

Housing and Credit Markets: Bubbles and Crashes

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Outline

- 1 Introduction
- 2 A Stark Model
- 3 Catastrophes
- 4 Bubbles and Sentiments
- 5 Conclusions

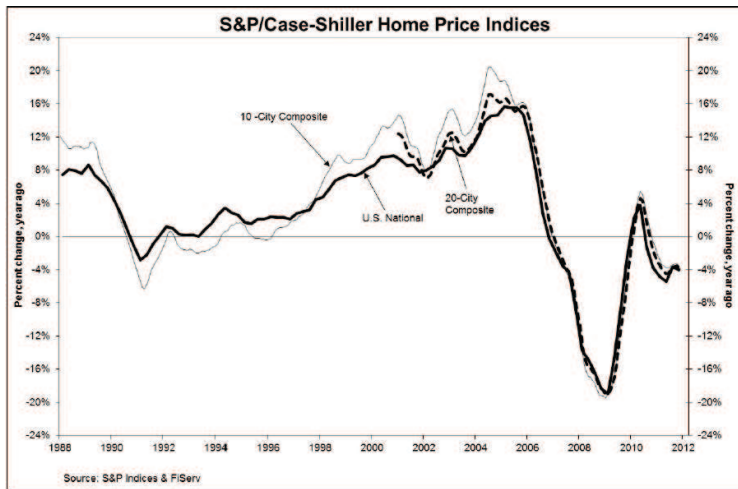
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Goal

- The purpose of this chapter is to examine a key connection between financial markets and macroeconomic activity. Specifically, we wish to examine a connection between two features
 - ① A boom-bust in house prices.
 - ② A boom-bust in credit markets.
- Large and growing literature, exploring these separately.
- This chapter: connection. Two possible channels:
 - ① Credit boom-bust \Rightarrow House price boom-bust.
 - ② House price boom-bust \Rightarrow credit boom-bust.
- Aggregate repercussions: not this chapter.
- Issues are far from resolved. Encourage future research.

The S&P/Case-Shiller Home Price Indices



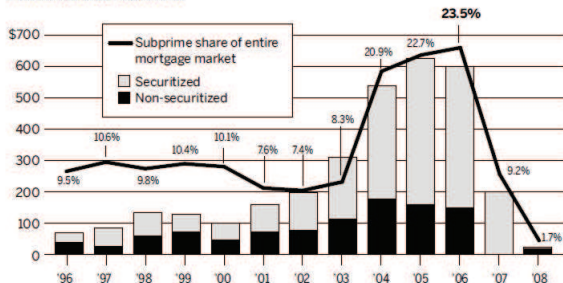
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Subprime Mortgage Originations

Subprime Mortgage Originations

In 2006, \$600 billion of subprime loans were originated, most of which were securitized. That year, subprime lending accounted for 23.5% of all mortgage originations.

IN BILLIONS OF DOLLARS



NOTE: Percent securitized is defined as subprime securities issued divided by originations in a given year. In 2007, securities issued exceeded originations.

SOURCE: Inside Mortgage Finance

Figure 5.2

Source: The Financial Crisis Inquiry Report, National Commission, January 2011

Outline

- ➊ Several small models to illustrate key ideas.
- ➋ To set the stage: a stark model.
 - ▶ Banks, HH with **long-term** mortgages, interaction.
 - ▶ Given: dynamics of both leverage and house prices.
 - ▶ Keep unconstrained house prices constant. Study the response to a boom and bust in leverage and its implications for credit-constrained house-prices.
 - ▶ Keep leverage constant. Study response to a boom and bust in house prices to banks.
- ➌ Catastrophe Models: credit boom-bust.
 - ▶ Savings glut leads to crash in lending and crash in house prices.
- ➍ Bubbles: house price boom-bust.
 - ➊ (Bubbles, type 1. Dynamically inefficient economies, bubbles do not grow or even die out on their own. Lit. review.)
 - ➋ Bubbles, type 2. Dynamically efficient. Buyers hope to find “greater fools”.
- ➎ ((Some) evidence: Lit. review.)

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A stark model

- Time: $t = \dots, -1, 0, 1, \dots$. Fixed stock of houses, one per HH.
- Cont. of borr. HH, income y per period. Frac λ dies/born with θ .
- HH born in s : willing to buy house at $p_s \leq \bar{p}_s$, exog..
- Borrow $p_s - \theta$ from banks. Interest-only loan at r . Consume

$$0 \leq c_{t;s} = y - r(p_s - \theta) \text{ in } t > s$$

- Thus:

$$p_s \leq \frac{y}{r} + \theta$$

- Death in t : sell house at p_t . Repay p_s , if possible, else “max”.
- Repayment fraction is $\phi_{t;s}$, where

$$\phi_{t;s}(p_s - \theta) = \min\{p_s - \theta, p_t + y - r(p_s - \theta)\}$$

- Default: $\phi_{t;s} < 1$.

Banks: accounting

- Assets: only mortgages. Discount at r . Book value: $v_s = p_s - \theta$.
- All assets (at book value):

$$a_t = \sum_{j=0}^{\infty} \lambda(1 - \lambda)^j (p_{t-j} - \theta)$$

- Example: $p_t \equiv p^*$. Then $a_t \equiv p^* - \theta$.
- Liabilities: net worth n_t , deposits d_t , emergency government loans L_t :

$$a_t = n_t + d_t + L_t$$

- Exogenous capital requirement κ_t :

$$\kappa_t a_t = n_t + L_t$$

Assume then that deposits evolve according to

$$d_t = (1 - \kappa_t) a_t$$

- Pay r_D on deposits. Pay r_L on gov loans, repay μ of gov loans.

