

Bubbles, Crashes & the Financial Cycle

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SCE@20 in Oslo, June 2014

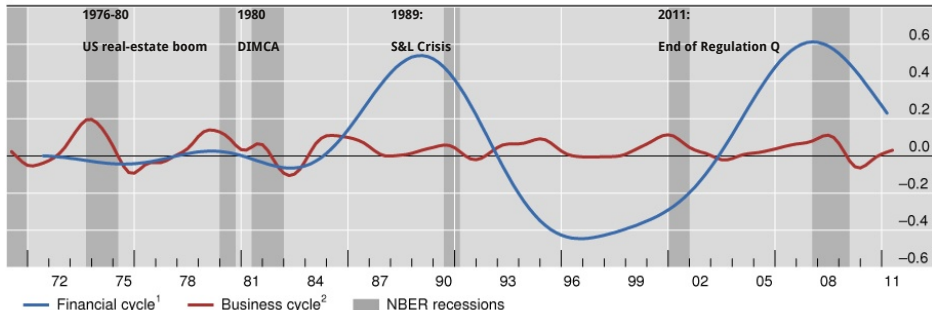
Outline of topics

- ▶ Agent-based Macroeconomics
- ▶ Leverage cycle – Geanakoplos
- ▶ Financial Instability Hypothesis – Minsky
- ▶ Basel III and the procyclicality of capital adequacy requirements
- ▶ Macro-prudential banking regulation

The Business & Financial Cycle

The financial and business cycles in the United States

Graph 1



¹ The line traces the financial cycle measured as the average of the medium-term cycle in the component series using frequency-based filters. ² The line traces the GDP cycle identified by the traditional shorter-term frequency filter used to measure the business cycle.

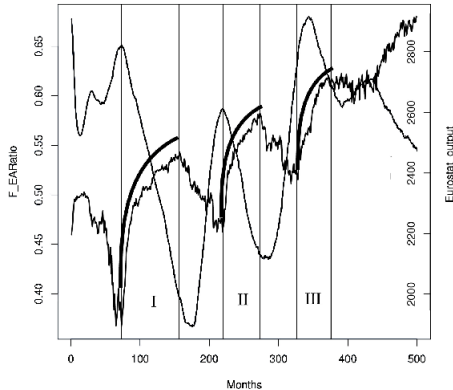
Source: Drehmann et al (2012). 1980: Depository Institutions Deregulation and Monetary Control Act: Deregulation of Savings and Loans institutions

2011: Regulation Q: prohibition of interest-bearing demand deposit accounts

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Financial Instability Hypothesis

- ▶ Equity/Asset-ratio: Measure for financial robustness
- ▶ Fragility synchronized with business cycle? (Fragile booms, deleveraging recovery)



Output and E/A ratio

Empirical Motivations

Features of macroeconomics with a financial cycle (Borio, 2012):

- ▶ the financial boom should not just precede the bust but cause it (à la Minsky).
- ▶ the presence of debt and capital stock overhangs (excess stocks, non-full utilization rates).

