The Macroeconomics of Imperfect Capital Markets

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Lecture 7: Managing Booms and Busts

Review

Financial Amplification = a mechanism by which

- declining net worth
- tightening borrowing capacity
- contracting economic activity
- falling prices

mutually reinforce each other

Note:

- in normal times, market forces are stabilizing
- During financial amplification: market forces become destabilizing

Infinite Horizon Model Setup

Jeanne and Korinek (2010), "Managing Credit Booms and Busts: A Pigouvian Taxation Perspective"

Infinite discrete time

Two sets of agents:

1. Insiders who exclusively own an asset (tree), representing e.g.
   - locals in emerging economy
   - entrepreneurs
   - households
   - ...
2. Outsiders: large in comparison, provide credit at rate R

Insiders impatient compared to outsiders ($\beta R < 1$)
$\rightarrow$ natural borrowers and natural lenders

Debt is the only financial contract and is subject to a constraint

Insiders

Optimization problem of representative insider at date t:

- Obtain endowment income $(1-\alpha)y_t$ and income from tree αy_t, where y_t is assumed i.i.d.
- Trade tree holdings a_t, but solely among insiders
- Hold financial wealth w_t with outsiders
- Maximize utility

$$U_t = E_t\left(\sum_{s=t}^{\infty}\beta^{s-t}u(c_s)\right) \qquad \text{where } u(c_s) = \frac{c_s^{1-\gamma}}{1-\gamma}$$

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

- and subject to a moral hazard problem that limits borrowing such that

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

Equilibrium

- **State of economy:**
  summarized by $m_t = w + y$

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

- **Equilibrium conditions:**

$$c(m) = \min\left\{m + \phi p(m) + \psi, \left[\beta RE\left(c(m')^{-\gamma}\right)\right]^{-1/\gamma}\right\}$$

$$p(m) = \frac{\beta E\left[u'(c(m'))(\alpha y' + p(m'))\right]}{u'(c(m))}$$

$$\lambda(m) = c(m)^{-\gamma} - \beta RE\left(c(m')^{-\gamma}\right)$$

- **Transition equation for wealth:**

$$m' = y' + R\left(m - c(m)\right)$$

Deterministic Case with $\beta R = 1$

Assume $y_t = y \ \forall \ t \rightarrow$ economy is deterministic

Denote debt $d_t = -w_t$

Unconstrained equilibrium: for sufficiently low debt $d_1 \leq \bar{d}$:

- Asset price constant at $p^{unc} = \frac{\beta}{1-\beta}\alpha y$
- Debt constant at $d^{unc} = d_1$
- Consumption constant at $c^{unc}(m) = y - (1-\beta)d_1$
- Threshold level of debt is $\bar{d} = \frac{\alpha\phi y}{1-\beta}$

Deterministic Case with $\beta R = 1$

Constrained equilibrium: for high debt levels $d_1 > \bar{d}$:

- Debt d_2 is constrained by $\frac{d_2^{con}}{R} = \phi p_1^{con}$
- Consumption constrained by debt $c^{con}(m_1) = y - d_1 + \frac{d_2^{con}}{R}$
- $d_2 < \bar{d} \rightarrow$ period 2 equilibrium unconstrained
- Asset price deflates to $p_1^{con} = \frac{\beta u'(c_2)(\alpha y + p^{unc})}{u'(c_1^{con})}$

$\Rightarrow$ Period 2 debt level is always unconstrained $d_2 \leq \bar{d}$

Deterministic Case with $\beta R = 1$

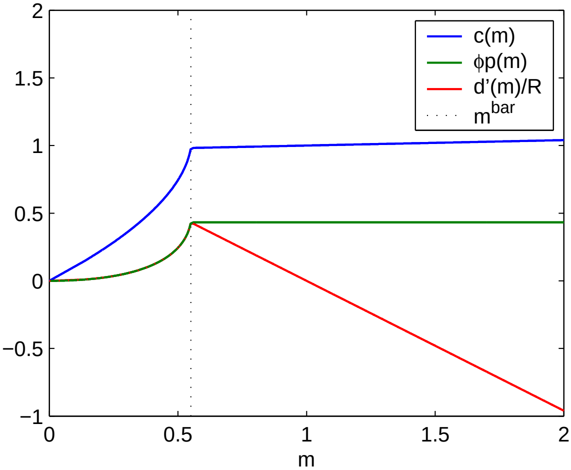

Figure: Equilibrium functions for deterministic case with $\beta R = 1$

Endogenous Gridpoints Bifurcation Method:

1. **Unconstrained solution:** for any $d_2 \le \bar{d}$:

$$S^{unc}\begin{cases} c_1^{unc} = c_2 = y - (1-\beta)\, d_2, \\ m_1^{unc} = c_1^{unc} - d_2/R = y - d_2. \end{cases}$$

2. **Constrained solution:** for any $0 \le d_2 < \bar{d}$:

$$S^{con}\begin{cases} c_1^{con} = [y - (1-\beta)\, d_2]\left(d_2/\bar{d}\right)^{1/\gamma}, \\ m_1^{con} = c_1^{con} - d_2/R. \end{cases}$$

Deterministic Case with $\beta R = 1$

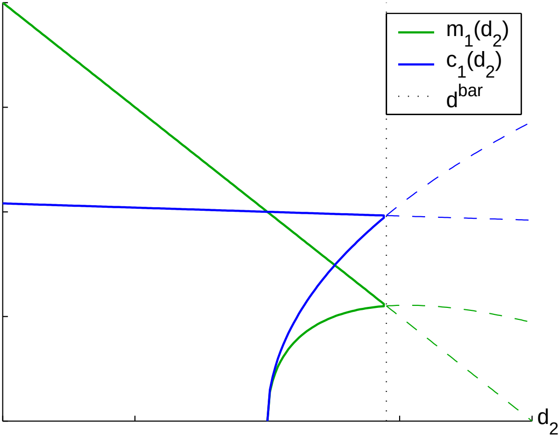

Figure: Period 1 equilibrium determined by reverse time iteration

Deterministic Case with $\beta R = 1$

Proposition

1. *If y is constant and $\beta R = 1$, the constraint is always loose after period 1*
2. *Consumption $c(m)$ is a continuous increasing function of initial wealth m if and only if*

$$\phi \leq \hat{\phi} = \frac{1-\beta}{1+\gamma-\beta} \cdot y$$

Deterministic Case with $\beta R = 1$

Otherwise, there are multiple equilibria:

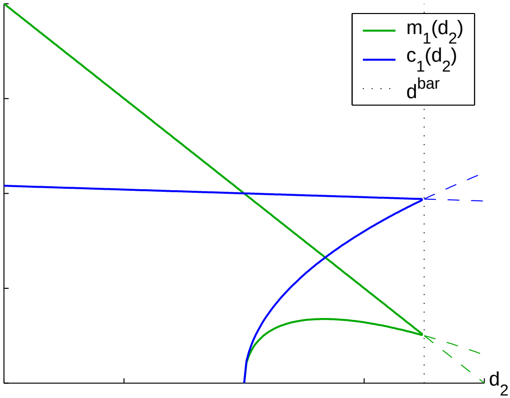

Figure: Case of multiple equilibria: $c_1(m_1)$ is not uniquely defined

General Solution Method for $\beta R < 1$

- **Define grid $\mathbf{m}^g$ for liquid net worth**
- **Solution through reverse time iteration:**
  - in step k, start with functions $c_k(m)$, $p_k(m)$ and $\lambda_k(m)$
  - for any w' derive unconstrained $t-1$ solution (c, p, λ, m)
  - for any $w' < -R\psi$ derive constrained $t-1$ solution (c, p, λ, m)
  - concatenate constrained/unconstrained functions
  - interpolate $c_{k+1}(m)$, $p_{k+1}(m)$ and $\lambda_{k+1}(m)$

$\rightarrow$ endogenous gridpoints bifurcation method

Unconstrained Equilibrium

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

- 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
  $c^{con}(w', y) = \left[\frac{\beta E\{u'(c')\cdot(\alpha y' + p^{con})\}}{p^{con}}\right]^{-\frac{1}{\gamma}}$
- net worth $w^{con}(w', y) = c^{con} - y - \phi p^{con} - \psi$
- shadow price $\lambda^{con}(w', y) = u'(c^{con}) - \beta RE\left[u'(c')\right]$

$\Rightarrow$ combine constrained/unconstrained policy functions
$\Rightarrow$ interpolate next iteration $c_{k+1}(w, y), p_{k+1}(w, y), \lambda_{k+1}(w, y)$