Banks: dynamics

- Exiting mortgages: bank receives $\phi_t \lambda a_{t-1}$ in total, where

$$\phi_t a_{t-1} = \sum_{j=0}^{\infty} \lambda(1 - \lambda)^j \min\{p_{t-1-j} - \theta, p_t + y - r(p_{t-1-j} - \theta)\} \quad (1)$$

- Change in deposits d_t . Change in gov loans. Residual cash position m_t is

$$m_t = (r + \phi_t \lambda) a_{t-1} + d_t + L_t - (1 + r_D) d_{t-1} - (\mu + r_L) L_{t-1} - \lambda(p_t - \theta).$$

- Two versions:

- Banker consumption can be negative (“equity injection”), no gov emergency loans:

$$c_{b,t} = m_t$$

- Banker consumption non-negative, $c_{b,t} \geq 0$. Government provides emergency loan to cover shortfall:

$$L_t = (1 - \mu) L_{t-1} - \min\{0, m_t\}$$

- With that, remaining dynamic equations follow (see paper).

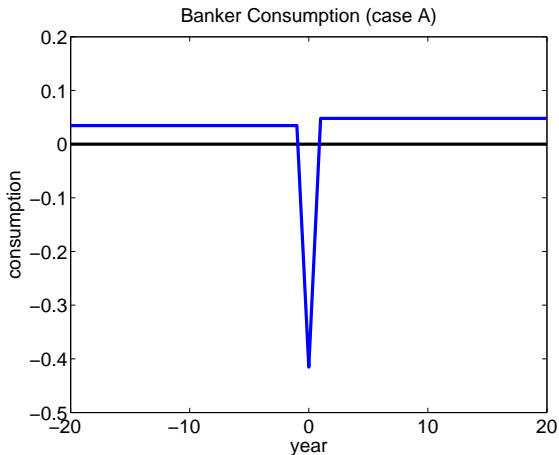
Numerical experiments: parameters

y	1
p^*	5
κ	0.05 (pre-crash, experiment 1) 0.2 (post-crash, experiment 1) 0.1 (always, experiment 2)
θ	2 y
r	0.04
r_D	0.03
r_L	0.03
μ	0.05
λ	0.1
γ	1.13 (experiment 2)
α	19 y (experiment 2)

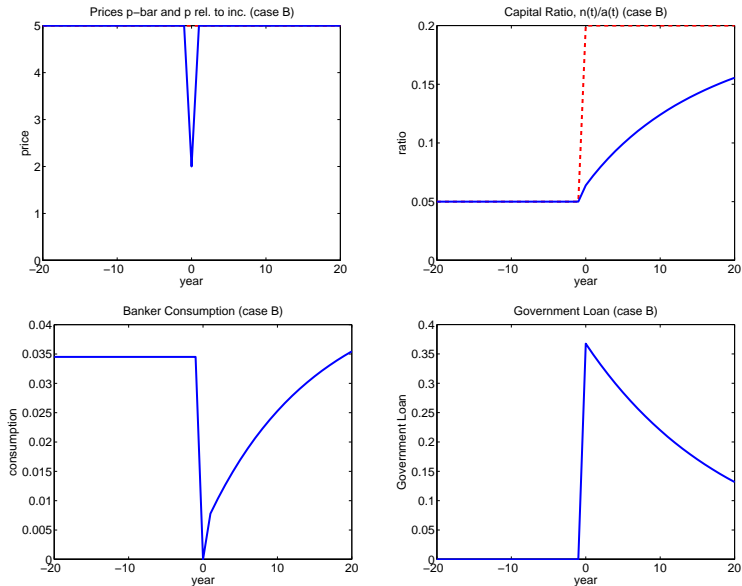
Numerical experiment 1: a credit bust

- capital ratio $\kappa_t = n_t/a_t$: exogenous.
- $t < 0$: $\kappa = 0.05$. $t \geq 0$: $\kappa = 0.2$.
- Max price: $\bar{p}_t \equiv p^* = 5$.
- Two versions:
 - 1 Allow for equity injection, i.e. negative banker cons.
 - 2 No equity injection, i.e. nonneg. banker cons.
- First version: only impact is on banker consumption.
- Second version: potentially rich implications.

