Lecture XXX: Bank Runs

See Doepke, Lehnert, and Sellgren (1999) Ch. 17.4

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Introduction

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- There is no financial system...the closest we get is something like:
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- But there will be a big problem...what?
- Because of how banks are structured, they'll be vulnerable to **bank runs**

Diamond and Dybvig

- Diamond and Dybvig:

  > *Bank runs are a common feature of the extreme crises that have played a prominent role in monetary history. During a bank run, depositors rush to withdraw their deposits because they expect the bank to fail. In fact, the sudden withdrawals can force the bank to liquidate many of its assets at a loss and to fail. In a panic with many bank failures, there is a disruption of the monetary system and a reduction in production.*

- The point: there are multiple equilibria. If everyone thinks the bank will fail, it fails. If people don't think it is fine, it will be.

- We'll tell a highly stylized story about turnips now.

Key To Bank Runs and Financial Crises???

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A whole new world

1. Our world starts off with a turnip technology: everything is turnips
2. Everyone starts off in period 0 with a turnip
3. They can all plant it (or give it to the bank to plant)
4. At the beginning of period 1, some proportion of the population θ finds out they'll die at the end of the period
5. Everyone can uproot their turnip and get 1 turnip back
6. At the beginning of period 2, all the turnips that are left grow to be $F > 1$ turnips
7. If you're still alive, you can eat your turnip

Preferences

- In this world everyone is perfectly patient (if alive). Let:
  - c_1 be consumption in period 1
  - c_2 be consumption in period 2
  - Θ be your "type"
    - $\Theta = 1$ if you die in period 1
    - $\Theta = 2$ if you die in period 2

$$U(c_1, c_2, \Theta) = \left\{ \begin{array}{ll} \log(c_1) & \text{if } \Theta = 1 \\ Q\log(c_1 + c_2) & \text{if } \Theta = 2 \end{array} \right\}$$

  Where $1 > Q > F^{-1}$, which will control how important it is to consume if you're the second type.
- The point of these preferences is just to say:
  - "People are have diminishing returns to consumption/are risk averse"
  - "The second type is willing to wait if it gains her anything"

On your own

- Imagine you're on your own in this world: what do you do?
  1. Plant turnip in period 0
  2. Enter period 1, find out type
  3. If type 1 (die in period 1) then dig up turnip, eat 1 turnip, get $\log(1)$
  4. If type 2 (die in period 2) then wait until period 2, dig up turnip, eat $F > 1$ turnips, get $\log(F)$
- To put meat and bones on this, I'm going to say that $F = 1.1$, and $\theta = 0.5$, $1 > Q > F^{-1}$ is, 0.98:
- Then with probability θ you get utility $\log(1) = 0$ and with probability $(1 - \theta)$ you get utility $\log(1.1) = 0.095$.
- On your own, you get expected utility:

  $\theta \cdot \log(1) + (1 - \theta) \cdot \log(1.1) = 0.5 \cdot 0 + 0.980.5 \cdot 0.095 = 0.046702$

Join together

- Question: can banks improve on this? Can we gain by joining together?
- Yes! This is what insurance markets are for!
- We could all pay a premium (give up our turnips) in period zero
- If we find out we're type 1, insurance company digs up our turnip and a little of someone else's, pays us some amount greater than 1
- If we find out we're type 2, insurance company will have some turnips left over, pays us some amount less than F and greater than 1
- We can all be better off by using insurance to smooth our consumption across states of the world

Budget constraint of the insurance company

- The insurance company will pay out c_1^1 to all individuals of type 1 and c_2^2 to all individuals of type 2
- Their budget constraint is, normalizing the population to 1,

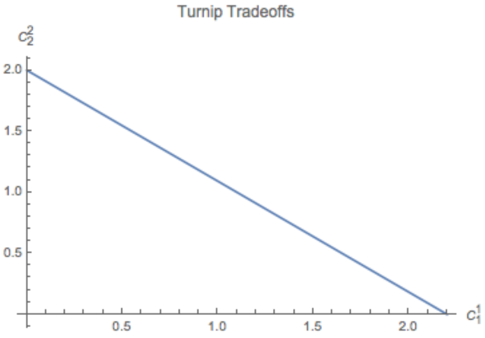
$$\theta c_1^1 + \frac{(1-\theta)c_2^2}{F} = 1$$

- This is saying that I have 1 turnip: if I increase c_1^1 a little, I lose that whole amount (times the population weight). If I increase c_2^2, I only have to leave $\frac{1}{F}$ turnips in the ground (times their population weight) in order to pay them.
- If we wanted to graph to make the tradeoff clear, writing c_1^1 as a function of c_2^2, we get:

$$c_1^1 = \frac{1}{\theta}\left(1 - \frac{(1-\theta)c_2^2}{F}\right)$$

- Let's graph this, with $F = 1.1$ and $\theta = 0.5$

Budget constraint example



- If you uproot the whole turnip and give it all to the half of the population that's type 1 in period 1, then they get 2 turnips each.
- If you uproot the whole 1.1 turnip and give it all to the half of the population that's type 2 in period 2, then they get 2.2 turnips each.
- Or you could do something in the middle

Competition

- If you don't do something that makes people as happy as possible, then another company will
- Competition forces you to make the best decision for your population
- Let's write down the utility maximization problem

Insurance utility maximization

$$\mathcal{L}(c_1^1, c_2^2, \lambda) = \theta \log(c_1^1) + (1-\theta) Q \log(c_2^2) + \lambda \left(1 - \theta c_1^1 - \frac{(1-\theta) c_2^2}{F}\right)$$

