The Macroeconomics of Imperfect Capital Markets

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Lecture 3: Incomplete Markets

Review

1. **Fisherian Separation:**
   in perfect capital markets, investment and consumption decisions can be made independently

2. **Bankruptcy:**
   in absence of frictions, bankruptcy risk does not distort investment decisions

Problems of Asymmetric Information in Capital Markets

Credit markets are special:

- "credit" is not a homogenous good
- creditor and borrower deliver their goods at different times
  $\longrightarrow$ creditor needs to rely on promises

$\Rightarrow$ Walrasian economics often not applicable

Importance of credit markets:

- at micro level: poor allocation of credit leads to poor investment projects and squanders resources
- at macro level: changes in credit allocation important source of fluctuations

Important Features of Credit Markets

Features of credit markets:

- Uncertainty and default risk:
  credit markets are a reflection of incomplete risk markets
- Limited liability:
  creditors can seize at most all assets of borrower
- Prime roles of lenders:
  1. screening (classification) of borrowers before lending
  2. monitoring of actions after lending

Note: screening and monitoring is often:

- a sunk cost
- a public good

→ case for natural monopoly in lending
→ case for long-term relationships

Basic Setup of Credit Markets

Simple setup of credit market:

- Borrowers and lenders risk-neutral
- Lenders competitive with cost of funds δ (free entry)
- Investment project of borrower: risky payoff $X \in \left[X^b, X^a\right]$ with $E\left[X\right] = X^e$
- Amount borrowed B
- Interest rate promised r
- Expected repayment R:

$$R = \int_{X^b}^{(1+r)B} X dF\left(X\right) + \left(1+r\right) B \int_{(1+r)B}^{X^a} dF\left(X\right)$$

Theorem

1. *The expected repayment rises as the interest rate rises.*
2. *The expected repayment falls as uncertainty rises.*

Note: once a project is chosen, borrowers & lenders are in a zero sum game

Definitions of Credit Rationing

Focus on two types of credit rationing:

1. **Redlining:** some groups of individuals cannot obtain any credit at the prevailing market interest rate (b/c lender cannot obtain required return), but would obtain credit if the supply of funds was larger
2. **Pure credit rationing:** within an observationally indistinguishable group, some obtain credit, while others cannot obtain credit at any interest rate

Prime reason for rationing: asymmetric information

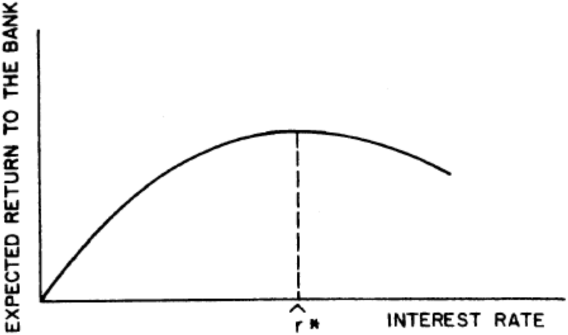
Problems of Asymmetric Information in Capital Markets

1. **Adverse selection:**
   - Rise in financing costs leads to less desirable pool of applicants
   - Involves ex-ante "hidden information"
   - Solution: screening/signaling using:
     - the price system to both equilibrate market and reveal information
     - additional variables (e.g. quantity transacted, type of finance, collateral, covenants, randomizing loan assignment, etc.)
2. **Moral hazard** (also adverse incentive or principal-agent problem):
   - Rise in financing costs changes behavior in an undesirable way
   - Involves a "hidden action," either ex-ante or ex-post
   - Solution: incentive-compatible contracts using:
     - the price system
     - additional variables (as above)

Contrast to neoclassical model:

- Prices ensure market clearing, and have no sorting/incentive effects
- *Market clearing is a very model-specific result!*

Stiglitz-Weiss (1981): Non-Monotonicity



Expected return to lenders: non-monotonic function of interest rate
$\longrightarrow$ creates possibility of credit rationing

Stiglitz-Weiss (1981): Adverse Selection

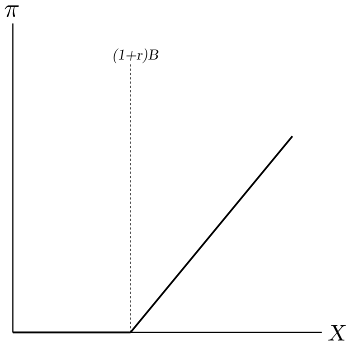
Intuition:

1. Increase in interest rates is more costly for safe borrowers than risky borrowers (who won't pay it when they go bust)
2. Rising interest rates cause safe borrowers to drop out of the market $\rightarrow$ remaining pool of applicants is riskier $=$ adverse selection
3. Effects of higher interest rates on bank profits:
   - direct effect: more interest earnings raise profits
   - indirect (adverse selection) effect: riskier applicant pool reduces profits
4. As interest rates rise, adverse selection effect may predominate $\rightarrow$ non-monotonic relationship between interest rate charged and expected return

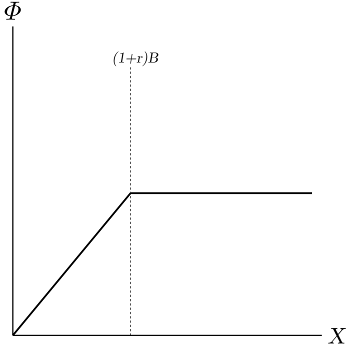
Notation for Adverse Selection Problem

- B ... amount borrowed
- r ... contractual interest rate

Return to borrower:
$\pi = \max\{0, X - (1+r)B\}$



Rate of return to lender:
$\Phi = \min\{X/B; (1+r)\}$



Stiglitz-Weiss (1981): Interest Rate as a Screening Device

Assume riskiness of X is determined by a (variance) parameter θ

Theorem (Cut-off value for borrowing)

For a given interest rate r, there is a critical value $\widehat{\theta}$ such that a firm borrows from the bank if and only if $\theta > \widehat{\theta}$.

Intuition:

- Firm profits are a convex function of X $\longrightarrow$ Jensen's inequality
- The more dispersion in X, the larger expected profits

$$\pi\left(r, \widehat{\theta}\right) = \int_0^\infty \max\left\{X - (1+r)B; 0\right\} dF\left(X, \widehat{\theta}\right) =$$

$$= \int_{(1+r)B}^\infty \left[X - (1+r)B\right] dF\left(X, \widehat{\theta}\right) = 0 \quad \text{for marginal firm}$$

Stiglitz-Weiss (1981): Interest Rate as a Screening Device

Theorem (Response of cut-off value to lending rate)

The threshold $\widehat{\theta}$, below which borrowers drop out of the market, is increasing in r.

Intuition:

- Firm profits are a convex function of X $\rightarrow$ Jensen's inequality
- The more dispersion in X, the larger expected profits
- Implicitly differentiate $\pi\left(r,\widehat{\theta}\right)=0$, which defines $\widehat{\theta}$:

$$\frac{d\widehat{\theta}}{dr}=\frac{B\int_{(1+r)B}^{\infty}dF\left(X,\widehat{\theta}\right)}{\partial\pi/\partial\widehat{\theta}}=\frac{B\cdot\left\{1-F\left[(1+r)\,B,\widehat{\theta}\right]\right\}}{\partial\pi/\partial\widehat{\theta}}>0$$

Stiglitz-Weiss (1981): Interest Rate as a Screening Device

Theorem (Expected return on bank loans)

The expected return on a loan to a bank is a decreasing function of the riskiness of the loan.

Intuition:

- Return to bank is a concave function of $R \longrightarrow$ Jensen's inequality
- More dispersion in R raises bankruptcy risk

Implications:

- higher lending rate increase riskiness
- safe borrowers drop out of the market $\longrightarrow$ negative impact on bank return
- adverse selection effect can outweigh the direct effect of higher interest rates on profits

Stiglitz-Weiss (1981): Interest Rate as a Screening Device

Definition:
$\Phi(r)$ ... expected bank return from all applicants at lending rate r

Theorem (Non-monotonicity of return on bank loans)

If there are a discrete number of types of borrowers, each with a different θ, the expected bank return $\Phi(r)$ will be a non-monotonic function.

