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

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WEHIA
Sophia Antipolis, 21-23 May 2015
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?
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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:
1. Firm’s default probability

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

2. Interest rate offered by bank \( b \) to firm \( i \)

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

\[ r_{ECB} = 0.01 \]

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

\( \varepsilon_t^b \): bank’s ideosyncratic operating costs
1. Risk-exposure of credit request (Expected Loss at Default):

\[ rwa_{it}^b = PD_{it} \cdot L_{it}, \quad \text{and} \quad RWA_t^b = \sum_{i=1}^{F} \sum_{k=0}^{K(i)} PD_{kt} \cdot L_{kt}, \]  

(1)

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

\[ RWA_t^b \leq \alpha \cdot E_t^b, \quad \alpha \geq 0 \]  

(2)

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

\[ V_t^b := \alpha \cdot E_t^b - RWA_t^b \]  

(3)

4. Risk-constrained loan demand:

\[ \overline{\ell}_{it}^b = \begin{cases} L_{it} & \text{if } PD_{it} \cdot L_{it} \leq V_t^b \\ 0 & \text{if } 0 \leq V_t^b \leq PD_{it} \cdot L_{it} \\ 0 & \text{if } V_t^b < 0. \end{cases} \]  

(4)
Reserve Ratio Requirement

- **Constraint 7: Reserve Ratio Requirement (RRR)**
  \[ M_t^b \geq \beta \cdot Dep_t^b, \quad \beta \in [0, 1] \]  

- Excess liquidity "budget" of the bank:
  \[ W_t^b := M_t^b - \beta \cdot Dep_t^b \]  

- Loan granted: risk- and liquidity constrained credit request
  \[ \ell_{i,t}^b = \begin{cases} \bar{\ell}_{i,t}^b & \text{if } W_t^b \geq \bar{\ell}_{i,t}^b \\ \phi \cdot \bar{\ell}_{i,t}^b & \text{if } 0 \leq W_t^b \leq \bar{\ell}_{i,t}^b \\ 0 & \text{if } W_t^b < 0 \end{cases} \]  

  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


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

$\beta$-sensitivity: Reserve Req.

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

Output vs. Quarters graph
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 → Increases bank equity capital

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

D. Cutting-off funding to all financially **unsound firms** → Prevents leverage

E. Cutting-off funding to **Ponzi firms** only → Prevents further leverage

F. Combined effect of BCD → Does it help to prevent bubbles?

G. Combined effect of BCE → Does it help to prevent bubbles?
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:


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

Bank activity ($\alpha = 2$)

Firm activity ($\alpha = 2$)

Bank equity

Firm fragility

Mean interest
Scenario: Minimum Reserve Requirement

Output

Bank activity ($\beta = 0.50$)

Firm activity ($\beta = 0.50$)

Bank equity

Firm fragility

Mean interest
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

Sander van der Hoog

Bubbles, Crashes & the Financial Cycle
Prevention and mitigation - Bank dividend payout

amplitude of recessions

cumulative loss
Bank accounting

1. Bank profit

\[ \pi_t^b = r^b L_t^b - r^b(\sum_h M_{h_t}^b + \sum_i M_{i_t}^b) + r^{ECB}(M_t^b - D_t^b) \]

2. Bank cash and reserves

\[ M_{t+1}^b = M_t^b + \Delta M_h^b + \Delta M_i^b + (1 - \tau) \max[0, \pi_t^b] - d^b (1 - \tau) \max[0, \pi_t^b] \]
3a. Insolvency bankruptcy

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

Target debt is given by:

$$D^* = \varphi A_t^f \quad \text{with} \quad 0 \leq \varphi \leq 1. \quad (8)$$

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

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

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

$$D^* = \begin{cases} \phi A^f_t & \text{if } \phi A^f_t \leq D^f_t \\ \phi D^f_t & \text{if } \phi A^f_t > D^f_t \end{cases} \quad \text{with} \quad 0 \leq \phi \leq 1.$$  \hspace{1cm} (10)

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

$$D^*/E^* = \begin{cases} \phi/(1 - \phi) & \text{if } \phi A^f_t \leq D^f_t \\ \phi/(A/D - \phi) & \text{if } \phi A^f_t > D^f_t \end{cases}.$$  \hspace{1cm} (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:**

\[
Div^f = \begin{cases} 
  d \cdot \langle \Pi^f \rangle_4 & \text{if } M^f_t \leq \mu \cdot \langle R^f \rangle_6 \\
  \langle \Pi^f \rangle_4 & \text{if } M^f_t > \mu \cdot \langle R^f \rangle_6.
\end{cases}
\]

\[d = 0.7, \mu = 0.5\]
5a. **Full/Partial credit rationing** is based on the (exogenously prescribed, ex ante) constraints of the bank (CAR, CRR).

- Full rationing for CAR constraint:
  \[
  \ell_{bt}^b = \begin{cases} 
  L_{it} & \text{if } PD_{it} \cdot L_{it} \leq V^b_t \\
  0 & \text{if } 0 \leq V^b_t \leq PD_{it} \cdot L_{it} \\
  0 & \text{if } V^b_t < 0.
  \end{cases}
  \]  
  (15)

- Partial rationing ("filling up to constraint") for CAR constraint:
  \[
  \ell_{bt}^b = \begin{cases} 
  L_{it} & \text{if } PD_{it} \cdot L_{it} \leq V^b_t \\
  \frac{V^b_t}{PD_{it}} & \text{if } 0 \leq V^b_t \leq PD_{it} \cdot L_{it} \\
  0 & \text{if } V^b_t < 0.
  \end{cases}
  \]  
  (16)