Topics in Bank Management: Lecture 12

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Macroeconomics and Financial Intermediation

- It seems obvious that the health of the financial sector can affect the "real" economy of jobs, unemployment, productivity, etc.
- After major financial crises, there are usually negative effects on employment, output, etc.
- However, it is not easy to include a financial sector in our current macroeconomic models.
- During the crisis, these models had little to say about the causes of the crisis or how to deal with it.

A Standard Representative-Agent Macro Model

- Assume there is an infinitely-lived representative agent that decides how much to consume and invest in each period.
- The infinite-horizon optimization problem is:

$$V(k_t) = \max_{c_t, c_{t+1}, \ldots} \sum_{t=0}^{\infty} \beta^t u(c_t) \qquad \text{s.t. } c_t + k_{t+1} = f(k_t) + (1-\delta)k_t$$

- where k_t is the capital stock at the beginning of time t, β is the discount factor, $f(k)$ is a production function, and δ is the depreciation rate

A Standard Representative-Agent Macro Model

- We can restate the problem with the Bellman equation

$$V(k_t) = \max_{c_t} \{u(c+t) + \beta V(k_{t+1})\} \qquad \text{s.t. } k_{t+1} = f(k_t) + (1-\delta)k_t - c_t$$

- This is a functional equation that usually must be solved numerically.
- We can write down the first-order conditions (the Euler equations).
- To test this model empirically, we use the national accounts data of a country for consumption, investment, capital stock, etc.
- We can add random technology shocks to productivity, e.g. $f(k_t) = z_t k_t^\alpha$, where z_t is a random variable that follows a Markov chain.

- As in the general equilibrium model we saw in Chapter 1, there is no role for banks or financial intermediaries.
- We can add asset markets (bonds, equity of firms, etc) but as in the GE model, the agent directly invests in securities, without going through an intermediary.
- In these models, it is said that "finance is a veil", i.e. the activities of the financial sector are irrelevant for the "real" variables in the economy: consumption, investment, etc.
- The only thing that should matter are technology shocks, which directly affect the productivity of the "real" economy.

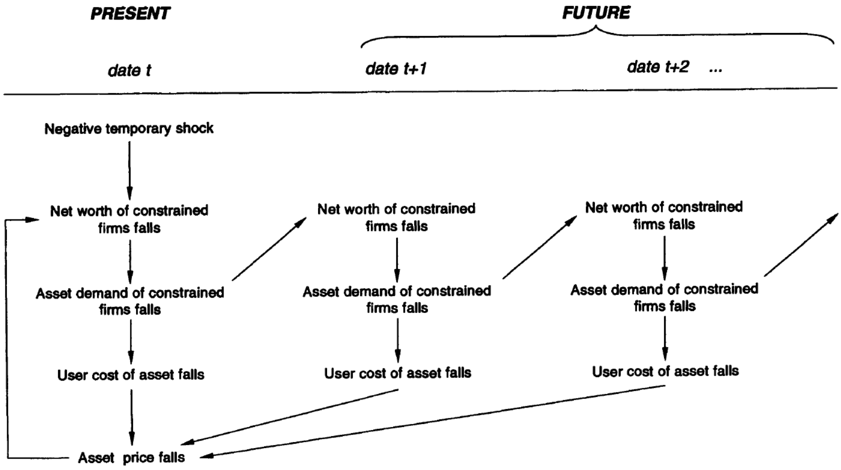
- Was the financial crisis caused by a "technology shock"? It's hard to see how.
- Models that can more realistically capture the effect of financial intermediaries are needed.
- This is an active area of research.
- We'll look at one of the early, influential models of a macroeconomy that includes a financial sector that affects the economy.
- In this model, the key mechanism is that the market value of collateral can reduce investment, which will reduce real output in the future.

Kiyotaki & Moore (1997)

- Kiyotaki & Moore (1997), "Credit Cycles", JPE
- This is one of the early efforts to create a macroeconomic model in which financial activity plays a meaningful role.
- The focus is still on a mechanism that *amplifies* shocks to productivity, rather than shocks that arise within the financial sector itself.
- Other early papers in this vein are:
  - Bernanke, Gertler, & Gilchrist (2000), "The Financial Accelerator in a Quantitative Business Cycle Framework"
  - Carlstrom & Fuerst (1997), "Agency Costs, Net Worth and Business Fluctuations"

- This paper attempts to introduce credit markets into a macroeconomic model, though in a very simplified manner.
- Credit markets can *amplify* and *propagate* effect of productivity shocks.
- In a representative-agent model, there may be prices of assets, but actual trade between agents is not captured in the model.
- In order for there to be meaningful credit activity, there must be heterogeneous agents: a borrower and a lender.
- The basic idea is to take a Hart & Moore's model of the borrower-lender relationship, and embed it in the RBC (real business cycle) framework.