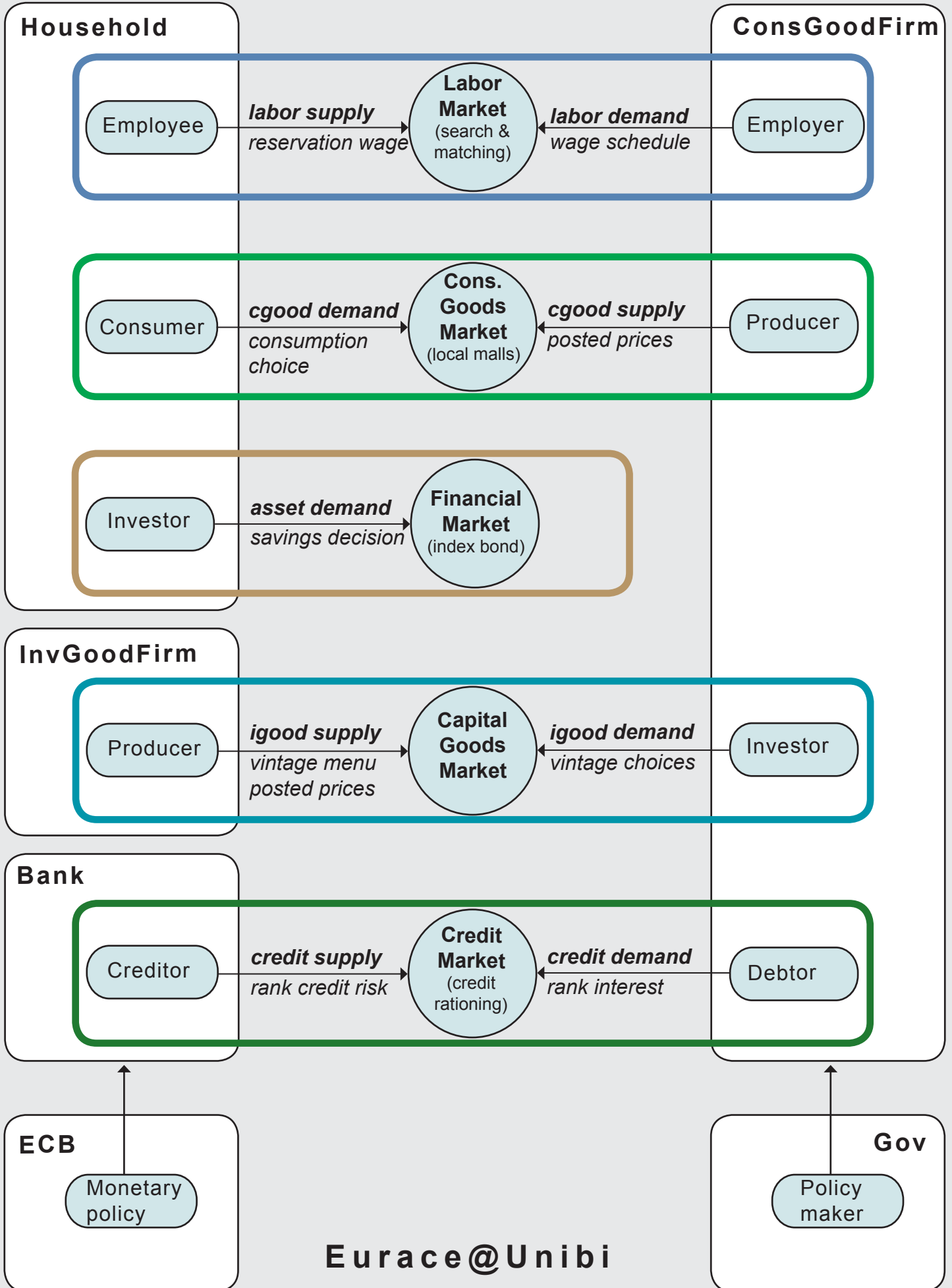
Findings:

- ▶ Recessions following a crisis after a fragile boom tend to have much larger declines in consumption, investment, output, and employment. (Shularick & Taylor, 2012)
- ▶ Balance sheet recessions: Recessions driven by deleveraging lead to a prolonged slump. (Koo, 2011)

Balance sheets

Firm		Bank	
Assets	Liabilities	Assets	Liabilities
Liquidity + revenues – wage bill – taxes – dividends + interest deposits – interest on loans + new loans		CB reserves (–0.1%) – interest deposits + interest on loans – taxes – dividends +/- CB reserves	Deposits +/- withdrawals + new loans
	Loans from banks + new loans – bad debt	Loans to firms + new loans – bad debt	CB debt (+0.15%) +/- CB reserves +/- interest
Inventory + output – sales			
Capital stock + investment	Equity + profits + bad debt		Equity + profits – bad debt

Agent **Role** **Activity** **Activity** **Role** **Agent**



Literature: The Credit Channel of Monetary Policy Transmission

1. The broad borrowers' balance sheet channel:

(Bernanke & Blinder 1988)

- ▶ Credit demand side
- ▶ Focuses on external finance premium: probability of default
External finance premium: inversely related to borrower's net worth.
- ▶ Changes in the value of assets on the balance sheet of a **firm** affect the firm's **ability to borrow**.

2. The narrow bank lending channel:

(Bernanke & Gertler 1995)

- ▶ Supply of bank loans determined by financial health of banks.
- ▶ Changes in the value of assets on the balance sheet of a **bank** affects the bank's **ability to lend**.

