Topic 8 : Bank Run, Systemic Risk and Deposit Insurance

Diamond(2007), Bank and Liquidity Creation: A Simple Exposition of the Diamond-Dybvig Model, Federal Reserve Bank of Richmond Economic Quarterly

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Outline

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Introduction

- Fractional reserve banking is a system in which banks retain only a portion of deposits as cahs reserve.
- Banks make loans that cannot be sold quickly at a high price.
- Bank issue demand deposit that allow depositors to withdraw at any time.
- Banks engage in maturity mismatch (or liquidity mismatch).
- In normal time, fractional reserve banking usually works properly.
- Banks can predict quite correctly the amount of withdrawals due to large scale of borrowing. (The bank can use statistical data to predict the amount of withdrawals. Banks obtain deposits from many depositors. The pattern of withdrawal becomes quite predictable.)
- Demand for cash of each depositors is unlikely to be perfectly correlated or coordinated. Most of the time it is likely to be inversely correlated. Interbank market provide liquidity to the banks.

- This mismatch of liquidity will cause problems for a bank when too many depositors attempt to withdraw at once.
- The situation is referred to as “a bank run”.
- A bank run happens in an unusual situation. Depositors want to withdraw large amount of money not because they need to spend but because they are panicking.
- Liquidity problem $\rightarrow$ Bankrupcy, Financial crises.
- Negative spillovers effect $\rightarrow$ Many banks suffer runs at the same time.
- “Systemic risk” is the risk of collapse of an entire financial system.
- To find the way to prevent “a bank run”, financial crises, we have to make understand why banks are subject to runs.

- Diamond and Dybvig (1983) develop a model to explain why banks are subject to runs.
- The model has been widely used. There are many interesting contribution that builds on Diamond and Dybvig (1983).
- This topic focuses on narrative and numerical examples given by Diamond(2007) to understand the ideas in Diamond and Dybvig(1983).
- Why do we need deposits to be highly liquid? $\Rightarrow$The demand for liquidity
- How do banks create liquidity to meet the demand? $\Rightarrow$Bank liquidity creation
- Why are banks subject to runs? $\Rightarrow$ Bank runs
- How to prevent banks from runs? $\Rightarrow$ Suspension of Convertibility and Deposit insurance

The Demand for Liquidity

Consider an economy where

- There are 3 dates, date 0, date 1 and date 2.
- "Primary investment" costs 1 in date 0, and yields 1 if cashed in date 1 $R > 1$ if cashed at date 2.
- Let $R = 2$.
- Each investor begins with 1 to invest on date 0.
- Investors face an uncertain horizon to hold the asset. Each will need to consume either at date 1 or 2.
- However, as of date 0, an investor does not know at which date he will need to consume. In other words, they are facing with liquidity risk.
- "Type 1" : an investor who needs to consume at 1.
- "Type 2" : an investor who needs to consumer at 2.
- For this example, this means an investor will consume only at 1 if of type 1, and only 2 if of type 2.

- At date 0, an investor does not know which type he will be, but each investor has a probability of π of being type 1 and $1-\pi$ of being type 2.
- Suppose that $\pi = \frac{1}{4}$ and that there are 100 investors in the economy. 25 will be type 1 and 75 will be type 2 but it is not known at date 0 which investors will be of each type.
- Type 1 investors will have utility $U(c_1)$. Type 2 investors will have utility $U(c_2)$.
- c_1 denotes consumption at date 1 and c_2 denotes consumption at date 2.
- The utility function $U(c)$ is the same for both types, but the date on which an investor will consume depends on his type.
- Both types are risk averse.
- Here, suppose $U(c) = 1 - \frac{1}{C}$.

- If there is no bank, all investors have just only one choice, to invest in "Primary Investment".
  - Type 1 will liquidate his investment at date .... . and get ....
  - Type 2 will liquidate his investment at .... and get ....
  - Type 1 will consume $c_1 =$ ....
  - Type 2 will consume $c_2 =$ ....
  - At date 0, an investor does not know his type. He expects to consume ...... if he is type 1 (with probability π) and expects to consume ...... if he is type 2 (with probability $(1-\pi)$).
  - The investor's expected utility is given by

$$
\begin{aligned}
\ldots\ldots U(\ldots\ldots) + \ldots\ldots\ldots\ldots U(\ldots\ldots\ldots) &= \ldots\ldots U(\ldots\ldots) + \ldots\ldots\ldots\ldots U(\ldots\ldots\ldots) \\
&= \\
&= 0.375
\end{aligned}
$$

- "Primary investment", with 1 unit invested at date 0, it will worth $R = 2$ at date 2, but only 1 at date 1.
- Suppose that there is another asset (so-called "Deposit") The deposit contract in which 1 unit invested at $T = 0$, it will worth $d_2 = 1.813$ at date 2, but only $d_1 = 1.28$ at date 1.
- Which one would an investor prefer?
- The expected utility from holding the "Deposits" is

$$.....U(....) + ...U(......) = 0.391 > 0.375.$$

- Therefore, an invester prefer .... ("Deposits", "Primary investment")

- Liquid asset offers a small loss when liquidated early.
- Illiquid asset is the one in which the procceds available from physical liquidation or a sale on some date are less than its payoff on some futre date.
- $\frac{\text{payoff on date 1}}{\text{payoff on date 2}}$ is used to measure the level of liquidity of an asset.
- Given that payoff on date 1 always less than payoff on date 2. The ratio is always .... one. The lower the ratio is, the .... liquid is the asset.
- “Deposits” : 1.28 at date 1 and 1.813 at date 2.
- “Primary Investment” : 1 at date 1 and 2 at date 2.
- Hence, “Deposits” is .... liquid than “Primary investment”.
- An investor prefer the .... liquid asset.

