# Topics in Bank Management: Lecture 8

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# Research Proposal

- You will write a proposal for a research article (6-8 pages).
- This will be due at the end of the semester.
- It will have the following sections:
  - Introduction (defines the main question and explains why it is important);
  - Literature review (what has been done so far and what questions remain unanswered);
  - Methodology (if a theory paper, explain the type of model you will use. If empirical, explain the data sources. In either case, list the potential problems that may be encountered)

# Research Proposal

- The first task is to come up with a *research topic*.
- This may be theoretical or empirical.
- Theory: you would like to explain some real-world situation as the outcome of optimal behavior by agents (may be a game, with asymmetric information, etc).
- Empirical: you would like to test if the data supports a model you've seen presented elsewhere.
- I will send you some collections of papers that may give you some ideas about a research topic.
- Let's aim for settling on a topic within the next two weeks.
- You can email me at any time, and I will give you feedback on the novelty of the idea and where to start looking for the literature review.

# Diamond-Dybvig Model

- There are three time periods: $t = 0, 1, 2$.
- There is 1 good.
- A continuum of consumers who are identical at $t = 0$ are endowed with 1 unit of the good.
- At $t = 1$, the consumers learn what type they are.
  - Type-1 consumers are called "early" consumers, and consume only in $t = 1$, with utility $u(c_1)$
  - Type-2 consumers are called "late" consumers, and consume only in $t = 2$, with utility $u(c_2)$
- Let $\pi_1, \pi_2$ be the probability of being Type-1 or 2. The expected utility at $t = 0$ is

$$U = \pi_1 u(c_1) + \pi_2 u(c_2)$$

# The Model

- At $t = 0$, a consumer can choose to consume his endowment, or save it in two ways:
  - Store it for 1 period. This is equivalent to a riskless asset with a net return of 1.
  - Invest amount $I$ in a long-run technology, which gives a net return of $R > 1$ at $t = 2$, but it can be *liquidated* early, to give a return of $L < 1$ in $t = 1$.
- For example, a long-dated certificate of deposit, or a long-term construction project.

# Optimal Allocation

- First, let's look at the optimal allocation, which maximizes expected utility at $t = 0$.

$$\max_{c_1, c_2, I} \pi_1 u(c_1) + \pi_2 u(c_2) \qquad \text{subject to}$$

$$\pi_1 c_1 = 1 - I, \pi_2 c_2 = RI \Rightarrow \pi_1 c_1 + \pi_2 \frac{c_2}{R} = 1$$

- The first order condition is

$$u'(c_1^*) = Ru'(c_2^*)$$

- The marginal rate of substitution between consumption at $t = 1, 2$ equals the return on the long-run technology.

# Autarky: No Trade Between Agents

- Suppose that trade between agents is not allowed.
- At $t = 0$, each agent chooses the amount to store, and the amount to invest $I$.
- Then at $t = 1$, their type is revealed.
  - Type-1 agents' income will be the amount they stored, plus $LI$ (the liquidation value of what was invested in $t = 0$)

$$c_1 = 1 - I + LI = 1 - I(1 - I)$$

  - Type-2 agents' will continue their storage until $t = 2$. Then, their income will be the amount they stored, plus $RI$ (the long-term return on what was invested in $t = 0$)

$$c_2 = 1 - I + RI = 1 + I(R - 1)$$

# Autarky: No Trade Between Agents

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$$c_2 = 1 - I + RI = 1 + I(R - 1)$$

- At $t = 0$, all investors will maximize expected utility subject to these two constraints.
- Note that $c_1 \leq 1$, with equality if $I = 0$.
- $c_2 \leq R$, with equality if $I = 1$.

# Autarky: No Trade Between Agents

- Note that $c_1 \leq 1$, with equality if $I = 0$.
- $c_2 \leq R$, with equality if $I = 1$. Since both cannot hold, then

$$\pi_1 c_1 + \pi_2 \frac{c_2}{R} < 1$$

- This is inefficient, since some resources are lost due to early liquidation.

# Introduce a Financial Market for Bonds

- Suppose that agents are allowed to trade a riskless bond with other agents.
- We model this by introducing a financial market at $t = 1$: agents can trade 1 unit of the good for 1 riskless bond that has price $p$ (endogenously determined), and returns 1 at $t = 2$.
- We will assume agents are price-takers.
- Since this is after agents' types have been revealed, Type 1 agents will trade with Type 2 agents.
- Both Type 1 and Type 2 agents chose the same amount of $I$, since their type was not yet revealed.

