Macroeconomics of Financial Markets

ECON 712, Fall 2018

Financial Markets and Business Cycles

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October 15, 2018

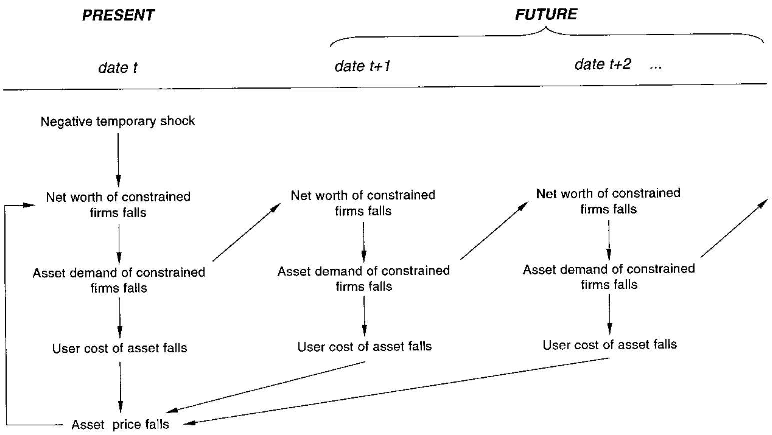
Financial Frictions in Macro

- Financial markets have the potential to magnify and generate fluctuations.
- Magnification of productivity shocks
  - Collateral constraints
    Kiyotaki and Moore (JPE 97).
  - Costly state verification
    Bernanke and Gertler (AER 89)
    Carlstrom and Fuerst (AER, 97).
- Generation of cycles.
  - Collateral Crises.
    Gorton and Ordonez (AER, 14)

The Role of Collateral Constraints

- **Main Paper: Kiyotaki and Moore (JPE, 1997)**
- Credit frictions → amplification & persistence of shocks
- Two roles for capital
  - Factor of production
  - Collateral for loans
- Negative productivity shock
  - Reduces output; reduces value of collateral
  - Reduces borrowing, which reduces output further
  - "Multiplier" effects amplifies losses

Mechanism Summary



Agents

- Farmers. measure 1

$$E_t \sum_{s=0}^{\infty} \beta^s x_{t+s}$$

- Gatherers, measure m

$$E_t \sum_{s=0}^{\infty} \beta'^s x'_{t+s}$$

- Farmers *more* impatient ($\beta < \beta'$)

  (will imply that Farmers are the borrowers in equilibrium)
- Both use land k_t to produce fruit
- Value of land $k_t q_t$ used as collateral

Farmers

- Farmers' production function for fruit

$$y_{t+1} = (a+c)k_t$$

ak_t = sellable fruit

ck_t = "bruised fruit" which must be consumed

- Investment happens at a rate $R = \frac{1}{\beta'}$, then

$$a + c = x + \frac{a-x}{\beta}$$

- Assumption $a + c > \frac{a}{\beta}$

(farmers do not want to consume more than ck_t, then sell ak_t)

Farmers (constrained)

- Can borrow b_t at rate R
- Borrowing Constraint (inalienability of farmers' human capital)

$$Rb_t \leq q_{t+1} k_t$$

- Farmers' "flow of funds" constraint

$$(a+c)k_{t-1} + b_t + q_t k_{t-1} = x_t + Rb_{t-1} + q_t k_t$$

x_t is consumption of fruit

Gatherers (unconstrained)

- They do not have specific skills to threat not paying.
- Gatherers' production function for fruit

$$y'_{t+1} = G(k'_t)$$

$G(\cdot)$ has decreasing returns to scale

- Gatherers' budget constraint

$$G(k'_{t-1}) + b'_t + q_t k'_{t-1} = x'_t + Rb'_{t-1} + q_t k'_t$$

x'_t is consumption of fruit

Equilibrium

- Sequences of land prices, allocations of land, debt, consumption for farmers and gatherers
  $\{q_t, k_t, k_t', b_t, b_t', x_t, x_t'\}$
  such that everyone's optimizing and markets clearing.

- No uncertainty: perfect foresight

Equilibrium Results: Farmers

- Farmers always borrow the maximum and invest in land

$$b_t = q_{t+1} k_t / R \qquad \texttt{and} \qquad x_t = c k_{t-1}$$

- From the budget constraint, farmers' land holdings are

$$k_t = \frac{1}{q_t - q_{t+1}/R} \underbrace{[(a + q_t) k_{t-1} - R b_{t-1}]}_{\text{net worth}}$$

$u_t \equiv q_t - q_{t+1}/R =$ "down payment"

- *Farmers spend entire net worth on difference between price of new land q_t and amount against which they can borrow against each unit of land q_{t+1}/R*

Farmers in the Aggregate

- Farmer aggregate landholding & borrowing

$$K_t = \frac{1}{u_t}[(a + q_t)K_{t-1} - RB_{t-1}]$$

$$B_t = \frac{1}{R}q_{t+1}K_t$$

- Note: higher q_t, q_{t+1} → farmers demand *more* k_t
  - can borrow more when $q_{t+1}k_t$ (collateral) values higher
  - net worth higher when q_t higher

Equilibrium Results: Gatherers

- Gatherer's demand for land.

$$G'(k'_t)/R = u_t = \underbrace{q_t - (q_{t+1}/R)}_{\texttt{user cost}}$$

Equalize the marginal product of land ($G'(k'_t)$) with its opportunity cost ($Rq_t - q_{t+1}$).

Market Clearing

- Land market resource constraint

$$mk'_t + K_t = \bar{K}$$

- Land market clearing

$$u_t = q_t - q_{t+1}/R = G'\left(\underbrace{\frac{1}{m}(\bar{K} - K_t)}_{k'}\right)/R$$

Note u_t is decreasing in k'_t (increasing in K_t) and gatherers are not constrained, then $R = \frac{1}{\beta'}$.

- ASS: No bubbles in land price: $lim_{s\rightarrow\infty}E_t(R^{-s}q_{t+s}) = 0$

Steady State

$$u^* = (1 - 1/R)q^* = a$$

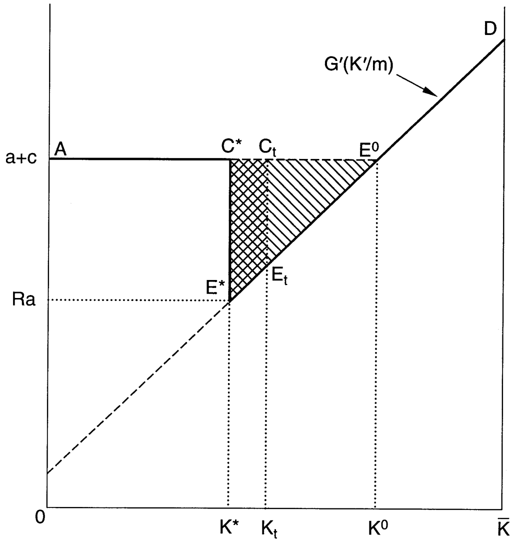
$$u^* = G'\left(\frac{1}{m}(\bar{K} - K^*)\right)/R$$

$$(R-1)B^* = aK^*$$

Assumption 1: $Ra = G'\left(\frac{1}{m}(\bar{K} - K^*)\right) < \frac{a}{\beta} < a + c.$

Inefficient allocation because of collateral constraint.