Credit bust: allow for equity injection



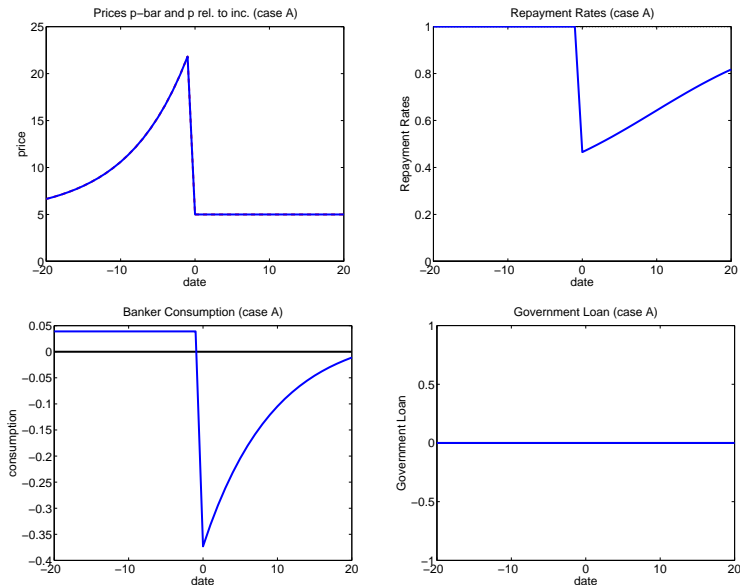
Credit bust: no equity injection



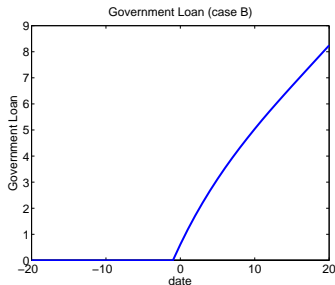
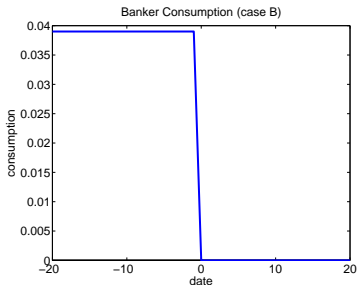
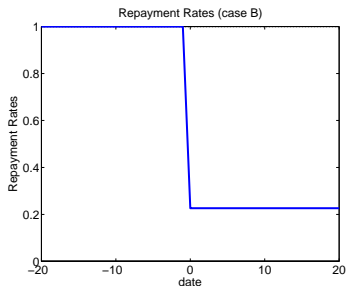
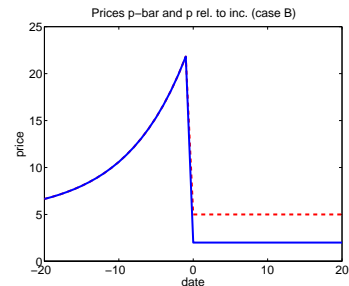
Numerical experiment 2: a house price boom-bust

- Let \bar{p}_t rise at rate γ or 13% to $\alpha y = 19$, then drop to $p^* = 5$.
- Two versions:
 - 1 Allow for equity injection, i.e. negative banker cons.
 - 2 No equity injection, i.e. nonneg. banker cons.

House price bust: allow for equity injection



House price bust: no equity injection



Some tentative conclusions from the stark model

- Long-term contracts important: overhang of (eventually) non-performing loans.
- With (full) private equity infusion, crises are short and further price impact is avoided.
- Without private equity infusion: government loans may be necessary. Longer crises, house prices may fall.
- Here: rise in capital requirements less dramatic than a boom and crash in house prices.
- Full analysis awaits.

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Saving Glut

- focus on the boom and bust in the mortgage market
- idea: increase in credit availability (“saving glut”) can endogenously generate a credit cycle
- in spirit of Boissay, Collard, and Smets (2016, JPE, forthcoming.)
- mechanism: as more credit is available, worse borrowers get funding and at some point good borrowers step out from the market generating a credit crunch
- key: adverse selection can generate multiple equilibria
- growing body of literature focus on leveraging/deleveraging cycle of households sector ...

Model

- two periods $t = 1, 2$
- continuum of 2 types of agents: households and banks
- households' utility u in period 2: cons $c \geq 0$, house h , choices:

$$u = c + \gamma h - 1_{\text{verify}} \kappa - 1_{\text{default}} \delta$$

- HH: Zero inc in $t = 1$. Income draw $y \sim F_\nu$ in $t = 2$ (next slide...).
- Type ν of hh private info: hh can “verify” (next slide...).
- houses in fixed size $\bar{h} = 1$. So, $h \in \{0; 1\}$
- houses are bought in $t = 1$. Price is fixed at 1
- households decide whether to buy a house in period 1
→ if “buy”, borrow 1 from banks, at disc. “**price**” p . (in 2 slides...).
- if don't buy/borrow: $c = y$, $u = y$.
- if borrow 1 at p , no default: repay $1/p$. $u = y - 1/p + \gamma - 1_\nu \kappa$.
- if borrow, default: loose house, “pay” δ , $u = y - \delta$. Bank gets zero.

Households

- Two-dimensional idiosyncratic risk: $[\nu, y]$.
- $\nu \in [0, 1]$ distributed according to $G(\nu)$: household type
- Given ν , households' income y distributed acc. to $F_\nu(y)$
- This talk: $y \in \{0, \bar{y}\}$. $\nu = P_\nu(y = \bar{y})$.
- ν is household's private information.
- at the beginning of period 1 households choose whether to “pay” κ to “verify” their type: $v(\nu) \in \{0, 1\}$. Type is then public information.
- Define: $\mathcal{S} = \{\nu \mid \text{don't verify, buy house}\}$
- household with realized income y repays iff $c = y - 1/p \geq 0$ and $y - 1/p + \gamma \geq y - \delta$
- Assume: $\delta > 1/p - \gamma$. HH repays iff $c = \bar{y} - 1/p \geq 0$.
- For p with $p \geq \underline{p} = 1/\bar{y}$, HH repays, if income is high.

Banks, Equilibrium

- banks can borrow at exogenous safe return R . Competitive.
- No arbitrage: for verified price $p = \tilde{p}_\nu \geq \underline{p}$, pooling price $p^P \geq \underline{p}$,

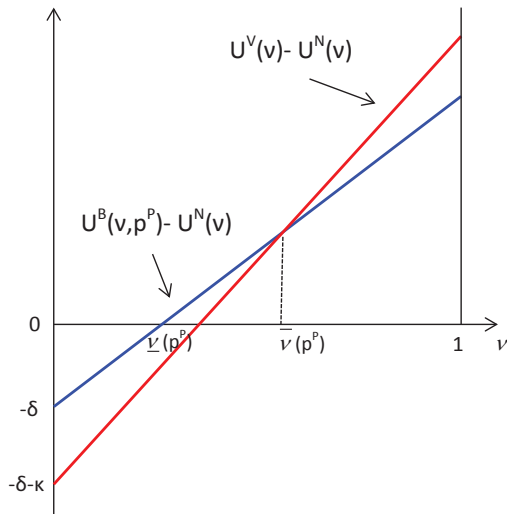
$$\tilde{p}_\nu = \frac{\nu}{R} \quad (2)$$

$$p^P = \frac{E[\nu | \nu \in \mathcal{S}]}{R} \quad (3)$$

- We need to solve for p^P .
- HH compares three indirect utilities $U_\nu^V(\tilde{p}_\nu)$, $U_\nu^B(p^P)$, U_ν^N .
- For $U_\nu^V(\tilde{p}_\nu)$ vs $U_\nu^B(p^P)$: benefit $\nu(\frac{1}{p^P} - \frac{1}{\tilde{p}_\nu})$ vs cost κ .
- For $U_\nu^B(p^P)$ vs U_ν^N : benefit $\nu(\bar{y} - 1/p^P + \gamma)$ vs cost $(1 - \nu)\delta$
- $\mathcal{S} = [\underline{\nu}(p^P), \bar{\nu}(p^P)]$.
- $\underline{\nu}(p^P)$ is decreasing, $\bar{\nu}(p^P)$ is increasing. Interior:

$$\nu(p^P) = \delta/(\bar{y} + \gamma + \delta - 1/p^P), \text{ and } \bar{\nu}(p^P) = p^P(R - \kappa)$$