- "Deposits" offers 1.28 with 0.25 probabilty and 1.813 with 0.75 probability. "Primary asset" offers 1 with 0.25 probability and 2 with 0.75 probability.
- Expected return on "Primary Asset" is equal to $0.25 \times .... + 0.75 \times .... = 1.75$.
- Expected return on "Deposits" is equal to $0.25 \times .... + 0.75 \times .... = 1.68 < 1.75$.
- If the investor were risk-neutral, he would prefer ".............".
- Investors are risk-averse. It is possible that they are willing to give up some expected return to get more liquid asset (to reduce their liquidity risk).

Bank Liquidity Creation

- Suppose initially there is only "Primary investment" available in the economy. If 1 unit invested at date 0, it will worth $R = 2$ at date 2, but only 1 at date 1.
- A bank can provide the more liquid asset ("Deposits") by offering demand deposits.
- Assume that there is only one bank without equity (for simplicity).
- At date 0, the bank receives $1 from each of the 100 investors. Then, the bank invests all they have got in "Primary investment" at date 0.
- Suppose in return for a deposit of 1 at date 0, the bank offers to pay $d_1 = 1.28$ to those who withdraw at date 1 or to repay $d_2 = 1.813$ to those withdraw at date 2.
- d_1 can be thought of as the return on short-term deposits and d_2 can be thought of as the return on long-term deposit.

- At date 1, the bank's entire portfolio is worth \$.............
- Suppose 25 depositors withdraw 1.28 each, then .... of "Primary Investment" must be liquidated.
- .... of "Primary Investment" will remain until date 2, when they worth ...... each at date 2.
- On date 2, there remain .... depositors, each will receive

$$\frac{\text{the value of the bank's entire portfolio at date 2}}{\text{the number of depositors remains at date 2}} =$$

$$= \quad 1.813$$

- Therefore, a bank can provide the more liquid asset ("Deposits"), which has a smaller loss from early liquidation than is available from holding the illiquid asset (Primary Investment) directly.
- At date 0, depositors now can get 1.28 with probability 0.25 and 1.813 with probability 0.75 if they deposit their funds at the bank.
- Depositors prefer bank "Deposits" to "Primary investment".
- It is an equilibrium for 25 depositors to withdraw at date 1, because if all depositors expect 25 to withdraw at date 1, only type 1 depositors will withdraw because the 75 type 2 depositors prefer 1.813 available at date 2 to the 1.28 available at date 1.
- It can be mathematically proved that this "Deposits" is optimal. It maximises the utility of all depositors. (See the Note on the optimal level of liquidity at the end of this lecture presentation for the proof, if you are interested. Questions are welcome.) The proof is not essential for the exam..

- Banks can create liquidity by offering deposits that are more liquid than their assets.
- If only the propoer depositors withdraw, it works out very well.
- However, creating this liquidy subjects the bank to bank runs.
- Recall: It is an equilibrium for 25 depositors to withdraw at date 1, because if all depositors expect 25 to withdraw at date 1, only type 1 depositors will withdraw because the 75 type 2 depositors prefer 1.813 available at date 2 to the 1.28 available at date 1.
- The equilibrium for 25 depositors to withdraw at date 1 will occur when all depositors expects that “the others” will choose the option that is the best for them.
- There are multiple equilibria.
- There is more than one “self-fulfilling” prophecy about who withdraws at date 1.

- There are 100 depositors. $d_1 = 1.28$ and $d_2 = 1.81$. Consider these following three cases.

1. Suppose that all depositors forecast that everybody else will withdraw at date 1.

- Each depositor forecasts that 99 depositors will withdraw at date 1.
- At date 1, the bank's entire portfolio is worth $.............
- 99 depositors withdraw .... each, then .... of "Primary Investment" must be liquidated.
- The bank will fail at date 1 because it does not have enough asset to repay its liability.
- Then, everybody will withdraw at date 1.

2. Suppose that all depositors forecast that 79 will withdraw at date 1.
   - 79 depositors withdraw .... each, then .... of “Primary Investment” must be liquidated.
   - The bank will fail at date 1 because it does not have enough asset to repay its liability.
   - Then, everybody will withdraw at date 1.