Steady State



One-time Productivity Shock

- Say $y_{t+1} = (1+\Delta)(a+c)k_t$
- Period of shock (period t)

$$u(K_t)K_t = (a + \Delta a)K^* + q_t K^* - \underbrace{RB^*}_{q^* K^*}$$

$$\implies u(K_t)K_t = (a + \Delta a + q_t - q^*)K^*$$

- Subsequent periods (periods $t+s$, $s = 1, 2, ...$)

$$u(K_{t+s})K_{t+s} = aK_{t+s-1} + \underbrace{q_{t+s}K_{t+s-1} - RB_{t+s-1}}_{=0}$$

One-time Productivity Shock

- Log-linearize around steady state
- Define for variable X_t the proportional change from steady state

$$\hat{X}_t = \frac{X_t - X^*}{X^*}$$

- Period of shock (period t)

$$(1 + 1/\eta)\hat{K}_t = \Delta + \frac{R}{R-1}\hat{q}_t$$

- Subsequent periods (periods $t+s$, $s = 1, 2, ...$)

$$(1 + 1/\eta)\hat{K}_{t+s} = \hat{K}_{t+s-1}$$

where η denotes elasticity of land supply of gatherers to user cost

Response of Land Price & Land Holdings

- Land price response

$$\hat{q}_t = \frac{1}{\eta}\Delta$$

- Overall land holding response

$$\hat{K}_t = \underbrace{\frac{1}{1+\frac{1}{\eta}}(1+\frac{R}{R-1}\frac{1}{\eta})}_{>1}\Delta$$

Response of Land Price & Land Holdings

- Land price response

$$\hat{q}_t = \frac{1}{\eta}\Delta$$

- Overall land holding response

$$\hat{K}_t = \underbrace{\frac{1}{1+\frac{1}{\eta}}(1 + \frac{R}{R-1}\frac{1}{\eta})}_{>1}\Delta$$

- Say $\eta = 1,\ R = 1.05$

$$\hat{K}_t \approx 11\Delta$$

Static Response of Land Price & Land Holdings

- Land price response

$$\hat{q}_t|_{q_{t+1}=q^*} = \frac{1}{\eta}\underbrace{\frac{R-1}{R}}_{<1}\Delta$$

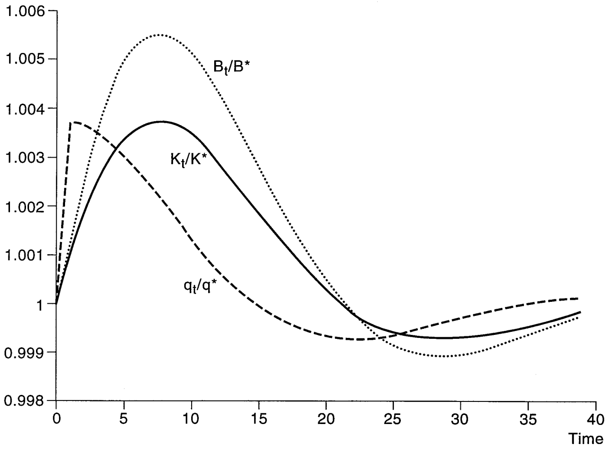
- Overall land holding response

$$\hat{K}_t|_{q_{t+1}=q^*} = \Delta$$

Response of Output & Productivity

$$\hat{Y}_{t+s} = \underbrace{\frac{a+c-Ra}{a+c}}_{\text{Productivity diff.}} \underbrace{\frac{(a+c)K^*}{Y^*}}_{\text{Farmers' share}} \hat{K}_{t+s-1}$$

Response to Shock



Net Worth Shock

- One time reduction in debt obligations
- Increases net worth
- Farmer increases leverage, production
- Another view of Bernanke-Paulson policies?

Wrapping Up

- Firms' productive capital also used as collateral
- Amplification and persistency of real shocks through lower collateral value of capital
- Real effects of lower asset values and financial frictions.

Critiques/Comments

- Kocherlakota (QR, 2000): Quantitative importance likely to be small if land & capital share less than 0.4
- Andres Arias (WP, 2005): Calibrated RBC model with KM credit constraints deliver small amplification effects
- Brunnermeier and Sannikov (2014): Non-linearities during crises.
- *Real effects of housing/stock bubbles*

The Conceptual Idea

- **Main Paper: Bernanke and Gertler (AER, 1989).**
- Costly state verification in a Real Business Cycle model.
- Debt-Deflation meets Real Business Cycle.
- Main idea.
  - The borrowers' net worth determines both their risk of default and agency problems (the intermediation cost).
  - Net worth is procyclical.
  - In recessions the costs of intermediation increase, reduce the net return of investment and depress investment, magnifying the recession.

Environment

- Risk neutral E and L.
- E has net worth n.
- E's technology:
  - i units of c good $\rightarrow \omega i$ units of k good
  - ω is iid over time and investors, st, $\int_0^\infty \omega d\Phi(\omega) = 1$.
  - We denote by q the price of the k good in terms of the c good.
- A fancy costly state verification
  - ω is private information to E. L has to pay μi to learn ω

Contracting Problem

- E borrows $i - n$ in c goods and repays $(1 + r^k)(i - n)$ in k goods.
- E defaults iff $\omega \leq \bar{\omega} \equiv (1 + r^k)\frac{i-n}{i}$.
- Then

$$r^k = \frac{\bar{\omega} i}{i - n} - 1$$

Expected income for E and L

- E's expected income (in terms of c goods)

$$\begin{aligned} & q\left[\int_{\bar{\omega}}^{\infty} \omega i d\Phi(\omega) - (1-\Phi(\bar{\omega}))(1+r^k)(i-n)\right] \\ = \quad & qi\underbrace{\left[\int_{\bar{\omega}}^{\infty} \omega i d\Phi(\omega) - (1-\Phi(\bar{\omega}))\bar{\omega}\right]}_{f(\bar{\omega})} \end{aligned}$$

- L's expected income (in terms of c goods)

$$\begin{aligned} & q\left[\int_{0}^{\bar{\omega}} \omega i d\Phi(\omega) + (1-\Phi(\bar{\omega}))(1+r^k)(i-n) - \Phi(\bar{\omega})\mu i\right] \\ = \quad & qi\underbrace{\left[\int_{0}^{\infty} \omega i d\Phi(\omega) + (1-\Phi(\bar{\omega}))\bar{\omega} - \Phi(\bar{\omega})\mu\right]}_{g(\bar{\omega})} \end{aligned}$$

Optimal Contract

- The optimal contract specifies

$$\max_{i,\bar{\omega}} qif(\bar{\omega}) \qquad st \qquad qig(\bar{\omega}) \geq i - n$$

- From the participation constraint, i is increasing in q and n

$$i = \frac{1}{1 - qg(\bar{\omega})} n$$

- The maximization becomes

$$\max_{\bar{\omega}} q \frac{n}{1 - qg(\bar{\omega})} f(\bar{\omega})$$

Optimal Contract

- FOC

$$g(\bar{\omega}) - g'(\bar{\omega})\frac{f(\bar{\omega})}{f'(\bar{\omega})} = \frac{1}{q}$$

where

$$f(\bar{\omega}) + g(\bar{\omega}) = 1 - \mu\Phi(\bar{\omega})$$

$$f'(\bar{\omega}) + g'(\bar{\omega}) = -\mu\phi(\bar{\omega})$$

- Then, implicit function $\bar{\omega}(q)$ increasing in q,

$$1 - \mu\Phi(\bar{\omega}) + \phi(\bar{\omega})\mu\frac{f(\bar{\omega})}{f'(\bar{\omega})} = \frac{1}{q}$$

The Quantitative Application

- **Main Paper: Carlstrom and Fuerst (AER, 1997).**
- Financial frictions provide a propagation mechanism....is this large quantitatively?

General Equilibrium Model

- Players
  - Two types of consumers
    - HHs: Households (risk averse)
    - E: Entrepreneur (risk neutral)
  - MF: Mutual Fund channels funds from HHs to E.

General Equilibrium Model

- Sequence of Events
  - θ_t: Aggregate productivity shocks
  - Firms produce c goods: $Y_t = \theta_t F(K_t, L_t^{HH}, L_t^E)$
  - HHs buy c goods and order new k goods from the MF at a price q_t
  - MF finances loans to E (with the technology we discussed).
  - iid shocks to E (in ω).
  - CSV contract.
  - Production of k goods.
  - Solvent E sell capital to MF and purchase c goods.
- Production is linear and net worth can just be aggregated in an aggregated net worth.

General Equilibrium Model

- This is calibrated with the following exercises.

