Macroeconomics of Financial Markets

ECON 712, Session 1 - Fall 2013

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Week 3
Introduction

- **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

Credit cycles 213

Fig. 1

Behavior of the constrained firms. They suffer a capital loss on their landholdings, which, because of the high leverage, causes their net worth to drop considerably. As a result, the firms have to make yet deeper cuts in their investment in land. There is an intertemporal multiplier process: the shock to the constrained firms' net worth in period $t$ causes them to cut their demand for land in period $t$ and in subsequent periods; for market equilibrium to be restored, the unconstrained firms' user cost of land is thus anticipated to fall in each of these periods, which leads to a fall in the land price in period $t$; and this reduces the constrained firms' net worth in period $t$ further. Persistence and amplification reinforce each other. The process is summarized in figure 1.

In fact, two kinds of multiplier process are exhibited in figure 1, and it is useful to distinguish between them. One is a within-period, or static, multiplier. Consider the left-hand column of figure 1, marked "date $t$" (ignore any arrows to and from the future). The productivity shock reduces the net worth of the constrained firms, and forces them to cut back their demand for land; the user cost falls to clear the market; and the land price drops by the same amount (keeping the future constant), which lowers the value of the firms' existing landholdings, and reduces their net worth further. But this simple intuition misses the much more powerful intertemporal, or dynamic, multiplier. The future is not constant. As the arrows to the right of the date $t$ column in figure 1 indicate, the overall drop in the land price is the cumulative fall in present and future user costs, stemming from the persistent reductions in the
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 (from 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}\n
such that everyone’s optimizing and markets clearing.

- No uncertainty: perfect foresight
Equilibrium Results: Farmers

- Farmers always borrow the maximum and invest in land

\[ b_t = \frac{q_{t+1} k_t}{R} \quad \text{and} \quad x_t = ck_{t-1} \]

- From the budget constraint, farmers’ land holdings are

\[ k_t = \frac{1}{q_t - q_{t+1}/R} \left[ (a + q_t)k_{t-1} - Rb_{t-1} \right] \]

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

- 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

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

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

- 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.

\[
\frac{G'(k'_t)}{R} = u_t = q_t - \left(\frac{q_{t+1}}{R}\right)
\]

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

  Note \( u_t \) is decreasing in \( k'_t \) (increasing in \( K_t \)).
  
  Note also Gatherers are not constrained, then \( R = \frac{1}{\beta'} \) (first Assump)

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

We are now in a position to compare consumption paths (8a), (8b), and (8c). In the steady state, the user cost equals $a$; and so, given the farmer's discount factor $\beta$, investment gives him discounted utility $\beta c/(1 - \beta)$, saving gives $\beta c/(1 - \beta)$, and consumption gives one. By assumption 1, investment strictly dominates saving; and by assumption 2, investment strictly dominates consumption. This completes the proof of our earlier claim about farmers' optimal behavior in the neighborhood of the steady state.

Figure 2 provides a useful summary of the economy. On the horizon...
One-time Productivity Shock with Credit Constraints

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

- Period of shock (period $t$)

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

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

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

$$u(K_{t+s})K_{t+s} = aK_{t+s-1} + q_{t+s}K_{t+s-1} - \underbrace{RB_{t+s-1}}_{=0}$$
One-time Productivity Shock with Credit Constraints

- 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 \( \eta \) 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

\[ \hat{K}_t = \frac{1}{1 + \frac{1}{\eta} \left(1 + \frac{R}{R - 1} \frac{1}{\eta}\right)} \Delta \quad \text{if } \frac{1}{\eta} > 1 \]
Response of Land Price & Land Holdings

- Land price response
  \[ \hat{q}_t = \frac{1}{\eta} \Delta \]

- Overall land holding response
  \[ \hat{K}_t = \frac{1}{1 + \frac{1}{\eta}} (1 + \frac{R}{R - 1} - \frac{1}{\eta}) \Delta \]
  \[ >1 \]

- Say \( \eta = 1, \ R = 1.05 \)
  \[ \hat{K}_t \approx 11\Delta \]
Static Response of Land Price & Land Holdings

- Land price response

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

- Overall land holding response

$$\hat{K}_t \big|_{q_{t+1}=q^*} = \Delta$$
Response of Output & Productivity

\[ \hat{Y}_{t+s} = \frac{a + c - Ra}{a + c} \left( \frac{(a + c)K^*}{Y^*} \right) \hat{K}_{t+s-1} \]

Productivity diff. Farmers’ share
Response to Shock

The movement in aggregate fruit output depends on the size of parameter $c$. We set $c = 1$, so the maximum savings rate of an individual farmer is 50 percent. Output is 1 percent higher than the steady state in period 1: this is simply the direct effect of the productivity shock. The sum of the increases in output between period 2 and the midpoint of the cycle (period 22) is 1.79 percent, which exceeds the direct effect in period 1. The sum of the decreases in output over the second half of the cycle is 0.35 percent.

