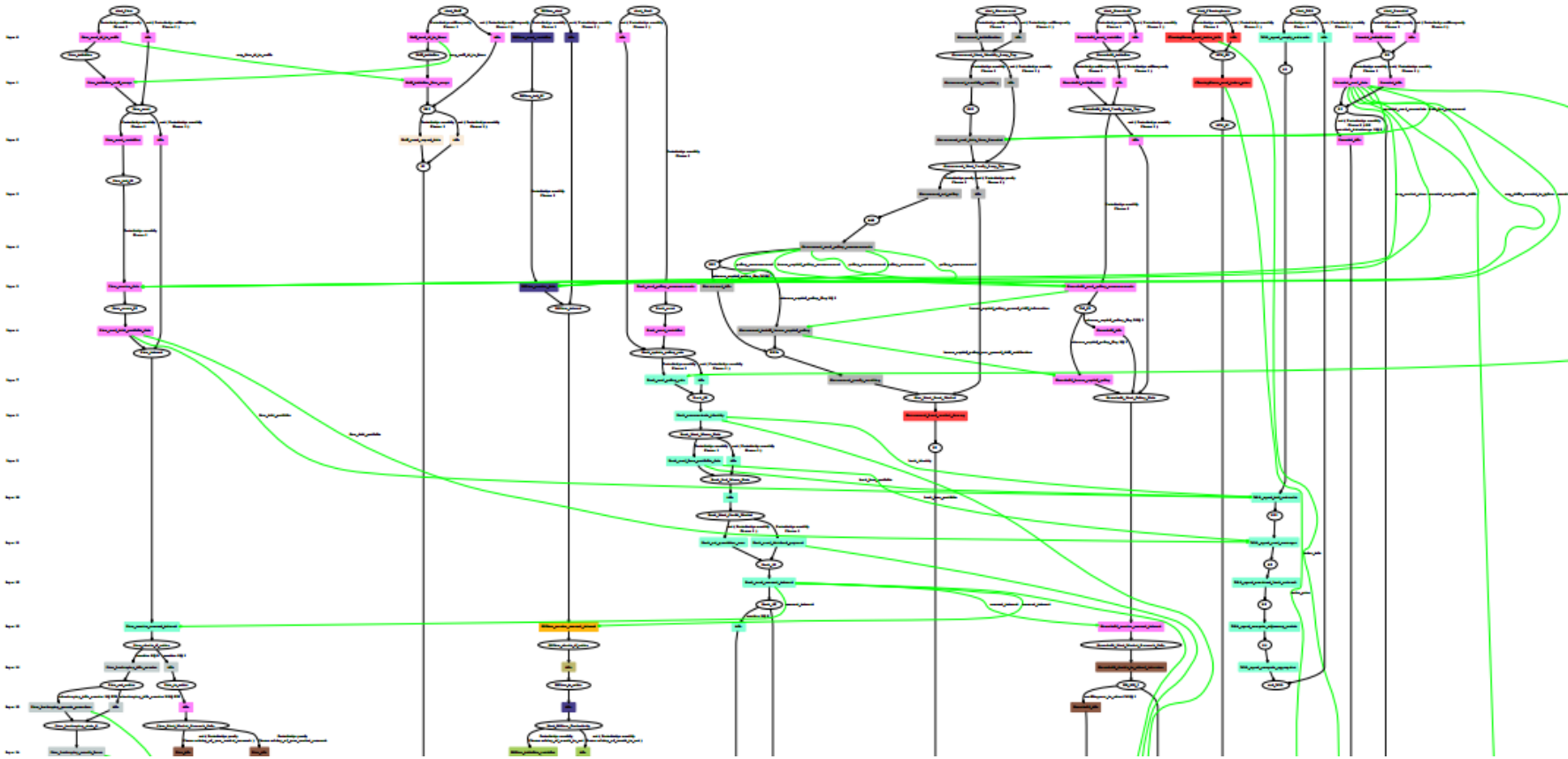
The Big Questions

- Which micro- or macro-prudential banking regulations are beneficial to **financial stability**?
- Prevention and mitigation policies:
- How to **prevent** severe downturns from occurring?
- How to **mitigate** the cumulative economic losses?


Agent
Role
Activity
Activity
Role
Agent
Household
ConsGoodFirm
Employee
labor supply
reservation wage
Labor Market
(search & matching)
labor demand
wage schedule
Employer
Consumer
cgood demand
consumption choice
Cons. Goods Market
(local malls)
cgood supply
posted prices
Producer
Investor
asset demand
savings decision
Financial Market
(index bond)
InvGoodFirm
Producer
igood supply
vintage menu
posted prices
Capital Goods Market
igood demand
vintage choices
Investor
Bank
Creditor
credit supply
rank credit risk
Credit Market
(credit rationing)
credit demand
rank interest
Debtor
ECB
Monetary policy
Gov
Policy maker
Eurace@Unibi



Mechanisms in the model

1. Probability of Default (PD): Internal Risk-Based approach (IRB)
2. Interest rate rule for commercial banks
3. Debt-equity transformation: Insolvency / Illiquidity
4. Dividend payout rule
5. Credit rationing rule
6. Capital Adequacy Requirement (CAR)
7. Central Bank Reserve Ratio Requirement (RRR)
8. Future research: Capital Conservation Buffers & Counter-Cyclical Capital Buffers:

Probability of Default, Interest rate rule

1. Firm's default probability

$$PD_t^f = \max\{0.0003, 1 - e^{-\nu D_t^f / E_t^f}\},\ \nu = 0.1$$

2. Interest rate offered by bank b to firm i

$$r_t^{bf} = r^{ECB}\left(1 + \lambda^B \cdot PD_t^f + \varepsilon_t^b\right),\ \varepsilon_t^b \sim U[0,1]$$

$r^{ECB} = 0.01$

$\lambda^B = 3$: penalty rate for high-risk firm, uniform across banks

ε_t^b: bank's ideosyncratic operating costs

Capital Adequacy Requirement

1. Risk-exposure of credit request (Expected Loss at Default):

$$rwa_{it}^b = PD_{it} \cdot L_{it}. \qquad \text{and} \qquad RWA_t^b = \sum_{i=1}^{F} \sum_{k=0}^{K(i)} PD_{kt} \cdot L_{kt}, \tag{1}$$

2. Constraint 6: **Capital Adequacy Requirement** (CAR)

$$RWA_t^b \leq \alpha \cdot E_t^b, \qquad \alpha \geq 0 \tag{2}$$

3. Risk-exposure "budget" of the bank:

$$V_t^b := \alpha \cdot E_t^b - RWA_t^b \tag{3}$$

4. Risk-constrained loan demand:

$$\bar{\ell}_{it}^b = \begin{cases} L_{it} & \text{if } PD_{it} \cdot L_{it} \leq V_t^b \\ 0 & \text{if } 0 \leq V_t^b \leq PD_{it} \cdot L_{it} \\ 0 & \text{if } V_t^b < 0. \end{cases} \tag{4}$$

Reserve Ratio Requirement

- Constraint 7: **Reserve Ratio Requirement (RRR)**

$$M_t^b \geq \beta \cdot Dep_t^b, \qquad \beta \in [0,1] \tag{5}$$

- Excess liquidity "budget" of the bank:

$$W_t^b := M_t^b - \beta \cdot Dep_t^b \tag{6}$$

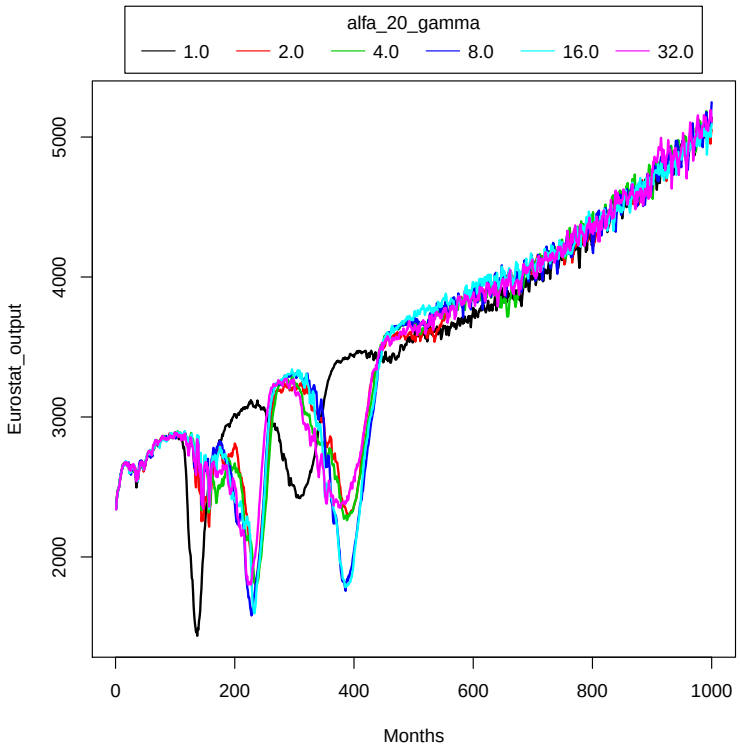
- Loan granted: risk- and liquidity constrained credit request

$$\ell_{i,t}^b = \begin{cases} \bar{\ell}_{i,t}^b & \text{if } W_t^b \geq \bar{\ell}_{i,t}^b \\ \phi \cdot \bar{\ell}_{i,t}^b & \text{if } 0 \leq W_t^b \leq \bar{\ell}_{i,t}^b \\ 0 & \text{if } W_t^b < 0. \end{cases} \tag{7}$$