- Shift of 0.1% of SS capital from HH to E.
  - This implies an increase in net worth of 13%.
  - $\uparrow I = 5.5\%$ and $\downarrow q$.
  - $\downarrow C^{HH} = 0.8\%$, $\uparrow L^{HH} = 2.2\%$ and $\uparrow Y = 1.4\%$
- A positive productivity shock on θ.
  - Increase in the demand for k goods but slow response on n.
  - Hump shaped increase in Y.

Motivation

- **Main paper: Gorton and Ordonez (AER 14)**

- Information is at the heart of financial intermediation.
- Transparency is at the heart of new proposed regulation.

- How information production shapes business cycles?
- Should policies induce information production?
- **We show information dynamics can account for fragility, magnification, persistence and asymmetry of cycles.**

Peeking at the Results

- In a world of collateralized short-term debt, symmetric ignorance about the quality of collateral may be efficient.
  - Firms with bad collateral get loans that they otherwise would not. "Ignorance Credit Boom".
- but fragile to small shocks that induce asymmetric information.
  - Firms with good collateral do not get loans that they otherwise would. "Collateral Crises".
- Endogenous tail events. Larger booms lead to larger crises.

Setting

- Single Period. Mass 1 of risk-neutral firms and households.

$$K' = \begin{cases} A\min\{K, L^*\} & \texttt{with prob. } q \\ 0 & \texttt{with prob. } (1-q) \end{cases}$$

  $qA > 1$. Optimal scale $K^* = L^*$

- Households: $\bar{K} > K^*$.
- Firms: L^* and a unit of land.

Setting

- Single Period. Mass 1 of risk-neutral firms and households.

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  $qA > 1$. Optimal scale $K^* = L^*$

- Households: $\bar{K} > K^*$.

- Firms: L^* and a unit of land.

$$\begin{cases} C > K^* & \texttt{with prob. } p \\ 0 & \texttt{with prob. } (1-p) \end{cases}$$

  Only households can privately learn the truth at a cost γ.

Induce Information

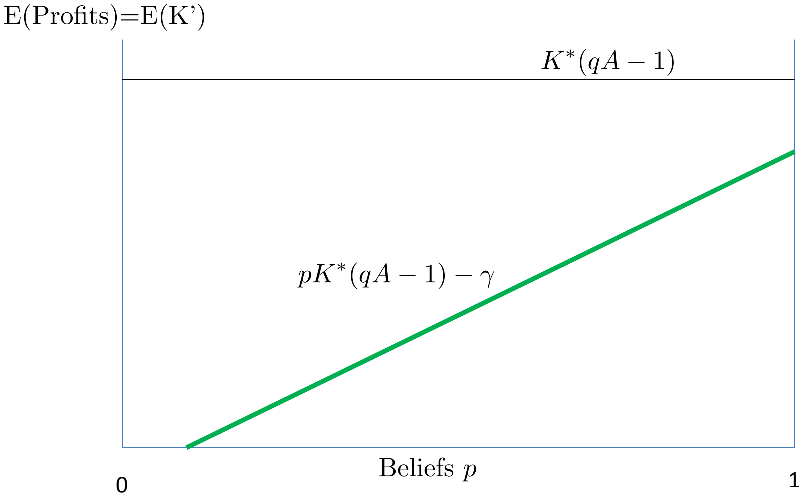
- Symmetric Information.
- Lenders break even and debt is risk free

$$p(qR_{IS} + (1-q)xC) = \gamma + pK \qquad \texttt{and} \qquad R_{IS} = xC$$

Then

$$x = \frac{pK + \gamma}{pC} \leq 1$$

Induce Information



Do Not Induce Information

- Symmetric Ignorance.
- Lenders break even and debt is risk free

$$qR_{II} + (1-q)pxC = K \qquad \texttt{and} \qquad R_{II} = pxC$$

Then $x = \frac{K}{pC} \leq 1$

Do Not Induce Information

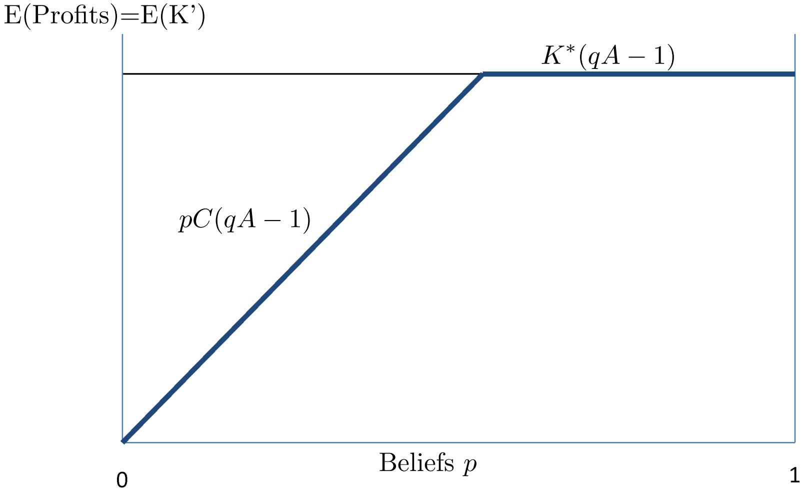
- Symmetric Ignorance.
- Lenders break even and debt is risk free

$$qR_{II} + (1-q)pxC = K \qquad \texttt{and} \qquad R_{II} = pxC$$

Then $x = \frac{K}{pC} \leq 1$

- Subject to loans not triggering information acquisition.

Do Not Induce Information



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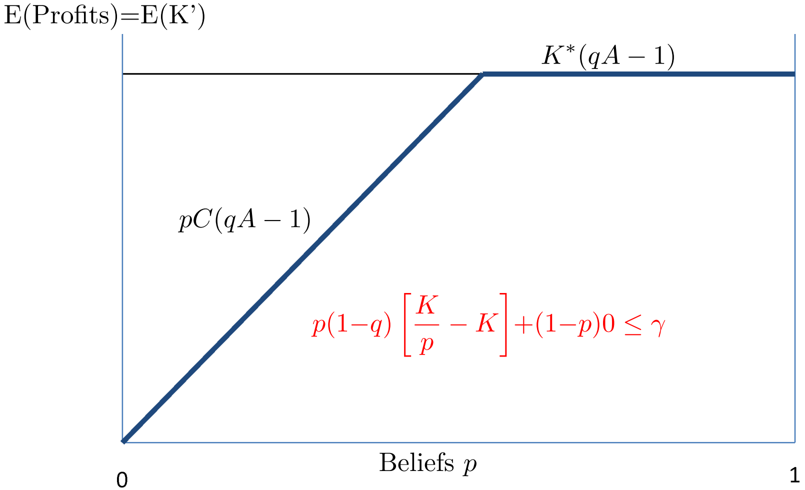

