Bubbles, Banks and Financial Stability

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Introduction

- Bursting bubbles: an important factor in many banking and economic crisis
  - Subprime/Japan/Scandinavia
- But occasionally busts can occur without a crisis - ‘Dot Com’ bubble of 1998-2000

Aim of the Paper:

- Build a limited commitment economy with explicit financial intermediation
- Model’s implications for the interaction of bubbles and bank balance sheets
The Economic Questions

1. Who holds the bubble?
2. How does the real impact of the bubble depend on who holds it?
3. How does the financial safety net affect bubbly equilibria?
Question 1: Who holds the bubble?
Answer:
- No financial safety net: savers
- Banks hold bubbles if financial safety net exists

Question 2: Real impact of the bubble
Answer: Bubbles held by banks lead to bigger output fluctuations.

Question 3: financial safety net and bubbly equilibria
Answer: (1) bubbles are bigger; (2) more fragile bubbles can exist.
Rational Bubbles: A (very) brief survey

- General economic problem: how to create efficient means of saving
- OLG (no credit constraints)
  - Samuelson (1958)
- Models with credit/resaleability constraints
  - Woodford (1990)
  - Kiyotaki-Moore (2008)
  - Caballero and Krishnamurthy (2006)
Rational bubbles in a credit constrained economy

- Inside liquidity created from private intermediation
  - debt for borrowers
  - stores of value for lenders
- Limited commitment - too little inside liquidity
  - inefficient stores of value
  - low interest rates
- Bubbles
  - replace inefficient stores of value
  - but: fragile
Our contribution

- Modelling financial intermediaries explicitly
  - Result: multiple asset holders with different economic roles
  - This matters: asset price bubbles have a different real impact depending on who holds them
- Impact of moral hazard on bubbly equilibria
Entrepreneurs

- Utility

\[ E_0 \sum_{t=0}^{\infty} \beta^t \ln c_t \]

- Production function

\[ y_{t+1} = ah_t, \quad a = a^H, a^L, \quad a^H > a^L \]

- Budget constraint: when becomes a borrower;

\[ c_t + \underbrace{w_t h_t}_{\text{investment}} - \underbrace{l_t}_{\text{loan}} + \mu_t m_t^e \leq (1 - \tau_t) \left( y_t - R_{t-1}^l l_{t-1} + \mu_t m_{t-1}^e \right) \]

when becomes a saver;

\[ c_t + w_t h_t + \underbrace{d_t}_{\text{deposit}} + \mu_t m_t^e \leq (1 - \tau_t) \left( y_t + R_{t-1}^d d_{t-1} + \mu_t m_{t-1}^e \right) \]

- Borrowing constraint

\[ R_t^l l_t + E_t \Upsilon_{t+1} \leq \theta y_{t+1}, \quad 0 < \theta < 1 \]
Entrepreneurs’ behavior: low productivity

- In equilibrium, the productives borrow and the unproductives save.
- Log utility \( \Rightarrow \) consumption is \((1 - \beta)\) share of wealth
- The unproductives allocate savings between deposit, bubbles and own production (if they produce)

\[
E_t \left[ \frac{1 - \tau_{t+1}}{c^L_{t+1}} \frac{\mu_{t+1}}{\mu_t} \right] = E_t \left[ \frac{1 - \tau_{t+1}}{c^L_{t+1}} \right] R^d_t \geq E_t \left[ \frac{1 - \tau_{t+1}}{c^L_{t+1}} \frac{a^L}{w_t} \right]
\]

where

\[
\mu_{t+1} = \begin{cases} 
\mu_{t+1} & \text{w.p. } \pi \\
0 & \text{w.p. } 1 - \pi 
\end{cases}
\]
Entrepreneurs’ behavior: high productivity

- When borrowing constraints bind \((a^H/w_t > R_t^l)\), the productives borrow up to the limit. Leveraged rate of return is

\[
\frac{a^H(1 - \tilde{\theta}_t)}{w_t - \tilde{\theta}_t a^H / R_t^l} > \frac{a^H}{w_t} > R_t^l
\]

where

\[
\tilde{\theta}_t = \frac{\theta - E_t \tau_{t+1}}{1 - E_t \tau_{t+1}} \leq \theta
\]

- The productives do not buy bubbles
Banks

- Risk neutral, exit with probability $1 - \gamma$
- Budget constraints and state evolution
  \[ c_t^B + l_t + \mu_t m_t = n_t + d_t \]
  - bubble purchase
  - net worth

  \[ n_{t+1} = R_t^l l_t + \mu_{t+1} m_t - R_t d_t \]

- Borrowing constraint
  \[ (1 - \lambda) d_t \leq V(n_t) \]
  - diversion value
  - continuation value of the bank

Constraint binds when $R_t^l > R_t^d$. $V(n_t)$ given by

\[ V(n_t) = \beta E_t [\gamma V(n_{t+1}) + (1 - \gamma) n_{t+1}] \]
Banks’ behaviour

