

# Bubbles, Crashes & the Financial Cycle

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## Outline of topics

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

## Motivations for Agent-based Macroeconomics with Integrated Finance

1. "Nobody has got something so convincing that the mainstream has to put up its hands and surrender" (Paul Ormerod 2013)
2. "No model yet produces the frequent small recessions, punctuated by rare depressions, seen in reality." (The Economist 2013)
3. "Macroeconomics without the financial cycle is like Hamlet without the Prince. [...] it is simply not possible to understand business fluctuations and their policy challenges without understanding the financial cycle." (Claudio Borio, 2012)
4. "The structure of an economic model that is relevant to a capitalist economy needs to include the **interrelated balance sheets** and income statements of the units of the economy." Hyman Minsky (1996)

## 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)

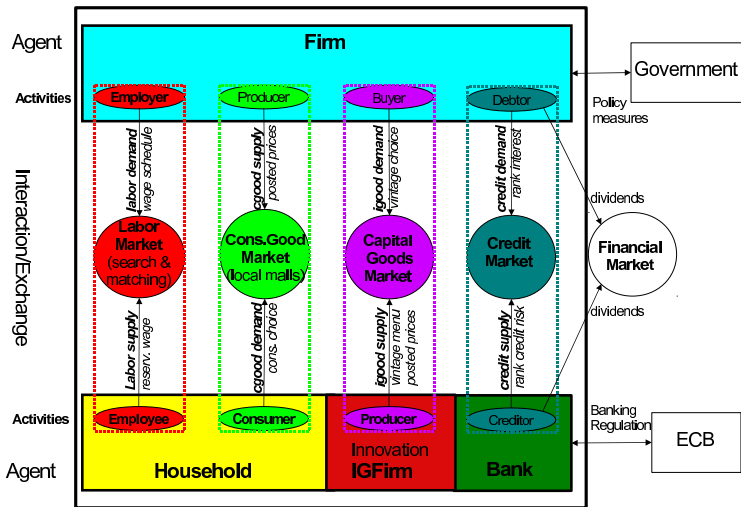
# Balance sheets

Firm		Bank	
Assets	Liabilities	Assets	Liabilities
<b>Cash</b> + revenue-wages + interest deposits + <b>new loans</b> - interest debt - principle - taxes - dividends  <b>Inventory</b> + output - sales  <b>Capital stock</b> + investment	<b>Debt</b> + <b>new loans</b> - principle - <b>bad debt</b>	<b>Cash reserves</b> - interest deposits + interest debt - taxes - dividends + principle <sup>creditors</sup> - principle <sup>depositors</sup>  <b>Loans</b> + <b>new loans</b> - principle <sup>creditors</sup> - <b>bad debt</b>	<b>Deposits</b> +/- withdrawals + <b>new loans</b> - principle <sup>depositors</sup>  <b>ECB debt</b> +/- <b>liquidity</b> +/- interest  <b>Equity</b> +profits - <b>bad debt</b>
	<b>Equity</b> +profits + <b>bad debt</b>		

## Balance sheets (Firm)

Assets	Liabilities
<p><math>M_i</math>: liquidity</p> $+p_i R_i$ $-w_i L_i - p^v I_i^v - T_i$ $+Loan_{i,b}$ $-\sum_b \Delta D_{i,b}$ $+r^b M_i - \sum_b r^b Loan_{i,b}$ $-d_i N_i$	<p><math>D_{i,b}</math>: debts to banks</p> $+Loan_{i,b}$ $-\sum_b \Delta D_{i,b}$ $-BD_i$
<p><math>Inv_i</math>: value of local inventory stock</p> $-p_i R_i$ $+p_i Q_i$	<p><math>E_i</math>: equity</p> $\pi_i = p_i R_i - w_i L_i - p^v I_i^v - T_i - d_i N_i$ $+r^b M_i - \sum_b r^b Loan_{i,b}$
<p><math>K_i</math>: value of capital stock</p> $+p^v I_i^v$	$+BD_i$

# Eurace@Unibi Model



## Financial cycle mechanisms

Financial accelerator amplifies business cycles (Bernanke & Blinder, 1988):



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## 1. Borrowers balance sheet channel