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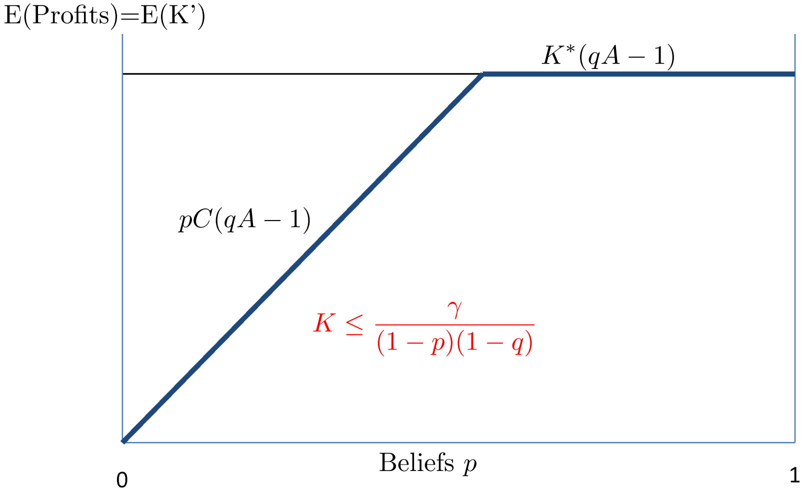
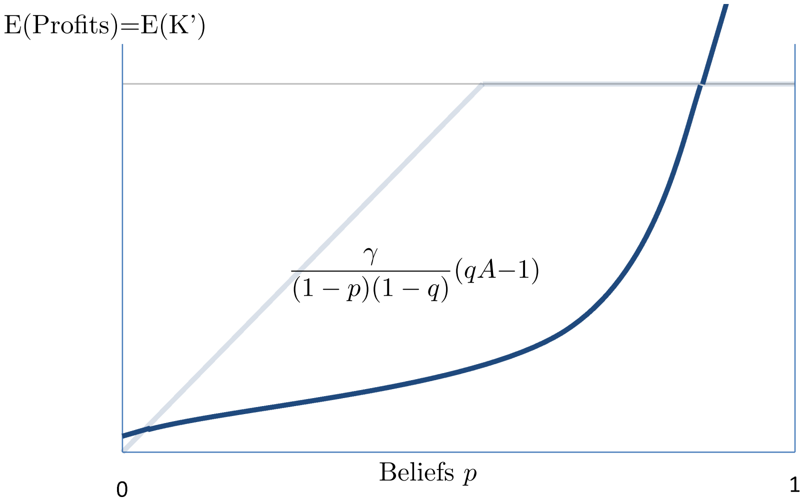
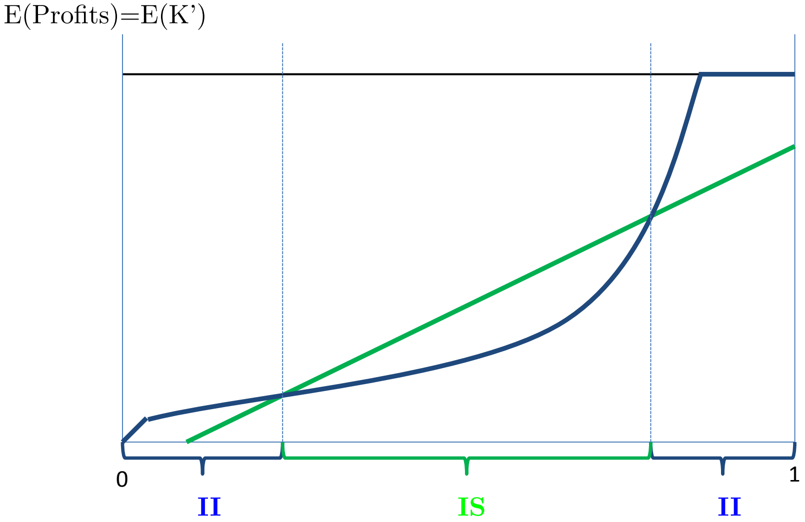


Do Not Induce Information

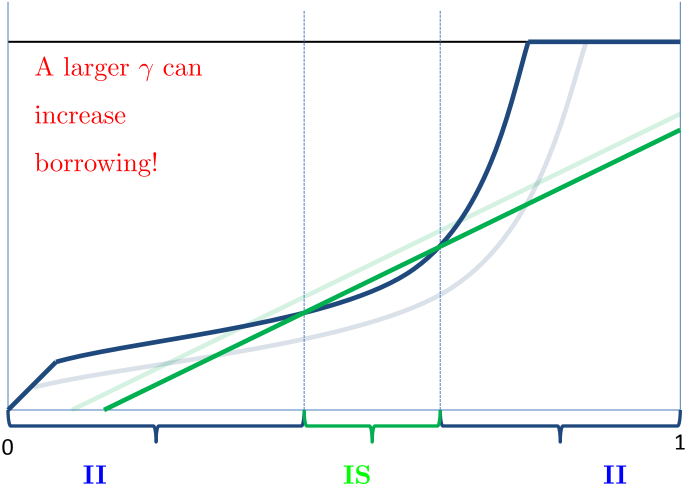


Optimal Information

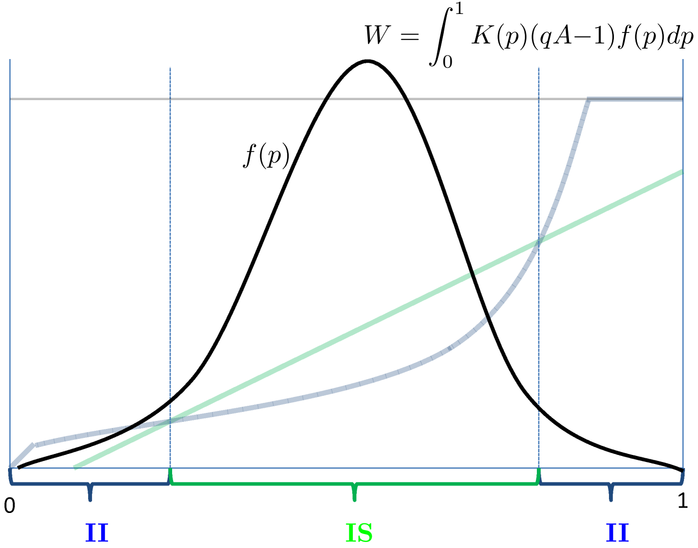


Optimal Information

E(Profits)=E(K')



Optimal Information



Setting Dynamics

How this distribution of beliefs evolves over time?

- Dynamic extension.
  - OG: "young" households, "old" firms.
  - Land is storable, K is not.
  - Land is transferred across generations.
  - We assume away bubbles and multiplicity.
  - There are no fire sales.
  - Price is pC (i.e., single match and buyers' negotiation power).

Timing

- Firm w/ collateral p
- Borrows K w/ II or IS debt (conditions R and x)
- Lender can privately observe collateral type.

Market for loans

- Project realization
- Debts are paid off and any info is revealed (p')
- Firms sell land at p'C to households.

Market for land

Timing

Idiosyncratic and Aggregate Shocks

- Firm w/ collateral p

- Borrows K w/ II or IS debt (conditions R and x)

- Lender can privately observe collateral type.

Market for loans

- Project realization

- Debts are paid off and any info is revealed (p')

- Firms sell land at p'C to households.

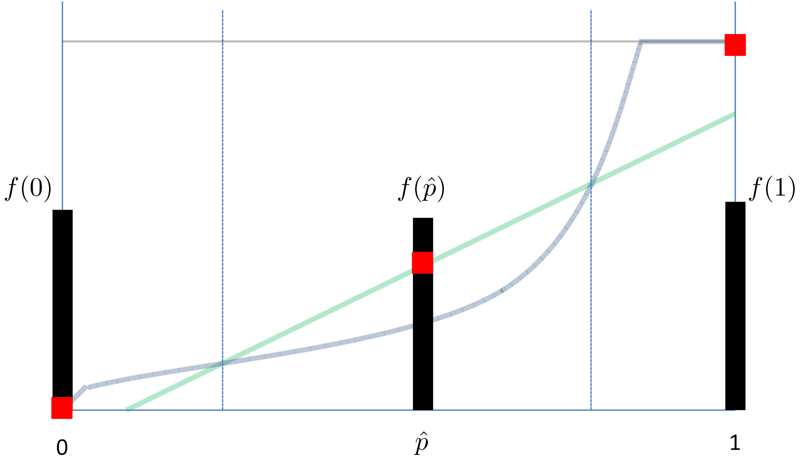
Market for land

Evolution of Collateral Types

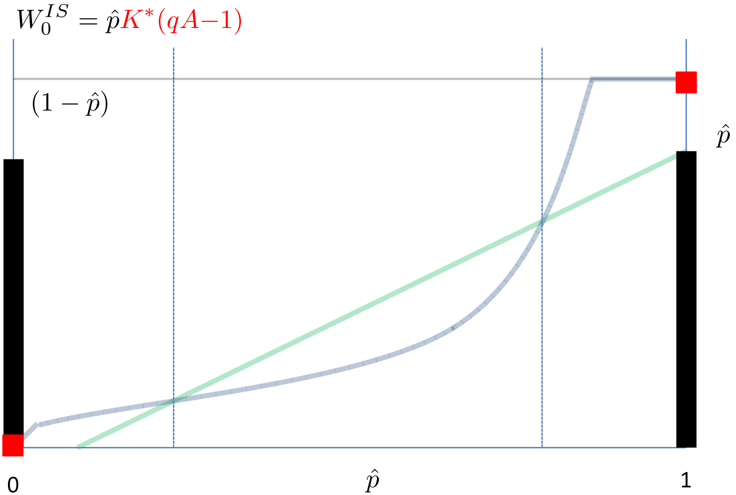
- Important assumption: Mean reversion of collateral.
- Simplifying assumptions
  - $\hat{p}$: Fraction of good land.
  - Idiosyncratic shocks
    - Occur with probability $(1 - \lambda)$
    - Land becomes good with probability $\hat{p}$.
    - The shock is observable, the realization is not.