In section 5 of Kiyotaki and Moore (1995), we report on simulations for other parameter values. In particular, we find that a lower $\pi$ or a higher $\phi$ leads to smaller contemporaneous effects, more persistence, longer cycles, and more volatility in prices relative to quantities.

IV. Spillovers

As the model is constructed, there cannot be any positive spillovers between the farming and gathering sectors, since their combined...
Net Worth Shock

- One time reduction in debt obligations
- Increases net worth
- Farmer increases leverage, production
- Another view of Bernanke-Paulson policies?
One-time Productivity Shock at First-Best Steady State

- Say $y_{t+1} = (1 + \Delta)(a + c)k_t$
- Output rises by $\Delta$
- Net worth rises
- But prices $q^0$ unaffected; land $k^0$ unaffected
- No change to future variables

Prices and production do not depend on changes in net worth.

Fluctuations are magnified and prolonged by collateral constraints.
Conclusions

- 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.

- Does this work through "investment wedge?" or TFP, or both?

- Real effects of housing/stock bubbles.
Financial Accelerator Model

- **Bernanke and Gertler (1989).**
- Costly state verification in a Real Business Cycle model.
- Debt-Deflation meets Real Business Cycle.
- Main idea.
  - The borrowers’ net worth determines their solvency and risk of default.
  - Net worth affects agency problems and 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.
Model

- Main elements.
  - Two period lived agents. Overlapping generations.
  - Two types of agents:
    - Entrepreneurs: A fraction $\eta$ of agents. Each has a single project with cost, $\omega \sim U[0, 1]$ to produce capital.
    - Investors. Monitoring cost $\gamma$.
  - Two goods:
    - Output: Can be consumed, stored or invested.
    - Capital. Fully depreciated in one period.
  - Production functions:
    - $y_t = \theta_t f(k_t)$
    - $k_{t+1} = \kappa i_t$, where $\kappa = \pi \kappa_L + (1 - \pi)\kappa_H$ (the output is non-observable to investors).
Model

- Main elements.
  - Preferences
    - Entrepreneurs: $E_t(c^e_{t+1})$
    - Investors. $U(c^y_t) + \beta E_t(c^o_{t+1})$
  - Labor income at wage $w_t$. Average savings
    - Entrepreneurs: $S^e_t = w_t L^e$
    - Investors: $S_t = w_t L - c^*_y(r)$, where $c^*_y$ is the optimal consumption when young and $r$ is the storage rate of return.
Perfect Information

- The Case of $\gamma = 0$.
  - Denote $q_t$ price of capital in terms of output.
  - Expected gross return of a project: $E_t(q_{t+1})\kappa$
  - Cost of a project: $r_x(\omega)$
  - Then $\omega$ is defined by $E_t(q_{t+1})\kappa - r_x(\omega) = 0$.
  - Then $k_{t+1} = \kappa \omega \eta$

- Supply of capital and Demand from output.
  - SS curve: $E_t(q_{t+1}) = \frac{r_x(k_{t+1})}{\kappa \eta}$
  - DD curve: $E_t(q_{t+1}) = E_t(\theta_{t+1})f'(k_{t+1})$
Perfect Information

- Investment is constant and production (the consumption and inventories) move with productivity shocks.

\[
E(q_{t+1}) \quad | \quad DD \quad | \quad SS
\]

\[
k_{t+1}
\]
Asymmetric Information

- The Case of $\gamma > 0$.
- Consider entrepreneurs who require to borrow $x(\omega) > S^e$
  - Full collateralization. The entrepreneur can pay even when the worst outcome $\kappa_L$ occurs.
    \[
    E_t(q_{t+1})\kappa_L \geq r(x(\omega) - S^e)
    \]
  - Incomplete collateralization. Monitoring problem because entrepreneurs are tempted to lie and say they produced $\kappa_L$
    \[
    E_t(q_{t+1})\kappa_L < r(x(\omega) - S^e)
    \]
Asymmetric Information

