

Macroeconomics and Financial Markets

Financial Intermediation

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Outline

1 Financial Intermediation

2 Gertler-Kiyotaki

3 Brunnermeier-Sannikov

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1 Financial Intermediation

2 Gertler-Kiyotaki

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2008

- The financial crisis 2008: banks matter.
- Put “banks” and “financial intermediation” into DSGE models.
- Fully micro-founded and dynamic: tricky.
- Still missing (I believe): fully dynamic, long-lived banks with long-lived credit relationships, with optimal contracts in light of asymmetric information and aggregate shocks.
- Instead: various simplifications.
- Typically: contracts are valid for one period only.
- Systemic effects? Mainly: “fire sales”.

Some Goals

Shocks → response:

- Increase **persistence**. Bernanke-Gertler (1989): gradual rebuilding of net worth.
- **Amplification**. Kiyotaki-Moore (1997), Bernanke-Gertler-Gilchrist (1999): leverage, collateral constraints, collateral prices.
- Systemic collapse.

Approaches: asymmetric information.

- Moral hazard, costly state verification.
 - ▶ Townsend.
 - ▶ Entrepreneurs see project outcomes, banks can monitor at a cost.
 - ▶ Optimal: bond contract. Monitor, if claimed outcome is below some threshold.
 - ▶ Bernanke-Gertler. Bernanke-Gertler-Gilchrist. Carlstrom-Fuerst. Christiano-Motto-Rostagno. De Fiore-Uhlig.
- Adverse selection in macroeconomics.
 - ▶ Assume “churning” in “good times”.
 - ▶ Lot's of good stuff gets traded in good times, adv sel problem small.
 - ▶ Only bad stuff gets traded in bad times, adv sel problem large.
 - ▶ Note: can easily get the opposite result.
 - ▶ Eisfeldt. Kurlat.

Approaches: resale constraints, collateral constraints.

Economics:

- Investing or holding assets requires net worth.
- Financial friction: Lenders with net-worth necessary. No “deep-pocket” lenders.
- Reason for borrowing: impatient entrepreneurs or banks.
- Balance sheet “amplification”.
- Fire sale externalities.

Literature:

- Kiyotaki-Moore.
- **Gertler-Kiyotaki**, handbook chapter.
- Brunnermeier-Sannikov.

T-Accounts 1

| Assets | Liabilities |
|--------------|-------------|
| Loans | Deposits |
| Bonds | Debt |
| Stocks | Net worth |
| Other assets | |

T-Accounts 2

| Assets | Liabilities |
|----------------------------------|--|
| assets: a $n \geq \theta a$ | d: deposits b: debt n: net worth |

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Islands

- Two types h of islands: “investing” (i) and “non-investing” (n).
- Type is drawn iid across time and islands.
- Shock ψ_{t+1} to quality of capital.
-

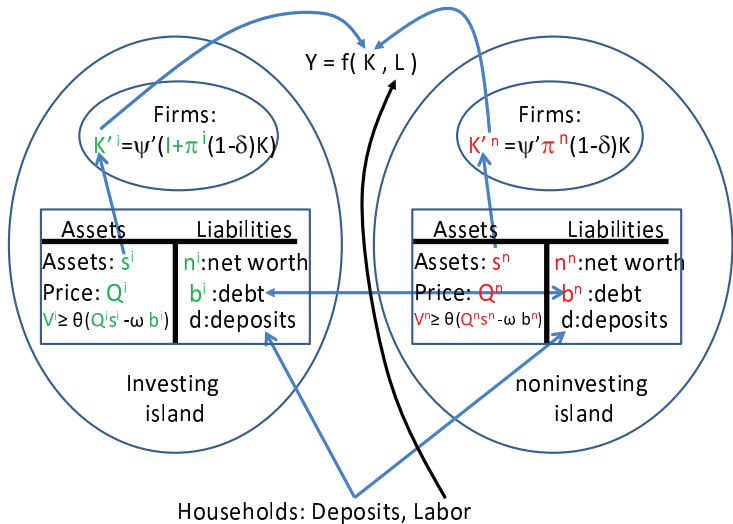
$$K_{t+1} = \psi_{t+1} \left(I_t + \pi^i (1 - \delta) K_t \right) + \psi_{t+1} \pi^n (1 - \delta) K_t$$

- Capital is useful in production, earning Z per unit for its owners.
- Banks: finance capital with net worth, interbank lending, deposits.
- Key friction: value of continuing with bank must be larger than “running away” with assets.