Simpler Aggregation

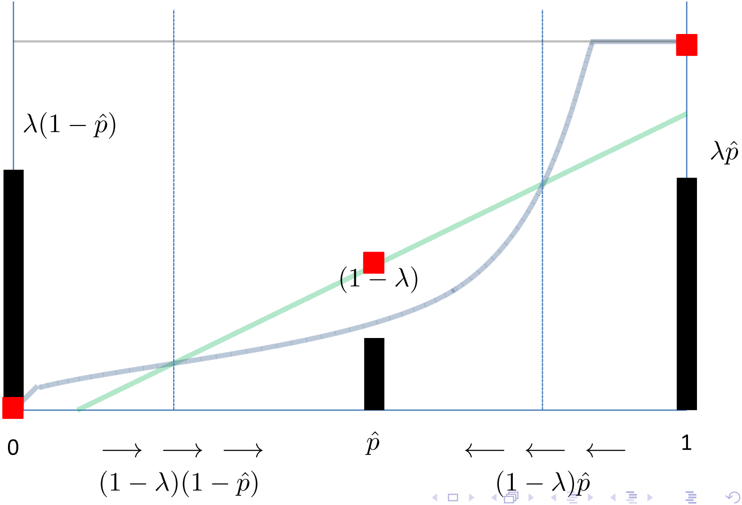
$$W_t = [0f(0)+K(\hat{p})f(\hat{p})+K^*f(1)](qA-1) \; < \; \mathbf{W}^* = \mathbf{K}^*(\mathbf{qA}-\mathbf{1})$$