- Recall the model of Hart & Moore (1994): the key feature of a debt contract is the "inalienability of human capital"
- That is, the entrepreneur/borrower cannot commit to not walk away from the project, so a credible contract cannot specify that the borrower remain with the project
- The borrower cannot credibly commit to always repay the debt.
- Therefore, the lender will demand collateral to be seized in case of default.
- In equilibrium, lenders will lend less and some borrowers will be credit-constrained.
- In Carlstrom & Fuerst and Bernanke, Gertler & Gilchrist, the same effect can be achieved using the costly verification framework.
- If there is a negative shock to the value of these borrowers' collateral, they will be forced to borrow less.
- If there is a negative productivity shock (which lowers the value of a firm), this can be amplified through by a loss in net worth.


PRESENT
FUTURE
date t
date t+1
date t+2 ...
Negative temporary shock
Net worth of constrained firms falls
Asset demand of constrained firms falls
User cost of asset falls
Asset price falls
Net worth of constrained firms falls
Asset demand of constrained firms falls
User cost of asset falls
Net worth of constrained firms falls
Asset demand of constrained firms falls
User cost of asset falls

Model Assumptions

- Assume there is no uncertainty (no productivity shocks, etc).
- There are two types of goods: a consumption good, and "land", a *factor of production*.
- Assume "land" has a fixed supply, $\bar{K}$.
- There are two types of agents: "farmers" and "gatherers", both assumed to be risk-neutral (and therefore linear)
- Utility functions are a simple discounted sum of consumption:

$$E_t \left(\sum_{s=0}^{\infty} \beta^s x_{t+s} \right)$$

- "Farmers" are more impatient than "gatherers": $\beta < \beta'$
- There is a 1-period credit market.
- In equilibrium, the more impatient agents ("farmers") will borrow from the more patient agents ("gatherers").

Production

- "Farmers":
  - Production has *constant returns*: $y_t = (a + c)k_{t-1}$
  - A fraction of their output $\frac{a}{a+c}$ is *tradable*, the rest $\frac{c}{a+c}$ is *nontradable* and can be consumed by the "farmer" only.
  - This is to ensure that the "farmers" will not continuously postpone consumption.
  - The key assumption is that "farmers" can decide to *withdraw their labor*: they cannot be forced to repay their debts if they produce nothing.
  - This is the "inalienability of human capital" assumption from Hart & Moore.
  - If this happens, the "land" can only be resold.
- "Gatherers":
  - Production has *decreasing returns*: $y'_t = G(k'_{t-1})$, where $G' > 0, G'' < 0$
  - All of their output is tradable.
  - No specific labor is required.

Debt Contract

- "Land" is both a factor of production, and used as collateral.
- The lender seizes the "land" in case of default, but if the borrower is a "farmer", the land is *less valuable* without the "farmer"'s labor
- Therefore, creditors will *not lend more than the value of collateral*.
- $R \cdot b_t \leq q_{t+1} k_t$
  - R = interest rate
  - b_t = amount borrowed
  - q_t = price of "land"
  - k_t = amount of "land"

Budget Constraints

- "Farmers":

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

- "Gatherers":

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

  - q_t = price of "land", $q_t(k_t - k_{t-1})$ = net amount paid for new "land"
  - b_t = amount borrowed
  - x_t = amount of consumption
  - c = fraction of "farmer"'s output that is nontradable

Equilibrium

- Claim: there is an equilibrium where
  - "farmers" consume exactly the amount of nontradable output: $x_t = ck_{t-1}$
  - "farmers" borrow as much as possible: $b_t = \frac{q_{t+1}k_t}{R}$
  - borrowing + tradable output is reinvested into "land"

$$k_t = \frac{(a + q_t)k_{t-1} - Rb_{t-1}}{q_t - \frac{1}{R}q_{t+1}}$$

- Let $u_t = q_t - \frac{1}{R}q_{t+1}$ denote the "downpayment" per unit of "land"
- Then: 1 unit of tradable output today, buys $\frac{1}{u_t}$ units of "land"
- which yields $\frac{c}{u_t}, \frac{a}{u_t}$ nontradable/tradable output at $t + 1$
- If all tradable output is reinvested, yields $\frac{a}{u_t}au_{t+1}$ at $t + 2$...

"Farmer"'s optimal strategy

- From the theory of repeated games, we have the "one-shot deviation principle".
- To prove a strategy s is optimal, it is sufficient to show a *one-shot deviation* from s is sub-optimal.
- Consider 3 strategies for "farmers":
  - "invest": $0, \frac{c}{u_t}, \frac{a}{u_t}\frac{c}{u_{t+1}}, \frac{a}{u_t}\frac{a}{u_{t+1}}\frac{c}{u_{t+2}}, \ldots$
  - "save": $0, 0, R\frac{c}{u_{t+1}}, R\frac{a}{u_{t+1}}\frac{c}{u_{t+2}}, \ldots$
  - "consume": $1, 0, 0, \ldots$
- Claim: the "invest" strategy is optimal around the steady state.