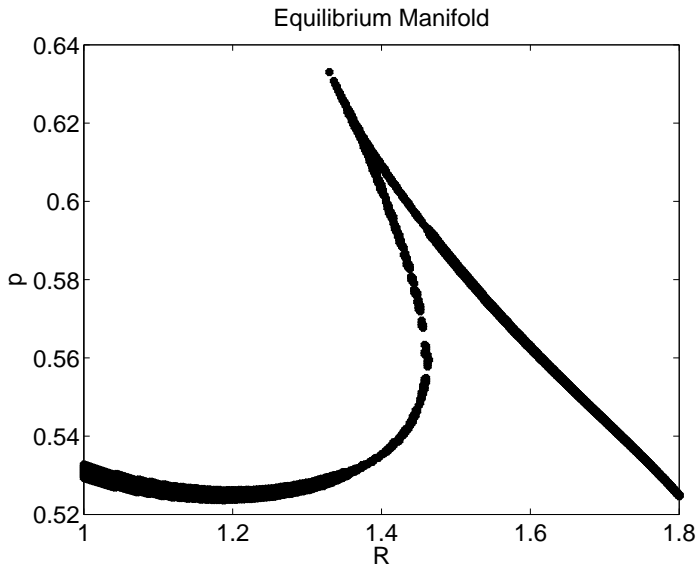
Households' problem



Multiple Equilibria

- there may be two types of equilibria:
 - 1 pooling equilibrium: nobody verifies his type \rightarrow pooling price high \rightarrow no incentive to verify
 - 2 separating equilibrium: good types verify \rightarrow pooling price low \rightarrow incentive to verify if good enough
- saving glut can generate a (comp.stat.) credit crash:
 - ▶ when R large, costly to borrow \rightarrow bad households do not borrow at all \rightarrow nobody verifies
 - ▶ as R declines \rightarrow pooling price increase \rightarrow more bad households borrow dampening the increase in price
 - ▶ as R keeps declining \rightarrow good types start verifying \rightarrow pooling price decrease discretely = “catastrophe”
 - ▶ as R increases back from there, we may remain stuck on the low-pooling-price, low-lending activity equilibrium branch.

The Equilibrium Manifold



Numerical examples

Tricky! Three cases. For all: $y \in \{0; \bar{y}\}$. $\nu = \pi_\nu = P(y = \bar{y})$.
 $\gamma \bar{h} = 2, \delta = 0.1$.

Case 0: uniform distribution for ν . No mult..

Case 1: mix expon. density and normal density, trunc.:

$$h(\nu) \propto \omega \frac{\lambda e^{-\lambda \nu}}{1 - e^{-\lambda}} + (1 - \omega) \frac{e^{-(\nu - \nu^e)^2 / (2\sigma^2)}}{\sqrt{2\pi}\sigma}$$

Params: $\kappa = 0.25, \lambda = -20, \nu^e = 0.1, \sigma = 0.2, \omega = 0.6$

Equil: $R = 1.3$ uniq sep, $R = 1.4$ mult, $R = 1.5$ uniq pool.

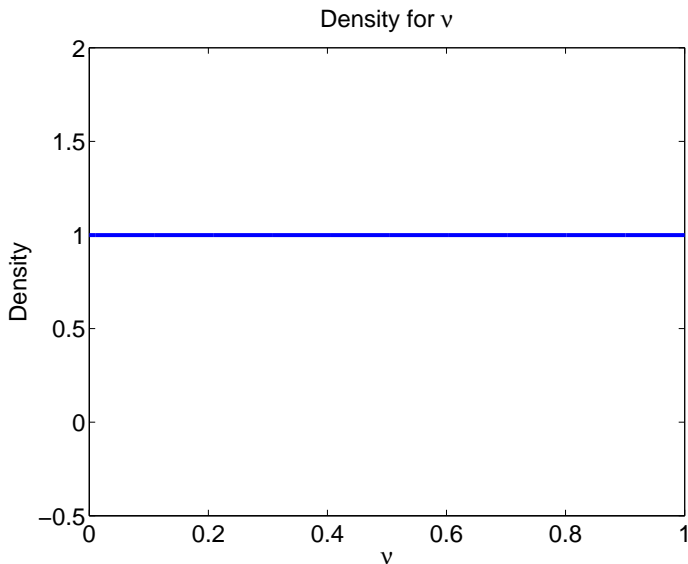
Case 2: A mixture of two exponential densities,

$$h(\nu) = \omega \frac{\lambda_1 e^{-\lambda_1 \nu}}{1 - e^{-\lambda_1}} + (1 - \omega) \frac{\lambda_2 e^{-\lambda_2 \nu}}{1 - e^{-\lambda_2}}$$