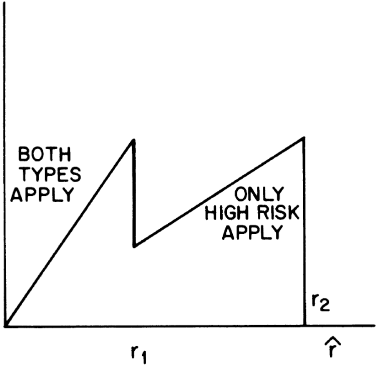
Intuition:

- Each type of borrower drops out of the market at a certain level of θ
- This causes a discrete fall in expected bank return $\Phi(r)$ since only riskier types remain
- The more dispersion in X, the higher probability of bankruptcy

Stiglitz-Weiss (1981): Interest Rate as a Screening Device

Example: Bank return $\Phi(r)$ for two types of borrowers:

- Safer borrowers drop out of the market at interest rate r_1
- Bank's expected return drops discontinuously



Stiglitz-Weiss (1981): Interest Rate as a Screening Device

Theorem (General equilibrium with credit rationing)

Whenever $\Phi(r)$ is non-monotonic, there exist supply functions of funds to banks such that the competitive equilibrium between banks and borrowers entails credit rationing

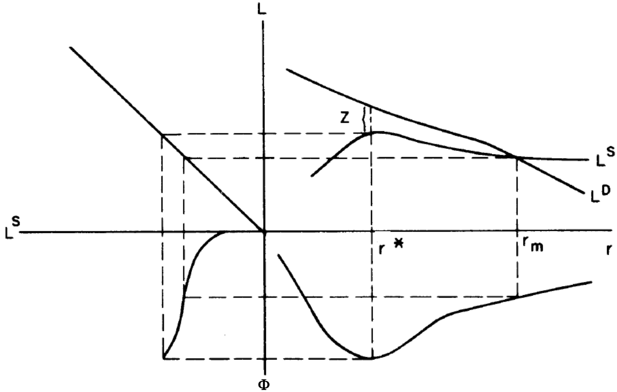
Intuition:

- Demand for funds depends on r
- Supply of funds depends on Φ
- If market-clearing rate r_m is greater than profit-maximizing interest rate r^*, then banks ration credit and offer loans at r^*

Stiglitz-Weiss (1981): Interest Rate as a Screening Device

Example: Market equilibrium with equilibrium credit rationing

- Upper right quadrant: demand and supply of bank loans
- Lower right quadrant: bank profit as function of interest rate charged
- Lower left quadrant: supply of loanable funds to banks



Stiglitz-Weiss (1981): Interest Rate as an Incentive Device

Intuition:

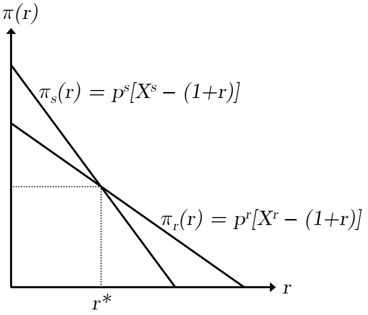
1. Interests of borrowers and lenders are not aligned:
   - borrowers care only about returns when firm not bankrupt (upside of projects)
   - lenders also care about recovery value in bankruptcy (downside of projects)

   $\rightarrow$ principal agent problem
2. Rising interest rates increase bankruptcy and magnify incentive problem
3. Effects of higher interest rates on bank profits:
   - direct effect: more interest earnings raise profits
   - indirect (adverse incentive) effect: riskier projects reduce bank profits
4. As interest rates rise, adverse incentive effect may predominate
   $\rightarrow$ non-monotonic relationship between interest rate charged and expected return

Stiglitz-Weiss (1981): Interest Rate as an Incentive Device

Example:

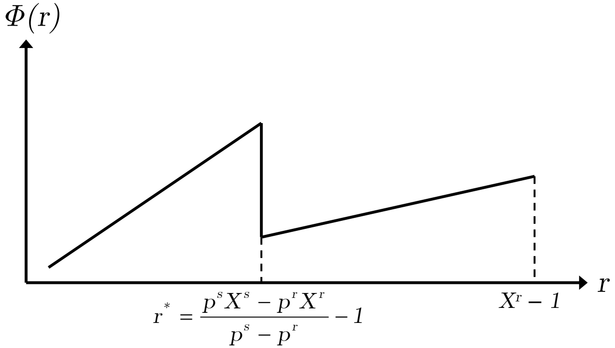
- Assume firms have two projects, "risky" and "safe," with returns $X^r > X^s$ and probabilities of success $p^r < p^s$
- The required investment is 1 and is entirely financed by borrowing
- At interest rate r^* firms are indifferent between the two projects: $p^r \left[X^r - (1 + r^*)\right] = p^s \left[X^s - (1 + r^*)\right]$