  Possibility of **credit rationing**: $\{\phi : W_t^b - \phi \cdot \bar{\ell}_{i,t}^b = 0\} \rightarrow \phi = W_t^b / \bar{\ell}_{i,t}^b$

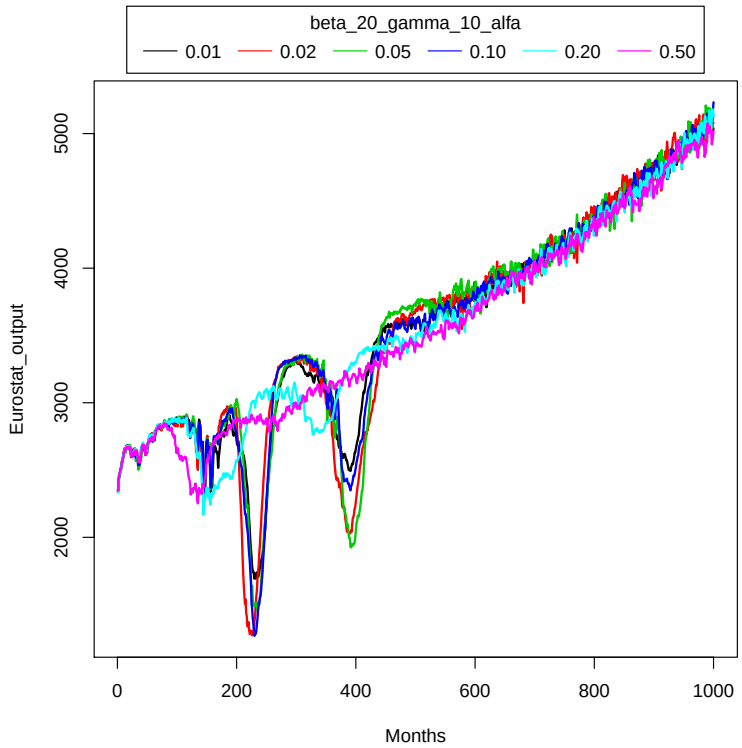
- Illiquid banks stop lending to all firms (bank lending channel)
- Risky firms cannot get loans (borrower's balance sheet channel)

Parameter sensitivity analysis



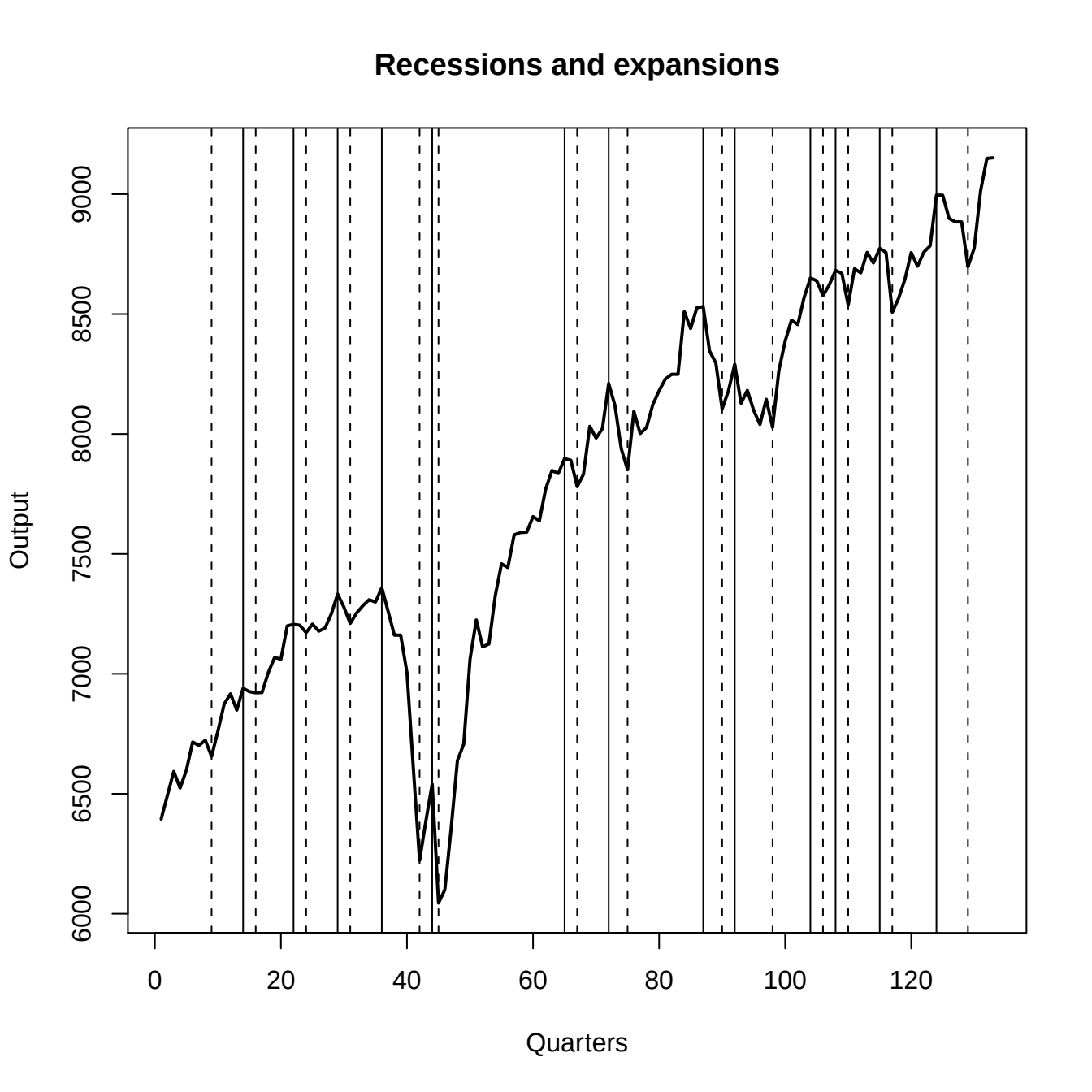
α-sensitivity: Cap. Adq. Req.

- Default: $\alpha = 32$ (3%)
- Lower: **amplitude of recessions increases**

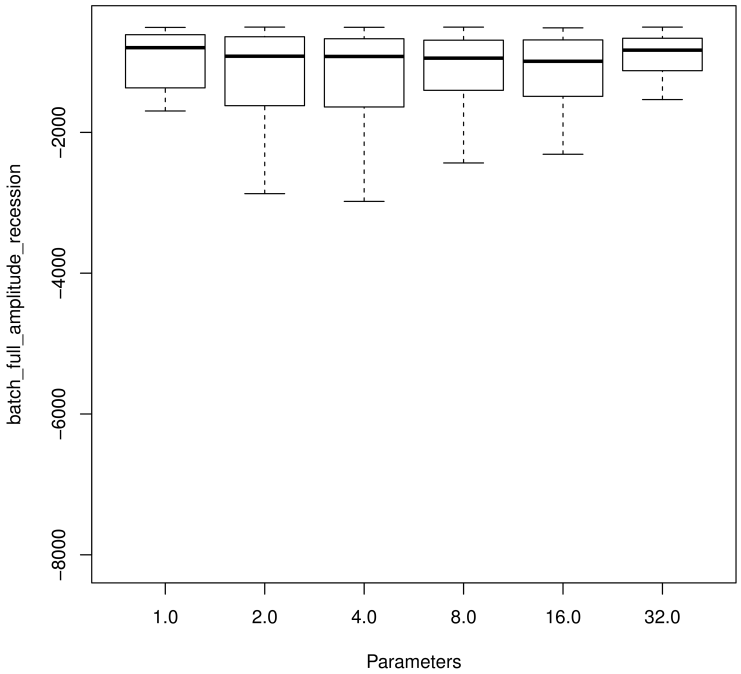


β-sensitivity: Reserve Req.

- Default: $\beta = 0.05$ (5%)
- Higher: **amplitude of recessions decreases**

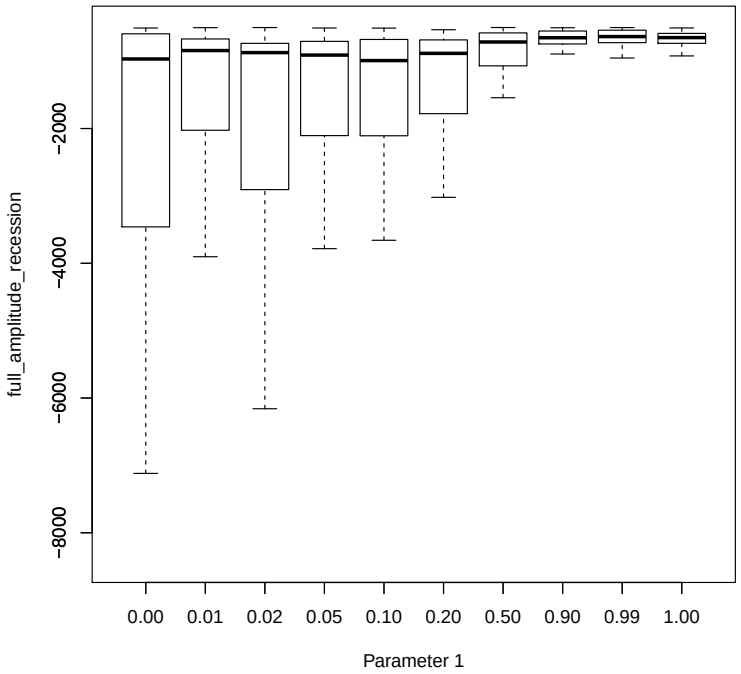

Recessions and expansions
Output
6000
6500
7000
7500
8000
8500
9000
0
20
40
60
80
100
120
Quarters

Parameter sensitivity analysis



α-sensitivity: Cap. Adq. Req.