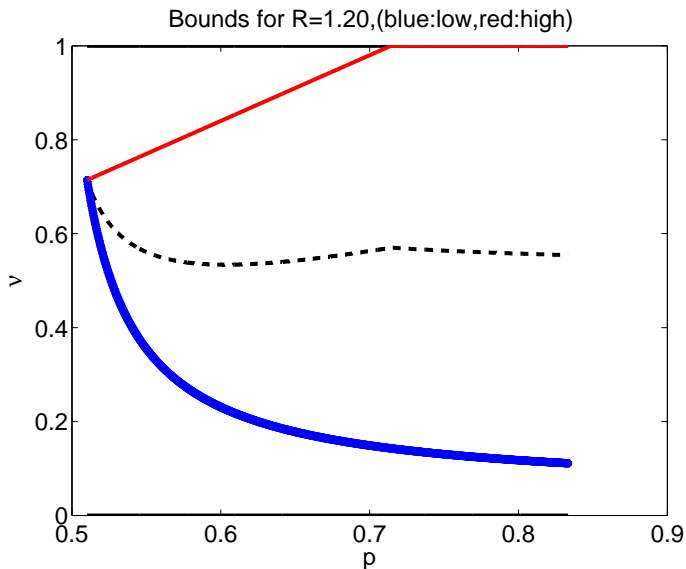
Params: $\kappa = 0.15, \lambda_1 = -20, \lambda_2 = 5, \omega = 0.8$.

Equ: $R = 1.4$ uniq sep, $R = 1.58$ mult, $R = 1.65$ uniq pool.

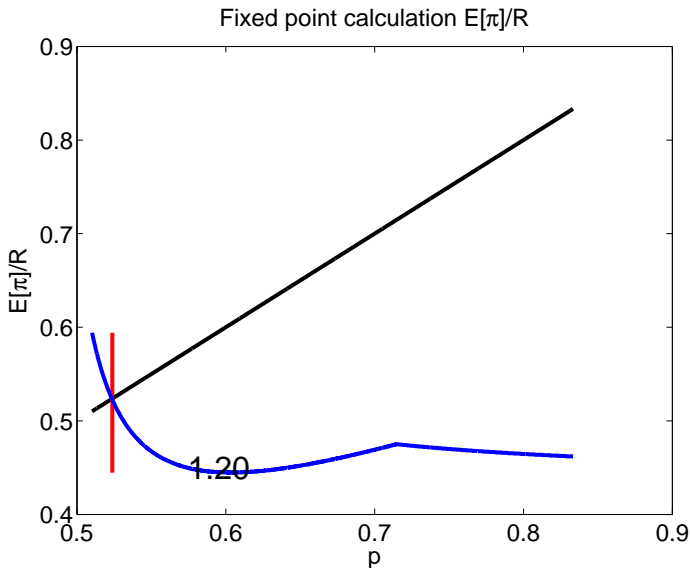
Case 0: type density



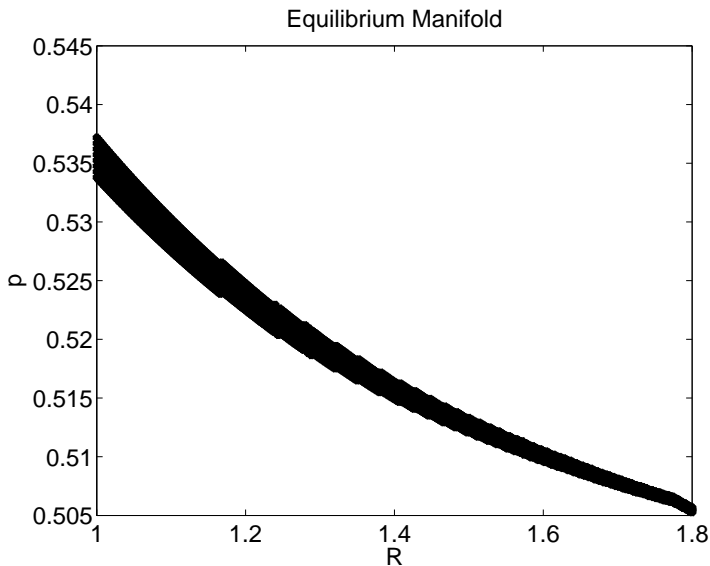
Case 0: particip.choices, bounds $\underline{\nu}(p^P)$ and $\bar{\nu}(p^P)$



