Managing Credit Booms and Busts
A Pigouvian Taxation Approach

Olivier Jeanne    Anton Korinek

JHU and UMD

Conference on the Future of Monetary Policy

Rome, October 1st, 2010
Key Question

How should policymakers respond to booms and busts in credit markets and asset markets?
Key Assumptions

Financial markets are imperfect:
- *borrowing is subject to constraints*
- *constraints depend on asset prices*
- *potential for feedback spirals between*
  - *collapsing asset prices*
  - *tightening borrowing constraints*
  - *declining spending*
→ *financial accelerator, debt deflation, ...*
Feedback Spirals

Economic shock

Falling Spending

Tightening Constraint

Adverse Movement in Relative Prices

Jeanne and Korinek (2010)
Feedback Spirals

Economic shock

Tightening Constraint

Falling Spending

Adverse Movement in Relative Prices
Key Findings

Key Results

1. *endogenous borrowing constraints amplify volatility*

2. *decentralized equilibrium is socially suboptimal:*
   - excessive debt
   - excessive exposure to binding constraints
   - excessive volatility (systemic risk)

3. *strong case for macroprudential regulation*
Relationship to Literature

- **Financial accelerator effects**: Fisher (1933), Kiyotaki-Moore (1997), Bernanke-Gertler-Gilchrist (1999), etc.

- **Deleveraging externalities**: Gromb and Vayanos (2002), Lorenzoni (2008), Korinek (2009)

- **Optimal policy in DSGE models with financial accelerator**: Bianchi (2010), Benigno et al. (2010), Bianchi-Mendoza (2010)

- **Empirical importance of amplification**: Adrian and Brunnermeier (2009), Adrian and Shin (2009ab), etc.
DSGE Setup in infinite discrete time

Two sets of agents:

1. Insiders who exclusively own an asset (tree), representing e.g.:
   - entrepreneurs: more productive at operating an asset
   - households: put higher utility on owning their home
   - locals in small open economy: value local assets more
   - speculators: more risk-tolerant towards an asset
   - agents with informational advantage

2. Outsiders: large in comparison, provide credit at rate \( R \)

Debt is the only financial contract
Optimization problem of representative insider:

- Hold $a_t = 1$ unit of tree
- Obtain endowment income $(1 - \alpha)y_t$ and income from tree $\alpha y_t$ every period
- Trade trees, but solely among insiders
- Hold financial wealth $w_t$ with outsiders
- Maximize utility

$$U_t = E_t \left( \sum_{s=t}^{\infty} \beta^{s-t} u(c_s) \right)$$

where $u(c_s) = \frac{c_s^{1-\gamma}}{1-\gamma}$

subject to:

$$c_t + a_{t+1} p_t + \frac{w_{t+1}}{R} = (1 - \alpha)y_t + a_t(p_t + \alpha y_t) + w_t$$

and subject to a moral hazard problem that limits borrowing to

$$\frac{w_{t+1}}{R} \geq -\phi p_t - \psi$$
Equilibrium

- **State of economy:**
  summarized by \((w, y)\)

- **Dynamics captured by 3 equilibrium functions:**
  \(c(w, y)\), \(p(w, y)\) and \(\lambda(w, y)\)

- **Equilibrium conditions:**

  \[c(w, y) = \min \left\{ w + e + y + \phi p(w, y), \left[ \beta \text{RE} \left( c(w', y')^{\gamma} \right) \right]^{-1/\gamma} \right\}\]

  \[p(w, y) = \frac{\beta E \left[ u'(c(w', y'))(y' + p(w', y')) + \phi \lambda(w', y')p(w', y') \right]}{u'(c(w, y))}\]

  \[\lambda(w, y) = c(w, y)^{-\gamma} - \beta \text{RE} \left( c(w', y')^{\gamma} \right)\]

- **Transition equation for wealth:**

  \[w'/R = w + y - c(w, y)\]
Solution Method

- Define grids $y^g$, $d^g$ for output shock and net worth

- Solution through reverse time iteration:
  - in step $k$, start with functions $c_k(w, y)$, $p_k(w, y)$ and $\lambda_k(w, y)$
  - for any $(w', y)$ derive unconstrained $t-1$ solution
  - for any $(w' > 0, y)$ derive constrained $t-1$ solution
  - for any $y$, determine threshold $\bar{w}(y)$ for binding constraints
  - concatenate constrained/unconstrained functions
  - interpolate $c_{k+1}(w, y)$, $p_{k+1}(w, y)$ and $\lambda_{k+1}(w, y)$

→ endogenous gridpoints bifurcation method
Unconstrained Equilibrium

Unconstrained equilibrium (for sufficiently high net worth and output) Given policy functions $c_k(w, y), p_k(w, y), \lambda_k(w, y)$ for next period,