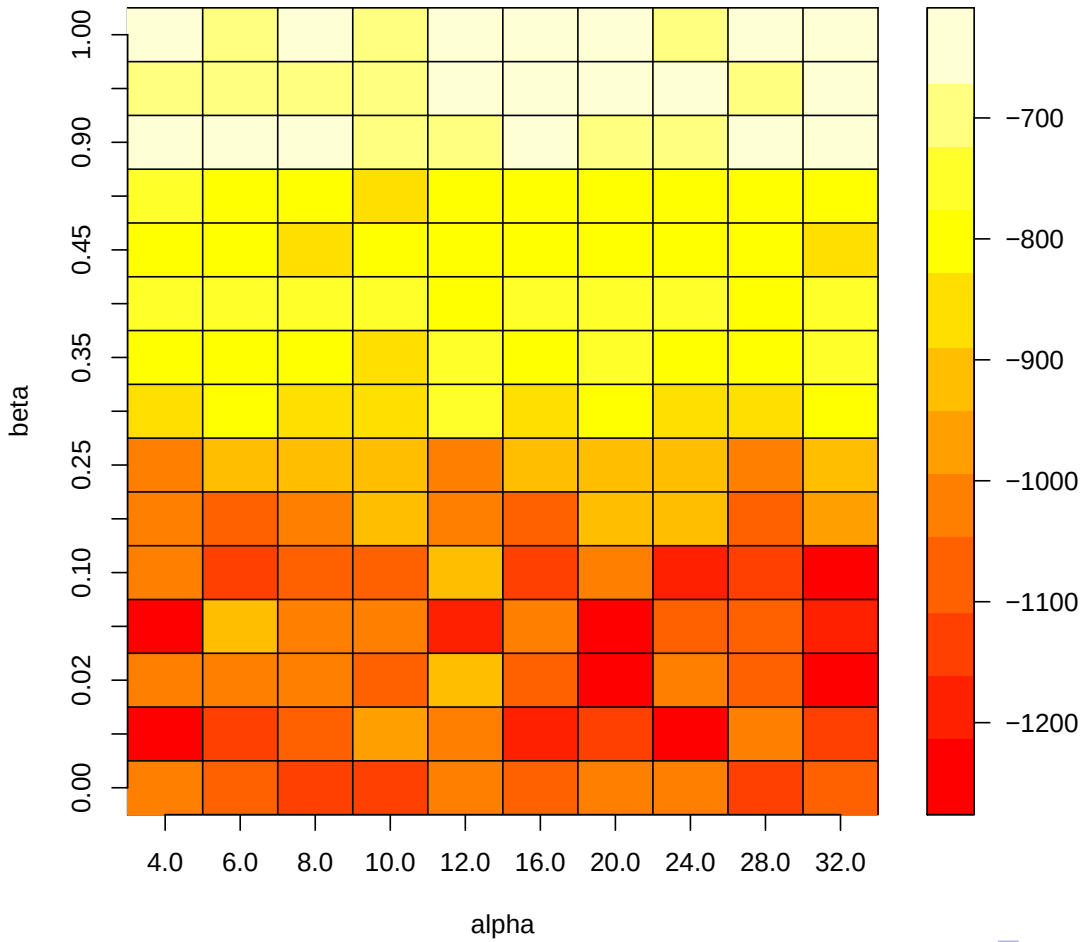
- Basel III: $4.5 - 10.5\%$ $\alpha = 22.2 - 9.5$
- Lower: **amplitude of recessions increases**



β-sensitivity: Reserve Req.

- EU: $\beta = 0.01$, US: $\beta = 0.10$, CA: $\beta = 0$
- Higher: **amplitude of recessions decreases**

Parameter sensitivity analysis 2D-grid



Prevention and mitigation policies: The Limits to Credit Growth

Proposed regulations to limit excesses in banking (eg. Admati & Hellwig, 2013):

A. Default regulation: Capital ratio 12.5%, Reserve ratio 10%.

B. Banning bank dividend payouts $\rightarrow$ Increases bank equity capital

C. Using non-risk-weighted capital ratios $\rightarrow$ Prevents abuse of risk-weights ("risk-weight management optimization")

D. Cutting-off funding to all financially **unsound firms** $\rightarrow$ Prevents leverage

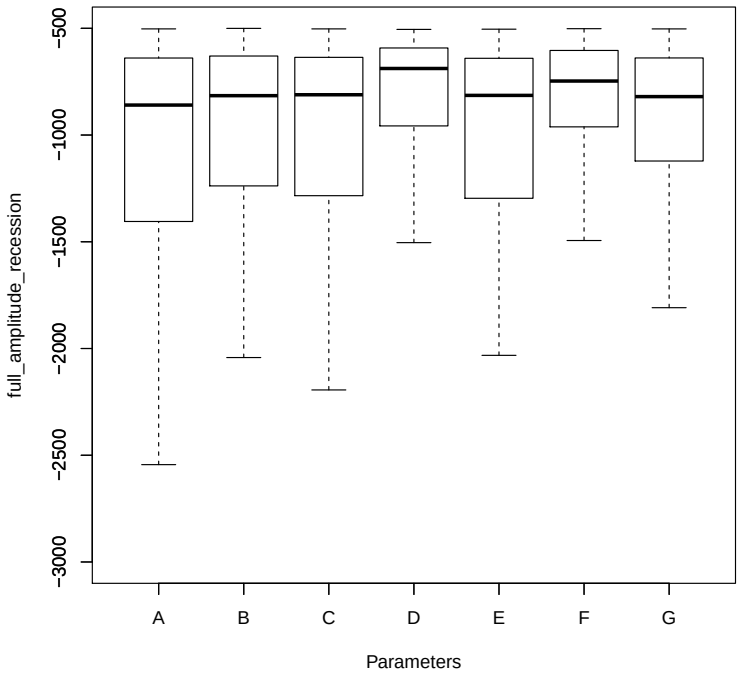
E. Cutting-off funding to **Ponzi firms** only $\rightarrow$ Prevents further leverage

F. Combined effect of BCD $\rightarrow$ Does it help to prevent bubbles?

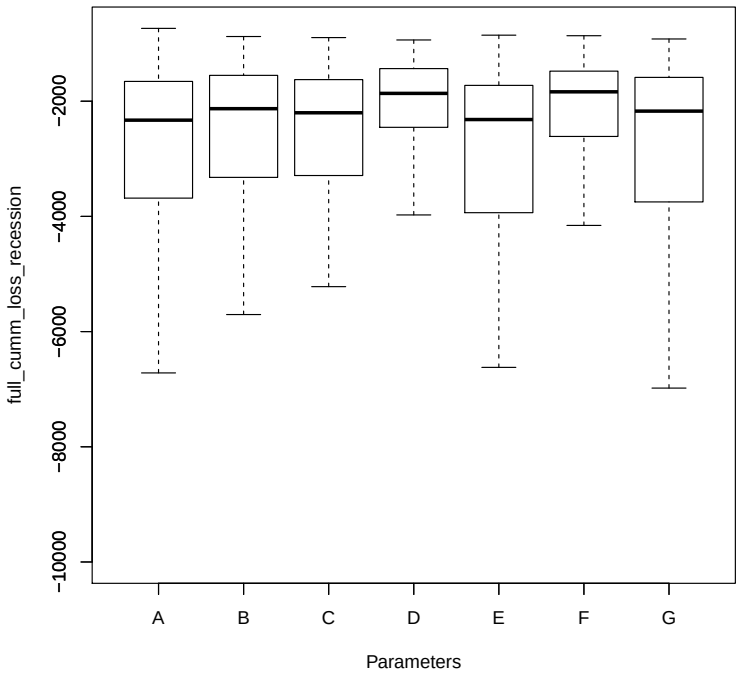
G. Combined effect of BCE $\rightarrow$ Does it help to prevent bubbles?

Prevention and mitigation policies: The Limits to Credit Growth

Comparison across regulations A - G



amplitude of recessions (output lost)



cumulative loss of output (amplitude & duration)

Main Conclusions

- To prevent large **cumulative losses** that follow from recessions, it is required to **cut-off funding** to all financially unsound firms (speculative and Ponzi firms).
- Mere capital ratios, and increasing them incrementally, **do not help** to prevent credit bubbles.
- Imposing strict **limits to growth** on the **excessive supply of credit** seems to work best to mitigate the severity of economic downturns.

Thank you for your attention!