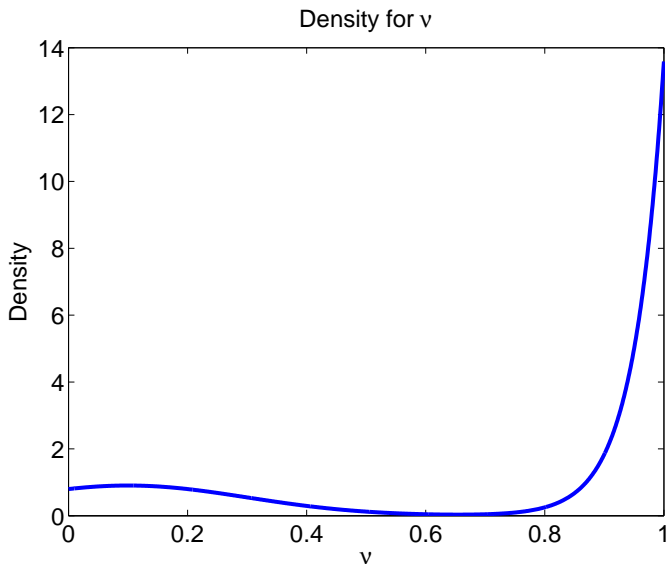
Case 0: finding the fixed points



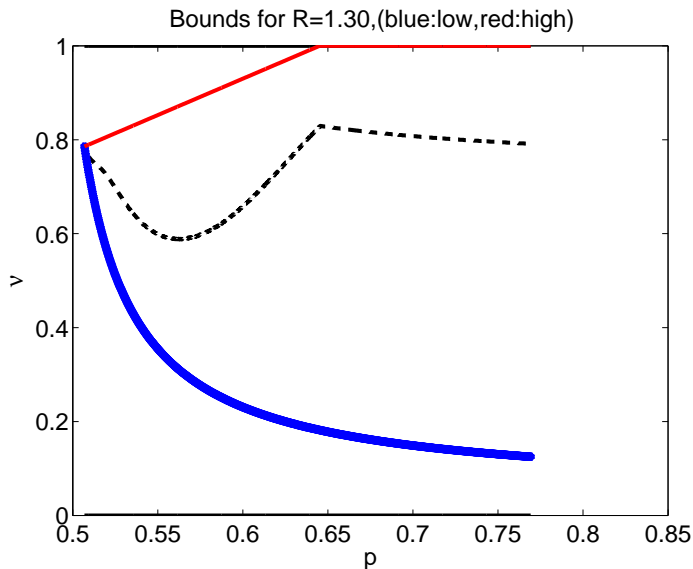
Case 0: The Equilibrium Manifold



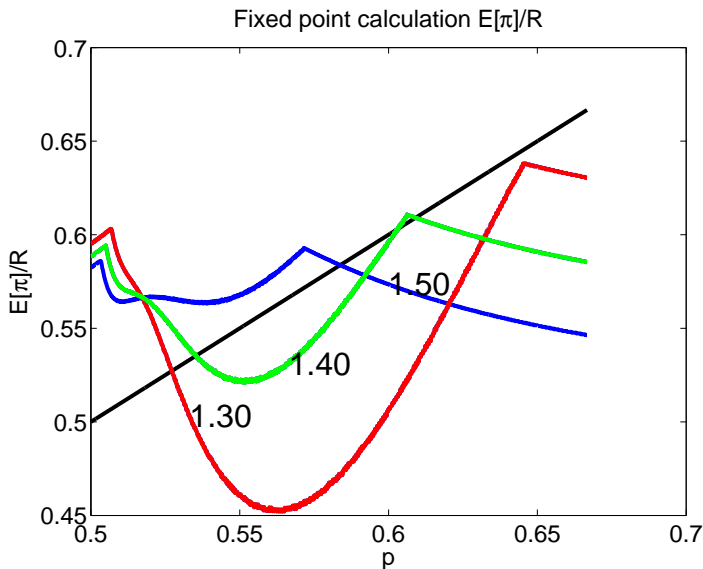
Case 1: type density



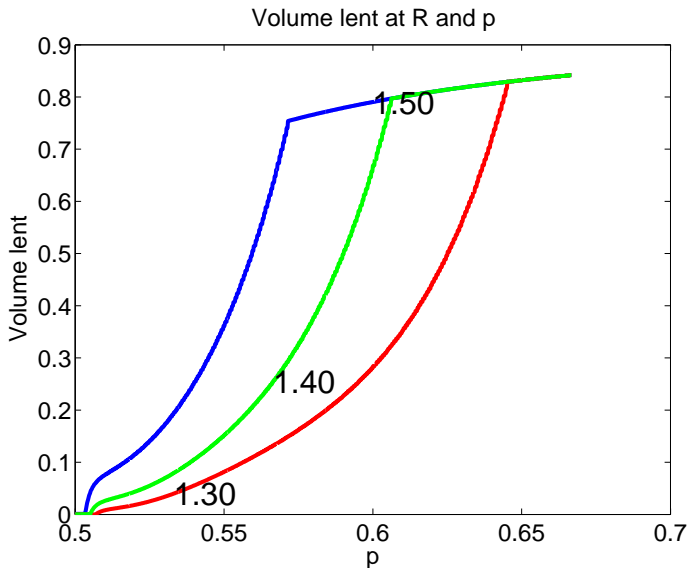
Case 1: particip.choices, bounds $\underline{\nu}(p^P)$ and $\bar{\nu}(p^P)$