- consumption $c_{unc}(w', y) = \left[ \beta RE \left( c' - \gamma \right) \right]^{-1/\gamma}$
- net worth $w_{unc}(w', y) = c_{unc} - y + \frac{w'}{R}$
- asset price $p_{unc}(w', y) = \beta E \left[ \frac{u'(c')}{u'(c_{unc})} \cdot (\alpha y' + p') \right]$
- shadow price $\lambda_{unc} = 0$
- threshold level of net worth is $w \geq \bar{w} = -\phi p_{unc} - \psi$

Constrained Equilibrium

Constrained equilibrium (for low net worth, low output shock)
Given policy functions $c_k(w, y), p_k(w, y), \lambda_k(w, y)$ for next period,

- asset price $p^{con}(w', y) = -\frac{1}{\phi} \left[ \frac{w'}{R} + \psi \right]$ from binding constraint
- consistent with a level of consumption of
  $$c^{con}(w', y) = \left[ \frac{\beta E\left\{ u'(c') \cdot (\alpha y' + p^{con}) + \phi \lambda' p' | y \right\}}{p^{con}} \right]^{-\frac{1}{\gamma}}$$
- net worth $w^{con}(w', y) = c^{con} - y - \phi p^{con} - \psi$
- shadow price $\lambda^{con}(w', y) = u'(c^{con}) - \beta RE \left[ u'(c') \right]$

⇒ combine constrained/unconstrained policy functions
⇒ interpolate next iteration $c_{k+1}(w, y), p_{k+1}(w, y), \lambda_{k+1}(w, y)$
Figure: Equilibrium equation: $c \leq w + y + \phi p(c) + \psi$
Figure: Equilibrium policy functions

Jeanne and Korinek (2010)
Introduce a constrained social planner who

- is subject to the same borrowing limits as insiders
- coordinates (regulates) borrowing choices in the economy
- internalizes effect of choices on asset prices
- optimizes every period (no commitment)
Social planner’s optimality condition:

\[ u'(c_t) = \lambda_t + \beta RE_t \left[ u'(c_{t+1}) + \phi \lambda_{t+1} \frac{\partial p_{t+1}}{\partial w_{t+1}} \right] \]

Interpretation of externality term \( \phi \lambda_{t+1} \frac{\partial p_{t+1}}{\partial w_{t+1}} \):

- \( \frac{\partial p_{t+1}}{\partial w_{t+1}} \) captures asset price increase resulting from higher wealth
- \( \phi \) reflects resulting relaxation in borrowing constraint
- \( \lambda_{t+1} E_t[u'(c_{t+1})] \) represents utility cost of constraint

externality active if borrowing constraint is binding in the future
Equilibrium with Social Planner

Social planner solution:
- planner takes on less debt in periods before constraint is binding (systemic precautionary savings)
- less debt, less severe future constraints
- less volatility and financial fragility
→ social planner reduces debt and uncertainty
Implementation of Constrained Social Optimum

Implementation through Pigouvian taxation:

- Introduce tax $\tau_t = \tau(w_t, y_t)$ on borrowing $-w_{t+1}/R$
- Rebate lump sum $T_t = -\tau_t \cdot w_{t+1}/R$

\[
\begin{align*}
\text{max } U_t &= E_t \left( \sum_{s=t}^{\infty} \beta^{s-t} u(c_s) \right) \\
\text{s.t. } c_t + (1 - \tau_t) \frac{w_{t+1}}{R} &= y_t + w_t + T_t \\
\frac{w_{t+1}}{R} &\geq -\phi p_t - \psi
\end{align*}
\]

To implement constrained optimum, tax must satisfy

\[
\tau(w_t, y_t) = \frac{\phi \beta RE_t \left[ \lambda_{t+1} \frac{\partial p_{t+1}}{\partial w_{t+1}} \right]}{u'(c_t)}
\]

Implementation of Constrained Social Optimum

Alternative mechanisms to implement Pigouvian tax:

- Direct taxation of debt
  (note: opposite of interest deductability on debt!)
- Prudential regulation: uses existing frameworks
- Limits on leverage / margin requirements
- Risk management systems
Calibration

Assumptions:

- capture booms and busts with binomial distribution for output $y_t \in \{y^L, y^H\}$ with probabilities $\pi$ and $(1 - \pi)$ (we set $\pi = 5\%$)
- calibrate parameters to match observed sectoral bust in 2008/09
- $\beta R < 1$ so insiders have a persistent motive for borrowing (we set $\beta = 0.96$, $R = 1.025$, $\gamma = 2$)

Table: Balance sheet data for US Households, SMEs and Corporations

<table>
<thead>
<tr>
<th></th>
<th>2008q2</th>
<th>2009q2</th>
<th>Chg.</th>
<th>2008q2</th>
<th>2009q2</th>
<th>Chg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households</td>
<td>74,273</td>
<td>64,425</td>
<td>-13.3%</td>
<td>14,418</td>
<td>14,116</td>
<td>-2.1%</td>
</tr>
<tr>
<td>SMEs</td>
<td>11,865</td>
<td>10,409</td>
<td>-12.3%</td>
<td>5,410</td>
<td>5,343</td>
<td>-1.2%</td>
</tr>
<tr>
<td>Corporations</td>
<td>28,579</td>
<td>26,521</td>
<td>-7.2%</td>
<td>13,039</td>
<td>13,597</td>
<td>+4.3%</td>
</tr>
</tbody>
</table>