Model documentation:

www.wiwi.uni-bielefeld.de/lehrbereiche/vwl/etace/Eurace_Unibi/

Papers:

- **S van der Hoog & H Dawid (2015):**
  Bubbles, Crashes and the Financial Cycle, Working Paper Bielefeld University.
- **H Dawid, S Gemkow, P Harting, S van der Hoog & M Neugart (2014):**
  Agent-Based Macroeconomic Modeling and Policy Analysis: The Eurace@Unibi Model. In: S-H Chen, M Kaboudan (Eds), Handbook on Computational Economics and Finance. Oxford University Press.
- **H Dawid, S Gemkow, P Harting, S van der Hoog & M Neugart (2012):**
  The Eurace@Unibi Model: An Agent-Based Macroeconomic Model for Economic Policy Analysis. Working Paper University Bielefeld.
- **H Dawid, S Gemkow, P Harting, S van der Hoog & M Neugart (2011):**
  Eurace@Unibi Model v1.0 User Manual. Working Paper Bielefeld University.
- **H Dawid & P Harting (2012):** Capturing Firm Behavior in Agent-Based Models of Industry Evolution and Macroeconomic Dynamics, in: G. Bünstorf (Ed), Applied Evolutionary Economics, Behavior and Organizations. Edward Elgar, pp. 103-130.
- **H Dawid & M Neugart (2011):** Agent-based Models for Economic Policy Design, Eastern Economic Journal 37, 44-50.

Eurace@Unibi

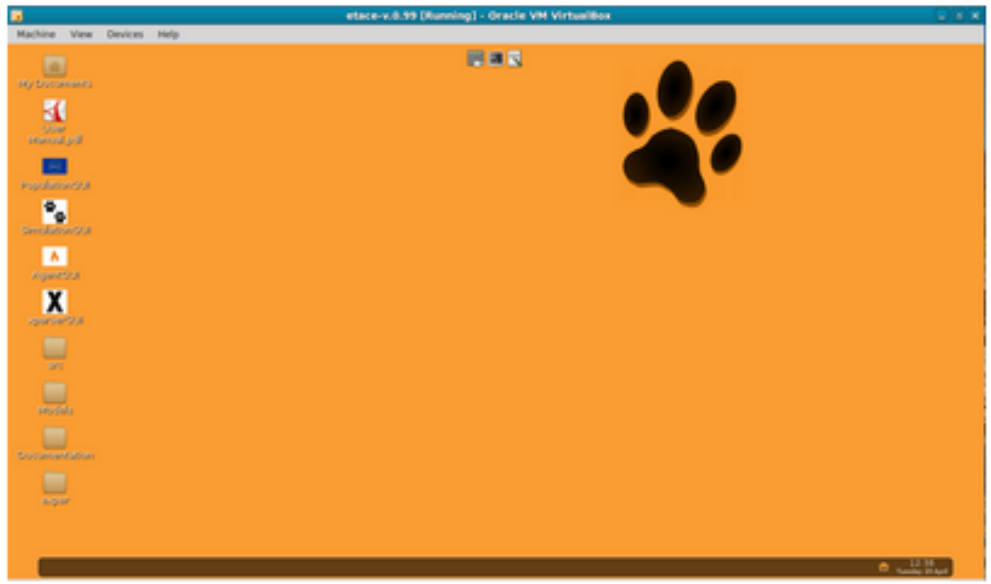
- The Model
- Papers and Model Documentation
- Ongoing Research Using the Eurace@Unibi Model
- Online illustration of simulation results
- FLAME Simulation Framework
- Documents FLAME
- Research Papers using the Eurace@Unibi Model
- **ETACE Virtual Appliance**

The ETACE Virtual Appliance

A Software Suite for Large-scale Agent-based Computational Economic Modelling

by Gregor Böhl, Sander van der Hoog, Philipp Harting, Simon Gemkow and Herbert Dawid

Download Installation Guide User Manual HOWTO Use Shared Folders

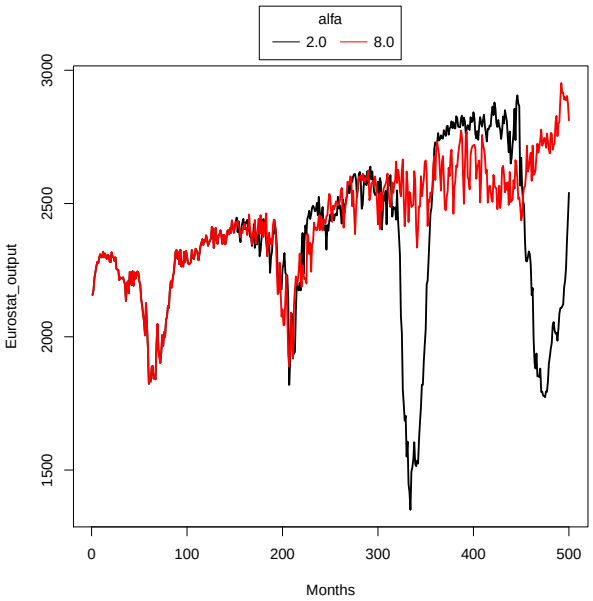


Outlook & Future research

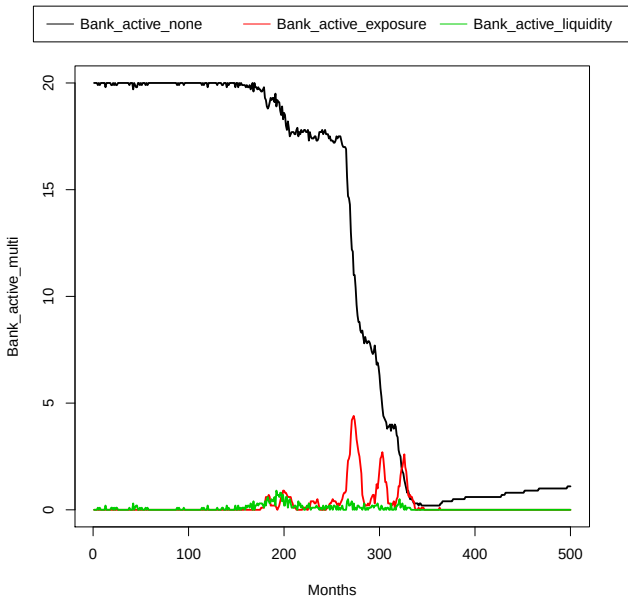
- Macroprudential regulation
  - Systemic risk (SIFIs, SIBs)
  - Bank-firm networks
    - size effects
    - balance sheet contagion
- Empirically-grounded bank behavior
  - Credit quotas
  - Credit rationing of SMEs
  - Tighter integration of Basel III regulation

Scenario: Capital Adequacy Requirement

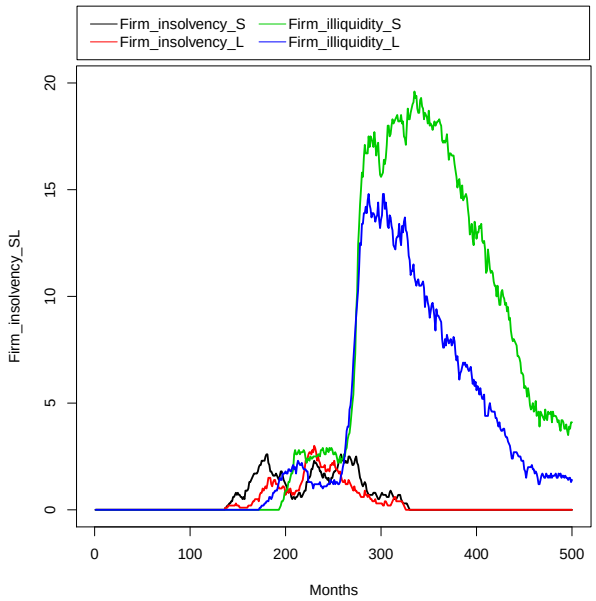
Output



Bank activity ($\alpha = 2$)

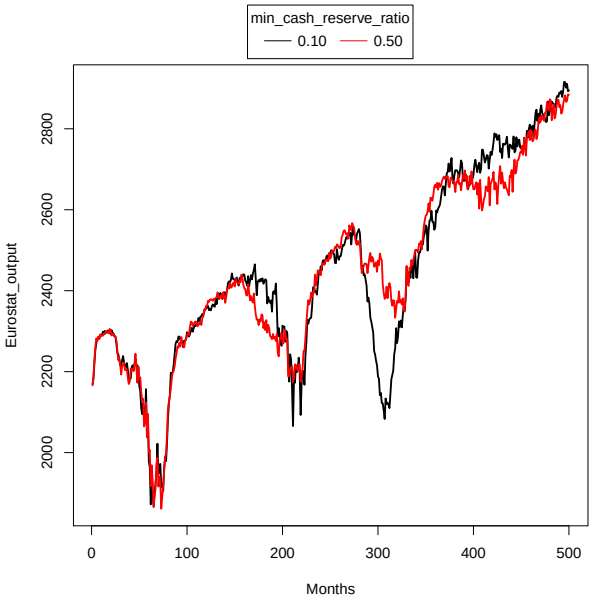


Firm activity ($\alpha = 2$)