- Taking first order conditions, we get:

$$\begin{aligned}
\frac{\partial \mathcal{L}}{\partial c_1^1} : \quad & \frac{\theta}{c_1^1} - \lambda\theta &= 0 \\
\frac{\partial \mathcal{L}}{\partial c_2^2} : \quad & Q\frac{1-\theta}{c_2^2} - \lambda\frac{1-\theta}{F} &= 0 \\
\frac{\partial \mathcal{L}}{\partial \lambda} : \quad & \theta c_1^1 + \frac{(1-\theta)c_2^2}{F} &= 1
\end{aligned}$$

- It's easy to solve these three equations for our three unknowns, c_1^1, c_2^2, and λ

Insurance utility solution

- Solving for c_1^1, c_2^2, and λ, we get:

$$c_1^1 = \frac{1}{\theta + Q(1-\theta)} \qquad c_2^2 = \frac{QF}{\theta + Q(1-\theta)}$$

- Assuming that $1 > Q > F^{-1}$ is, say, 0.98:

$$c_1^1 = \frac{1}{0.5 + 0.98(1-0.5)} = 1.\overline{01}$$

$$c_2^2 = \frac{0.98 \cdot 1.1}{\theta + 0.98(1-\theta)} = 1.0\overline{888}$$

- Are people really better off?? They lose 0.011111 units if they're type 2 but only gain 0.010101 if they're type 1!
- Recall we have to beat expected utility of 0.046702...let's see the expected utility

$$E_0(U(c_1^1, c_2^2, \Theta)) = 0.5\log(1.\overline{01}) + 0.5\log(1.0\overline{8}) = 0.046752$$

- We did it! Improved utility slightly.

Insurance problem: summary

- We have a problem in which people can invest and earn interest
- But sometimes some people want their money now
- Think of mortgages like planted turnips
- Banks will allow people to withdraw whenever
- People can benefit by participating in this "insurance" system, where we're insuring your liquidity needs
- Now we'll reframe this as a bank problem, but with one difference (what?)
  - People can withdraw at any time! (No proof of type)

Bank problem

- Banks have the same problem as insurance companies, with a small twist:

  1. They'll make promises in period 0 about how much you can receive if you withdraw in period 1 or period 2

  2. They then have to keep those promises no matter how many people actually do withdraw in period 1

- The point:

  - If too many people withdrew in period 1, then there would be nothing left in period 2!

  - If I fear too many people are going to withdraw in period 1, then I'll withdraw in period 1 even if I'm of type 2

- Bank run!

Bank problem

- Banks face the same basic problem: choose an interest rate r_1 for type 1 and then whoever withdraws in period 2 gets the rest:

$$c_1^1 = 1 + r_1$$

$$c_2^2 = F\frac{1-\theta(1+r_1)}{1-\theta}$$

- If for some reason θ, the proportion that withdraw in period 1, is very high, then c_2^2 goes down.
- If c_2^2 ever slips below c_1^1, then all the type 2's should run on the bank.
- How should a bank choose r_1?
- Maximize utility

Bank maximization problem

- Banks must maximize consumer expected utility, plugging in for c_2^2:

$$\theta \log(1 + r_1) + (1 - \theta) Q \log \left(F \frac{1 - \theta(1 + r)}{1 - \theta} \right)$$

- You can notice that this is the exact same problem as the insurance company faced, with $1 + r_1 = c_1$ and the budget constraint plugged in:
- Consequently, it has the same maximization solutions:

$$1 + r_1 = \frac{1}{\theta + Q(1 - \theta)}$$

- The bank chose the interest rate so everything is exactly the same as the insurance problem.
- If all goes according to plan, type 1 will get $1.0\overline{1}$ and type 2 will get $1.0\overline{8}$
- Type 2's won't want to run on the bank if nobody else is

Bank runs

- What if for some reason I fear that too many people are withdrawing?
- Bank pays them out and I get the residual. I should get $1.0\overline{8}$ if 50% of population withdraws
- What if 80% withdraws? Then I only get

$$c_2^2 = F\frac{1-\theta(1+r)}{1-\theta} = 1.1\frac{1-0.6\cdot 1.0\overline{1}}{1-0.6} = 1.05$$

- Then I don't want to run
- What if 89% withdraws? Then I get:

$$c_2^2 = F\frac{1-\theta(1+r)}{1-\theta} = 1.1\frac{1-0.89\cdot 1.0\overline{1}}{1-0.89} = 1.001$$

- If I fear that 89% of the population should withdraw, then I'll withdraw too!
- That means that (say) 90% of the population is withdrawing, the heat is turned up for others who aren't withdrawing
- Self-fulfilling Bank run!

Bank runs: the story

- If everyone is doing what they're supposed to, then there's no problem, everyone is happier and the economy is better than if there were no banks
- But if I *fear* too many people are withdrawing at once, then I should withdraw, creating a self-fulfilling bank run
- This happens because banks make promises that they are able to keep only when people think they're able to keep them
- Pro and con of banks:
  - On the one hand, they improve utility
  - On the other hand, they're vulnerable to bank runs
- Is there a way to avoid bank runs?

Avoiding bank runs

- There are a few possibilities to avoid bank runs:

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  1. Suspension of convertibility
  2. Deposit insurance
  3. Mutual funds
- Let's talk about each in turn

Suspension of convertibility

- What is suspension of convertibility?
- Government comes in and says: "only θ of you will be able to withdraw today."
- Then as a type 2, I know I'm safe: even if all the other type 2's try and succeed at withdrawing (which would be bad for the type 1's) then I will still get my due
- Consequently, none of the type 2's will line up, and everything is wonderful
- This method fails if you don't know θ in advance! It would be a bad day for many of the type 1's if the government declared that only 25% of the population can withdraw!