Jeanne and Korinek (2010)
Managing Credit Booms and Busts
The Future of Monetary Policy
### Sectoral Calibration

#### Table: Sectoral Parameter Values

<table>
<thead>
<tr>
<th>Sector</th>
<th>( \alpha )</th>
<th>( \phi )</th>
<th>( \psi )</th>
<th>( Y_L )</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Households</td>
<td>24.5%</td>
<td>3.1%</td>
<td>307%</td>
<td>0.963</td>
</tr>
<tr>
<td>US SMEs</td>
<td>20.0%</td>
<td>4.6%</td>
<td>197%</td>
<td>0.969</td>
</tr>
</tbody>
</table>

- Corporate sector: no credit crunch detected (corporate debt substituted for bank credit)
- Financial sector: parameter \( \phi \) is in multiple equilibrium region → dynamics cannot be captured by our model

Model Dynamics

Model dynamics:

- Boom steady state $w^{SS}_H$: determined by trade-off of
  - impatience ($\beta R < 1$) versus
  - precautionary savings (smooth $c$ in case of bust)

- During booms, insiders accumulate debt up to $w^{SS}_H$ → create vulnerability to next bust

- During busts, binding constraints and debt deflation occurs
Figure: Next-period wealth function in states H and L
Figure: Decentralized equilibrium vs. planner’s solution

Jeanne and Korinek (2010)
Sample Paths of Macroeconomic Variables

Figure: Sample path of planner’s $y$, $c$, $w'$, $p$ and $\tau$
### Table: Optimal magnitude of Pigouvian tax by sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>$\tau_H^{SS}$</th>
<th>$\Delta c^{DE}$</th>
<th>$\Delta c^{SP}$</th>
<th>$\Delta p^{DE}$</th>
<th>$\Delta p^{SP}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Households</td>
<td>0.48%</td>
<td>-6.80%</td>
<td>-5.99%</td>
<td>-13.33%</td>
<td>-11.75%</td>
</tr>
<tr>
<td>US SMEs</td>
<td>0.56%</td>
<td>-6.22%</td>
<td>-5.21%</td>
<td>-12.27%</td>
<td>-10.29%</td>
</tr>
</tbody>
</table>

**Note:** if impatience motive strong, planner chooses constrained $w_H^{SS}$ \(\rightarrow\) debt levels determined by constraint, not $\tau_H^{SS}$ (cp. Greenspan doctrine)
Effects of liberalization that increases borrowing capacity:

After financial liberalization, insiders experience

- first a debt-financed consumption boom (honeymoon of liberalization)
- then lower and more volatile consumption (binding constraints amplify effects of output shocks)
Figure: Dependence of externality $\tau_{H}^{SS}$ on interest rate

Jeanne and Korinek (2010)
Managing Credit Booms and Busts
The Future of Monetary Policy
Figure: Dependence of externality $\tau^{SS}_H$ on pledgeability $\phi$
Figure: Dependence of externality $\tau_H^{SS}$ on crisis risk $\pi$
Adaption of Framework to Financial Shocks:

- we model busts as declines in $\psi$ rather than $y$
- calibrating policy measure $\tau_{H}^{SS}$ yields almost identical results
Inclusion of Bailout Funds:

- assume policymakers tax insiders during booms and accumulate a bailout fund
- in bad times the fund is used to make a transfer to insiders
→ bailout will be precisely offset by increased risk-taking, unless tax in booms is large enough to make insiders constrained
Assume insiders can sell an equity stake $s \leq \bar{s}$:

- outsiders immediately buy maximum possible $\bar{s}$ at price $\tilde{p} = \frac{E(y)}{R-1}$
- insiders experience a temporary consumption boom
- in the long run, equilibrium is almost unchanged (aside from parameter $\psi$, model is homogenous of degree 1)

→ optimal macroprudential tax unaffected by equity investments
Financial Stability vs. Growth

Trade-off financial stability vs. growth:

- Assume insiders need to invest $x$ to obtain growth $g(x)$, where $g(\cdot)$ is concave.
- Binding constraints make investment more expensive.
- In decentralized equilibrium, severe busts curtail growth.

→ Optimal macro-prudential regulation increases stability and growth.

Jeanne and Korinek (2010)
Managing Credit Booms and Busts
The Future of Monetary Policy
Conclusions

- Endogenous financial constraints generate **financial amplification**

- In such an economy, decentralized agents **borrow excessively** → exacerbate boom-busts cycles in credit and asset prices

- Social planner can improve welfare by leaning against the wind through appropriate **macro-prudential regulation**