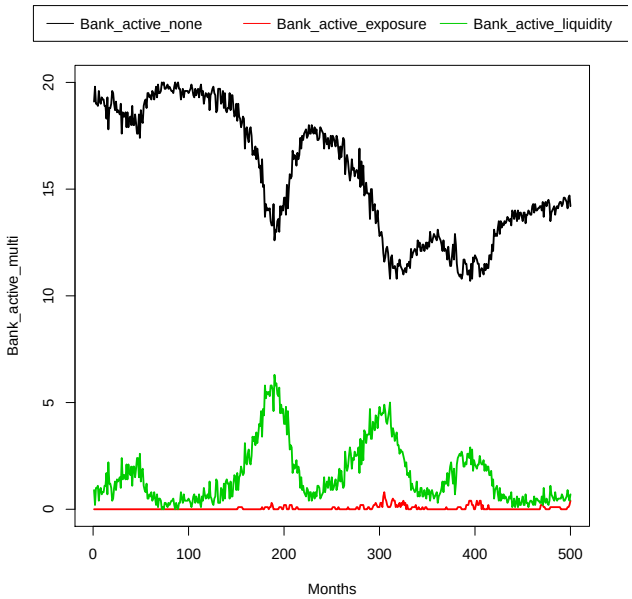


Scenario: Minimum Reserve Requirement

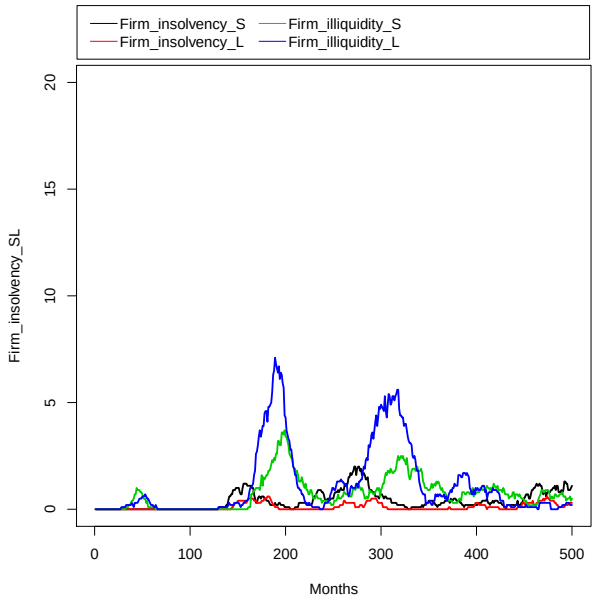
Output



Bank activity ($\beta = 0.50$)

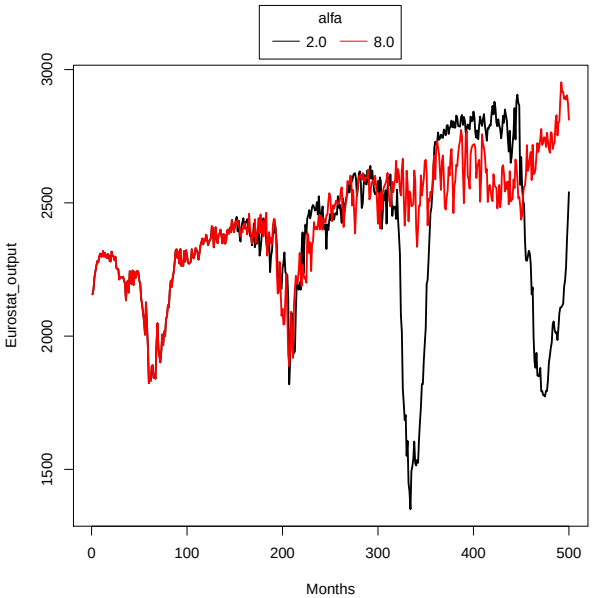


Firm activity ($\beta = 0.50$)



Scenario: Capital Adequacy Requirement

Output



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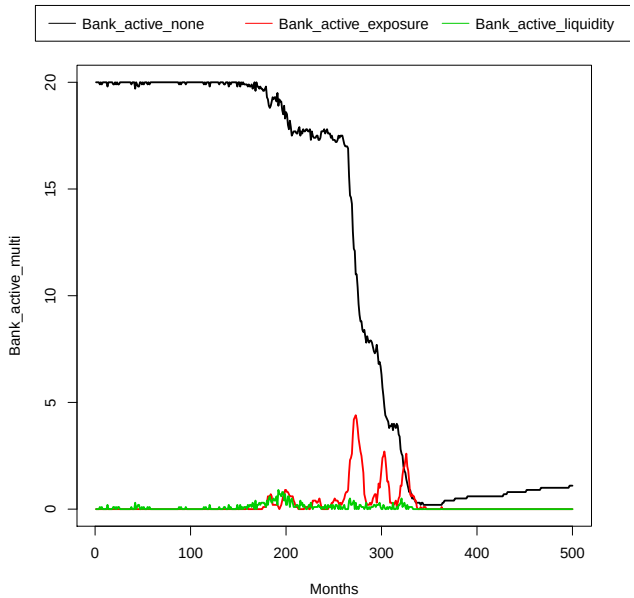
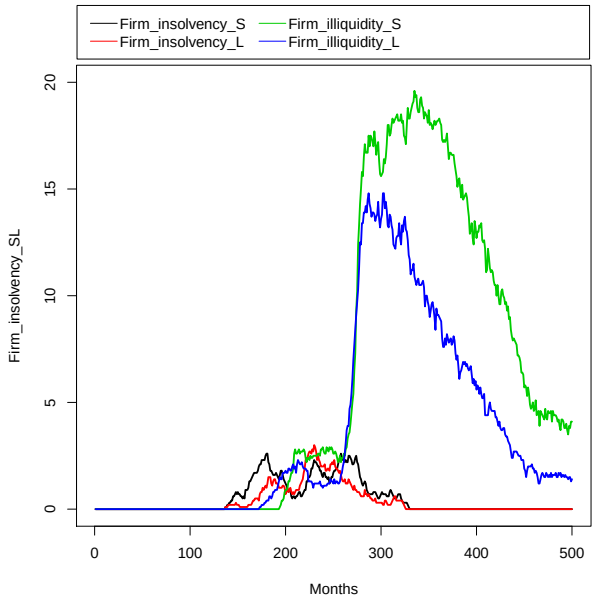
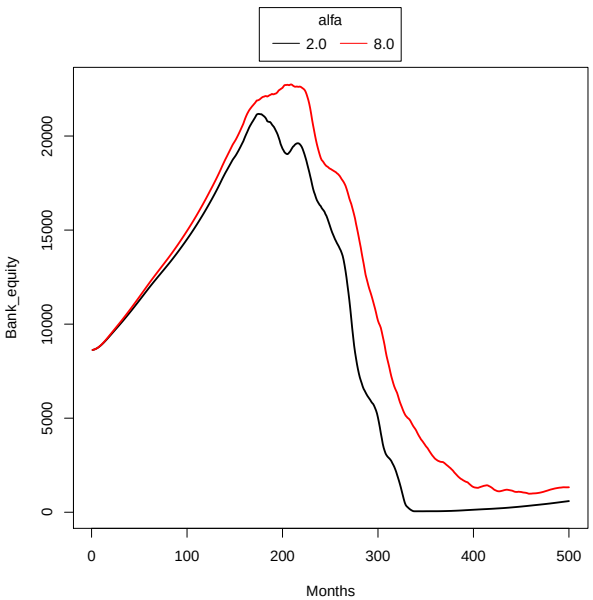
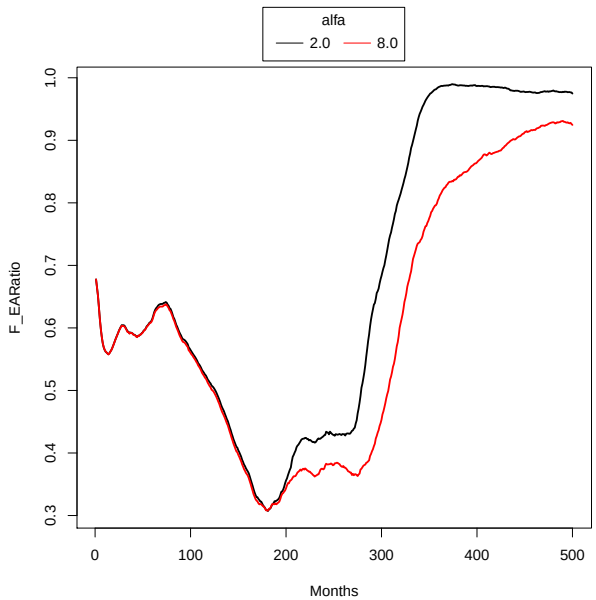


Firm activity ($\alpha = 2$)