Policy Functions

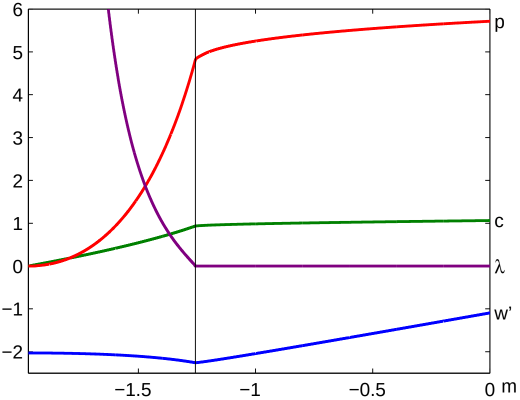

Figure: Policy functions p, c, λ, w'

Wealth Dynamics $\beta R < 1$

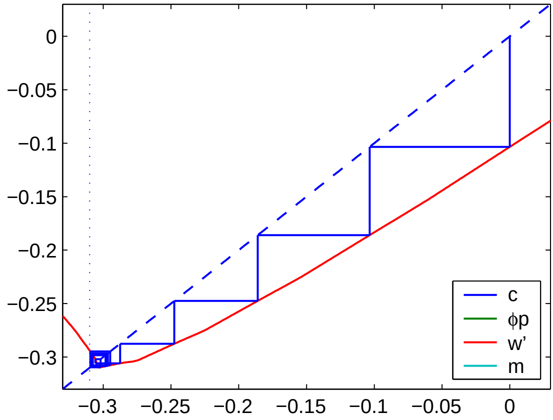

Figure: Wealth dynamics in deterministic case with $\beta R < 1$

Financial Liberalization with $\beta R < 1$

After financial liberalization, insiders experience

- first a debt-financed consumption boom (honeymoon of liberalization)
- then lower and more volatile consumption

Proposition

If $\beta R < 1$ and output is constant, the economy possesses a deterministic steady state with $w = w'$.

1. *If $\phi < \hat{\hat{\phi}}$, this is the only steady state.*
2. *If $\hat{\hat{\phi}} < \phi < \hat{\phi}$, the deterministic steady state is unstable. The economy converges with probability one to an endogenous cycle in which constrained and unconstrained equilibria alternate.*

Financial Liberalization with $\beta R < 1$

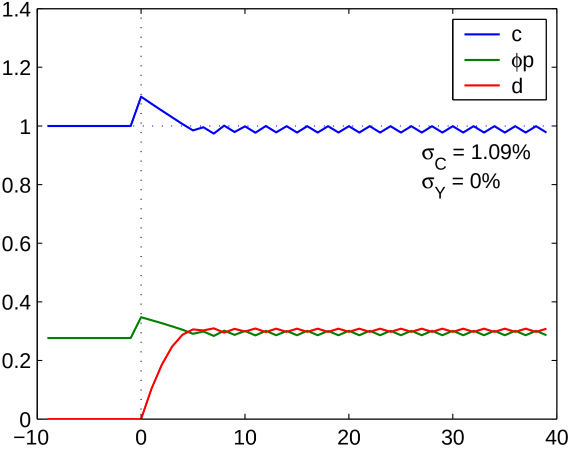

Figure: Time path of c in deterministic case with $\beta R < 1$

Constrained Social Planner

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 (time-consistent solution)

$$\max_{w_{t+1}} U_t \quad \text{s.t.} \quad \text{budget constraint, borrowing constraint}$$

$$p(m) \text{ determined by equilibrium condition of private agents}$$

Social planner's optimality condition:

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

Interpretation of externality kernel $\phi \lambda_{t+1} \frac{\partial p_{t+1}}{\partial w_{t+1}}$:

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

Externality arises if borrowing constraint binding next period

- planner takes on less debt (systemic precautionary savings)
- less severe future constraints
- less volatility and financial fragility

Implementation of Constrained Social Optimum

Alternative mechanisms to implement Pigouvian tax:

- Direct taxation of debt at rate $\tau_t = E_t \left[\frac{\beta R \lambda_{t+1}}{u'(c_t)} \cdot \phi \frac{\partial p_{t+1}}{\partial w_{t+1}} \right]$ (note: opposite of interest deductability on debt!)
- Macro-prudential regulation: countercyclical capital requirements
- Limits on leverage / margin requirements