T-Accounts 3

| Assets | Liabilities |
|---|----------------|
| Assets: s | n :net worth |
| Price: Q | b :debt |
| $V \geq \theta(Qs - \omega b)$ | d :deposits |
| V : value of bank. NPV of present and future n 's | |

Gertler-Kiyotaki



Bank Finance

- Firm capital must be held by banks: purchase price Q^h per unit.
- Banks: accumulate net worth, “die” with probability $1 - \sigma$.
- Banks choose s, b, d to maximize value.
- d : before island-type is known. b, s : after.
- Banks have collateral constraints.

$$Q^h s = n + b + d$$

$$n' = (Z' + (1 - \delta)Q')\psi' s - R_b b - R d$$

$$V(s, b, d) = E_t \left[\sum_{i=1}^{\infty} (1 - \sigma) \sigma^{i-1} \Lambda_{t,t+i} n_{t+i} \right]$$

$$V(s, b, d) \geq \theta(Q^h s - \omega b)$$

Conjecture:

$$V(s, b, d) = \nu_s s - \nu_b b - \nu d$$

Deriving FONCs

$$\max_{b,s,d} \nu_s s - \nu_b b - \nu d \quad \text{s.t.}$$

$$(\mu^h :) \quad n + b + d = Q^h s$$

$$(\lambda^h) \quad \nu_s s - \nu_b b - \nu d \geq \theta(Q^h s - \omega b)$$

Take derivatives:

$$(1/Q^h) \partial L / \partial s : \quad 0 = \frac{\nu_s}{Q^h} + \mu^h + \lambda^h \left(\theta - \frac{\nu_s}{Q^h} \right)$$

$$\partial L / \partial b : \quad 0 = -\nu_b - \mu^h - \lambda^h (\theta \omega - \nu_b)$$

$$\partial L / \partial s : \quad 0 = -\nu - \bar{\mu} + \bar{\lambda}$$

Subtract expected second from third. Add second to first.

$$0 = \nu_b - \nu + \bar{\lambda} \theta \omega + \bar{\lambda} (\nu_b - \nu)$$

$$0 = \frac{\nu_s}{Q^h} - \nu_b + \lambda^h \theta (1 - \omega) - \lambda^h \left(\frac{\nu_s}{Q^h} - \nu_b \right)$$

FONCs: equ's (14) to (16)

$$\theta\omega\bar{\lambda} = (\nu_b - \nu)(1 + \bar{\lambda})$$

$$\lambda^h\theta(1 - \omega) = \left(\frac{\nu_s}{Q^h} - \nu_b\right)(1 + \lambda^h)$$

$$\nu n^h \geq \left(\theta - \left(\frac{\nu_s}{Q^h} - \nu\right)\right) Q^h s^h - (\theta\omega - (\nu_b - \nu)) b^h$$

Case 1: frictionless wholesale financial market, $\omega = 1$

Bank returns equalize \rightarrow asset prices equalize.

$$\frac{\nu_s}{Q} = \nu_b$$

$$\text{let: } \mu = \frac{\nu_s}{Q} - \nu > 0$$

$$Qs^h - b^h = \phi n^h$$

$$\text{where lev ratio: } \phi = \frac{\nu}{\theta - \mu}$$

$$\text{aggr: } QS = \phi N$$

Dynamic program implies relationship between current and future $\nu_{s,t}, \nu_{b,t}, \nu_t$. Return on assets independent of island type.