Aggregate Demand & Market Clearing

- "Farmer"'s aggregate demand
  - $K_t = \frac{1}{u_t}\left[(a + q_t)K_{t-1} - RB_{t-1}\right]$
  - $B_t = \frac{1}{R} q_{t+1} K_t$
- "Gatherer"'s demand:
  - $\frac{1}{R} G'(k'_t) = u_t$
  - aggregate demand: $\bar{K} = K_t + mk'_t$
- "Land" equilibrium:
  - $u_t = u(K_t) = \frac{1}{R} G'\left[\frac{1}{m}(\bar{K} - K)\right]$
- For "gatherers", marginal utility from consumption & lending must be equal: $R = \frac{1}{\beta'}$

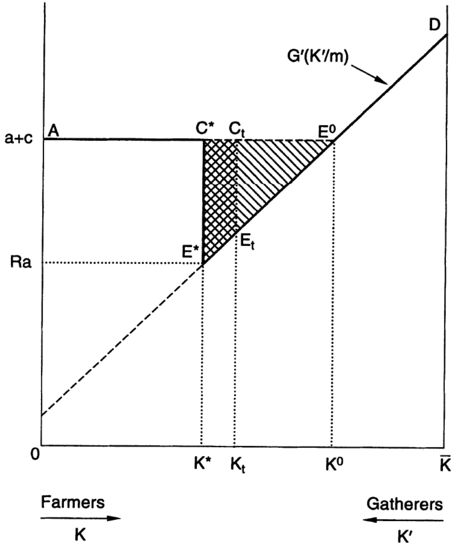
Steady State

- $\frac{R-1}{R} q^* = u^* = a$
- $\frac{1}{R} G' \left[\frac{1}{m} (\bar{K} - K^*) \right] = u^*$
- $B^* = \frac{a}{R-1} K^*$
- "farmer"'s tradable output = interest on debt
  - $aK^* = (R-1)B^*$
- size of "farms" (holdings of k per "farmer"), debt is constant

Proof of "Farmer"'s Optimal Strategy

- Plug in u^* to get NPV of "farmer"'s strategies.
  - "invest": $\beta \frac{c}{(1-\beta)a}$
  - "save": $R\beta^2 \frac{c}{(1-\beta)a}$
  - "consume": 1
- "invest" gives the highest NPV, therefore is optimal.

Marginal productivity of land vs. land usage



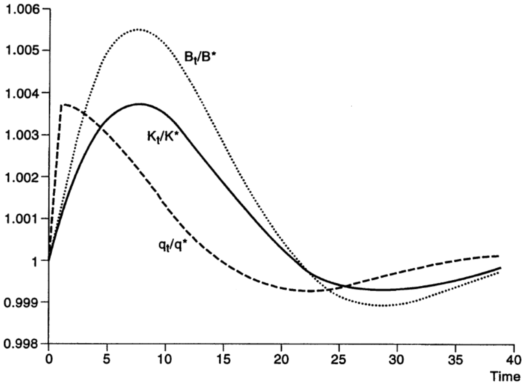
Dynamics

- Suppose there is an unexpected *productivity shock* at t: all harvests *increase* by a factor of $1 + \triangle$.
- At date t: $u(K_t)K_t = (a + \triangle a + q_t + q^*)K^*$
- At date $t + s$: $u(K_{t+s})K_{t+s} = aK_{t+s-1}$
- Linearize around the steady state:
  - Let η denote the elasticity of residual supply of land to farmers w.r.t. $u(K^*)$
  - At date t: $\left(1 + \frac{1}{\eta}\right)\hat{K}_t = \triangle + \frac{R}{R-1}\hat{q}_t$
  - At date $t + s$: $\left(1 + \frac{1}{\eta}\right)\hat{K}_{t+s} = \hat{K}_{t+s}$
- 2 components of change to "farmer"'s net worth:
  - direct effect of $\triangle$
  - indirect of capital gain, scaled up by leverage $\frac{R}{R-1}$

Effect on Land Prices & Demand

- $\hat{q}_t = \frac{1}{\eta}\triangle$
- $\hat{K}_t = \frac{1}{1+\frac{1}{\eta}}\left(1 + \frac{R}{R-1}\frac{1}{\eta}\right)\triangle$
- The effect on land price is of the same order of magnitude as the shock $\triangle$.
- $\hat{Y}_{t+s} = \frac{a+c-Ra}{a+c}\frac{(a+c)K^*}{Y^*}\hat{K}_{t+s-1}$
- There is a *persistent* effect on output, due to the composition effect (more land used by farmers, who have a higher marginal productivity)

Simulated effect of 1% shock



Conclusion

- Economists are still working on integrating financial intermediaries into macroeconomic models.
- It is not obvious what banks do even in microeconomic models, so it is even harder to fit them into macro.
- Some form of heterogeneous agents seems necessary, which makes the model difficult to solve.
- Lots of current research going on in this field.

Next Week

- Next week will be the final class meeting.
- 6 students will give a 15-minute presentation on a paper of their choice.
- If you haven't done so, please let me know which paper you choose.