

Lecture 21: Finance Part III

Financial Intermediation

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Advanced Monetary Economics 2018

Roadmap

- 1 Introduction
- 2 Model Environment
- 3 Social Planner's Problem
- 4 Implementing the Optimal Contract with Intermediation
- 5 Conclusion

Motivation

- A financial intermediary is an institution that brings lenders and borrowers together to facilitate financial transactions.
- Banks are the most obvious examples.
- We'll typically think of banks as taking liquid deposits (from households) and then making out illiquid loans (to businesses or other households).
- This **maturity mismatch** can create problems...

Bank Runs



Bank Runs



Nottingham University

- Me to a friend back in Australia: *no banks in Nottingham would take me since I don't have proof of address. But I found a dodgy one on campus that would accept a lower standard of proof called Santander.*
- Friend to me: *nice, you'd better be careful though man, they might go under.*

Bank Runs

- Diamond-Dybvig (1983), “Bank Runs, Deposit Insurance and Liquidity”, *Journal of Political Economy*.



Intuition

- The paper utilises a simple game-theoretic model where banks balance a tensions between efficient risk sharing and the possibility of runs.
- Depositors may get a bad shock (e.g. lose their job), which would require them to withdraw their funds from the bank.
- There end up being two equilibria: one where there is efficient risk sharing and everything is happy.
- Another where depositors all panic and run to withdraw their deposits.

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Setup: Depositors

- Three time periods $t \in \{0, 1, 2\}$.
- Unit mass of ex-ante identical depositors and a single bank.
- Each depositor has endowment of 1 to invest at $t = 0$.
- Idiosyncratic shocks drawn by the depositors at $t = 1$.
 - Fraction s are **impatient** and want to consume at $t = 1$.
 - Fraction $1 - s$ are **patient** and can consume either at $t = 1$ or $t = 2$.
 - An individual's type is private information but the fraction s is known publicly.
- Assume CRRA preferences $c^{1-\sigma}/(1 - \sigma)$ with $\sigma \geq 1$.

Setup: Asset

- The bank takes the depositor's funds and invests them into an **illiquid** asset.
- Denote the returns from liquidating this asset at time $t \in \{1, 2\}$ by r_t .
- If you liquidate that asset at $t = 1$, you get no return, (i.e. $r_1 = 1$).
- If you liquidate at $t = 2$ you get a positive return, (i.e. $r_2 = R > 1$).
- The issue will be that some depositors will want to withdraw their funds at $t = 1$, (impatient types), before the asset has generated a positive return.

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Optimal Contract

- If a social planner could offer an optimal insurance contract, what would it look like?
- I.e. how much should impatient and patient depositors get to consume, (c_1 and c_2 respectively).
- Same as usual: maximise welfare subject to a resource constraint.
- Also need an **incentive compatibility** constraint since this is now a contracting problem with information asymmetry.

Optimal Contract

- Solve the problem

$$\max_{c_1, c_2} s \left\{ \frac{c_1^{1-\sigma}}{1-\sigma} \right\} + (1-s) \left\{ \beta \frac{c_2^{1-\sigma}}{1-\sigma} \right\}$$

subject to

$$s c_1 + (1-s) \frac{c_t}{R} \leq 1$$
$$\frac{c_1^{1-\sigma}}{1-\sigma} \leq \beta \frac{c_2^{1-\sigma}}{1-\sigma}$$

where the first constraint is the **resource** constraint and the second is the **incentive compatibility** constraint.

Constraints

- Recall the two constraints were given by

$$sc_1 + (1 - s) \frac{c_t}{R} \leq 1$$
$$\frac{c_1^{1-\sigma}}{1-\sigma} \leq \beta \frac{c_2^{1-\sigma}}{1-\sigma}$$

- Resource constraint says we divide-up the unit endowment between the early withdrawals and the (discounted) late withdrawals.
- Incentive compatibility constraint says that the patient households are better off waiting until $t = 2$ to consume than to consume at $t = 1$.