Case 2: wholesale = retail friction, $\omega = 0$

Bond finance and deposit finance are equal. Share prices are not.

$$\nu = \nu_b$$

$$\text{let: } \mu^h = \frac{\nu_s}{Q^h} - \nu \geq 0$$

$$\text{note: } \mu^i > \mu^n \geq 0$$

$$Q^i s^i = \phi^i n^i$$

$$Q^n s^n \leq \phi^n n^n$$

$$\text{where lev ratio: } \phi^h = \frac{\nu}{\theta - \mu^h}$$

Dynamic program implies relationship between current and future $\nu_{s,t}, \nu_{b,t}, \nu_t$. Return on assets depends on island type “today” as well as “tomorrow”.

Evolution of net worth

Banks exit with prob $1 - \sigma$, rest “old” (o). New “young” (y) banks are created, with fraction $\xi/(1 - \sigma)$ of total assets of existing banks.

$$N_t^h = N_{ot}^h + N_{yt}^h$$

$$N_{ot}^h = \sigma \pi^h \left(\left(Z_t + (1 - \delta) Q_t^h \right) \psi_t S_{t-1} - R_t D_{t-1} \right)$$

$$N_{yt}^h = \xi \left(Z_t + (1 - \delta) Q_t^h \right) \psi_t S_{t-1}$$

Completing the model

- Financial market clearing: deposits equal to assets minus net worth, shares equals new capital

$$D = \sum_{h=i,n} (Q_t^h S_t^h - N_t^h)$$

$$S_t^i = I_t + (1 - \delta)\pi^i K_t$$

$$S_t^n = (1 - \delta)\pi^n K_t$$

- Households, preferences, final goods production, wages, payments to capital, ...
- Calibrate.

Gertler-Kiyotaki: Parameters

Source: Gertler-Kiyotaki

Table 1: Parameter Values for Baseline Model

| Households | | |
|--------------------------|-------|--|
| β | 0.990 | Discount rate |
| γ | 0.500 | Habit parameter |
| χ | 5.584 | Relative utility weight of labor |
| ε | 0.333 | Inverse Frisch elasticity of labor supply |
| Financial Intermediaries | | |
| π^i | 0.250 | Probability of new investment opportunities |
| θ | 0.383 | Fraction of assets divertable: Perfect interbank market |
| | 0.129 | Fraction of assets divertable: Imperfect interbank market |
| ξ | 0.003 | Transfer to entering bankers: Perfect interbank market |
| | 0.002 | Transfer to entering bankers: Imperfect interbank market |
| σ | 0.972 | Survival rate of the bankers |
| Intermediate good firms | | |
| α | 0.330 | Effective capital share |
| δ | 0.025 | Steady state depreciation rate |
| Capital Producing Firms | | |
| If^n/f' | 1.500 | Inverse elasticity of net investment to the price of capital |
| Government | | |
| $\frac{G}{Y}$ | 0.200 | Steady state proportion of government expenditures |

Government policies

- Lots of places for intervention
- Government deposits to banks.
- **Direct lending to firms.**
- Lending to banks, with another ω (“discount window”)
- Equity injections to banks.

Numerical experiment: crisis simulation

- Trigger: exogenous decline in quality of capital.
- Case 1: $\omega = 1$, no policy response.
- Case 2: $\omega = 0$, no policy response.
- Policy response: central bank intermediates a fraction ϕ of credit to firms:

$$Q^h S^h = Q^h (S_p^h + S_g^h)$$

$$S_g^h = \phi S^h$$

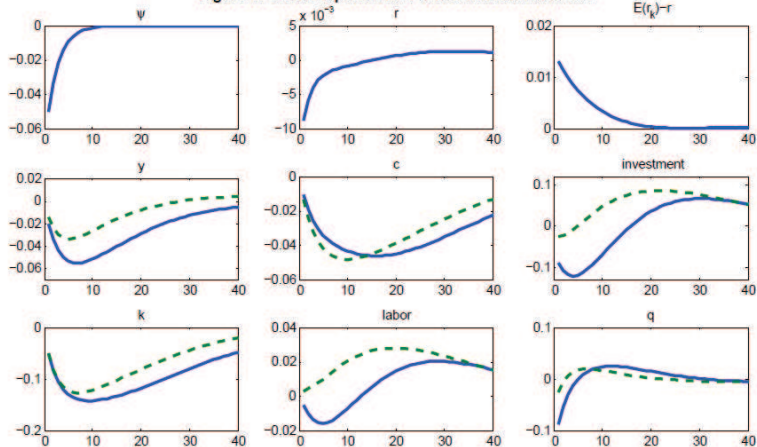
$$\phi = v_g \left((E_t[R_{k,t+1}^{ih'}] - R_{t+1}) - (E[R_k^{ih'}] - R) \right)$$

for some policy parameter v_g on the spread on investing islands, compared to steady state spread.

Gertler-Kiyotaki: $\omega = 1$, perfect interbank market

Gertler-Kiyotaki, Fig. 1. green-dashed: RBC.

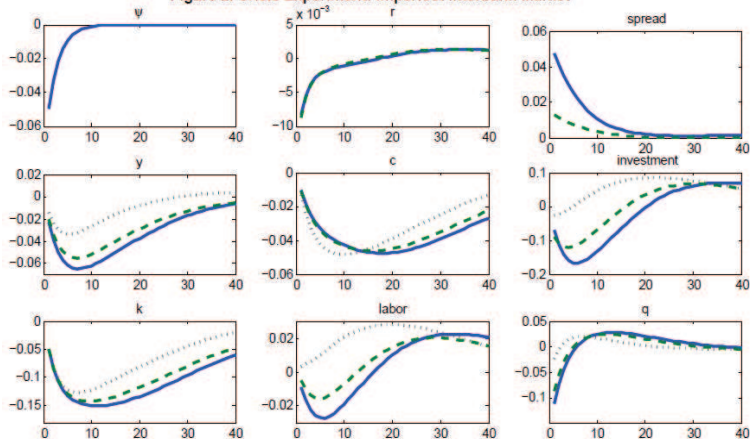
Figure 1. Crisis Experiment: Perfect Interbank Market



Gertler-Kiyotaki: $\omega = 0$, interbank = deposits

Gertler-Kiyotaki, Fig. 2. grey: RBC. green-dashed: $\omega = 1$.

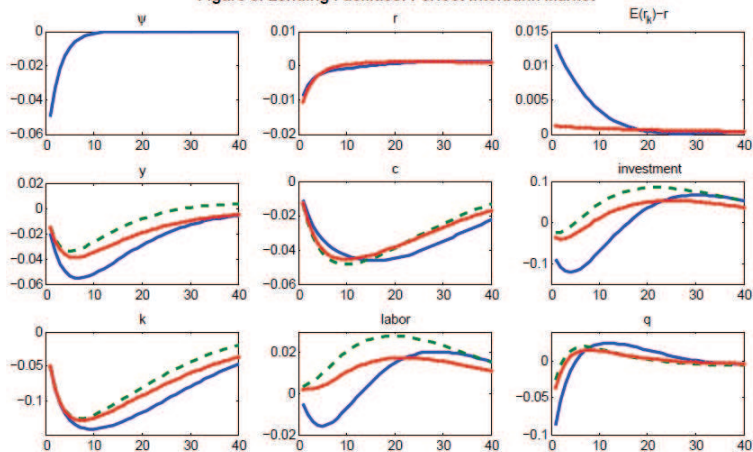
Figure 2. Crisis Experiment: Imperfect Interbank Market



Gertler-Kiyotaki: $\omega = 1$. Gov. intervention

GK, Fig. 3. blue: $v_g = 0$. red: $v_g = 100$. green-dashed: RBC.