Information Sensitive Dynamics

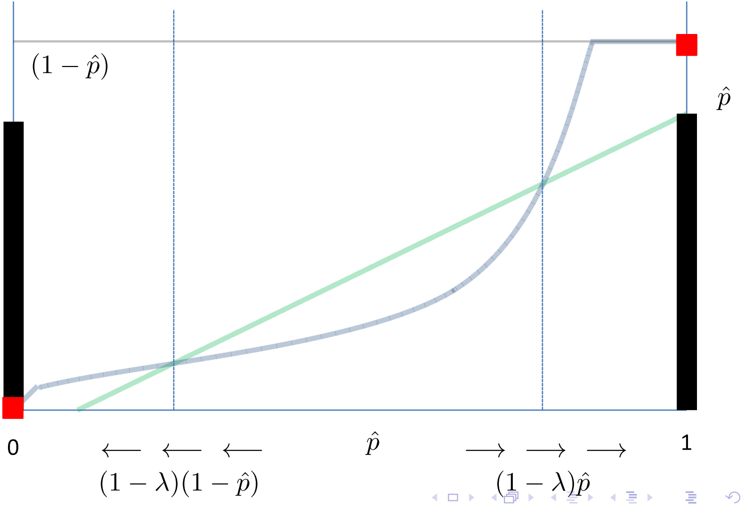


Information Sensitive Dynamics



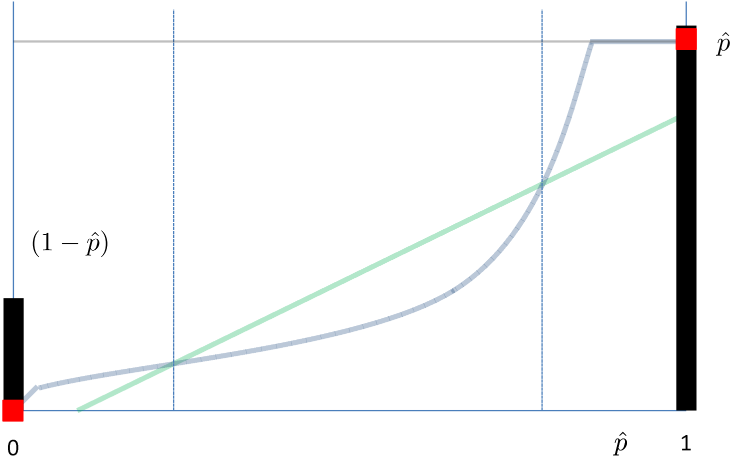
Information Sensitive Dynamics

$$W_t^{IS} = \hat{p}K^*(qA-1) - (1-\lambda)\gamma \quad < \quad \mathbf{W}^*$$



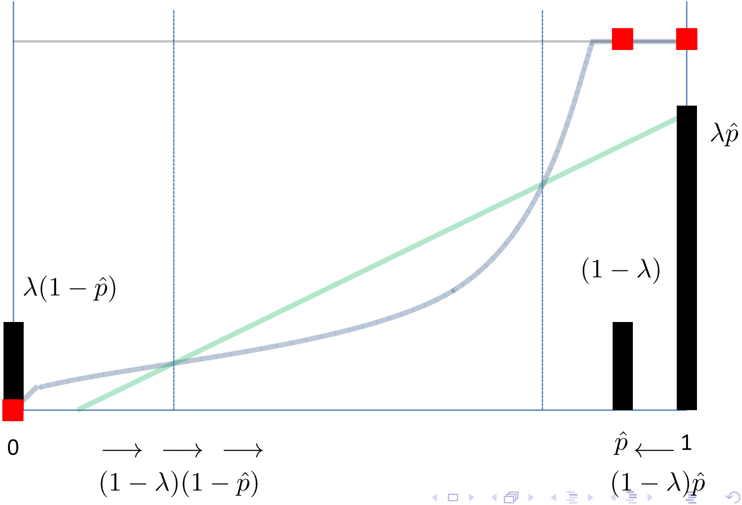
Information Insensitive Dynamics

$W_0^{II} = \hat{p}K^*(qA-1)$



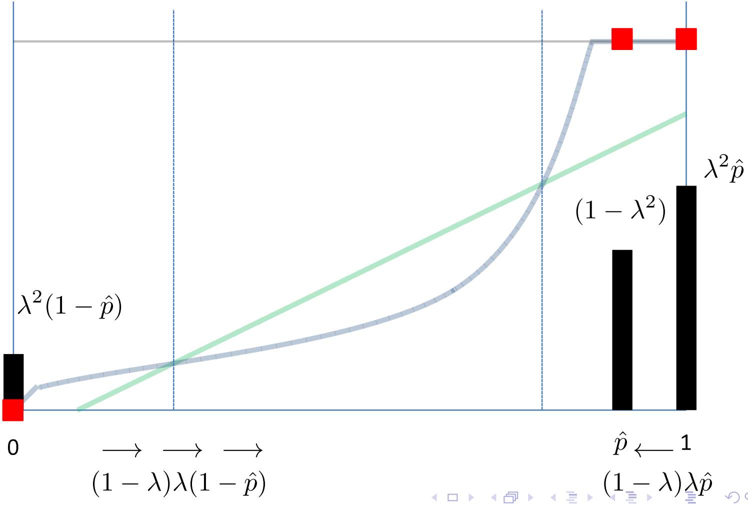
Information Insensitive Dynamics

$$W_1^{II} = [(1-\lambda)K(\hat{p}) + \lambda\hat{p}K^*]\,(qA-1)$$



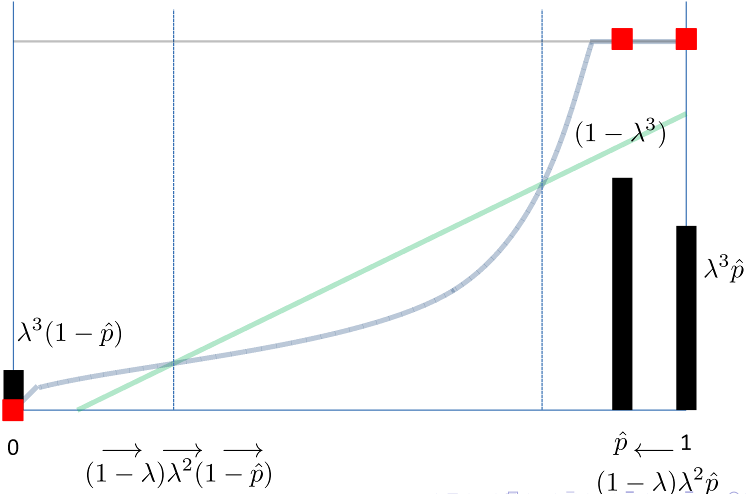
Information Insensitive Dynamics

$$W_2^{II} = \left[(1-\lambda^2)K(\hat{p}) + \lambda^2 \hat{p} K^*\right](qA-1)$$



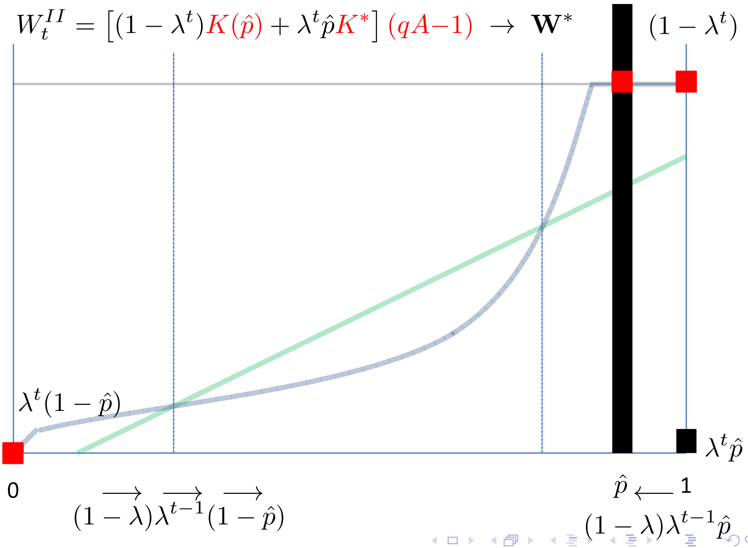
Information Insensitive Dynamics

$$W_3^{II} = \left[(1-\lambda^3)K(\hat{p}) + \lambda^3 \hat{p} K^*\right](qA-1)$$



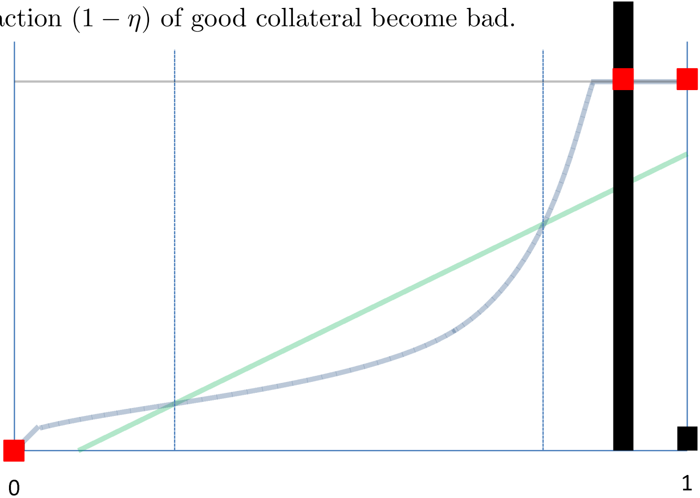
Information Insensitive Dynamics

$$W_t^{II} = \left[(1-\lambda^t)K(\hat{p}) + \lambda^t \hat{p} K^*\right](qA-1) \rightarrow \mathbf{W}^*$$



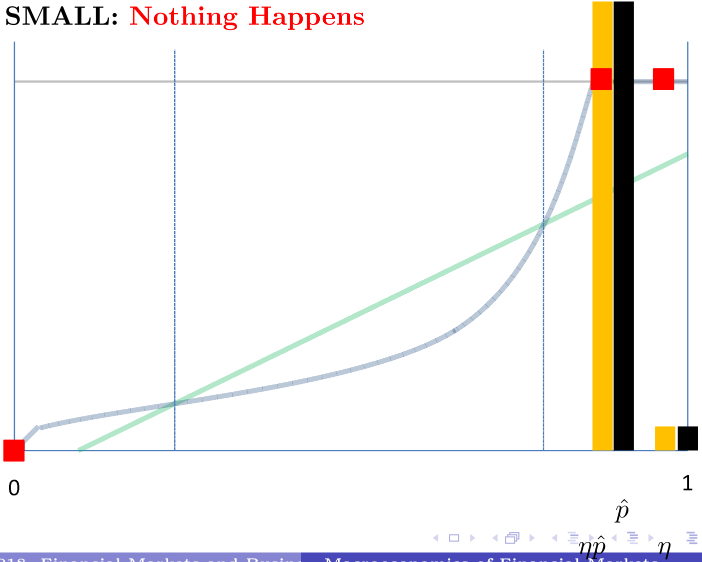
Negative Aggregate Shocks

A fraction $(1 - \eta)$ of good collateral become bad.