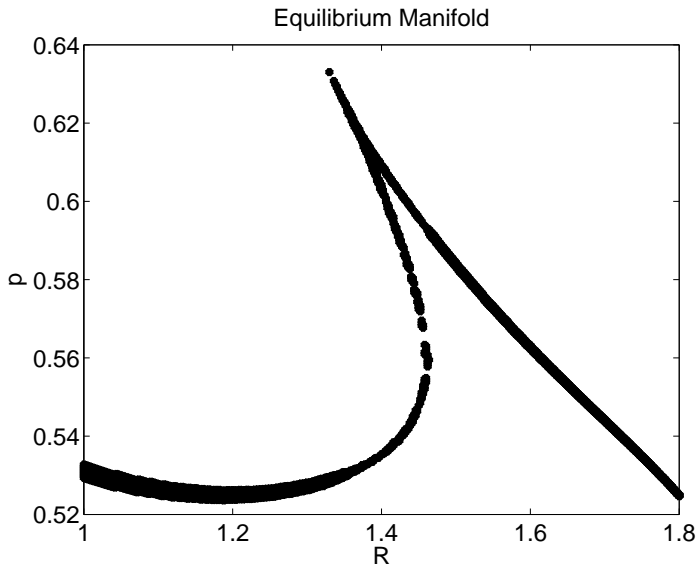
Case 1: finding the fixed points



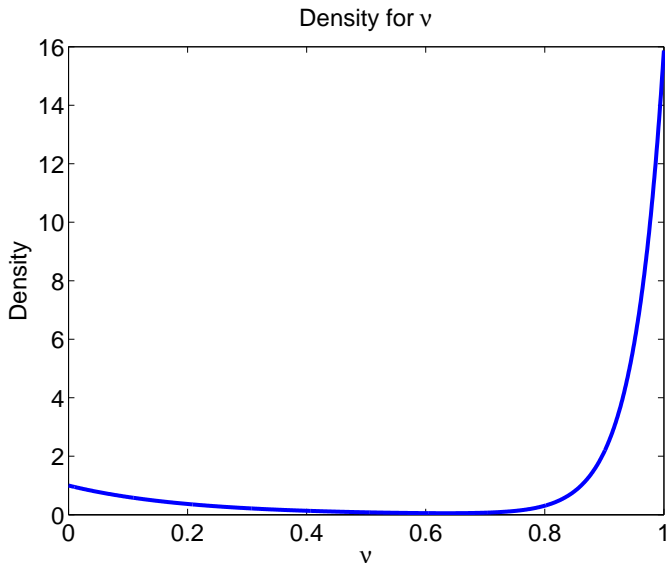
Case 1: Lending Activity



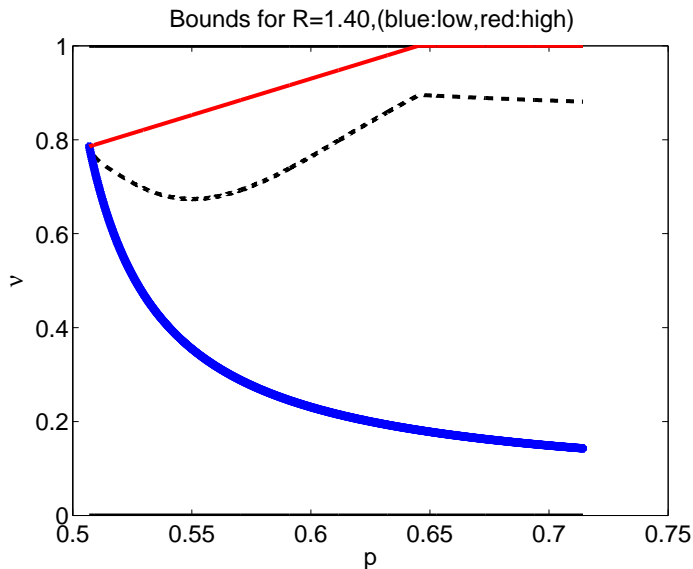
Case 1: The Equilibrium Manifold



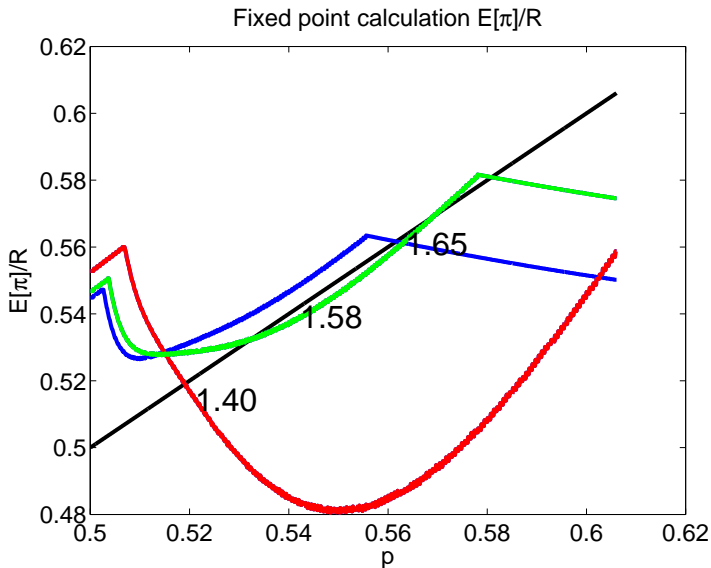
Case 2: type density



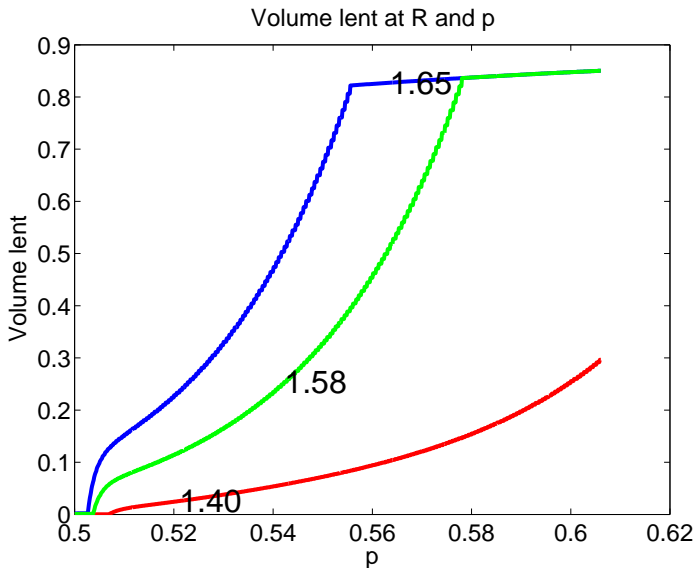
Case 2: particip. choices, bounds $\underline{\nu}(p^P)$ and $\bar{\nu}(p^P)$



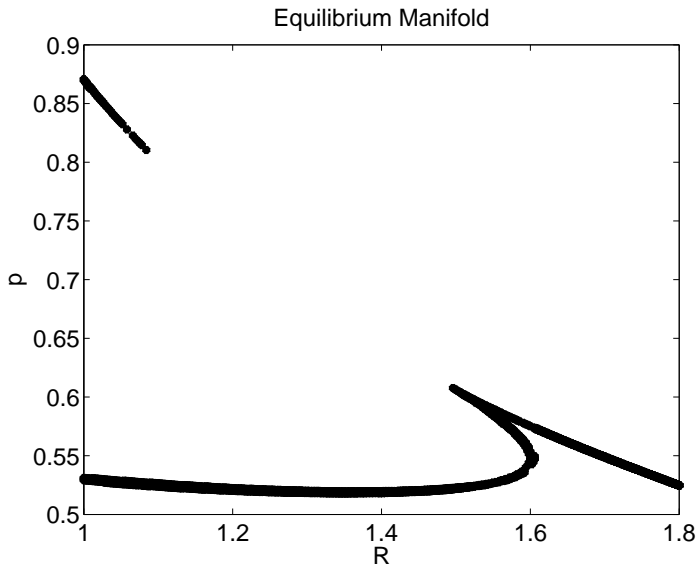
Case 2: finding the fixed points



Case 2: Lending Activity



Case 2: The Equilibrium Manifold



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Two types of bubbles

- ➊ (Expected) growth rate of bubbles \leq growth rate of economy
 - ▶ Dynamically inefficient economies.
 - ▶ Bubbles die out “on their own”
 - ▶ Chapter: literature review.
 - ▶ Martin-Ventura, Scheinkman-Xiong, ...
- ➋ (Expected) growth rate of bubbles $>$ growth rate of economy
 - ▶ Limit to bubble size.
 - ▶ “Last fool” or “collector”.
 - ▶ Inconsistent with rational expectations.
 - ▶ Enough: everyone hopes to sell to “greater fools”.
 - ▶ Belief heterogeneity, sentiments.
 - ▶ Geanakoplos, Simsek, Abreu-Brunnermeier, Burnside-Eichenbaum-Rebelo, Golosov-et-al ...