- Risk neutrality implies that

\[ V(n_t) = \phi_t n_t \]

\[ \phi_t = \frac{\beta \left[(1 - \gamma) + \gamma E_t \phi_{t+1}\right] R^l_t}{1 - \beta \left[(1 - \gamma) + \gamma E_t \phi_{t+1}\right]} \] \[ \frac{R^l_t - R^d_t}{1 - \lambda} \] \[ > 1. \]

- Expectation of high future leverage allows the bank to borrow more (i.e. high leverage today)

- Deposits (under a binding collateral constraint on banks)

\[ D_t = \frac{\phi_t}{(1 - \lambda) \gamma} N_t \approx \text{leverage} \]
Banks’ behaviour (cont)

- Banks’ portfolio choice between bubbles and loans

\[ E_t \left[ (1 - \gamma + \gamma \phi_{t+1}) \frac{\tilde{\mu}_{t+1}}{\mu_t} \right] \leq E_t \left[ (1 - \gamma + \gamma \phi_{t+1}) \right] R_t \]

where

\[ \tilde{\mu}_{t+1} = \begin{cases} \mu^b_{t+1} & \text{with prob. } \pi \\ \rho_{t+1}\mu_t & \text{with prob. } 1 - \pi \end{cases} \]

- \( \rho \) captures the financial safety net
Workers: (passive role)

- Utility

\[ U = E_0 \sum_{t=0}^{\infty} \beta^t \left( c^w_t - \frac{h_t^{1+\eta}}{1+\eta} \right) \]

- No collateralisable assets \(\rightarrow\) cannot borrow

- Do not save in equilibrium due to low interest rate

- Labour supply

\[ h^s_t = w_t^\eta \]
Government

- The government only spends money on bailing out banks
- Balanced budget

$$\tau_t Z_t = \rho_t m_{t-1}^b \mu_{t-1}$$
In equilibrium bubbles must be (a) attractive to hold and (b) affordable.

**Bank-held bubbles**

\[ R^d_t < \text{bubble return} = R^l_t \leq 1 \]

**Saver-held bubbles**

\[ R^d_t = \text{bubble return} \leq 1 \]

Banks choose not to buy bubbles when \( R^l_t > R^d_t \) = bubble return.
Who holds the bubble: stochastic steady state

- Base line case: $\rho = 0$

<table>
<thead>
<tr>
<th>$\pi$</th>
<th>% of bubbles held by banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.965</td>
<td>0</td>
</tr>
<tr>
<td>0.975</td>
<td>0</td>
</tr>
<tr>
<td>0.985</td>
<td>0.016</td>
</tr>
<tr>
<td>0.995</td>
<td>0</td>
</tr>
</tbody>
</table>
Consider $\rho > 0$

What effect does it have

- on bank’s bubble holdings?
- on bubble size?
- on bubble amplification?
Impact of the safety net
Banks’ bubble holdings as % of total

<table>
<thead>
<tr>
<th></th>
<th>$\pi = 0.965$</th>
<th>$\pi = 0.975$</th>
<th>$\pi = 0.985$</th>
<th>$\pi = 0.995$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho = 0.00$</td>
<td>-</td>
<td>0.000</td>
<td>0.016</td>
<td>0.000</td>
</tr>
<tr>
<td>$\rho = 0.25$</td>
<td>-</td>
<td>0.000</td>
<td>0.068</td>
<td>0.000</td>
</tr>
<tr>
<td>$\rho = 0.50$</td>
<td>1.000</td>
<td>0.312</td>
<td>0.183</td>
<td>0.000</td>
</tr>
<tr>
<td>$\rho = 0.75$</td>
<td>1.000</td>
<td>1.000</td>
<td>0.660</td>
<td>0.016</td>
</tr>
</tbody>
</table>

- $\rho = 0$: banks hold few bubbles at intermediate values of $\pi$ (risk-sharing)
- $\rho >> 0$: banks’ bubble holding grows at low values of $\pi$ (risk-shifting)
### Impact of the safety net

bubble size as % of GDP

<table>
<thead>
<tr>
<th></th>
<th>$\pi = 0.965$</th>
<th>$\pi = 0.975$</th>
<th>$\pi = 0.985$</th>
<th>$\pi = 0.995$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho = 0.00$</td>
<td>-</td>
<td>0.118</td>
<td>0.463</td>
<td>0.674</td>
</tr>
<tr>
<td>$\rho = 0.25$</td>
<td>-</td>
<td>0.118</td>
<td>0.467</td>
<td>0.674</td>
</tr>
<tr>
<td>$\rho = 0.50$</td>
<td>0.008</td>
<td>0.245</td>
<td>0.475</td>
<td>0.674</td>
</tr>
<tr>
<td>$\rho = 0.75$</td>
<td>0.361</td>
<td>0.411</td>
<td>0.511</td>
<td>0.676</td>
</tr>
</tbody>
</table>