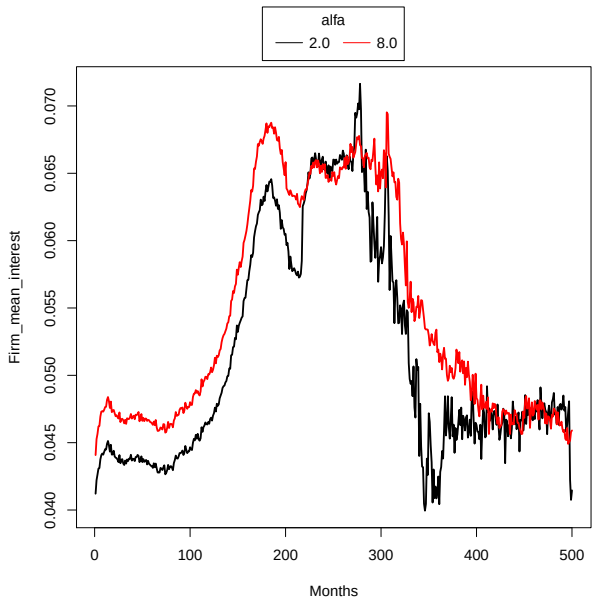




Bank equity



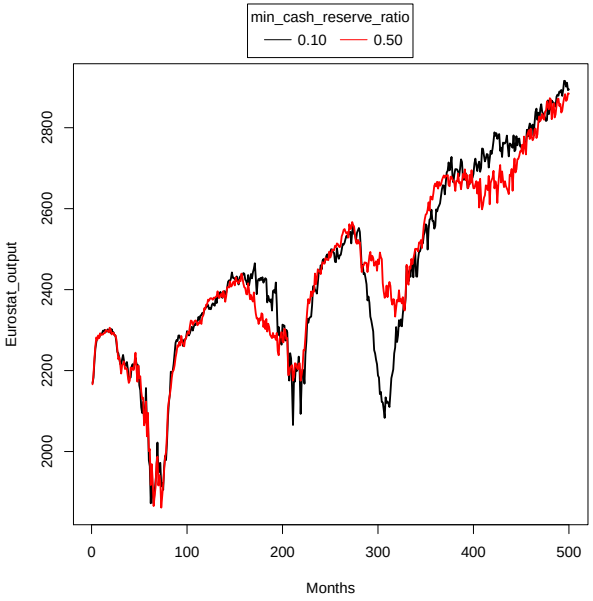
Firm fragility



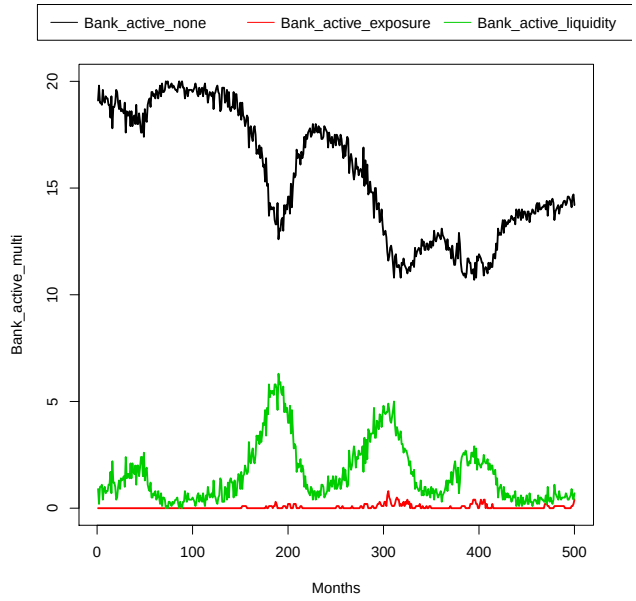
Mean interest

Scenario: Minimum Reserve Requirement

Output



Bank activity ($\beta = 0.50$)



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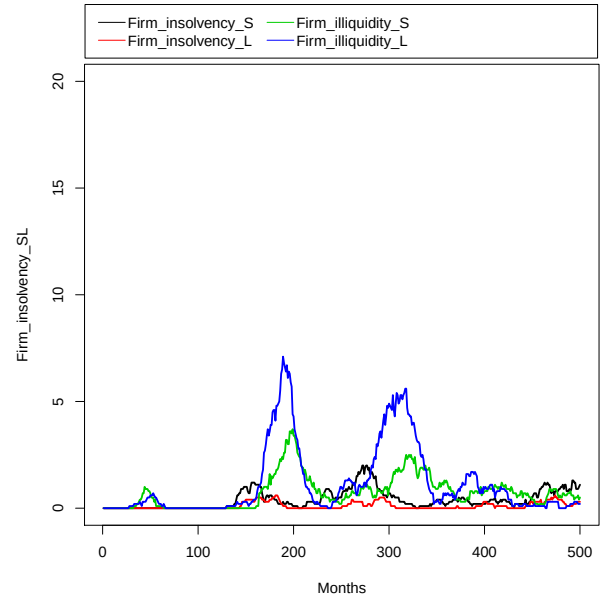
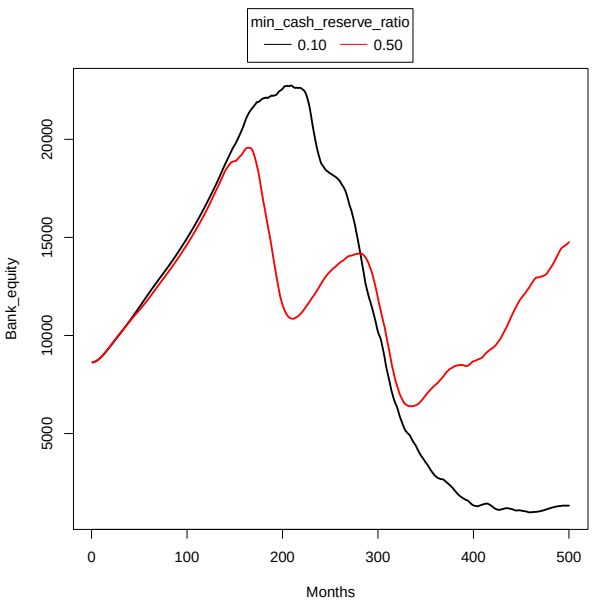
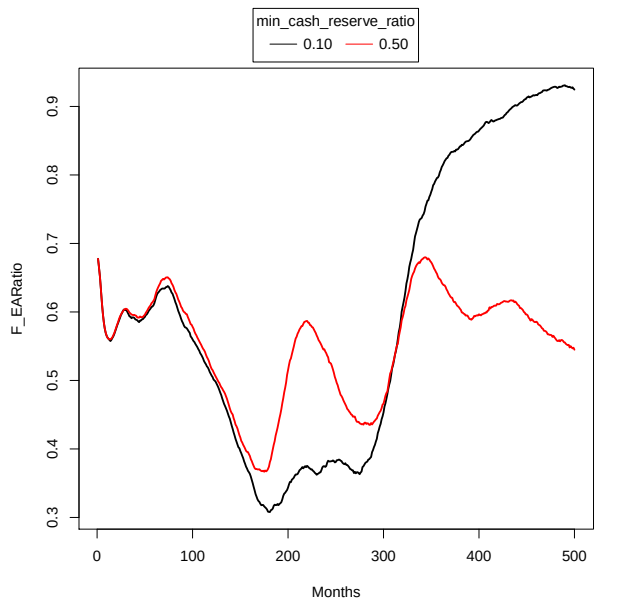
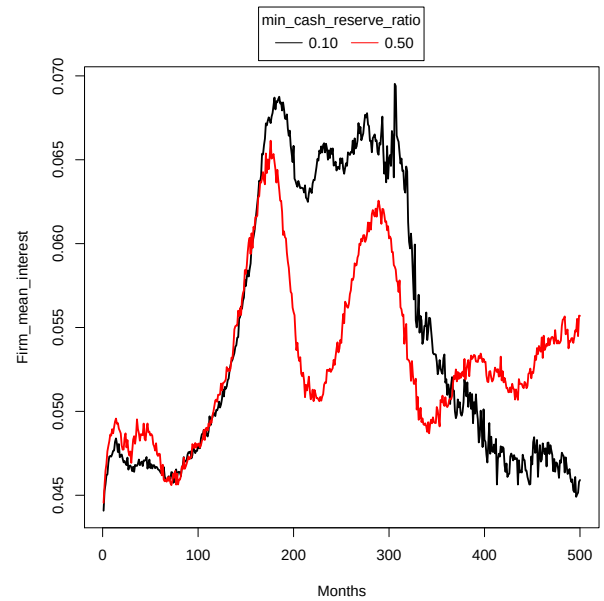