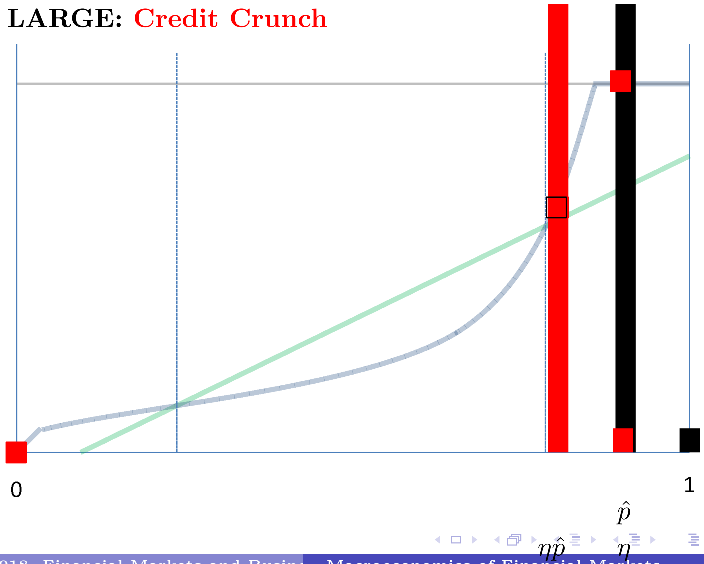
Negative Aggregate Shocks

SMALL: Nothing Happens



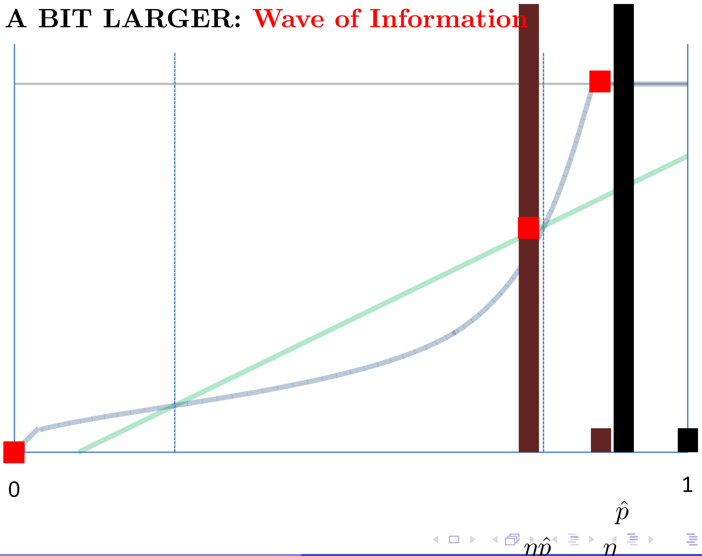
Negative Aggregate Shocks

LARGE: Credit Crunch

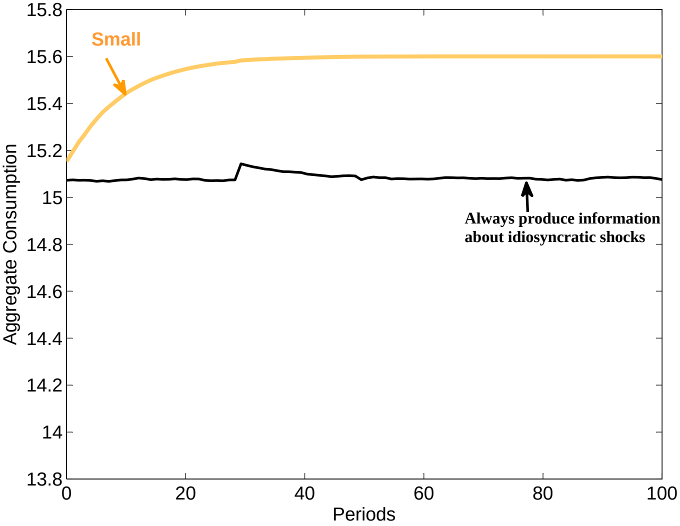


Negative Aggregate Shocks

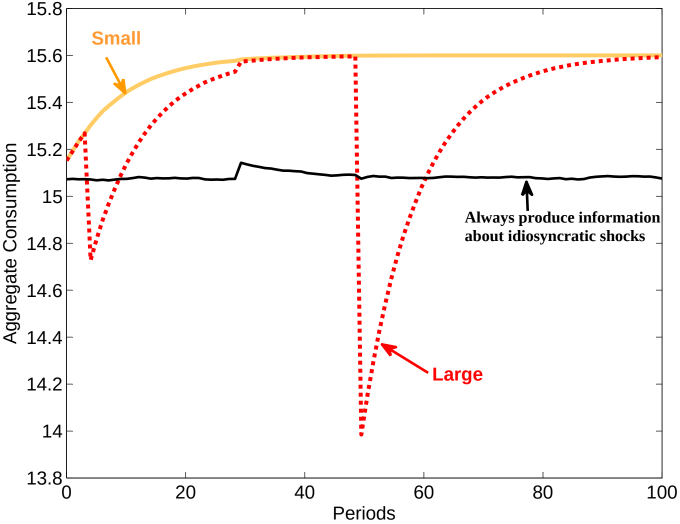
A BIT LARGER: Wave of Information



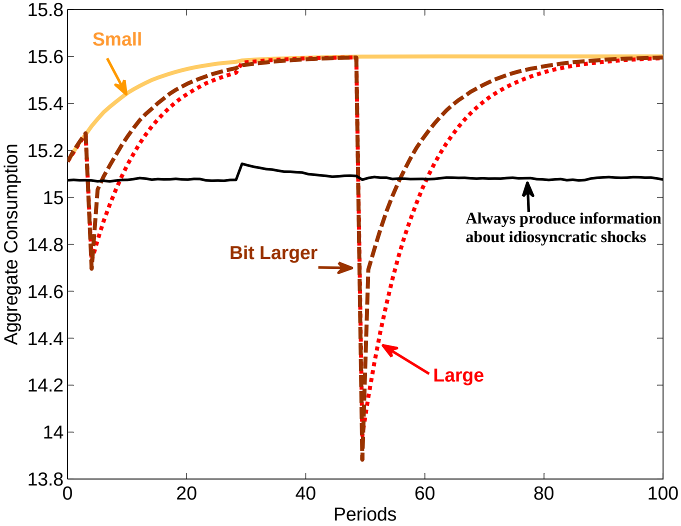
Numerical Example



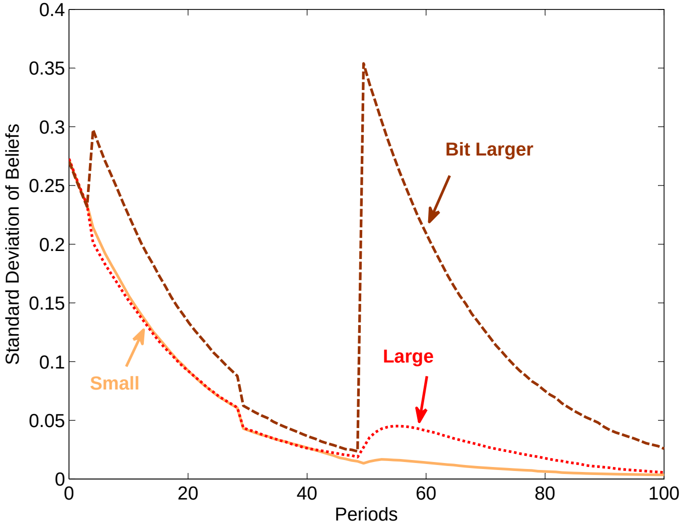
Numerical Example



Numerical Example



Numerical Example

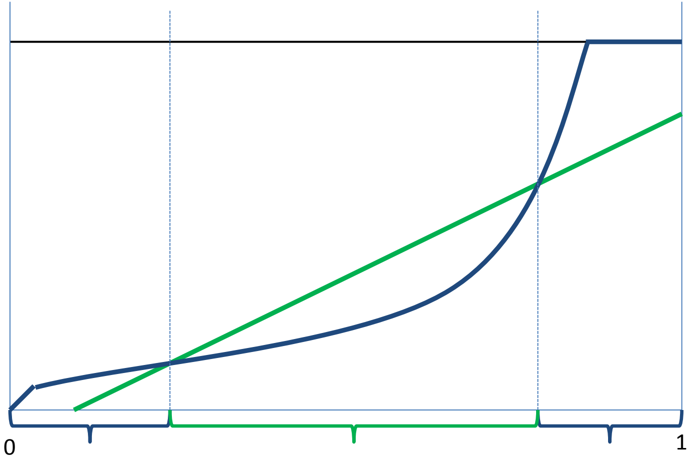


A Planner

- Assume a planner that maximizes the discounted utility of cohorts
$$U_t = E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t} W_t.$$
- Optimal range of information production is wider.
- The planner can implement the optimum by subsidizing a fraction $\beta\lambda$ of the information cost γ.