Capital Adequacy Requirement

1. Firm's default probability

$$PD_t^f = \max\{0.03, 1 - e^{-\nu D_t^f / E_t^f}\}, \quad \nu = 0.1$$

2. Interest rate offered by bank b to firm i

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

$$r^{ECB} = 0.01$$

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

ϵ_t^b : bank's idiosyncratic operating costs

Capital Adequacy Requirement

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

$$x_t^f = PD_t^f \cdot L_t^f \quad (1)$$

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

$$\sum_f x_t^f \equiv X_t^b \leq \alpha E_t^b, \quad \alpha \geq 0 \quad (2)$$

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

$$V_t^b \equiv \alpha E_t^b - X_t^b \quad (3)$$

4. Loan granted:

$$\ell_t^f = \begin{cases} L_t^f & \text{if } x_t^f \leq V_t^b & \text{No rationing} \\ \theta \cdot L_t^f = V_t^b / PD_t^f & \text{if } 0 \leq V_t^b \leq x_t^f & \text{Partial rationing} \\ 0 & \text{if } V_t^b \leq 0 & \text{Full rationing} \end{cases} \quad (4)$$

Possibility of **credit rationing**: $\{\theta : V_t^b - PD_t^f \cdot \ell_t^f = 0\} \rightarrow \theta L_t^f = V_t^b / PD_t^f$

Reserve Requirement

- ▶ Constraint: **Reserve Requirement**

$$M_t^b \geq \beta \cdot Dep_t^b \quad (5)$$

- ▶ Excess liquidity "budget" of the bank:

$$W_t^b \equiv M_t^b - \beta \cdot Dep_t^b \quad (6)$$

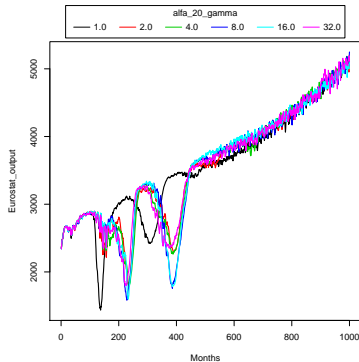
- ▶ Loan granted:

$$l_t^{bf} = \begin{cases} L_t^f & \text{if } W_t^b \geq L_t^f & \text{No rationing} \\ \phi \cdot L_t^f = W_t^b & \text{if } 0 \leq W_t^b \leq L_t^f & \text{Partial rationing} \\ 0 & \text{if } W_t^b < 0 & \text{Full rationing} \end{cases} \quad (7)$$

Possibility of **credit rationing**: $\{\phi : W_t^b - \phi \cdot L_t^f = 0\} \rightarrow \phi = W_t^b / L_t^f$

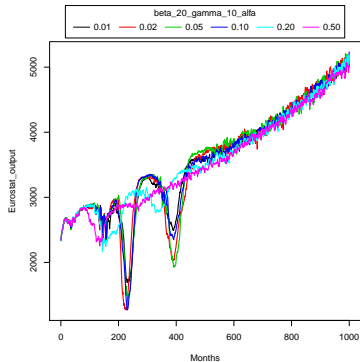
- ▶ Illiquid banks stop lending to all firms (bank lending channel)
- ▶ Risky firms cannot get loans (borrower's balance sheet channel)

Parameter sensitivity analysis



α -sensitivity: Cap. Adq. Req.

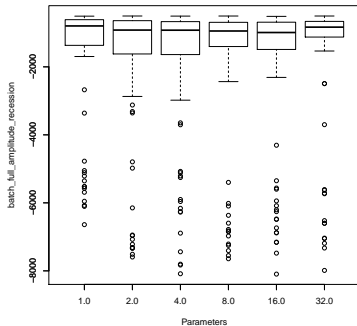
- ▶ Default: $\alpha = 32$ (3%)
- ▶ Lower: **amplitude of recessions increases**



β -sensitivity: Reserve Req.

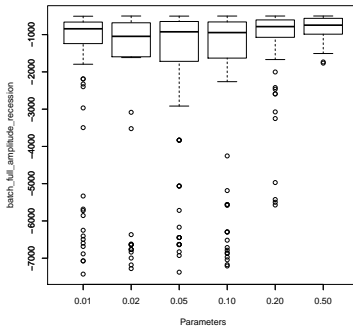
- ▶ Default: $\beta = 0.05$ (5%)
- ▶ Higher: **amplitude of recessions decreases**

Parameter sensitivity analysis



α -sensitivity: Cap. Adq. Req.