# Introduce a Financial Market for Bonds

- Both Type 1 and Type 2 agents chose the same amount of $I$, since their type was not yet revealed.
- Type 1 agents will sell bonds at $t = 1$. They will repay these bonds at $t = 2$ with the returns of the long-term technology:

$$c_1 = 1 - I + pRI$$

- Type 2 agents will buy bonds at $t = 1$ with the amount they stored, and get extra consumption at $t = 2$:

$$c_2 = \frac{1 - I}{p} + RI = \frac{1}{p}(1 - I + pRI)$$

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# Introduce a Financial Market for Bonds

$$c_1 = 1 - I + pRI$$
$$c_2 = \frac{1-I}{p} + RI = \frac{1}{p}(1 - I + pRI)$$

- Note that $c_1$ and $c_2$ are linear functions of $I$, and $c_2 = \frac{c_1}{p}$.
- The only interior equilibrium occurs when $p = \frac{1}{R}$.
- If $p > \frac{1}{R}$, then $I = 1$ and there is an excess supply of bonds: Type-1 agents will sell bonds, but no one will buy them
- If $p < \frac{1}{R}$, then $I = 0$ and there is excess demand of bonds: Type-2 agents want to buy bonds, but no one will sell them

# Introduce a Financial Market for Bonds

- At equilibrium, $c_1 = 1, c_2 = R, I = \pi_2$.
- This Pareto-dominates the autarky solution since there is no liquidiation, therefore no wasted resources.
- However, the first-order condition $u'(c_1^*) = Ru'(c_2^*)$ is not satisfied.
- Efficiency is acheived when there is *perfect insurance*: the marginal utility is equalized across all possible states of the world (that is, all possible random outcomes).
- In a complete market (i.e. there is a security corresponding to every outcome), risk-averse agents will perfectly insure.
- This market, however, is incomplete, since there is no security corresponding to the outcome of the liquidity shock (Type 1 vs. Type 2).

# Fractional Reserve Banking

- Suppose we know what the optimal allocation $(c_1^*, c_2^*)$ is.
- This allocation can be implemented by a *fractional reserve* system, in which banks invest a fraction of deposits, while offering them withdrawal on demand.
- A deposit contract $(C_1, C_2)$ between depositors and the bank specifies the amounts $C_1, C_2$ which can be withdrawn at $t = 1, 2$.
- Competition between banks leads them to offer the optimal contract $(c_1^*, c_2^*)$.
- Will the banks be able to fulfull their contractual obligations in all circumstances?

# Fractional Reserve Banking

- Consider a late consumer who believes the bank will be able to fulfill its obligations.
- The consumer has the choice to:
  - withdraw $c_2^*$ at $t = 2$ (and leave money in the bank at $t = 1$), or;
  - withdraw $c_1^*$ at $t = 1$ and store it until $t = 2$.
- From the first-order condition of the optimal allocation:

$$Ru'(c_2^*) = u'(c_1^*)$$

- Since $R > 1$ and $u'$ is decreasing, then $c_2^* > c_1^*$.

# Fractional Reserve Banking

- We can formulate this as a game between depositors.
- A late consumer who trusts the bank will always prefer to withdraw at $t = 2$.
- By the law of large numbers, the proportion of withdrawals at $t = 1$ will be $\pi_1$, the fraction of early consumers.
- The bank has to keep exactly $\pi_1 c_1^*$ in liquid reserves on hand, to satisfy early consumers.
- Then, the bank will be solvent with probability 1, and late consumers' beliefs will be consistent.
- This is a Nash equilibrium that implements the optimal allocation.

# Bank Runs

- Now, suppose that each late consumer believes all other late consumers will withdraw at $t = 1$.
- The bank must liquidate its long-term investment, yielding a total of $\pi_1 c_1^* + (1 - \pi_1 c_1^*)L < 1$
- This is less than the total value of liabilities $c_1^*$, so the bank will fail and nothing will be left at $t = 2$.
- The best response for a late consumer is to withdraw at $t = 1$.
- This is a second Nash equilibrium in which all depositors withdraw at $t = 1$ and the bank is liquidated.
- This is called an *inefficient* bank run.