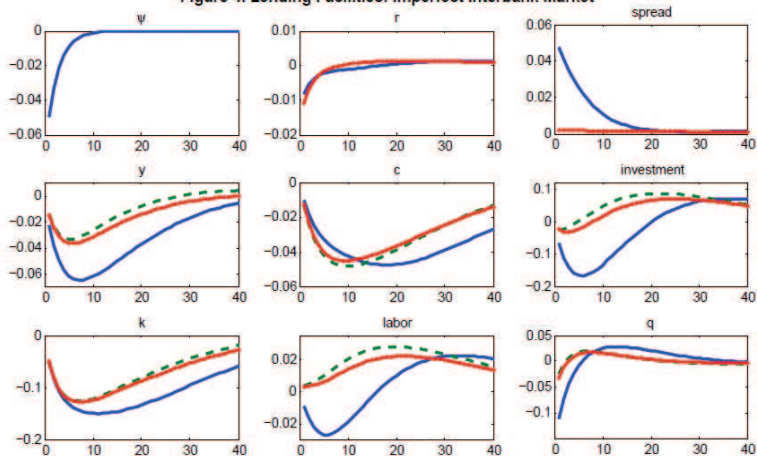
Figure 3. Lending Facilities: Perfect Interbank Market



Gertler-Kiyotaki: $\omega = 0$. Gov. intervention

GK, Fig. 4. blue: $v_g = 0$. red: $v_g = 100$. green-dashed: RBC.

Figure 4. Lending Facilities: Imperfect Interbank Market



Gertler-Kiyotaki: $\omega = 0$ and $\omega = 1$, + gov. intervention

Source: Gertler-Kiyotaki, Figures 3 and 4

Figure 3: perfect interbank market:

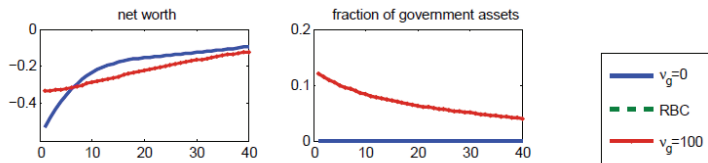
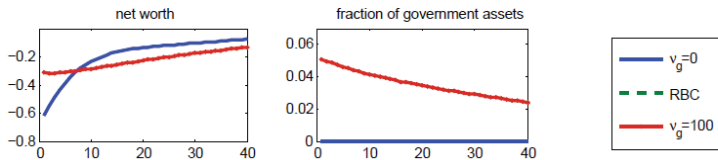


Figure 4: interbank market = deposits



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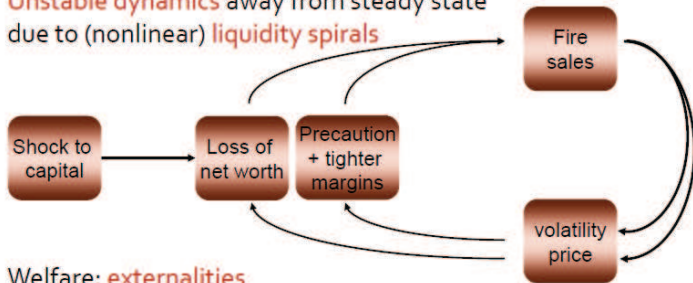
Brunnermeier-Sannikov

- Continuous-time model
- State variable $\eta = N/K$, ratio of net worth to capital.
- “Good times”
 - ▶ η is high.
 - ▶ There may be so much net worth that bonuses are paid.
 - ▶ Benign and “usually” stable dynamics around the steady state.
 - ▶ Normal times.
- “Bad times”:
 - ▶ η is low.
 - ▶ The economy is severely credit constrained.
 - ▶ With some low probability, the economy can “spiral” out of control from normal to crisis.

Brunnermeier-Sannikov: feedback spiral

Source: Brunnermeier-Sannikov slides

1. **Unstable dynamics** away from steady state due to (nonlinear) **liquidity spirals**



2. **Welfare: externalities**

Brunnermeier-Sannikov: stationary distribution for η

Source: Brunnermeier-Sannikov slides