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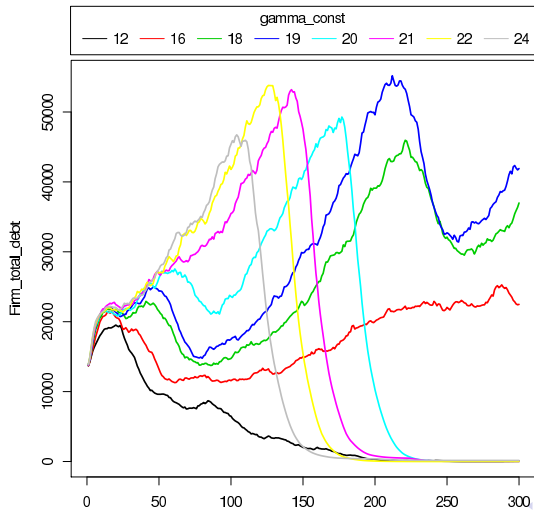
## 1. Borrowers balance sheet channel

- ▶ Changes in the value of assets on the balance sheet of firms affect the ability to borrow

## 2. Bank lending channel

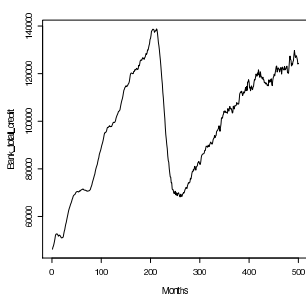
- ▶ Changes in the value of assets on the balance sheet of a bank affects the bank's ability to lend

## Scenario: A Credit Crunch

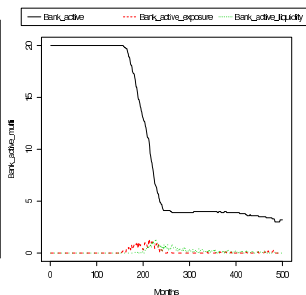


# The road to Financial Fragility

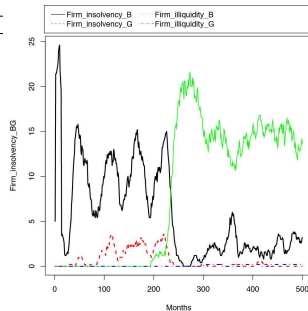
**Relationship between over-endebedtness of firms and bank's willingness to lend: Credit bubble and deleveraging crash**



Total debt firms



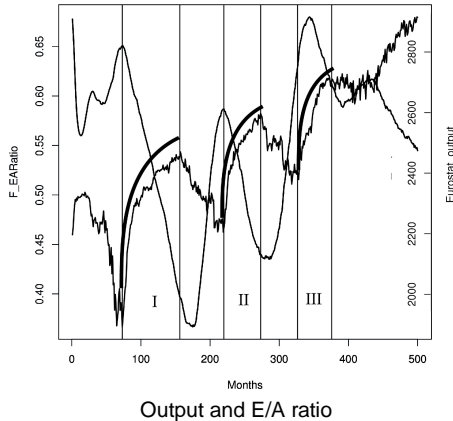
Bank activity



Firm insolvency/illiquidity

# Financial Instability Hypothesis

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



## Research questions (Policy)

### Can the credit crunch be avoided by stricter banking regulations?

Instruments available to Central Banks to regulate commercial banks' financing

- ▶ Capital adequacy requirement: constrain exposure risk
- ▶ Reserve requirement: regulate the liquidity
- ▶ Lender-of-last resort: CB provides emergency liquidity to banks with low reserves

## Bank regulation (I): Capital requirement

1. Firm prob. of default

$$prob_i^{def} = 1 - e^{-0.1D_{i,t}/E_{i,t}}$$

2. Interest rate offered by bank  $b$  to firm  $i$

$$r_i^b = r^{ECB} \left( 1 + \lambda^B (1 - e^{-0.1D_{i,t}/E_{i,t}}) + U[0, 1] \right)$$

$\lambda^B = 3$ : penalty rate for high-risk firm

3. Risk-weighted credit (expected loss at default) for a single loan

$$CR_i = \left( 1 - e^{-0.1D_{i,t}/E_{i,t}} \right) \cdot Loan_{i,t}$$

4. Minimal **capital requirement** (Basel II): risk-weighted assets

$$CR_b^{tot} \leq \alpha E^b \tag{1}$$

$\alpha$ : max. risk-weighted leverage ratio ( $\sim 10$ )

## Bank regulation (II): Cash Reserve requirement

- ▶ Liquidity constraint: minimal **cash reserve requirement**

$$M_b \geq \beta \left( \sum_{h \in H} M_h^b + \sum_{i \in F} M_i^b \right)$$

⇒ Possibility of **credit rationing**:

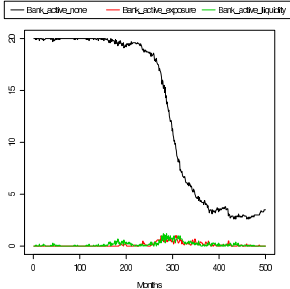
- ▶ Illiquid banks stop lending to all firms (bank lending channel)
- ▶ Risky firms cannot get loans (borrower's balance sheet channel)



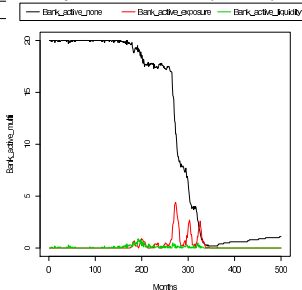
# Scenarios: Bank activity

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

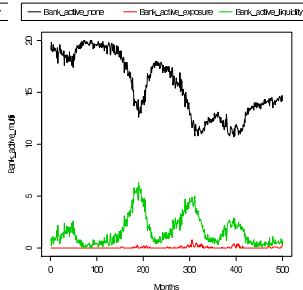
No constraint



Capital constraint ( $\alpha = 2$ )



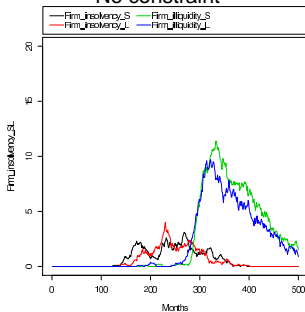
Liquidity constraint ( $\beta = 0.5$ )



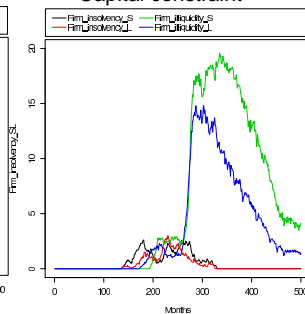
# Scenarios: Firm activity

## Number of illiquid firms

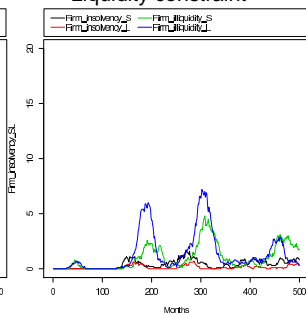
No constraint



Capital constraint



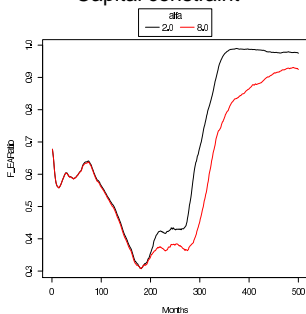
Liquidity constraint



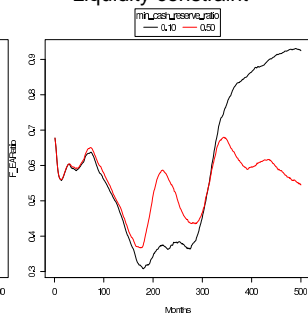
# Scenarios: Firm Fragility

## Firm E/A-ratio

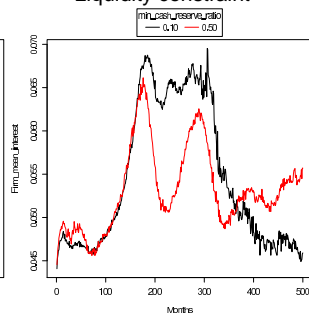
### Capital constraint



### Liquidity constraint



### Liquidity constraint



## Summary

### Limits on excessive risk-taking:

1. Amplitude recessions increases
2. More banks fail
3. More firms go illiquid
  - ▶ constraint does not discriminate
  - ▶ constraint self-reinforcing
4. Steep sudden deleveraging
5. Concentration banking sector

### Limits on liquidity:

1. Amplitude recessions decreases
2. Banks stay alive
3. Large firms go illiquid
  - ▶ large firms largest credit demand
  - ▶ liq. constraint helps small firms
4. Gradual deleveraging in waves
5. Bank equity recovers

**Thank you for your attention!**

**Model documentation:**

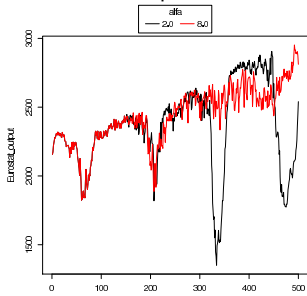
<http://www.wiwi.uni-bielefeld.de/vpl1/research/eurace-unibi.html>