3. Suppose that all depositors forecast that 27 depositors will withdraw at date 1.

- Each depositor forecasts that 27 depositors will withdraw at date 1.
- At date 1, the bank's entire portfolio is worth $.............
- 99 depositors withdraw .... each, then .... of "Primary Investment" must be liquidated.
- The bank will not fail at date 1.
- .... of "Primary Investment" will remain until date 2, when they worth ...... each at date 2.
- On date 2, there remain .... depositors, each will receive

$$\frac{\text{the value of the bank's entire portfolio at date 2}}{\text{the number of depositors remains at date 2}} =$$

$$= \quad 1.75$$

- Type 2 investors will withdraw at date 2. There are no bank runs.

- “Bank runs are a common feature of the extreme crises that have played a prominet role in monetary history. During a bank run, depositos rush to withdraw their deposits because they expect the bank to fail. In fact, the sudden withdrawals can force bank to liquidate many of its asets at a loss and to fail. In a panic many bank failures, there is a disruption of monetay system and a reduction in production.”
- Bank runs disrupt production because they force banks to call in loans early.

- There are many “good” equilibria where there are no bank runs. (for example, all depositors forecast that 25, 27 depositors will withdraw at date 1.)
- There are many “bad” equilibria where there are bank runs. (for example, all depositors forecast that 99, 79 depositors will withdraw at date 1.
- Moving away from a good equilibrium requires a large change in belief.
- For example, a newspaper story that the bank is performing poorly could cause a run even if many knew that it was inaccurate, because those who know it is inaccurate can believe that the other will decide to withdraw based on the story.

Wallstreet Journal

“Greek depositors withdrew €700 million ($898 million) from the country’s banks on Monday, fueling fears of a bank run amid the growing political disarray.”

http://www.ft.com/intl/cms/s/0/4a46285e-9ddb-11e1-9456-00144feabdc0.html#axzz2CC6QSXs2 (Financial Times, May 2012)

“One crucial uncertainty hanging over a Greek exit is whether it would lead to a deposit flight, with customers and companies rushing to withdraw money from banks in other eurozone countries.”

CNN (May 2012) Greeks set election date amid possibility of bank panic

"If Greece exits the euro it won’t be alone. Others will exit," said Paul Donovan, a global economist with UBS bank. "There would be bank runs across multiple countries," he predicted.

Suspension of Convertibility

- Bank suspends withdrawals of deposits.
- In this simple model, a bank can suspend convertibility of deposits to cash in order to stop arun.
- The bank does not allow more than 25 depositors to withdraw.
- Then, no matter how many depositors attempt to withdraw at date 1, a type 2 depositor will get $d_2 = 1.81$ at date 2.
- As a result, the depositors would never panic and a run would never start.
- In the days before deposit insurance, banks regularly suspended convertibility to stop runs.
- Many people are worse-off when suspension of convertibility actually occurs. They actually need to withdraw the money to pay their bills.
- Each depositor's type is his own private information.
- Suspension of convertibility is costly.

Deposit Insurance

- An alternative way to stop and prevent bank runs is deposit insurance.
- Deposit insurance can be defined as a promise to pay the amount promised by the bank no matter how many depositors withdraw.
- In the example, this is a promise of 1.28 to those who withdraw at date 1 and 1.81 to those who withdraw at date 2.
- How can this accomplished if everyone withdraws?
- The only way is to take some resources from those who run and wthdraw.

- The government can collect taxes, which is an ability to take resources.
- A survey by the World Bank states that “Almost all countries actually have financial safety nets in place which include explicit and implicit deposit insurance..”
- Deposit insurance may induce moral hazard problems. Banks undertake excessive risk. Depositors are still willing to deposit their money into risky banks.

Note on the optimal level of liquidity

- This note on the optimal level of liquidity is excluded from the final exam.
- What is the optimal level of d_1 and d_2 that will maximise the ex ante expected utility of each investor at date 0?
- $c_1 = d_1$ and $c_2 = d_2$

$$\underset{d_1, d_2}{\text{Max}} \quad \pi U(d_1) + (1-\pi) U(d_2)$$

subject to $d_2 \leq \dfrac{(1-\pi d_1)\,R}{1-\pi}$

- The optimal values satisfy

$$\begin{aligned} \pi U'(d_1) + (1-\pi) U'(d_2) \frac{(-\pi d_1) R}{1-\pi} &= 0 \\ \frac{U'(d_1)}{U'(d_2)} &= R \end{aligned}$$

- $U(c) = 1 - \frac{1}{C}$. $U'(C) = \frac{1}{C^2}$. $R = 2$.
- Then $\left(\frac{d_2}{d_1}\right)^2 = 2$, $\frac{d_2}{d_1} = \sqrt{R}$.
- $\frac{d_2}{d_1} \approx 1.4142$. (1)
- $d_2 = \frac{(1 - 0.25d_1)}{0.75}$. $0.75d_2 = (1 - 0.25d_1)$. (2)

- Substitute (1) into (2) and get

$$\begin{aligned} \frac{0.75}{1.4142} d_1 &= 1 - 0.25 d_1 \\ d_1 &= \frac{1}{0.78034} \approx 1.28 \end{aligned}$$

- Substitute $d_1 = 1.28$ into (1). $d_2 = 1.4142 \times 1.28 \approx 1.81$.