- **High $\pi$:** $\rho$ has little effect on bubble size
- $\rho \uparrow \Rightarrow$ bubble size $\uparrow$ dramatically at low values of $\pi$
### Effects of bubble holdings on banks

<table>
<thead>
<tr>
<th></th>
<th>$\rho = 0.00$</th>
<th>$\rho = 0.25$</th>
<th>$\rho = 0.50$</th>
<th>$\rho = 0.75$</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of bubbles held by banks</td>
<td>0.000</td>
<td>0.081</td>
<td>0.237</td>
<td>0.881</td>
</tr>
<tr>
<td>Bubble to GDP ratio</td>
<td>0.296</td>
<td>0.348</td>
<td>0.396</td>
<td>0.442</td>
</tr>
<tr>
<td>$E(\text{Bubble Return}</td>
<td>\text{bank}) - R^l$</td>
<td>-0.002</td>
<td>0.005</td>
<td>0.009</td>
</tr>
<tr>
<td>$E(\text{Bubble Return}</td>
<td>\text{saver}) - R^d$</td>
<td>0.010</td>
<td>0.010</td>
<td>0.009</td>
</tr>
<tr>
<td>Bank NW/GDP (pre-crash)</td>
<td>0.055</td>
<td>0.063</td>
<td>0.074</td>
<td>0.116</td>
</tr>
<tr>
<td>Bank Loss/GDP</td>
<td>0.000</td>
<td>0.021</td>
<td>0.047</td>
<td>0.097</td>
</tr>
<tr>
<td>% fall in bank NW</td>
<td>0.000</td>
<td>0.337</td>
<td>0.630</td>
<td>0.842</td>
</tr>
</tbody>
</table>

- The percentage fall in bank net worth is computed after the receipt of government assistance.
- Large increase in net worth before crash and loss after crash
How do bubbles affect the economy?

- Decomposition of output

\[ Y = a^L H^L_t + a^H H^H_t \]

\[ = \frac{1}{w_t} \left[ a^L (\beta Z_t + \gamma N_t) - a^L \mu_t + \left( a^H - a^L \right) (\beta s_t Z_t + L_t) \right] \]

- \( w \): production cost
- 1st term: liquidity effect
- 2nd term: crowding out
- 3rd term: reallocation
  - share of productives
  - credit supply
## Effects of bubbles on the economy

### Table: Percentage point contributions of each channel to total increase in output

<table>
<thead>
<tr>
<th>Channel</th>
<th>$\rho = 0$</th>
<th>$\rho = 1/3$</th>
<th>$\rho = 2/3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank bubble holdings (% of total)</td>
<td>0.00</td>
<td>0.11</td>
<td>1.00</td>
</tr>
<tr>
<td>Total $Y \uparrow$ relative to 'no bubble' SS</td>
<td>1.03</td>
<td>1.32</td>
<td>3.11</td>
</tr>
<tr>
<td>(1) Liquidity effect</td>
<td>19.64</td>
<td>20.01</td>
<td>21.78</td>
</tr>
<tr>
<td>(2) Bubble 'crowding out' effect</td>
<td>-19.54</td>
<td>-19.67</td>
<td>-19.99</td>
</tr>
<tr>
<td>(3) Investment composition effect</td>
<td>0.95</td>
<td>1.04</td>
<td>1.65</td>
</tr>
<tr>
<td>...of which</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3.1.) Productive net worth</td>
<td>0.31</td>
<td>0.34</td>
<td>0.54</td>
</tr>
<tr>
<td>(3.2.) Bank lending</td>
<td>0.64</td>
<td>0.70</td>
<td>1.11</td>
</tr>
<tr>
<td>(4) Labour costs</td>
<td>-0.02</td>
<td>-0.06</td>
<td>-0.32</td>
</tr>
</tbody>
</table>

- Output larger when banks hold bubbles
- high contribution of liquidity effect and increase in bank lending

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1Percentage point contributions of each channel to total increase in output relative to bubbleless SS
Increase in net worth due to bubble risk premium

This results in increase in credit supply...

and decline in spread

\[ \rho = 0 \quad \rho = 1/3 \quad \rho = 2/3 \]

<table>
<thead>
<tr>
<th></th>
<th>( \rho = 0 )</th>
<th>( \rho = 1/3 )</th>
<th>( \rho = 2/3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank net worth (% increase)</td>
<td>14.43</td>
<td>25.03</td>
<td>113.7</td>
</tr>
<tr>
<td>Bank lending</td>
<td>13.03</td>
<td>14.35</td>
<td>22.69</td>
</tr>
<tr>
<td>Lending-Deposit spread</td>
<td>0.02</td>
<td>-0.01</td>
<td>-0.22</td>
</tr>
</tbody>
</table>
Figure 3: Comparing a bank-held (solid line) and a saver-held (dashed line) bubble

- Large expansion and severe contraction under bank bubble
Conclusions

- Bubbles held by banks have a more amplified impact on the economy while they survive when they burst
- Banks invest in bubbles when their risk is underwritten by the government