Bank equity



Firm fragility

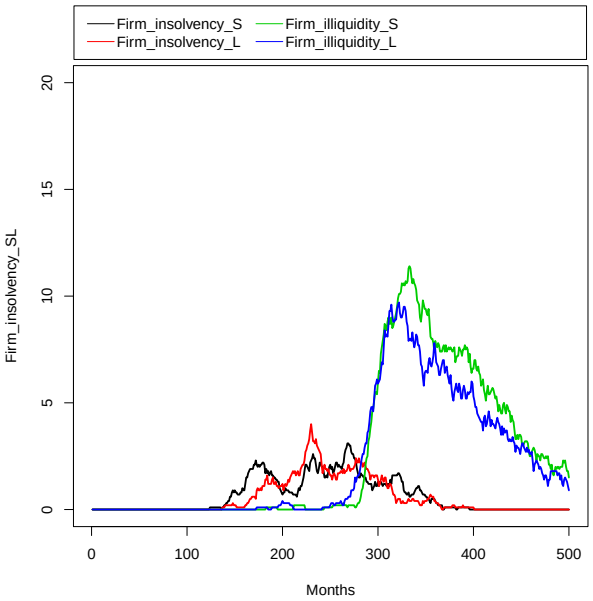


Mean interest

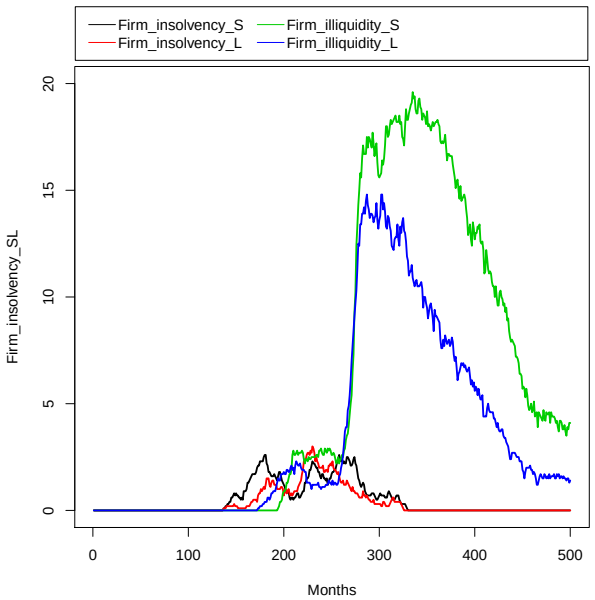
Firm activity

Number of illiquid firms

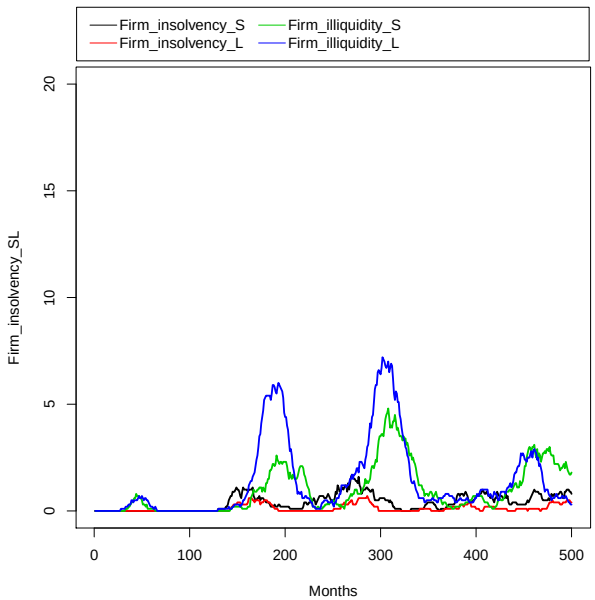
No constraint



Capital constraint ($\alpha = 2$)



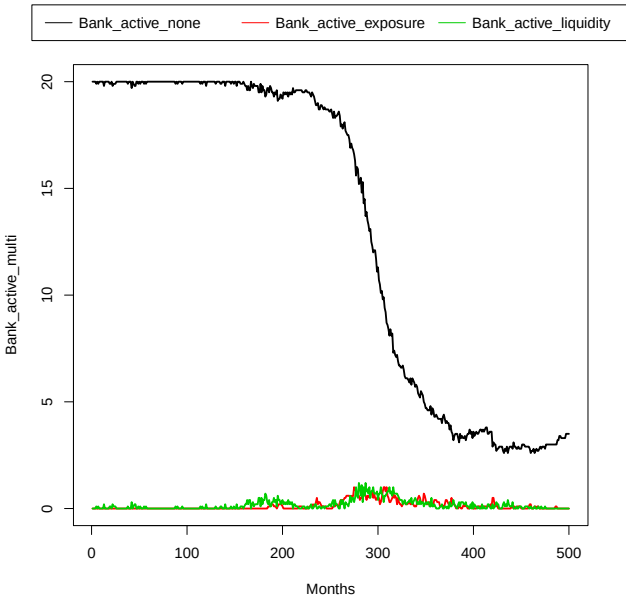
Liquidity constraint ($\beta = 0.50$)



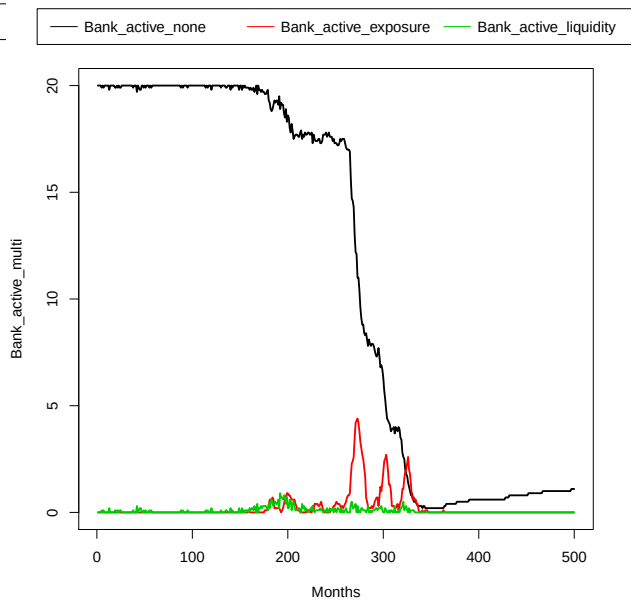
Bank activity

Number of active banks (unconstrained + constrained by equity/liquidity constraint)

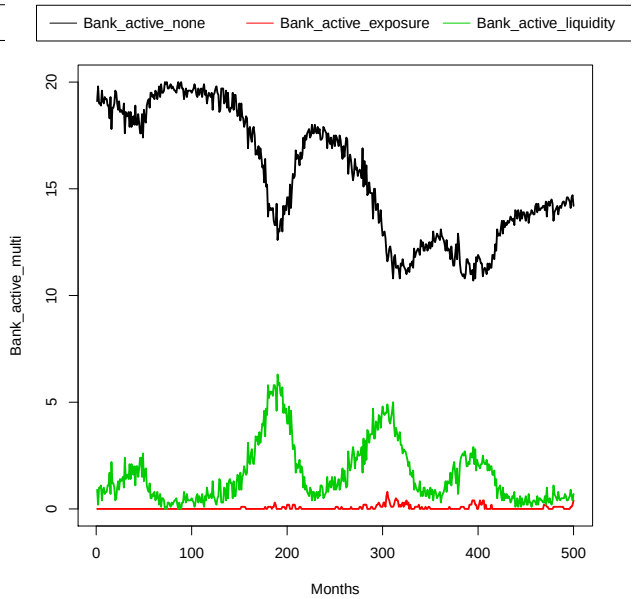
No constraint



Capital constraint ($\alpha = 2$)



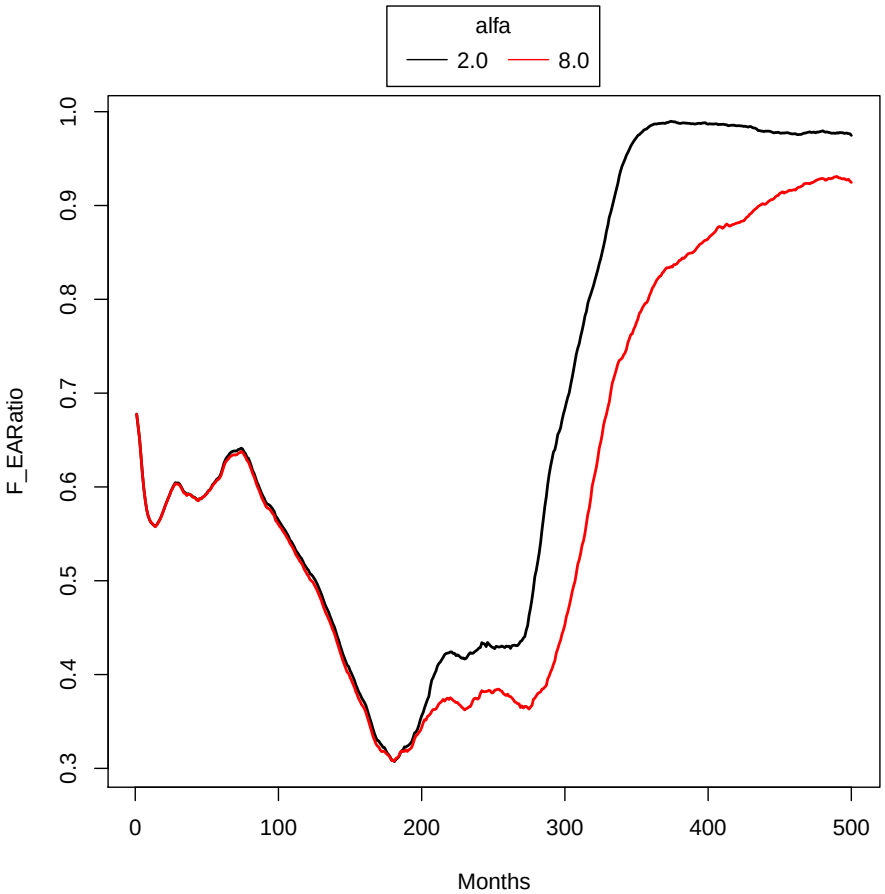
Liquidity constraint ($\beta = 0.5$)