Quantitative Exploration

Balance sheet data for US Households, SMEs and Nonfinancial Corporations in 2008/09:

	Assets			Debt		
	2008q2	2009q2	Chg.	2008q2	2009q2	Chg.
Households	74,273	64,425	-13.3%	14,418	14,116	-2.1%
SMEs	11,865	10,409	-12.3%	5,410	5,343	-1.2%
Corporations	28,579	26,521	-7.2%	13,039	13,597	+4.3%

- Corporate sector: no aggregate credit crunch detectable (corporate debt substituted for bank credit)
- Financial sector: outside of our model (leverage so high that it is inherently prone to multiple equilibria)

Quantitative Exploration

Assumptions:

- output $y_t \in \{y^L, y^H\}$ with probabilities 5% and 95% to capture booms and busts
- parameters chosen to match observed 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: Sectoral Parameter Values

	α	ϕ	y_L
US Households	24.5%	3.1%	0.963
US SMEs	20.0%	4.6%	0.969

Model Dynamics

Model dynamics:

- Boom steady state w_H^{SS}: 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_H^{SS}
  $\rightarrow$ create vulnerability to next bust
- During busts, binding constraints and debt deflation occurs

Wealth Dynamics

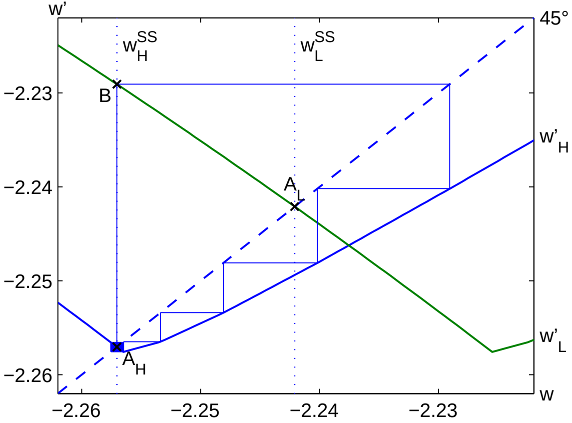

Figure: Next-period wealth function in states H and L

Oscillations in Bust

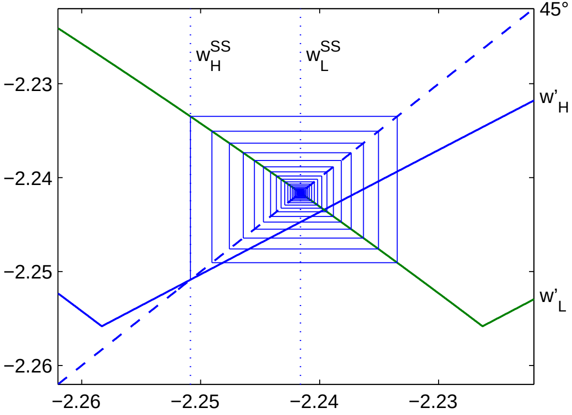

Figure: Oscillations in bust state L

Sample Paths of Macroeconomic Variables

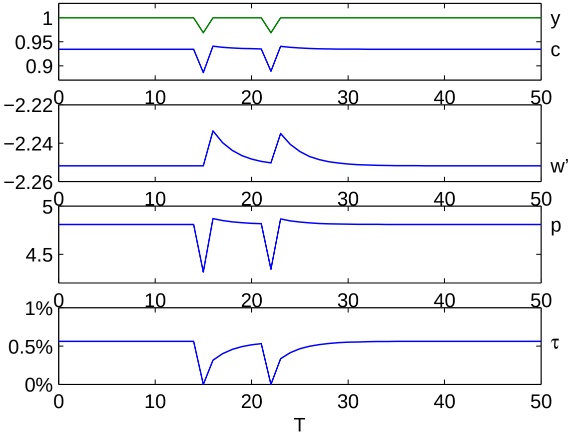

Figure: Sample path of planner's y, c, w', p and τ

Decentralized Equilibrium Vs. Social Planner

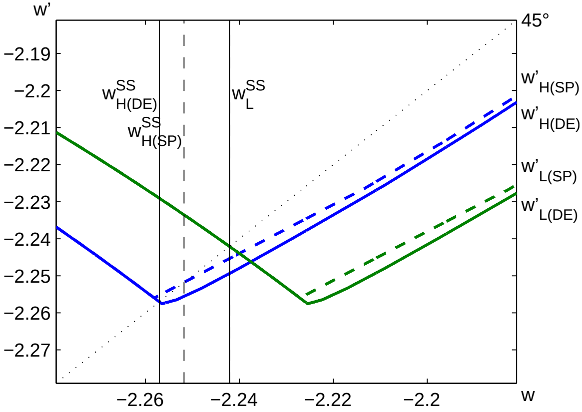

Figure: Decentralized equilibrium vs. planner's solution

Magnitude of Pigouvian Tax

Recall $\tau = E_t \left[\frac{\beta R \lambda'}{u'(c)} \cdot \phi \frac{\partial p'}{\partial w'} \right]$

	$\frac{\beta R \lambda'}{u'(c)}$	ϕ	$\frac{\partial p'}{\partial w'}$	π	τ_H^{SS}
US SMEs	13.4%	.046	18	5%	0.56%
US Households	15.0%	.031	20	5%	0.48%