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



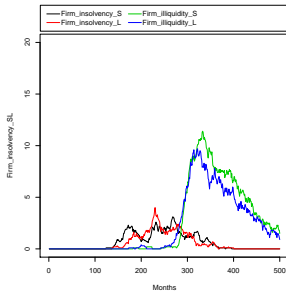
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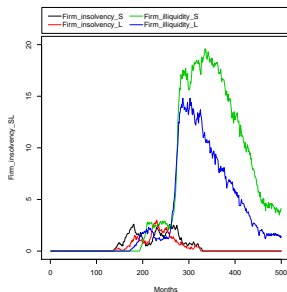
Firm activity

Number of illiquid firms

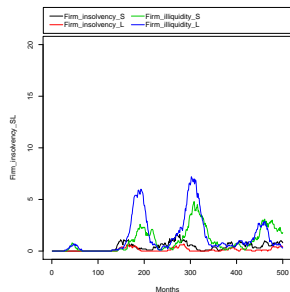
No constraint



Capital constraint ($\alpha = 2$)



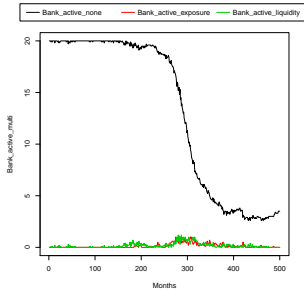
Liquidity constraint ($\beta = 0.50$)



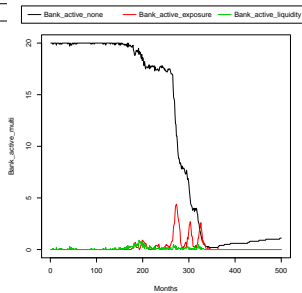
Bank activity

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

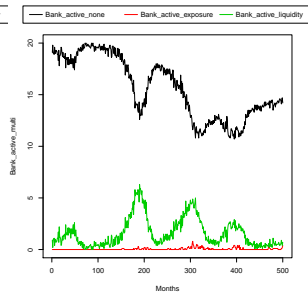
No constraint



Capital constraint ($\alpha = 2$)



Liquidity constraint ($\beta = 0.5$)



Summary

Capital Adequacy Requirement (α)

1. More limits on **excessive risk-taking**
2. Amplitude recessions increases
3. More banks fail
4. More firms go illiquid
 - ▶ constraint does not discriminate
 - ▶ constraint self-reinforcing
5. Steep, sudden deleveraging
6. Concentration in banking sector

Reserve Requirement (β)

1. More limits on **liquidity supply**
2. Amplitude recessions decreases
3. Banks stay alive
4. Large firms go illiquid
 - ▶ large firms largest credit demand
 - ▶ liq. constraint helps small firms
5. Gradual deleveraging in waves
6. Bank equity can recover

Outlook

- ▶ Macroprudential regulation
 - ▶ Systemic risk
 - ▶ Bank-firm networks
- ▶ Empirically-grounded bank behavior
 - ▶ Credit quotas
 - ▶ Credit rationing of SMEs

Thank you for your attention!

Model documentation:

www.wiwi.uni-bielefeld.de/vpl1/research/eurace-unibi.html

Papers:

- ▶ **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
- ⌘ **The ETACE Virtual Appliance**

The ETACE Virtual Appliance

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



Installation Guide

Download:



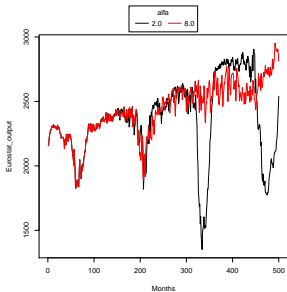
Why is it?

The intention behind the software package is to make every step related to the initialization, execution and analysis of the Eurace@Unibi model as easy as possible. The following versions of the Eurace@Unibi model are included:

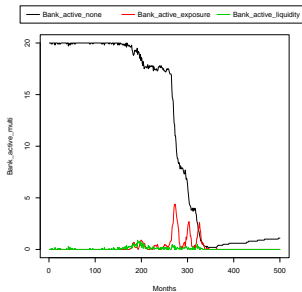
- [Dawid, Gemkow, Harting, van der Hoog & Neugart \(2012\)](#): Eurace@Unibi

Scenario: Capital Adequacy Requirement

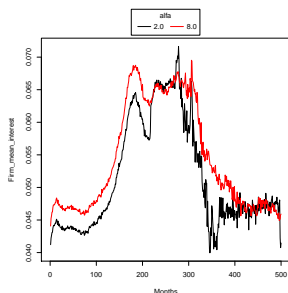
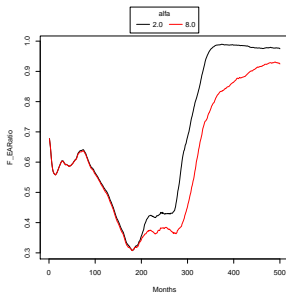
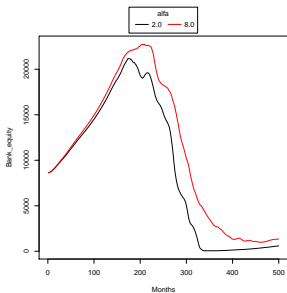
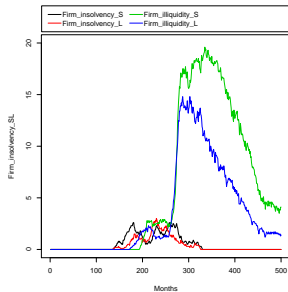
Output