**Papers:**

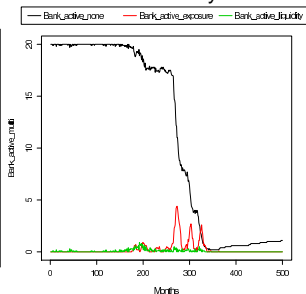
- ▶ **H Dawid, S Gemkow, P Harting, S van der Hoog & M Neugart (2013):** Agent-Based Macroeconomic Modeling and Policy Analysis: The Eurace@Unibi Model. In: S-H Chen, M Kaboudan (Eds), Handbook on Computational Economics and Finance. Oxford University Press.
- ▶ **H Dawid, S Gemkow, P Harting, S van 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.

# Scenario: Capital adequacy constraint

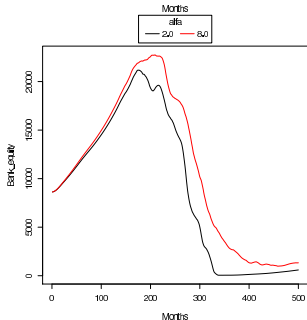
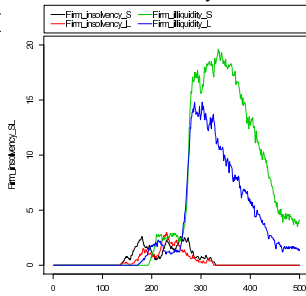
Output



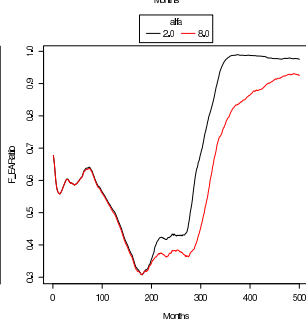
Bank activity



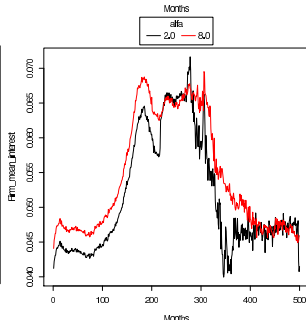
Firm activity



Bank equity



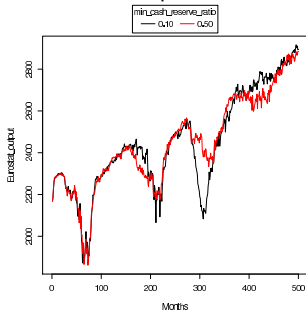
Firm fragility



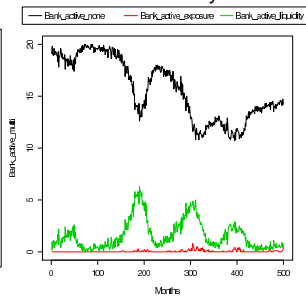
Mean interest

# Scenario: Minimum reserve requirement

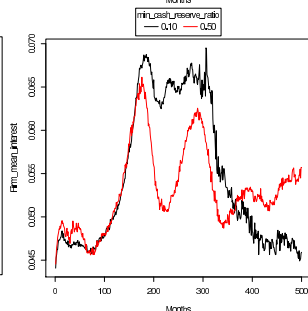
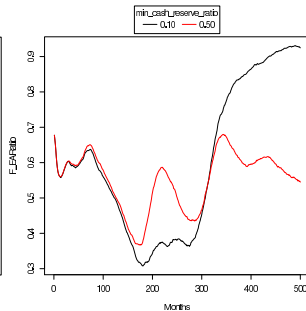
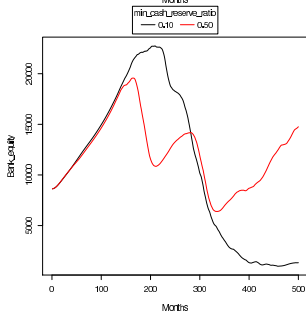
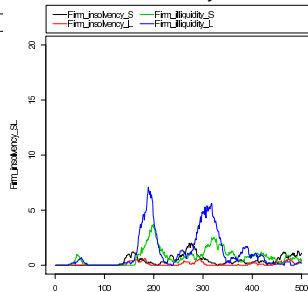
## Output



## Bank activity



## Firm activity



Bank equity

Firm fragility

Mean interest