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

<table>
<thead>
<tr>
<th>Firm</th>
<th>Liabilities</th>
<th>Bank</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assets</strong></td>
<td><strong>Debt</strong></td>
<td><strong>Assets</strong></td>
<td><strong>Liabilities</strong></td>
</tr>
<tr>
<td>Cash</td>
<td>Debt</td>
<td>Cash reserves</td>
<td>Deposits</td>
</tr>
<tr>
<td>+ revenue-wages</td>
<td>+ new loans</td>
<td>- interest deposits</td>
<td>+/- withdrawals</td>
</tr>
<tr>
<td>+ interest deposits</td>
<td>- principle</td>
<td>+ interest debt</td>
<td>+ new loans</td>
</tr>
<tr>
<td>+ new loans</td>
<td>- bad debt</td>
<td>- taxes</td>
<td>- principle&lt;sub&gt;depositors&lt;/sub&gt;</td>
</tr>
<tr>
<td>- interest debt</td>
<td></td>
<td>- dividends</td>
<td></td>
</tr>
<tr>
<td>- principle</td>
<td></td>
<td>+ principle&lt;sub&gt;deployors&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>- taxes</td>
<td></td>
<td>- principle&lt;sub&gt;creditors&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>- dividends</td>
<td></td>
<td>- bad debt</td>
<td></td>
</tr>
<tr>
<td><strong>Inventory</strong></td>
<td>Equity</td>
<td>Loans</td>
<td>ECB debt</td>
</tr>
<tr>
<td>+ output - sales</td>
<td>+ profits</td>
<td>+ new loans</td>
<td>+/- liquidity</td>
</tr>
<tr>
<td></td>
<td>+ bad debt</td>
<td>- principle&lt;sub&gt;creditors&lt;/sub&gt;</td>
<td>+/- interest</td>
</tr>
<tr>
<td><strong>Capital stock</strong></td>
<td>Equity</td>
<td>- bad debt</td>
<td>Equity</td>
</tr>
<tr>
<td>+ investment</td>
<td>+ profits</td>
<td></td>
<td>+ profits</td>
</tr>
<tr>
<td></td>
<td>+ bad debt</td>
<td></td>
<td>- bad debt</td>
</tr>
</tbody>
</table>
### Balance sheets (Firm)

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

$Inv_i$: value of local inventory stock  
$E_i$: equity  
$\pi_i = p_i R_i - w_i L_i - p^v I_i^v - T_i - d_i N_i$  
$+ r^b M_i - \sum_b r^b Loan_{i,b}$  
$+ BD_i$
Eurace@Unibi Model

Sander van der Hoog

Bubbles, Crashes & the Financial Cycle
Financial cycle mechanisms

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

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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
Financial cycle mechanisms

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

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-endebtedness 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)
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

\[ \text{prob}_{i}^{\text{def}} = 1 - e^{-0.1 D_{i,t}/E_{i,t}} \]

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

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

\( \lambda^{B} = 3 \): penalty rate for high-risk firm

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

\[ CR_{i} = \left( 1 - e^{-0.1 D_{i,t}/E_{i,t}} \right) \cdot \text{Loan}_{i,t} \]

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

\[ CR_{b}^{\text{tot}} \leq \alpha E^{b} \] \hspace{1cm} (1)

\( \alpha \): max. risk-weighted leverage ratio (\( \sim 10 \))
Bank regulation (II): Cash Reserve requirement

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

\[ M_b \geq \beta \left( \sum_{h \in H} M^b_h + \sum_{i \in F} M^b_i \right) \]

⇒ 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

<table>
<thead>
<tr>
<th>Limits on excessive risk-taking:</th>
<th>Limits on liquidity:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Amplitude recessions increases</td>
<td>1. Amplitude recessions decreases</td>
</tr>
<tr>
<td>2. More banks fail</td>
<td>2. Banks stay alive</td>
</tr>
<tr>
<td>3. More firms go illiquid</td>
<td>3. Large firms go illiquid</td>
</tr>
<tr>
<td>- constraint does not discriminate</td>
<td>- large firms largest credit demand</td>
</tr>
<tr>
<td>- constraint self-reinforcing</td>
<td>- liq. constraint helps small firms</td>
</tr>
<tr>
<td>5. Concentration banking sector</td>
<td>5. Bank equity recovers</td>
</tr>
</tbody>
</table>
Thank you for your attention!

Model documentation:
http://www.wiwi.uni-bielefeld.de/vpl1/research/eurace-unibi.html

Papers:


Scenario: Capital adequacy constraint

Output

Bank activity

Firm activity

Bank equity

Firm fragility

Mean interest
Scenario: Minimum reserve requirement

**Output**

- **Bank activity**
  - `min_cash_reserve_ratio`: 0.10, 0.50

- **Firm activity**
  - `Firm_insolvency_S`, `Firm_liquidity_S` for `min_cash_reserve_ratio`: 0.10, 0.50

- **Bank equity**

- **Firm fragility**

- **Mean interest**