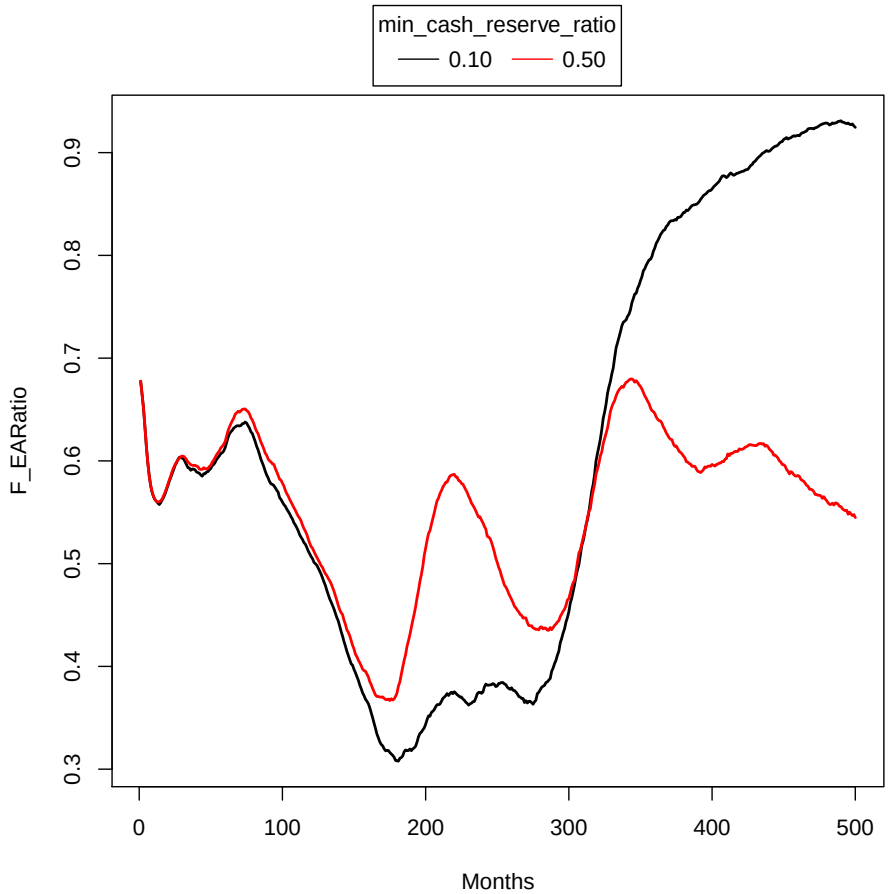
Scenarios: Firm Fragility

Firm E/A-ratio = 1/leverage

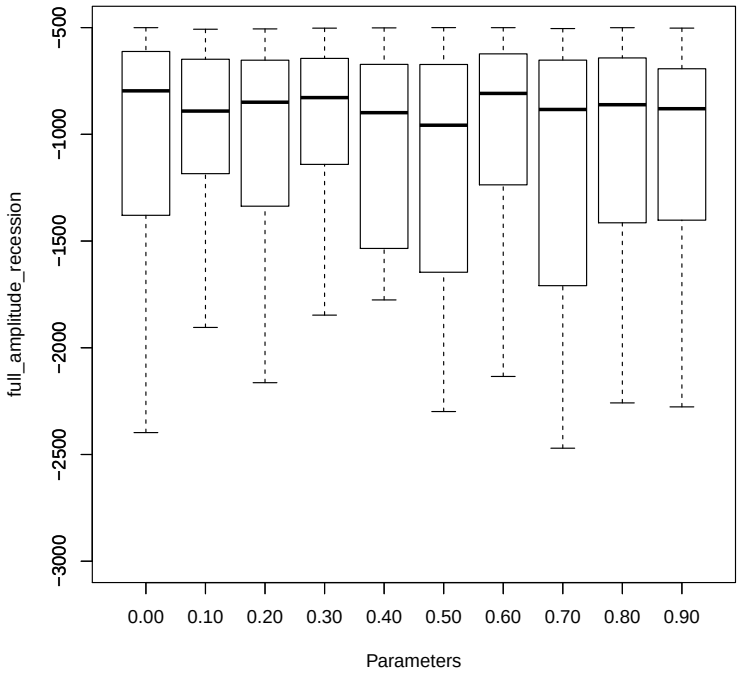
Capital constraint



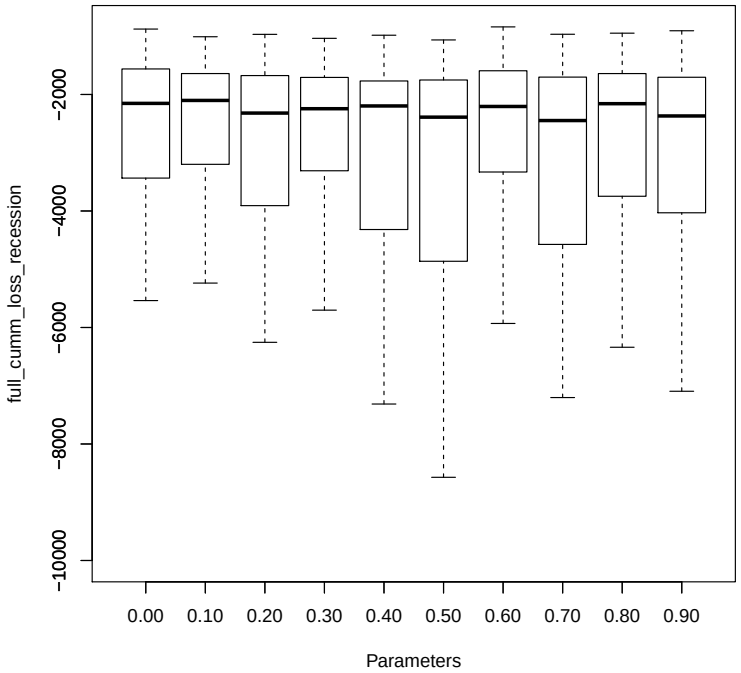
Liquidity constraint



Prevention and mitigation - Bank dividend payout



amplitude of recessions



cumulative loss

Bank accounting

1. **Bank profit**

$$\pi_t^b = r_i^b L_i^b - r^b(\sum_h M_h^b + \sum_i M_i^b) + r^{ECB}(M_t^b - D_t^b)$$

2. **Bank cash and reserves**

$$M_{t+1}^b = M_t^b + \Delta M_h^b + \Delta M_i^b + (1-\tau)\max[0, \pi_t^b] - d^b(1-\tau)\max[0, \pi_t^b]$$

Debt-equity transformation

3a. **Insolvency bankruptcy**

Debt renegotiation is addressed by re-scaling the total debt D_t^f with a debt rescaling parameter φ.

Target debt is given by:

$$D^* = \varphi A_t^f \qquad \text{with} \qquad 0 \leq \varphi \leq 1\,. \tag{8}$$

After debt restructuring, the equity of the firm is now positive:

$$E^* = (1-\varphi)A_t^f > 0. \tag{9}$$

The new debt/equity-ratio is given by the constant $D^*/E^* = \varphi/(1-\varphi) < 1$.

Debt-equity transformation

3b. **Illiquidity bankruptcy**

Debt-renegotiation is not necessary per se, rescaling of the debt is either based on the level of total assets or on the level of the original debt:

$$D^* = \begin{cases} \varphi A_t^f & \text{if } \varphi A_t^f \leq D_t^f \\ \varphi D_t^f & \text{if } \varphi A_t^f > D_t^f . \end{cases} \qquad \text{with} \qquad 0 \leq \varphi \leq 1 . \tag{10}$$

The new debt/equity-ratio is given by the following piece-wise function:

$$D^*/E^* = \begin{cases} \varphi/(1-\varphi) & \text{if } \varphi A_t^f \leq D_t^f \\ \varphi/(A/D-\varphi) & \text{if } \varphi A_t^f > D_t^f . \end{cases} \tag{11}$$

Dividend payout rule

- $\langle R^f \rangle_{n_R}$: average revenues over previous n_R months ($n_R = 3, 6, 12$)
- $\langle \Pi^f \rangle_{n_E}$: average net earnings (after-tax profits) over the last n_E months

$$\langle R^f \rangle_{n_R} = \frac{1}{n_R} \sum_{i=0}^{n_R - 1} R^f_{t-i} \tag{12}$$

$$\langle \Pi^f \rangle_{n_E} = \frac{1}{n_E} \sum_{i=0}^{n_E - 1} \Pi^f_{t-i} \tag{13}$$

- Prevent liquidity hoarding by firms: Liquidity Buffer Stock

4. **Dividend payout rule:**

$$Div^f = \begin{cases} d \cdot \langle \Pi^f \rangle_4 & \text{if } M^f_t \leq \mu \cdot \langle R^f \rangle_6 \\ \langle \Pi^f \rangle_4 & \text{if } M^f_t > \mu \cdot \langle R^f \rangle_6. \end{cases} \qquad d = 0.7, \mu = 0.5 \tag{14}$$

Exogenous Credit Rationing

5a. **Full/Partial credit rationing** is based on the (exogenously prescribed, ex ante) constraints of the bank (CAR, CRR).

- Full rationing for CAR constraint:

$$\bar{\ell}_{it}^{b} = \begin{cases} L_{it} & \text{if } PD_{it} \cdot L_{it} \leq V_t^b \\ 0 & \text{if } 0 \leq V_t^b \leq PD_{it} \cdot L_{it} \\ 0 & \text{if } V_t^b < 0. \end{cases} \tag{15}$$

- Partial rationing ("filling up to constraint") for CAR constraint:

$$\bar{\ell}_{it}^{b} = \begin{cases} L_{it} & \text{if } PD_{it} \cdot L_{it} \leq V_t^b \\ V_t^b / PD_{it} & \text{if } 0 \leq V_t^b \leq PD_{it} \cdot L_{it} \\ 0 & \text{if } V_t^b < 0. \end{cases} \tag{16}$$