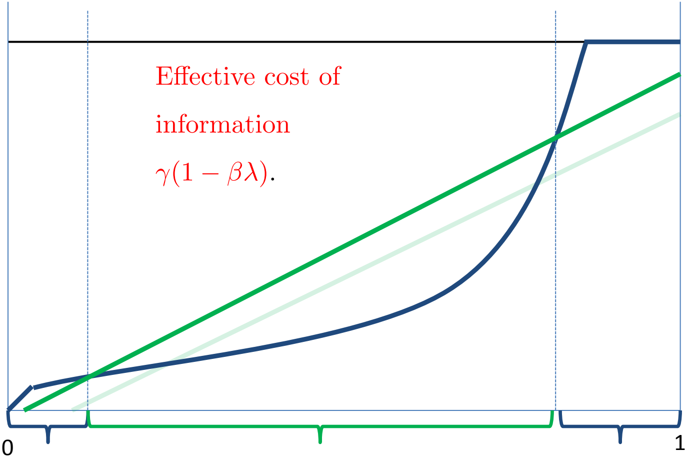
A Planner: Cutoffs

E(Profits)=E(K')



A Planner: Cutoffs

E(Profits)=E(K')

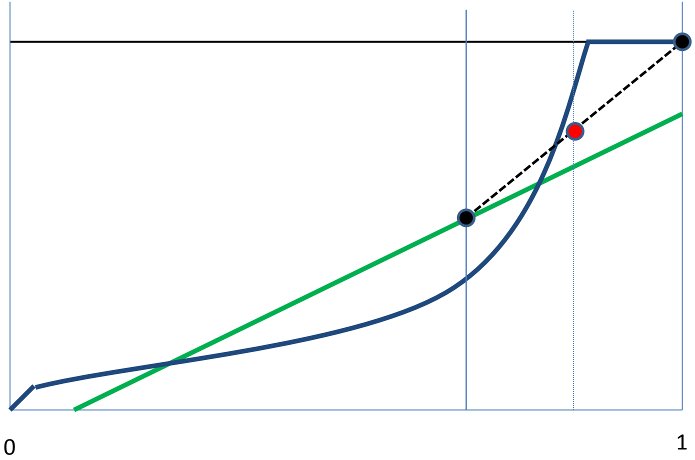


Extensions

- Endogenous complex securities.
- Real Shocks.
- Two Sided Information Production.
- Crises without shocks.

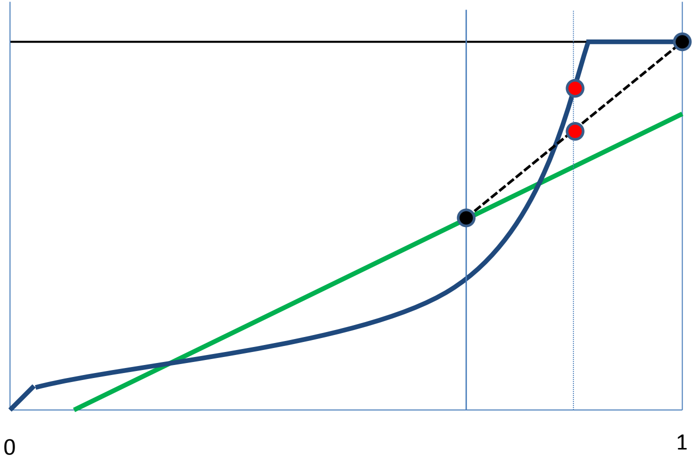
Endogenous Security Structure

Two securities with different p



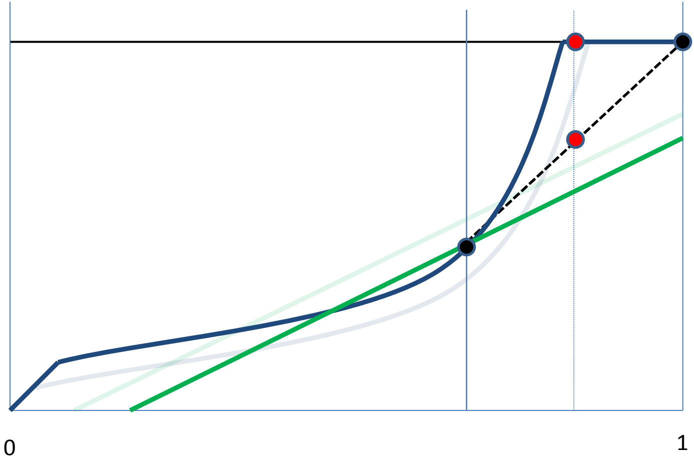
Endogenous Security Structure

Pooling Collateral



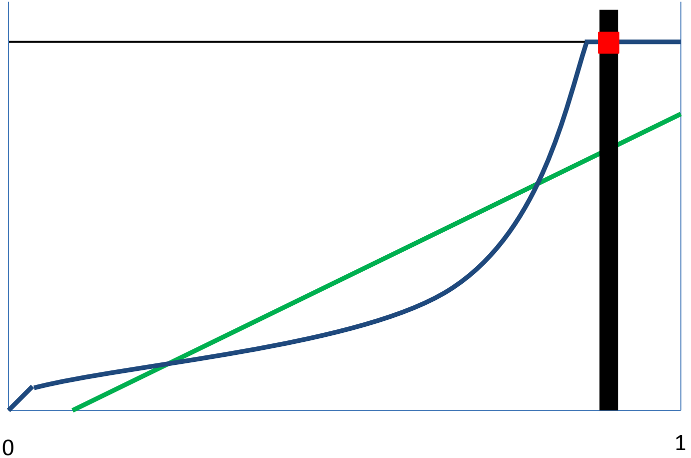
Endogenous Security Structure

Complexity of Securities (Larger γ)



A Real Source of a Credit Crunch

A reduction in the success probability q can lead to a credit crunch.



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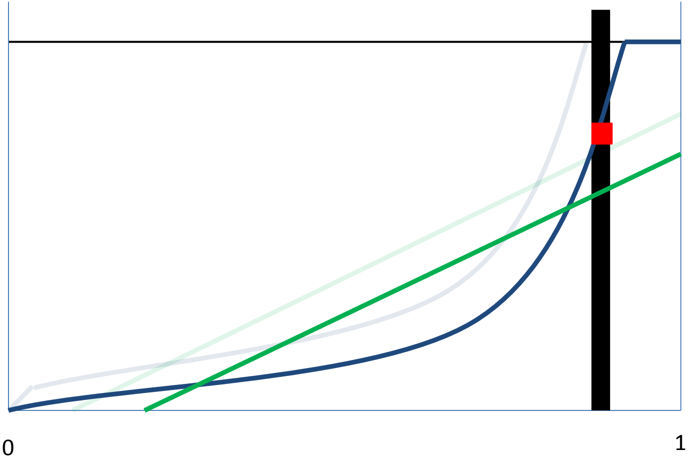
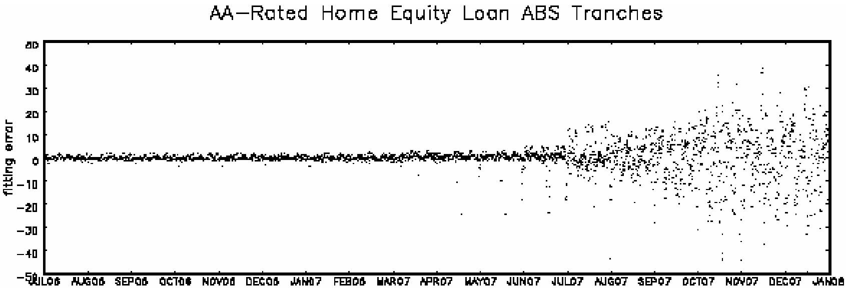


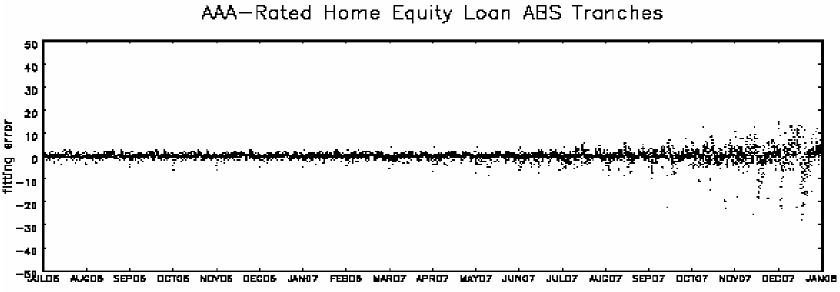
Suggestive Evidence Information Production

Perraudin and Wu (2008)



Suggestive Evidence Information Production

Perraudin and Wu (2008)



Final Remarks

- Symmetric ignorance may be socially desirable, but it is vulnerable to a sudden loss of confidence in its symmetry.
- Macroeconomic implications:
    - Larger "ignorance credit booms" lead to larger crises.
    - The planner may not want to eliminate fragility.
    - Dispersion of beliefs (and of credit and production) is endogenous. We are testing this implication of the mechanism empirically (Kyriakos, Gorton and Ordonez, 18?).