Optimal Contract

- Lagrangian given by

$$\begin{aligned} \mathcal{L} = & s \left\{ \frac{c_1^{1-\sigma}}{1-\sigma} \right\} + (1-s) \left\{ \beta \frac{c_2^{1-\sigma}}{1-\sigma} \right\} + \lambda_1 \left[1 - sc_1 - (1-s) \frac{c_2}{R} \right] + \\ & + \lambda_2 \left[\beta \frac{c_2^{1-\sigma}}{1-\sigma} - \frac{c_1^{1-\sigma}}{1-\sigma} \right] \end{aligned}$$

Optimal Contract

- FOCs given by

$$\frac{\partial \mathcal{L}}{\partial c_1} = 0 \Rightarrow s c_1^{-\sigma} - \lambda_1 s - \lambda_2 c_1^{-\sigma} = 0$$

$$\frac{\partial \mathcal{L}}{\partial c_2} = 0 \Rightarrow (1-s)\beta c_2^{-\sigma} - \lambda_1(1-s)\frac{1}{R} + \lambda_2\beta c_2^{-\sigma} = 0$$

Optimal Contract

- Guess and verify that the incentive compatibility constraint is slack.
- That is: $\lambda_2 = 0 \Rightarrow \frac{c_1^{1-\sigma}}{1-\sigma} < \beta \frac{c_2^{1-\sigma}}{1-\sigma}$.
- Follow-through with the implications of this to get restrictions or a contradiction. The c_1 FOC says

$$\begin{aligned}\Rightarrow s c_1^{-\sigma} - \lambda_1 s &= 0 \\ \Rightarrow \lambda_1 &= c_1^{-\sigma}\end{aligned}$$

which can be substituted-into the c_2 FOC to get

$$\begin{aligned}\Rightarrow \beta c_2^{-\sigma} - [c_1^{-\sigma}] \frac{1}{R} &= 0 \\ \Rightarrow c_2 &= c_1 \left(\frac{\beta}{R} \right)^{-\frac{1}{\sigma}}\end{aligned}$$

Optimal Contract

- Assume that $\beta = 1$: so now no discounting.
- Notion of patience and impatience relates purely to this idea of whether they **have** to consume now or not.

$$c_2 = c_1 R^{\frac{1}{\sigma}}$$

where $c_2 > c_1$ given that $\sigma > 1$ (risk averse) and $R > 1$.

Optimal Contract

- Back-out c_1 and c_2 optimal from the resource constraint to get

$$c_1 = \frac{1}{s + (1-s)R^{\frac{1-\sigma}{\sigma}}} \geq 1$$

$$c_2 = \frac{R^{\frac{1}{\sigma}}}{s + (1-s)R^{\frac{1-\sigma}{\sigma}}} \leq R$$

- This is good: insuring against risk.
- The autarky allocation is unit consumption for impatient at $t = 1$ and R consumption at $t = 2$ for patient depositors.
- Insurance: consumption smoothing better facilitated!

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Implementation

- Bank takes deposits (liquid liability) and invests them in asset (illiquid) with payoff R at date $t = 2$.
- Use the following **deposit contract**:
 - Take deposit of 1 at $t = 0$,
 - Pay r_1 to depositors who withdraw early at $t = 1$,
 - Pay r_2 to depositors who withdraw late at $t = 2$.
- Check feasibility:
 - Need sr_1 funds at $t = 1$.
 - The remaining $1 - sr_1$ is divided up amongst patient depositors
$$r_2 = \max\left(0, R \frac{1 - sr_1}{1 - s}\right).$$

Implementation

- Set the early return $r_1 = c_1$ from the social planner's problem.
- From the resource constraint, you'll get that

$$r_2 = R \frac{1 - r_1}{1 - s}$$

meaning that we can implement the optimal contract using deposits!

Implementation

- This is only **one Nash equilibrium** of the deposit game.
- Unfortunately there is also a **bank run** Nash equilibrium.
- All types might panic at $t = 1$ and withdraw early.

Bank Runs

- Suppose some fraction η withdraw at $t = 1$.
- Return at $t = 2$ then depends on η .
- $r_2(\eta) = \max \left[0, R \frac{1-\eta r_1}{1-\eta} \right]$.
- Impatient types will always withdraw due to their preferences, so $\eta \geq s$.
- Patient types also find it optimal to withdraw when

$$\begin{aligned} r_2(\eta) &< r_1 \\ \Rightarrow \eta &\geq \frac{1}{r_1} \frac{R - r_1}{R - 1} \end{aligned}$$

where $\eta < 1 \iff r_1 > 1$.

Bank Runs

- Since $r_1 > 1$, it follows that there are two Nash equilibria!
 - (i) Regular times: $\eta = s$ and $r_2(s) = c_2$ in the optimal contract.
 - (ii) Bank run: $\eta = 1$ and $r_2(1) = 0$.

Suspension of Convertibility

- If the bank can commit to stop letting-out withdrawals at $t = 1$, then there is no issue.
- Hard to be credible though...
- Deposit insurance by the government can achieve this!

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Takeaways

- We can, in principle, implement the optimal risk sharing contract that the social planner chooses using intermediation.
- The maturity mismatch can create problems though.
- We get another Nash equilibrium where a bank run takes place and it goes bust.