Bank activity



Firm activity



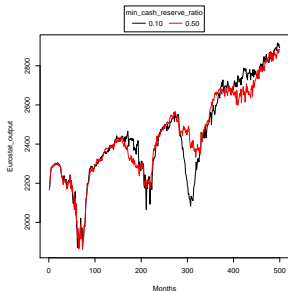
Bank equity

Firm fragility

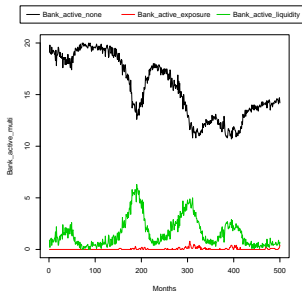
Mean interest

Scenario: Minimum Reserve Requirement

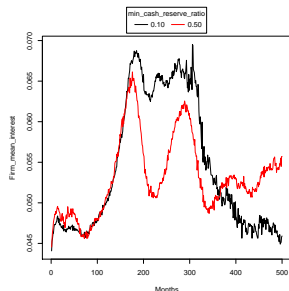
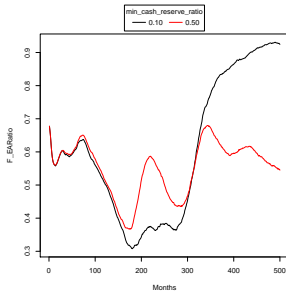
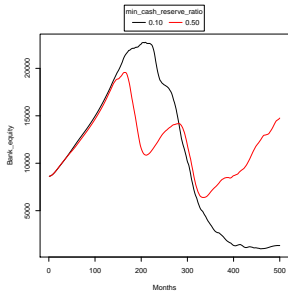
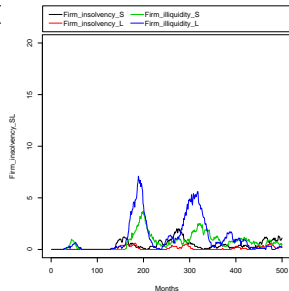
Output



Bank activity



Firm activity



Bank equity

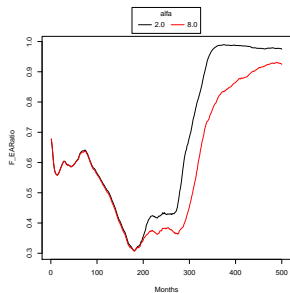
Firm fragility

Mean interest

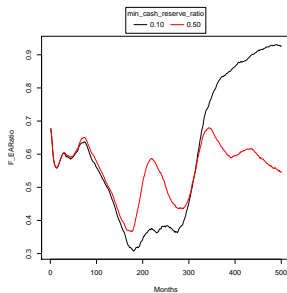
Scenarios: Firm Fragility

Firm E/A-ratio

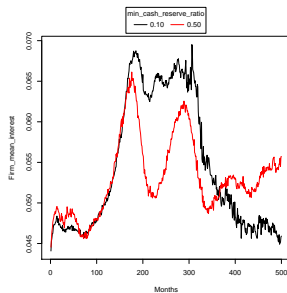
Capital constraint



Liquidity constraint



Liquidity constraint



Literature

- ▶ Hyman P. Minsky (1982): The Financial Instability Hypothesis: Capitalistic Processes and the Behavior of the Economy
- ▶ Hyman P. Minsky (1986, 2008): *Stabilizing an Unstable Economy*
- ▶ Delli Gatti, Desiderio, Gaffeo, Cirillo & Gallegati, 2010: *Macroeconomics from the Bottom-Up*
- ▶ Dosi, Fagiolo, Napoletano & Roventini, 2012: Income distribution, credit and fiscal policies in an agent-based keynesian model. LEM Papers Series 2012/03,
- ▶ Ashraf, Gershman & Howitt, 2011: Banks, Market Organization, and Macroeconomic Performance: An Agent-Based Computational Analysis
- ▶ Schularick & Taylor, 2012: Credit booms gone bust: Monetary policy, leverage cycles, and financial crises, *American Economic Review* 102 (2), 1029-61.
- ▶ Claessens, Kose & Terrones, 2011: How do business and financial cycles interact?