# Narrow Banking

- One natural response to the instability of the banking system is for regulators to *require* that banks be able to fulfill their obligations, under *any possible circumstance*.
- This idea is called *narrow banking*.
- Banks must maintain enough liquidity to guarantee payment to all depositors. But there are multiple interpretations of what this means. For example:
  - Banks must be able to withstand a run without liquidating any holdings;
  - Banks may liquidate its long-run technology to face a bank run;
  - Banks may securitize its long-run technology to face a bank run.

# 100% Reserve Banking

- In the first interpretation of narrow banking, the bank must have a reserve ratio of 100 %.
- That is, it must have enough cash on hand to satisfy the possibility that *all* depositors withdraw at the same time.
- If $I$ is the amount invested in the long-term technology, then $1 - I$ must be at least equal to $C_1$, the maximum possible amount of withdrawals at $t = 1$.
- The deposit contract $(C_1, C_2)$ must satisfy $C_1 \leq 1 - I$, $C_2 \leq RI$.
- This option has the least amount invested in the long-term technology, so it results in a lower expected utility for depositors than even the autarkic situation.

- The second interpretation allows the bank to liquidate its long-term technology before facing a bank run.
- The amount $I$ must satisfy $C_1 \leq LI + (1 - I)$.
- The liquidation value $LI$ plus the cash on hand $1 - I$ is enough to cover $C_1$.
- Therefore, at $t = 2$, $C_2 \leq RI + 1 - I$, which is equivalent to the autarkic situation.

- The third interpretation allows securitization of the bank's long-term assets.
- This requires that there be a well-functioning market for the bank's long-term assets.
- Alternatively, the bank may be restricted to only investing in riskless financial securities.
- This is equivalent to the financial market situation, where there is a riskless bond traded in additional to the long-term technology.
- As we have seen, this is still not as efficient as the financial intermediation outcome.

# Regulatory Responses

- In the Diamond-Dybvig model we've been looking at so far, both the efficient outcome (no bank run) and the bank run outcome are Nash equilibria.
- The only thing that causes one outcome or the other is the beliefs of the late consumers.
- If regulation could change their beliefs without incurring too much of a cost elsewhere, this could be an effective regulation strategy to protect against bank runs.

# Suspension of Convertibility

- One possibility is *suspension of convertibility*: the bank, or the government, could simply declare that the bank will limit the number of withdrawals at $t = 1$.
- In the model, if the bank announces it will not allow more than $\pi_1 C_1$ withdrawals at $t = 1$.
- Late consumers will have the belief that the bank can satisfy withdrawals at $t = 2$, and will have no incentive to withdraw early.
- The only equilibrium is the one with no bank run, so in equilibrium, suspension never actually takes place.

# Suspension of Convertibility

- This is sometimes called a "bank holiday".
- Technically, this is a violation of the bank's contractual obligations, so it can also damage the public's trust in the financial system.
- Additionally, if the underlying problem is not solved, then depositors will simply wait until suspension is lifted to start withdrawing again.
- In the United States during the late 19th-early 20th centuries, the banking system suspended convertiblity eight times (Gorton 1985).
- "A curious aspect of suspension is that despite its explicit illegality, neither banks, depositors, nor the courts opposed it at any time."
- This indicates that the bank run was indeed simply a coordination problem.
- There are other possible situations in which the bank run is *efficient*; we will examine this later

# Deposit Insurance

- Suspension of convertibility requires that the fraction of early consumers be known ahead of time.
- If $\pi_1$ is random, then bank runs may still occur, since it is uncertain if there will be enough cash to satisfy all withdrawals
- To prevent bank runs completely, convertibility must be suspended as soon as the *smallest* realization of $\pi_1$ is observed
- However, if the realization of $\pi_1$ is larger than the smallest amount, some early consumers will be unable to withdraw
- An alternative solution to prevent bank runs is *deposit insurance*.
- A third party, perhaps the government, promises to repay the depositors in case of a bank run.
- The government can fund insurance with a tax based on the realization of $\pi_1$.

# Deposit Insurance

- Deposit insurance can lead to problems of moral hazard.
- Given deposit insurance, depositors have no incentive to monitor their bank.
- This gives an incentive for excessive risk-taking at the bank.
- Note that in the Diamond-Dybvig model, the bank itself is not an agent with a utility function; it is simply interpreted as a contract.
- Later on we'll see models of the bank itself as a self-interested agent.

- Homework #2 is due next week.
- Please start thinking about a topic for a research article.