Stiglitz-Weiss (1981): Interest Rate as an Incentive Device

Example (ctd.):

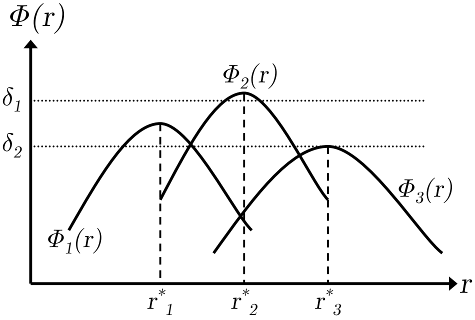
- Bank returns falls as r is increased above r^*



- Interior interest rate r^* is optimal whenever $p^s r^* > p^r X^r$

Stiglitz-Weiss (1981): Red-Lining

Credit rationing with different types of borrowers i, j:
Assume each group is observationally distinguishable and yields a maximum expected return $\Phi_i\left(r_i^*\right)$ to the bank:



1. Low $\Phi_i\left(r_i^*\right)$ types only receive credit if high $\Phi_i\left(r_i^*\right)$ types do
2. All types obtain credit at interest rates such that their expected returns are identical, i.e. $\Phi_i\left(r_i^*\right) = \Phi_j\left(r_j^*\right)$

Criticism of Stiglitz-Weiss (1981)

Criticisms:

1. Availability of multiple screening instruments, e.g. collateral
2. Optimal contract view: is debt finance optimal?

Availability of Multiple Screening Instruments

Bester (1985):

- In Stiglitz-Weiss (1981), screening via interest rate
- Bester (1985): credit rationing can be eliminated if a menu of (r_i, C_i) including collateral is offered

Intuition:

- Credit rationing equilibrium always is a pooling equilibrium of good and bad risks
- With 2 instruments, separating equilibrium can be obtained (raising C is less costly for good risks than bad risks)
- High risk borrowers choose contract with high r and low C
- Other possible screening instrument: randomization

Availability of Multiple Screening Instruments

General Setup:

- Assume set I of types with weight μ_i
- Lenders offer contracts $\gamma_i = (r_i, C_i, \sigma_i, ...)$ $\forall$ $i \in I$ where $r_i, C_i, \sigma_i, ...$ are different screening instruments
- Firm i's individual rationality constraint: $\pi_i(\gamma_i) \geq 0$
- Firm i's incentive compatibility constraint: $\pi_i(\gamma_i) \geq \pi_i(\gamma_j)$ $\forall$ $i, j \in I$
- Bank's problem: $\max_{\{\gamma_i\}_{i \in I}} \sum_i \mu_i \Phi(\gamma_i)$

The Price Mechanism and Screening

- Price mechanism = one particular screening mechanism:
  It finds out who has the highest marginal valuation of a contract
  → leads to most efficient allocation of resources
- Standard (neoclassical) market setup:
  - 1 dimension of heterogeneity: valuation
  - 1 instrument: price
- As a result, market "clears," i.e. asymmetric information problem "solved:"
  - all types of borrowers can be distinguished (screened)
  - separating equilibrium is obtained
  - market equilibrium is constrained efficient
- In real world: separating equilibrium across all dimensions of heterogeneity unlikely:
  - lender never has perfect information about all characteristics of borrower
  - lender can never perfectly monitor all actions of borrower

→ therefore some pooling is likely to always occur

Mathematical Appendix

Theorem (Leibniz rule)

$$\frac{d}{dx}\left[\int_{a(x)}^{b(x)} f(x,z)\,dz\right] = \frac{d}{dx}\left[F(x,b(x)) - F(x,a(x))\right] =$$

$$= \quad \int_{a(x)}^{b(x)} f_x(x,z)\,dz + f(x,b(x))\,b'(x) - f(x,a(x))\,a'(x)$$