- **Costly State Verification Contract**
  - If entrepreneurs report $\kappa_H$, $R = E_t(q_{t+1})\kappa_H - C^e_{t+1}$.
  - If entrepreneurs report $\kappa_L$, they pay $E_t(q_{t+1})\kappa_L$ and get monitored with probability $p$. If entrepreneur told the truth, the lender gets nothing extra. If the entrepreneur lied, the lender gets $E_t(q_{t+1})(\kappa_H - \kappa_L)$.
  - Entrepreneurs tell the truth in good states.

  \[
  E_t(q_{t+1})\kappa_H - R \geq (1 - p)E_t(q_{t+1})(\kappa_H - \kappa_L)
  \]

  \[
  C^e_{t+1} \geq (1 - p)E_t(q_{t+1})(\kappa_H - \kappa_L)
  \]
Asymmetric Information

- **Costly State Verification Contract**
  - If entrepreneurs report $\kappa_H$, $R = E_t(q_{t+1})\kappa_H - C_t^e$.
  - If entrepreneurs report $\kappa_L$, they pay $E_t(q_{t+1})\kappa_L$ and get monitored with probability $p$. If entrepreneur told the truth, the lender gets nothing extra. If the entrepreneur lied, the lender gets $E_t(q_{t+1})(\kappa_H - \kappa_L)$.
  - Lenders prefer to lend than to store at rate $r$

$$r(x(\omega) - S^e) \leq (1 - \pi)R + \pi E_t(q_{t+1})\kappa_L - \pi p E_t(q_{t+1})\gamma$$

$$r(x(\omega) - S^e) \leq (1 - \pi)[E_t(q_{t+1})\kappa_H - C_t^e] + \pi E_t(q_{t+1})[\kappa_L - p\gamma]$$
Asymmetric Information

- The two constraints bind. Optimal monitoring probability $p$ is

$$p^* = \frac{r(x(\omega) - S^e) - E_t(q_{t+1})\kappa_L}{E_t(q_{t+1})[(1 - \pi)(\kappa_H - \kappa_L) - \pi \gamma]}$$

- and consumption of the entrepreneur in good states is,

$$C^e_{t+1} \geq (1 - p^*)E_t(q_{t+1})(\kappa_H - \kappa_L)$$
Asymmetric Information

- What projects SHOULD be financed (efficiency)

\[ E_t(q_{t+1}) \kappa \geq rX(\omega) \]

- What projects ARE financed.
  - The fully collateralized: \( E_t(q_{t+1}) \kappa L \geq r(x(\omega) - S^e) \)
  - Partially collateralized if \( E_t(q_{t+1})(\kappa - p^* \gamma) \geq rX(\omega) \)
Asymmetric Information

- Cyclical movements in $S^e$ affects investment, no longer constant.

Can you see how?

\[
E_t(\omega) \left[ \kappa - p(\omega, S^e) \gamma \right] \frac{r}{\kappa_L} + S^e
\]

\[
\frac{E_t(q_{t+1}) \kappa}{r} + S^e
\]

\[
\frac{E_t(q_{t+1}) \kappa}{r}
\]
Asymmetric Information

- Now investment depend on a current variable, which is the net worth of entrepreneurs that affect agency costs.
Shocks

- Where exogenous movements in $S^e$ come from?
  - Redistribution of endowment from entrepreneurs to lenders.
    - "Debt-deflation" story in which a combination of unindexed contracts and deflation redistributes wealth from debtors to creditors.
Implications

- Financial frictions do not generate business cycles.
- Financial frictions do amplify business cycles.
- The financial accelerator effect is nonlinear and asymmetric over time.
- Financial instability has asymmetric effects across borrowers and lenders.
- How long a recession lasts depend on the flexibility of agent to reevaluate the default risk.
- Monetary policy that reduces interest rates may be irrelevant if there is a "pessimism trap".
Critiques

- If investment is not sensitive to interest rates, it may be even less sensitive to intermediation costs.
- Quantity constraints (no credit) seem more relevant than price constraints (always a price at which credit is available).
Quantitative Implications

- Carlstrom and Fuerst (AER, 1997)
  - Calibration analysis of Bernanke and Gertler.
  - They replicate the hump-shaped response of output, i.e., it generates some propagation dynamics that are absent in the technology shock.
  - Households delay their investment decisions until agency costs are at their lowest, several periods after the shock.
  - Agency costs fall over time because the productivity shock increases the return to internal funds, which in turn distributes wealth from households to entrepreneurs.