Table: Calculation of Pigouvian tax for boom state

Note: if insiders strongly impatient, then planner chooses a constrained w_H^{SS}

$\rightarrow$ debt levels determined by constraint, not τ_H^{SS} (Greenspan doctrine)

Interest Rates and Financial Fragility

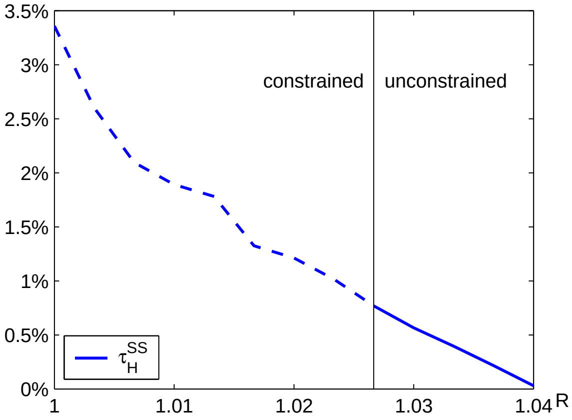

Figure: Dependence of externality τ_H^{SS} on interest rate

Debt Maturity

Assume only a fraction δ of debt needs to be rolled over per period

$$\rightarrow \text{modified constraint: } \quad \frac{w_{t+1} - (1-\delta)w_t}{R} + \delta(\psi + \phi p_t) \geq 0$$

- impact of asset price on debt reduced to $\delta\phi$
- unique equilibrium sustained with higher leverage (30y mortgages stable if $\phi \leq .84$)

Debt Maturity

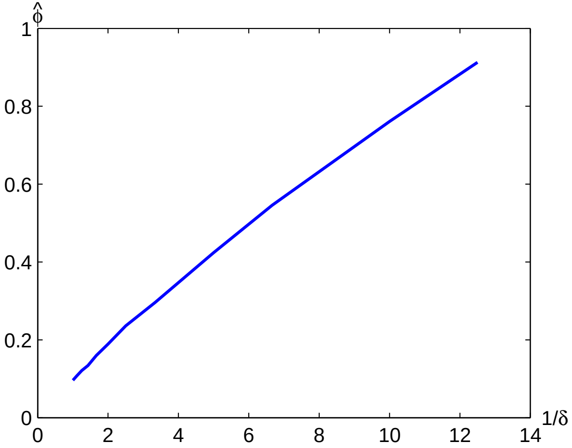

Figure: Maximum stable leverage as a function of debt duration

Booms, Busts and Growth

Trade-off financial stability and 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

$\rightarrow$ optimal macro-prudential regulation increases stability and growth

Hot Money and Serial Financial Crises

Multi-country framework of collateralized borrowing:

- financial constraints in one region of world economy lead to lower effective world demand for capital

$\rightarrow$ lower world interest rates

$\rightarrow$ more capital ("hot money") flows to unconstrained regions

$\rightarrow$ higher leverage implies greater financial vulnerability

$\rightarrow$ potential for "serial financial crises"

Conclusions

- In economies/sectors with financial amplification effects, decentralized agents **borrow excessively**
- Excessive **boom-bust cycles** in credit and asset prices
- Welfare can be improved by "leaning against the wind"
  $\rightarrow$ rationale for procyclical **macro-prudential regulation**
- Optimal policy can be implemented by sector-specific countercyclical tax on debt