A model, part 1

- continuous time
- continuum of measure 1 of agents
- agents' type $\theta \in [0, 1] \sim H(\theta)$
- no mass at $\theta = 1$: “collector”
- agent of type θ believes *other* agents' type x drawn from

$$H_\theta(x) = (1 - \theta)H(x) + \theta 1_{x=1}$$

- aggregate revelation event arrives at rate α : all believe H

A model, part 2

- all agents have a large “cash” endowment
- single indivisible asset (“coconut”) first owned by $\theta = 0$
- preferences from consumption (allow for $c_t < 0$):

$$E \left[\int_0^{\infty} e^{-\rho t} c_t dt \right]$$

- coconut worthless to all except “collector” with valuation v_1
- random pairwise meetings with hazard rate λ
- seller of type θ makes a TIOLI offer q_θ
- buyer of type x values asset v_x and buys if $q \leq v_x$

Analysis

- sale probability at q for type θ :

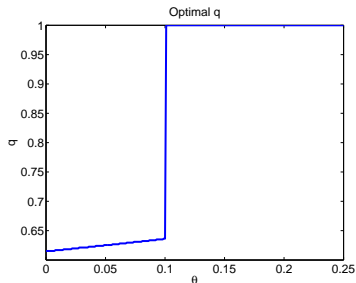
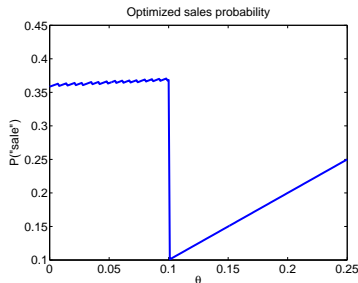
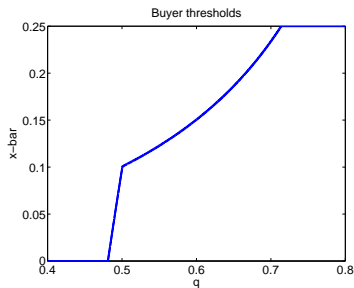
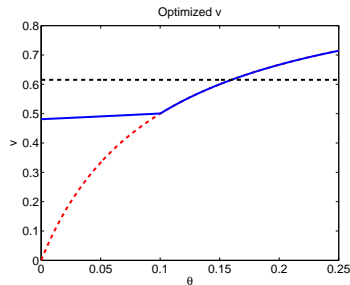
$$\phi_{\theta}(q) = \int_{q \leq v_x} H_{\theta}(dx)$$

- seller posts $q = q_{\theta}$ that solves

$$\rho v_{\theta} = \lambda \max_q \{ \phi_{\theta}(q)(q - v_{\theta}) \}$$

- equilibrium v_{θ} increasing in θ
- threshold property: buyers buy iff $x \geq \underline{x}(q)$
- dynamics: price rises and trade frequency declines as asset gets traded to higher types (price crashes upon revelation to $p = 0$)
- numerical example: $\lambda = 1$, $\rho = 0.1$, H a uniform distribution on $[0, 0.25]$, $v_1 = 1$

Numerical example

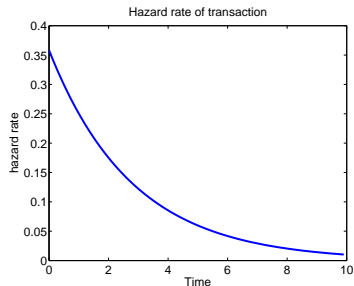
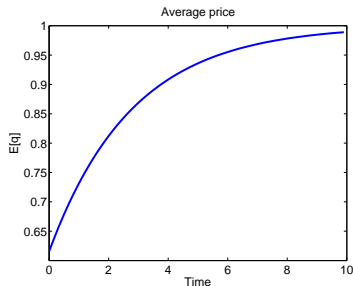


Price dynamics

- Consider now averaging across many simulations or individual markets, where the asset is initially held by the least optimistic agent $\theta = 0$.
- Two stages:
 - ▶ If asset owned by initial $\theta = 0$ agent, it will be sold at the hazard rate $\xi = \phi_0(q_0)$.
 - ▶ Once sold, it will be posted at price $q_{\tilde{\theta}} = 1$ and not trade again
- Unconditional date- t probability π_t , that the asset remains in the hands of initial $\theta = 0$ agent: $\pi_t = \exp(-t\xi)$.
- Average price:

$$E[q_t] = v_1 - (v_1 - q_0(q_0)) \exp(-t\xi)$$

Price dynamics



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Summing Up

- key interplay between the housing market cycle and the credit market cycle
- large literature focused on one of the two possible stories:
 - ① credit market boom-bust \rightarrow housing market boom-bust
 - ② housing market boom-bust \rightarrow credit market boom-bust
- we first described a stark model to think about this interplay.
- then we developed two new models inspired by existing literature:
 - ① given prices, increase in credit availability generates a credit boom-bust
 - ② given leverage, irrational optimism can generate a house price boom-bust
- We believe these analyses point to important issues on this important topic.
- The models are simple and deficient, but interesting!!
- We hope that this inspires lots of good future work in the area.